REPUBLIC OF TÜRKİYE
MINISTRY OF INDUSTRY
AND TECHNOLOGY

İZMİR
DEVELOPMENT
AGENCY

# ANALYSIS ON THE DEVELOPMENT OF FOREIGN TRADE IN TÜRKİYE AND IN İZMİR

2021

**ANALYSIS ON THE DEVELOPMENT OF FOREIGN TRADE IN TÜRKİYE AND IN İZMİR**
2021, İZMİR

**Published by**
İzmir Development Agency
Megapol Çarşı Kule, Halkapınar Mahallesi,
1203/11. Sk. No: 5-7, Kat: 19
35170 Konak / İzmir
Phone : +90 232 489 81 81
Fax : +90 232 489 85 05
E-mail : info@izka.org.tr

**Thanks**
We would like to extend our appreciation to the Piri Reis University team for their contributions.

**Prepared by**
Oral Erdoğan, Prof. Dr.
M. Ziya Söğüt, Assoc. Prof. Dr.
Oktay Çetin, Assist. Prof. Dr.
Murat Saka, Instructor Dr.
Kenan Tata, Instructor
Müge Özdemir, Research Assistant

**Contributors**
Zafer Acar, Prof. Dr.
Taner Albayrak, Assoc. Prof. Dr.
Erhan Aslanoğlu, Prof. Dr.
Sevda Dede, Instructor
Hüseyin Gençer, Instructor Dr.
Tutku E. İşçioğlu, Assist. Prof. Dr.
Batuhan Kocaoğlu, Assoc. Prof. Dr.
Engin Kurun, Assoc. Prof. Dr.
Ali Cem Kuzu, Assist. Prof. Dr.
Seda Perek, Assist. Prof. Dr.
Özgül Taşpınar, Prof. Dr.
Funda Yercan, Prof. Dr.

**Graphic Design**
Orçun ANDIÇ

This report was prepared by Piri Reis University through service procurement by the İzmir Development Agency within the scope of the Marine Economies Result-Oriented Program (DESOP) of 2021.

REPUBLIC OF TÜRKİYE
MINISTRY OF INDUSTRY
AND TECHNOLOGY

İZMİR
DEVELOPMENT
AGENCY

# ANALYSIS ON THE DEVELOPMENT OF FOREIGN TRADE IN TÜRKİYE AND IN İZMİR

PİRİ REİS ÜNİVERSİTESİ
2008

# EXECUTIVE SUMMARY

Global growth and trade were severely impacted by the COVID-19 pandemic throughout 2020 and the first months of 2021. The pandemic, which continues to have a strong impact, forced many developing and even developed countries to decline in GDP in 2020. While the Turkish economy also experienced negative consequences, we managed to stand out in the global platform. In 2021, global vaccinations and normalization paved the path to monetary and fiscal policies around the world. In light of these developments, 2021 estimations were more optimistic than for 2020.

In 2020, global maritime transport declined by a mere 3.6 percent despite the 7.5-percent decrease in the global trade. The share of maritime transportation in the global transport, on the other hand, increased to 89.97 percent.

The 2008 Financial Crisis, likened to the 1929 Great Depression, followed by the 2018 U.S.-China trade wars crippled globalization and prompted protective policies to surface. The COVID-19 pandemic further pushed these protective policies.

The lockdowns around the world and in Türkiye caused a chain reaction of recessions in many industries, and the surging unemployment rates further accentuated the decline in demand. This negative outlook is expected to improve once the effects of this pandemic relent. As such, it is evident that we must take steps towards improving our current ports and maritime transportation to subsequently boost the maritime transport and ports in İzmir.

The concept of a port city, which gained a national aspect in Türkiye and around the world, presents a substantial opportunity for sustainable socio-economic development. The many economic, political, social and cultural opportunities that port cities offer to the city and the country in terms of structural development and transformation are evident in port cities. Of particular note, these opportunities include alternative power sources, such as wind, solar and off-shore, as well as new business and employment opportunities to develop the regional economy. The green growth concept also presents exciting new economic opportunities. Ports in the İzmir region should be considered advantageous as they incorporate an exemplary transformation infrastructure.

The purpose of this study, based on the previous conjunction, is to estimate the development potential of the ports of İzmir for the 2021–2033 period in consideration of the current situation and future developments in the global economy as well as the potential growth of Turkish foreign trade. The study considers the current global trends and technologies, and submits development scenarios on sustainable economic growth through the use of İzmir's current structures and sources to strengthen the trade center identity of the city.

As part of the field studies, the ports of İzmir were visited at various times to conduct interviews with relevant institutions, organizations and individuals in addition to holding online video meetings. The collected data and opinions were shared with these institutions and, following comprehensive analysis, led to the modeling stage.

The study used data for the 1970 to 2020 period from the Statistics of the Ministry of Transport and Infrastructure, International Monetary Fund (IMF), United Nations Conference on Trade and Development (UNCTAD), Clarksons, World Trade Organization, The Central Bank of the Republic of Türkiye (TCMB) and Turkish Statistical Institute (TurkSTAT) databases and formulated econometric estimation models.

In the implementation stage, three unique scenarios were formulated for the projection model for the Turkish foreign trade worth an annual $389.17 billion in accordance with the most recent data. None of the three scenarios used an equal growth rate or trends by year. Based on the average scenario, the study estimates that Türkiye's trade volume will reach

$783.65 billion by 2033. The above-average scenario, on the other hand, which projects positive shocks in addition to a fluctuating economy, estimates Turkish trade volume to surge to $1.02 trillion. This figure is considered attainable if the outward Turkish economy manages to capitalize on these opportunities.

İzmir's foreign trade was worth $20.08 billion by 2020. The econometric projection model for 2033 estimate the foreign trade volume for İzmir to be $31.41 billion in average, $21.22 billion in below-average and $49.22 billion in above-average scenarios.

The econometric model for handling volume in the ports of İzmir region is based on global trade, economic growth, global maritime trade, Turkish trade, growth and handling data. While the handling volume in the ports of İzmir was worth 80.07 million metric tons in 2020, the model estimates the figures to reach 152.4 million metric tons on average, 99.11 million metric tons on below-average, and 207.8 million metric tons on above-average scenarios for 2033. While the average scenario is considered more likely, global developments often present substantial opportunities for Türkiye and for İzmir in particular. It is, therefore, considered possible to register over 200 million metric tons of handling.

Many of the recent developments, including the expansion of the Panama and Suez canals, strategic mergers and alliances between transportation companies, competitive restructuring, fluctuating fuel prices, and the increasingly common use of container ships over 5,000 TEUs have substantial implications for the entire transportation chain.

2,836,445 TEUs on average, 3,496,254 TEUs on above-average and 2,194,565 TEUs on below-average scenarios for 2033. However, as the trend towards container trade is expected to increase in the upcoming period, and considering the developments over the 10 years, the estimations are predominantly optimistic.

The current Ro-Ro handling of 58,799 items is estimated to increase by 80 percent by 2033 to reach 106,887 items. The above-average scenario, which includes positive shocks for Ro-Ro transport, estimates an increase of around 166 percent by 2033 while the below-scenario of negative shocks foresees a 2.66-percent loss and minimal fluctuations to 57,236 items. The general opinion, in line with the previous statements, suggests optimistic projections, particularly for Ro-Ro transportation.

BRI (Belt and Road Initiative) Map

The study consists of five chapters, including the introduction and conclusion. The second chapter explores the current situation in global maritime trade and ports, while the third chapter focuses particularly on ports in İzmir. The fourth chapter includes the actual implementation of the study and provides details on the 2033 projections based on data related to the ports of İzmir and the global and Turkish trade. The chapter begins with the data and methodology for the study, then presents the findings. The final chapter then summarizes the main conclusions of the study and offers suggestions.

This study is carried out for the benefit of the ports in İzmir. It emphasizes that the port operations, management, logistics clusters and the green port concept to boost sustainable economic development in regional maritime transport and to support blue growth strategies must be studied through a multi-disciplinary approach and a holistic strategy.

İZMİR DEVELOPMENT AGENCY

**SECRETARY GENERAL**

# CONTENTS

# FIGURES

# TABLES

# ABBREVIATIONS

**ACF** : Autocorrelation Function
**ADF** : Augmented Dickey Fuller
**AHP** : Analytic Hierarchy Process
**AR** : Autoregressive
**ARMA** : Autoregressive Moving Average
**BRI** : Beltand Road Initiative Map
**BTK** : Baku – Tbilisi – Kars
**CAGR** : Compound Annual Growth Rate
**CNC** : Core Network Corridor
**CRS** : Container Reach Stacker
**DF** : Dickey Fuller
**DT** : Dwell Time
**ECM** : Error Correction Model
**GDP** : Gross Domestic Product
**GR** : Gross Revenue
**GT** : Gross Metric Tonnage
**İDÇ** : İzmir Iron and Steel (İzmir Demir Çelik)
**IMF** : International Monetary Fund
**IMO** : International Maritime Organization
**ISPS** : International Ship and Port Facility Security
**İZKA** : İzmir Development Agency (İzmir Kalkınma Ajansı)
**LS** : Least Squares
**MA** : Moving Average
**MHC** : Mobile Harbour Crane
**MKE** : The Mechanical and Chemical Industry Corporation (Makine Kimya Endüstrisi )
**OPEC** : Organization of the Petroleum-Exporting Countries
**P** : Peak Factor
**PACF** : Partial Autocorrelation Function
**RF** : Russian Federation
**RMG** : Rail Mounted Gantry Crane
**ROPME** : Result-Oriented Program for Marine Economy
**RTG** : Rubber Tyred Gantry Crane
**SECA** : Sulphur Emission Control Area
**STS** : Ship to Shore
**TCMB** : Central Bank of the Republic of Türkiye (Türkiye Cumhuriyeti Merkez Bankası)
**TEU** : Twenty-Foot Equivalent Unit
**TurkSTAT** : Turkish Statistical Institute
**UNCTAD** : United Nations Conference on Trade and Development
**WTO** : World Trade Organization
**WTTC** : World Travel and Tourism Council

# INTRODUCTION

This study was carried out as complementary in terms of foreign trade projections and their impacts on maritime transportation to the C**urrent Situation Analysis and Development Perspective on the Ports of İzmir** within the scope of the Result-Oriented Program for Marine Economy (ROPME) by the İzmir Development Agency (İZKA) for the TR31 İzmir Region.

Within the new economy and trade environment created by the COVID-19 pandemic, maritime transportation and its integral component, the ports, were impacted on a deeper level than other global economic actors. Considering the high economic expectations in the post-pandemic world, fiercer competition is anticipated particularly between ports. While the ship sizes and lengths grow continuously to decrease the transportation cost per unit, the ports must adjust their infrastructure accordingly and enhance their service quality.

The third-largest Turkish region by population and the largest of the Aegean Region, İzmir has been increasing its share in foreign trade through initiatives by private port authorities, particularly over the last 10 years. However, it has fallen behind its past achievement in figures. Catching up with the world trade and making the right decisions with a proactive approach will not only further increase the share of İzmir ports in Türkiye, but will also highlight them in the Mediterranean trade.

This study conducts regional and national port and foreign trade analysis to shed light on the strategies to strengthen the ports of İzmir in the Mediterranean trade and to gain them a more competitive structure.

To this end, the study considers the developments in the global economy and the potential development of Turkish foreign trade to estimate the development potentials of the ports in İzmir for 2033. These analyses are based on foreign trade data for the world, Türkiye and İzmir.

The share of İzmir, a port city, in the Turkish economy was taken into particular consideration to assess its impacts, especially those in foreign trade, in terms of its capacity to serve as an infrastructure to economic sustainability.

Encompassing the minimization of environmental risks and ecological scarcities to improve maritime and coastal potential, the blue economy also foresees the sustainability of ports. The blue economy consists of a multifaceted economic development structure that includes marine life, tourism, fishery, maritime technologies and port economies. In line with the vision to strengthen the blue economy, the study aims to analyze Turkish foreign trade within the context of the global economy and foreign trade, and to formulate projections in relation to the development of maritime transportation and ports in İzmir. A demand projection was formulated for maritime trade in İzmir based on suitable models to serve as a strategic basis for positioning İzmir. In the same vein, the potential development or requirement of supply in correlation to demand was also examined. In conclusion, the projections included in this study are to provide a sufficient source of information for decision-makers.

Complementing the Current Situation Analysis and Development Perspective for the Ports of İzmir Region, this study was prepared in consideration of the development of Turkish foreign trade to ensure the improvement and sustainability of maritime transportation and ports in İzmir. The second chapter of the study explores the current situation in global maritime trade and ports, while the third chapter focuses particularly on ports in İzmir. The fourth chapter includes the actual implementation of the study and provides details on the 2033 projections based on data related to the ports of İzmir and the global and Turkish trade. The chapter begins with the data and methodology for the study, then presents the findings. The final chapter then summarizes the main conclusions of the study and offers suggestions.

CHAPTER 1.

# Maritime Transportation and Ports in Global Trade

# 1.1. Economy, Trade and Maritime Transport

The OECD International Transport Forum (ITF, 2021) highlights connectivity, decarbonizing, accessibility and inclusiveness, safety and security, digitalization and innovation as priorities while signaling the enhancement of human prosperity in the global economy. As the world rapidly moves towards integration, it becomes easier every day to comprehend the economy-trade-transport-port correlation.

The main explanatory variable that creates demand for ports is the maritime transport. And for maritime transport, exportation and importation activities between countries are essential. It is worth noting here that the total gross revenue (GR) of countries as global economic growth is correlated with the total global export (=import) and the development of total cargo volume by maritime transport. The years of increase and decline of global GR are particularly striking (Figure 1).

During the periods of 1986–1992 and 2002–2008 when the economic revival accentuated, global economy and trade showed simultaneous and rapid growth. In 2009, 2016 and 2020, each underwent a substantial decline. As for maritime transportation, which acts in accordance with the other two parameters, the striking point is that its growth rate is slower than the gross revenue and trade, which are both measured by monetary values. As GR increased by 24.5 times and global trade by 55 times from 1970 to 2020, the total cargo load of maritime trade only increased by 4.4 times. It is clear that there is a substantial increase in the price of the cargo goods rather than their volume.

Within the context of the above explanations, a projection for the ports of İzmir starts with the estimations on the global economy. Fluctuations in the production-consumption trends of economic actors prompt commercial activities, which, in turn, impact transportation and maritime transport. Throughout history, new routes, new ports, new port cities and civilizations have risen through chain reactions.

Natural disasters and epidemics are among the radical events that trigger a shock impact, directly hitting economic and commercial developments. Their timing, intensity and locations are substantial diversions in projections. The examination of past data on the global economic trends requires average, above-average and below-average econometric estimations.

The September, the 2019 front page of the Financial Times read “Capitalism: Time to Reset.” This title underlined a need for a fundamental change in the global economy even before the initial outbreak of COVID-19. The onset of COVID-19 then stressed a clearer and more comprehensive need for a change. Other issues necessitating a reform in the global economy can be categorized under various chapters: high indebtedness, issues in income distribution, technological changes, trade wars and climate change.

In accordance with IMF data, by the end of 2020, the total global debt stock nears four times the global GDP. However, 15 years prior, the total debt was only twice the income. We registered a critical increase within a very short period. With the influences of COVID-19, the global economy underwent a historical contraction. The income loss incurred created repayment risks and other risks related to high indebtedness. The substantial debt restructuring is estimated to continue in the following years. The inequalities in the income distribution are also expected to continue. We need a comprehensive health and education reform coupled with a planned and prioritized fiscal policy to resolve the current global issues.

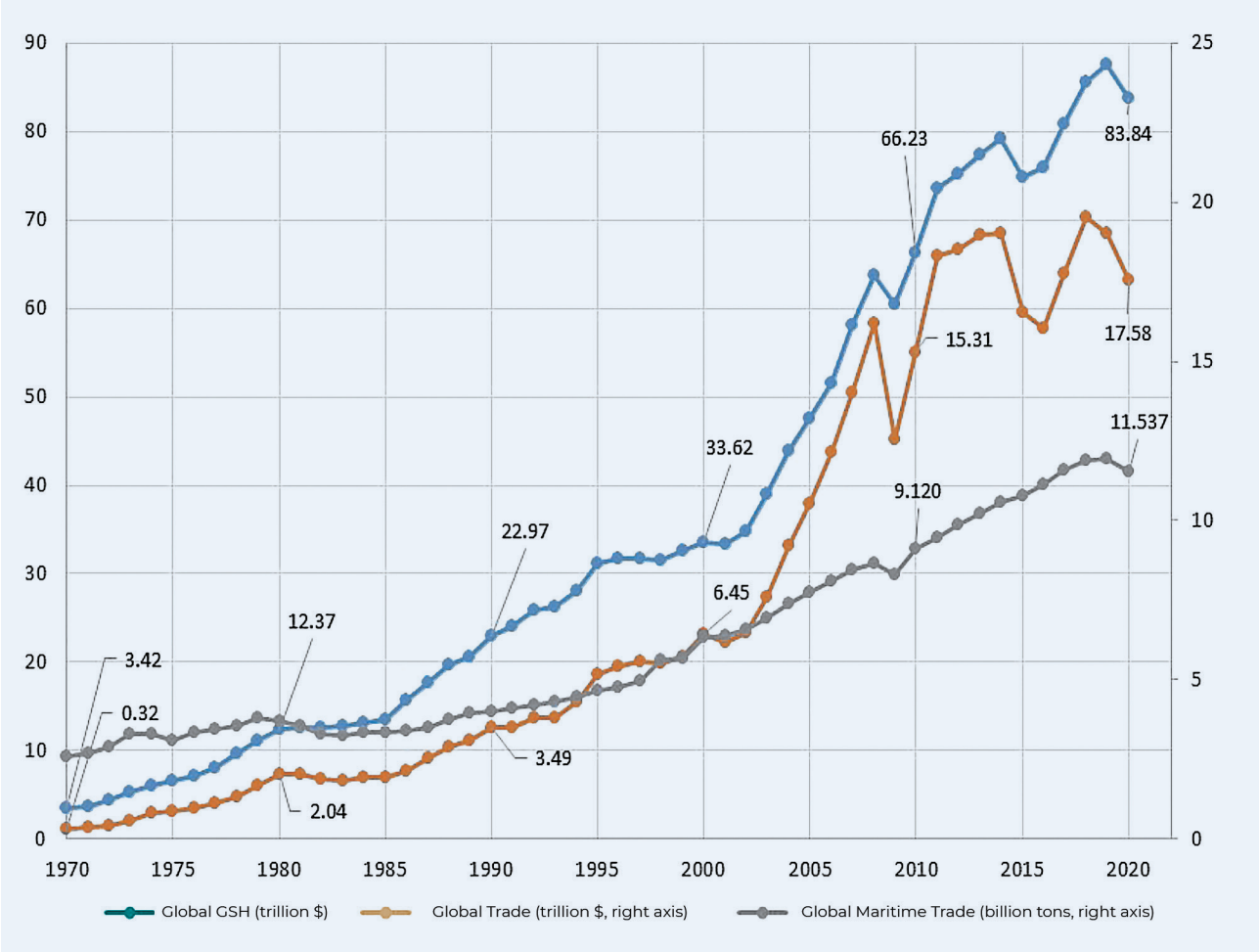
The impact of technological transformation on our daily lives has continued to increase in recent years. A major transformation, which is expected to last for the upcoming period, in biotechnology, robots, artificial intelligence, nanotechnology and their subcategories, are influencing our day-to-day lives. Digitalization has become increasingly influential in every field and connects objects to one another.

The pandemic advanced and accelerated this technological transformation. Business approaches have also changed in all fields from healthcare to logistics with remote working or remote learning systems.

The trade wars between the U.S. and China, which had become particularly noticeable by 2018, can be considered an outcome of a hegemonic competition. Therefore, it would be wise not to dismiss these events as a temporary development that occurred during the Trump Government, but as part of a long-term process. The trade wars continue, and may potentially be followed by a digital currency war and a technology war. The implications of this process on trade routes and supply chains will likely be significant. The dynamics of the pandemic period also inflicted changes in the supply chain and trade route dynamics.

Global climate change has been on the agenda for a long while. It is evident that it will bring about significant changes that will impact the business world on both micro and macro levels. As mentioned previously, the debt issue presents another challenge to global economic stability. These two issues are closely related to all sectors and regions in the Turkish economy. As for the İzmir region and ports in particular, the implications of these factors should not be neglected.

**FIGURE 1.** Correlation Between Global Gross Revenue, Trade and Maritime Transport



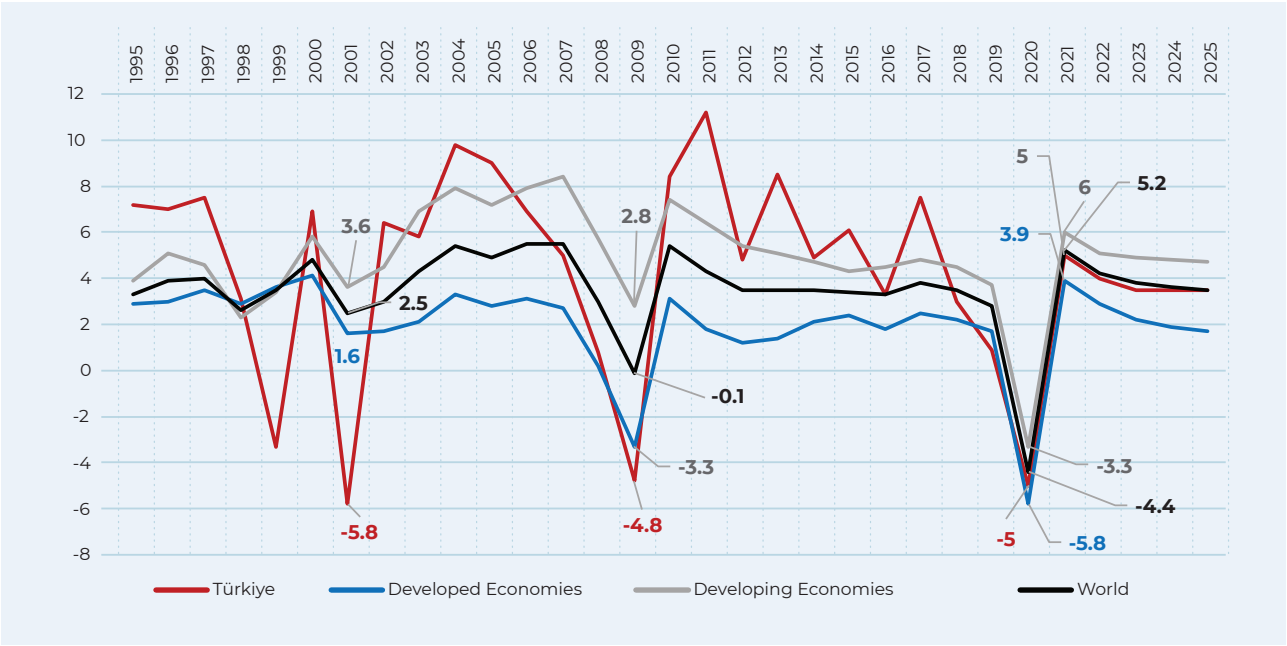

*Data source: IMF, UNCTAD. The calculations are carried out by the author.*

# 1.2. Correlation Between Growth and Maritime Transport

The surging international trade and capital movements, financial liberalization and the subsequent increase in globalization prompt mutual dependency of economies. In this vein, the dynamic interaction between maritime transportation and trade volume is a key structure in portfolio diversification, investment decisions and market estimations. The economic data dissemination among financial markets and maritime markets is another key finding that could be employed in maritime market estimations (Erdoğan et al., 2013). By 2020, 89.97 percent of transportation in global trade consists of maritime transportation (Clarksons, 2020). Clarksons estimations indicate these ratios as 87.47 percent and 84.79 percent for 2021 and 2022, respectively. As the consumption demand and labor supply of the increasing global population move towards manufacturing, agriculture and industry as well as shaping the transportation and energy requirements in line with other needs increasing over time, it is estimated that these will become the definitive indicators of the logistics and transportation sectors.

The current pandemic crisis caused a worse trend than the 2008–2009 crisis, which itself was deemed the worst crisis since the Great Depression. The exacerbating factors include protective policies in economic and commercial activities. One of the main drivers, however, is the lack of demand that has lingered since 2009 and has barely been impacted by the expansionary monetary policies. Lockdowns on local and international levels have caused the chain regression of many sectors. As unemployment rates surged, the regression of demand became more evident. Early 2021 marks the approximate beginning of the recovery period. Efforts concerning the pandemic will be defined during this period. The estimated global real growth is set forth in percentage values in Figure 2. An increase is expected by 2021 with the influence of base effect in the economies that rapidly shrank in 2020 with the offset of the pandemic. As for Türkiye, which closed 2020 with a 5-percent shrinkage, a 5-percent growth is estimated for 2021.

**FIGURE 2.** Global Growth and Growth in Türkiye

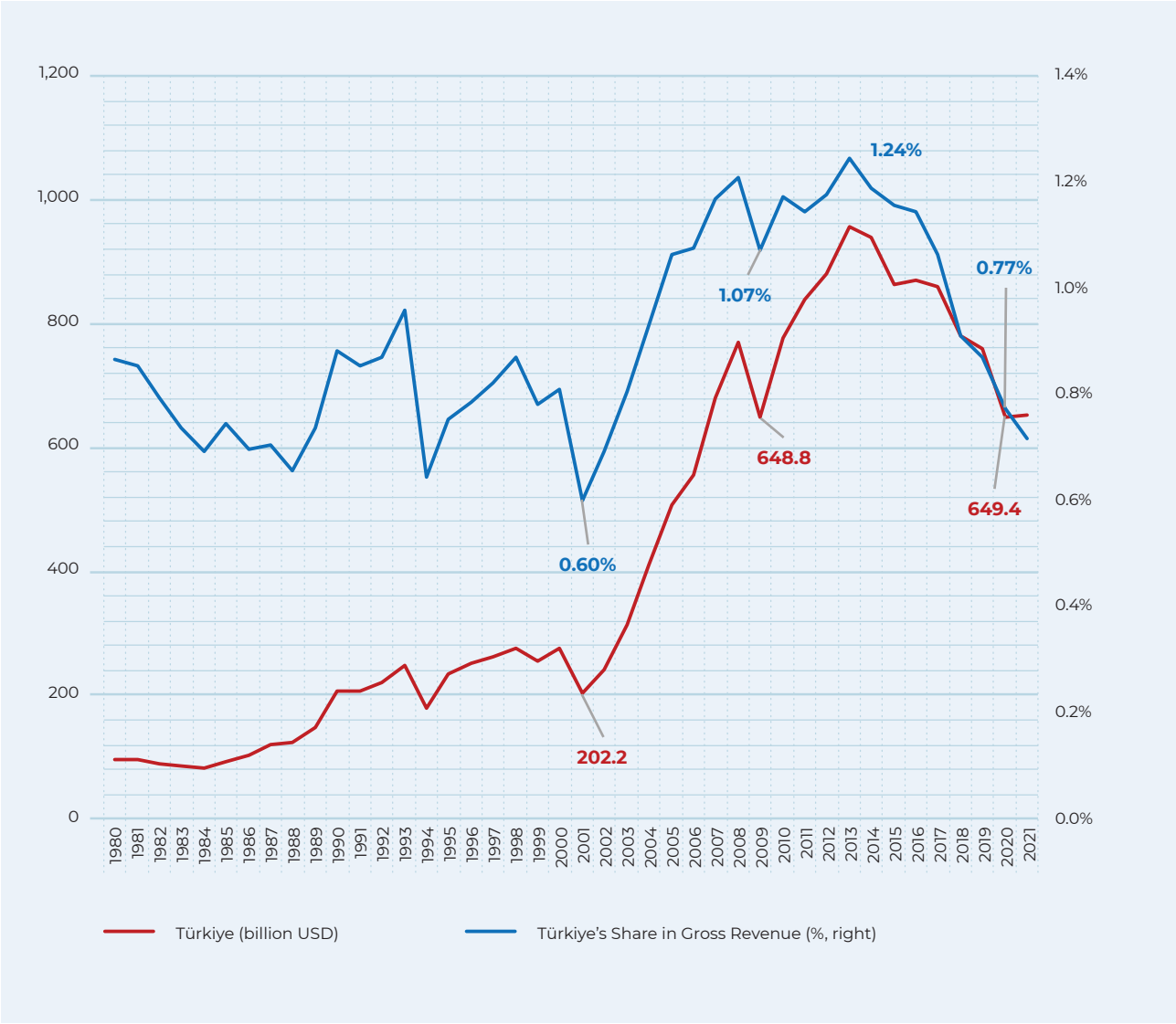



*Data source: IMF. The calculations are carried out by the author.*

Türkiye has also experienced a regression, with the shrinkage in the service industry reflecting on other industries. Subsequently, its share in the global economy dropped from 1.2 percent to below 1 percent.

The assessment of Türkiye's share in global gross revenue (GR) indicates a decline during periods of crisis (Figure 3).

**FIGURE 3.** Türkiye's Share in the Global Gross Revenue




*Data source: The chart was prepared by the author based on data from IMF.*

According to IMF 2020 data, Türkiye constituted 0.77 percent of global gross revenue, which was worth $83.8 trillion at the time, and achieved a GDP of $649.4 billion (Table 1). According to 2020 data, Türkiye ranked 20th in the world GDP list.

**TABLE 1.** Türkiye's Rating in Gross Revenue (2020, billion USD)

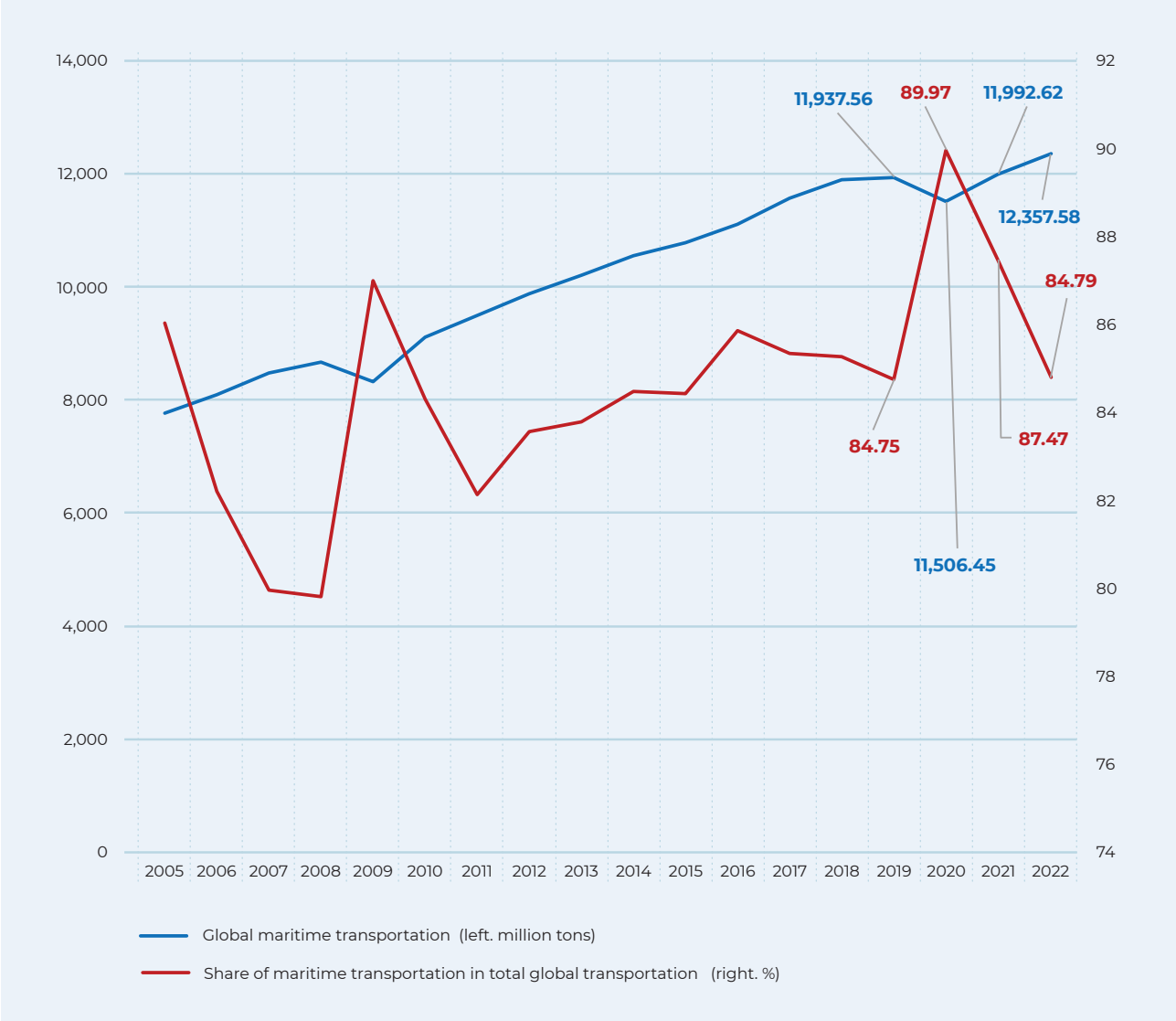
| No | World | 83,845.00 |
|---|---|---|
| 1 | United States of America | 20,807.30 |
| 2 | China | 14,860.80 |
| 3 | Japan | 4,910.60 |
| 4 | Germany | 3,780.60 |
| 5 | United Kingdom | 2,638.30 |
| 6 | India | 2,592.60 |
| 7 | France | 2,551.50 |
| 8 | Italy | 1,848.20 |
| 9 | Canada | 1,600.30 |
| 10 | South Korea | 1,586.80 |
| 11 | Russia | 1,464.10 |
| 12 | Brazil | 1,363.80 |
| 13 | Australia | 1,334.70 |
| 14 | Spain | 1,247.50 |
| 15 | Indonesia | 1,088.80 |
| 16 | Mexico | 1,040.40 |
| 17 | The Netherlands | 886.3 |
| 18 | Switzerland | 707.9 |
| 19 | Saudi Arabia | 680.9 |
| 20 | Türkiye | 649.4 |

*Data source: The table is prepared by the author based on IMF data*

The global trade experienced a substantial plunge during the pandemic, as it did during the 2008–2009 period. In 2009, the global transportation registered an 11.9-percent decline in metric tons and maritime transportation registered a 4.1-percent decline.

According to Clarksons data, global maritime transportation dropped from 11,937.56 million metric tons in 2019 to 11,506.45 million metric tons in 2020, by a 3.6 percent margin. The share of maritime transportation in total global transportation, on the other hand, increased from 84.75 percent in 2019 to 89.97 percent in 2020 (Figure 4).

**FIGURE 4.** Share of Maritime Transport in World Transportation




*Data source: Clarksons. The chart was prepared by authors.*

As per the distribution of main cargo types in global transportation, changes have occurred in crude oil, oil derivatives and containers over the last 10 years. While crude oil and oil derivatives had their shares declining, container cargo registered an increase.

In 2020, compared to the previous year, the cargo load of iron ore, coal, minor dry bulk, crude oil, and oil derivatives registered a decline while grains and chemicals increased. There was no significant change in container, dry bulk and other dry cargo products.

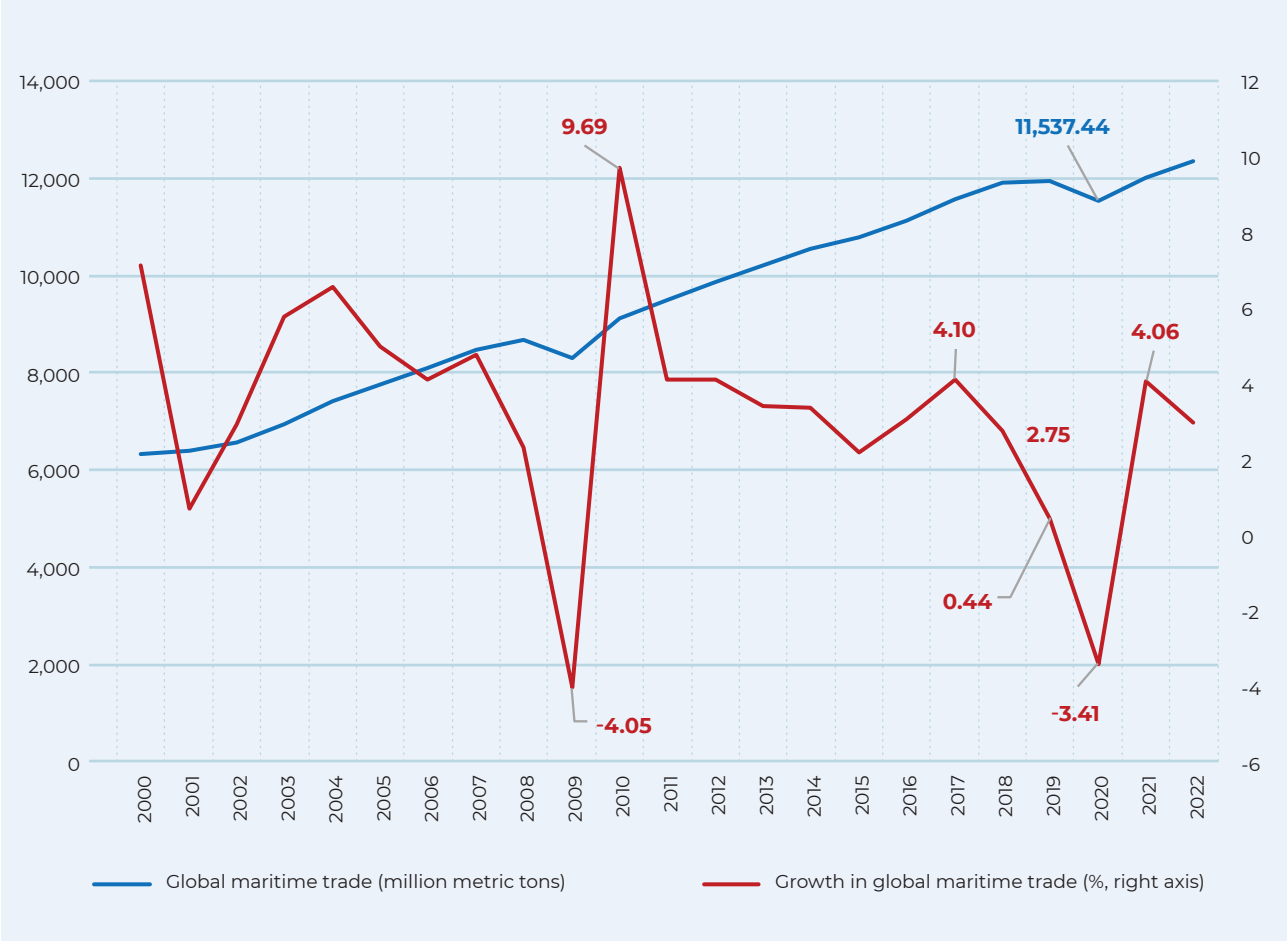
**FIGURE 5.** Distribution of Global Maritime Transport by Cargo


*Data source: Clarksons. The chart was prepared by authors.*

When China joined the World Trade Organization in the early 2000s, the global trade volume witnessed a rapid growth spurt. The 2008 Global Crisis proved to be a breaking point, however, and the average growth rate dropped. When the trade wars between the U.S. and China broke out in 2018, the growth rate in global trade entered a regression period.

Then, when the pandemic set off in late 2019, the global trade volume registered a historical shrinkage of approximately 10 percent in 2020. According to international institutions (World Bank, 2021), it will take until late 2022 for the global trade volume to resume the value it had in 2019.

**FIGURE 6.** Growth in Maritime Trade




Maritime trade accounts for 90 percent of global transportation and, having surged by 4.1 percent in 2017, it only registered a 2.7-percent increase in 2018 following the implications of the trade wars (Figure 6.) Growing by 0.44 percent in 2019, maritime trade shrank by 3.41 percent in 2020 and reached 11,537.44 million metric tons (Clarksons, 2021). After becoming the pacesetter of the global economy, particularly of trade, China single-handedly accounts for half of the dry cargo and container transportation. The trade wars particularly impact the exportation of goods in the manufacturing industry and the trade of grains, iron-steel and such goods. On the other hand, geopolicital developments, such as the sanctions imposed by the United States on Iran and the oil production restrictions of OPEC (The Organization of the Petroleum Exporting Countries) with a view to balance oil prices, had a negative collective impact on tanker trade. While the shrinkage of maritime trade is indeed severe, it remains below the overall trade volume regression in global trade, which is estimated at around 10 percent (UNCTAD, 2019a, 2020).

# 1.3. Implications of the Global Maritime Trade on the Ports of İzmir

## 1.3.1. Expectations in the Global Maritime Trade

Table 2 presents the Compound Annual Growth Rate (CAGR) estimations for the short and medium term by various companies researching maritime trade and running growth estimations. While the 2019 studies of these companies include medium-term estimations, their 2020 studies include only short-term estimations. However, following the regression estimated in 2020 caused by the pandemic, the previously estimated growth rates are now long-term figures.

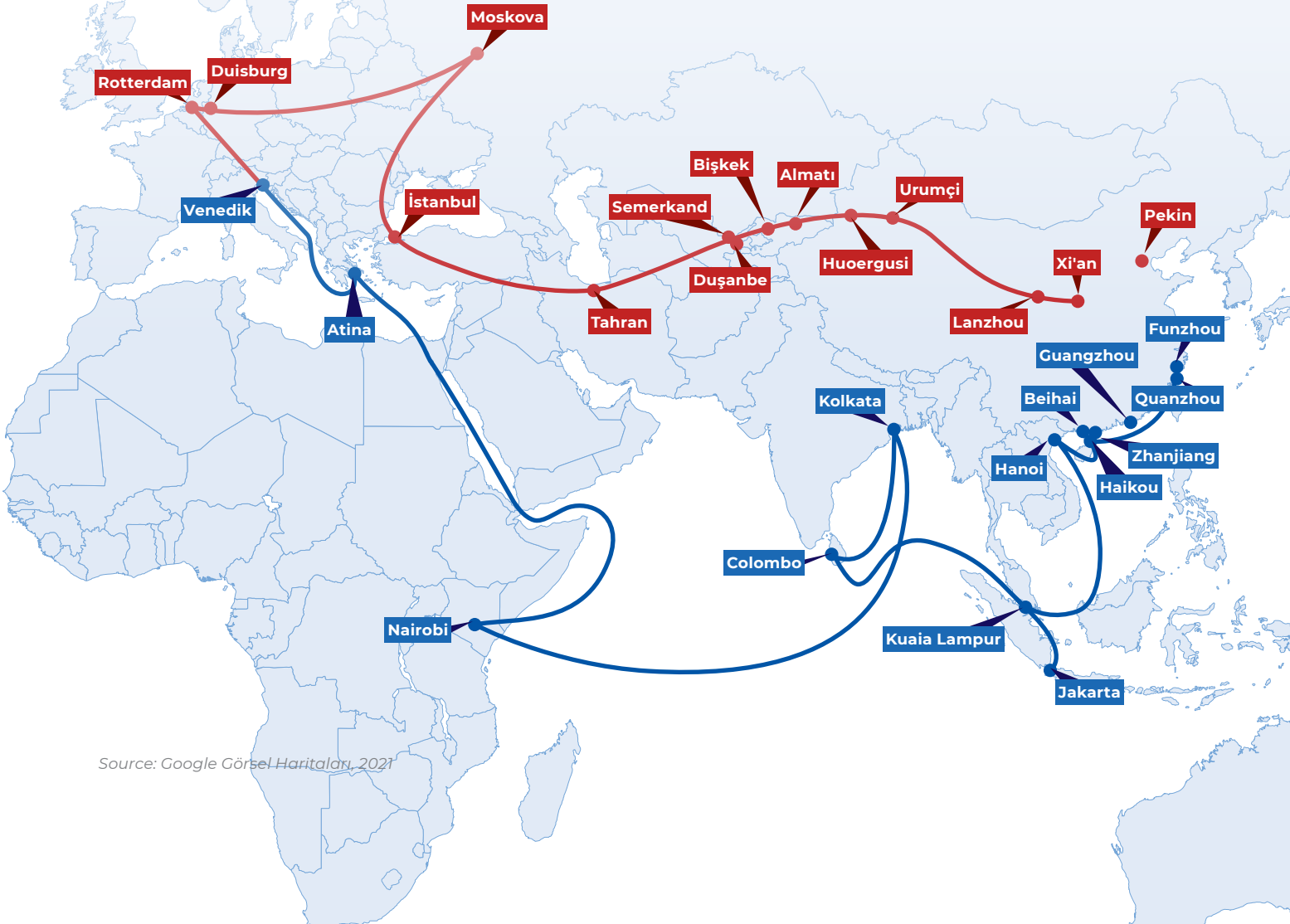
**TABLE 2.** Growth Estimations for Maritime Trade

| Estimation by | Period | Types of Maritime Trade | CAGR (%) | Source |
|---|---|---|---|---|
| UNCTAD | 2019-2024 | Maritime trade (overall) | 3.4 | Review of Maritime Transport, 2019 |
| | | Container trade | 4.5 | |
| | | Dry cargo | 3.9 | |
| | | Liquid cargo | 2.2 | |
| Lloyd's List Intelligence | 2019-2026 | Maritime trade (overall) | 3.1 | Review of Maritime Transport, 2019 (Lloyd's List Intelligence research, 2017) |
| | | Container trade | 4.6 | |
| | | Dry cargo | 3.6 | |
| | | Liquid cargo | 2.5 | |
| UNCTAD | 2020 | Maritime trade (overall) | -4.1 | Review of Maritime Transport, 2020 |
| | 2021 | | 4.8 | |
| Clarksons Research Services | 2020 | | -4 | |
| | 2021 | | 4.7 | |

The UNCTAD report (2020) on global maritime transportation estimates a 4-percent decline in maritime trade in 2020 during the negative effects of the pandemic, while a higher increase rate is estimated by UNCTAD and Clarksons Research by 2021, when normalization is expected. The pre-pandemic UNCTAD (2019) report, on the other hand, includes estimations by UNCTAD and Lloyd's List Intelligence on container trade. Accordingly, container trade was to increase by 1 to 1.5 percent higher than overall maritime trade in the medium term.

When examining the position of İzmir in the development of Turkish foreign trade, it is essential to consider the developments in the far east, which has become the heart of global maritime trade over the last 20 years. Currently a global power, the economic policies and projects of China have gained a substantial importance. Within this scope, China's 2013 Belt and Road Initiative (BRI) aims to establish a transportation infrastructure as well as a trade and investment link between critical economies along the Europe-Asia path. The project includes two critical global trade routes: one by sea and one by land. These are the Historical Silk Road Economic Belt (Belt) and Maritime Silk Road (Road). The "Belt" concept in the project includes a land transportation network consisting of road, railroad, and oil and natural gas piping reaching from Central China to Central Asia, Moscow, Rotterdam and Venice. Türkiye is located on the China – Central and West Asia Corridor, dubbed the "Middle Corridor." While the shortest route to the sea is across Beirut and Lasky, given the current situation of the region, Türkiye also lies on the South Corridor over Iran. The second stage of the project, the "Road," includes the ports across the seas from South and Southeast Asia to East Africa and the north of the Mediterranean. A major national container port, Kumport ranks third in Türkiye in cargo handling. The fact that the Chinese COSCO, one of the top five global logistics companies, purchased Kumport indicates in the Chinese perspective that Türkiye is located on the maritime route of the BRI (Utikad, 2021; Figure 7).

**FIGURE 7.** BRI (Belt and Road Initiative) Map




*Source: Google Görsel Haritaları, 2021*

Currently, 126 countries are willing to participate in the Belt and Road Initiative, also called the Modern Silk Road Project, which is China's largest economic and global cooperation project. Given that many of the countries within the project scope are financially indebted to China, the feasibility of the project is undeniable. On the other hand, various economic agreements were signed between China and Türkiye within the scope of the project, and China's investments in Türkiye increased substantially. Over the course of the last five years, a total of $126.08 billion worth of trade was registered between Türkiye and China. Of this sum, $13.18 billion is the export and $112.9 billion is the import volume. Türkiye, following Russia, is the second-largest trade destination of China with an annual trade volume of $25 billion. The goal is to gradually boost the annual trade volume initially to $50 billion, then to $100 billion (Estate Nation, 2021). Chinese Ambassador to Ankara, Deng Li, affirmed that they aim to augment their investments in Türkiye by up to $6 billion (Daily Sabah, 2020).

According to UNCTAD (2019) report, the fluctuations in the supply and demand between 2007 and 2018 indicate an often close development, save for the extreme drop and rise in demand in 2009 and 2010 (Figure 8). The same report estimated a 3.4-percent annual growth in global maritime trade under the chapter Global Maritime Trade Overlook for 2019–2024.

In line with this growth expected in the global maritime trade, container and Ro-Ro traffic, respectively, are considered likely to follow suit. Türkiye's geopolitical location presents a critical advantage in the BRI. Despite the pandemic conditions, Türkiye's loss in the labor force was negligible in comparison to the rest of the world due to its young population and strong SME system. This production potential is estimated to increase in the post-pandemic period. Moving from this intriguing potential, it could be deduced that the interest of maritime transportation companies will increase over time. For instance, the DFDS launched lines as of February 7, 2021 between the TCDD Port of İzmir and the Port of Tarragona in Spain. Furthermore, given that the container traffic in the Black Sea ports will climb, our Mediterranean and Aegean ports will have a substantial advantage as transfer points for the maritime cargo. From this perspective, Türkiye is in a key location for the BRI. However, a holistic approach is lacking for the ports in the İzmir region in terms of boosting competitive power.

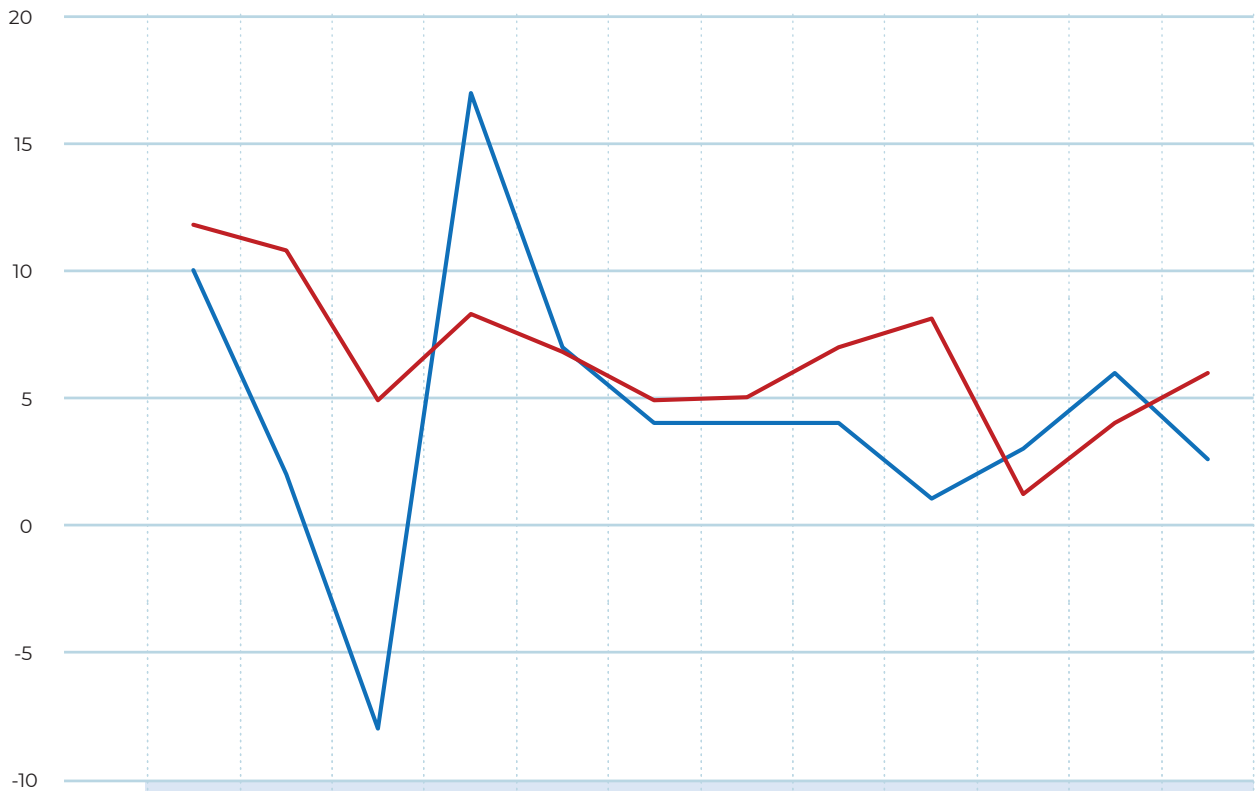
In terms of global trends and current developments on ports and maritime transportation, the following documents were examined and assessed: IMO 2018–2023 Strategic Plan (Resolution A.1110-30), UNCTAD Maritime Transportation 2019 Report, EU Blue Economy 2020 Report, MoTI Study Result Report for the Master Plan on Road and Railroad Connections in Port Hinterlands, Directorate General of Maritime Affairs (DGM) Container and Cargo Statistics 2020 Newsletters, İZKA Report on Result-Oriented Program for the Marine Economy (2020), EU Green Paper on Sea Ports and Maritime Infrastructure, EU Commission Evaluations for Green Paper on Sea Ports and Maritime Infrastructure, EU Memorandum on the Priorities of European Ports for 2019–2024, EU Ports – Trans-European Transport Network Framework and Turkish Chamber of Shipping Industry Report 2020. Building on these findings, the following documents were analyzed to draw conclusions towards the future: Coronavirus, Climate Change & Smart Shipping; Three Maritime Scenarios 2020–2050 (Stopford, 2020); Deloitte Smart Ports Point of View; Global Port Trends 2030 – Deloitte; and S&P Global Shipping. Many of the recent developments, including the expansion of the Panama and Suez canals, strategic mergers and alliances between transportation companies, competitive restructuring, fluctuating fuel prices, and the increasingly common use of container ships over 5,000 TEU have substantial implications for the entire transportation chain. According to DGM statistics for July 2020, the number of containers handled at Türkiye ports in July 2020 declined, with the impact of the COVID-19 pandemic, by 11.9 percent on a year-on-year basis and registered as 886,994 TEUs.

During the period of January–July, 2020, the number of containers handled at Türkiye ports decreased by 4.1 percent on a year-on-year basis and registered as 6,379,300 TEUs. Greece achieved the highest

container handling volume by 107,985 TEUs in July 2020, followed by Egypt with 79,979 TEUs and Israel with 76,388 TEUs. A recommendation has been issued to closely follow and assess transportation within the context of the recent 2020 maritime disputes in the East Mediterranean.

Considering the current economic depressions, exacerbated by the implications of the pandemic, the regression in manufacturing and export, the declining share of Türkiye in maritime transportation and the political developments in the region, a recommendation has been made to at least highlight the transit transport advantages of Turkish ports and to suggest new approaches to accentuate the strengths of Türkiye. If Türkiye loses its status as an important market with the reducing purchasing power, we may lose the possibilities of establishing terminal ports. Therefore, an efficient competition analysis is critical. Currently, the Port of Piraeus remains the most competitive port backed by the EU. Keeping in mind that the insecurities prompted by the developments in the East Mediterranean will further emphasize Piraeus, it would be wise to focus on transportation models, port facilities and port capacities in the competition analysis.

**FIGURE 8.** Development of Supply and Demand in Container Transport (2007–2018)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Demand | 10 | 2 | -8 | 17 | 7 | 4 | 4 | 4 | 1 | 3 | 6 | 2.6 |
| Supply | 11.8 | 10.8 | 4.9 | 8.3 | 6.8 | 4.9 | 5 | 7 | 8.1 | 1.2 | 4 | 6 |

*Source: UNCTAD, Review of Maritime Transport 2019. Grafikte dikey eksen yüzde olarak yıllık değişim oranıdır.*

China's current policies include becoming more influential in distant regions in the changing world order. Due to its economic development, internal political conflicts and regional issues, China has turned to new reforms and policies and formulated strategies including the BRI and March West. Subsequently, the Chinese foreign policy entered a period of radical change. China boosted its visibility and presence in the Middle East with the infrastructure policies covering the Levant and the Gulf. There is a strong and deep-rooted anti-U.S. trend in this region, which presents a positive opportunity for the Chinese presence in the area. While previously dealing with Saudi Arabia as its main oil supplier, China switched its procurement source to the Russian Federation as part of its policy to weaken competition. Subsequently, for the first time in history, the Russian Federation outranked Saudi Arabia in the list of petrol-exporting countries. Indeed, China surpassed the U.S. and became the EU's largest trade partner. In 2020, the total worth of import and export combined between the EU and China reached $709 billion. During the same period, the trade volume between the EU and the U.S. remained at $671 billion (BBC News, 2021). EU–Chinese trade is primarily run by maritime transportation (EU–China by sea: import 90.8%; export 96.4%). A container in a warehouse in China takes three days by air ($40,000) to reach a warehouse in Poland, two weeks by rail ($10,000) and

six weeks by sea ($5,000). The interest in the northern route (China–Kazakhstan–the Russian Federation–Belarus–Poland–Germany) has also gained gradual popularity.

The Baku–Tbilisi–Kars (BTK) railway has the potential to contribute in the growing and developing Turkish-Chinese trade. BTK is a significant relay alternative between China, which is predominantly a manufacturing center, and Western Eurasia. The main advantages of the BTK railway are as follows:

- While railway is more expensive than maritime transportation, it has the benefit of speed, which makes it eligible for prevailing use in the transportation of particular goods to particular locations.
- The estimation for this line is a minimum of 6.5 million metric tons of cargo and over 1 million tourists per year.
- Marmaray, as well as the third bridge across the Bosphorus, will ensure non-stop travel to Europe.
- The Caspian Region is rich in carbon reservoirs. The five countries on the coast of Caspian (Azerbaijan,
- Iran, Kazakhstan, Russian Federation and Turkmenistan) signed an agreement on August 12, 2018 concerning the legal status of the Caspian Sea. The agreement will allow for higher cargo movement in the near future.
- Ports of Baku (including Alat) and Turkmenbash are now open for service. Within this scope, Azerbaijan and Turkmenistan will boost their ferry fleet capacities within the Caspian.
- Türkiye and China launched cooperation on regional e-commerce. Within this scope, Turco-Chinese joint venture companies are expected to initiate activities in cargo transportation.
- The Railway, Middle Corridor and Caravanserai Projects signed between the two countries in 2016 are included in the joint agenda of Türkiye and China. Furthermore, the Edirne–Kars Railway Project is another joint agenda for the two countries.

### 1.3.2. The Needs of Ports in Line with the Developing Maritime Trade

In container transportation, it is essential to maximize storage capacity and minimize container-handling costs to ensure sustainable competition. It is therefore of increasing importance that the recent developments in the quay and terminal crane technologies are closely followed, including semi- and fully automated systems; to improve berth depth, container-handling equipment and docking systems to facilitate the serving of larger modern ships, and to efficiently and effectively cost optimize the ensuing rise in container traffic.

Intermodal cargo transportation includes multiple stages of transport with transfers between various vehicles including trains, ships and lorries without unpacking the cargo at any point. Well-planned cargo transportation reduces the number of modes involved, increases security and speed, and decreases the risks of loss and damage.

According to the DGM statistics, the total amount of cargo handled in maritime transportation as part of foreign trade activities during the period of January to July 2020 increased by 3.9 percent on a year-on-year basis and registered as 209,885,680 metric tons. However, in July 2020, the transit cargo transportation at Türkiye ports reduced by 15 percent on a year-on-year basis to 5,683,658 metric tons. Similarly, the coastal shipping cargo load also declined by 6.6 percent compared to the previous year and registered as 4,792,878 metric tons.

Dry and liquid bulk cargo require special transportation and storage solutions. As the transportation of fuels, petrochemicals, grains and other such goods require piping or conveyors on ships or terminals, these systems are extremely important facilities. Road transportation and storage equipment for loading and unloading ships vary significantly, and some cargo requires highly tailored solutions. These include mechanical and electrical services often required for individual bulk berth configurations, as well as different approaches to the handling of bulk cargo by train or lorry, port storage, ship loading, port berths and passage planning. Unlike the highly specific requirements for container and intermodal terminals, bulk cargo is characterized by its non-standard nature and changing size. It may require open and closed storage, special transportation equipment, ship service, terminal transfer and, on occasion, heavy-lifting capacities that all call for high levels of resources on both the berth and transportation ends.

Vehicle-handling ports and Ro-Ro ports, on the other hand, require large spaces where low-density cargo can be stored. If automobiles and other wheeled cargo are stored in close proximity, as they are in a parking lot, the risk of damage rises. Ro-Ro cargo also requires expensive parking facilities, which prompts the highest and best land use as well as competition with other cargo terminals. Therefore, such cargo terminals must be constructed in typically low-competition areas or in niche ports where they are separated from containers and other terminal operations.

The increasing prevalence of the seas in human transportation and sports signals that the maritime industry has become a significant driver in the local and global economic growth. The recreational use of the seas should be mindfully managed to prevent intervention by commercial and military operations.

The ferry industry, on the other hand, is currently undergoing a substantial growth as a whole. In addition to carrying local vehicles and tourists from one point to another, ferries eliminate cargo and road congestion while offering a more sustainable model of transportation with alternative fuel options. The planning of these terminals should particularly consider more affordable facilities compared to other transportation models.

### 1.3.3. Changing Supply Chains

As the growth issues triggered by the pandemic raised protective tendencies across the globe, we could also discuss an overall protective approach and the trade war. The trade war had already triggered a transformation in supply chains and logistics centers. The supply shocks triggered by the pandemic revealed the risks in the China-centered manufacturing industry and accelerated the restructuring of supply chains.

Within this scope, the establishment of new supply and logistics centers appears to have been prioritized. This change is estimated to be on a product and region basis. The emergence of new regions and the strengthening of existing ones is the result of the expectation that the trade war will boost not only the global trade, but also the regional trade. COVID-19 presents as a crucial factor inflicting the dynamics of change already triggered in the supply chain. The pandemic predominantly revealed the risks of clustering supply chains in a few centers. Establishing unique supply chains gained importance in risk management. Online shopping and changing consumer product demand require supply chains to be as close as possible.

The rapid delivery of products gained critical importance and required strategically significant products to be moved within the country. The international literature (UNCTAD, 2020) calls these new developments “reshore” or “near-shore” instead of “offshore.”

The overstocking tendency is among the new company strategies cultivated by the pandemic period. Setbacks in the supply chains disrupted the manufacturing processes in turn. Low-inflation technological and logistical competencies in the global economy where demand could be immediately met led companies towards demand-based working methods. This manufacturing method is known as "just in time (JIT) manufacturing" in the international literature. The risks in stockless operations prompted by the supply chain disruptions during the pandemic caused companies to opt toward overstocking. Apparent particularly in the global manufacturing industry data, this trend is considered a switch from "just in time" manufacturing to "just in case" manufacturing in the international literature. The manufacturing and distribution strategies of international companies will be the main determinants of new centers. Another significant determinant, on the other hand, will be the changes and priorities within the scope of the Chinese Belt and Road Initiative.

### 1.3.4. Global Change and the Ports of İzmir

Located at the heart of the trade routes between the European Union, Africa and the Middle East, the Turkish economy has the potential to become a strong logistics and manufacturing center with the dynamics of the pandemic and trade war. The EU, as a whole, constitutes the second-largest global economy. Africa and the Middle East, on the other hand, register rapid population growth and will likely achieve rapid growth in the following years. The need for new supply chains and the international trade opting for regional and closer destinations boost Türkiye's importance. Within this scope, we posit three main roadmaps to boost exports in the Turkish economy. The first includes changing supply chains to increase Türkiye's share in the global economy with traditional products in the current manufacturing structure. The second refers to increasing the share of high-technology products in the manufacturing structure to expand export capacity. And the third is to expand our range to export not only within our region, but to further distances. This includes expanding our export capacity from China to Canada, Brazil and Australia. While the global trade indeed switches to primarily shorter distances, the long-distance trade will not simply disappear but will instead grow in line with the global economy. The dynamics of the trade war and the pandemic both have the potential to boost the share of the Turkish economy. Increasing the share of high-technology products in our exports or to reach further distances is directly related to Turkish economic policies. Should Türkiye tap into that potential, its share in global export will initially rise from 1 percent to 1.5 percent, then continue to reach 2 percent. Based on current data, such an increase would highly boost our current $169.6 billion export.

It is possible for the Turkish economy to become a manufacturing and logistics center in the new world order through the more efficient use of its potential and through foreign investments. The switching of supply centers from Asia and particularly from China to other regions will trigger direct investments. Türkiye could receive direct investments from both Asia, particularly from China, and from Europe. These investments could be in the form of green space investments from scratch or of acquisitions. Both forms would significantly boost Türkiye's foreign trade potential. Some such investments could be directed to high-technology final products as well as their input. The growth potential of the Turkish economy is a substantial advantage in attracting such direct investments.

Within the scope of these adjustment scenarios for the Turkish economy, the İzmir region and ports therein will likely gain further importance and volume. According to TurkSTAT data, İzmir was one of the top-five provinces in 2020 in terms of total annual trade volume worth $20.08 billion. While European countries take the lead in İzmir's export, China and the rest of Asia are leaders in import. As a lively trade route between Asia and Europe, İzmir holds a substantial potential in increasing both export and import (İzmir Chamber of Commerce, 2021). The Belt and Road Initiative, which aims to strengthen road, maritime and railway connections from China to Europe, naturally leans closer to the seas (Figure 7).

Türkiye has so far failed to achieve the power it desired in the Belt and Road Initiative. The increasing rate of regional export is likely to exceed that of Türkiye's average. Within that scope, the potential stands to increase the railway and maritime connections within the Silk Road project. The two active road routes included in the Belt and Road Initiative reach from China to Europe. One of these is the North Corridor, which crosses over China, Russia, Belarus and Poland. So far, 11,000 unit trains passed through this route and the total of cargo carried reached 600,000 TEUs. This route takes 12 days to complete and includes cargo transfer from maritime transport to railways. The maritime route currently takes 40 days to cross and, while it is somewhat expensive in terms of unit cost, contributes greatly in reducing the duration.

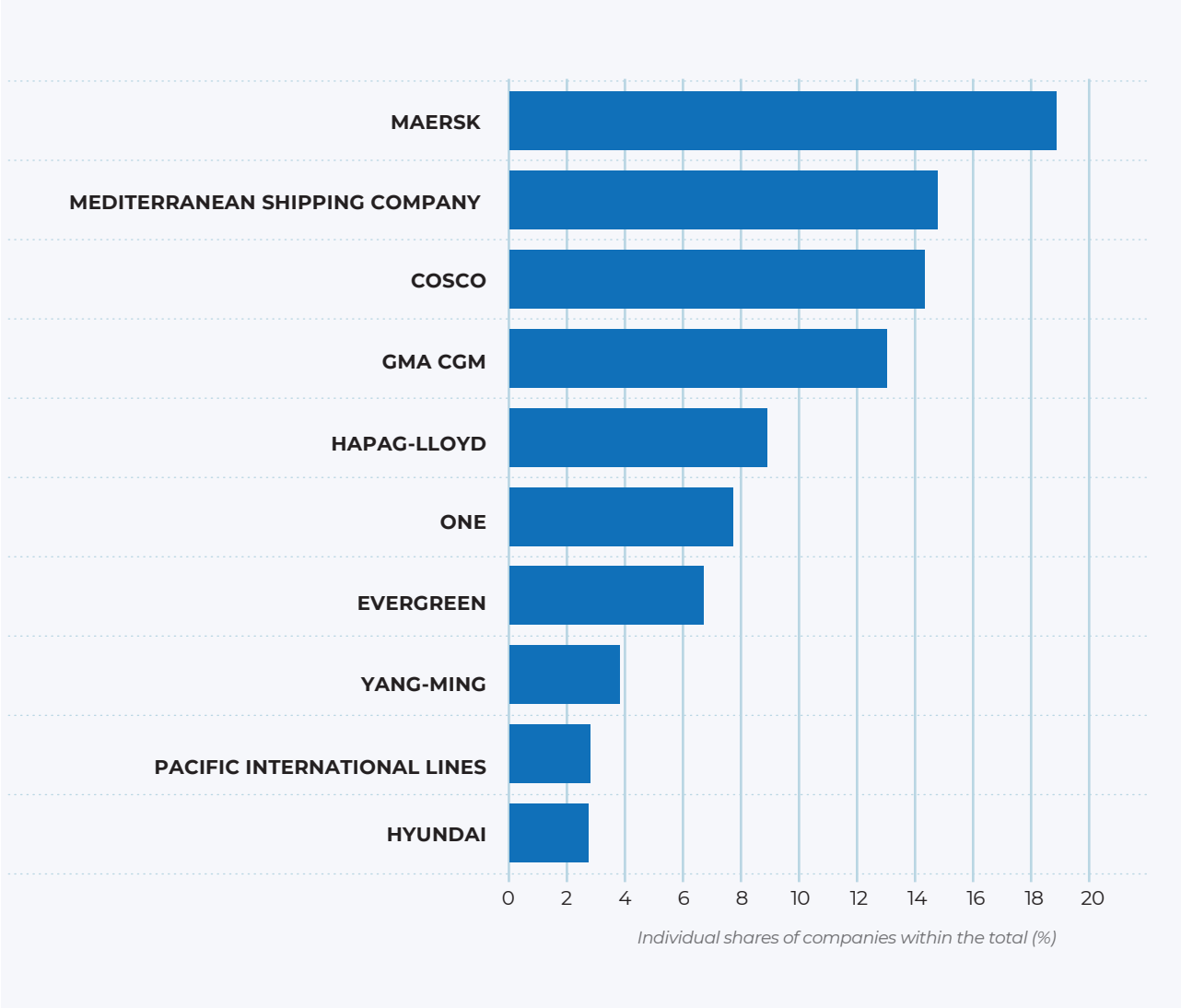
The Middle Corridor that connects Türkiye to China, on the other hand, was launched in 2019 and the exportation train crossing the Kocaeli (Köseköy)–Xian route completed its first journey in 12 days in December 2020 (Esmer, 2021). The trade volume will further increase if this route is developed. By connecting İzmir to Kocaeli (Köseköy), railways can be linked to the maritime routes to achieve higher trade volumes. On a micro basis, the structure of ports and their capacity to adjust to the upcoming changes will be substantial in becoming a supply and logistics center. In that aspect, the question of how to boost port efficiency is critical. First of all, ports must integrate cutting-edge technology in their operations and shorten the docking time for ships. The use of technologies such as digitalization, artificial intelligence and blockchain is prominent in ports. Augmenting the integration of technology will help increase the number of female employees and contribute in positive discrimination. Efficient ports with shorter docking durations can boost their connection points and have higher chances of becoming important hubs.

Another development in the maritime industry is the global container shipping companies further encouraging focus, cooperation and specialization in the industry. The market share of the top 10 companies (Figure 9) increased from 68 percent in 2014 to 90 percent in 2019 (UNCTAD, 2019a). Mergers between shipping companies and port authorities are currently on the rise. As these developments are projected to increase in the coming period, it is critical to assess these events in terms of competition when establishing economic policies.

The estimations on global changes include rapid escalation in global warmth and the widespread implications of climate change. Substantial developments have occurred in recent years as part of the sustainability efforts to alleviate the negative impacts of these processes. Various organizations including the United Nations 2030 Sustainable Development Goals, 2015 Paris Agreement on Climate, 2018 Katowice Climate Change Conference, and the 2018 San Francisco Civil Society Conference have been influential on the manufacturing, distribution and sharing dynamics in many countries. Increasingly, national and international strategies include environmental regulations concerning industrial processes.

The International Maritime Organization (IMO) also integrated multi-faceted regulations in the fight against climate change. For instance, a 0.5-percent limitation has been imposed as an industrial regulation on the sulfur content of ship fuel. Further precautions have been implemented favoring sustainability and climate change combat, including the port operations. The Customs Union Agreement between the EU and Türkiye to be updated will also introduce various practices towards the new green order. Port operations and manageable business processes will also be influenced by these transformations. In conclusion, the development and employment of technology in line with the global trends, the developments in the Chinese Belt and Road Initiative, harmonization with the green transformation, cooperation, specialization and mergers, as well as reduced docking durations will contribute in boosting export volume in the coming period.

**FIGURE 9.** Top 10 Companies in Container Transport




*Source: UNCTAD, 2019*

*Note: The data in the table is in line with container ship metric tonnages and does not include short-distance shipping activities*

# 1.4. Short-Distance Sea Shipping and Opportunities in the Mediterranean

Prior to assessing the current situation of the ports of İzmir, it is essential to explore the developments, types of transportation, overlook of the ports and the potential in terms of maritime trade in the Mediterranean with a view to estimate in the future of maritime transport.

## 1.4.1. Short-Distance Sea Shipping in the Region and the Country

In its current sense, an integrated logistics system includes critical cooperation, competition and timing based on the harmonic functioning of a series of operations including the manufacturing and distribution of goods and services. From an economic point of view, the goods are to be delivered to the markets on time, without any disruptions, at an affordable price. This requires a well-integrated and well-functioning logistics system to facilitate global supply chain processes (Çetin and Köseoğlu, 2020). The modern international transportation system primarily includes road, railway, inland waterway and air transportation in addition to ocean transportation. There are three types in this system. The first is the interregional transportation, which includes deep-sea shipping and air shipping. The second is the short-distance sea shipping, which picks up cargo delivered to the ports through deep-sea shipping to transport them over short distances. The third type includes transportation by road, railway, river or canal. This system is called the inland transportation.

Deep-sea shipping is the only cost-effective cargo transportation method between high-volume regions. Sea traffic routes primarily cluster between the industrial zones in Europe, Asia and North America. Today, the global transportation network is a wide system consisting of thousands of ports and facilities addressing different types of ships and services for affordable prices. In this system, short-distance sea shipping is preferred between regions. This type of transportation opts for smaller ships from 400 DWTs to 6,000 DWTs and provides services between relatively closer ports. The goods delivered by large-capacity deep-sea ships, operating between regions, from regional hubs including Hong Kong, Shanghai or Rotterdam to hub ports, are then picked up by short-distance sea shipping vessels to be distributed to other ports. The inland transportation system, on the other hand, includes a comprehensive road, railway and waterway network integrated to the overall logistics system through ports and special terminals (Stopford, 2009).

Short-distance sea transportation is the main transportation type between the Mediterranean countries and is particularly significant in the European Union maritime policies. The EU short-distance sea shipping volume increased by 4.4 percent in 2018 and by 1.5 percent in 2019, both on a year-on-year basis, and subsequently reached approximately 1.8 billion gross metric tons. The overall increase in the short-distance sea shipping registered by the major EU ports underwent an economic downslide in 2009 following the global crisis in 2008, then peaked to a new record in 2018 (Table 3: Eurostat, 2020).

In 2018, short-distance sea shipping across the main EU ports accounted for approximately 59 percent of total sea transportation. The share of short-distance sea shipping in the total sea transportation, however, differed significantly between reporting countries. EU countries carry out short-distance sea shipping operations significantly more than deep-sea shipping. Finland, Malta, Cyprus, Denmark, Sweden, Ireland, Bulgaria, Italy, Latvia, Estonia, Greece, Poland, Romania, Lithuania and the United Kingdom, in particular, opt for this type of transportation. In addition,

the share of short-distance sea shipping in the main ports of Norway and as well as of two candidate countries, Montenegro and Türkiye, are approximately 70 percent or higher (Figure 10) (Eurostat, 2020).

The high share of short-distance sea shipping in most European countries stems from geographic elements such as long coastlines or high resident population on islands. Large-scale feeder services at hub ports are the reason for the high share in the short-distance sea shipping of countries functioning as regional transfer points. On the contrary, in countries such as Spain and the Netherlands where major ports are focused on intercontinental trade, the share of short-distance sea shipping remains below 50 percent.

Italy became the leading European country in short-distance sea shipping, accounting for approximately 15 percent of the total metric tonnage in 2019 with 310 million metric tons. The Netherlands follows Italy with 300 million metric tons and Spain by 235 million metric tons registered at the main ports (Table 3).

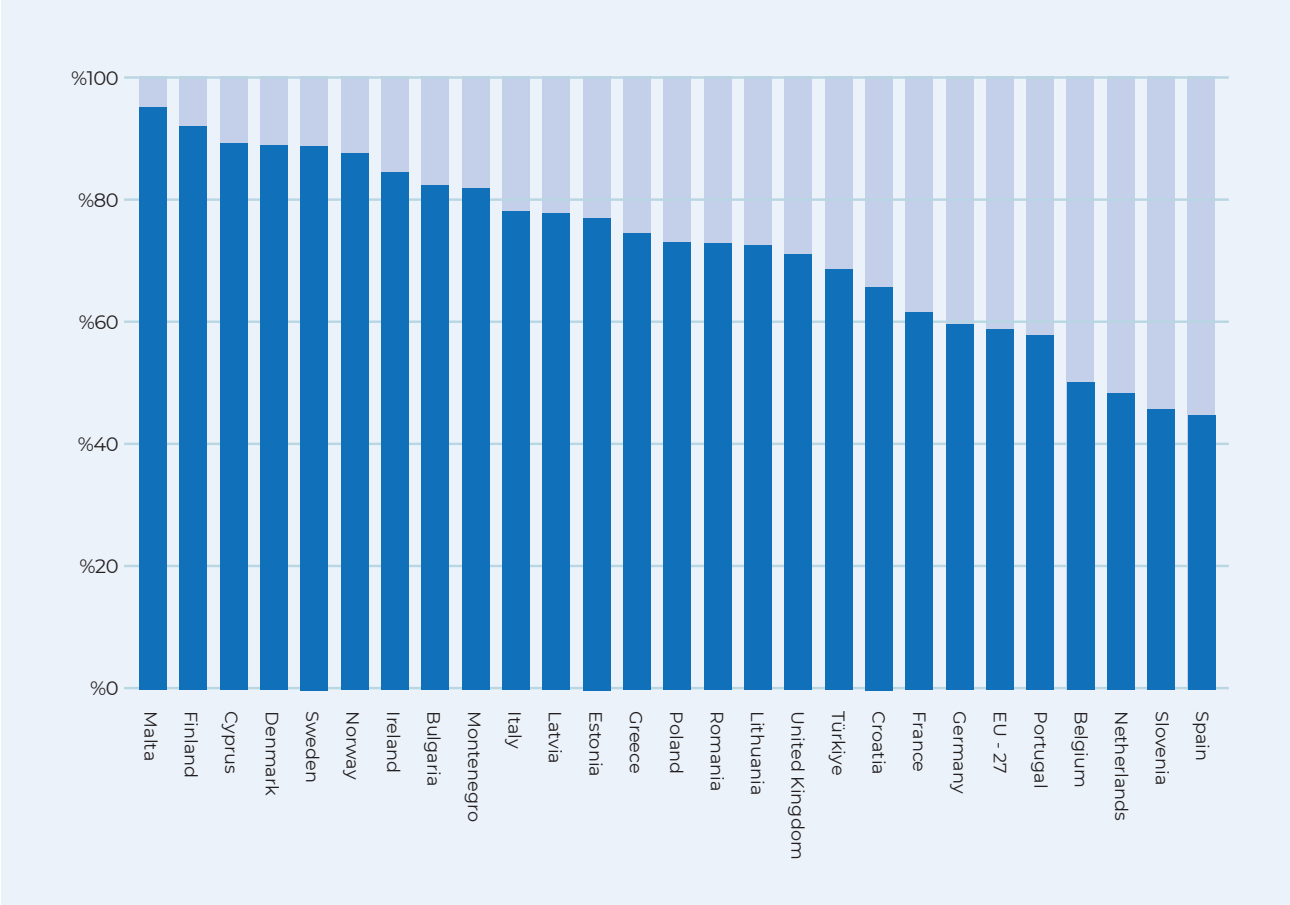
**TABLE 3.** Short-Distance Sea Shipping in Different Countries by Years (2008–2019)

| Country / Year (Thousand Metric Tons) | 2008 | 2009 | 2012 | 2015 | 2017 | 2018 | 2019 | Changing Profile 2019/2008 (%) |
|---|---|---|---|---|---|---|---|---|
| EU (27) | 1,697,905 | 1,543,036 | 1,614,816 | 1,655,537 | 1,711,753 | 1,771,693 | 1,798,631 | 5.93 |
| Belgium | 128,668 | 111,662 | 123,928 | 131,176 | 130,515 | 136,179 | 143,308 | 11.38 |
| Bulgaria | 20,907 | 18,166 | 22,111 | 21,451 | 25,634 | 23,023 | 26,103 | 24.85 |
| Denmark | 76,684 | 65,156 | 66,185 | 73,055 | 72,959 | 72,539 | 71,100 | -7.28 |
| Germany | 189,907 | 155,978 | 170,372 | 174,077 | 175,378 | 175,323 | 171,294 | -9.8 |
| Estonia | 22,900 | 22,570 | 25,459 | 23,673 | 24,042 | 25,057 | 26,329 | 14.97 |
| Ireland | 38,081 | 35,016 | 37,007 | 40,005 | 42,907 | 44,107 | 42,808 | 12.41 |
| Greece | 89,373 | 83,320 | 90,517 | 98,158 | 103,940 | 112,045 | 114,298 | 27.89 |
| Spain | 187,089 | 174,356 | 191,110 | 193,471 | 193,788 | 210,557 | 235,639 | 25.95 |
| France | 222,125 | 194,855 | 170,916 | 167,512 | 175,609 | 178,187 | 169,761 | -23.57 |
| Croatia | 18,502 | 16,264 | 12,120 | 11,863 | 14,408 | 12,728 | 11,835 | -36.03 |
| Italy | 334,011 | 308,521 | 285,475 | 272,172 | 289,487 | 312,784 | 310,602 | -7.01 |
| South Cyprus | 2,749 | 2,471 | 5,676 | 6,929 | 6,954 | 6,217 | 6,793 | 147.11 |
| Latvia | 49,177 | 48,767 | 60,969 | 56,187 | 45,792 | 47,351 | 43,995 | -10.54 |
| Lithuania | 28,627 | 25,420 | 32,391 | 31,348 | 35,155 | 38,208 | 38,298 | 33.78 |
| Malta | 3,077 | 3,008 | 3,045 | 3,409 | 3,707 | 4,351 | 4,324 | 40.53 |
| The Netherlands | 250,759 | 243,788 | 262,938 | 286,231 | 291,726 | 293,745 | 300,151 | 19.7 |
| Poland | 39,431 | 37,710 | 48,755 | 55,789 | 55,157 | 66,211 | 69,272 | 75.68 |

| Country / Year (Thousand Metric Tons) | 2008 | 2009 | 2012 | 2015 | 2017 | 2018 | 2019 | Changing Profile 2019/2008 (%) |
|---|---|---|---|---|---|---|---|---|
| Portugal | 35,248 | 29,265 | 34,663 | 44,909 | 49,372 | 48,872 | 47,101 | 33.63 |
| Romania | 22,779 | 22,588 | 23,908 | 31,285 | 33,527 | 35,351 | 38,034 | 66.97 |
| Slovenia | 8,740 | 7,769 | 8,809 | 11,336 | 11,426 | 10,623 | 10,546 | 20.66 |
| Finland | 97,747 | 78,981 | 87,984 | 85,492 | 95,924 | 100,997 | 102,551 | 4.91 |
| Sweden | 148,013 | 130,425 | 142,110 | 151,101 | 154,901 | 156,128 | 148,445 | 0.29 |
| Norway | 138,878 | 126,481 | 147,360 | 160,418 | 158,710 | 153,090 | 156,680 | 12.82 |
| United Kingdom | 348,448 | 313,398 | 310,998 | 313,498 | 316,196 | 313,739 | 306,770 | -11.96 |
| Montenegro | | | | | | 1,606 | 1,534 | |
| Türkiye | 211,361 | 214,494 | 254,590 | 268,491 | 302,669 | 295,283 | 320,701 | 51.73 |

*Source: Eurostat https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=mar_sg_am_cw&lang=en*

**FIGURE 10.** Share of Short-Distance Sea Shipping (Percent Share in Terms of Metric Tons, 2018)

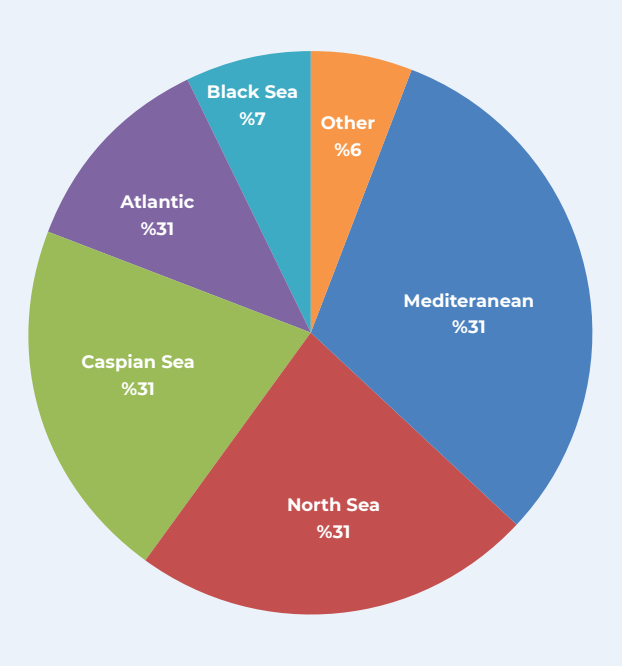



*Source: Eurostat https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=mar_sg_am_cw&lang=en*

The ports of the Mediterranean account for the highest share in short-distance sea shipping (Figure 11). If this high percentage of traffic to and from the Mediterranean ports can be effectively wielded, then an opportunity can be created during the gradual recovery of regional trade in the post-pandemic period. Countries housing large-scale ports functioning as hub ports or transfer points are estimated to grow in terms of transit transportation and have the tendency to focus mainly on short-distance sea shipping.

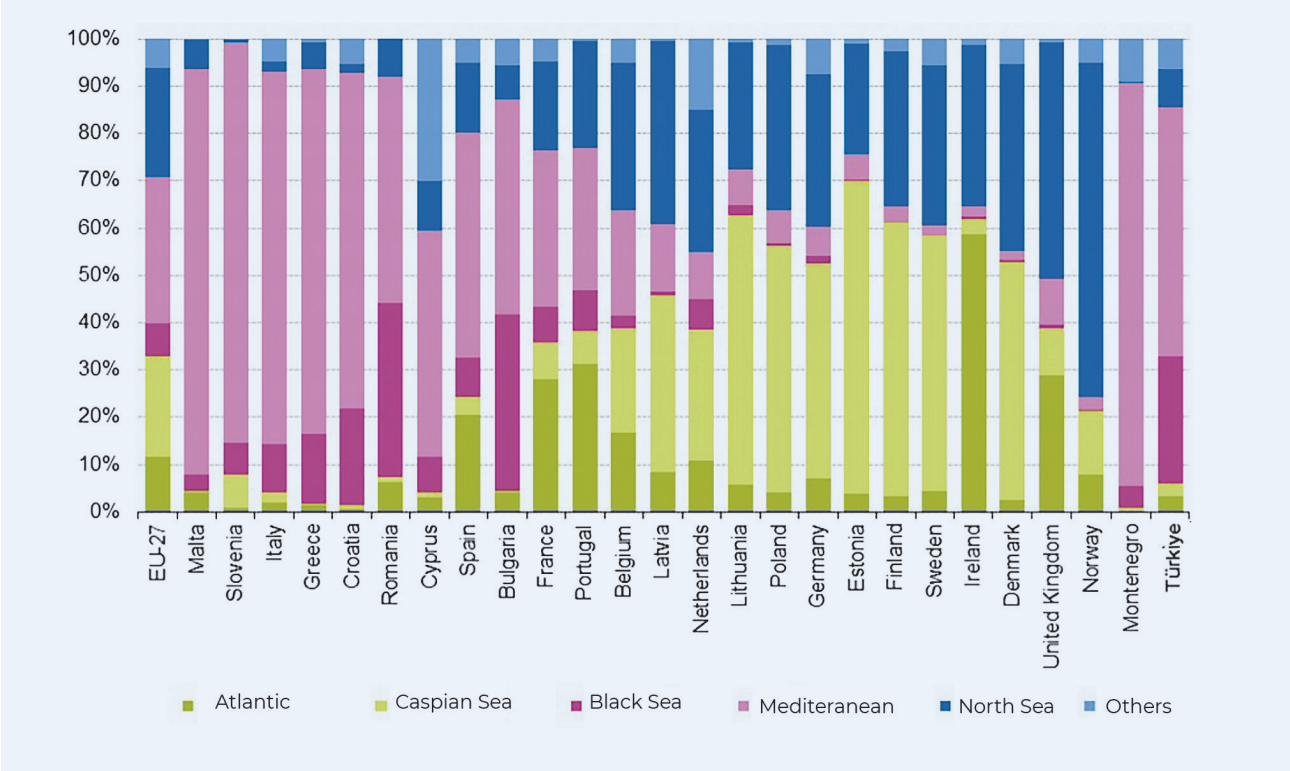
As in Malta, Slovenia, Italy, Greece, Croatia and Montenegro, the share of short-distance sea shipping in the Mediterranean is also high in Türkiye (Figure 12). Within Türkiye, the Black Sea region ranks second in terms of short-distance sea shipping.

**FIGURE 11.** Share of Short-Distance Sea Shipping by Regions (2018)




*Source: Eurostat (mar_sg_am_cws)*

**FIGURE 12.** Maritime Transport Volume by Regions (million metric tons, 2018)

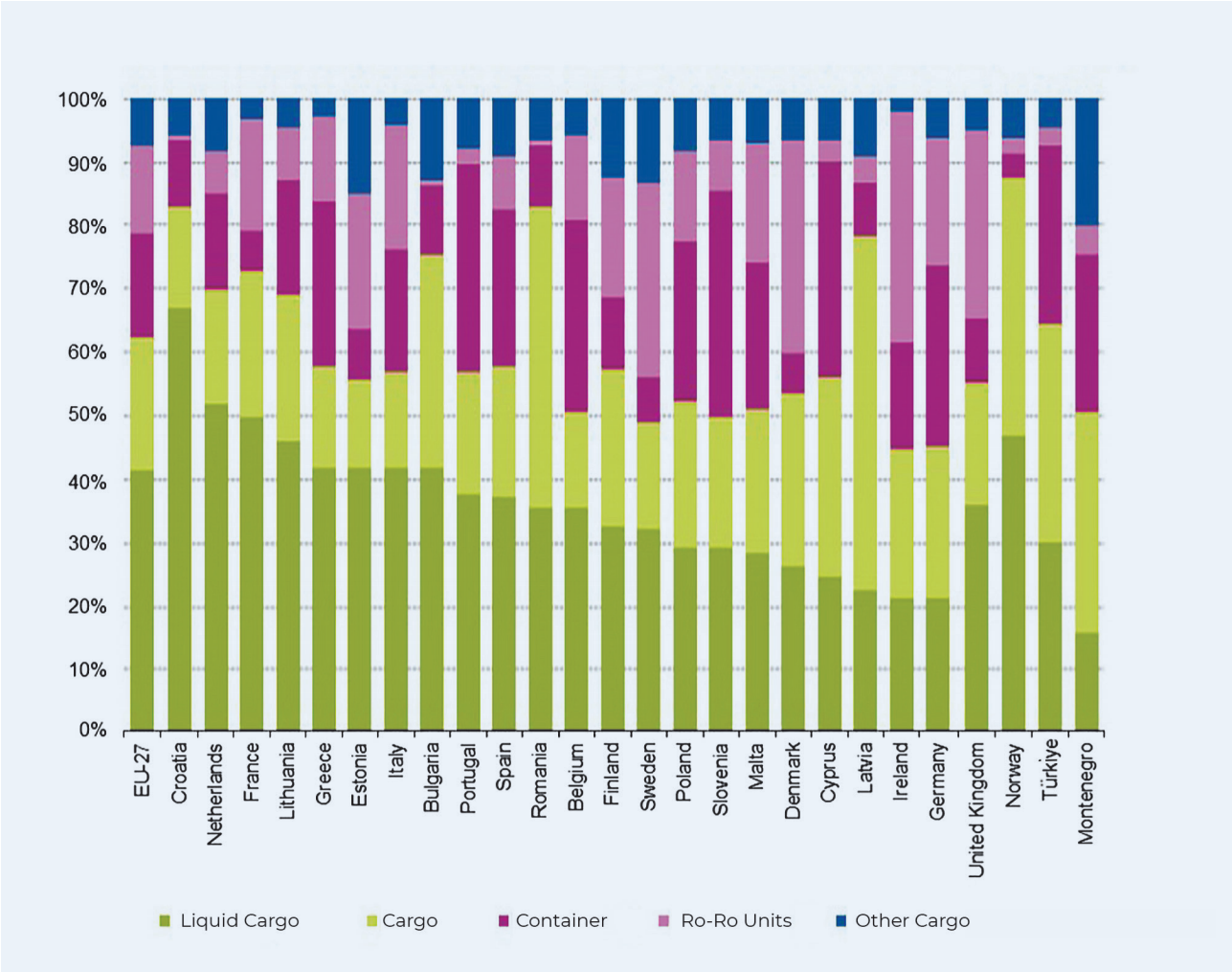



*Source: Eurostat(mar_sg_am_cws)*

### 1.4.2. Short-Distance Sea Shipping By Cargo Type

Liquid bulk cargo maintained its prevailing share in the EU short-distance sea shipping as it did in the previous years. Furthermore, 734 million metric tons of liquid bulk cargo constituted 41 percent of total short-distance sea shipping to and from EU ports in 2018. Following the liquid bulk was dry bulk with 374 million metric tons (21 percent) container with 288 million metric tons (16 percent), and Roll on-Roll off (Ro-Ro) with 249 million metric tons (14 percent). Italy ranked the top in short-distance sea shipping in container (60 million metric tons) and Ro-Ro (62 million metric tons) categories (Figure 13) (Eurostat, 2020).

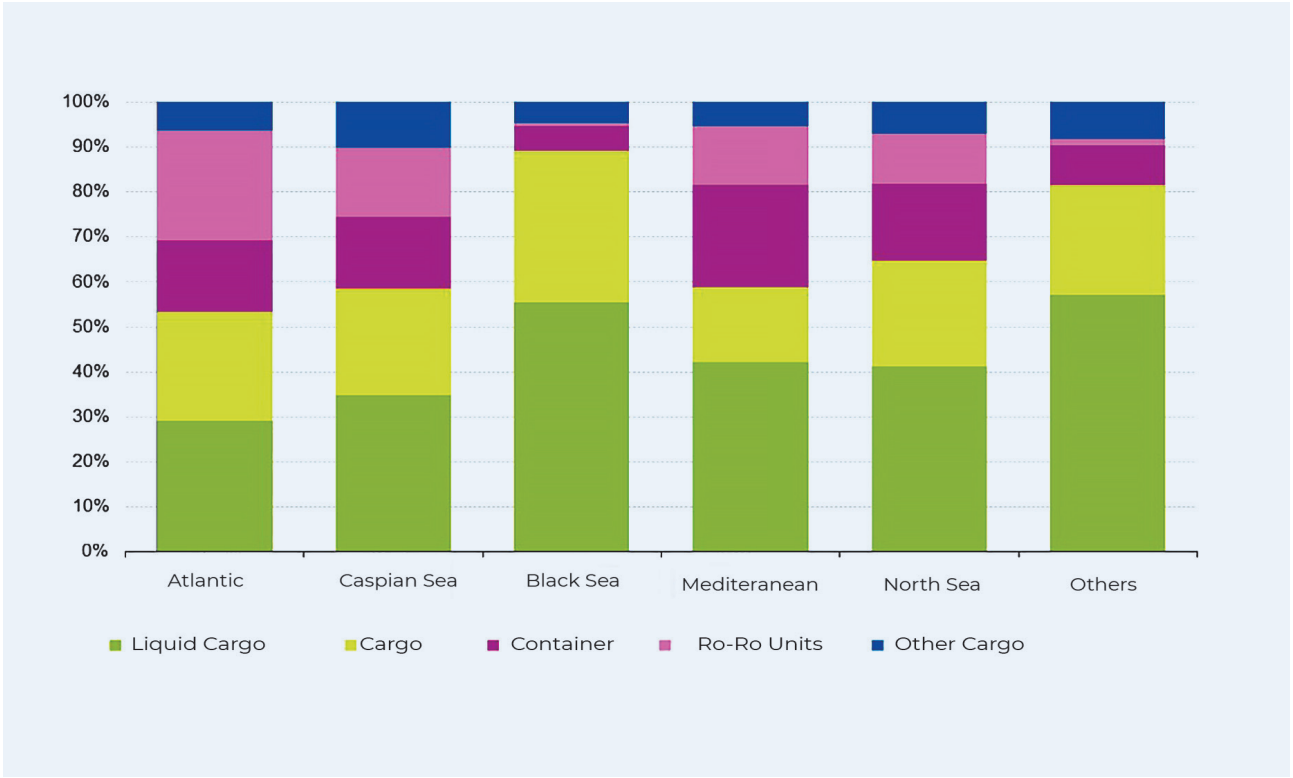
**FIGURE 13.** Share of Short-Distance Sea Shipping (Percent Share in Terms of Metric Tons, 2018)




*Source: Eurostat (mar_sg_am_cws)*

The distribution of liquid bulk, dry bulk and container are roughly equal in Türkiye's short-distance sea shipping activities. Ro-Ro, however, falls behind the other categories. While the overall distribution of short-distance sea shipping cargo varies in sea regions, liquid bulk prevailed in all sea regions in 2018. While liquid bulk accounted for over 55 percent of total short-distance sea shipping in the Black Sea, the ratio dropped to almost one third in the Atlantic Ocean. The share of dry bulk, in contrast, was distributed rather evenly with 17 percent in the Mediterranean and 34 percent in the Black Sea (Figure 14) (Eurostat, 2020).

**FIGURE 14.** Shares of EU Short Distance Sea Shipping By Cargo Type

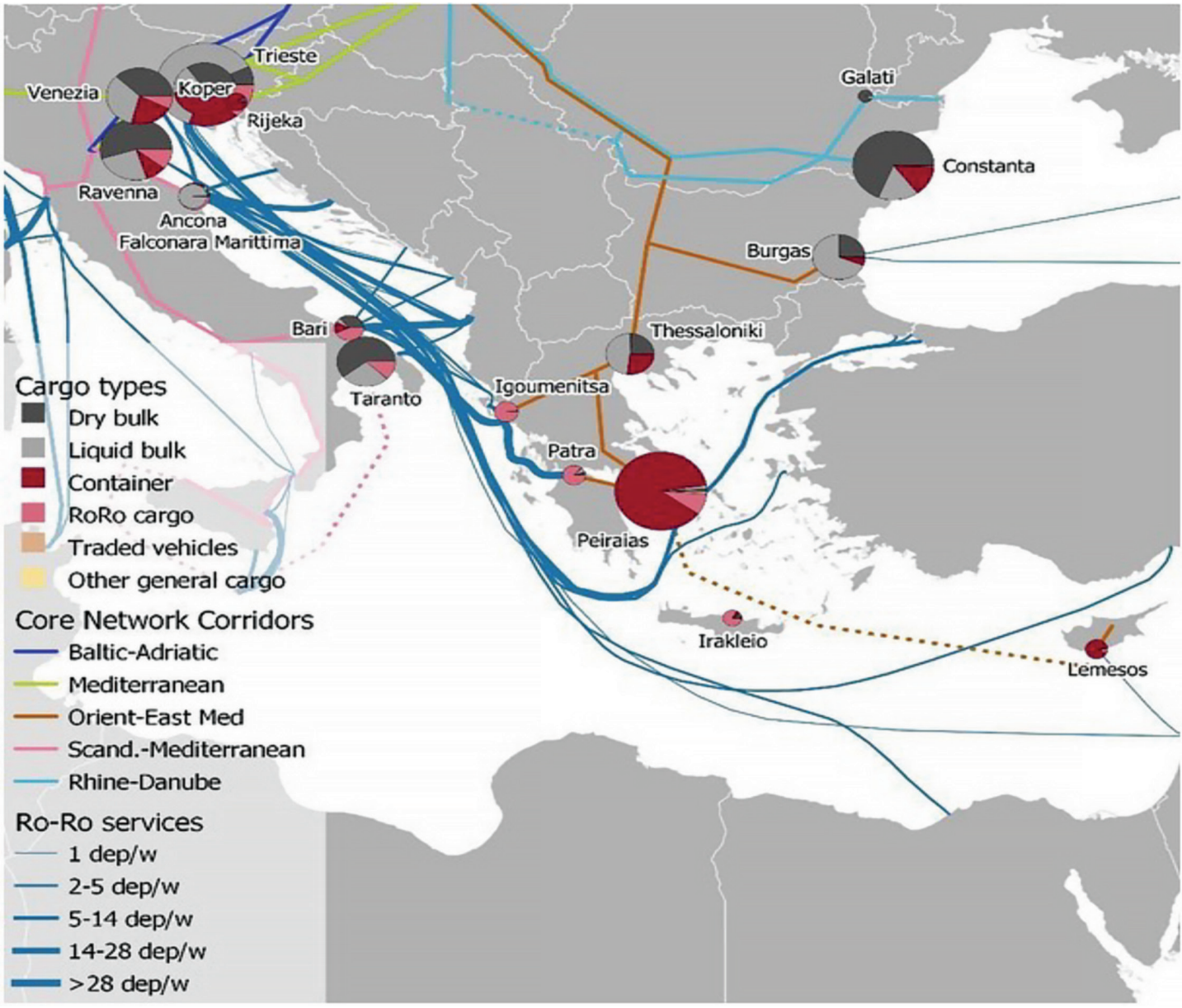



*Source: Eurostat (mar_sg_am_cws), 2018 yılı verileri.*

### 1.4.3. Ro-Ro Transportation

Eastern Mediterranean ports are located on five different core network corridors. Three of these are connected to ports in the Adriatic Sea: Scandinavian–Mediterranean, Baltic–Adriatic and Mediterranean. The Adriatic includes a busy Ro-Ro service network from the east coast of Italy to Croatia, neighboring Montenegro and Albania. There are also various service lines connecting the Adriatic CNC ports with Greece and Türkiye (Figure 15). These lines present an alternative to road transportation from Western Europe to Greece and the East-East Mediterranean Corridor (Docks The Future, 2020).

**FIGURE 15.** Core Network Corridor Ports and Ro-Ro Services




*Source: ISL, 2019 and 2018 data.*

There are nine ports with a total annual sea traffic of over 10 million metric tons. The larger of these are the Trieste, Piraeus and Constanța. Almost half of the entire regional traffic operates in the North Adriatic ports. Ro-Ro traffic is slightly above average. Trieste and Piraeus are the main Ro-Ro ports in the region (Docks The Future, 2020).

Türkiye continues to increase its impact in Ro-Ro transportation. The two major companies operating in that field in Türkiye are DFDS and Ulusoy Denizcilik. The DFDS transports cargo to Europe over eight scheduled lines.+ Ulusoy Denizcilik, on the other hand, has been conducting two-way Ro-Ro lines three times a week since 2000 on the Çeşme–Trieste line.[1] The correlation between the DFDS and the Turkish market can be categorized under three stages:[2]

- The first stage includes data assessed at the time concerning the future of the Ro-Ro market before the company decided to acquire the UN Ro-Ro company.
- The second stage is the data pertaining to the company's performance in Ro-Ro transportation once it entered the Turkish market (data obtained from the company).
- The third stage, on the other hand, includes the assessment of projected investments in the Aegean Region or the Black Sea market (likely in the Port of Constanța or Varna) within the following five years based on the company's estimations concerning the future of the Turkish market.

The first stage of the study concluded the following:

- Commercial operations within Europe and the Mediterranean increased by 4 percent; this value is higher than the 2.9 percent of deep-sea imports and is a substantial indicator for the Ro-Ro industry; the Far East interference in the European markets is decreasing, which is a positive development for Ro-Ro trade within Europe;
- More cargo is carried over long sea routes in Ro-Ro transportation and switching to longer routes will present a growth opportunity once the fuel costs are optimized;
- The Ro-Ro industry is not coherent in its SECA (Sulphur Emission Control Area) strategy, and the importance of the matter has only recently been acknowledged; while switching to the LNG system, which can be installed later, is indeed important, additional cost-efficient investment will ensure larger ships and a higher industrial focus in a stagnant market;
- The expansion of SECA to the Mediterranean and the Irish Sea is likely;
- As for the boat size trends, the degradation in the boat rental market for the smaller boats (only the Ro-Pax – Ro-Ro ship, which carries passengers as well as freight) sustains, and, subsequently, the number of smaller boats declines and are replaced with larger ships;
- Switching from a short sea distance to deep-sea routes (and services) is the easiest opportunity to expand the Ro-Ro market;
- Relations should be established with ports including strong hinterland areas instead of transit ports;
- Tapping into the potential of LNG could be considered to reduce costs in deep-sea routes;
- The focus should be on the main advantages of Ro-Ro transportation including fast operation and the capacity to carry a wide range of cargo on the same ship (Garratt and Teodoro, 2014).

The second stage of the study included interviews with the DFDS authorities and the procurement of data pertaining to the company's performance in the Ro-Ro transportation following its entry into the Turkish market. The table below includes data for 2019 and 2020. Maritime transportation could not deflect the impacts of the COVID-19 pandemic in 2020, the implications of which still persist, and registered decreases as all other industries.

1 The entry of the Danish Det Forenede Dampskibs-Selskab (DFDS – The United Steamship Company) company into the Turkish market through the acquisition of the UN Ro-Ro company is a substantial development in Ro-Ro transportation in the Mediterranean.

2 These are the author's evaluations based on different interviews with DFDS authorities over the course of the project from October 2020 to April 2021

The data indicates a rise in both export and import on the Pendik–Trieste (Italy) line despite the pandemic. The Mersin–Trieste and Yalova–Sète (France) lines also registered volumes close to the 2019 data. As for the Marmara–Bari and Yalova–Trieste lines, a decline has been registered in transportation volume (Table 4). The cause of this decline was justified with the changes to departure ports caused by COVID-19 with the departure points to Patras and Trieste switching between Pendik and Yalova. This restructuring was enforced within the scope of Voyage Management to reduce costs per line and to prevent operations at expense.

The authors were informed that DFDS had purchased a north-bound train line from Trieste through Europe, and that the line, called Bettembourg trains, continue its operations on the Trieste–Bettembourg–Gent–Gothenburg line seven times a week since September 2018 (Figure 16).[3]

**TABLE 4.** DFDS 2019 and 2020 Ro-Ro Transport Data

| | 2019 | | | | 2020 | | | |
|---|---|---|---|---|---|---|---|---|
| | Export | | Import | | Export | | Import | |
| | Standard | Container | Standard | Container | Standard | Container | Standard | Container |
| PENDİK–TRIESTE | 43,603 | 17,249 | 44,547 | 16,464 | 58,606 | 19,170 | 60,107 | 17,012 |
| MARMARA–BARI | 3,073 | 1,719 | 105 | 1,778 | 1,648 | 1,246 | 325 | 1,371 |
| YALOVA–TRIESTE | 17,899 | 4,561 | 19,755 | 4,134 | 2,402 | 293 | 2,156 | 352 |
| MARMARA–PATRAS | 764 | 476 | 647 | 1,628 | 340 | 537 | 548 | 1,385 |
| PATRAS–TRIESTE | 1,173 | 2,404 | 1,433 | 3,957 | 813 | 2,620 | 1,008 | 3,512 |
| MERSİN–TRIESTE | 14,365 | 1,532 | 16,143 | 1,516 | 15,127 | 1,504 | 15,927 | 1472 |
| YALOVA–SÈTE | 29,631 | 4,807 | 31,072 | 4,206 | 26,758 | 4,421 | 28,123 | 4,040 |
| **TOTAL** | **110,508** | **32,748** | **113,702** | **33,683** | **105,694** | **29,791** | **108,194** | **29,144** |

*Source: DFDS-Pendik*

3 The data was obtained by the authors during interviews with DFDS-Pendik authorities. As DFDS currently prevails in the Turkish Ro-Ro market, its lines and investment decisions were explained in detail. This information will provide the basis for Ro-Ro transportation in the later estimations

**FIGURE 16.** Railway Lines Used by DFDS within Europe


2018

| ROUTE | FREQUENCY |
|---|---|
| Bettembourg | 7 RT* x Week |
| Wels | 7 RT x Week |
| Münih | 4 RT x Week |
| Ludwigshalen | 3 RT x Week |
| Dulsburg | 4 RT x Week |
| | |
| | |
| | |
| **TOPLAM** | 25 RT x Week |
| | 50 RT x Week |

2019

| ROUTE | FREQUENCY |
|---|---|
| Bettembourg | 9 RT* x Week |
| Wels | 10 RT x Week |
| Münih | 5 RT x Week |
| Ludwigshalen | 2 RT x Week |
| Duisburg | 4 RT x Week |
| **Milano** | **3 RT½ x Week** |
| **Genk** | **2 RT x Week** |
| | |
| **TOPLAM** | 35 RT x Week |
| | 70 RT x Week |

2020

| ROUTE | FREQUENCY |
|---|---|
| Bettembourg | 9 RT*x Week |
| Wels | 7 RT x Week |
| Münih | 4 RT x Week |
| Ludwigshalen | 5 RT x Week |
| Duisburg / Neuss | 3 RT x Week |
| **Ostrava** | **3 RT x Week** |
| **Köln** | **8 RT x Week** |
| **Karlsruhe** | **2 RT x Week** |
| **TOPLAM** | 41 RT x Week |
| | 82 RT x Week |

*Source: DFDS-Pendik*

During the initial impact of COVID-19 on markets (March, April, May, 2020), the freight volume of DFDS plummeted. The third quarter of 2020 witnessed a substantial increase compared to the previous months, particularly in September and October, indicating a promising increase in the total operations volume despite the pandemic. DFDS also launched the Alsancak–Tarragona/Spain line.

The company's performance in Ro-Ro transportation proves to be successful following its entry into the Turkish market. Exploring the company's projections concerning the Turkish market should also include administrative evaluations. For instance, Executive Vice President of the DFDS Ferry Division, Peder Gellert Pedersen refers to the "acquisition of the U.N. Ro-Ro, operating seven Ro-Ro lines in the Mediterranean, for €1 billion" while affirming a strong momentum in Turkish export and underlined the relevance of the export towards Europe in the Turkish economy (Pedersen, 2018).

It was revealed that future priorities of DFDS will include expansion in the Ro-Ro market by offering new services to customers through acquisitions or cooperation.[4]

DFDS is currently the flagship of Ro-Ro transportation in Türkiye and their confidence in the market cements estimations concerning the escalation of the Ro-Ro market first in the Mediterranean, then in the Black Sea.

### 1.4.4. High-Performance European Ports

In 2018, short-distance sea shipping accounted for over 40 percent of total handling at the top 20 EU ports. Rotterdam maintained its position as the largest short-distance sea shipping port in the EU and singlehandedly processed 207 million metric tons of cargo. The top 20 EU ports included, in order: Marseille (4), Trieste (6), Geneva (7), Algeciras (8), Piraeus (10), Valencia (12), Ravenna (19) and Gioia Tauro (20) in the Mediterranean.

In 2018, 23 percent of container cargo consisted of short-distance sea shipping in the Mediterranean while the ratio remained at 5 percent in the Black Sea (Eurostat, 2020). One striking competitor for Türkiye in the Mediterranean is Piraeus in the third rank (Table 5). As for Ro-Ro transportation, no Mediterranean ports made it in the top-5 list.

**TABLE 5.** Top 5 EU Ports in Short-Distance Sea Shipping for Container

| 2018 Rank | Ports | Compared to 2017 | Total Short-Distance Sea Shipping (million metric tons) | 2018/2017 Difference in Percentage | Share of EU-27 in Short-Distance Sea Shipping | Other Types of Sea Shipping (million metric tons) |
|---|---|---|---|---|---|---|
| 1 | **Rotterdam** | = | 42.6 | 11.7 | 10.3 | 82.6 |
| 2 | **Antwerp** | = | 40 | 11 | 9.6 | 67.6 |
| 3 | **Pire** | = | 27.2 | 13.3 | 6.5 | 17.4 |
| 4 | **Hamburg** | = | 23.8 | 2.4 | 5.7 | 48.2 |
| 5 | **Gioia Tauro** | +1 | 23.3 | 32.6 | 5.6 | 3.1 |
| Total Top Five | | | 157 | 12.8 | 37.8 | 218.9 |
| Total cargo handled at the main EU-27 ports | | | 415.4 | 10.6 | 100 | 424.9 |

*Source: Eurostat (mar_sg_am_cws)*

4 The data was obtained by the authors during interviews with DFDS-Pendik authorities.

### 1.4.5. Short-Distance Sea Shipping of Containers

Unlike the dry cargo, operations pertaining to the short-distance sea shipping of containers remain clustered around a few hub ports. In 2018, the top-five ports for container operations accounted for 38 percent of total short-distance shipping container cargo handled in the main EU ports. The share of 20 TEU containers in short-distance sea shipping at the main EU ports increased by 9.6 percent in 2018 compared to the previous year and exceeded 33 million TEUs (Table 6; Eurostat, 2020).

The most striking detail in the table is that Türkiye overtook all EU countries, including Italy in short-distance sea shipping of containers in 2018 and further advanced up the list 2019. Italy, Belgium and Greece each registered over 14 percent of the increase in 2018, compared to the previous year, and are among the countries with the highest operations volume in the short-distance sea shipping of containers.

**TABLE 6.** Short-Distance Sea Shipping for Container (2010–2019)

| Coun-try/Year (Thousand TEUs) | 2010 | 2012 | 2015 | 2017 | 2018 | Difference % 2018/2017 | 2019 |
|---|---|---|---|---|---|---|---|
| EU (27) | 23,507 | 26,326 | 28,535 | 30,592 | 33,501 | 9.51 | 32,880 |
| Belgium | 4,440 | 3,843 | 3,988 | 3,480 | 4,038 | 16.03 | 4,550 |
| Bulgaria | 140 | 164 | 200 | 222 | 234 | 5.41 | 256 |
| Denmark | 665 | 590 | 609 | 625 | 640 | 2.4 | 624 |
| Germany | 4,421 | 5,632 | 5,744 | 5,418 | 5,486 | 1.26 | 5,396 |
| Estonia | 152 | 228 | 209 | 230 | 240 | 4.35 | 239 |
| Ireland | 752 | 705 | 854 | 942 | 976 | 3.61 | 1,036 |
| Greece | 801 | 1,961 | 2,545 | 2,965 | 3,391 | 14.37 | 3,714 |
| Spain | 3,975 | 4,599 | 5,183 | 5,679 | 5,843 | 2.89 | 5,791 |
| France | 1,205 | 1,128 | 1,434 | 1,475 | 1,451 | -1.63 | 1,379 |
| Croatia | 109 | 103 | 123 | 145 | 145 | 0 | 170 |

| Coun-try/Year (Thousand TEUs) | 2010 | 2012 | 2015 | 2017 | 2018 | Difference % 2018/2017 | 2019 |
|---|---|---|---|---|---|---|---|
| Italy | 4,205 | 4,811 | 5,487 | 6,236 | 8,148 | 30.66 | 6,132 |
| South Cyprus | 103 | 267 | 290 | 354 | 383 | 8.19 | 356 |
| Latvia | 256 | 366 | 358 | 453 | 479 | 5.74 | 476 |
| Lithuania | 295 | 381 | 350 | 474 | 749 | 58.02 | 705 |
| Malta | 79 | 82 | 67 | 89 | 94 | 5.62 | 93 |
| The Netherlands | 4,090 | 2,811 | 2,603 | 2,961 | 3,024 | 2.13 | 3,346 |
| Poland | 850 | 1,256 | 1,311 | 1,631 | 1,964 | 20.42 | 2,210 |
| Portugal | 953 | 1,056 | 1,289 | 1,556 | 1,656 | 6.43 | 1,609 |
| Romania | 158 | 208 | 492 | 508 | 473 | -6.89 | 482 |
| Slovenia | 308 | 346 | 535 | 465 | 385 | -17.2 | 382 |
| Finland | 1,229 | 1,189 | 1,223 | 1,435 | 1,411 | -1.67 | 1,434 |
| Sweden | 1,203 | 1,277 | 1,148 | 1,245 | 1,289 | 3.53 | 1,266 |
| Norway | 601 | 650 | 699 | 741 | 778 | 4.99 | 812 |
| United Kingdom | 2,875 | 3,320 | 4,219 | 4,565 | 4,462 | -2.26 | 4,423 |
| Montenegro | | | | | 28 | | 30 |
| Türkiye | 4,897 | 5,976 | 6,673 | 7,710 | 8,442 | 9.49 | 9,026 |

*Source: Eurostat: https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=mar_sg_am_cv&lang=en*

### 1.4.6. Maritime and Cruise Tourism

Cruise tourism is one of the most active sub-divisions of maritime tourism. To properly accentuate the importance of cruise tourism in the ports of İzmir, it is essential to take a further look in maritime tourism in the Mediterranean.

Coastal and maritime tourism has a substantial leverage on tourism income and, in addition to creating employment and generating income, it interacts with and contributes in other income-generating sectors. Greece, for instance, is a considerable opponent of İzmir in maritime tourism and, in 2017, the tourism industry accounted for 19.7 percent of GDP in Greece.

Furthermore, the industry employed 934,500 people, thus contributing to employment levels by 24.8 percent (World Travel and Tourism Council – WTTC, 2018). It is known that coastal and maritime tourism activities offer a significant leverage to the economic and social development of Greece. According to the current data, maritime tourism in Greece accounts for 3.8 percent of the tourism industry's total contribution in the national GDP. As for cruise and yacht tourism, a positive trend was registered up until the economic crisis (EU Project SUPREME, 2018).

In addition to Greece, the tourism industry in Italy was also examined to set the basis for the assessment of Türkiye's and İzmir's tourism potential. Accordingly, the tourism industry in Italy created 500,000 new jobs as well as a €30 billion increase in the GDP by 2020 (Tourism in Italy 2020: Leadership, Workforce, South). The industry is expected to expand by 2.3 percent per year to reach €83.4 billion by 2024, which corresponds to 4.7 percent of the GDP. Approximately 5 percent of GDP is a significant rate. The maritime economy had a significant role in that achievement, with maritime transportation, shipbuilding, fishery (farming included), and maritime and cruise tourism taking the lead. As cruise tourism is part of the large-scale travel and tourism industry, it sustained a substantial growth. The estimations indicate an increasing demand up to 25 million passengers by 2030. Italian coastal and maritime tourism represents a €19 billion industry (EU Project SUPREME, 2018). While cruise tourism sustained the highest injury during the pandemic, it is expected to attract high demand in the post-pandemic period. Based on these development estimations of Italian and Greek maritime and cruise tourism, a similar growth potential is estimated for İzmir.

Cruise tourism is an integral component of maritime tourism. It is affirmed that tourists traveling abroad by cruise spend almost seven times more than tourists traveling by other means. Given the abundance of tourist attractions within easy access by road, including Ephesus and Bergama, İzmir becomes a prime destination for cruise tourism.

# 1.5. Port Sustainability in the Development of Foreign Trade

## 1.5.1. Port Development and Expansion Plans

In today's economy, there are many ways to boost efficiency to handle larger ships and to increase container volumes. Coordinately, the environmental impacts of port and terminal operations must be decreased. Automation in these operations could be the best solution. Recent developments in the quay and portal crane technology, including semi- and fully automated systems, remote controlling and tandem operation, as well as the interconnected integration of these technologies in the system are crucial. Container terminals, for instance, consist of four main components: equipment, process, operating system and labor force. While these four components usually develop intertwiningly, their harmony can be disrupted every now and then.

Additionally, comprehensive solutions for navigation and improvement, including dredging and dock deepening as well as the disposal of dredged material, should be evaluated. The constantly changing and developing international maritime industry introduces larger-capacity and draft boats. The ports require new designs to expand existing docks and to handle these larger ships. Navigational requirements depend on environmental conditions, boat type and expected traffic flow. Based on the detailed analysis of environmental conditions and boat types for the use of a certain channel, alternative routes should be assessed to minimize the volume, cost and environmental impacts of dredging and navigational safety measures should be implemented.

The maritime industry is highly dynamic in Türkiye, as it is around the world. Developments in the global economy directly impact trade in goods and services. The estimations concerning the trade of goods particularly influence the investment plans on ports, the most important infrastructure components in transportation. Increasing expectations on the trade of goods and services in the medium and long term accelerate port investments while decreasing expectations often postpone investments. Two options are available to boost port capacity. These are to enhance existing efficiency and to carry out physical investments.

Physical investments include expanding the physical conditions by constructing new quays and hinterland spaces in existing ports, and boosting port-handling capacity by purchasing new equipment.

There are three mega port investment projects planned as state investments. The North Aegean Port in Çandarlı is currently under construction while the other two are in the survey and project phases, respectively. The North Aegean Port in Çandarlı is planned in two stages. The first stage consists of three chapters (1 million TEUs + 1 million TEUs + 2 million TEUs) and the second stage has not yet been planned. The capacity of Port of İzmir, on the other hand, will be increased to 2.5 million TEUs through privatization by additional investments. The industrial wharfs owned by government institutions or private industrial companies are located in the Aliağa district in the Aegean Region (DTO Industry Report 2020).

The ports of Türkiye are structured conventionally as they are equipped with unique types of equipment capable of serving many different cargo types, rather than with ports specialized in one type of cargo. A holistic approach to the logistics industry and the lack of a background logistics network to back up port investments are some of the current concerns needing to be addressed in Turkish port administration (DTO Industry Report 2020). To this end, Türkiye's handling demand should first be determined based, in particular, on foreign trade projections. Port investments should then be evaluated accordingly.

### 1.5.2. System-Oriented Sustainability Framework for Port Cities

Despite the major transformations they have undergone throughout history, port cities have always remained the flagship of economic development in their city and region. According to Campbell (1993), ports have been the center of economic and cultural activities within the cities. Companies looking to export or import goods by sea have sought to locate their operations within close proximity to ports to cut down on costs. Furthermore, cargo-handling operations during the early development stages of port cities are considered key igniters for local business, taxes and economic activities (Zhang and Lam, 2013).

The recent advances in the transportation technology transformed the role of ports in the economic development. This case was observed and explained by Norcliffe et al. (1996), who held the view that ports created cities and large ports created large cities until the post-World War II era. At this point, things became more complicated. Containerization, for instance, turned cargo movement into a capital intensive industry and robbed the cities of the employment opportunities of a local port. There are also increasing concerns that low-priced import might replace existing local production. While a port's economic contributions decline, its social and environmental costs duplicate. The underlying cause of traffic and pollution around the ports, stemming from the port operations, is the escalating competition for land use between ports and urban development (Liao et al., 2010; Saz-Salazar and García-Menéndez, 2012). These elements disrupt the coherent development of the ports and cities in which they are located in terms of economy and function.

In 2020, the IMO focused on the theme "Sustainable Transport for a Sustainable World" to raise sectoral awareness within the scope of the United Nations Sustainable Development Goals for 2030. The subsequent "EcoPort" concept, referring to sustainable and environmentally friendly ports, surfaced with a focus on 120 ports and cities around the world and highlighted the implications of sustainability on port cities. This project evaluates a sustainability framework based on the green port concept and energy efficiency criteria for the ports of İzmir. To this end, this chapter outlines the framework in the following three steps: problem, method and action. The three fundamental aspects of systems-oriented sustainability – namely: the economy, social structure and environmental integrity – were individually examined within the context of port cities. The economic aspect of systems-oriented sustainability in the context of port cities includes GDP generation, income and profitability, and tax revenue generation. The social aspect includes productivity; the spatial impact of society; quality of living and working environments; employment results; heritage and cultural impacts; and corporate, legal and political impacts. Finally, the environmental aspect includes air quality, water quality, coastal and marine environment, and waste management.

In the economic aspect of sustainability, port activities create a business income on a local level and contribute to the value multiplier effect of ports. The generated income is then allocated to income costs including labor and capital expenses, payments to accumulated earnings, shareholders and stakeholders, and to pay miscellaneous taxes. A port's contribution in the GDP stems primarily from the operations of the port and the facilitation of trade. Conversely, a city's GDP is generated through various commercial activities. Impacting production-consumption models, the GDP per person can also influence how the GDP is generated (Shen et al., 2011). A city's contribution in the GDP is mainly correlated with the port's contribution in the GDP. For instance, export-/import-/warehouse-oriented ports play a more important role than service-oriented economies in GDP generation by facilitating trade in their city. The profitability of a port in terms of economic value can be measured by net income. Determining the optimal productivity level of a port will contribute in maximizing the profit, which is the main goal of an establishment. The optimal productivity level is the preferred capacity, or the utilization rate of a port (Talley, 2007). The tax revenue generated from port operations comprise the majority of the city's tax income. This might include goods and services, corporate, property, export and import taxes. Port productivity is measured by the amount of cargo handled based on given resource utilization, while the productivity of a city is measured by labor productivity and investment returns (Table 7).

The social aspect of the sustainability framework in the context of port operations includes the location and construction of a port, with a particular interest on the spatial impact of operations. Ports often occupy the coastal lands, which might necessitate the relocation of the local city or community. Standard of living is a significant indicator in determining where the local community works and lives. Within this scope, the port operations, port constructions, freight ships, air and noise pollution due to operations, waste discharged in the vicinity of the port, and the obstruction of recreation by cutting access to nearby beaches (if applicable) are some of the social components influencing the housing preferences of local communities.

**TABLE 7.** System-Oriented Sustainability for Port City Development Analysis

| Criteria | Overall sub-criteria | System-specific main issues/indicators Port | |
|---|---|---|---|
| | | Port | City |
| Economic | GDP generation/value factor (Suykens, 1989; Zhang and Lam, 2013; Humphreys, 2012; Shen, Ochoa, Shah and Zhang, 2011) | Port operations; Facilitation of trade | GDP per person; commercial activities |
| | Income and Profitability (Toh, Phang and Khan, 1995; Talley, 2007; World Bank, 2012; Zhang and Lam, 2013) | Port fees; Income cost; Optimum productivity level | Disposable income per household; gross savings |
| | Tax Generation (Toh et al., 1995; Humphreys, 2012; Zhang and Lam, 2013) | Corporate and real-estate taxes | Corporate, income, property, goods and services; income/ export taxes |
| Social | Productivity (Toh et al., 1995; Talley, 2007) | Number of handled cargo per resource used (labor, equipment) | Urban Productivity; Labor productivity |
| | Spatial Impact on Society (UN, 1992; Wang and Ducruet, 2012; Yap and Lam, 2013) | Coastal land occupation | Housing and shelter; Transport |
| | Quality of Living and Working Environments (UN, 1992; Hayuth, 2007; De Vor and De Groot, 2011; Merk, Ducruet, Dubarle, Haezendonck, and Dooms, 2011) | Security; comfort | Security; comfort; recreation |
| | Employment Results (Zhang and Lam, 2013) | Number of employment opportunities created; employment factor | Employment factor; unemployment rate |
| | Heritage and cultural impact (Shaw, 2001) | Maritime heritage and culture | Preservation of heritage and culture |
| | Corporate, legal and political impact (Daamen and Vries, 2013) | Management productivity; Maritime industry regulatory framework | Transparent, accountable and productive governance; political stability |
| Environ-mental | Water Quality (Yap and Lam, 2013) | Water pollution due to port operations (organic, inorganic) | Accessible clean and reasonably priced water; water consumption efficiency |
| | Air Quality (Berechman and Tseng, 2012; Bailey and Solomon, 2004) | Concentration of pollutants stemming from ships and port operations; quality of ambient air and atmosphere | Concentration of pollutants; quality of ambient air and atmosphere |
| | Coastal and Marine Environment (Peris-Mora, Diez Orejas, Subirats, Ibanez, and Alvarez, 2005; IMO, 2011) | Coastal hydrology; sublevel pollution | Coastal hydrology; sublevel pollution; biological diversity |
| | Waste Management (Darbra, Ronza, Stojanovic, Wooldridge and Casal, 2005; Yap and Lam, 2013) | Ship discharge; waste stemming from cargo operations | Recycling and reuse rate; treatment of hazardous waste |

*Source: Xiao (2017)*

Evidence also suggests a negative correlation between the proximity to port areas and housing prices, which relates to the higher intensity of social deprivation (Merk et al., 2011). The negative correlation implicating lower prices should not be attributed to ports alone. Similar studies on industrial zones revealed a negative impact on housing prices (De Vor and De Groot, 2011). Employment results are another criterion of the sustainability framework for ports. These results correspond to the number of full-time equivalent of jobs in the port operations. These consist of direct employment, corresponding to the number of employees recruited in port operations, and indirect employment, corresponding to jobs created in the local economy by the ports' procurement of goods and services. This impact reflects the employment factor.

Another aspect of the sustainability framework for ports is the environmental impact. The quality of air and water, coastal and marine environment, and waste management are considered main indicators. The United Nations (1992) asserts the location of the port, construction and port authority, handling, warehousing and road transport as sustainability criteria. The location of a port correlates with the location of the development site and the existence of a waste disposal site or facility. Port operations include processes in ship traffic and discharge, the impacts of shipping leaks and spills, hazardous goods, and cargo-handling activities in port-hinterland transportation (Darbra et al., 2005). The main impact of ports on sea water stems from the discharge of pollutants and toxic substances in seas. Ballast water, disposal of waste produced by port operations, and fuel and cargo residues are the primary pollutants of water. Accidents resulting in oil spills trigger more severe damages and instant implications. These sea pollutants harm the wildlife in coastal and marine ecology as well as the related marine sources (Yap and Lam, 2013). Air quality consists of two main components: (i) dry bulk cargo handling and warehousing, construction works on road, and road traffic impacting the particulate matter (PM) concentration, and (ii) pollutants such as sulfur dioxide ($SO_2$) concentration dispersed by ships, and nitrogen dioxide ($NO_2$), carbon monoxide (CO) and hydrocarbons (HC) emitted by vehicles and port equipment (Berechman and Tseng, 2012). These pollutants negatively impact the ambient air quality and life forms in the vicinity of ports (Bailey and Solomon, 2004). The environmental impact includes coastal hydrology such as coastal and marine environment, currents, tides, coastal erosion, coastal currents, residue accumulation, underground water currents, water drainage and other physical factors in the coastal areas. It also includes species, sizes, toxicity, and sediment pollution, closely correlating with biological diversity and ecosystem, referring to the pollution of seafloor as measured by coastal and marine ecology. Oil transportation operations, an auxiliary industry, introduce higher risks of oil spills (IMO, 2011). In addition to the above components, the implications of dredging are also closely studied by various scientists. Dredging substantially transforms the environment. It may have negative implications on the entire sub-criteria defining the port city and the marine and coastal environment. For instance, comprehensive dredging in the Ems Estuary in the Netherlands (De Jonge et al., 2012) escalated turbidity, which, in turn, disturbed the ecosystem and significantly affected the sustainability of marine ecology in the entire region, including fishery stocks.

The Port of Singapore, located in one of the world's largest port cities, is a good example in terms of economic contribution and land limitation (Xiao and Lam, 2017). This stems from Singapore being a small island city-state, highly dependent on the port for import and export. As a transfer hub, it acknowledges the world as its hinterland. From economic, social and environmental perspectives, it is clearly evident that the positive correlations between the port and the city of Singapore heavily outweigh the negative correlations. Deductions for policy-makers include continuously improving the port to maximize Singapore's economic and social positive relations and to minimize the environmental impacts.

However, it should be noted that the correlation between the city and the port is dynamic and subject to change in time. In that aspect, Singapore's decision to relocate transfer hub operations to the

planning area Tuas is considered a positive development. Bridging the local and global economies, the Singapore port city is a prime example of the integration of urban and port systems in a complex and dynamic nature. Recognition of a port city's green approach and habitability brings economic benefits. Future research may focus on case studies on port cities to examine size, national economy, handled cargo types and other variables to better explore the factors impacting the development of a port city.

Shanghai is another city that handled 43.3 million TEUs in 2019. The port developed rapidly once the central authority allowed Shanghai to set off an economic reform in 1991. In 2004, the Yangshan deep-sea port was constructed on the Yangshan Islands in the Hangzhou Bay, connected to Shanghai by the Donghai Bridge. This allowed the port to overcome the challenges of shallow waters in the current location of the port and to rival the neighboring deep-sea port, Ningbo Zhoushan. The city and the port mutually supported each other's development in the 20th century, particularly during the traditional debris transportation connecting the city to the hinterland areas by the Yangtze River and the Grand Canal. During the early 30 years of the People's Republic in the 1950s and 1970s, the country carried out little direct trade with the outer world, with the exception of the former Soviet Union, and indirect trading was mostly carried out through Hong Kong. In the post-Mao period in the 1980s and 1990s, China launched the "open skies" policy and economic reforms. Shanghai subsequently regained its development acceleration as the most important manufacturing hub in China, targeting both domestic and international commerce.

The Port of Shanghai has maintained its leading position among the global container ports since 2010. Having achieved a new record in monthly figures in October 2020 with a 4.2 million TEU business volume, the Port of Shanghai went on to break a new record in daily figures on July 30, 2020 with 149,565 TEUs (Dag, 2020). The Port Authority of Shanghai joined in the partnership, consisting of "COSCO Shipping," "China Railway" and "China Railway Container Transport," for an investment project to boost the current capacity in the maritime- and railway-linked container transportation up to 200,000 TEUs with a 45-percent share. In developed ports, the share of maritime and railway linked container transport reaches 20 to 40 percent in total handling volume (Ying, 2019).

Such an example in Türkiye is the ports located in the Kocaeli Region. The report on the Port of Derince and Kocaeli Region, a significant port city in Turkish foreign trade, contains a current situation analysis, examines the region's contributions in the industry, commerce, transportation and Turkish economy, determines the port's conditions in terms of partnership, authority, technical infrastructure, investment, transportation connections and other external factors, then evaluates the potential (Erdoğan et al., 2014). It is considered crucial to expand the capacity of the Port of Derince on both the national level and in the Kocaeli Region to maximize speed, quality and ease; compete on a global level; and to contribute significantly in the previously supplied foreign trade volume. Based on the current commercial developments, the demand in the globally trading ports in Kocaeli will continue to surge rapidly. Accordingly, at least one port must be improved to the higher scale. The Port of Derince (Safiport) is estimated to have the appropriate potential. Both the surveys and the face-to-face interviews and focus group studies concluded that the Port of Derince is perceived as a strategic port with the potential to contribute not only to the local economy in Kocaeli, but to the national economy at large. It should therefore be considered a critical port. Furthermore, its hinterland reaches approximately 70 percent of Central and East Anatolia with highly significant.

In that respect, the following is advised: efficient use of the railway; immediate implementation of projects to this end and the development of new projects; considering that the current road connection will prove insufficient and create bottlenecks against the increasing capacity subsequent to the new investments, the construction of a new connection line linking with TEM and connecting the port to this new line by an underpass; and the planning of intermodal

connections in consultancy with the relevant parties to address the integrated supply chain currently trending around the globe. Port of Derince, Safipo, is one of the rare ports where the rail line reaches the docks. This allows for the handling of all types of cargo by railway. The port has the target to handle 4 million metric tons of cargo arriving by railway on the eight lines within the port, employing the cranes to operate on these lines (UTİKA 2016).

The common aspects of the above examples include the use of technological handling equipment and prioritizing railway connection and intermodal transportation capacity to ease the flow of container traffic. A focus on gaining and improving this capacity in the investment projects towards the container ports of İzmir has been advised.

To summarize: the sustainability of ports requires a systems-oriented approach that considers all economic, social and environmental factors. Demand projections gain significance in that context, while further evaluations are necessitated in social and environmental issues.

Ports and port cities are considered with a holistic approach within the sustainability framework. The sustainability of port vicinity in the İzmir region, however, is the priority aspect in decision-making. The close correlation between the ports and the living areas highlight environmental sustainability. While this aspect is currently dealt with the green port approach in Türkiye, applying international criteria would present a sectoral advantage. With that in mind, the report includes the green concept and the energy efficiency and management of ports as criteria in the assessment of port sustainability.

### 1.5.3. Energy and Environmental Sustainability

The energy and environmental sustainability aspect in the development axes of the ports of İzmir are the main indicators contributing to the integral sustainability ports and the development of İzmir as a port city. Environmental sustainability is assessed based on green port criteria and the sustainability of energy based on energy efficiency and management.

Leading many operations in diverse disciplines of navigation and the economic movement of sectoral shareholders, port cities are also subject to the implications of energy consumption in these dynamic processes. Improving resource efficiency as well as environmental sustainability in ports will contribute to coastal expectations and transformation through benefits to the sustainable development goals. In that context, ports are strategic targets for cities in terms of green growth and energy resource management in the value chain of a circular economy. The estimations by global economies indicate that, in line with the growth scenarios for trade, ship sizes and related port facilities and capacities as well as the investments based on estimations will increase while simultaneously dragging up fossil fuel consumption in proportion (OECD, 2012; PIANC, 2014a). This correlation has highlighted in the recently trending sustainable economies the importance of developing national and regional economies and social structures in terms of quality and quantity through more sustainable models (Asgari et al., 2015; ESPO, 2016). Indeed, conceptual transformations such as the blue and green growth concepts in these models have been acknowledged as strategic preferences in national and international policies. Energy efficiency and management, as well as the development of the green concept in these conceptual transformations, became the main indicators of economic and social change.

The sustainability of energy is a transformation process from fossil fuel consumption behavior to a zero-carbon approach. In long-term structural institutions such as ports, however, the sustainability of energy is directly correlated with the efficient and effective management of energy. Currently, the ISO 50001 Energy Management Systems are considered an efficient management tool for such institutions. In terms of the sustainability of energy, improving low-carbon approaches and installing renewable energy sources is a strategic goal for authorities.

The green concept introduces significant gains including process improvement, establishment development planning and preserving environmental sustainability. The green port concept can be assessed in two categories: for Türkiye and for the world. Neither process is imperative at the moment for all ports in Türkiye. The main criteria of green ports in Türkiye include the following:

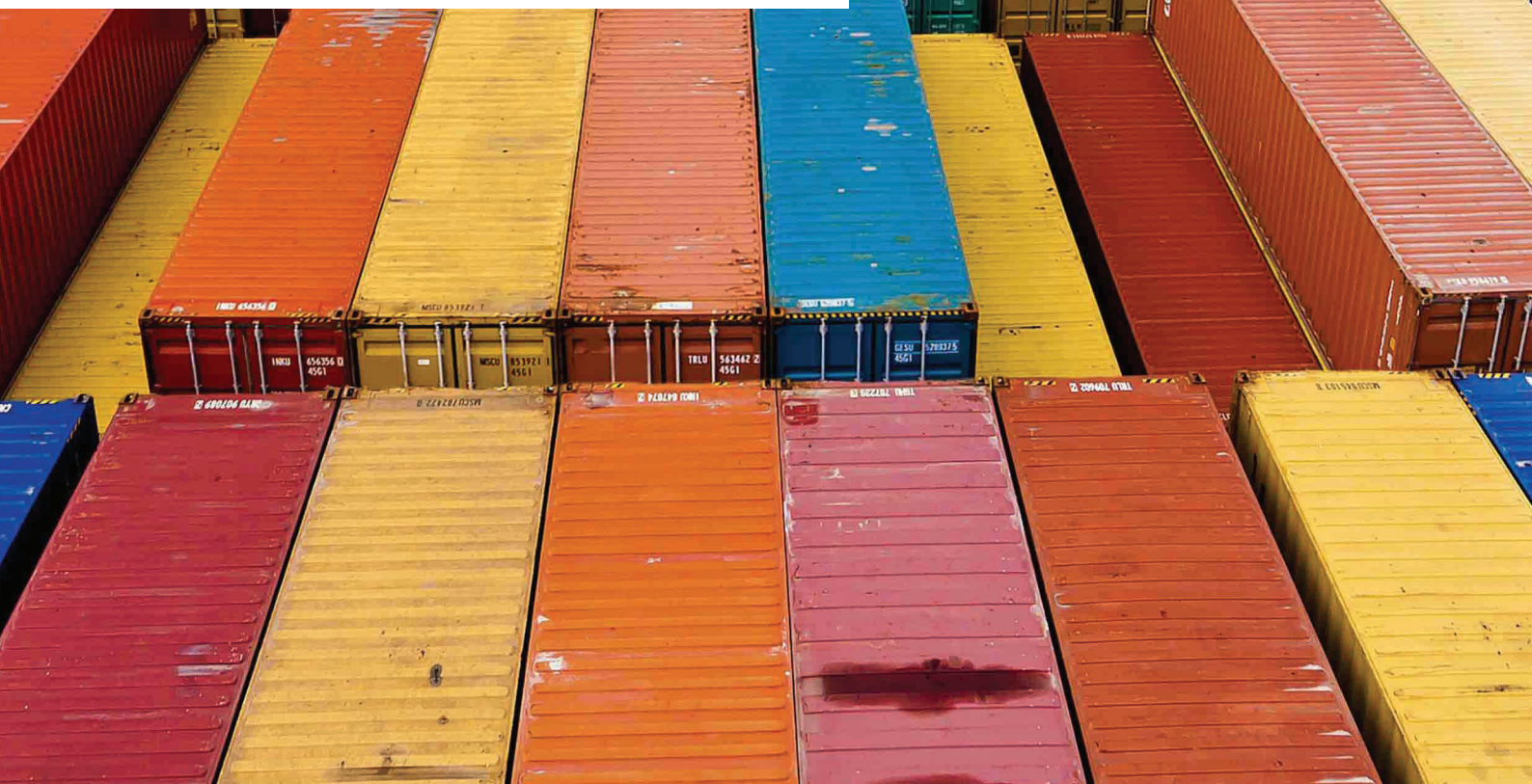
- Established and certified the integrated management system, including ISO 9001 Quality Management System,
- OHSAS 18001 Occupational Health and Safety Management System, and ISO 14001 Environment Management System.
- Effective upkeep of these quality certificates,
- Operations in line with legal regulation on environment.
- Green port certification in Türkiye is under the authority of the General Directorate of Maritime Trade with corporate support by the Turkish Statistical Institute.

The General Directorate expects Green Port certified port authorities to comply with all waste regulations including:

- Regulation on Solid Waste Management,
- Regulation on Packaging Waste Management published on November 6, 2008 in the Official Gazette No. 27046
- Regulation on Amendments to the Regulation on Legal Provisions for Green Port Facilities,
- Regulation on Waste Battery and Accumulator Management and the Regulation on Amendments to the Regulation on Waste Battery and Accumulator Management as published in the Official Gazette No. 27537 on March 5, 2010,
- Regulation on Hazardous Waste Management,

- Regulation on Waste Collection from Ships and Waste Management,
- Regulation on Water Pollution Management, Regulation on Hazardous Chemicals,
- Regulation on Training and Authorization within the scope of the International Maritime Dangerous Goods Code,
- Regulation on Waste Oil Management,
- Regulation on Water Pollution Management and Regulation on Amendments to the Regulation on Water Pollution Management,
- Regulation on the Management of Expired Tires,
- Regulation on the Management of Soil Pollution and Point Source Pollution

Developing energy and environmental sustainability concepts along the development axis of ports in İzmir is a strategic preference. In this aspect, there is a need for fundamental indicators contributing to the integral sustainability of İzmir as a port city. Within the scope of this study, the green concept was acknowledged as the basis for environmental sustainability, and energy efficiency and management as the basis for energy sustainability in the context of the current situation of the ports in İzmir.



CHAPTER 2.

# Assessment of the Ports in the İzmir Region

# 2.1. Foreign Trade and Maritime Transport in Türkiye

Despite the 7.5 percent shrinkage in global trade in 2020 (World Trade Organization, 2020), Türkiye's total trade volume dropped by only 0.5 percent and registered as $389.18 billion (TurkSTAT, 2020). Like in other developed economies, import dropped from $15,533.19 billion to $13,908.13 billion by a 10.5-percent decline margin (Table 8). The import in developing economies dropped from $9,107.85 billion to $8,179.29 billion with a 10.2-percent decline.

In 2020, Türkiye's exports registered at $169.67 billion, with $100.92 billion consisting of exports made by sea (Table 9). The share of maritime transport in exports was 59.5 percent. The share of exports carried out with maritime transport gained particular momentum in 2016, increasing from 53 to 60 percent.

As of 2020, Türkiye's total import registered as $219.51 billion while maritime import reached $114.83 billion. The share of maritime trade in Türkiye's import is 52.3 percent. In 2019, the relatively severe decline in import prompted a decline in the share of maritime trade as well.

Maritime transportation accounted for $215.75 billion, corresponding to 55.3 percent of the total $389.18 billion monetary value of Türkiye's foreign trade volume.

In 2020, foreign trade deficit surged by 68.8 percent from $29.51 billion to $49.84 billion. The correspondence rate of import and export declined from 86 percent in 2019 to 77.3 percent in 2020 (Figure 17). Over the last two years, fluctuations in the foreign trade components have particularly influenced the share of maritime trade.

**TABLE 8.** Türkiye in Global Trade

| (billion USD) | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|
| Global (export) | 16,045.25 | 17,742.93 | 19,550.44 | 19,014.68 | 17,582.92 |
| Developed Economies (export) | 13,423.08 | 14,580.73 | 15,843.55 | 15,533.19 | 13,908.13 |
| Developing Economies (export) | 7,354.17 | 8,310.89 | 9,237.63 | 9,107.85 | 8,179.29 |
| Türkiye (export+import) | 351.44 | 403.21 | 408.32 | 391.18 | 389.18 |

*Source: WTO, IMF and TurkSTAT*

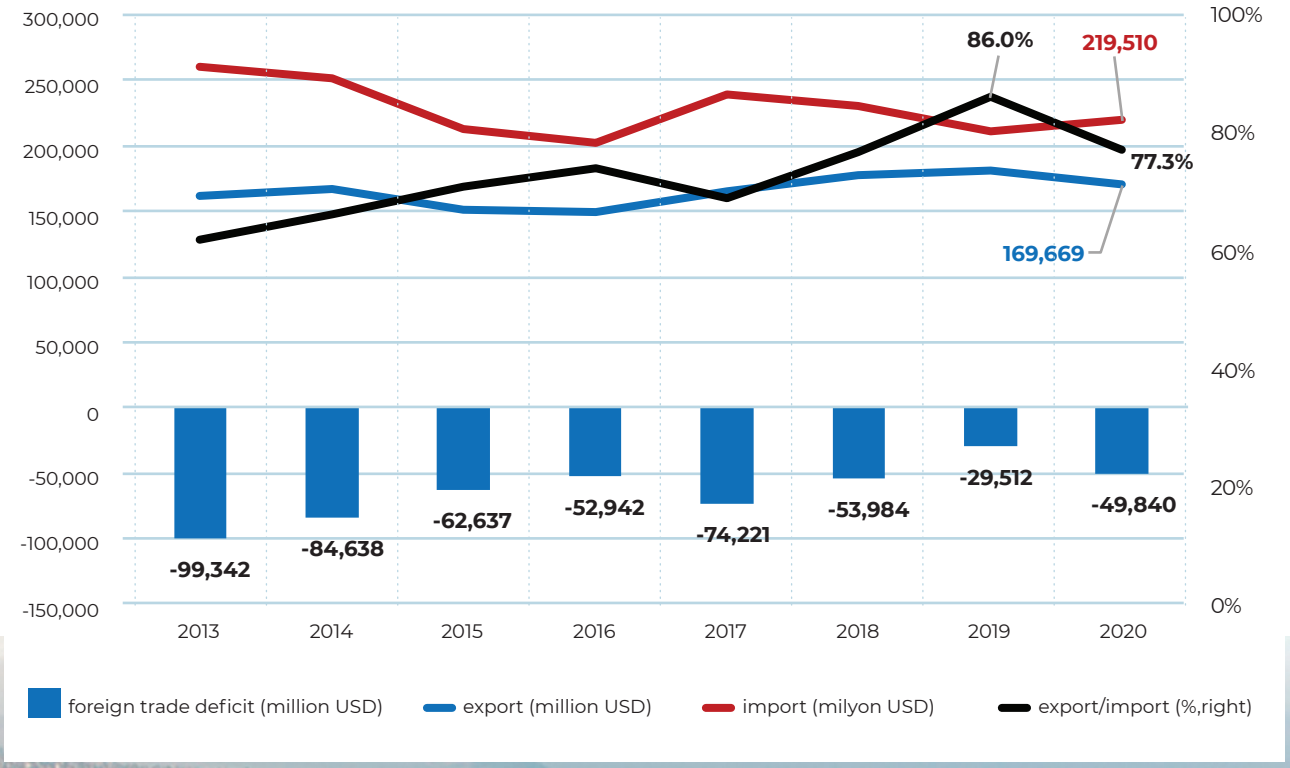
**TABLE 9.** Share of Maritime Transport in Turkish Export and Import

| | Total export (billion USD) | Export by maritime trade (billion USD) | Share of maritime trade in export (%) |
|---|---|---|---|
| January 2021 | 15.05 | 8.74 | 58.1% |
| 2020 | 169.67 | 100.92 | 59.5% |
| 2019 | 180.83 | 109.11 | 60.3% |
| 2018 | 177.17 | 108.80 | 61.4% |
| 2017 | 164.49 | 93.38 | 56.8% |
| 2016 | 149.25 | 80.14 | 53.7% |
| 2015 | 150.98 | 79.76 | 52.8% |
| 2014 | 166.50 | 88.90 | 53.4% |
| 2013 | 161.48 | 88.20 | 54.6% |

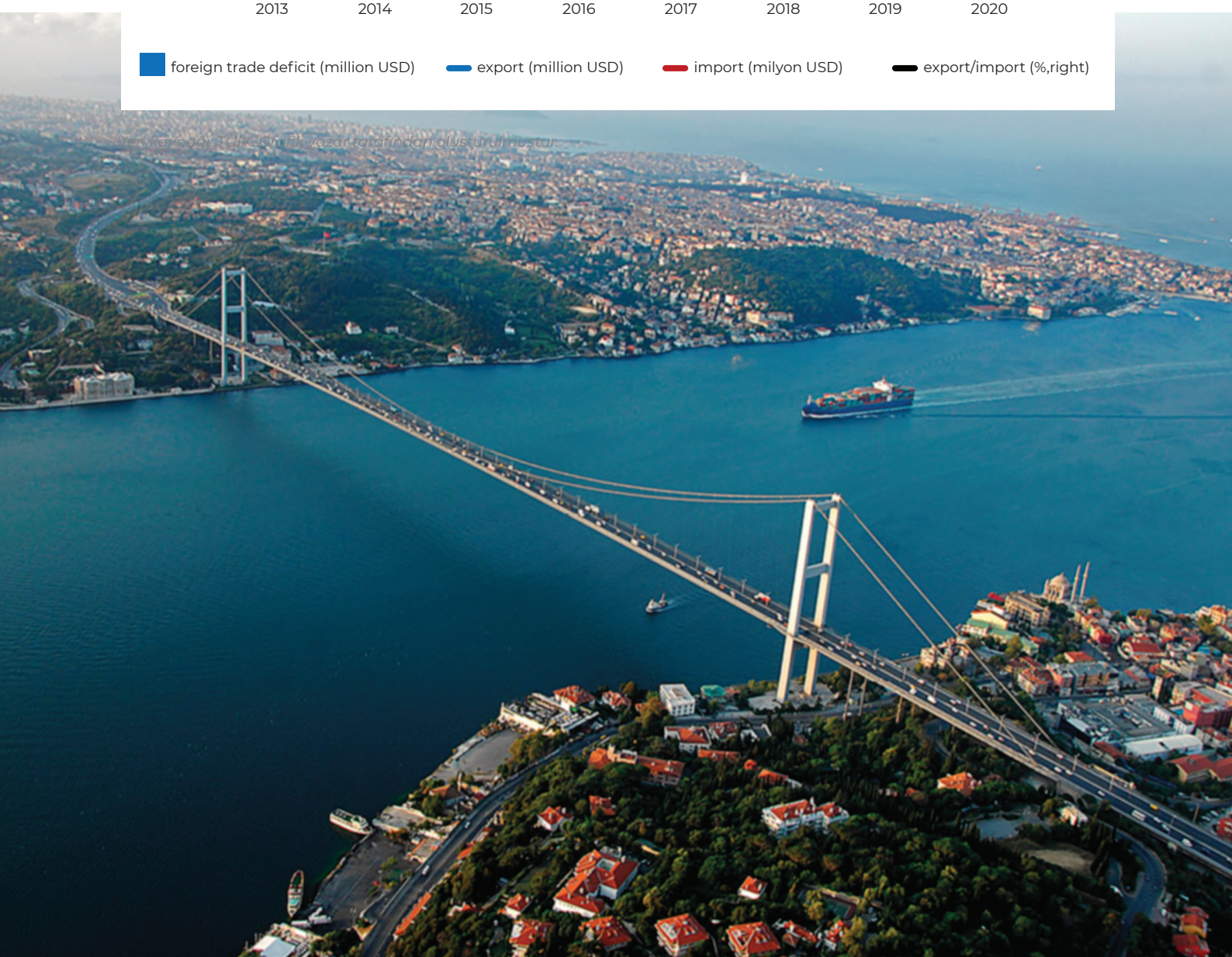
| | Total import (billion USD) | Import by maritime trade (billion USD) | Share of maritime trade in import (%) |
|---|---|---|---|
| January 2021 | 18.08 | 9.91 | 54.8% |
| 2020 | 219.51 | 114.83 | 52.3% |
| 2019 | 210.35 | 112.97 | 53.7% |
| 2018 | 231.15 | 136.74 | 59.2% |
| 2017 | 238.72 | 138.60 | 58.1% |
| 2016 | 202.19 | 121.01 | 59.9% |
| 2015 | 213.62 | 126.87 | 59.4% |
| 2014 | 251.14 | 147.78 | 58.8% |
| 2013 | 260.82 | 146.44 | 56.1% |

*Data source: TurkSTAT*

**FIGURE 17.** Foreign Trade Balance of Türkiye




*Veri kaynağı: TÜİK, Gümrük Müsteşarlığı tarafından oluşturulmuştur.*



## 2.2. Maritime Trade and Transport in İzmir

İzmir is located on the trade route through the Suez Canal towards Mediterranean, reaching the Black Sea via Dardanelles and İstanbul Straits. This ancient route predates the Suez Canal and connects significant port cities including Alexandria, İzmir, Athens (Piraeus), İstanbul, Constanta and Sevastopol.

Türkiye has 185 International Ship and Port Facility Security (ISPS) certified ports and registered the handling of 460.1 million metric tons in 2018, and 484.2 million metric tons in 2019 by a 5.2-percent increase margin. Of the total cargo handled at 2018, 72.3 million metric tons corresponding to 15.7 percent was handled in the Aegean Region while, in 2019, the amount handled in the Aegean reached 83.9 million metric tons, corresponding to 17.3 percent. The export and import cargo account for 90.4 percent of the total load while the remaining cargo consists of coasting with a negligible amount of transit cargo.

Ports under the İzmir and Aliağa port authorities account for 78 percent of total trade in the Aegean and the entire container-handling operations, as well as 99.4 percent of liquid bulk cargo, 98.9 percent of general cargo and 69.5 percent of dry bulk cargo handling.

The increasing distribution activities in the vicinity of ports are particularly in line with the escalation of container transport prompt ports to further prioritize intermodal transportation corridors and integration with inner regions through dry (inner) ports (Monios et al., 2018). Eventually, the port city becomes the heart of a logistics cluster influenced by the positive and negative implications of the increasing logistics activities.

The variation in the maritime activities in line with the variation of commercial and industrial activities led to the surfacing of terminals specialized on different areas. The distinction and development of cruise, container, liquid fuel, bulk and dry cargo terminals in the İzmir region revealed in line with the timeline of the port city development model in five stages, formulated by Hoyle (1989).

As the relations between the city and port are strengthened, a port-centered logistics cluster approach gains significance to ensure a modern urban lifestyle is retained in the city. This perspective will boost the productivity of the ports area and introduce a significant commercial income to the national economy, and enable the port to benefit from the advantages of the city.

The maritime transport system consists of a network of transport infrastructure linking the ports, production facilities and terminals that specialized ships visit during journeys to distribution hubs and markets. Timing and continuity are the keys to maritime transport. The Egyptian “Ever Given” container ship that, on March 24, 2021 ran aground in the Suez Canal and remained stuck for six days, blocking all passages through the canal in the meanwhile, had implications across the entire global economy. This accident exemplifies the significance of maritime transport and demonstrates the critical impact that loading and unloading planning has at ports. The unfortunate ship in this example was a 399.94-meter container ship with a 20,124 TEU capacity. The intense competition over the last 10 years prompted maritime companies to trade multiple smaller ships for fewer high-capacity ships. It is, therefore, essential for the ports of İzmir to have formulated existing strategies to install the requirements to serve such larger ships.

While maritime transport a significant component in export, a critical income source for countries, and, in import, a substantial operation to obtain necessary resources, it only creates value within its ecosystem and not on its own. As for its ports, İzmir evidently must regain its port city identity, which is an ancient heritage, to boost its share in the maritime transportation.

According to the 2020 data by UNCTAD, Türkiye ranks 16th in the world's merchant fleet with a total capacity of 28,090,402 DWTs. Crucially, we have climbed from the 24th rank up to the 16th in the last 10 years. The recently increased appetite of Turkish shipowners for higher shares in the global maritime operations and the multiplying numbers of maritime trainees indicate that the younger generation is being tempted to work in the maritime industry. These are all positive indicators for the development of the Turkish maritime industry. Within this scope, port operations are also expected to boost and develop, through modern technology, in line with developments in the maritime industry.

Container transport, on the other hand, is highlighted by the advancing global trade. The global maritime trade fleet reached a total of 24.3 million TEU container transportation capacity in 2019 while the Turkish maritime trade fleet registered 329,000 TEUs in total container capacity. The share of the Turkish maritime trade fleet in the global container transportation capacity is 1.4 percent. In addition to the Chinese public company COSCO having purchased the operating rights of the Asyaport in Tekirdağ, the overall improvements made to the container-handling capacity of Turkish ports reinforce the positive outlook for the future.

Ports are the most important destinations for ships, the main vessels of maritime transport and trade, and they are at the heart of goods movement. Given the development of ports in Türkiye, 149 port facilities in 2000 increased by a 40-percent margin and reached 210 facilities in 2019. There were 60 ports in 2000, which then increased to 185 in 2019. There has been a 210-percent increase in the number of facilities subject to international transportation. As for the cargo volumes for the same period at ports, the greatest increase rate was registered by export with a 389-percent margin. Türkiye's foreign trade cargo traffic by sea increased by 249 percent in 19 years.

While the cargo traffic increased by 0.5 percent on a year-on-year basis on a global level in 2019, the operations volume in the Turkish ports for the same period escalated by 5.2 percent and reached 484.2 million metric tons. The distribution of cargo types handled at Türkiye ports is 32 percent liquid bulk, 31 percent dry bulk, 25 percent container, 11 percent general cargo and 1 percent vehicle. Liquid bulk cargo has the greatest transaction volume with a total of 150.3 million metric tons corresponding to one third or a 32 percent share in all cargo types.

# 2.3. Ports

## 2.3.1. Overview

Freight fees in container transport have recently augmented. The operation volume of the container ports in the Aliağa region is predicted to surge in the post-COVID-19 period. One definitive factor will be the Volkswagen manufacturing plant to be established in the Manisa region to begin operations. However, recent news seems to indicate Volkswagen is having a change of heart about the investment.[5]

Evidently, the two major issues for ports are the railway connections and port expansions based on prediction of future operation volume. The 800-meter railway installed by Nemport in the Aliağa region on its own budget in 2020 is a critical development. The green port-certified Nemport thus boosted its 150 daily container-handling capacity to 200 containers per day. Technically speaking, a seaward expansion of ports is extremely cost for the maritime industry. Expansion towards land is the more feasible option. Given that the TCDD Port of İzmir is located in the city center and considering the additional load it will introduce to the city traffic as well as the insufficient port depth, it is recommended that the ports in the Aliağa region be evaluated as container ports. Within this context, it is significant to expand container ports in the Aliağa region to increase their storage capacity[6] to serve higher-capacity (7,000 TEUs and above) container ships.

According to the information provided by the authorities at the İzmir Iron and Steel (IDÇ) Port, the handled general cargo and dry bulk hiked from 3,309,000 metric tons in 2019 to 4.2 million metric tons (3.6 million metric tons of which is dry bulk) in 2020 (late December). This is a record-breaking figure for IDC. The IDC Port prioritizes the cargo by the company İzmir Iron and Steel (38 percent), though it also continues to undertake third-party operations. The port recently updated eight cranes and replaced two diesel cranes with electric ones. The port authority noted that they have the potential for a capacity boost, yet remain restricted due to the neighboring land, which is owned by the Mechanical and Chemical Industry (MKE) Institution.

The previously discussed ports in İzmir are sufficiently equipped with port facilities to handle various types of cargo (Table 10).

It is advised to examine the total handling statistics for ports in Türkiye and in İzmir to evaluate the current capacity utilization rate. Table 11 presents the amount of cargo handled in the ports of İzmir for all cargo types between 2011 and 2020 and the total amount of cargo handled in all Turkish ports during the same period. The share of ports in İzmir in the total cargo handled at Türkiye varied from 13 to 16 percent and reached approximately 16 percent in 2020.

5 The field study of the project included interviews with port authorities in the İzmir region to learn about the current situation and future predictions.

6 Options in expansion could be reevaluated. The MKE land could be considered, for instance

**TABLE 10.** Annual Capacities of the Ports of İzmir by Cargo Types

| Port Facility | Liquid Bulk Cargo (Metric Tons) | General Cargo (Metric Tons/Year) | Container (TEU) | Ro-Ro (Vehicle-Item) |
|---|---|---|---|---|
| ALPET ŞAMANDIRA | 200,000 | | | |
| PORT OF BATIÇİM | | 6,000,000 | | |
| ÇEŞME ULUSOY | | | | 200,000 |
| EGE STEEL PORT AUTHORITY | | 7,000,000 | | |
| EGE GAZ TERMINAL | 4,415,040 | | | |
| EGE FERTILIZER PORT | 310,000 | 5,000,000 | 1,000,000 | |
| ETKİ PORT | 3,700,000 | | | |
| PORT OF DIKILI | | 800,000 | | |
| PORT OF HABAŞ | | 10,000,000 | | |
| IDC PORT | | 7,500,000 | | |
| NEMPORT PORT | | 500,000 | 750,000 | |
| NEMRUT PLATFORM | 240,000 | | | |
| PETKIM TERMINAL | 7,000,000 | 2,000,000 | | |
| SOCAR REFINERY STORAGE | 3,000,000 | | | |
| SOCAR ALİAĞA TERMINAL | | 350,000 | 1,500,000 | |
| STAR REFINERY | 10,277,400 | | | |
| TCDD PORT OF İZMİR | | 1,369,000 | 1,000,000 | 200,000 |
| TOTAL OIL TERMINAL | 1,385,064 | | | |
| TÜPRAŞ TERMINAL | 21,000,000 | | | |
| **TOTAL** | **51,527,504** | **40,519,000** | **4,250,000** | **400,000** |

*Data Source: The liquid bulk and general cargo capacity data in the table were obtained from the IMEAK DTO Aliağa Branch Manager on January 28, 2021; container terminal capacities from the corporate websites and/or through port operators; and Ro-Ro vehicles capacities were roughly calculated based on data obtained from port operators. The methods to calculate the capacity of a container terminal are explained in "Chapter 3.3.2" while the methods to calculate the capacity of a Ro-Ro terminal is explained in "Chapter 3.3.3."*

**TABLE 11.** Cargo-Handling Statistics for the Ports of İzmir and Türkiye 2011-2020 (Metric Tons)

| Years | Ports of Aliağa | Ulusoy Çeşme Port | TCDD Port of İzmir | Total in İzmir | Total in Türkiye | Ports of İzmir – Share in Türkiye (%) |
|---|---|---|---|---|---|---|
| 2011 | 37,907,516 | 914,178 | 10,471,241 | 49,740,219 | 363,346,723 | 13.69 |
| 2012 | 43,167,047 | 828.01 | 9,545,331 | 54,103,994 | 387,426,232 | 13.96 |
| 2013 | 40,014,873 | 971,286 | 11,096,292 | 52,630,143 | 384,930,758 | 13.67 |
| 2014 | 42,365,293 | 1,048,788 | 10,754,461 | 54,568,020 | 383,120,619 | 14.24 |
| 2015 | 48,794,379 | 1,064,412 | 9,604,994 | 59,815,737 | 416,036,695 | 14.38 |
| 2016 | 50,540,449 | 1,236,127 | 9,692,386 | 61,813,049 | 430,201,162 | 14.37 |
| 2017 | 55,635,041 | 1,243,164 | 9,891,727 | 67,157,805 | 471,173,896 | 14.25 |
| 2018 | 53,985,243 | 1,400,003 | 9,040,779 | 64,800,719 | 460,153,560 | 14.08 |
| 2019 | 65,799,062 | 1,553,848 | 9,226,482 | 77,098,663 | 484,168,412 | 15.92 |
| 2020 | 68,946,001 | 1,236,404 | 9,390,012 | 80,070,434 | 496,642,651 | 16.12 |
| **CAGR (%)** | | | | | | |
| 2011-2020 | 6.87 | 3.41 | -1.2 | 5.43 | 3.53 | |
| 2019-2020 | 4.78 | -20.43 | 1.77 | 3.85 | 2.58 | |
| 2011-2016 | 5.92 | 6.22 | -1.53 | 4.44 | 3.44 | |
| 2014-2019 | 9.2 | 8.18 | -3.02 | 7.16 | 4.79 | |

*Source: MoTI, 2021*

Prior to the COVID-19 pandemic, UNCTAD (2019) predicted that maritime trade would sustain its 3.4-percent annual compound growth rate throughout the period of 2019–2024 based on the estimated income flexibility of maritime trade for the 2006–2018 period and on the IMF growth estimation for GDP for the period of 2019 to 2024. However, the unprecedented global health crisis and ensuing economic crisis triggered by the COVID-19 pandemic critically injured maritime transportation. Global maritime trade registered a mild increase (2.8 percent) in 2018 before coming to a halt in 2019 due to the overall regression in global trade and reached the lowest point since the 2008–2009 financial crisis by a 0.5-percent marginal increase (UNCTAD 2020).

The performances of ports in Türkiye were affected by this global staggering. While the Turkish ports registered an annual growth of 3.53 percent over the last 10 years, this momentum regressed to 2.58 percent in 2020. The Compound Annual Growth Rate (CAGR) in the pre-pandemic five-year period from 2014–2019 peaked at 4.79 percent. This rate exceeds the concurrent global average as well as the medium-term predictions for global average in maritime trade. The total performance of ports in İzmir during the same period peaked at 7.16 percent and the ports in Aliağa reached 9.2 percent CAGR, both exceeding the concurrent average of Türkiye.

Global maritime trade achieved an annual average growth rate of 3 percent since 1970. Container transportation is the fastest-growing type of maritime transportation. Based on data for the period of 2008 to 2020, global maritime trade for all cargo types indicates a compound annual growth rate of 2.41 percent while global container traffic handled at ports registered a 3.64-percent increase(Table 12). During the same period, the transaction volume for all cargo types in the ports of Türkiye and İzmir reached 3.88 percent and 4.17 percent, respectively, in CAGR while container traffic registered 7.13 percent and 5.59 percent, respectively, with all values exceeding the global average.

**TABLE 12.** Comparison of the Ports in the World, in Türkiye and in İzmir

| Yıllar | Maritime Trade (Total of all cargo types – million metric tons) | | | Container traffic handled at ports (million TEUs) | | |
|---|---|---|---|---|---|---|
| | Global Total | Total in Türkiye | Total of Ports of İzmir | Global Total | Total in Türkiye | Total of Ports of İzmir |
| 2008 | 8,665 | 314 | 49 | 533 | 5.09 | 0.89 |
| 2020 | 11,537 | 496 | 80 | 819 | 11.63 | 1.71 |
| YBBO | 2.41% | 3.88% | 4.17% | 3.64% | 7.13% | 5.59% |

*Data source: UNCTAD, 2009; Clarksons Research Shipping Intelligence Network; MoTI Cargo Statistics (https://denizcilikistatistikleri.uab.gov.tr/yuk-istatistikleri.)*

In addition to maritime transport, cargo transportation is widely preferred in the transport network within the hinterland as it facilitates intermodal transportation and had a high positive impact on the performance of ports in Türkiye. The recent trend of general cargo switching to container transportation is predicted to continue. In that context, investments towards container terminals exceed the investments made in other types of ports all around the world. Gradually increasing efforts in the shipbuilding industry to build higher-capacity container ships oblige container ports to handle more containers and to store a higher number of containers within a certain period of time. In addition to the increased capacity, the increased size and draft in container ships are the other two aspects that the container terminals must consider. With that in mind, the following are the qualities a container terminal today should have or improve on: quays or berths suitable for longer ships to dock; further-reaching and faster-operating ship-to-shore cranes to load and unload from the longer ships; suitable quay depth; expanded stacking area; crane systems to rapidly transfer containers whose dwelling time is up to carriers; accelerating customs procedures to minimize container dwell time; and easy integration with internal transportation systems. The higher growth rate of container traffic compared to other types of transportation highlight container terminals as a priority in the competency assessment of ports.

### 2.3.2. Capacities and Handling Statistics of Container Terminals

The capacity of a container terminal consists of the "maximum container traffic that the terminal can operate" (Soberón, 2012). Expressed in TEU, the capacity value basically refers to the port's supply capacity in handling or stacking.

Various suggestions have been made concerning the calculation of a container terminal's capacity. There are three methods worth mentioning at this point. The first method is based on the operating capacity of the terminal's handling equipment. The operator's competency is just as significant in this method. The maximum number of containers a terminal can handle within a day, including unloading the containers from ship to shore and loading from shore to the ship, is expressed in TEU. The second method expresses the number of containers entering and exiting the port gates within a day in TEU. This method highlights the operating speed, or the competency of the port gate. The third method, on the other hand, includes the stacking area of a terminal as well as the capacity of equipment used in this area in the calculation and is the prevailing method in the capacity calculation. At this point, the maximum number of lanes where cranes can stack containers one on top of the other, and the number of ground slots to stack one TEU container gains significance. The most basic approach postulates that the larger a terminal's stacking area, the higher the number of ground slots. For this value to be reflected in the capacity calculation, there must be operating cranes moving containers within these slots. Capacity calculated based on the number of ground slots often equals a lower value than in the other two methods. It is therefore advised to consider this method in capacity calculation. In light of the above information, the capacity of a container terminal is calculated using the formula below (Watanabe, 2001; Soberón, 2012; Kourounioti et al., 2016; Saka, 2020).

$$C = \frac{(G * H * S * W)}{(DT * P)}$$

Variables in the formula are explained below:

- **C:** Annual capacity (TEU/year),
- **G:** Number of container ground slots (in TEU), H: Container stacking height
- **S:** Operational factor/the proportional value of the number of containers in a stack for a smooth operation ($0 < S < 1$),
- **W:** Total number of work days within the period (365 days per year),
- **DT:** Average container dwell time (days) at the stacking site,
- **P:** Peak factor (safety factor included to account for potential high traffic during peak periods) ($P \geq 1$).

Peak period (P) is often neglected in the capacity calculation. However, ports must consider potential peak periods, as explained in detail in the following chapter.

The number of ground slots refers to the number of slots allocated to a container of one TEU where multiple containers can be stacked one on top of the other and where containers can be moved (stacked or retrieved). The number of containers that can be stacked on this slot is expressed by the stacking height (H). Basically, the number of ground slots by the stacking height (H*G) equals the immediate theoretical capacity. Multiplying that amount by the number of work days per year (H*G*365) gives the theoretical annual capacity. Utilizing a port's theoretical capacity to the fullest is considered an unlikely real-life scenario. Once all slots are filled, there won't be sufficient movement area to retrieve a container stacked in a lower level. For this reason, operating a terminal's stacking area based on a reasonable operational factor (S) is the most feasible and preferred methodology. Even a 0.5 surpass over this value will result in more movements in container operations, thus extending the maneuvering time allocated per container and subsequently impacting the effective operation of the terminal. In light of this information,

the lowest possible S value is aspired for ideal operating conditions and the operational factor is generally assumed as "0.7" in capacity calculation (Saka, 2020). Soberón (2012), on the other hand, postulates that the operational factor can vary between "0.55 to 0.70."

The above described factors have a positive impact on the capacity of a container terminal. In other words, any increase in these factors will proportionately increase the terminal capacity. For example, if a terminal operator gains a new stacking area to the terminal, thus increasing the number of slots, the terminal capacity will increase accordingly. Alternatively, increasing the stacking height by procuring new cranes for the terminal will also increase the capacity. On the other hand, any loss in the number of work days of a port within a year, for whatever the reason, will result in the loss of terminal capacity.

In contrast to these factors in positive correlation with terminal capacity, there are two other factors located in the denominator of the formula which are in negative correlation with the container terminal capacity. The first of these is referred to as "Dwell Time (DT)" in the literature, which refers to the literal waiting time of a container. Extended DT caused by a delayed customs clearance or other reasons will result in the extended occupation of container stacking area, subsequently reducing the port's stacking capacity. Once a port manages to cut down the DT, a container's hold in the stack area will also reduce and the stacking capacity of the terminal will be enhanced.

DT varies for import and export cargo. For an imported container, a customs clearance period will occur before the container is picked up by the carrier company. Furthermore, the delays in the picking up of the container as well as the other factors may lead to extended DT. The fees applied by the ports are also influential on the DT. For export cargo, however, the DT is much lower as the cargo is often transported to the port within a very short period of loading. While providing a definite number of days is not possible, a deduction can be made based on previous research on the matter. UNCTAD collected and analyzed data from a total of 48 ports in 24 countries between the years 2017 and 2020 and concluded that the average container DT was six days for these ports (UNCTAD, 2018). Kourounioti et al. (2016) categorizes the factors impacting the container DT as follows: (1) The day and month of unloading, (2) Port of origin of the cargo, (3) Container type and size, (4) Container type to transfer. Based on a 2017 field study with port operators in Kocaeli, the DT can be grouped in three categories: (1) Five to six days on average for export containers, (2) Seven to eight days on average for import containers, (3) 12 days on average for empty containers (Saka, 2020).

The ports in İzmir operate primarily in export. According to the container trade statistics for the last three years (2018–2020), approximately 53 percent of containers handled in the container ports of İzmir are export cargo while 47 percent are import cargo. These figures mean that the export cargo will be prevalent when determining the container DT in the ports of İzmir. Taking other known factors into account, the capacity calculation for the container ports in İzmir has concluded that the average DT is five to six days.

The other factor in negative correlation with capacity is the "Peak factor." A type of security factor, peak factor takes changes in cargo traffic into account. It is used to calculate how much real stacking capacity can be created if a sudden peak is experienced in cargo traffic in a particular period. This value is determined based on the previous handling statistics of the port. Often symbolized as "P" in literature, the peak factor should be higher than the integer factor (1) ($P \geq 1$). Gonzalez (2015) suggests that this factor is often in the 1.1–1.3 range (can lead to a peak by a 10 to 30 percent increase). If a port authority expects a high peak, the stacking area should have sufficient capacity to handle the expected cargo traffic. Otherwise, the terminal operator will find it difficult to stack the arriving cargo during the peak period, which will cause disruptions to ship docking services.

Table 10 includes annual container capacities for four ports. Of these four ports, the yearly handling capacity of NEMPORT, whose number of ground slots and crane stacking capacity (6+1) is known[7], is calculated below by the formula explained in this chapter. As for the other factors in the formula, the below estimated values are used:

**G** : 3,046 TEU (Number of ground slots),
**H** : 7 (Stacking height),
**S** : 0.64 (Operational factor)
**W** : 365 days (Total number of work days within the period),
**DT** : Six days (Container dwell time),
**P** : 1.1 (Peak factor).

$$C = \frac{(3.046 * 7 * 0{,}64 * 365)}{6 * 1{,}1} = 754.669$$

Using the port's known number of ground slots and the RTG stacking height in addition to the above estimated values, the capacity of the NEMPORT port was calculated as close to the value 750,000 TEUs provided in Table 10. NEMPORT port is provided as an example for the calculation of a container terminal's capacity.

Table 13 shows the handling statistics for the container ports in İzmir and in Türkiye for the period of 2011 to 2020. The table provides the total of transaction volumes for the other three container terminals except the Port of İzmir within the scope of the Port of Aliağa. The performances of container ports in Türkiye over the last 10 years registered 6.63 percent in CAGR, surpassing the world average. Excluding the 2020 data, the CAGR for the five-year period between 2014 and 2019 was 6.78 percent, and was 9.78 percent for the more recent three-year period between 2016 and 2019. This data indicates that the transaction volume growth rate of the ports of Türkiye has increased in recent years.

The total data for container ports in İzmir indicates a close performance to all container ports in Türkiye. The 2020 data inflicted by the pandemic reveals a near-zero growth rate for both the world and Türkiye, while the ports in İzmir achieved a 2.25-percent increase rate during the same period. The fact that the ports in İzmir managed to maintain growth in operations volume despite the near-halt in the growth rate of global maritime trade in 2020, stems from the demand to ports of Aliağa. Container terminals in the area achieved a high growth rate of 12.63 percent. The Aliağa container ports had achieved a strikingly high CAGR of 20.84 percent during the three years prior to the pandemic. While there is a significant increase in demand to the ports in İzmir, the main driver of such a high increase in demand to the ports of Aliağa is that the TCDD Port of İzmir (Alsancak) has lost clients. The main reason of the shift in demand is the inclination towards terminals with more advanced technological equipment and faster service. Furthermore, the demand in the TCDD Port of İzmir may further decline if the quay depth proves insufficient for higher-capacity container ships. Currently, the total capacity of container ports in İzmir is approximately 4.25 million TEUs. According to 2020 data, around 40 percent of this total capacity is being used.

7 During the field study on January 28, 2021, NEMPORT Deputy General Director explained that, at the time, containers were stacked on 3,046 ground slots and that the port's vision for 2023 included raising that figure to 7,000. The cranes used in the terminal area, on the other hand, had a stacking capacity of 6+1.

**TABLE 13.** Container-Handling Statistics 2011–2020 (TEU)

| Years | TCDD Port of İzmir | Ports of Aliağa | Total in İzmir | Total in Türkiye |
|---|---|---|---|---|
| 2011 | 672,486 | 377,147 | 1,049,633 | 6,523,505 |
| 2012 | 695,798 | 413,573 | 1,109,371 | 7,192,396 |
| 2013 | 683,607 | 466,009 | 1,149,616 | 7,899,933 |
| 2014 | 678,756 | 536,518 | 1,215,274 | 8,351,121 |
| 2015 | 649,566 | 580,249 | 1,229,815 | 8,146,398 |
| 2016 | 679,904 | 641,844 | 1,321,748 | 8,761,974 |
| 2017 | 637,902 | 794,342 | 1,432,244 | 10,010,536 |
| 2018 | 610,908 | 944,705 | 1,555,613 | 10,843,998 |
| 2019 | 541,679 | 1,132,480 | 1,674,159 | 11,591,837 |
| 2020 | 436,385 | 1,275,521 | 1,711,906 | 11,626,650 |
| **CAGR %** | | | | |
| 2011-2020 | -4.69 | 14.5 | 5.59 | 6.63 |
| 2019-2020 | -19.44 | 12.63 | 2.25 | 0.3 |
| 2014-2019 | -4.41 | 16.12 | 6.62 | 6.78 |
| 2016-2019 | -7.3 | 20.84 | 8.2 | 9.78 |

*Source: UAB, 2021*

### 2.3.3. Capacities and Handling Statistics of Ro-Ro Terminals

The main approaches to calculating a container terminal's capacity are explained in the previous chapter. However, the method for calculating a Ro-Ro terminal differs. There are three major aspects of a Ro-Ro terminal's capacity: (1) How many ships can be handled simultaneously? (2) How much time is spent loading or unloading a ship? (3) What is the available waiting area for tractor-trailers/trailers and similar vehicles?

The TCDD Port of İzmir, for instance, can handle all cargo types yet lacks a designated waiting area for tractor-trailer/trailer type of vehicles. Therefore, calculating a definitive Ro-Ro handling capacity for the TCDD Port of İzmir won't be possible.[8]

The Çeşme (Ulusoy) Ro-Ro Port, unlike the TCDD Port of İzmir, is specialized on Ro-Ro transportation. The port contains two quays extending 323 meters and 213 meters, respectively.[9] Four ships can dock simultaneously to these quays. The total area of the port is 80,000 square meters. The area includes a 180-vehicle waiting area allocated to export vehicles and a 270-vehicle waiting area allocated to import vehicles. Each unit is a standardized 16 meter x-2.70 meter area, suitable for parking a tractor-trailer/trailer. The largest ships currently operating in Ro-Ro lines are 31,500 GT and 208 meters in size with a capacity of 270 tractor-trailers/trailers. The average loading or unloading time of a ship is six to eight hours on average. As the port equipment and personnel can only operate on one ship at a time, the average loading and unloading capacity per day is the handling of 540 vehicles. While the current personnel and equipment have the capacity to handle 600 vehicles per day, the ships used in lines cannot carry over 540 ships per patrol. It is, therefore, logical to assume the theoretical daily capacity as 600 vehicles and the current daily handling capacity suitable for operations as 540 tractor-trailer/trailer vehicles. Import vehicles can be kept at the port for at least 24 hours. The maximum annual handling capacity of the port under the existing conditions is calculated as 197,100 (365*540) vehicles.

While there are currently no short-term capacity boost projects for the Çeşme Port, a medium- or long-term action plan is on the table should the need arise. It is noted that there is a piece of land within the port area that can be repurposed as an additional 50- to 100-vehicle parking space. However, to achieve the theoretical daily capacity of 600 vehicles, the capacity of carrier ships operating in the lines should also be updated. In other words, if a ship with a 300-vehicle capacity is operated on at the port, the daily capacity will increase to 300 vehicles while the annual capacity will reach 219,000 vehicles.

If the TCDD Port of İzmir focuses on Ro-Ro transportation and allocates waiting areas for import and export vehicles as in the Çeşme Port, a more definitive port capacity can be estimated. An area of approximately 43 square meters (16*2.70) is required per tractor-trailer/trailer. Considering that a 30- to 40-percent safety margin will be allowed in the parking, an area of around 16,000 square meters should be allocated for this purpose. Given the size of the TCDD Port of İzmir, it is possible to repurpose the area in the future to meet the requirements in the Ro-Ro transportation if the need arises.

If such an action is considered in the long-term, then the same values can be considered for port capacity. Within this context: the current Ro-Ro handling capacity of ports in İzmir is 394,200 (2*197,100) vehicles with a potential to increase this capacity up to 438,000 (2*219,000) vehicles in the long-term by 2033.

Table 14 shows the handling statistics for the Ro-Ro ports in İzmir and in Türkiye for the period of 2011 to 2020.

8 Information obtained during the interview on March 19, 2021 with the Director of the TCDD Port of İzmir.

9 Information obtained during the interview on March 22, 2021 with the Operating Manager responsible for the operations of terminal.

**TABLE 14.** Ro-Ro Statistics for the Ports of İzmir and Türkiye 2011–2020 (Number of Vehicles)

| Year | Ulusoy Çeşme Port | | | TCDD Port of İzmir | | | Ports of Aliağa | Total of Ports of İzmir | Türkiye | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | B | Total | A | B | Total | B | | A | B | Total |
| 2011 | 42,681 | 2,800 | 45,481 | | 85,183 | 85,183 | | 130,664 | 362,958 | 1,392,746 | 1,755,704 |
| 2012 | 43,818 | 2,648 | 46,466 | | 67,782 | 67,782 | | 114,248 | 390,282 | 1,361,440 | 1,751,722 |
| 2013 | 45,586 | 3,350 | 48,936 | | 75,872 | 75,872 | | 124,808 | 453,730 | 1,586,400 | 2,040,130 |
| 2014 | 47,692 | 4,001 | 51,693 | 1,018 | 37,819 | 38,837 | | 90,530 | 458,974 | 1,507,080 | 1,966,054 |
| 2015 | 50,463 | 4,084 | 54,547 | 12,107 | 18,477 | 30,584 | 3,352 | 88,483 | 484,108 | 1,728,680 | 2,212,788 |
| 2016 | 54,819 | 4,148 | 58,967 | 13,529 | 19,063 | 32,592 | | 91,559 | 472,35 | 1,880,982 | 2,353,332 |
| 2017 | 52,388 | 5,358 | 57,746 | 23,046 | 19,489 | 42,535 | | 100,281 | 542,301 | 1,959,109 | 2,501,410 |
| 2018 | 61,365 | 5,258 | 66,623 | 18,994 | 18,750 | 37,744 | | 104,367 | 583,56 | 1,778,525 | 2,362,085 |
| 2019 | 72,315 | 7,168 | 79,483 | | 11,378 | 11,378 | | 90,861 | 591,734 | 1,534,665 | 2,126,399 |
| 2020 | 58,600 | 199 | 58,799 | | 15,565 | 15,565 | 590 | 74,954 | 504,752 | 1,435,111 | 1,939,863 |
| **YBBO % (2011-2019)** | | | **7.23** | | | **-22.25** | | **-4.44** | | | **2.42** |

*A: Tow-truck, tractor-trailer, trailer, and freight car carried by Ro-Ro ships, B: Other vehicles carried by Ro-Ro ships.*
*Note: The port-handling capacities of 100 vehicles and above are reflected in the statistical values. Source: MoTI, 2021*

A striking issue is the constant decline in the amount handled by the TCDD Port of İzmir over the years, dropping from 85,183 metric tons to 15,565 metric tons. The amount handled at Çeşme Port, on the other hand, registered a continuous increase and surged from 45,481 metric tons to 58,799 metric tons. The ports in Aliağa mainly provide container-handling services and have a very low rate of Ro-Ro handling. The performances of Ro-Ro ports in Türkiye over the last 10 years registered a 2.42 percent CAGR. The TCDD Port of İzmir, on the other hand, regressed by -22.25 percent. However, the gradual increase in the number of vehicles transported by the DFDS company over its Tarragona line from the TCDD Port of İzmir, launched in February 2021,[10] can be evaluated as a sign of capacity increase in the TCDD Port of İzmir.

While the Çeşme (Ulusoy) Port registered a decline in 2020 due to the pandemic, it overall achieved 7.23 percent CAGR, far surpassing the average of Türkiye. These figures reassure that the ports of İzmir will demonstrate a higher operation volume in terms of Ro-Ro transportation in the medium term.

There are two major ports in the area that primarily provide Ro-Ro services. Çeşme (Ulusoy) Port stands out in the handling of large hauler vehicles such as tractor-trailers/trailers. The TCDD Port of İzmir reached its peak performance in terms of Ro-Ro statistics in 2017, after which it spiraled into a gradual decline. The vehicles leaving this port immediately merge into the heavy urban traffic, presenting a critical problem for both the carriers and the community involved in the city traffic. Carriers seeking to avoid this issue are seeking alternative options.

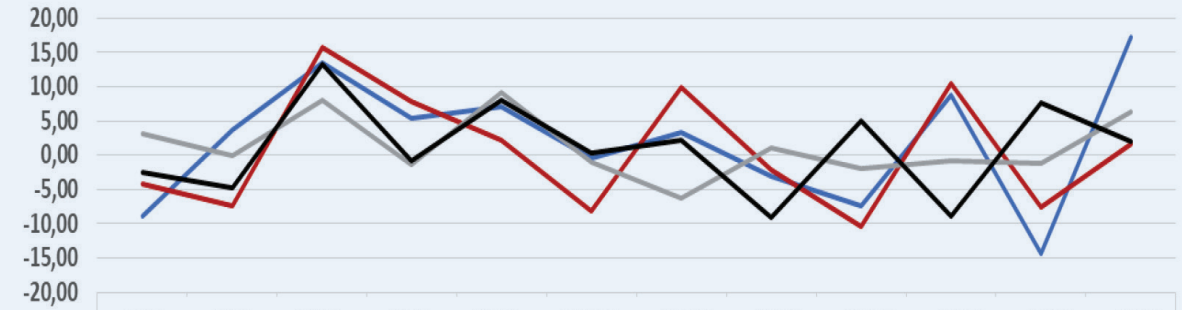
The TCDD Port of İzmir temporarily ceased tractor-trailer/trailer operations in 2018 and only maintained Ro-Ro transportation services for smaller vehicles. Following the assessments and reorganization of port entry and exit for larger vehicles during this period, the TCDD Port of İzmir resumed Ro-Ro transportation services for larger vehicles by the end of 2020 (Şengül, 2020). The reorganization assigned separate entrance and exit gates to the tractor-trailers/trailers and periodic Ro-Ro lines were launched in 2021 between the Port of Tarragona in Spain and the TCDD Port of İzmir.

10 During the authors' meeting with the DFDS official on April 5, 2021, it was noted that 237 vehicles were handled in February 2021 as part of the recently launched lines, while the number escalated to 621 vehicles in March 2021.

## 2.3.4. Examination of Peak Periods and Their Implications in the Turkish Ports

The growth rates based on monthly developments in the container traffic between 2010 and 2020 at Türkiye's ports are examined in three sub-periods below. Figure 18 includes individual curves representing each year and shows a striking increase in late February, early March. The lowest growth rate was 7.99 percent in 2012 while the other years ranged from 13 to 16 percent. The most striking growth rates were July (9.87 percent) and October (10.54 percent) in 2011 and October (8.73 percent) and December (17.23 percent) in 2010.

**FIGURE 18.** Increase in Transaction Volume at Türkiye's Container Ports (2010-2013)

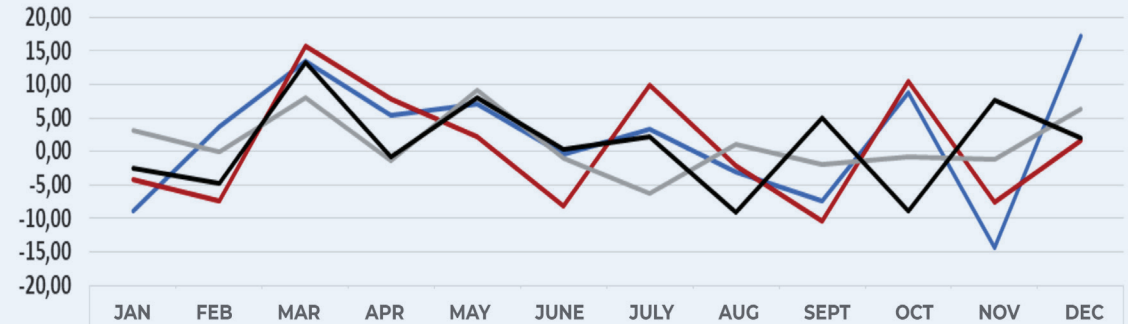



| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | -8,84 | 3,63 | 13,39 | 5,36 | 7,03 | -0,43 | 3,37 | -3,14 | -7,47 | 8,73 | -14,26 | 17,23 |
| 2011 | -4,22 | -7,44 | 15,75 | 7,85 | 2,23 | -8,08 | 9,87 | -2,09 | -10,37 | 10,54 | -7,49 | 1,68 |
| 2012 | 3,19 | -0,05 | 7,99 | -1,38 | 9,11 | -1,09 | -6,35 | 1,15 | -1,95 | -0,79 | -1,13 | 6,25 |
| 2013 | -2,56 | -4,84 | 13,27 | -0,85 | 8,01 | 0,40 | 2,12 | -9,05 | 5,06 | -8,80 | 7,61 | 2,09 |

*Source: https://denizcilikistatistikleri.uab.gov.tr/konteyner-istatistikleri. The chart was prepared by the author*

Every year in late February, early March is a striking increase (Figure 19). March 2015 witnessed an increase rate of over 22 percent. The other striking growth corresponds to October. All three Octobers, with the exception of the year 2014, registered an increased growth. October 2016 is the peak with a 14.22-percent increase. In August 2015 and 2016, 6-percent and 8-percent growth rates were determined, respectively. Another peak period occurred in December 2015 with a 10.44-percent increase.

**FIGURE 19.** Increase in Transaction Volume at Türkiye's Container Ports (2014–2017)




| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2010 | -8,84 | 3,63 | 13,39 | 5,36 | 7,03 | -0,43 | 3,37 | -3,14 | -7,47 | 8,73 | -14,26 | 17,23 |
| 2011 | -4,22 | -7,44 | 15,75 | 7,85 | 2,23 | -8,08 | 9,87 | -2,09 | -10,37 | 10,54 | -7,49 | 1,68 |
| 2012 | 3,19 | -0,05 | 7,99 | -1,38 | 9,11 | -1,09 | -6,35 | 1,15 | -1,95 | -0,79 | -1,13 | 6,25 |
| 2013 | -2,56 | -4,84 | 13,27 | -0,85 | 8,01 | 0,40 | 2,12 | -9,05 | 5,06 | -8,80 | 7,61 | 2,09 |

*Source: https://denizcilikistatistikleri.uab.gov.tr/konteyner-istatistikleri. The chart was prepared by the author.*

The 2020 data was affected by the pandemic and subsequently differed from previous years. However, the traditional peaks that occur in March and October were present. March 2020 witnessed an increase rate of 4.79 percent while March in 2018 and 2019 were 7.80 percent and

12.81 percent, respectively (Figure 19). In October, an increase rate between 9.96 percent to 13.87 percent was registered in all three years. Unlike the previous years, August 2020 enjoyed a 16.29-percent increase. This peak is attributed to the trade flow that was staggered or postponed in the previous years due to the pandemic.

The monthly distribution of container traffic in Türkiye's ports over the last 10 years indicates that the highest growth rate from the previous month was in March 2015 with a 22-percent growth. Every year in March, a significant increase is observed compared to the previous month's cargo traffic. The striking increase, on the other hand, either occurred in October or spread as a gradual increase over July and August.

Based on the assessment of container traffic in Türkiye ports over the last 10 years, it was concluded that the peak factor can be assumed as "P=1.2" (meaning that a 20-percent increase can occur), and that the operation volume at Türkiye ports is likely to peak in March and October.

**FIGURE 20.** Increase in Transaction Volume at Türkiye's Container Ports (2018–2020)


| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2018 | -4,40 | -3,28 | 7,80 | 0,80 | 8,03 | -4,55 | -1,46 | -7,22 | -2,16 | 13,87 | -9,12 | 8,50 |
| 2019 | -7,76 | -2,71 | 12,81 | 7,46 | -1,71 | -7,40 | 7,68 | -5,79 | 1,94 | 9,96 | -6,20 | -3,01 |
| 2020 | 2,87 | -7,38 | 4,79 | -6,29 | -4,18 | -3,15 | 5,65 | 16,29 | -2,61 | 12,20 | -8,62 | 2,36 |

*https://denizcilikistatistikleri.uab.gov.tr/konteyner-istatistikleri. The chart was prepared by the author.*

Evaluating the İzmir region within the framework of the port-centric logistics cluster model highlighted strong facilities and competencies in some fields and shortcomings in others (Acar, 2020):

Aliağa–Menemen, Manisa, Kemalpaşa and Torbalı routes are connected by state roads to the İzmir–İstanbul highway through the Aydın–Selçuk ve Manisa–Kemalpaşa routes.

There are rail lines arriving from the Aliağa–Menemen–Basmane, Manisa–Menemen–Basmane and Aydın–Torbalı–Basmane routes, which then connect via high-capacity road transportation to the Balıkesir, Afyon, Kütahya, Uşak, Denizli and Manisa provinces. The rail line in the Aliağa –Menemen–Manisa route

has a range D axis pressure capacity with a 22.5-metric-ton capacity per axis. Moreover, the largest OIZ in the region, the Manisa OIZ is along this route and is included among the priority junction line plans by TCDD. The Menemen–Basmane and the Aydın–Torbalı –Basmane routes both have a range C axis with a 20-metric-ton capacity per axis.

The Adnan Menderes Airport is located 14 kilometers from İzmir city center within the limits of the Gaziemir district. It is the third-largest cargo terminal in Türkiye with a total cargo terminal area of 21,319 square meters, of which 7,794 square meters are indoors.

The most important criterion for a port-centric logistics cluster in terms of first-level cluster competencies is whether the evaluated port is a major port with an efficient customs office. In that context, the ports in the İzmir and Aliağa regions must be evaluated in terms of logistics competency. The TCDD Port of İzmir, Nemport, Ege Fertilizer, IDC, Petkim and SOCAR Aliağa ports in the region collectively have a significant port capacity consisting of different cargo classes.

The TCDD Port of İzmir (Alsancak): It is established on a 635,000-square-meter space. The existing 25 berths/quays can serve 25 ships at a time. Draft varies between seven to 12 meters. The port has an annual container capacity of approximately 800,000 TEUs and cargo capacity of 10 million metric tons. In

2019, the port handled 6,487,304 metric tons of cargo corresponding to 605,727 TEUs. In 2020, the amount dropped to 5,760,066 metric tons, corresponding to 531,682 TEUs. The handled cargo declined in 2020 on a year-on-year basis by 11.2 percent in metric tons and

by 12.2 percent in TEU. The port also has a railway connection and singlehandedly accounts for approximately 40 percent of foreign trade carried out in the region and in İzmir (Acar and Gürol, 2016). The port has five SSG, nine MHC, 15 CRS, 14 RTG and 15 CRS cranes (İZKA, 2019). The port's distance from the regional logistics centers is as follows: Gökköy (Balıkesir) 172 kilometers, Uşak 215 kilometers, Kaklık (Denizli) 245 kilometers. It is also located 45 kilometers from the Manisa Organized Industrial Zone. Manisa OIZ is one of the largest organized industrial zones in West Anatolia and is only recently recognized when it stood out in this study. The 14 organized industrial zones operating under the Aegean Region Chamber of Industry, which gathers the industrials of İzmir under its roof, are located within 10–114 kilometers from the TCDD Port of İzmir.

SOCAR Aliağa Port (Petlim): Located in the Aliağa region, the port is established on a 420,000-square-meter space. The port includes a 700-meter quay with a 16-meter draft. The port's annual container-handling capacity is 1.3 million TEUs (Acar and Gürol, 2016). The port has 10 RTG, three STS, three Reach Stacker, three empty container-handling equipment and 26 tow trucks (TÜRKLİM, web). The port's distance from the regional logistics centers is as follows:

Gökköy (Balıkesir) 150 kilometers, Uşak 265 kilometers, Kaklık (Denizli) 325 kilometers and Manisa Organized Industrial Zone 60 kilometers.

Petkim Port: Located in the Aliağa region, the port has three quays: a 175-meter quay with a 9.5-meter draft, a 120-meter quay with a 5.5-meter draft, and a 221-meter quay with a 10-meter draft. The port operates on general, bulk, and liquid-gas cargo. The total annual handling capacity is 7.5 million metric tons (TÜRKLİM, web).

Nemport Port: Established on a 160,000-square-meter space, the port maintains new investments. It has an annual container handling capacity of 750,000 TEUs with a 1,080-meter quay with a 21.5-meter draft. The port has two STS, five MHC, five RTG and nine Rig Stacker cranes (TÜRKLİM, web). The port's distance from the regional logistics centers is as follows: Gökköy (Balıkesir) 150 kilometers, Uşak 256 kilometers, Kaklık (Denizli) 325 kilometers.

TCE Ege Port: Located in the Aliağa region, the port is established on a 485,000-square-meter space. It has two quays, each with a 28-meter draft, and a total length of 784 meters. The installed structure allows the annual handling of 1 million TEUs, 2.5 million metric tons of general cargo, or 5 million metric tons of bulk cargo. The port has two STS, two MHC, and 11 pieces of container-stacking equipment (TÜRKLİM, web). The port's distance from the regional logistics centers is as follows: Gökköy (Balıkesir) 153 kilometers, Uşak 253 kilometers, Kaklık (Denizli) 323 kilometers and Manisa Organized Industrial Zone 57 kilometers.

IDC Port: Located in the Aliağa region, the port is established on a 200,000-square-meter space. It has two quays, each with a 28-meter draft, and a total length of 950 meters. Operating in general and dry bulk, the port's annual capacity is 7.5 million metric tons (TÜRKLİM, web). The port's distance from the regional logistics centers is as follows: Gökköy (Balıkesir) 153 kilometers, Uşak 253 kilometers, Kaklık (Denizli) 323 kilometers.

These ports are mainly clustered in the Aliağa region and are operated by the Aliağa Port Authority. The evaluation of these ports in terms of container transportation, which has recently gained significance due to global developments, indicate over 3.85 million TEUs in handling capacity according to the official figures. Consisting of three separate terminals,

Türkiye's largest container port, İstanbul Kumport, has a capacity of 5 million TEUs. The nearest rival in the Mediterranean, the Port of Piraeus, had a 5.65 million TEU container-handling capacity in 2019 (Ministry of Trade, 2021). October 2020 data pertaining to the Aliağa Customs Directorate affirms that, despite the 7.8-percent decline compared to the previous year, it was still the second-highest export customs directorate of Türkiye in 2020, as it was in 2019. The 2020 regional data by the Ministry of Trade also backs this

conclusion. A comparison of the port authority statistics indicate that the Aliağa Port Authority is the third in total handling following the Botaş and Kocaeli Port Authorities.

The 900-meter breakwater of the Port of Çandarlı to be constructed in the region is completed and 697 million Turkish lira was expended. However, the tender, valued at 12 million TEUs, failed to attract any buyers and the project was divided into batches of 4 million TEUs. A second tender couldn't be held, however, and the construction came to a halt. The projected port is 100 kilometers from the Basmane train station and 66 kilometers from Menemen. Railway connection is only possible through the Aliağa train station at 33 kilometers.

The second level of the port-centric logistics clustering hierarchy requires logistics villages, inner ports, intermodal terminals and such facilities to enable freight transportation, transfer and distribution.

The only logistics village/center in the region that is yet to be completed is the Kemalpaşa Logistics Center.[11] The incomplete facility currently has no direct connections to the railway. According to calculations, approximately 68 kilometers of railway construction is required for a direct connection to the existing railway, which is the İzmir–Aydın–Denizli line of 20 metric tons of capacity per axis. The facility is located on the İzmir–İstanbul highway.

The closest port to the above-mentioned logistics center is the TCDD Port of İzmir, which stands at 30 kilometers by state roads. The planned logistics center has the potential to become a regional logistics center in the context of the needs of İzmir.

Despite being located very close to the ports in Aliağa, the Biçerova railway station, currently operating as a freight transfer hub, lacks the sufficient infrastructure to operate in the ports area. It requires both a warehouse area and an additional line allocated to freight.

As for the nearest logistics centers and the organized industrial zone in the region, the distances from the ports in the Aliağa region are as follows: Gökköy (Balıkesir) 150 kilometers, Uşak 265 kilometers, Kaklık (Denizli) 325 kilometers and Manisa Organized Industrial Zone 60 kilometers. The furthest facility, therefore, is within a five-hour reach by an average speed of 60 km/h, taking all possible conditions into account. The distance is therefore within the legal limits for a single driver to cover within a day. However, there are no naturally occurring logistics centers/villages/hubs in the area to directly support the port cluster in the Aliağa region. This undermines the transportation operations towards the ports.

The third level of port-centric logistics clustering includes indoor container warehouses, distribution centers and container sites/warehouses for storage and distribution clustering.

There are sufficient container sites and storage areas in the İzmir region within the reach of the main highway and railway routes and in the vicinity of ports. The most recent logistics center is the Kemalpaşa, which has not yet officially launched operations.

11 The Kemalpaşa Logistics Center was initially to be completed by 2015 and the majority of infrastructure investments are completed through the two tenders held so far. In August 2020, the "Kemalpaşa Logistics Center Infra- and Super-Structure Construction Completion Work Tender" was opened to complete the remaining work. The tender subject and the works to be completed were defined as: "Manufacturing of interception channels and outlets, field leveling works, manufacturing of concrete-covered loading and unloading site and concrete-covered vehicle roads, manufacturing of 12 kilometers of railway, procurement and installation of 13 switches, manufacturing of the remaining railings." (MoTI, IKN 2020/320003). The Kemalpaşa Logistics Center currently awaits investments to complete the superstructure requirements to launch operations.

## 2.4. Sustainability at the Ports of İzmir

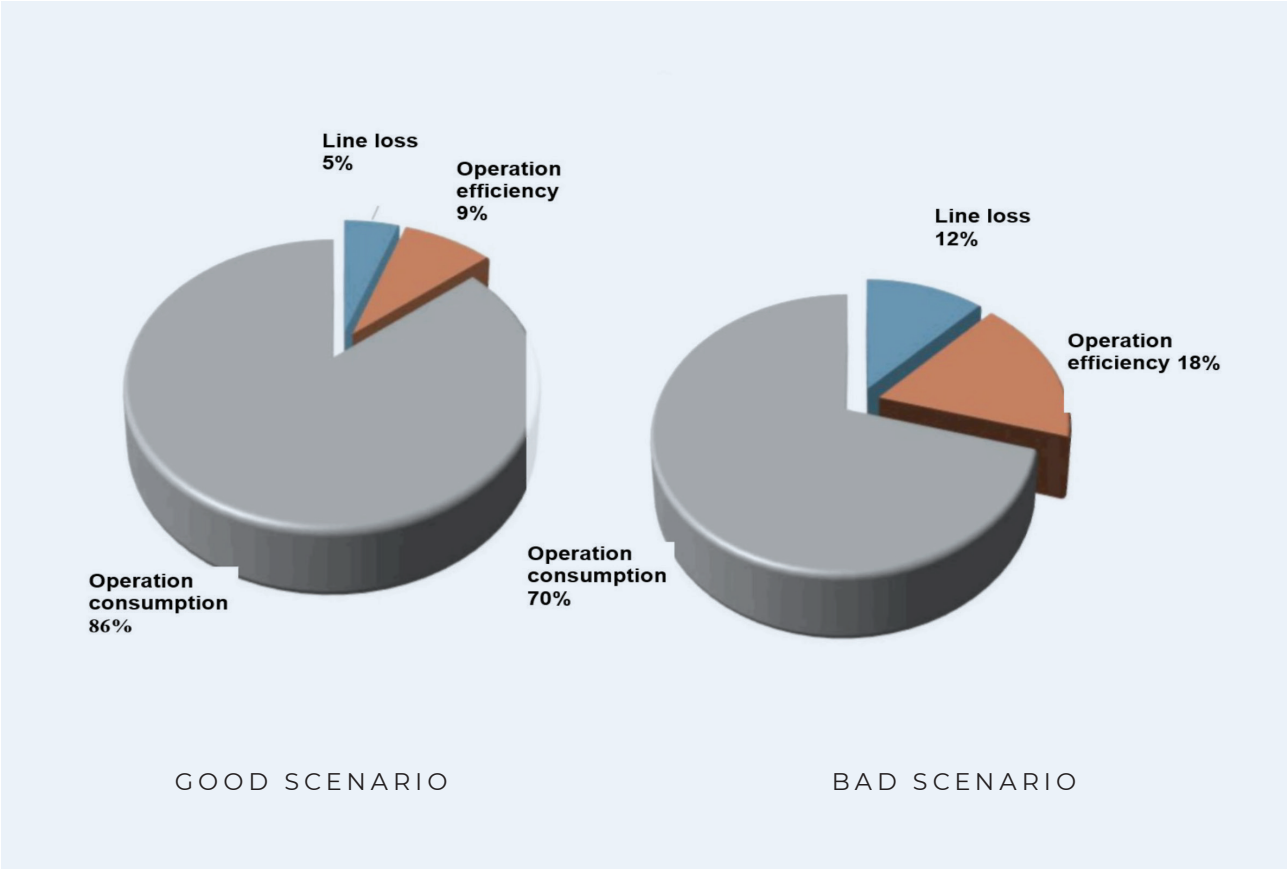
The ports area will add value to the sustainable growth strategies of İzmir as a historical port city. The impact potential pertaining to the sustainability indicators of the ports area is explored in this chapter. Initially, with a view to enhance the environmental profile of the ports in İzmir and to add value to the operating performance of port authorities, a "situation assessment on ports" was carried out based on the green growth concept as well as energy efficiency and management. Energy efficiency and management at ports are important steps in port infrastructure, efficient and reliable port services, and transparent port funding and management. However, interviews revealed that there are currently no effective energy management infrastructures implemented in the ports. Energy efficiency activities, on the other hand, are carried out as individual actions. During field visits to the ports in İzmir, the authors inquired about the energy costs and noted a 10 to 15 percent share in the operating costs. An annual energy consumption evaluation was carried out with a holistic approach including all ports, and the evaluation concluded, for port authorities combined, a minimum of 60 million Turkish lira/year in consumption costs and an annual consumption potential of approximately 154 GWh/year in 2020. Given the tractor-trailer and similar transportation movements to and from the ports in İzmir, the real energy usage is likely to have a much higher potential. However, no studies were found on the matter.

The green port concept was assumed as an environmental criterion in the context of environmental sustainability criteria within the study and the analysis carried out in the ports of İzmir concluded crucial problems, particularly the air quality and energy use. Energy and environmental sustainability manifest as crucial problems in the sustainability actions plans or strategies for the port city or the port area based on the current development trends in the ports in İzmir.

While the ports aren't legally obliged to establish an energy management system, the energy consumption data of the ports in İzmir indicates that they are in need of a management strategy for energy efficiency and management in line with the green port concept and port sustainability. Within this concept, an initial study was conducted on the impact criteria pertaining to the green concept as part of the environmental sustainability. A status assessment was then conducted on energy efficiency and management within the scope of the sustainability of energy.

The study included as references eight of the ports in İzmir (TCDD Port of İzmir, SOCAR, Nemport, TCE Ege, Batı, IDC, Çeşme and Dikili) since they provide services to third parties in compliance with the technical evaluation criteria. The cost assessment concluded that the total energy consumption of these ports reached a minimum of 12,800 MWh/month with an annual consumption potential of approximately 154 GWh/year. Two main parameters were taken into account as reference criteria when studying the ports. As detailed port data on consumption performance could not be obtained, target efficiency potentials were assumed as 9.05 percent (good scenario – Gökçin and Eyibil, 2020) and 20 percent (bad scenario – EU 2020 energy efficiency target). The port locations have wide interiors. The main energy source for the reference ports is electricity. Accordingly, the energy performance assessment of ports was carried out in two categories, namely: the efficiency of electricity distribution lines and the operating efficiency. These two categories were examined separately in line with the above-mentioned target efficiency levels. Figure 21 presents the cumulative efficiency potentials derived from the two scenarios prepared for the ports area.

**FIGURE 21.** Cumulative Efficiency Potentials of the Ports of İzmir




Within the scope of the cumulative approach to the efficiency of electricity distribution lines and operating efficiency in ports, the cumulative energy efficiency reflects a share of 8.58 percent in the good scenario and a potential of 17.6 percent in the bad scenario compared to the referenced total energy consumption distribution. These values will be attained through survey studies as a priority target in the establishments with an efficient energy management culture. For the establishment lacking such data collection and process infrastructure, however, it should be considered a first step towards the integrated consumption structure. While the transmission losses are considered unavoidable in the context of energy efficiency, transformers and distributions units should be acknowledged as action points by establishments and they should be included in the action plans. The 7-percent higher share in the bad scenario compared to the good scenario should not be considered normal. Transformer and transmission losses. can be dropped to a maximum of 2 percent in the total target. The shares of operational consumption should be assessed in the context of load at port establishments. Given that the electricity consumption is the main source of power, it should be noted that significant savings can be assured, particularly through driver checks. All these comprise a holistic model. An efficient energy management infrastructure can be defined for each business process in each of the ports to reveal the true efficiency values. Subsequently, energy efficiency action plans will be more sound. This is a significant shortcoming for the ports in İzmir. The assessment of energy consumption behavior in ports is based both on consumption forecasts and on energy use, which is a green port criterion. The main criteria for the Green Port Energy Use actions is an assessment from one to five (Table 15).

**TABLE 15.** Green Port Energy Usage Criteria

| Criterion | Actions | Criteria |
|---|---|---|
| Energy Usage | EU1. New environmentally friendly energy use in offices and port areas (for instance: solar energy) | Yes (Applied all across the facility – Implemented completely) (5)<br>Mostly (Definitely applied in the main buildings) (4)<br>Partially (Applied in a couple of main buildings) (3)<br>Limited (Very limited or exemplary practice) (2)<br>No (Definitely not applied) (1) |
| | EU2. Microclimate design | |
| | EU3. Energy efficiency control system | |
| | EU4. "Heat trapping" paint to coat cooled con-tainers | |
| | EU5. Energy management system | |
| | EU6. Energy-efficient lighting in the port area | |

The assessment of energy consumption behavior for the ports in İzmir was carried out based on the above-described criteria and opinions collected from ports. Within this scope, the weighted average of opinions collected from ports is calculated as two. The most problematic issue in the energy consumption of the ports in İzmir is concluded to be energy management. Figure 22 presents the distribution of criteria pertaining to the actions based on the collected opinions and achieved results.

With an assumed applicability standard of 3.89 (Chiu et al., 2014) for the criteria (1–6) for the actions in Table 15, the management problem concerning the use of energy in the ports of İzmir indicates the need for actions towards efficient management and awareness. It was evident during both the field visits and operational business processes that energy efficiency must be addressed together with service flows.

The secondary aspect of the study is to assess the energy management infrastructure of ports. Within this scope, the energy-efficient systems in the ports of İzmir were also assessed. Based on data collected during field meetings with the ports of İzmir – Aliağa and the TCDD Port of İzmir as references, as well as during the workshops, it was concluded that an efficient energy management system is not present. However, another assessment was conducted in line with the ISO 50001 Energy Management System criteria, taking 19 of the criteria into consideration (Figure 23).

**FIGURE 22.** Energy Usage at the Ports of İzmir

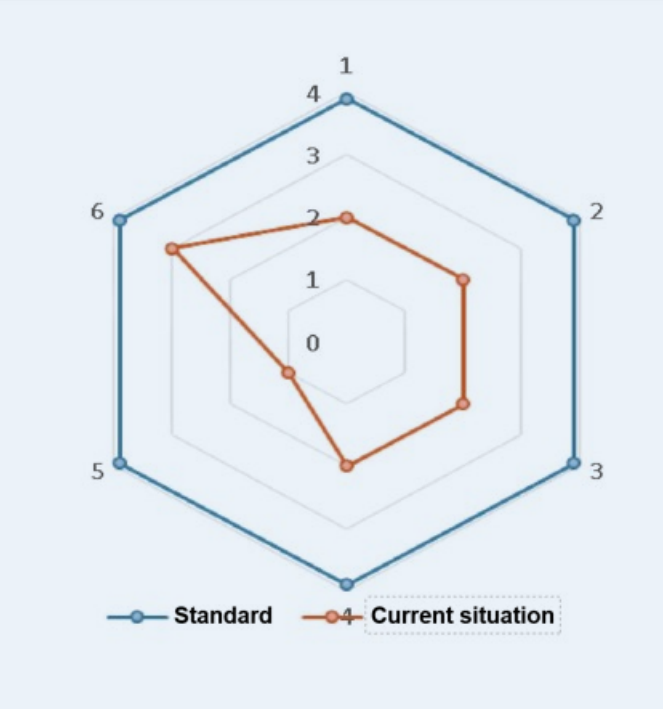
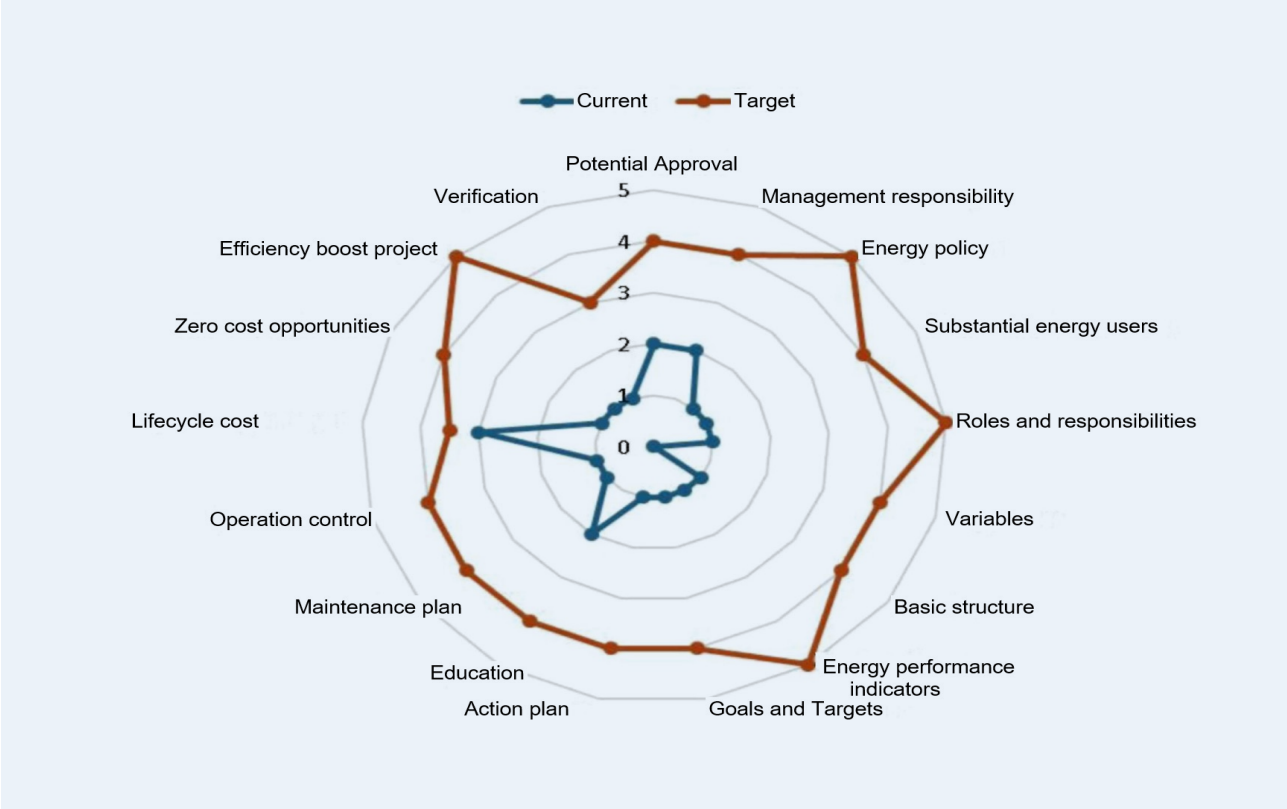


**FIGURE 23.** Energy Management Performance of the Ports of İzmir




It is observed that an ISO 50001-compliant energy management approach is required by port authorities in the ports in İzmir. Numerous energy-efficient opportunities were mentioned during field visits to ports. These assessments are related to the technological transformation of ports and the industrial experience of personnel. The Energy Management System Approach first identifies the major energy users, then creates a list of actions, based on an effective cost analysis, towards efficiency in the problematic areas. The system aims for continuous improvement and instills a cultural habit concerning energy efficiency and opportunities in ports. It was concluded that the ports in İzmir require a management intervention. Data collected in this study indicates that, in port authorities: an efficient energy management system should be developed in a holistic approach with senior management support in energy action plans, roles and responsibilities, major energy users, energy performance indicators, action plans and opportunities, operational control, process review and constant improvement.

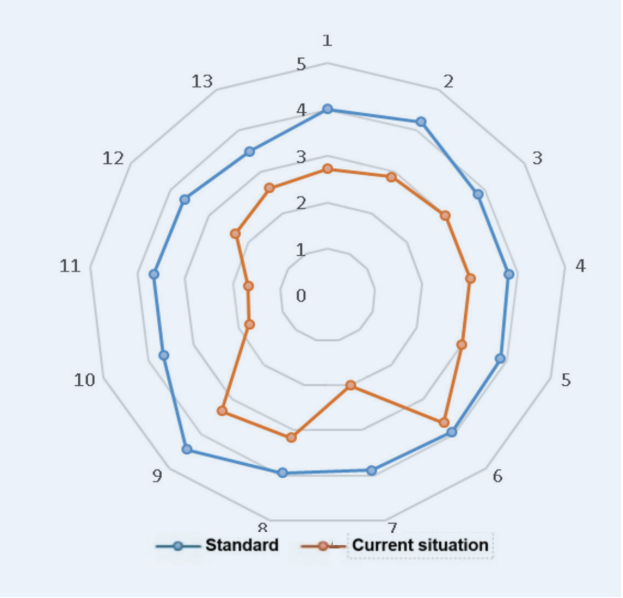
Port authorities and management in Europe have shaped their business process to minimize their environmental impacts, with a particular interest in port operations. The 13 criteria based on the green port assessment standard were examined using two different methods. The first method includes 78 assessment questions for the 13 criteria to collect field opinions in the ports of İzmir. The second method includes applying the Analytical Hierarchical Process (AHP) methodology to the 13 criteria to identify the significance and priorities of the green port criteria for the existing ports. As a multiple approach method, AHP reflects both the subjective and objective opinions of decision-makers. AHP is, therefore, a mathematical decision-making method that collectively assesses the quantitative and qualitative variables and takes into consideration the priorities of individuals and groups. Within the scope of this study, field opinions were collected for the defined criteria. Table 16 presents the referenced criteria.

**TABLE 16.** Green Port Criteria

| No | Code | Criteria | Standard | Criterion |
|---|---|---|---|---|
| 1 | AP | Air | 4.01 | Yes (Applied all across the facility – Implemented completely) (5)<br>Mostly (Definitely applied in the main buildings) (4)<br>Partially (Applied in a couple of main buildings) (3)<br>Limited (Very limited or exemplary practice) (2)<br>No (Definitely not applied) (1) |
| 2 | WP | Water pollution | 4.21 | |
| 3 | NP | Noise pollution | 3.82 | |
| 4 | LP | Land degradation and pollution | 3.81 | |
| 5 | MS | Material selection | 3.87 | |
| 6 | WS | Water use | 3.93 | |
| 7 | EU | Energy Usage | 3.89 | |
| 8 | GH | General household waste | 3.95 | |
| 9 | HH | Household hazardous waste | 4.44 | |
| 10 | HQ | Ambient quality | 3.67 | |
| 11 | PG | Port Greenery | 3.66 | |
| 12 | CE | Education | 3.63 | |
| 13 | PT | Awareness | 3.5 | |

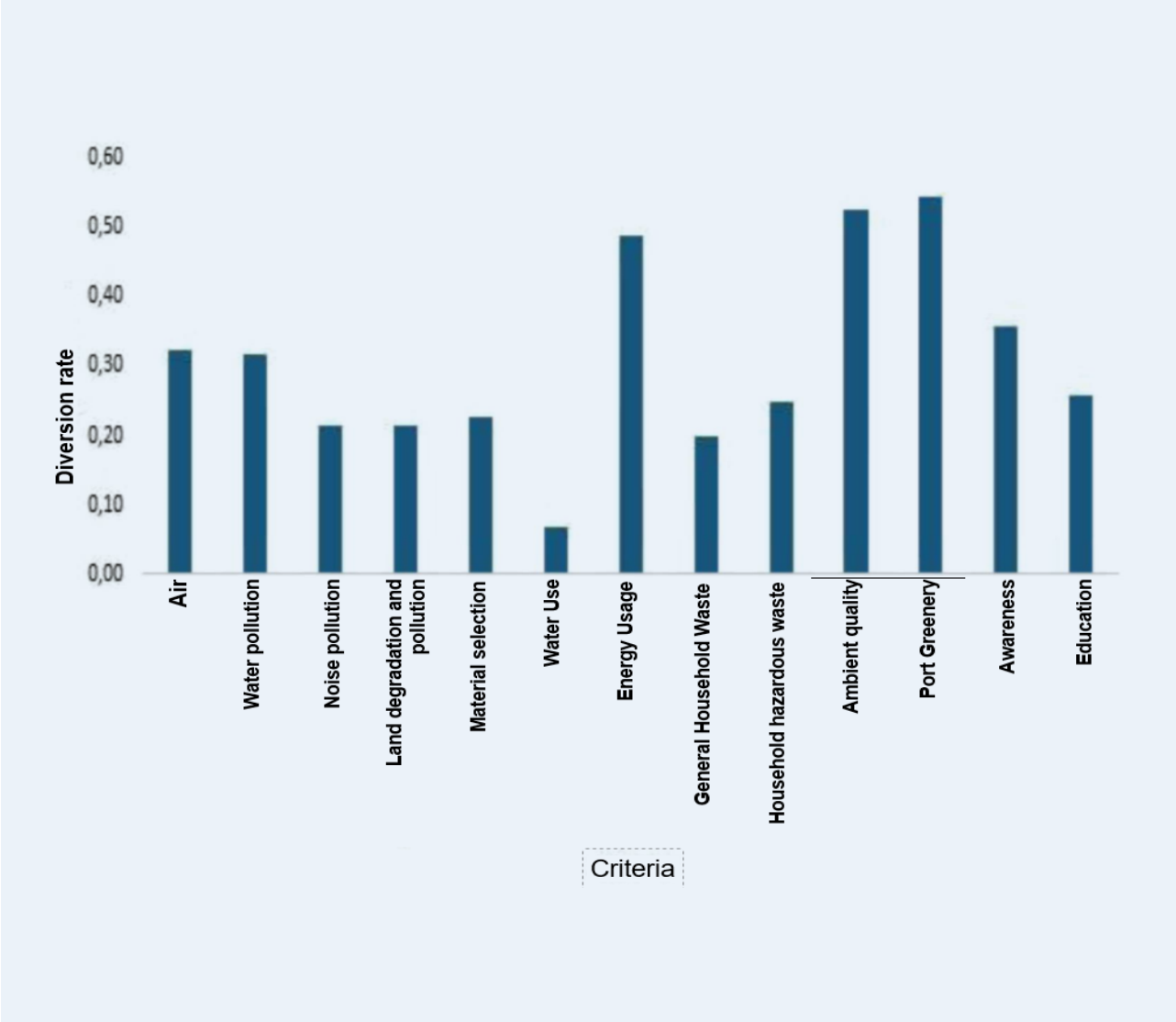
The average of the field opinions collected from the ports for the 13 criteria of the green port concept was calculated and the standard and current situation were reviewed for each criterion. Following the analysis, the distribution of the 13 criteria in accordance with the standards was examined. The results are presented in Figure 24

**FIGURE 24.** Green Port Criteria Impact Distribution for the Ports of İzmir Region



The analysis highlights port greenery, ambient quality and energy use of the green port criteria. The priority of needs was created based on all related criteria. The results are presented in Figure 25.

**FIGURE 25.** Green Port Priorities of the Ports of İzmir

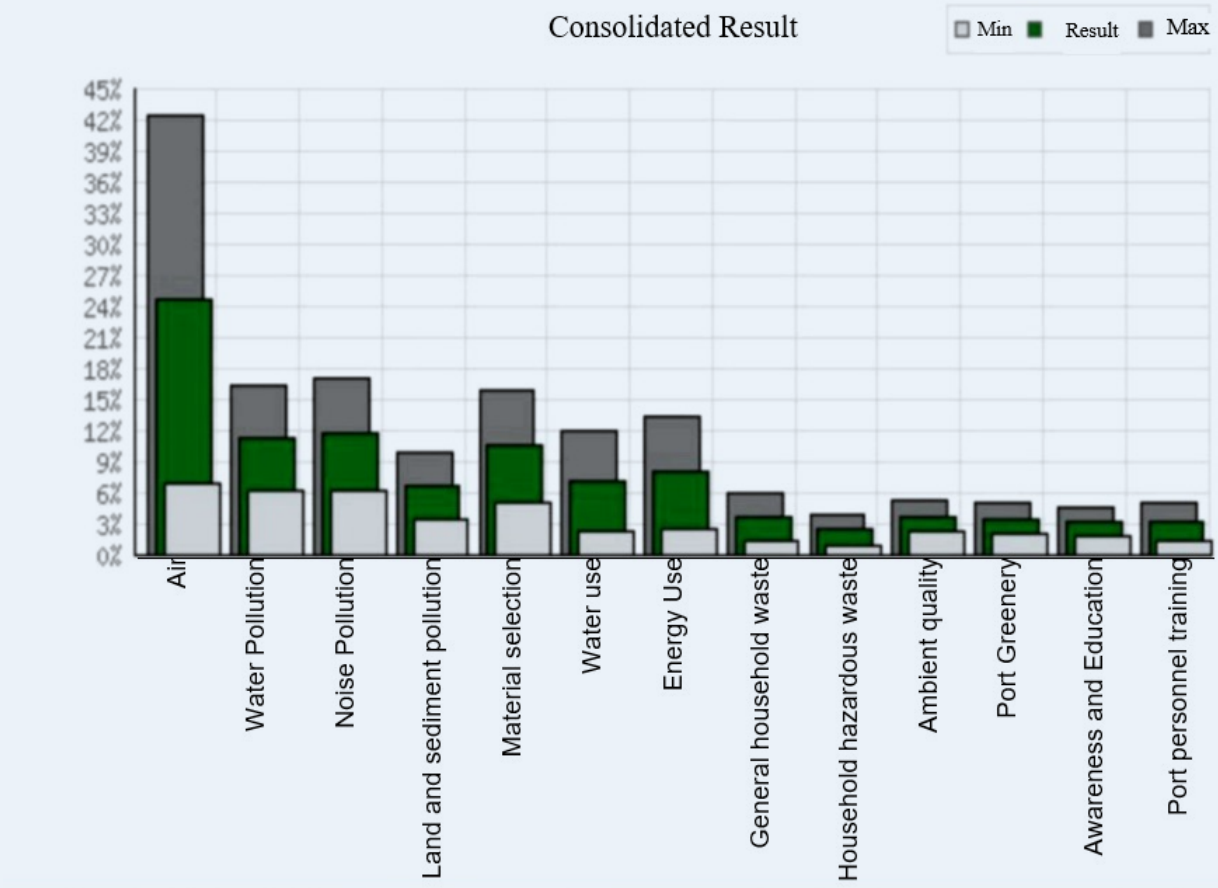


The priority of needs in correlation with the green port concept is explored for the ports in İzmir based on the AHP methodology. Within this scope, 78 paired comparisons and coherence were assessed and the results are presented in Figure .

**FIGURE 26.** Green Port AHP for the Ports of İzmir

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 2,00 | 6,00 | 5,00 | 7,00 | 3,00 | 1,00 | 6,00 | 9,00 | 5,00 | 4,00 | 5,00 | 6,00 |
| 2 | 0,50 | 1 | 2,00 | 3,00 | 1,00 | 1,00 | 2,00 | 1,00 | 7,00 | 3,00 | 5,00 | 2,00 | 3,00 |
| 3 | 0,17 | 0,50 | 1 | 2,00 | 2,00 | 2,00 | 2,00 | 7,00 | 8,00 | 3,00 | 2,00 | 3,00 | 4,00 |
| 4 | 0,20 | 0,33 | 0,50 | 1 | 1,00 | 1,00 | 1,00 | 1,00 | 6,00 | 1,00 | 3,00 | 2,00 | 4,00 |
| 5 | 0,14 | 1,00 | 0,50 | 1,00 | 1 | 3,00 | 2,00 | 3,00 | 2,00 | 5,00 | 4,00 | 3,00 | 7,00 |
| 6 | 0,33 | 1,00 | 0,50 | 1,00 | 0,33 | 1 | 1,00 | 5,00 | 8,00 | 2,00 | 1,00 | 1,00 | 1,00 |
| 7 | 1,00 | 0,50 | 0,50 | 1,00 | 0,50 | 1,00 | 1 | 4,00 | 7,00 | 1,00 | 3,00 | 2,00 | 1,00 |
| 8 | 0,17 | 1,00 | 0,14 | 1,00 | 0,33 | 0,20 | 0,25 | 1 | 1,00 | 1,00 | 1,00 | 2,00 | 1,00 |
| 9 | 0,11 | 0,14 | 0,12 | 0,17 | 0,50 | 0,12 | 0,14 | 1,00 | 1 | 1,00 | 1,00 | 1,00 | 2,00 |
| 10 | 0,20 | 0,33 | 0,33 | 1,00 | 0,20 | 0,50 | 1,00 | 1,00 | 1,00 | 1 | 1,00 | 2,00 | 1,00 |
| 11 | 0,25 | 0,20 | 0,50 | 0,33 | 0,25 | 1,00 | 0,33 | 1,00 | 1,00 | 1,00 | 1 | 2,00 | 1,00 |
| 12 | 0,20 | 0,50 | 0,33 | 0,50 | 0,33 | 1,00 | 0,50 | 0,50 | 1,00 | 0,50 | 0,50 | 1 | 1,00 |
| 13 | 0,17 | 0,33 | 0,25 | 0,25 | 0,14 | 1,00 | 1,00 | 1,00 | 0,50 | 1,00 | 1,00 | 1,00 | 1 |

| Criterion | Priority | Degree | + | - |
|---|---|---|---|---|
| Air | %24,2 | 1 | %17,8 | %17,8 |
| Water pollution | %11,3 | 3 | %5,00 | %5,00 |
| Noise pollution | %11,2 | 2 | %5,5 | %5,5 |
| Land degradation and pollution | %6,7 | 7 | %3,2 | %3,2 |
| Material selection | %10,6 | 4 | %5,5 | %5,5 |
| Water Use | %7,2 | 6 | %4,8 | %4,8 |
| Energy Usage | %8,1 | 5 | %5,5 | %5,5 |
| General Household Waste | %3,6 | 9 | %2,3 | %2,3 |
| Household hazardous waste | %2,5 | 13 | %1,5 | %1,5 |
| Ambient quality | %3,8 | 8 | %1,5 | %1,5 |
| Port Greenery | %3,5 | 10 | %1,5 | %1,5 |
| Awareness and Education | %3,2 | 12 | %1,4 | %1,4 |
| Specialist personnel training | %3,2 | 11 | %1,7 | %1,7 |



The AHP concluded the air quality, and noise and water pollution as the main problems. Based on analysis concerning the green port concept for the ports in İzmir, port greenery, air quality, noise and water pollution, material selection and energy use were highlighted as problem areas among the 13 main criteria. Green ports not only target business processes and the economic sustainability of ports, but also the preservation of regional ecology through social awareness. While this is not a legal requirement for the ports, İzmir, as part of its social responsibility efforts, should take the lead in regional awareness by adopting actions and behavior.

The status analysis concerning the ports in İzmir concluded that

- an energy management system with a standard infrastructure such as the ISO50001 is not present and that the ports in İzmir require a management system for energy efficiency and management.
- It was also concluded that developing energy efficiency and management strategies for ports requires a multi-disciplinary approach. The lack of comprehensive field studies is another shortcoming that was identified. The lack of detailed field studies, particularly in green port certified ports, is a substantial shortcoming.

Green ports not only target business processes and the economic sustainability of ports, but also the preservation of regional ecology through social awareness. Both assessments indicate structural shortcomings in the ports of İzmir. While it is not a requirement for the ports in the region, a regional awareness should be established by endorsing a framework model through actions and behavior.

The field studies focusing on the green port concept and sustainable energy management infrastructure for the ports in İzmir indicate significant opportunities in both aspects. The lack of actions in the Turkish adaptation of the green port concept underline that this transformation is simply a strategic certificate for the ports. While not an obligation, this structural transformation could be an indicator of İzmir's green transformation starting with the ports. Energy efficiency and management in ports are administrative requirements and is predicted to gain significant benefits. Within this context, the study suggests effective management strategies for the environmental sustainability of energy (Table 17):

**TABLE 17.** Efficient Energy Management Strategies for Environmental Sustainability

| **STRATEGY – 1 IMPROVING ENERGY EFFICIENCY** | |
|---|---|
| **ACTION 1** | **ZERO INVESTMENT OPPORTUNITIES** |
| **Activity 1** | **Institutionalization of energy efficiency**<br>Developing an institutionalized model defining roles and responsibilities in energy management supported by energy-monitoring infrastructure, and particularly including a port-specific energy accounting. |
| **Activity 2** | **Establishing energy-efficient purchasing processes**<br>Prioritizing energy efficiency as much as costs in procurement for all purchasing processes, but particularly for all energy consuming or energy utilizing processes in port operations |
| **Activity 3** | **Improving individual awareness**<br>Organizing energy efficiency and management awareness training programs in line with the responsibilities of all personnel involved in operational processes and the corporate management of ports. |

| STRATEGY – 1 IMPROVING ENERGY EFFICIENCY | |
|---|---|
| **ACTION 2** | **LOW INVESTMENT OPPORTUNITIES** |
| **Activity 1** | **Establishing a monitoring infrastructure:**<br>Energy monitoring infrastructure should be prioritized in port operations. In that context, business processes and workloads should be evaluated. The monitoring infrastructure should be supported by a data collection and evaluation system. |
| **Activity 2** | **Installation of submeters:**<br>Electric consumption is a significant potential in port operations. Accordingly, submeters are advised for major energy users in the business processes. These should be installed together with the data collection system and all consumption should be recorded. |
| **Activity 3** | **Management of operating parameters:**<br>This is defined as the inquiry of parameters, and the determining and managing of limit values in port operations. The managing of operating parameters related to operational values should be a continuous behavior. Additional control systems should be developed for this purpose. |
| **ACTION 3** | **OPPORTUNITIES REQUIRING INVESTMENT PLANNING** |
| **Activity 1** | **Resource continuity and management**<br>Resource continuity in the main supply lines and power management should be constantly monitored and managed in the ports. |
| **Activity 2** | **Technology updates**<br>Updating the cranes, in particular, with the most recent energy efficient technology is crucial in port operations. Updating the engine technologies following an inventory will also prove beneficial. |
| **Activity 3** | **Engine inventory and update program**<br>Technological challenges and energy inefficiency are significant issues in some ports. Engines are major energy users in the ports. As such, an update program should be created following an inventory. |
| **Activity 4** | **Renewable energy use**<br>The ports area in İzmir has a great advantage in both solar and wind power. Switching to renewable energy technologies for energy needs is crucial. |

| STRATEGY – 2 TECHNOLOGY MANAGEMENT | |
|---|---|
| **ACTION 1** | **SMART SYSTEMS AND AUTOMATION IN PORT OPERATIONS**<br>The development of an automation infrastructure to support the efficiency and effective management of business processes in port operations should be a corporate strategy. In the same vein, conducting prioritization efforts concerning service planning and business processes in the ports will contribute to the development of simple and smooth business methods, and will improve production quality and add value to the ports. The establishment of an infrastructure in the administration is therefore advised. |
| **ACTION 2** | **RENEWABLE ENERGY TECHNOLOGIES AND THEIR MANAGEMENT**<br>These technologies will not yield short-term benefits based on the current demand. The use and potential of solar and wind energies should be addressed by a comprehensive analysis. The management of energy, along with the resource utilization, must be projected. |

| STRATEGY – 3 DEVELOPING A CORPORATE MANAGEMENT MODEL FOR ENERGY | |
|---|---|
| **ACTION 1** | **DEVELOPING A CORPORATE MODEL** |
| **Activity 1** | **Institutionalization of energy management:**<br>Port Authorities are not compatible with the conditions of the ISO 50001. Therefore, port authorities must develop unique management models in line with the ISO 50001. A liability structure should be established for corporate monitoring and management. |
| **Activity 2** | **Ensuring continuity in energy management:**<br>To ensure quality corporate management in ports, administration should be assigned. The evaluation of energy management processes should be included as agenda items in the meetings. These processes must be monitored. |
| **ACTION 2** | **SUSTAINABILITY** |
| **Activity 1** | **Establishing a sustainability model:**<br>Sustainability criteria are the most effective solutions for ensuring energy efficiency and management as well as for monitoring continuity in the port authorities. According to this system model, it is important for the establishment to be included in the management hierarchy and to install the model. |
| **Activity 2** | **Establishing strong internal and external communication channels:**<br>The establishment should share with all internal and external shareholders its efforts towards energy management. It is particularly important that customers and suppliers are kept informed. Therefore, the sustainability of the management model should be planned in a corporate struc-ture. |

CHAPTER 3.

# Foreign Trade and Handling Projections for Türkiye and İzmir

# 3.1. Fundamental Approach of Projection

A sustainable port area and investments meeting the expectations depend on many different factors. Interactions between disciplines such as economics, finance, logistics, governance and international relations shape the current and future outcome of the investments. Globalization and the subsequently changing production and consumption hubs, for instance, have been around for the last 15–20 years and have led to significant changes in the transportation and port investments. There have been substantial increases in the handling loads of ports. While this increasing trend staggered in 2008 and 2009, it regained momentum leveraged by the cheap money policies of states. Beginning in 2016 during the term of President Trump in the U.S., globalization slowed down and protectionism began to rise. The consumption hubs, which were falling behind in terms of income, and the subsidy packages that failed to yield the expected outcomes paved the path to this new trend.

Another major blow to the already weakening trade came from the COVID-19 pandemic, which emerged in China in 2019 and gained worldwide momentum in 2020. Each of these developments influenced the amount of cargo loaded and unloaded in the ports. Varying factors in both supply and demand further disrupted the balance in handling. Handling volume plays a substantial role in determining whether a port is financially and operationally sustainable, and in identifying current potential as well as possible investment areas. Financially speaking, handling data is a particularly significant source impacting free cash flow used in value determination and feasibility studies. This study not only identifies the measurable factors impacting handling volume and employs these factors in modeling the handling amounts, but also examines the direction and size of the imbalance caused by potential shocks in different scenarios. Taking a top-down approach from global trade to handling in İzmir, the study will include time series analysis.

While some approaches in the literature are based on econometric methods, some rely on input and output data and analysis, and other build on qualitative expert commentary and content analysis. De Jong et al. (2004) and Tavasszy and Jong (2013) introduced the overlook to transportation models. The models discussed in this chapter are based primarily on econometric methods. Input and output tables and analyses are conducted in long intervals in Türkiye. Strategic decisions including intersectoral interactions, added value and investment needs in many developed countries build on these constantly updated tables.

Single or multiple variable time-series models based on the Box-Jenkins methodology are commonly applied. The main advantage of such models is that they can replace immeasurable variables that are influential on handling data with depending variables or can employ previous shocks as systematic explanatory variables. The general formula is as follows:

$$y_{it} = f(y_{it-j}, \varepsilon_{it-k}, \phi())$$

Past occurrences, past systematic shocks significant only within a certain co-variant structure, and other explanatory variables can be incorporated in the model. GDP and other variables concerning foreign trade can be applied as independent variables. Seasonality can also be differentiated. A dependent variable can be a single variable, such as the handling volume, or a data matrix covering multiple domains. Multiple estimation models enable effective and significant models where a significant correlation between domains is present.

Variables impacting trade often demonstrate trends or, in other words, constantly changing environments. To demonstrate the long-term correlation between such variables, Error Correction Mode (ECM)

or a similar correction mechanism for short-term deviations should be employed. It is also possible to estimate and predict these models particularly for short-term periods. It is therefore practical to assess different scenarios and to include independent variables in these simulations. Examples of such research include Kavussanos (1996), Veenstra and Haralambides (2001), Peng and Chu (2009), Zhang et al. (2013), Akar and Esmer (2015), Rashed et al. (2016), and Farhan and Ong (2018).

A common bilateral trade model is the gravity model based on the universal law of gravitation. Kepaptsoglou et al. (2010) presents an overlook and summarizes empirical implementations of models in this domain. Given that the increase in the trade volume is the force of attraction, the trade volume can be expressed as follows based on the parameters subject to that force:

$$\text{Trade Volume} = \frac{f\,(\text{Economic Indicators})}{g\,(\text{Distance Criteria})}$$

GDP as an economic indicator can be an example of GDP per person. Numerous variables can be included in this model: transportation costs, access to different transportation routes, transportation to logistics centers, etc. Baltagi et al. (2003) implements this model, which is predictable in cross-sectional time based on panel data. The majority of global trade models are based on this fundamental approach. This approach is also commonly used in maritime transportation and particularly in container transportation (Biermann, 2012; Fugazza, 2015; Fugazza and Hoffman, 2017). Other prevalent methods are qualitative and based on content analysis, or have adjusted artificial neural network models to transportation. Qualitative studies are applied in forecasting based on expert opinion including Delphi, focus groups and in-depth interviews for port areas.

In addition to the macro variables including GDP and foreign trade applied in these models, the study also contains transport-specific variables such as “TEU,” “metric ton” and “number of tractor trailers.” Issues such as frequency and availability are substantial obstacles that could potentially limit studies. It is, therefore, natural to observe discrepancies between the theoretical and practical. Applying too many variables also leads to forecasting challenges. Forecasting errors for each variable accumulating in the target variable forecasts may cause more harm than good. As such, only variables that are strictly necessary should be applied. That said, a limited number of variables will also harm the reliability of parameters constituting the model. Accurate model and simulations are a priority in forecasting and scenario analysis.

The main contrast of maritime trade against the other two data points is that it is expressed in quantity rather than as a monetary unit. Still, when the global economy staggered, the maritime trade suffered equally. The oil crisis in the early ’70s, the banking crisis in the ’80s, the dot-com boom in the early 2000s, 9/11, the 2008–2009 financial crisis, the trade war between U.S. and China, and finally the development of COVID-19 are among the staggering factors. Maritime trade came through the crises relatively unfazed. One primary reason is that the expenses, investments and subsidies that the governments increased to overcome the crises impacted the maritime trade in numerous ways.

# 3.2. Data and Methodology

## 3.2.1. Data

The outlook of the year 2020 had many forecasts revised. The damage and possible consequences of COVID-19 thus far remain scenarios. According to this year's IMF data, both the growth and trade volumes registered declines by 4.4 and 7.5 percent, respectively. In the year 2021, the previous long-term averages and the growth are expected to recover.

This chapter used the following databases: the Statistics of the Ministry of Transport and Infrastructure, International Monetary Fund (IMF), United Nations Conference on Trade and Development (UNCTAD), Clarksons, World Trade Organization, The Central Bank of the Republic of Türkiye (TCMB) and Turkish Statistical Institute (TurkSTAT). All data used in models within the scope of the study are on an annual basis. The time spans and sources for the variable employed in the models are as follows: data range for global GR, global trade, global maritime trade is 1970–2020 (IMF, WTO, Clarksons, UNCTAD), 1980–2020 for GDP in Türkiye (TurkSTAT, IMF), 1985–2020 for trade in Türkiye (TurkSTAT, CBRT), 2001–2020 for trade in İzmir (TurkSTAT), 1997–2020 for handling volume in the ports of Türkiye and İzmir (Ministry of Transport and Infrastructure), 2004–2020 for the TEU of containers handled in the ports of İzmir (Ministry of Transport and Infrastructure), and 2011–2020 for the numbers of Ro-Ro and automobiles handled in the ports of İzmir (Ministry of Transport and Infrastructure).

The projected period, on the other hand, covers the years between 2021 and 2033. Descriptive statistics of primary data are provided in Table 18:

**TABLE 18.** Descriptive Statistics of Data

| Variables | Average Growth Rate (%) | Standard Deviation (%) | Skewness | Kurtosis (-3) |
|---|---|---|---|---|
| GR ($) | 6.78 | 6.13 | 0.09 | -0.44 |
| Global trade ($) | 8.95 | 12.07 | 0.32 | 1.34 |
| Global maritime trade ($) | 3.10 | 4.14 | -0.43 | 1.15 |
| GDP of Türkiye ($) | 5.94 | 14.97 | -0.02 | 0.19 |
| Trade in Türkiye ($) | 10.22 | 16.48 | -0.11 | -0.75 |
| Trade in İzmir ($) | 9.58 | 17.55 | -0.24 | -0.28 |
| Handling in Türkiye (metric tons) | 5.79 | 6.66 | -0.24 | -0.24 |
| Handling in İzmir (metric tons) | 5.74 | 8.51 | -0.45 | 0.01 |
| Container handling in İzmir (TEU) | 7.40 | 6.65 | -0.50 | 1.25 |
| Ro-Ro handling in İzmir (Quan-tity) | 3.70 | 12.88 | -1.58 | 3.79 |
| Automobile handling in İzmir (Quantity) | -9.53 | 35.20 | -0.39 | -0.54 |

The most striking facts in the descriptive statistics table are that Türkiye's GDP and trade levels and the trade growth rate of İzmir are all close to or right above the global values. Given the average change ratio of cargo handled in ports of İzmir in metric tons, container cargo demonstrated a better improvement. The other data related to Türkiye clearly indicates higher fluctuations overall. Such fluctuations are an obstruction to future projections as they increase the error margins of predictions and, instead of the desired outcome as the forecast horizon extends, prediction intervals expand accordingly. This ambiguity not only impacts models and projections, but also the investment, production and consumption processes.

Skewness statistics combined with average values indicate that the extreme negative observations produced particularly during the time of crisis have the potential to drag down average values, albeit rarely. This concludes that average value alone cannot function as a descriptive statistic value. Moreover, it can escalate the error margins of coefficients predicted in models and cause the confidence intervals to be miscalculated. Similarly, the further from zero the kurtosis values are (package programs often calculate with Kurtosis-3 and yield results based on three in normal distribution), the further the variables from their expected qualities and the hypothesis of models, thus harming the reliability of the findings. Values greater than zero (based on normal distribution) is a common problem in financial and economic data. They indicate a higher probability than where end values, positive or negative, reflect a normal distribution. That results in risks that are calculated lower than their normal value. For Ro-Ro trade, for instance, in case of a standard deviation of 2 from the average of 3.7 percent, normal distribution will suggest that only 5 percent of observations fall outside of this range. High kurtosis, however, indicates that this value might be higher, meaning that it considers the risks lower than they are in either a positive or negative direction.

## Methodology

In creating the demand projections for the ports of İzmir, we build on the size of the global economy and trade. The method in designing the handling and trade projections for the ports of İzmir, in a top-down approach starting from the global trade to handling in İzmir, is essentially based on time series analysis. The models we applied and their functions are as below:

Global Trade = f(Global Growth, Global Maritime Trade, ARMA)

$$\text{Global trade}_t = \gamma_0 + \alpha_i \sum_{i=0}^{t} \text{global growth}_{t-i} + \beta_i \sum_{i=0}^{t} \text{global maritime trade}_{t-i} + \text{ARMA} + \varepsilon_t$$

Trade in Türkiye = f(Global Trade, Growth in Türkiye, ARMA)

$$\text{Trade in Türkiye}_t = \gamma_0 + \alpha_i \sum_{i=0}^{t} \text{global trade}_{t-i} + \beta_i \sum_{i=0}^{t} \text{Growth in Türkiye}_{t-i} + \text{ARMA} + \varepsilon_t$$

Handling in Türkiye = f(Trade in Türkiye, Global Growth, Global Maritime Trade, ARMA)

$$\text{Handling in Türkiye}_t = \gamma_0 + \alpha_i \sum_{i=0}^{t} \text{Trade in Türkiye}_{t-i} + \beta_i \sum_{i=0}^{t} \text{global maritime trade}_{t-i} + \beta_i \sum_{i=0}^{t} \text{global growth}_{t-i} + \text{ARMA} + \varepsilon_t$$

Trade in İzmir = f(Growth in Türkiye, Global Trade, ARMA)

$$\text{Trade in İzmir}_t = \gamma_0 + \alpha_i \sum_{i=0}^{t} \text{Growth in Türkiye}_{t-i} + \beta_i \sum_{i=0}^{t} \text{global trade}_{t-i} + \text{ARMA} + \varepsilon_t$$

Handling in İzmir = f(Handling in Türkiye, Global Maritime Trade, ARMA)

$$\text{Handling in İzmir}_t = \gamma_0 + \alpha_i \sum_{i=0}^{t} \text{Handling in Türkiye}_{t-i} + \beta_i \sum_{i=0}^{t} \text{global maritime trade}_{t-i} + \text{ARMA} + \varepsilon_t$$

Moving from global to local, this approach facilitates the examination of the impacts of shocks on İzmir in both the global economy and trade, and in the Turkish economy and trade.[12]

As a general practice all econometric methods using time series, and particularly the analysis applying financial economic time series data, are based on the hypothesis that the series is stationary

12 The data applied has been explained in the previous chapters, though some points that are particularly valid for the model should be emphasized. While all available data has been obtained sufficiently for the analysis, the number of observations has substantially declined due to data such as frequency, handling and maritime trade being annual values. This hinders the effective measurement of correlation between variables and leads to higher deviations. The length of the possible deviations horizon for projections also plays a significant role.

Working with non-stationary time series presents the problem of fake regression. In that case, the findings of traditional regression analysis and time series analysis can be misleading.

Predicting the future values of market variables through time series modeling and analysis is a main discipline in finance and economy. Applying either Autoregressive (AR) or Moving Average (MA) models to best define the dynamic structure of a time series requires multiple parameters, resulting in a higher degree of models with multiple parameters to predict. To overcome these challenges, the use of the Autoregressive Moving Average (ARMA) model is advised. Consisting of the basis of time series analysis, the autoregressive moving average model includes the autoregressive (AR) and moving average (MA) concepts and is abbreviated as ARMA (p,q). It is expressed as follows:

$$r_t = \mu + \sum_{i=1}^{p} \emptyset_i r_{t-i} + \sum_{i=1}^{q} \theta_i \varepsilon_{t-i} + \varepsilon_t$$

Stationarity is a preliminary condition to model time series by ARMA. If the average and variant of a stochastic process is stationary over a period and if the covariant between two periods is not dependent on the real period but only on the distance or delay between the periods, the series is considered stationary. Such a stochastic process is referred to as a weak stationary, covariant stationary or second order stationary in the literature (Gujarati, 2009). Traditional econometrics is based on the hypothesis that the variants and averages of time series pertaining to variables applied in regression analysis remain stationary over a period. This means that the time series is stationary. In other words, averages, variants and autocorrelations in a stationary series can often be approximated effectively through extended time averages based on a single implementation set (Enders, 2010). Examining the time chart of a series will present preliminary information regarding the stationarity of the series. Another method of stationarity determination is to apply the Autocorrelation Function (ACF) or the Partial Autocorrelation Function (PACF). More precise results require statistical tests or unit root tests. Unit root tests yield more definitive results than the two former methods in the statistical analysis of the stationarity of a time series. The starting point of these tests is the unit root (stochastic) process. Wayne A. Fuller, in 1976, revealed the first order autoregressive model as the underlying process for unit root tests on the stationarity of time series. Dickey-Fuller (1979) Unit Root Test considers the autoregressive model. If the AR(1) model is applied while the actual structure of the time series is AR(p), then autocorrelation should be incorporated to compensate for the wrong specification of error terms. This invalidates the utilization of the distribution based on the hypothesis that autocorrelated error terms comply with the white noise process. In that case, Dickey and Fuller included the delayed values of the dependent variable in their model and developed the Augmented Dickey-Fuller (ADF) (1981) test. This study applies the ADF unit root test to determine stationarity.

The established model regressions were predicted by the Least Squares method. The hypotheses for this model include the following: (1) Error term is a stochastic variable.

(2) The expected value of the error term is zero. (3) Error terms are distributed normally. (4) Error terms have stationarity variants. (5) There are no autocorrelations between the error terms. (6) The independent variable covariant for the error term is zero. (7) There is no strong linear correlation between independent variables (multiple linear correlation problem).

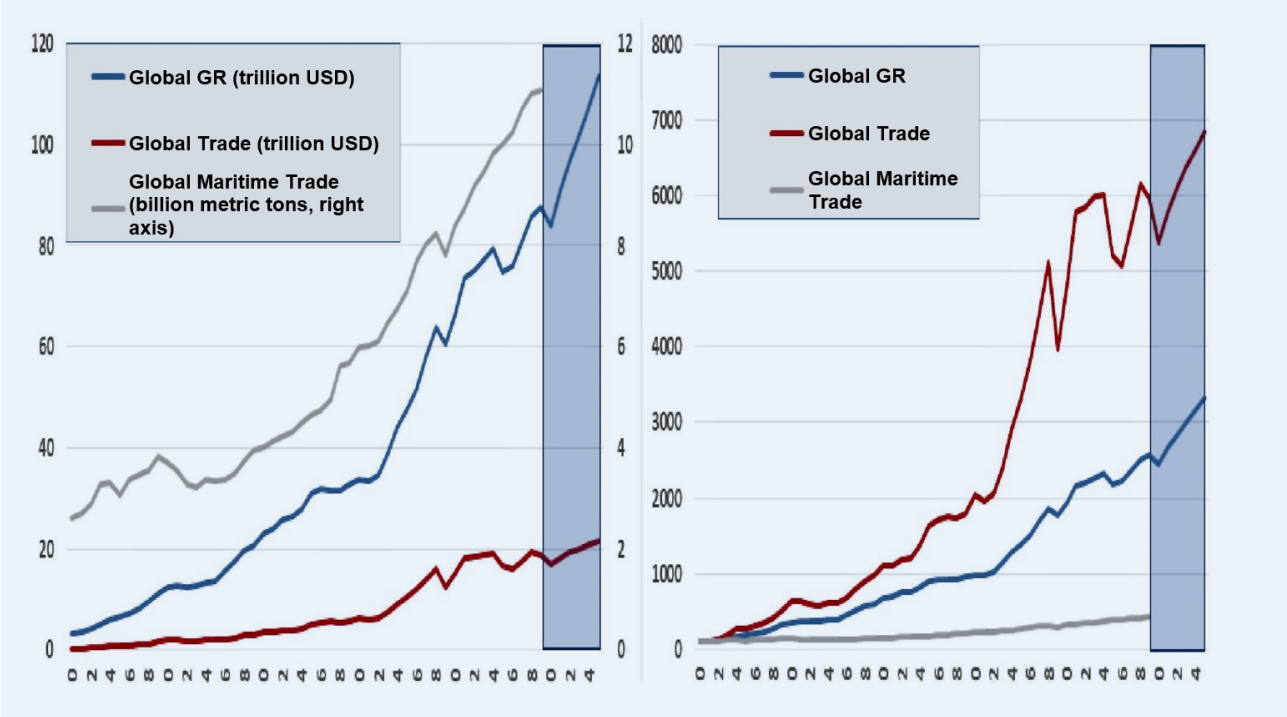
# 3.3. Findings

This chapter includes, based on the data and methodology applied, the projections and findings on supply predictions concerning Turkish foreign trade, foreign trade and handling in İzmir, container handling in İzmir, and Ro-Ro handling in İzmir. Fluctuating growth values are used in the projection scenarios within the scope of the study. A distribution from the above average scenario to the below average scenario is presented, including the error margins.

It is significant to examine the data correlation, which guided the econometric models in the projections. These range from the overarching view on the global economy to trade and handling in İzmir. In line with that approach, the study will share results pertaining to the correlation between global growth – global trade – global maritime trade, global trade – global GR, global trade – global maritime trade, global GR – global maritime trade, Trade in Türkiye – the amount of cargo handled in the ports of Türkiye, Maritime trade in Türkiye – maritime trade in İzmir, and amount of cargo handled in Türkiye – amount of cargo handled in İzmir.

As the global growth and trade volume are expressed in monetary units, their development is distinct from that of maritime trade (Figure 27). The figure on the right shows the growth and trade volume in 1970 with an index value of 100. Recovery in 2021 is expected to remain at 8.3 percent in growth (-4.7 percent on fixed prices) and around 8 percent in trade following the base effect of the 2020 loss.

**FIGURE 27.** Global Growth and Trade Overview




*Data source: IMF, UNCTAD. The calculations are carried out by the author.*

*Note: The initial values of all three data in the figure on the right have the index value of 100.*

To examine the net impact in the bilateral correlations between variables in the projection equations, all other statements are considered ceteris paribus and, thus, the net impact of a variable on another is observed. Comparing global trade to the global GR, global GR reached $83.85 trillion in 2020 while the global trade registered as $17.1 trillion. Changes in the global GR account for 72 percent of changes in global trade.

**FIGURE 28.** Correlation Between Global Trade and Global Revenue

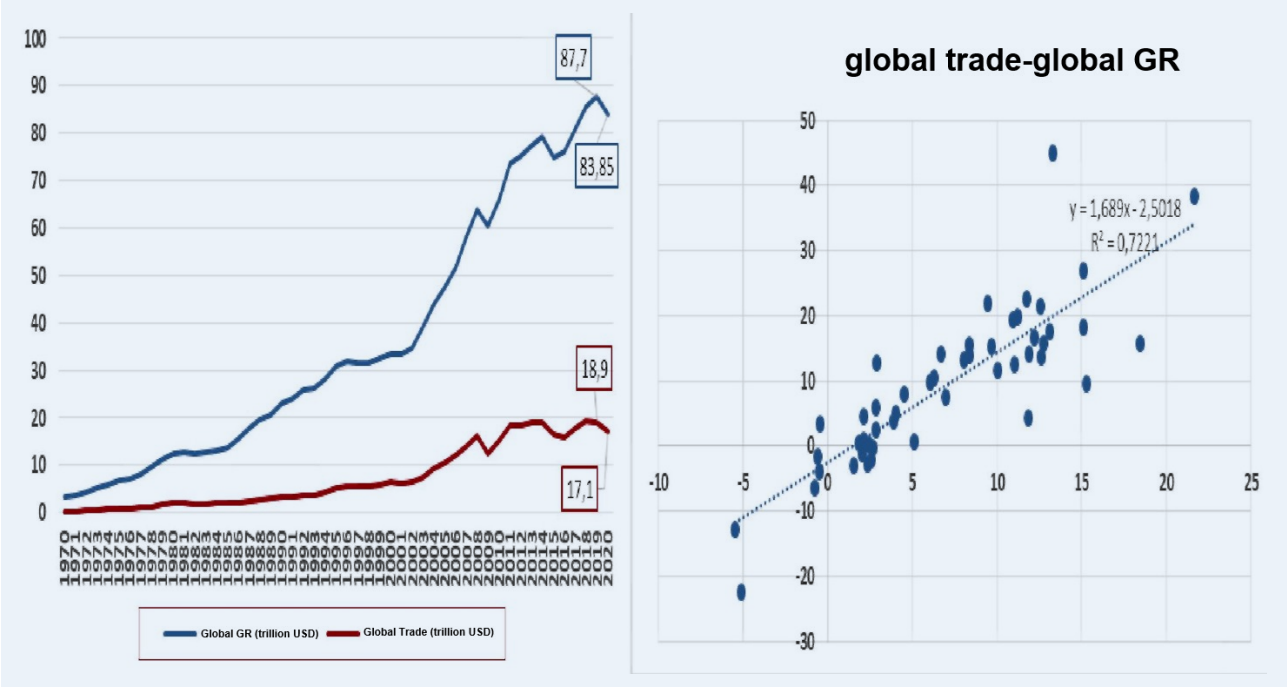
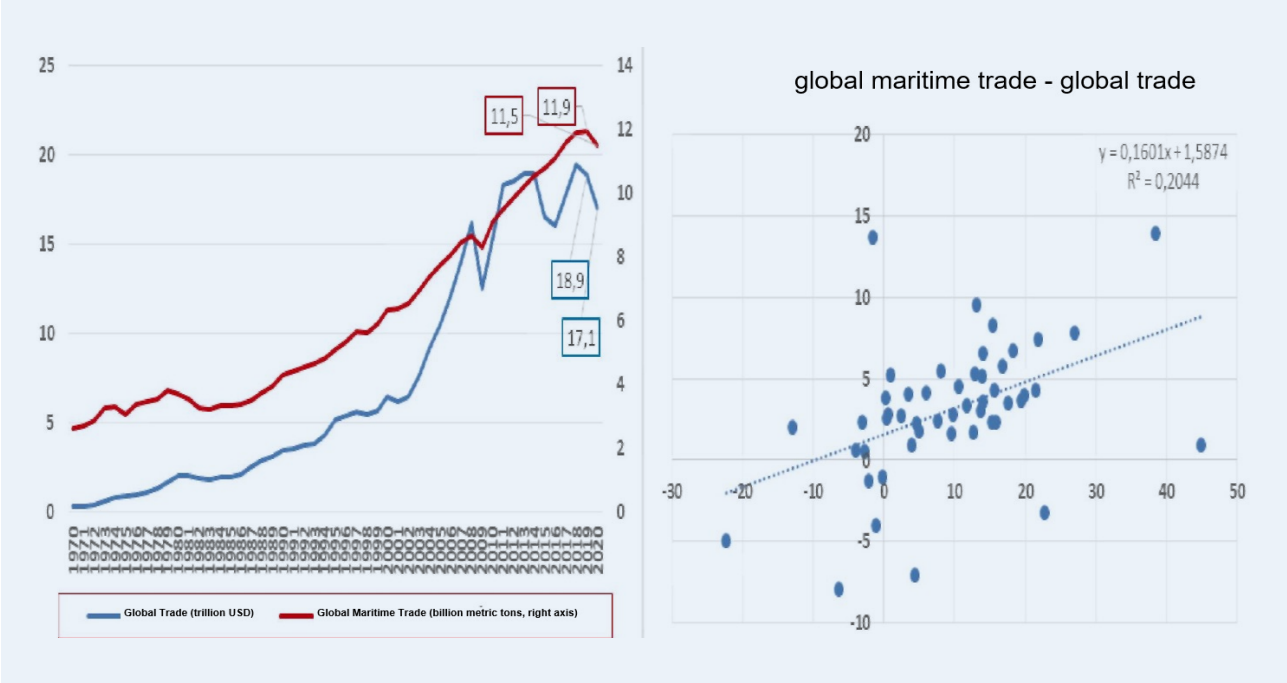



**FIGURE 29.** Correlation Between Global Maritime Trade and Global Trade



While approximately 87 percent of global trade was carried out by maritime trade and considering trends are similar in the long-term, short-term dynamics will result in different reactions by consumption and investment supply and demand in the short term. One main cause of the fluctuations and differentiation is that the variable global trade is expressed in US dollars and includes the service industry. Figure 29 compares global maritime trade and global trade and indicates that, as of 2020, global trade registered at $17.1 trillion while global maritime trade reached 11.5 billion metric tons. The regression equation indicates that 20 percent of changes occurring in the global maritime trade are accounted for by the global trade.

Figure 30 shows global maritime trade on the right axis in metric tons. Regression equation provides that the changes in the global GR account for 10 percent of changes in the global maritime trade.

**FIGURE 30.** Correlation Between Global Maritime Trade and Global Revenue

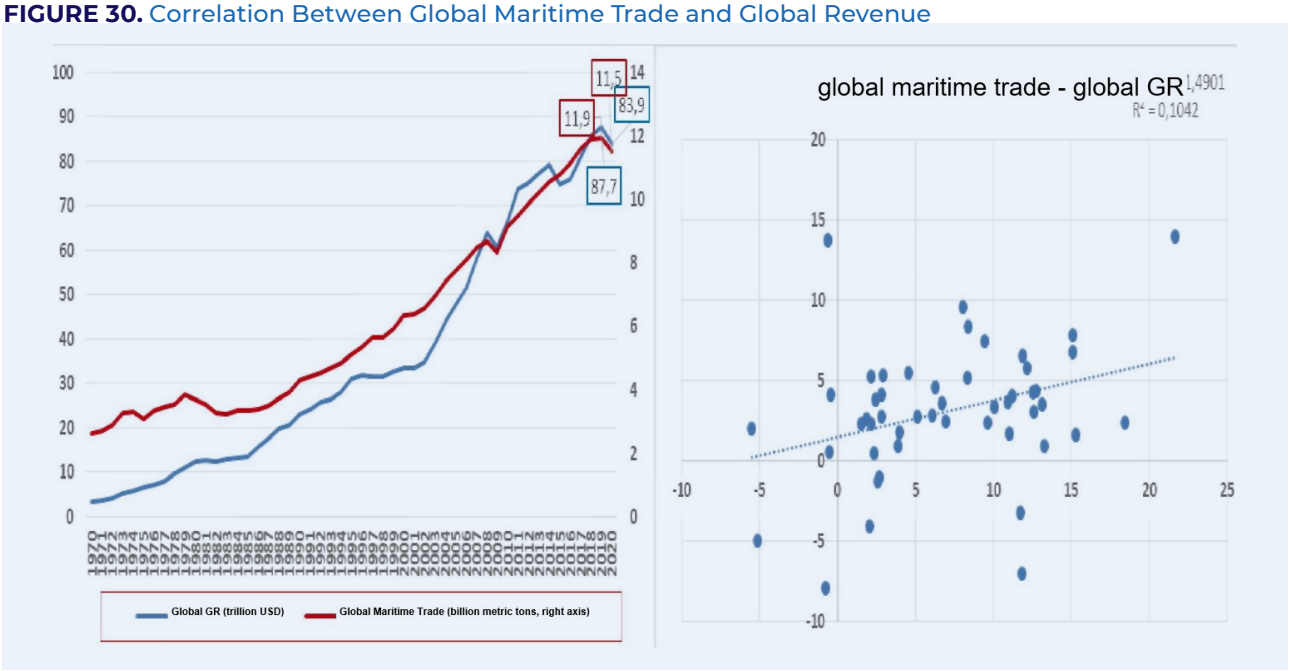
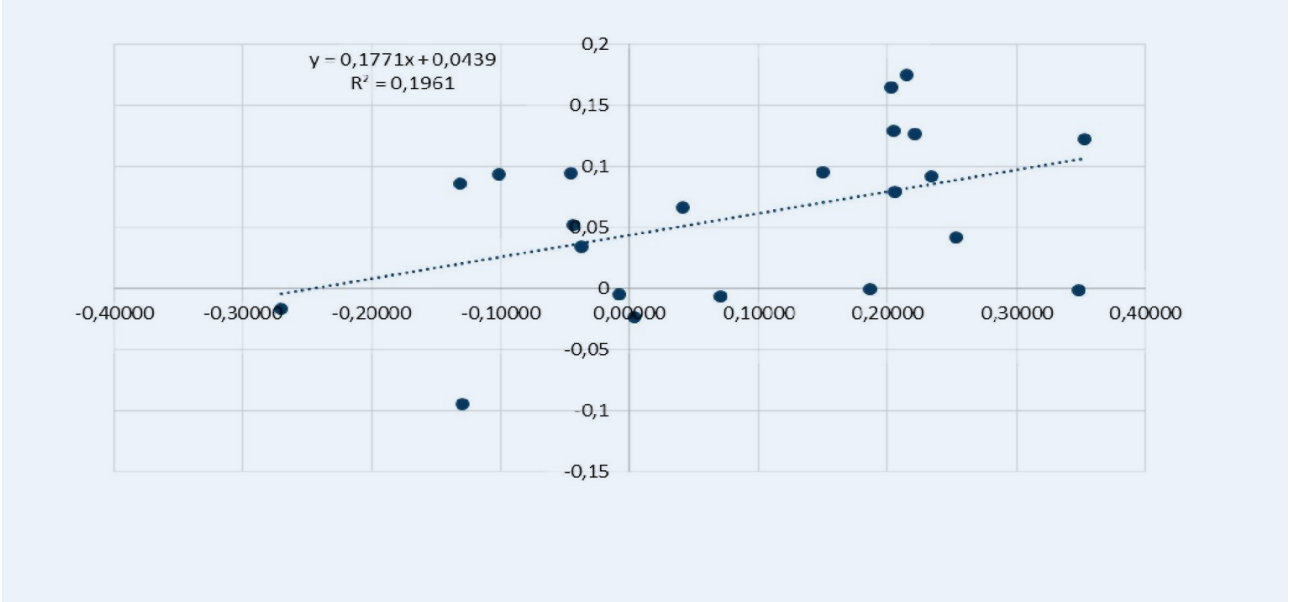



**FIGURE 31.** Correlation Between Handling Volume and Trade in Türkiye



As for the regression in the Turkish trade and handling variables, approximately 20 percent of changes in the handling volume in Türkiye are accounted for by the changes in Turkish trade (Figure 31).

Figure 32 shows the correlation between maritime trade in İzmir and in Türkiye. Of the changes that occurred in the İzmir maritime transportation, 52 percent is accounted for by the changes in the Turkish maritime transportation.

Figure 33 shows the correlation between the amount of cargo handled in the ports of Türkiye and İzmir. Forty-five percent of the change that occurred in the amount of metric tons handled in the ports of İzmir is accounted for by the change in the amount of metric tons handled in the ports of Türkiye.

The chart on the left in Figure 34 shows the amount of cargo handled in the ports of Türkiye and İzmir. The chart on the right, on the other hand, shows both the changes in the amount of cargo handled in the ports of İzmir and Türkiye with the value in 1997 indexed at 100, and the share of İzmir in terms of cargo handling to the total amount handled in the ports of Türkiye.

The amount of cargo handled in the ports of Türkiye in 2020 reached 496.6 million metric tons while the amount in the ports of İzmir remained at 80.1 million metric tons. The share of İzmir in the total cargo handled at Türkiye is 16.1 percent.

The share of İzmir in total handled cargo drops strikingly in 2006. Having reached around 20 percent of share prior to 2006, İzmir follows a consistent trend at around 14 percent after that. The purchasing of the Port of Piraeus in 2016 by the Chinese COSCO signaled the sharing of the cargo and further declines in İzmir's share. In 2017–18, the overall national regression was proportionately reflected in İzmir's share.

The chapter will continue to show the projections for the period until 2033 for Turkish foreign trade, foreign trade and handling in İzmir, container handling in İzmir, and Ro-Ro handling in İzmir using the variables and models previously explained in the data and methodology chapter.

**FIGURE 32.** Correlation Between the Maritime Transport in İzmir and in Türkiye

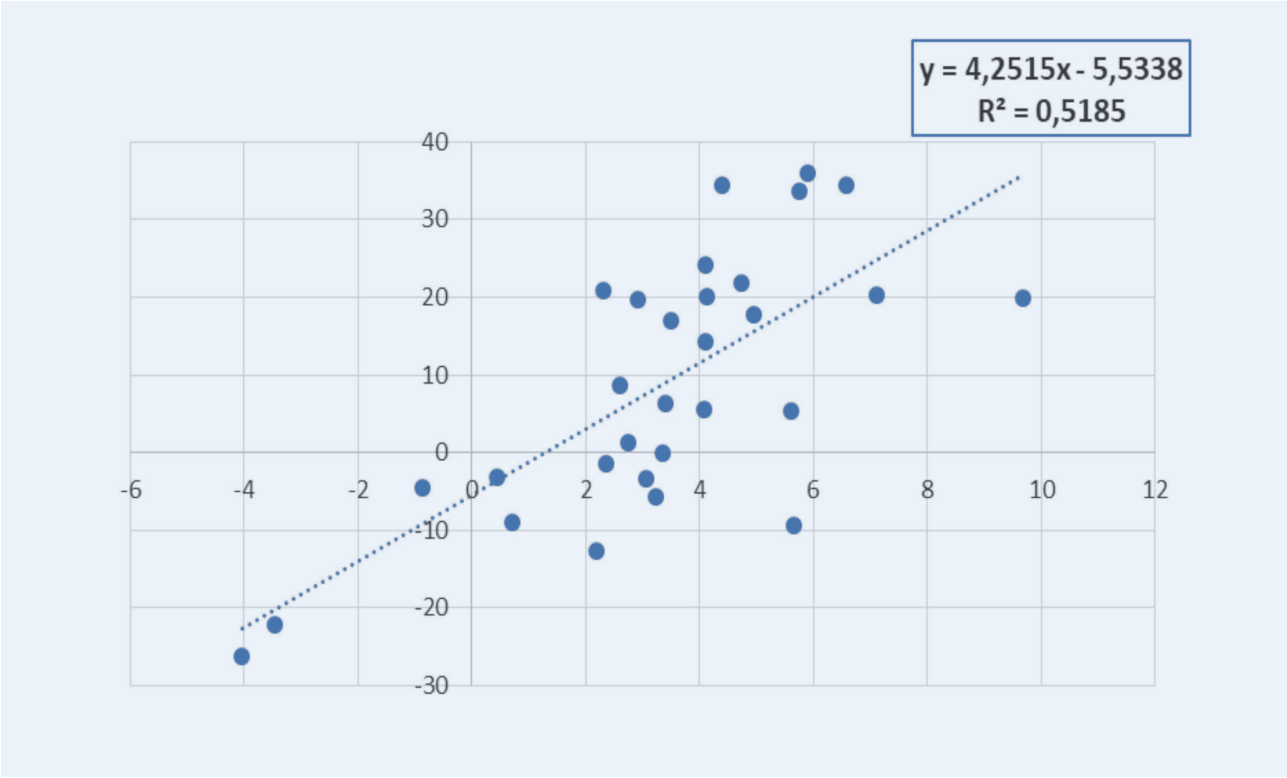


**FIGURE 33.** Correlation Between Handling in İzmir and in Türkiye

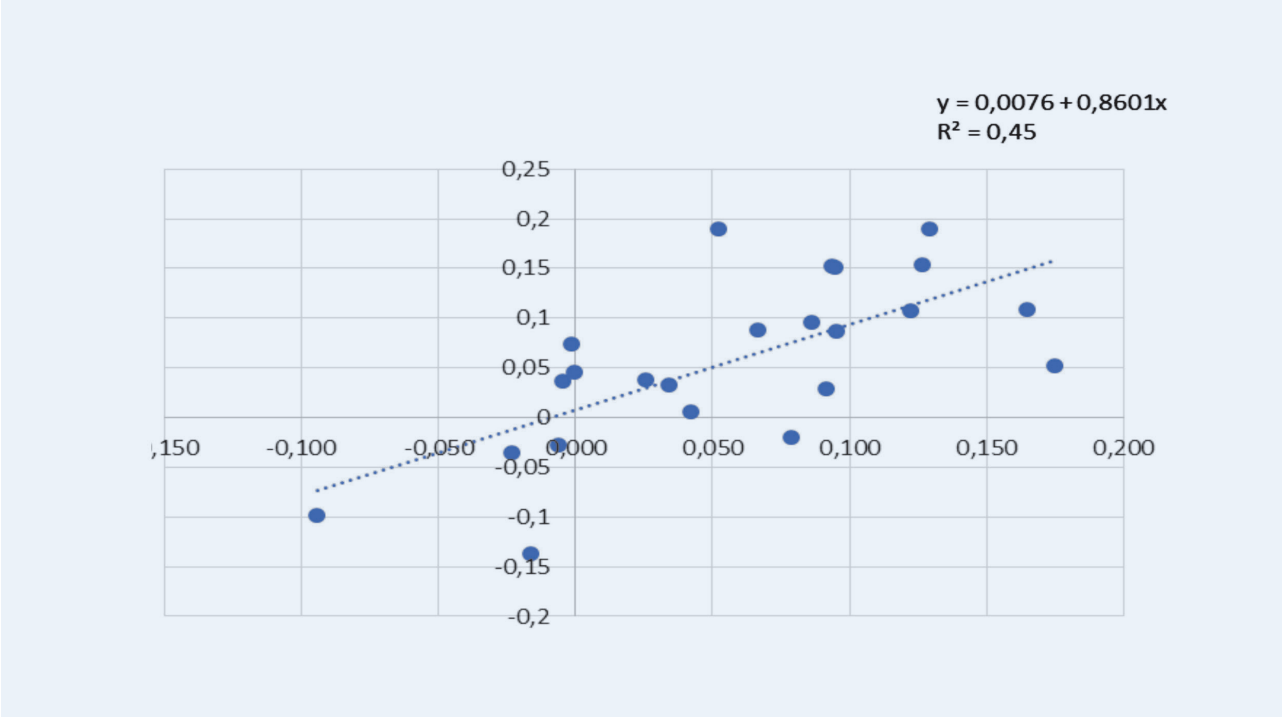
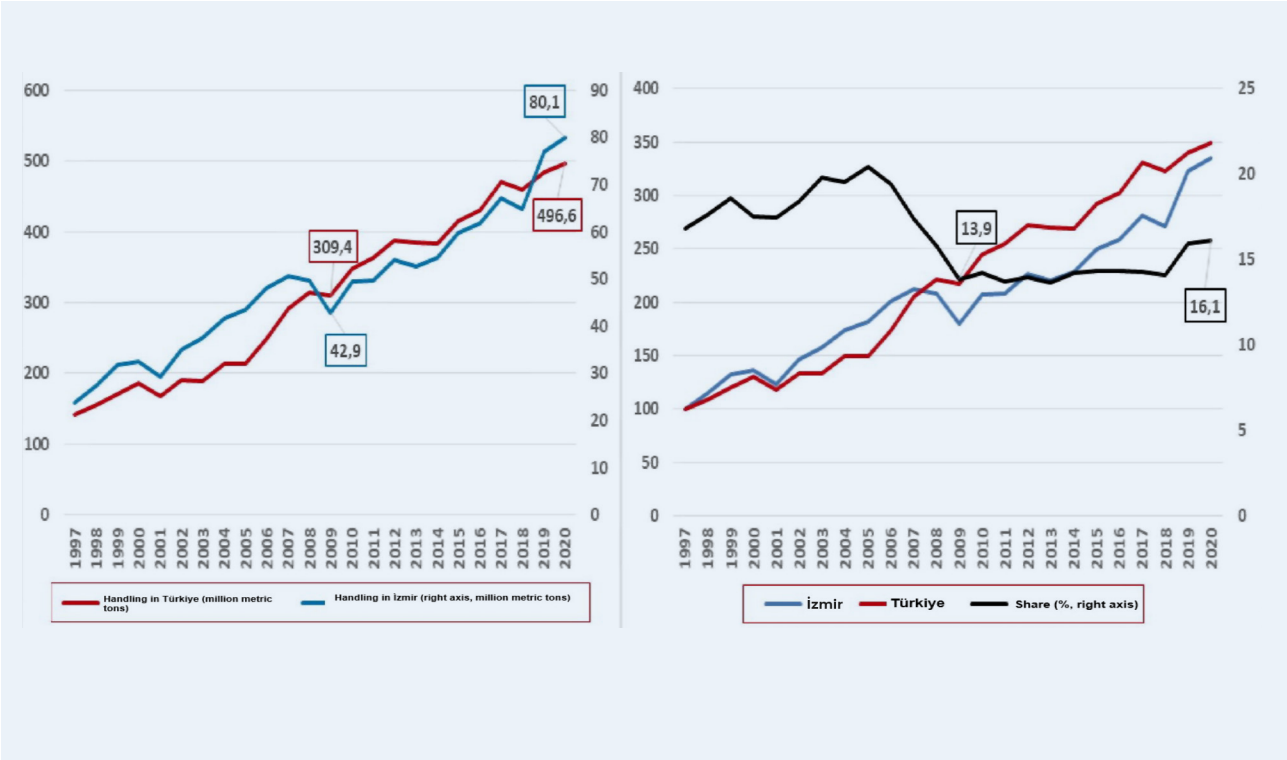



**FIGURE 34.** The Amount of Cargo Handled in the Ports of Türkiye and İzmir




*Source: Ministry of Transport and Infrastructure The calculations are carried out by the author.*
*Note: The data in the first chart is in metric tons while the second chart is indexed. The beginning is set at 100 for both series and the second axis reflect the percentage share.*

### 3.3.1. Foreign Trade Projection for Türkiye

The model reflecting the Turkish foreign trade employs the global trade, growth in Türkiye and ARMA variables as discussed in the chapter method. The three unique "fluctuating" scenarios of the global economy are applied in the projection of Turkish foreign trade (Figure 35). Having registered at $389.17 billion in 2020, Turkish foreign trade is predicted to reach $783.65 billion by 2033 in the average scenario. In addition to the fluctuating growth estimations in the long-term, Turkish foreign trade is predicted to reach $531.26 billion by a 36 percent increase margin by 2033 in case of negative shocks. The above-average scenario forecasting positive shocks in addition to the fluctuating growth scenarios predicts Turkish foreign trade to reach $1,016.86 billion (Table 19). It should be noted that the average scenario is the most likely to occur out of the three scenarios. It is, therefore, advised to both macro- and micro-level decision-makers to primarily consider the average scenario.

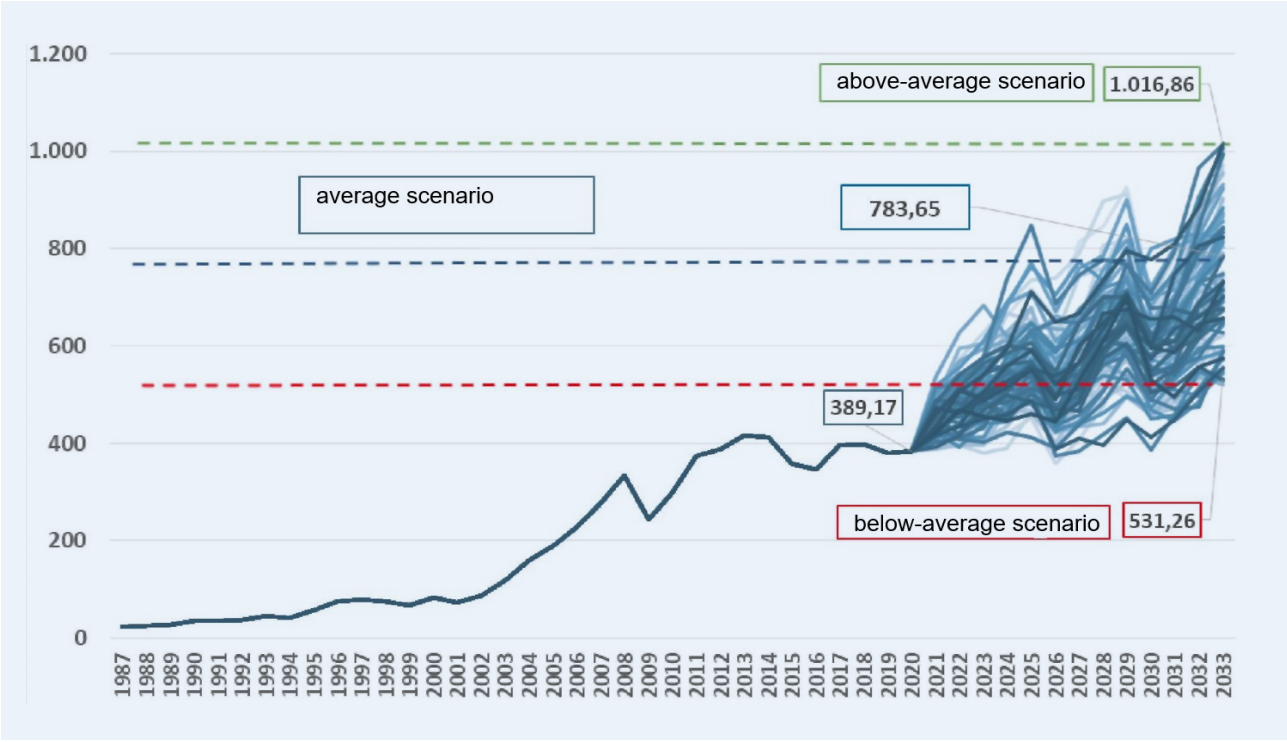
It should also be noted that in the upcoming years, the projections should be revised in line with the realized data and conjunctural developments, and that the above-average and below-average scenarios should also be given due consideration.

**TABLE 19.** Foreign Trade Projection Values for Türkiye

| Türkiye foreign trade scenarios (2033) | değer (milyar dolar) | büyüme (%) |
|---|---|---|
| above-average scenario | 1,016.86 | 161.29 |
| average scenario | 783.65 | 101.36 |
| below-average scenario | 531.26 | 36.51 |

**FIGURE 35.** Foreign Trade Projection for Türkiye (billion USD)

*Note: The model reflecting projections on trade in Türkiye employs the global trade, growth in Türkiye, and trade in Türkiye (-2) independent variables. The R2 of the model is 80.2 percent. The p-values are 0.023, 0.000 and 0.003, respectively.*



### 3.3.2. Foreign Trade and Handling Projection for İzmir

The model reflecting projections on foreign trade in İzmir employs the global trade, growth in Türkiye, and ARMA variables. The foreign trade in İzmir variable differs from the other variables in frequency and number of observations. Province-specific foreign trade data and overall data referenced by TurkSTAT for Türkiye will be available from 2013. That is because the data calculation method for foreign trade was switched to the bottom-up approach. Data reaching further back in history was last reported in 2019 (Figure 36).

An alternative to formulating projections for the period until 2033 relying on data from 2013 to 2020 is to employ İzmir's share in the GDP to retrospectively calculate its share in trade to increase the number of observations. This rate is calculated as 6.2 percent historically within the relevant period (Figure 37).

**FIGURE 36.** Foreign Trade in General and Special Trade Systems

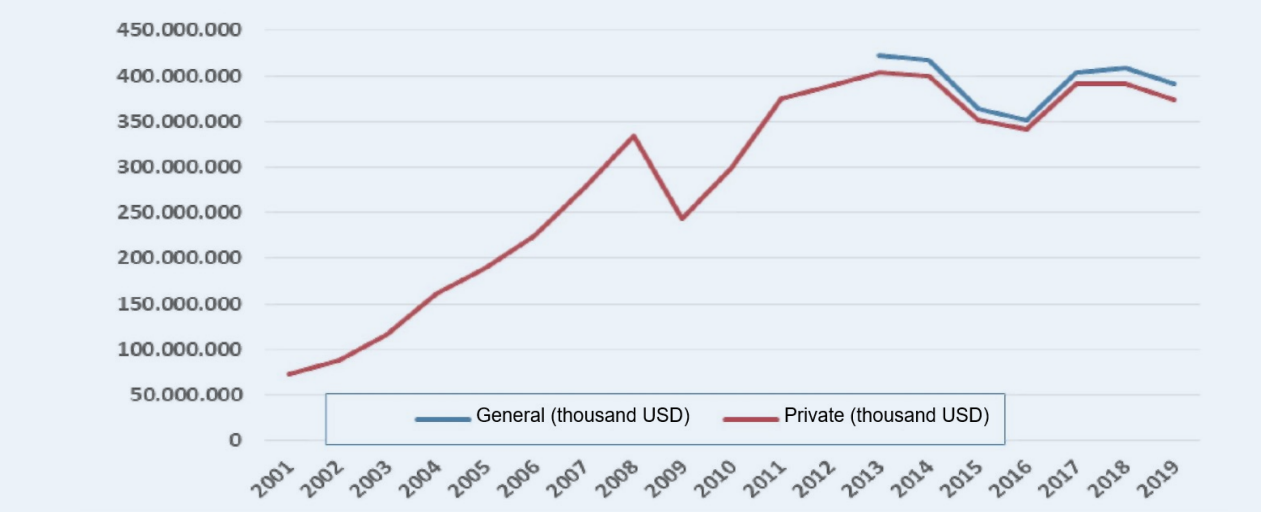


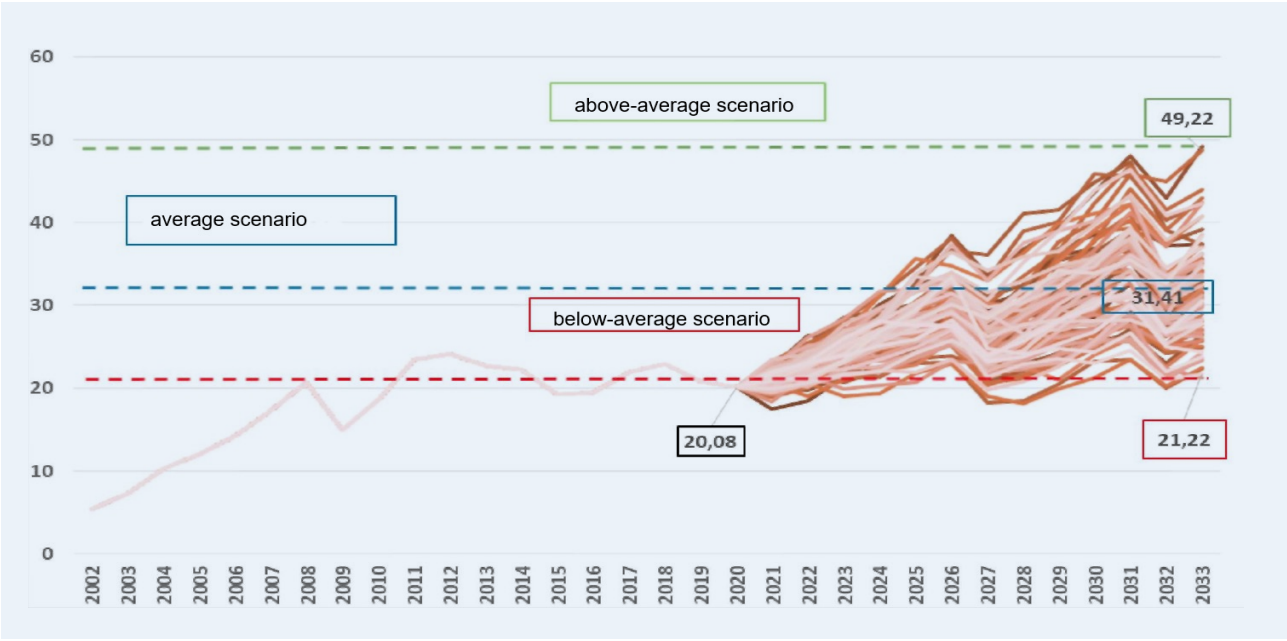

**FIGURE 37.** İzmir's Share in GDP

Following the combination of the growth and trade data, the development of foreign trade in İzmir is provided in Figure 38. The foreign trade volume in İzmir is $20.08 billion as of 2020.

Figure 39 shows the foreign trade projections for İzmir and postulates fluctuating global growth and negative shocks every four to five years. In the event that the shocks become more severe and the overall course takes a negative turn, only a 5-percent growth rate is expected by 2033, reaching $21.22 billion. This scenario, however, postulates fluctuating growth combined with unpleasant developments. The average scenario for 2033 predict the foreign trade volume in İzmir will reach $31.41 billion by a 55-percent increase margin.

**FIGURE 38.** Foreign Trade Volume of İzmir By Years (billion USD)


**FIGURE 39.** Foreign Trade Projection for İzmir (billion USD)



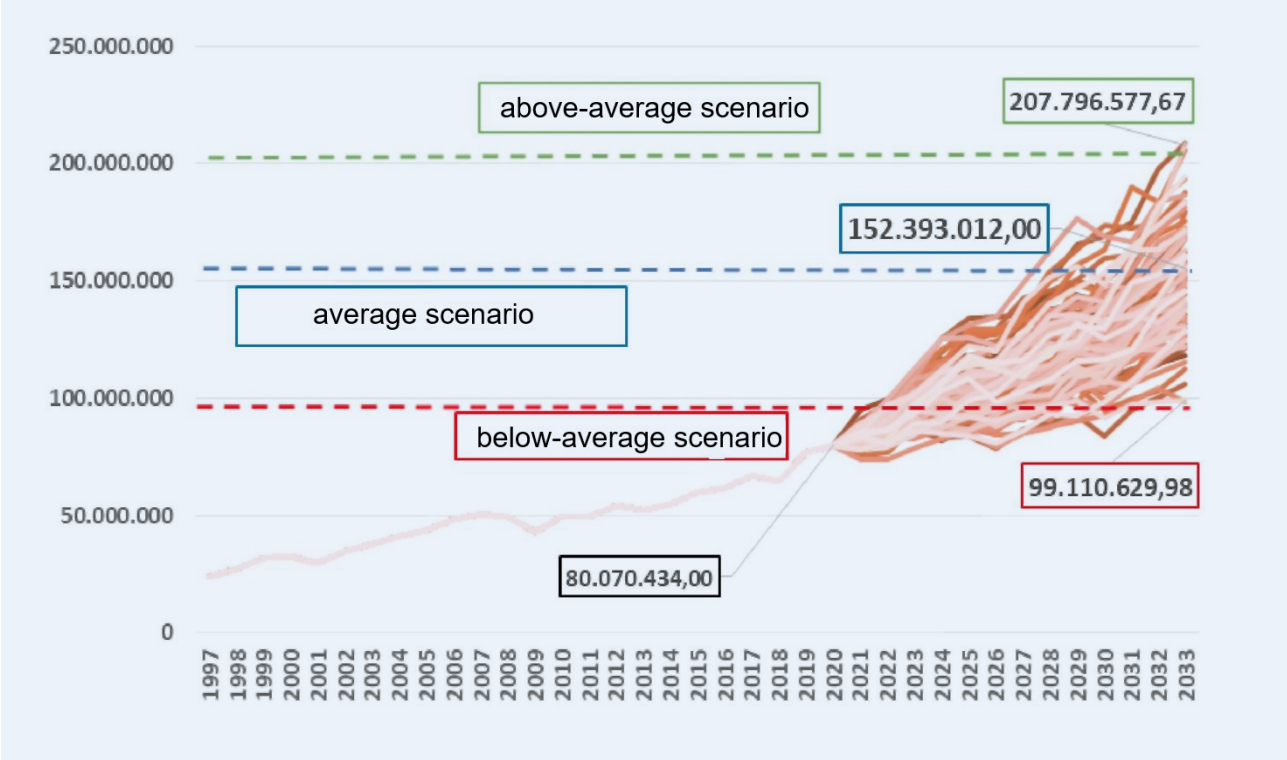

*Note: The model reflecting projections on foreign trade in İzmir employs global growth and growth in Türkiye variables. The R2 of the model is 90 percent. The p-values of the variables are 0.000 and 0.0189, respectively.*

**TABLE 20.** Foreign Trade Projection Values for İzmir

| İzmir foreign trade scenarios (2033) | value (billion USD) | growth (%) |
|---|---|---|
| above-average scenario | 49.22 | 145.12 |
| average scenario | 31.41 | 56.42 |
| below-average scenario | 21.22 | 5.68 |

The econometric model formulated to predict the amount of cargo in metric tons handled in the ports of İzmir, the final link of the chain model from global trade down to handling in İzmir, contains the amount of cargo handled in the ports of Türkiye in metric tons and global maritime trade variables as well as the ARMA structure. The amount of cargo handled in the ports of İzmir in 2020 is 80.07 million metric tons. Figure 40 shows the average scenario based on fluctuating global economy, predicting a 90-percent increase by 2033, reaching 152.4 million metric tons. The above-average scenario which forecasts positive shocks in addition to fluctuating growth in the global economy, predicts 207.8 million metric tons of cargo handled in the ports of İzmir by 2033 while the below-average scenario forecasting negative shocks predicts 99.11 million metric tons (Table 20).

**FIGURE 40.** Handling Projection for İzmir (metric tons)




*Note: The model reflecting the cargo handled in İzmir employs trade in Türkiye, trade in Türkiye (-1), global growth (-1), and global maritime growth (-2) as independent variables. The R2 of the model is 63 percent. The p-values of variables are 0.002, 0.004, 0.024 and 0.067, respectively.*

**TABLE 21.** Handling Projection Values for İzmir

| İzmir handling scenarios (2033) | value (metric tons) | growth (%) |
|---|---|---|
| Above-average scenario | 207.796.577,67 | 159,52 |
| Average scenario | 152.393.012,00 | 90,32 |
| Below-average scenario | 99.110.629,98 | 23,78 |

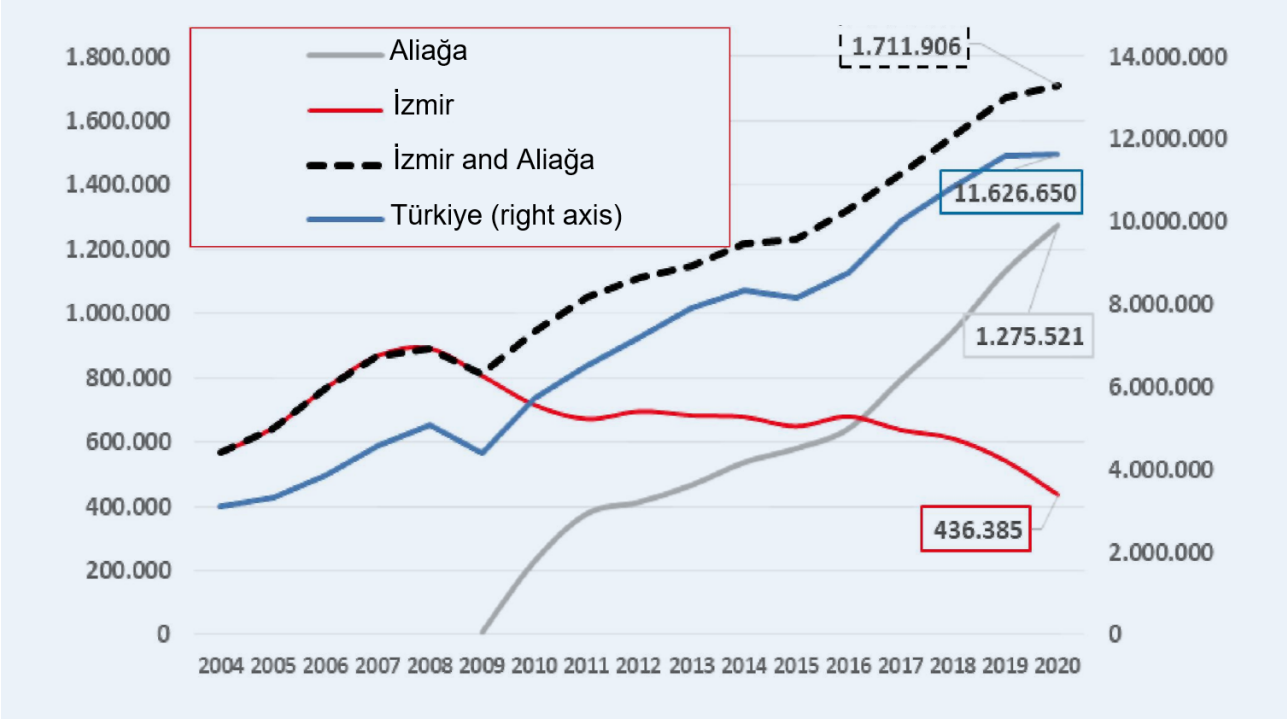
While a 56-percent increase is predicted in foreign trade in İzmir, an approximate 90-percent increase is predicted in the amount of cargo handled in the ports of İzmir (Table 21).[13]

To summarize: the econometric model for handling volume in the ports of İzmir region is based on global trade, overall economic growth, global maritime trade, Turkish trade, growth and handling data for Türkiye. While the handling volume in the ports of İzmir was worth approximately 80 million metric tons, the average scenario estimates that the figures will reach 152.4 million metric tons by 2033.

### 3.3.3. Container Handling Projection for İzmir

Figure 41 shows the number of containers handled in the ports of İzmir and Türkiye in TEU. Once the Port of Aliağa entered into service, the region gained a substantial share in the number of containers handled (the average annual increase neared 20 percent) and this trend continued in the latest data in 2019. This data suggests that the regional trends are not significantly distinct from the overall trends in Türkiye.

**FIGURE 41.** Container Handling in İzmir and in Türkiye (TEU)




13 The correlations between handling amount and estimated growth differ. It is important to note that the handling amount does not refer to foreign trade alone and includes domestic trade operations. If the study used handling data per cargo type, the underlying causes could have been examined.

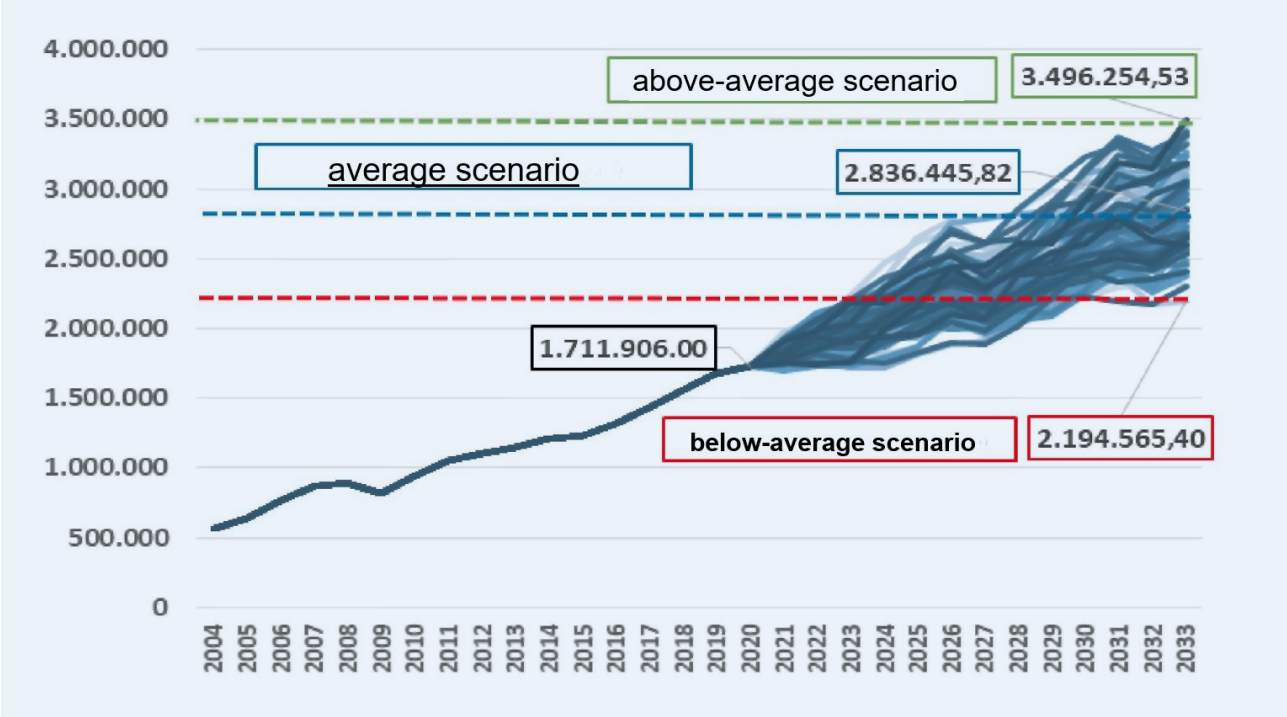
The amount of cargo handled in Türkiye over the course of last 10 years almost doubled. As for the İzmir region specifically, we register an 80-percent increase (Table 22).

Regarding the projections on the total number of containers handled in the Ports of İzmir and Aliağa, it was noted that only the global maritime trade was sufficiently explanatory out of all the other variables employed in the model (trade in Türkiye, growth in Türkiye, global growth, global maritime trade, total containers handled in Türkiye).

**TABLE 22.** Recent Fluctuations in Handling in Türkiye and in İzmir

| Growth % | Türkiye | Aliağa | İzmir | Aliağa and İzmir |
|---|---|---|---|---|
| last one year | 0.30 | 12.63 | -19.44 | 2.25 |
| last five years | 42.72 | 119.82 | -32.82 | 39.20 |
| last 10 years | 102.43 | 455.37 | -39.06 | 81.01 |

**FIGURE 42.** Container Handling Projection for İzmir (TEU)




*Note: The model reflecting projections for the container handling in İzmir region includes global maritime trade data as an independent variable. The R2 of the model is 78 percent. The p-value of the independent variable is 0.00.*

**TABLE 23.** Container Handling Projection for İzmir

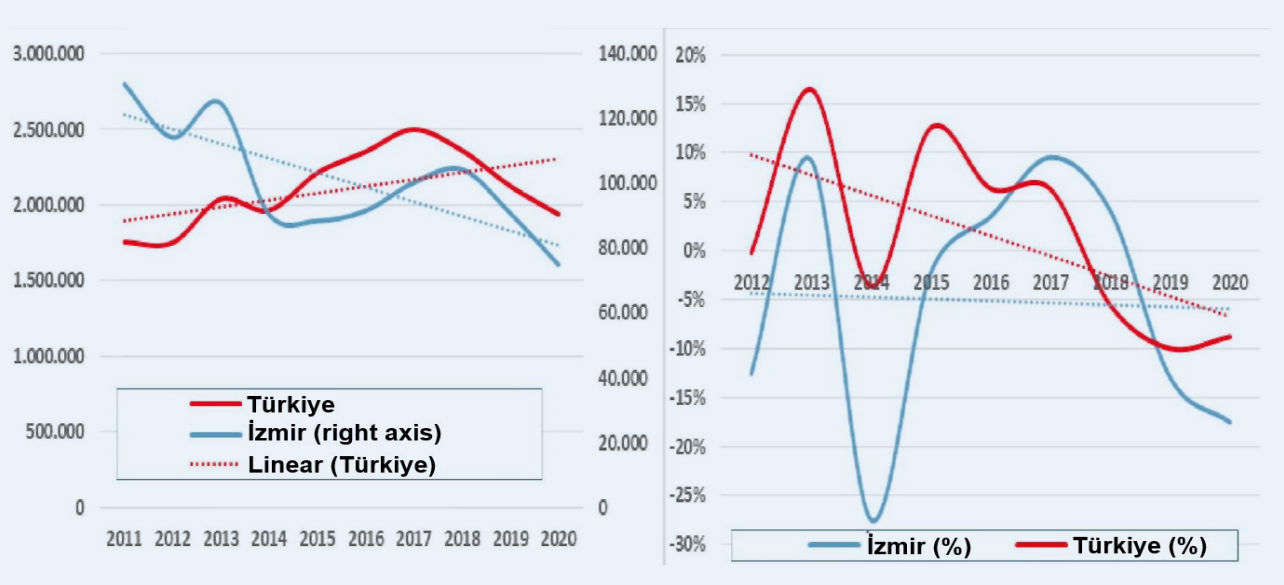
| İzmir container scenari-os (2033) | value (TEU) | growth (%) |
|---|---|---|
| Above-average scenario | 3,496,254.53 | 104.23 |
| Average scenario | 2,836,445.82 | 65.69 |
| Below-average scenario | 2,194,565.40 | 28.19 |

According to the results, the average scenario predicts a 65 percent increase in cargo handling in İzmir with a total of 2,836,445 TEUs to be handled in 2033. In case of multiple negative and positive shocks in this scenario, the increase in the number of handled containers might remain at 28 percent in the below-average scenario or register a 104-percent increase (Table 23). It should be noted, however, that multiple negative and positive shocks during the period set for the average scenario are highly unlikely.

## 3.3.4. Ro-Ro Handling Projection for İzmir

There are two major ports in İzmir that handle vehicle transportation: Çeşme Ulusoy and the TCDD Port of İzmir. The former focuses on Ro-Ro, meaning tractor trailer transportation, while the latter focuses on automobiles. Therefore, the data for the İzmir region consists of the combined data for these components.[14] As neither the global variables nor local macro variables that are predicted to impact the Ro-Ro and automobile transportation revealed any significant correlations, the overall transportation in Türkiye was considered with the expectation of a positive correlation (Figure 43). As the data for Türkiye also comprises transportation in İzmir, a correlation between the two is natural.

**FIGURE 43.** Development of Ro-Ro and Automobile Transportation in Türkiye and in İzmir



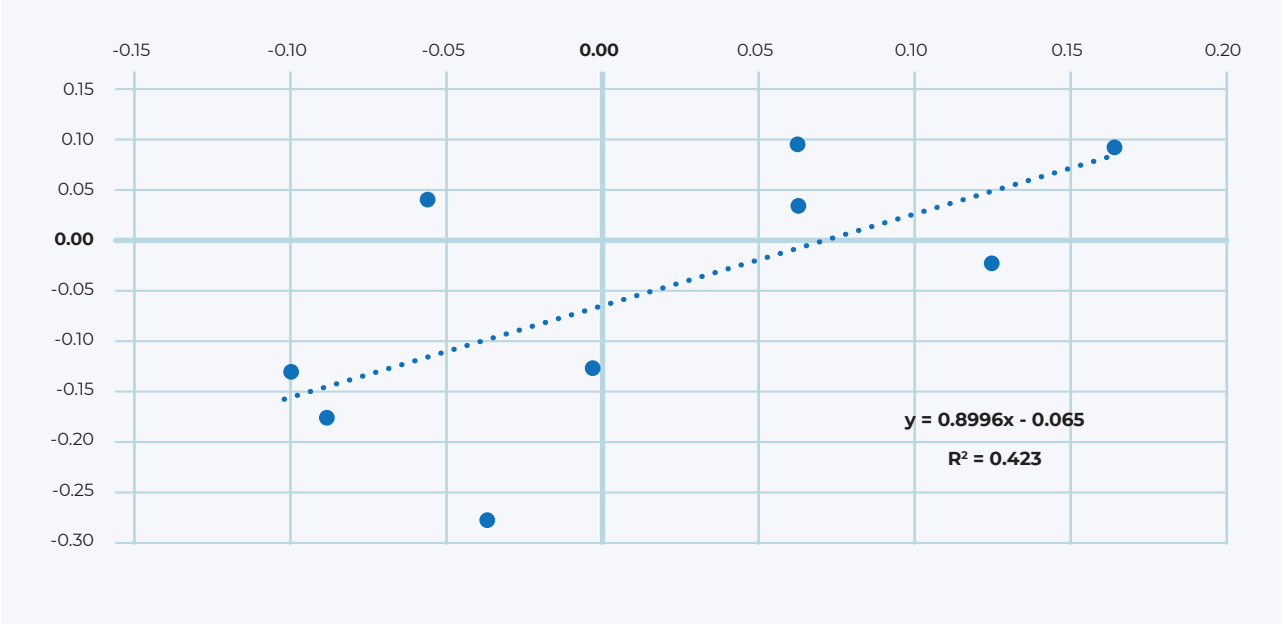

*Data source: Ministry of Transport and Infrastructure*
*Note: The unit of the first chart is the number of vehicles while the second is in percentage.*

14 The data set covers the period between 2011 and 2020. Given the data interval of the model, statistical tests are only valid in the event of strict hypotheses.

Overall transportation in Türkiye accounts for 42 percent of changes in the Ro-Ro and automobile transportation in the İzmir Region (Figure 44).

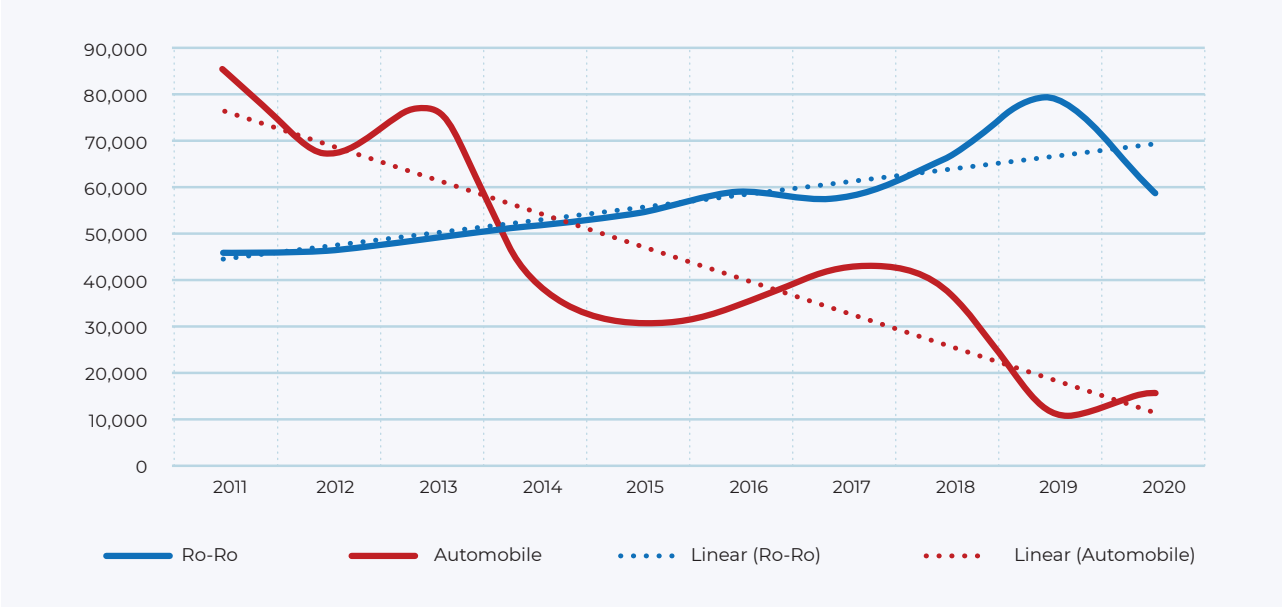
In case of mutual pressure occurring between projection trends, each trend should be explored individually in the Ro-Ro and automobile transportation. As demonstrated in Figure 45, different trends in Ro-Ro and automobile handling were examined individually as total figures can eliminate the distinction in these trends, each shaped by a different dynamic. While Ro-Ro transportation registered an increasing trend, automobile transportation witnessed a declining one.

**FIGURE 44.** Ro-Ro and Automobile Transportation in Türkiye and in İzmir




*Note: Horizontal axis Türkiye (%), vertical axis İzmir (%)*

**FIGURE 45.** Ro-Ro and Automobile Handling in İzmir (Number of Vehicles)



In the econometric model reflecting the Ro-Ro transportation, neither global nor local macro variables proved to be sufficiently significant as demonstrated above. Therefore, the trend analysis, assuming time series as an independent variable, was employed in the predictions of Ro-Ro transportation. As per the below- and above-average scenarios, the standard deviations of annual changes were used (Figure 46).

**FIGURE 46.** Ro-Ro Projection for İzmir (Quantity)

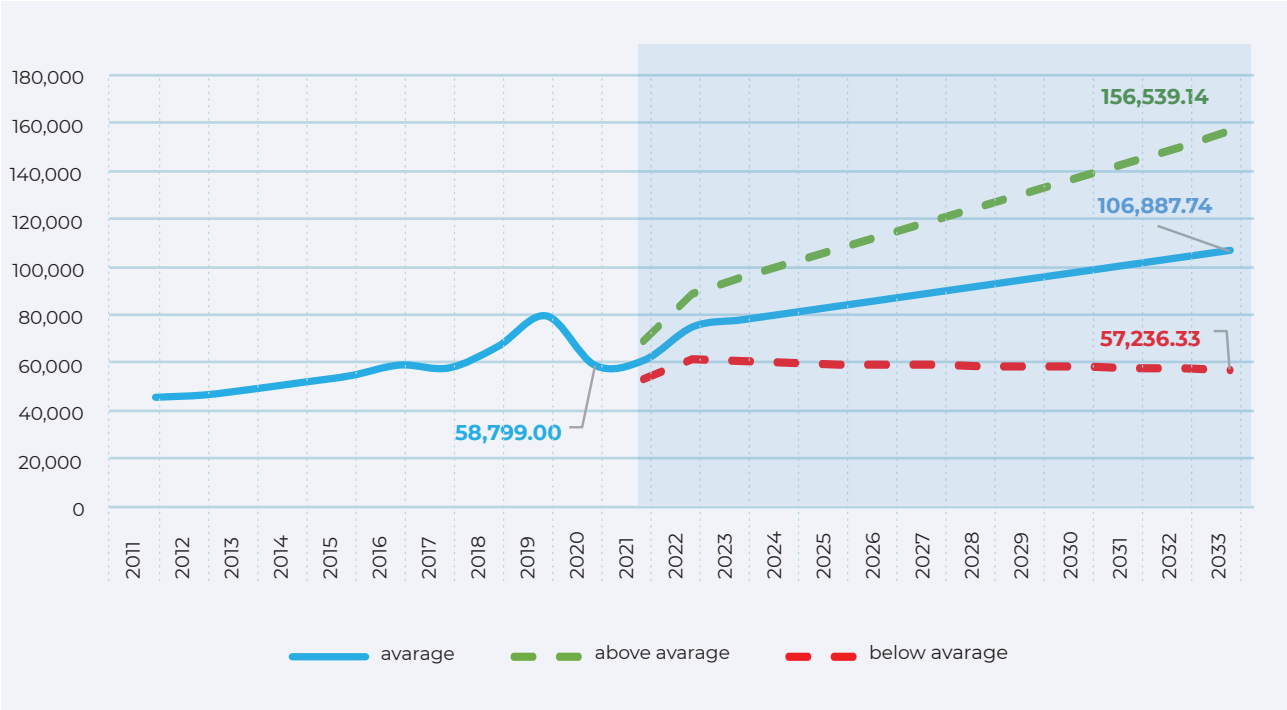



**TABLE 24.** Ro-Ro Projection Values for İzmir

| Ro-Ro scenarios (2033) | number | growth (%) |
|---|---|---|
| Above-average scenario | 156,539.14 | 166.23 |
| Average scenario | 106,887.74 | 81.78 |
| Below-average scenario | 57,236.33 | -2.66 |

The base scenario assumes long-term average increase to be consistent and predicts that the current 58,799 items in Ro-Ro handling will register an 80-percent increase to reach 106,887 items by 2033. The above-average scenario, which includes positive shocks for Ro-Ro transport, estimates an increase of approximately 166 percent by 2033 while the below-scenario of negative shocks foresees a 2.66-percent loss and minimal fluctuations to 57,236 items (Table 24). The general opinion, in line with the previous statements in the study, suggests optimistic or average projections, particularly for Ro-Ro transportation.

### 3.3.5. Evaluation of the Supply in the Context of Demand Projections

This chapter will assess the supply capacity of ports in İzmir for the period until 2033 in the context of predicted projections. The assessment was conducted in three categories, namely: total cargo, container and Ro-Ro.

Table 10 explores the current capacity of ports in İzmir and provides liquid bulk and general cargo capacity in metric tons, container capacity in TEU, and Ro-Ro capacity in the number of vehicles. First of all, the total supply potential of İzmir ports should be determined for all cargo types. In that aspect, capacity provided per TEU container and capacity forecast for each vehicle should be expressed in metric tons. With a view to reflect these capacity values in metric tons, the statistical data of the last four years were studied.

According to the MoTI cargo statistics, a total of 44,073,022 TEUs were handled in the ports of Türkiye over the last four years (2017–2020). The handling statistics per cargo type on the same portal indicates that the total weight of this container cargo handled over the course of four years equal 462,628,331 metric tons. Using this data, the average weight of a TEU container handled is calculated to be 10.5 metric tons. In light of this calculation, the average weight of a TEU container was counted as 11 metric tons in reflecting the total capacity per cargo type in metric tons.

However, as the cargo carried by Ro-Ro transportation varies greatly, it is difficult to assume an average value. According to the MoTI cargo statistics, a total of 8,929,757 vehicles were handled in the ports of Türkiye over the last four years (2017–2020). Of these:

2,222,347 items were tow trucks, tractor-trailers, tankers, trailers and freight cars while 6,707,410 were categorized as other vehicles. The total weight of vehicles in the second category is significantly lower, though they comprise nearly 75 percent of total handled vehicles. As for the handling statistics per cargo type, the total weight of vehicles handled over the mentioned four years was registered as 34,244,499 metric tons. Using this data, the average weight of a vehicle handled over this period is calculated to be 3.8 metric tons.

In fact, when the vehicles in the first category are loaded in compliance with the loading limits of the General Directorate of Roads, their weight can reach 29 metric tons (KGM, 2011). On the other hand, experienced port operators suggest that 19 metric tons can be assumed as average value for the first category of vehicles while 1.2 metric tons is applicable for the second category[15]. Based on the total weight indicated in the four-year data and considering the advised average weights, the average weight per vehicle handled at Türkiye ports equals 6.6 metric tons. However, as some boats sail without any cargo, it was concluded that the average weight per vehicle will be lower in the case of real life. The factor to be employed in the metric ton conversion of total supply capacity in the ports of İzmir was posited as “5.2 metric tons/vehicle,” the average value of the two above discussed values. Table 25 shows the total supply capacity of the ports of İzmir in metric tons as calculated with the posited value (The current capacity data in the table was previously provided in Table 10, denoting the total capacity per cargo type in the ports of İzmir).

15 During the interview with the Port Manager of the TCDD Port of İzmir on April 8, 2021, it was noted that the average weight for vehicles such as tractor-trailers/trailers be posited as 19 metric tons and for other vehicles as 1.2 metric tons. 15

**TABLE 25.** Total Capacity of the Ports of İzmir for All Cargo Types

| Cargo Type | Current Capacity | Factor | Capacity in Metric Tons |
|---|---|---|---|
| Liquid Bulk Cargo | 51,527,504 Metric Tons | 1 | 51,527,504 |
| General Cargo | 40,519,000 Metric Tons | 1 | 40,519,000 |
| Container | 4,250,000 TEUs | 11 metric tons/TEU | 46,750,000 |
| Ro-Ro | 400,000 Items | 5.2 metric tons/item | 2,080,000 |
| Total Capacity (Metric Tons) | | | 140,876,504 |

To be able to assess the current situation of supply based on demand projections, the currently known projects concerning the ports for the period until 2033 should also be considered. It is known that the NEMPORT aims to increase its capacity from 750,000 TEUs to 1,750,000 TEUs within the scope of its vision for 2023. Moreover, certain ports may convert suitable lands within their hinterlands into stacking areas to boost capacity in line with future requirements. Table 26 provides the current capacities of container ports in İzmir as well as their potential capacities by 2033 in line with the planned and predicted projects.

**TABLE 26.** Handling Capacities of İzmir Container Ports (2021–2033)

| Port Facility | Handling Capacity (TEU) | | | Evaluation |
|---|---|---|---|---|
| | 2021 (Current) | 2023 (Planned) | 2033 (Prediction) | |
| TCDD Port of İzmir | 1,000,000 | 1,000,000 | 1,000,000 | Note 1 |
| NEMPORT | 750,000 | 1,750,000 | 1,750,000 | Note 2 |
| SOCAR Aliağa | 1,500,000 | 1,500,000 | 2,000,000 | Note 3 |
| TCEEGE Fertilizer | 1,000,000 | 1,000,000 | 1,500,000 | Note 4 |
| **Total** | **4,250,000** | **5,250,000** | **6,250,000** | – |

*Note 1: The authors verified the current situation in the interview with the Director of Port Authority of the TCDD Port of İzmir on March 19, 2021. There are no estimated investment projects. Although the current capacity is reflected in this table, it is left to the relevant authorities to evaluate the projections in this study.*

*Note 2: The authors verified the current situation on March 4, 2021, during a phone interview with the Deputy General Manager of NEMPORT. The ongoing project to boost capacity up to 1.75 million TEUs is scheduled to be completed by 2023. As the Port Authority has not issued any statements concerning 2033, the predictions were left as is.*

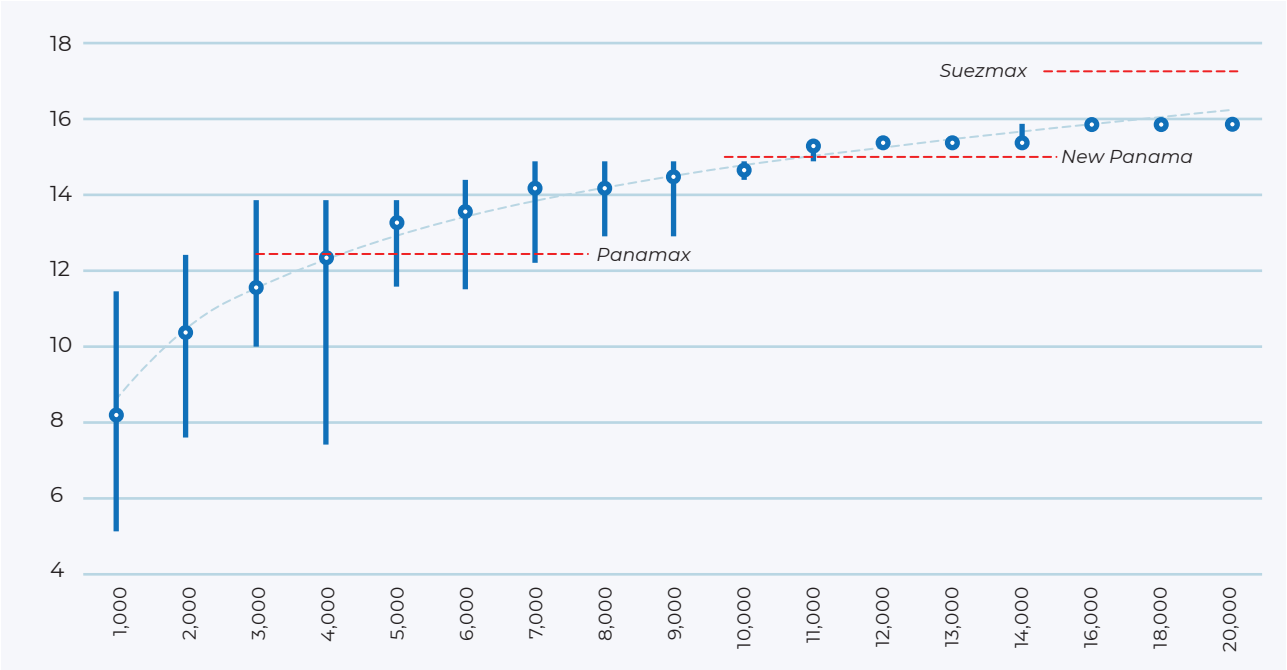
*Note 3: SOCAR has the potential to increase its stacking area by repurposing the suitable lands in its hinterland. A capacity-increase investment project is predicted to be made by 2033.*

*Note 4: The authors verified the current situation in the interview with the Director of Port Authority of the TCEEGE Fertilizer on March 19, 2021. An ongoing project is currently underway to extend the two docks by 100 meters each, and a capacity-increase investment project is predicted to be made by 2033.*

*Source: http://www.socar.com.tr/en/business-fields/port-operations*

One of the major issues of the TCDD Port of İzmir is the dock depth. The current depth reaches 10 meters, but the target is 11 meters. Dock depth in other container ports varies between 16 and 22 meters. Dock depths at NEMPORT, SOCAR Aliağa and TCE EGE ports allow the new high-capacity container ships to dock. Figure 47 shows the development of average ship drafts in line with the capacity development of container ships, a major actor in the global maritime trade.

**FIGURE 47.** Average Ship Drafts by Container Ship Capacity




*Source:https://transportgeography.org/contents/chapter5/maritime-transportation/draft-containership-capacity/ (Adapted from Clarksons Research).*

To serve container ships of 14,000 TEUs or a higher capacity, the terminal must provide an effective handling service in addition to an at least 16-meter deep dock for the ship to edge in. When the dock depth is limited to 11 meters, the port can only dock ships no larger than 4,000 TEUs in capacity. As larger-capacity container ships replace the lower-capacity container ships in transportation systems, the demand in container traffic is estimated to fall for TCDD Port of İzmir.

Comprehensive information on the capacities of Ro-Ro ports is provided in chapter 3.3.3. The current annual capacity of the İzmir Ro-Ro terminal is calculated as 400,000 vehicles. If the TCDD Port of İzmir opts to specialize in Ro-Ro transportation, it may allocate an area within the port as a parking lot for the handled vehicles to boost capacity. The estimations suggest that by simply improving the Çeşme Ulusoy Port, the total handling capacity may be expanded by 438,000 vehicles by year. The other ports handling other types of cargo will also have a two-to-three-year window to expand their capacities once they decide to invest. Following the investments to this end, the total capacity of liquid bulk and general cargo ports are estimated to increase by at least half by 2033. Within that scope, the total supply capacity of ports in İzmir is predicted to reveal as in Table 27.

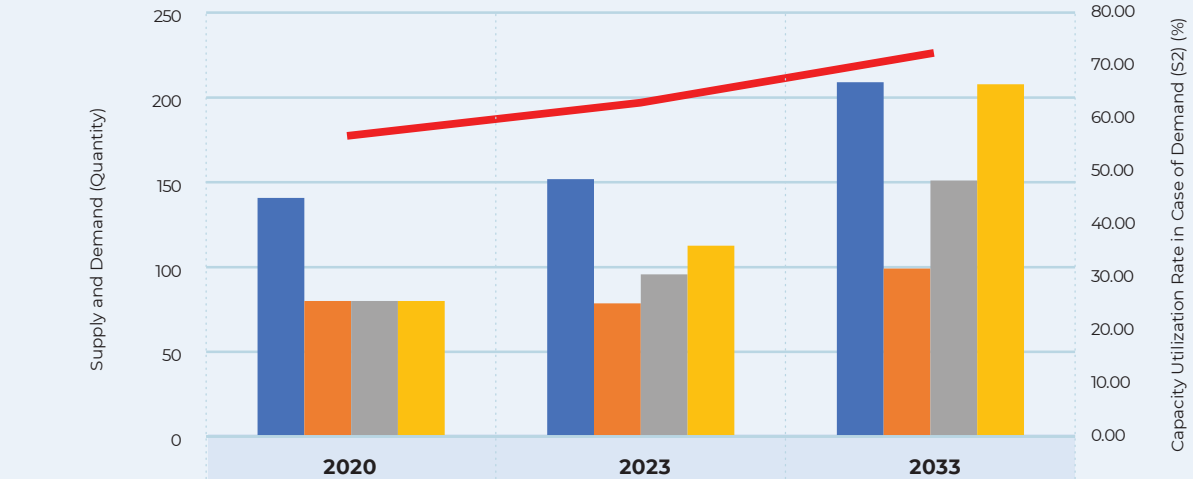
The current total capacity is calculated as 140,876,504 metric tons (Table 25). Once the NEMPORT project is completed in 2023, the current total is predicted to increase by at least 11 million metric tons to reach 151,876,504 metric tons. By 2033, the total capacity is predicted to be at least 209,097,356 metric tons.

Figure 48 compares the total demand projections and capacity supply for all cargo types in the ports of İzmir. In case of the average scenario, the total capacity utilization rate of İzmir ports are expected to augment from 56.82 percent in 2020 to 62.98 percent in 2023 and to 72.25 percent in 2033.

**TABLE 27.** Supply Estimations by Cargo Types for the Ports of İzmir (2033)

| Cargo Type | Current Capacity | 2033 Predicted Capacity | Capacity in Metric Tons 2033 |
|---|---|---|---|
| Liquid Bulk Cargo | 51,527,504 Metric Tons | 77,291,256 Metric Tons | 77,291,256 |
| General Cargo | 40,519,000 Metric Tons | 60,778,500 Metric Tons | 60,778,500 |
| Container | 4,250,000 TEUs | 6,250,000 TEUs | 68,750,000 |
| Ro-Ro | 400,000 Items | 438,000 Items | 2,277,600 |
| **Total Capacity (Metric Tons)** | | | **209,097,356** |

**FIGURE 48.** Comparison of Projections for Supply and Demand for Cargo Types



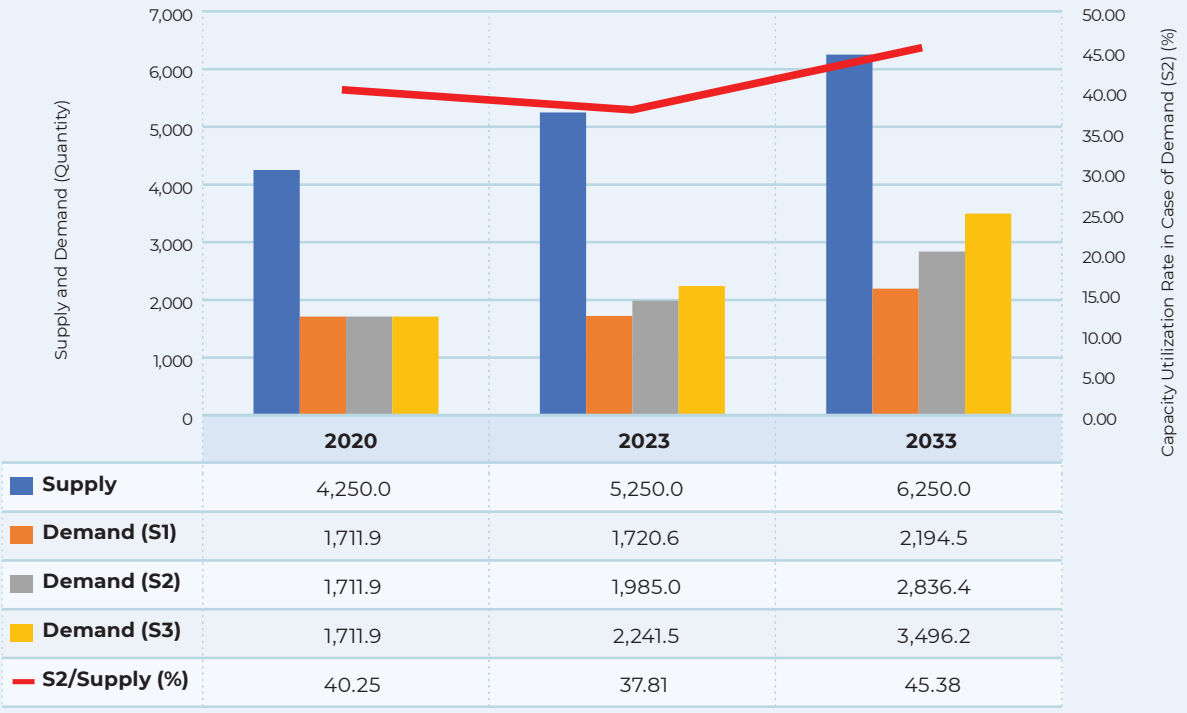

| | 2020 | 2023 | 2033 |
|---|---|---|---|
| **Supply** | 140.8 | 151.8 | 209.0 |
| **Demand (S1)** | 80.0 | 78.6 | 99.1 |
| **Demand (S2)** | 80.0 | 95.6 | 151.0 |
| **Demand (S3)** | 80.0 | 112.5 | 207.7 |
| **S2/Supply (%)** | 56.82 | 62.98 | 72.25 |

*Note: S1: Below-average scenario; S2: Average scenario; S3: Above-average scenario; S2/Supply: Capacity utilization rate in case the average scenario happens.*

In terms of container traffic, the current capacity supply of 4.25 million TEUs of the İzmir container terminals are predicted to reach 5.25 million TEUs in 2023 and at least 6.25 million TEUs by 2033. Figure 49 compares the total demand projections and capacity supply for the ports of İzmir in terms of container traffic.

In case of the average scenario, the total capacity utilization rate of container ports in İzmir is predicted to fluctuate from the 40.25 percent in 2020 and drop to 37.81 percent in 2023 subsequent to the expected capacity boost at NEMPORT, and to increase once again to 45.38 percent by 2033.

**FIGURE 49.** Comparison of Projections for Supply and Demand for Container

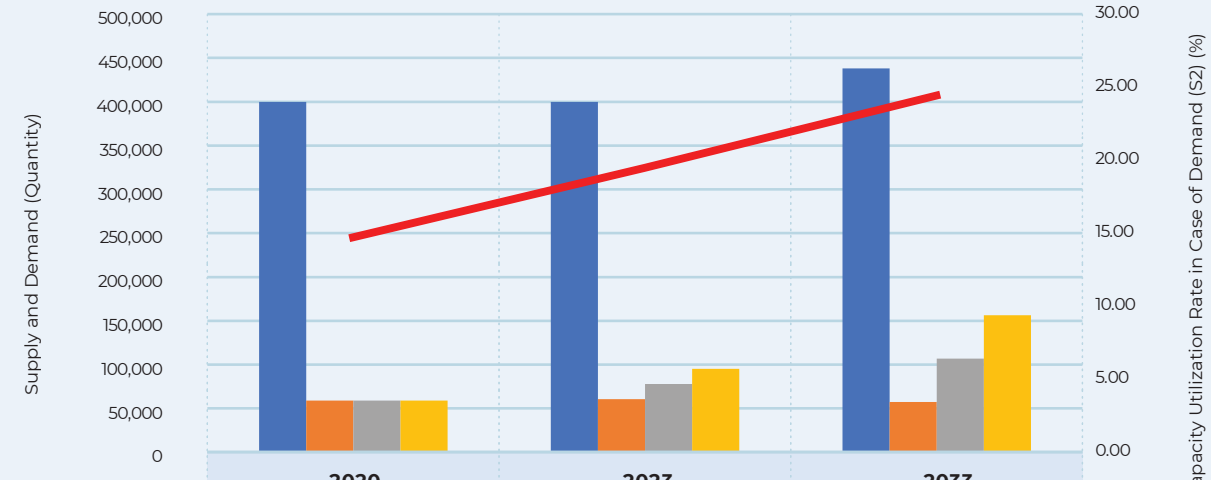



| | 2020 | 2023 | 2033 |
|---|---|---|---|
| Supply | 4,250.0 | 5,250.0 | 6,250.0 |
| Demand (S1) | 1,711.9 | 1,720.6 | 2,194.5 |
| Demand (S2) | 1,711.9 | 1,985.0 | 2,836.4 |
| Demand (S3) | 1,711.9 | 2,241.5 | 3,496.2 |
| S2/Supply (%) | 40.25 | 37.81 | 45.38 |

*Note: S1: Below-average scenario; S2: Average scenario; S3: Above-average scenario; S2/Supply: Capacity utilization rate in case the average scenario happens.*

In terms Ro-Ro traffic, the Ro-Ro ports of İzmir do not estimate any capacity increase by 2023. Should the need arise, a partial capacity boost is on the table through an investment plan in the long term. The study compares the total demand projections and capacity supply in İzmir in terms of Ro-Ro traffic involving large vehicles such as tow trucks, trailer-tankers, tankers, trailers and freight cars (Figure 50). In case of the average scenario, the total capacity utilization rate of İzmir Ro-Ro ports are expected to augment from 14.7 percent in 2020 to 19.5 percent by 2023 and to 24.4 percent by 2033.

**FIGURE 50.** Comparison of Projections for Supply and Demand for Ro-Ro




| | 2020 | 2023 | 2033 |
|---|---|---|---|
| **Supply** | 400,000 | 400,000 | 438,000 |
| **Demand (S1)** | 58,799 | 60,479 | 57,236 |
| **Demand (S2)** | 58,799 | 77,851 | 106,887 |
| **Demand (S3)** | 58,799 | 95,224 | 156,539 |
| **S2/Supply (%)** | 14.7 | 19.5 | 24.4 |

*Note: S1: Below-average scenario; S2: Average scenario; S3: Above-average scenario; S2/Supply: Capacity utilization rate in case the average scenario happens.*

A capacity boost project targeting the ports will take around two to three years to be realized. It is therefore crucial to thoroughly explore the current situation and potential developments, and to closely monitor the increasing trend of capacity utilization rate prior to taking such a strategic step. The advised capacity utilization rate is below 70 percent for the efficient operation of the terminal. Consequently, the goal should be to evaluate the future projections and to complete any investment projects towards capacity increase before the capacity utilization rate exceeds 70 percent.

The 2020 data affirm that in the current situation, the total capacity utilization rate for all ports in İzmir and for all cargo types is close to 60 percent. The rate is predicted to exceed 70 percent in 2033 should the average scenario realizes. In light of these possibilities, it is advised to implement any new investment decisions prior to 2030 .

It should be noted, however, that the investment project should be studied a year or two prior to the implementation date.

There are strategic factors to be taken into account when formulating the growth and development plans for ports, which can potentially impact future predictions. These include: the geopolitical uncertainties in the world, possible increase in the transport costs following the IMO decision to cut sulfur oxide emissions to 0.5 percent, disruptions in quality workforce procurement due to the pandemic, possible gradual increase in the use of airlines in e-commerce, possible disruption of the supply and demand balance, possible decline in purchasing power, and possible decline in government subsidies to citizens should the pandemic lasts longer than expected.

Bu bölümdeki projeksiyonlardaki olasılıkları, gelecekte gerçekleşmesi muhtemel veya beklenmeyen

Please keep in mind that the projections in this chapter are vulnerable to predicted or unforeseen events in the future. Some scenarios that could deviate the predicted projections as partially discussed in the previous chapters are listed below:

- An event similar to the 2007-2008 Global Financial Crisis,
- A new and deadlier pandemic breaking out, disrupting global trade once again,
- Possible conflicts stemming from the trade war between the U.S. and China (New tension in the Chinese-Taiwanese relations and/or China persisting to obtain exclusive economic zone status for artificial islands it constructed far off the mainland coast),
- Potential conflict of interest between Russia, the U.S. and China in the event that China attempts to increase its influence on a majority of countries along the route/path of the "Belt and Road Initiative" leveraging their significant economic indebtedness to it and escalating its presence in the areas where the rivaling Russia and U.S. are influential,
- A new earthquake in or around İzmir impacting both the city and the vicinity of ports,
- Greece, backed by the EU, triggering a new and substantial tension concerning maritime jurisdiction in Cyprus and the East Mediterranean,
- The US Government considering Türkiye's influence on Syria, Libya and Caucasus as a threat to its own presence and increasing pressure on Türkiye with various justifications (embargo, etc.) as exemplified by the past,
- The widespread use of oil and natural gas pipelines in the long term, thus undermining the maritime trade.

# CONCLUSION

This study focuses on the development potential of ports in İzmir for the period until 2033 and draws conclusions regarding these development projections within the scope of the Result-Oriented Program for Marine Economy by İZKA. Building on data pertaining to foreign trade in the world, Türkiye and İzmir, a demand projection was formulated for maritime trade in İzmir based on suitable models to serve as a strategic basis for positioning İzmir. Accordingly, potential growth and the requirement of supply in correspondence to these demand projections were also analyzed within the context of port sustainability.

COVID-19 is considered a substantial factor in estimating the future of the global economy. COVID-19 introduced permanent changes to consumer and investor behavior including remote working and education, online shopping and adjustments to the supply chain that impact the economy. In the pre-COVID-19 era, the global economy was brimming with issues. The most critical of these were the high indebtedness, inequalities in income distribution, climate change, and trade wars. These issues still persist. The regression in growth and employment triggered by the COVID-19 has the potential to further exacerbate these persisting issues. If we can manage to control COVID-19, 2021 and 2022 could register significant growth with the base impact. However, the average growth rate may decline for a determinate period as these issues will require adjustment.

A potential decrease in the average growth in the global economy does not equal a harmonized progress among sectors, regions or countries. The trade wars and the pandemic, in particular, have the potential to change the supply chains as well as logistics and manufacturing centers. Within that context, Türkiye has the potential to be a rising regional logistics and manufacturing center if suitable economic and non-economic reforms can be implemented. Currently, the İzmir region is a substantial trade center in the Turkish economy. Therefore, İzmir will be one of the greatest beneficiaries should the Turkish economy rise as a logistics and manufacturing center. Proximity to the second-largest global economy, the EU; and the world's greatest potential for rapid growth, Africa; potential to link the railways and the seaways of the BRI project; and qualified workforce percentage above the national average are among the strengths that make İzmir stand out from other provinces.

While the average growth rate of the global economy might decline in the upcoming period, it is highly likely that there will be differentiation between countries, regions and sectors. Countries that succeed in improving their investment environment on a sustainability metric will be more likely to endure positive discrimination. If the Turkish economy can succeed in standing out through proper policies, İzmir and the surrounding areas will be the greatest beneficiaries.

The Belt and Road Initiative implemented decisively by China is expected to hit a growth spurt within the following 10 to 15 years. Built on a strong historical infrastructure, the critical long-term project passes through Türkiye on both the road and maritime routes. Due to the geographic proximity to Europe and Africa as well as the strong infrastructures and organizations of port authorities, thanks to the privatization policies, the Mediterranean ports of Türkiye and, in particular, the ports in İzmir are estimated to gradually increase their share in this trade. Türkiye's status as China's second-largest trade destination after Russia further backs these estimations. The Belt and Road Initiative is a significant development for the benefit of Türkiye and is expected to boost the trade volume. It is, therefore, particularly important to accentuate the potential impacts on the ports of İzmir and to contact the policy-makers. Historical developments that set the basis for this deduction have been unfolding in the Far East. As you may know, China, South Korea and Japan, in this order, monopolize 90 percent of the global shipbuilding industry.

Furthermore, the ports in these countries hold the highest shares in the global trade. The enabling factor in this success is the holistic approach to maritime policies and government-subsidized implementation. Formulating and implementing such maritime policies for İzmir within a national port policy context is an important aspect for assessment. The current economic conditions have even the largest companies competing for mergers or joint ventures. In light of this development, the private companies operating the ports of İzmir are expected to formulate their future port policies today with a holistic approach led by and in close cooperation with the public institutions. The Mediterranean is a traditional hub not only for the coastal countries, but also for the connected geopolitical regions. Geopolitical developments have been on a stable rise in line with the maritime policies of China. Trade, particularly between Europe and Asia, has gained momentum in recent years under the collective influence of the demographic pressure, the economic growth prior to the pandemic and the resuming of markets. This growth not only prompts environmental risks, but also requires port investment strategies through thorough calculations and evaluations.

It is evident that not only the current situation and the post-pandemic recovery of demand, but also the growth of maritime trade should be estimated and considered when projecting the growth potential of the Mediterranean. These calculations should also evaluate the risks in port overcapacity on a regional level.

Tourism, on the other hand, is the third-greatest export product in the world. According to the 2019 data, Türkiye was the eighth country in terms of highest tourist attraction, and the 13th in terms of highest income. However, it was the tourism industry that suffered the greatest global loss during the pandemic. A regression is expected in business tourism in the post-pandemic period. The main reason for this is the facilitation of online meetings. Leisure tourism activities, on the other hand, are estimated to resume at full speed following the pandemic. İzmir and its neighboring regions are home to some of Türkiye's most important and valuable tourist attractions. As a leading tourism destination in the world, Türkiye and İzmir can both benefit from this growth in tourism through the implementation of effective policies. Within this scope, the ports in the İzmir region have great capacity for cruise tourism.

This study used the following databases for the econometric analysis: the Statistics of the Ministry of Transport and Infrastructure, International Monetary Fund (IMF), United Nations Conference on Trade and Development (UNCTAD), Clarksons, World Trade Organization, The Central Bank of the Republic of Türkiye (TCMB) and Turkish Statistical Institute (TurkSTAT). The time spans for the variable employed in the models are as follows: data range for global GR, global trade, global maritime trade is 1970–2020, 1980–2020 for GDP in Türkiye, 1985–2020 for trade in Türkiye, 2001–2020 for trade in İzmir, 1997–2020 for handling volume in the ports of Türkiye and İzmir, 2004–2020 for the TEU of containers handled in the ports of İzmir, and 2011–2020 for the numbers of Ro-Ro and automobiles handled in the ports of İzmir.

In the current period of 2020, the global economy registered a gross revenue worth $83.85 trillion and a trade volume of $17.1 trillion. Turkish economy, for the same period, registered a GDP of $649.4 billion, export of $169.7 billion and import of $219.5 billion. Maritime transportation, on the other hand, registered as 11.5 billion metric tons in the world and as 496.6 million metric tons in the ports of Türkiye. In the same vein, the total export and import volume of İzmir registered as $20.08 billion while the total handling capacity of all ports in İzmir registered as 80,070,434 metric tons. In terms of capacity utilization for 2020, the ports of İzmir have an overall supply capacity of 150 million metric tons. The container-handling volume for the period registered as 1,711,906 TEUs while the actual capacity was 4.25 million TEUs. As for Ro-Ro and wheeled vehicles, only 74,954 of the total 400,000 vehicle capacity were registered.

According to the analysis that set the basis for our projections, the changes in the global GR account for 72 percent of the changes in the global trade. Twenty percent of changes in the global maritime trade are significantly explained through global trade. As for the regression in the Turkish trade and handling variables, approximately 20 percent of changes in the handling volume in Türkiye are explained through changes in Turkish trade. Fifty-two percent of the changes that occurred in the İzmir maritime transportation is accounted for by the changes in the Turkish maritime transportation. Forty-five percent of the change that occurred in the amount of metric tons handled in the ports of İzmir is accounted for by the change in the amount of metric tons handled in the ports of Türkiye.

In the implementation stage, three unique scenarios were formulated for the econometric projection model for the Turkish foreign trade worth an annual $389.17 billion in accordance with the most recent data. None of these three scenarios included the same growth rate or trend. Based on the average scenario, the study estimates that Türkiye's trade volume will reach $783.65 billion by 2033. The above-average scenario, on the other hand, which projects positive shocks in addition to a fluctuating economy, estimates Turkish trade volume to surge to $1.02 trillion. This figure is considered attainable if the outward Turkish economy manages to capitalize on these opportunities.

İzmir's foreign trade was worth $20.08 billion by 2020. The econometric projection model for 2033 estimate the foreign trade volume for İzmir to be $31.41 billion in average, $21.22 billion in below-average and $49.22 billion in above-average scenarios.

The econometric model for handling volume in the ports of İzmir region is based on global trade, economic growth, global maritime trade, Turkish trade, growth and handling data. While the handling volume in the ports of İzmir was worth 80.07 million metric tons in 2020, the model estimates that the figures will reach 152.4 million metric tons on average, 99.11 million metric tons on below-average, and 207.8 million metric tons on above-average scenarios for 2033. The average scenario is the most likely to unfold. It should also be noted that the global developments present major opportunities for Türkiye and İzmir, and that it is possible to attain a handling volume of 200 million metric tons above our estimations.

As for the container-specific econometric model, it is estimated to reach 2,836,445 TEUs on average, 3,496,254 TEUs on above-average and 2,194,565 TEUs on below-average scenarios for 2033. However, as the trend towards container trade is expected to increase in the upcoming period, and considering the developments over the 10 years, the estimations are predominantly optimistic.

The current Ro-Ro handling of 58,799 items is estimated to increase by 80 percent by 2033 to reach 106,887 items. The above-average scenario, which includes positive shocks for Ro-Ro transport, estimates an increase of approximately 166 percent by 2033 while the below-scenario of negative shocks foresees a 2.66-percent loss and minimal fluctuations to 57,236 items. The general opinion, in line with the previous statements, suggests optimistic projections, particularly for Ro-Ro transportation.

As the logistics chains facilitating access to Asian manufacturing centers are professionalized, it will be possible to reduce operational costs, thus ensuring higher feasibility in short-distance sea shipping. Accordingly, it is considered a realistic approach to first lean towards container trade, then towards Ro-Ro investments in short-distance sea shipping in the ports of the Mediterranean. It is possible that SECA will prompt the redirection of cargo from seaways to the road or railway, a particularly wide network in the Europe, thus resulting in a negative trend in the maritime transportation sector. However, it is also noted that Ro-Ro transportation in the East Mediterranean is strengthening with a high momentum and that the company DFDS, a critical actor in the region, has registered a growing business volume despite the pandemic and is highly likely to invest in the new ports in our region in the upcoming five to eight years.

In light of these assessments, a critical boost is expected to occur in the Ro-Ro business volume and capacity in the ports of İzmir in the following five to eight years.

Correspondingly, it is considered more logical to increase the efficiency of existing ports in the region and to improve the logistics platforms connecting to the railways instead of establishing new larger ports.

Although there is no shortage of port capacity in Aliağa, İzmir, it should be noted that the ports in the region do not operate within a cluster. Complementing the quantitative data are the participant opinions from the workshops organized as part of the project. The majority of participants acknowledge that the ports of İzmir–Aliağa do not experience any capacity-related issues concerning the export or import products. The priority issues pertaining to the ports in the Aliağa region include: the finalization of the railway junction lines; limiting the operations of freight trains on the existing rail lines to evenings and nights; the immediate need for a logistics center either in Kemalpaşa or an equally advantageous location; and a need for a supra-institutional authority. It is also imperative to cooperate with national institutions to boost the existing capacities of ports in the İzmir region. Strengthening the railway infrastructure is considered a priority requirement. Another important requirement is the improvement of the logistics infrastructure and network, starting with the road network in the ports area.

Improved energy and environmental sustainability in the ports of İzmir region should be considered as a developmental axis. The first step in the process evaluation consists of the improvement of ports and the suggestions for main indicators include the following: reducing harmful emissions; improving urban integration through green urban/port landscaping solutions such as trees, which will absorb the noise and air pollution; increasing the use of renewable energy sources; establishing and operating an energy management system; building on the green growth concept in environmental planning; and encouraging digitalization in port operations. For these indicators to be valued in circular economies, “Sustainability Management” systems should be established along with correlated infrastructure within the port authorities of İzmir region, the port hinterlands should be expanded, and an action plan should be formulated to define the envisioned impact of this transformation on ports and the city.

This study on the ports of İzmir, which entails formulating development projections for the period until 2033, concludes the following as important issues: the sustainable economic development strategy for regional maritime transportation to follow a demand-driven supply approach; support to regional development in line with blue growth; and a holistic approach to port operations, management, logistics clusters and the green port concept. It is our greatest hope for the estimations set forth in the study to prove positive and the project to prove beneficial to decision-makers.

# REFERENCES


- Acar, A. Z. (2020). Proposing of a port-centric logistics clustering model for Turkey, International Journal of Logistics Economics and Globalization, 8(2), 110-133, DOI: 10.1504/IJLEG.2020.10030247
- Acar, A.Z. ve Gürol, P. (2016) Türk Deniz Ticaretinde Taşımacılık ve Lojistik: Güncel Durum, Gelişmeler ve Altyapı, ISBN: 978-605-83541-0-4, Hazar Strateji Enstitüsü, İstanbul
- Akar, O. ve Esmer, S. (2015). Cargo Demand Analysis of Container Terminals in Turkey. Journal of ETA Maritime Science. 3. 117-122. 10.5505/jems.2015.54254.
- Bailey, D., ve Solomon, G. (2004). Pollution prevention at ports: Clearing the air. Environmental Impact Assessment Review, 24, 749–774.
- Baltagi, B. H., Egger, P., ve Pfaffermayr, M. (2003). A generalized design for bilateral trade flow models. Economics letters, 80(3), 391-397.
- BBC News-Türkçe (2021). Çin, ABD›yi geçerek AB'nin en büyük ticaret ortağı oldu (17 Şubat 2021). https://www.bbc.com/turkce/haberler-dunya-56095919 (Access: 25.04.2021)
- Berechman, J., ve Tseng, P. H. (2012). Estimating the environmental costs of port related emissions: The case of Kaohsiung. Transportation Research Part D, 17, 35–38.
- Biermann, F. (2012). The impact of distance in seaborne trade: An analysis of bilateral container transport flows, No 134, HWWI Research Papers, Hamburg Institute of International Economics (HWWI).
- Birleşmiş Milletler Ticaret ve Kalkınma Konferansı (United Nations Conference on Trade and Development-UNCTAD), 2020.
- Campbell, S. (1993). Increasing trade, declining port cities: Port containerization and the regional diffusion of economic benefits. In H. Noponen , J. Graham , & A. R. Markusen (Eds.), Trading industries, trading regions: International trade, American industry, and regional economic development (pp. 212-255). New York: Guilford.
- Çetin, O. ve Köseoğlu, M.C. (2020). A Study on the Classification of Maritime Security Threat Topics, International Journal of Environment and Geoinformatics (IJEGEO), ISSN: 2148-9173, 7(3): 365-371, DOI: 10.30897/ijegeo.00000.
- Chiu, R. H., Lin, L. H., & Ting, S. C. (2014). Evaluation of green port factors and performance: a fuzzy AHP analysis. Mathematical problems in engineering, 2014.
- Clarksons Shipping Intelligence Network (https://sin.clarksons.net/)
- Daamen, T. A. and Vries, I. (2013). Governing the European port–city interface: Institutional impacts on spatial projects between city and port. Journal of Transport Geography, 27, 4–13.
- Dag, Zinar. (09.11.2020). Port of Shanghai Hits New Record High Container Volume in October. https://www.morethanshipping.com/port-of-shanghai-hits-new-record-high-container-volume-in-october/ (Access: 11.04.2021).
- Daily Sabah (2019). https://www.dailysabah.com/economy/2019/03/28/china-aims-to-double-investments-in-turkey-to-6-billion-by-2021 (Access: 27.01.2021)
- Darbra, R. M., Ronza, A., Stojanovic, T. A., Wooldridge, C., ve Casal, J. (2005). A procedure for identifying significant environmental aspects in sea ports. Marine Pollution Bulletin, 50, 866–874.
- De Jong, G., Gunn, H.F. ve Walker, W. (2004). National and international freight transport models: overview and ideas for further development. Transport Reviews., 24 (1). pp. 103-124. ISSN 1464-5327
- De Jonge, V. N., Pinto, R., ve Turner, R. K. (2012). Integrating ecological, economic and social aspects to generate useful management information under the EU Directives''ecosystem approach'. Ocean & Coastal Management, 68, 169-188.
- De Vor, F., ve De Groot, H. (2011). The impact of industrial sites on residential property values: A hedonic pricing analysis from the Netherlands. Regional Studies, 45(5), 609–623.
- Dickey, David A., Fuller, Wayne A.(1979). "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", Journal of the American Statistical Association, Vol. 74, No. 366, s. 427-431.
- Dickey, David A., Fuller, Wayne A.(1981). "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root", Econometrica, Vol. 49, No. 4, s. 1057-1072.
- Ege Genç İş İnsanları Derneği İnternet Sitesi (https://www.egiad.org.tr/)
- Enders, Walter (2010). Applied Econometric Time Series, 3. Edition, John Wiley & Sons.
- Erdoğan, O., Engin, N., Aslanoğlu, E., Arslan, A., Tata, K., Salman, R., (2014). Kocaeli'nden Dünyaya: Derince Limanı ve Hinterlandı Projesi.
- Erdogan, O., Tata, K., Karahasan, B. C., ve Sengoz, M. H. (2013). Dynamics of the co-movement between stock and maritime markets. International Review of Economics & Finance, 25, 282-290.
- Esmer, S. (2021), "Kuşak ve Yol Girişimi Türkiye için Ne Fırsatlar Yaratıyor", 14 Ocak, Dünya Gazetesi.

- ESPO, (2016). Code of good practices for cruise and ferry ports. ESPO report.
- Estate Nation (2020). https://estatenation.com/blog/chinese-investment-in-turkey-doubled-by-2021/ (Access: 20.01.2021)
- EU Commission Ports 2030, Gateways fort he Trans European Transport Network
- EU Committee of the Regions, Opinion on Sea Ports and Maritime Infrastructure
- EU Green Paper on Sea Ports and Maritime Infrastructure
- EU Project SUPREME (2018). SupportingMaritimeSpatial Planning in the Eastern Mediterranean (SUPREME), spatial demands, future trends for maritime sectors and related cumulative impacts, December 2018.
- European Commission (2020). ''The EU Blue Economy Report. 2020'' Publications Office of the European Union. Luxembourg.
- Eurostat, Maritime Transport Statistics (March 2020).
- Farhan, Javed ve Ong, Ghim. (2018). Forecasting seasonal container throughput at international ports using SARIMA models. Maritime Economics ve Logistics. 20. 131-148. 10.1057/mel.2016.13.
- Fugazza M., (2015). "Maritime Connectivity And Trade," UNCTAD Blue Series Papers 70, United Nations Conference on Trade and Development.
- Fugazza, M. ve Hoffmann, J. (2017). Liner shipping connectivity as determinant of trade. Journal of Shipping and Trade. 2. 1. 10.1186/s41072-017-0019-5.
- Gökçin B. Mehmet ve Eyibil T.H. (2020) Energy Management in Port, Mezuniyet tezi, Piri Reis Üniversitesi, Denizcilik Fakültesi, İstanbul, Haziran 2020.
- Gonzalez, R.G. (2015). A methodology proposal to obtain operational parameter forecasts and operational risk assessment in container terminals. Doctoral thesis, Madrid Polytechnics University.
- Gujarati, Damodar N., Porter, Dawn C: Basic Econometrics, Fifth Edition, McGraw Hill, Boston, 2009.
- Hayuth, Y. (2007). Globalisation and the port-urban interface: Conflicts and opportunities. In J. Wang, D. Olivier, T. Notteboom, ve B. Slack (Eds.), Ports, cities and global supply chains (pp. 141–156). England: Ashgate.
- Hoyle, B. S. (1989). The port—City interface: Trends, problems and examples. Geoforum, 20(4), 429-435.
- Humphreys, J.M. (2012). The economic impact of Georgia's deepwater ports on Georgia's economy in FY 2011. Selig Center for Economic Growth, Terry College of Business, University of Georgia. Published by the Georgia Ports Authority.
- IMEAK DTO Denizcilik Sektör Raporu 2020. Shipping Special Report 2020, Shipping, Tankers, Bulk, Containers Outlook -2020, S&P Global Platts, www.spglobal.com/platts,
- IMEAK DTO İzmir Şubesi (2011), Ege Bölgesi Limanları ve Sektör Durumu.
- IMO (International Maritime Organizsation), (2011). IMO. IMO: London. On-Line Available at: http://www.imo.org
- IMO Resolution A.1110 (30) Adopted on 6 December 2017, ''IMO Strategic Plan for The Organization for the Six-Year Period 2018 to 2023''.
- International Monetary Fund (https://www.imf.org/en/Data)
- International Transport Forum (ITF), (2021), ITF Transport Outlook, Transport Research Committee, OECD, March, 2021.
- İzmir Kalkınma Ajansı (2019). TCDD İzmir Alsancak Limanının Geçmişten Günümüze Bölge Ekonomisi Açısından Değerlendirilmesi. https://izka.org.tr/wp-content/uploads/pdf/liman-raporu.pdf (Access: 12.04.2021)
- İzmir Kalkınma Ajansı 2014-2023 İzmir Bölge Planı, ISBN: 978-605-5826-14-7.
- İzmir Kalkınma Ajansı 2020 Çalışma Programı, Deniz Ekonomisi Sonuç Odaklı Programı (DESOP)-2020
- İzmir Ticaret Odası (2008, Haziran). Project of the İzmir Logistics Center. [çevrimiçi] http://izto.org.tr/demo_betanix/uploads/cms/yonetim.ieu.edu.tr/6183_1447838544.pdf
- İzmir Ticaret Odası (2012). Türkiye›nin lojistik potansiyeli http://www.izto.org.tr/portals/0/iztogenel/dokumanlar/turkiyenin_lojistik_potansiyeli_s_kaya_25.04.2012%2010-51-19.pdf
- İzmir Ticaret Odası (2021), İstatistikler, www.izto.org.tr.
- İzmir Ticaret Odası İnternet Sitesi (http://www.izto.org.tr/tr/)
- İzmir Valiliği İnternet Sitesi (http://www.izmir.gov.tr/)
- Kavussanos, Manolis. (1996). Highly disaggregrated models of seaborne trade. An empirical model for bilateral dry-cargo trade flows in the World economy. Maritime Policy ve Management. 23. 27-43. 10.1080/03088839600000050.
- Kepaptsoglou, K., Karlaftis, M. G., ve Tsamboulas, D. (2010). The gravity model specification for modeling international trade flows and free trade agreement effects: a 10-year review of empirical studies. The open economics journal, 3(1).
- KGM (Karayolları Genel Müdürlüğü). (2011). Karayollarında Ağır Taşıt Trafiğinin ve Yük Taşımacılığının Özellikleri ve Eğilimleri (2007 - 2008 - 2009 Yılı Etüt Sonuçları).
- Kourounioti, I., Polydoropoulou, A. ve Tsiklidis, C. (2016). Development of models predicting dwell time of import containers in port container terminals – an Artificial Neural Networks application. Transportation Research Procedia 14 (2016) 243 – 252. 6th Transport Research Arena April 18-21, 2016.

- Liao, C. H., Tseng, P. H., Cullinane, K., ve Lu, C. S. (2010). The impact of an emerging port on the carbon dioxide emissions of inland container transport: An empirical study of Taipei port. Energy Policy, 38, 5251–5257.
- Merk, O., Ducruet, C., Dubarle, P., Haezendonck, E., ve Dooms, M. (2011). The competitiveness of global port-cities: The case of the seine axis (Le Havre, Rouen, Paris, Caen) -France, OECD regional development working papers, 2011/07. OECD Publishing.
- Monios, J., Bergqvist, R. ve Woxenius, J. (2018). Port-centric cities: The role of freight distribution in defining the port-city relationship. Journal of Transport Geography, 66, 53-64.
- Norcliffe, G., Bassett, K., ve Hoare, T. (1996). The emergence of postmodernism on the urban waterfront: geographical perspectives on changing relationships. Journal of Transport Geography, 4(2), 123–134.
- OECD (2012). http://www.oecd.org/regreform/sectors/48837794.pdf.
- One belt One Road Project map https://www.google.com.tr/search?q=one+belt+one+road+g%C3%B6rselleri&sxsrf=ALeKk03noBrhi1EqN-soEhBUyO6-J-sTdw:1611135556022&tbm=isch&source=iu&ictx=1&fir=i9NyuR7tsrZUMM%252CnLpQDR2suNZozM%252C_&vet=1&usg=AI4_-kQlS7KeCnu9D_2e51KxvLt-rQZ1-Q&sa=X&ved=2ahUKEwjNs4HUm6ruAhVJXRoKHZU_CNUQ9QF6BAgIEAE#imgrc=i9NyuR7tsrZUMM (Access: 20.01.2021).
- Pedersen, P.G. ve Boztepe, S. (2018). Konuşma metni, Uluslararası Logitrans Transport Lojistik Fuarı (14-16 Kasım 2018), http://www.dfds.com.tr/sektor-lideri-un-ro-ro-2019a-iddiali-hedeflerle-giriyor/tr/2050 (Access: 19.11.2020).
- Peng, Wen-Yi ve Chu, Ching-Wu. (2009). A comparison of univariate methods for forecasting container throughput volumes. Mathematical and Computer Modelling. 50. 1045-1057. 10.1016/j.mcm.2009.05.027.
- PIANC, (2014b). "Sustainable Ports" A Guide for Port Authorities. PIANC report no 150-2014.
- Rashed, Yasmine ve Meersman, Hilde ve Voorde, Eddy ve Vanelslander, Thierry. (2016). Short-term forecast of container throughout: An ARIMA-intervention model for the port of Antwerp. Maritime Economics ve Logistics. 19. 10.1057/mel.2016.8.
- S&P Global (2021). https://plattsinfo.spglobal.com/rs/325-KYL-599/images/shipping-tankers-bulk-containers-outlook-2020 (Access: 22.02.2021)
- Saka, M. (2020). A Dry Port Model for Kocaeli Container Terminals. Doktora Tezi. Piri Reis Üniversitesi.
- Saz-Salazar, S. d., ve García-Menéndez, L. (2012). Meeting the environmental challenge of port growth: A critical appraisal of the contingent valuation method and an application to Valencia port, Spain. Ocean and Coastal Management, 59, 31–39.
- Şengül, S. (2020). TCDD İzmir Alsancak Limanı yeniden Ro-Ro operasyonlarına açıldı. https://www.aa.com.tr/tr/ekonomi/tcdd-izmir-alsancak-limani-yeniden-ro-ro-operasyonlarina-acildi/2054689 (Access: 23.03.2021)
- Shaw, B. (2001). History at the water's edge. In R. MARSHALL (Ed.), Waterfronts in postindustrial cities (pp. 160–172). London: E and FN Spon.
- Shen, L. Y., Ochoa, J. J., Shah, M. N., ve Zhang, X. (2011). The application of urban sustainability indicators — A comparison between various practices. Habitat International,35(1), 17–29.
- Soberón, A.M.M. (2012). The Capacity in Container Port Terminals. UNCTAD Ad Hoc Expert Meeting on Assessing Port Performance, 12 Aralık 2012. (Access: 21.03.2021) <https://unctad.org/meetings/en/Presentation/dtl_ttl_2012d10_Soberon.pdf>
- Stopford, M., (2009). Maritime Economics, third edition, Routledge, London. ISBN 13: 9780415275576.
- Stopford, M., (2020), Coronavirus, Climate Change & Smart Shipping - Three Maritime Scenarios 2020-2050, A White Paper published by Seatrade Maritime, part of Informa Markets, Copyright Martin Stopford 2020
- Suykens, F. (1989). The city and its port: An economic appraisal. Geoforum, 20(4),437–445.
- Talley, W. K. (2007). Port performance: An economics perspective. Research inTransportation Economics, Vol. 17, 499–516 (Devolution, port governance and port performance).
- Tavasszy, L.A. ve Jong, Gerard. (2013). Modelling Freight Transport, 1st edition, Elsevier, ISBN 9780124104006.
- Ticaret Bakanlığı (2021). https://ticaret.gov.tr/blog/ulkelerden-ticari-haberler/yunanistan/pire-akdenizin-en-buyuk-konteyner-ellecleme-limani-oldu (Access: 15.02.2021)
- Toh, R., Phang, S. -Y., ve Khan, H. (1995). Port multipliers for Singapore: Impact on income, output, and employment. Research collection school of economics. Paper 463. http://ink.library.smu.edu.sg/soe_research/463.
- Türkiye Cumhuriyeti Devlet Demiryolları İnternet Sitesi (http://www.tcddtasimacilik.gov.tr/)
- Türkiye Cumhuriyeti Merkez Bankası İstatistikleri (https://evds2.tcmb.gov.tr/index.php?/evds/serieMarket Türkiye Cumhuriyeti Merkez Bankası)
- Türkiye Cumhuriyeti Ulaştırma ve Altyapı Bakanlığı (https://www.uab.gov.tr/istatistikler)
- Türkiye Cumhuriyeti Ulaştırma ve Altyapı Bakanlığı İnternet Sitesi (https://denizcilikistatistikleri.uab.gov.tr/yuk-istatistikleri)

- Türkiye İstatistik Kurumu İnternet Sitesi (https://www.tuik.gov.tr/)
- Türklim, web, Üye Limanlar, Türkiye Liman İşletmecileri Derneği, Türklim, http://www.turklim.org/uye-limanlar/ (Access: 10.09.2020).
- UDHB Konteyner İstatistikleri, Denizcilik Genel Müdürlüğü Sayı: K-002 Haber Bülteni 17.08.2020
- UDHB Yük İstatistikleri, Denizcilik Genel Müdürlüğü Sayı: Y-002 Haber Bülteni 17.08.2020
- Ulaştırma ve Altyapı Bakanlığı (2021). https://denizcilikistatistikleri.uab.gov.tr/yuk-istatistikleri (Access: 22.02.2021)
- Ulaştırma, Denizcilik ve Haberleşme Bakanlığı, Altyapı Yatırımları Genel Müdürlüğü, ''Limanlar Geri Saha, Karayolu Ve Demiryolu Bağlantıları Master Plan Çalışması Sonuç Raporu'' (2015).
- UN Environment Programme (UNEP) (May 2020).: Maritime Transport of Goods in The Mediterranean: Outlook 2025.
- United Nations Conference nOn Trade aAnd Development- (UNCTAD), (2019).: Review of Maritime Transport. 2019.
- United Nations Conference on Trade and Development UNCTAD, (2019a). – Review of Maritime Transport, UN Publications
- United Nations Conference on Trade and Development –UNCTAD, (2018) - Review of Maritime Transport, UN Publications
- United Nations Conference on Trade and Development –UNCTAD, (2019b) – Trade and Development Report, UN Publications
- United Nations Conference on Trade and Development –UNCTAD, (2020). - Review of Maritime Transport, UN Publications.
- United Nations Conference on Trade and Development-UNCTAD, (2019). Review of Maritime Transport 2019, ISBN 978-92-1-112958-8, eISBN 978-92-1-004302-1, ISSN 0566-7682, eISSN 2225-3459
- Utikad (2021). https://www.utikad.org.tr/Detay/Sektor-Haberleri/14489/bir-kusak-bir-yol-one-belt-one-road-projesinde-turkiye-nin-onemi (Access: 27.01.2021).
- UTİKAD. (2016). Safiport Derince, İntermodal Lojistik Merkezi Kuruyor. https://www.utikad.org.tr/Detay/Sektor-Haberleri/13343/safiport-derince-intermodal-lojistik-merkezi-kuruyor (Access: 11.04.2021).
- Veenstra, Albert ve Haralambides, Hercules. (2001). Multivariate autoregressive models for forecasting seaborne trade flows. Transportation Research Part E: Logistics and Transportation Review. 37. 311-319. 10.1016/S1366-5545(00)00020-X.
- Wang, C. ve Ducruet, C. (2012). New port development and global city making: Emergence of the Shanghai–Yangshan multilayered gateway hub. Journal of Transport Geography, 25, 58–69
- Watanabe, I. (2001). Container Terminal Planning - A Theoretical Approach. Leatherhead, UK: World Cargo Publishing.
- Wayne A. Fuller (1976)., Introduction to Statistical Time Series, John Wiley & Sons, New York, 1976, s. 546.
- World Bank (2021). – Global Economic Prospects, Washington D.C
- World Bank, (2012). World development indicators, On-Line Available at: http://data.worldbank.org/data-catalog/world-development-indicators
- World Trade Organization (https://www.wto.org/english/res_e/statis_e/merch_trade_stat_e.htm)
- Xiao, Z., ve Lam, J. S. L. (2017). A systems framework for the sustainable development of a Port City: A case study of Singapore's policies. Research in Transportation Business ve Management, 22, 255-262.
- Yap, W. Y. ve Lam, J. S. L. (2013). 80 million-twenty-foot-equivalent-unit container port? Sustainability issues in port and coastal development. Ocean and Coastal Management, 71(3), 13–25.
- Ying, W. (10.05.2019). New venture to enhance multimodal transport options at Shanghai Port. http://www.chinadaily.com.cn/a/201905/10/WS5cd4d071a3104842260bae23.html (Access: 11.04.2021).
- Zhang, C., Huang, L., ve Zhao, Z. (2013). Research on combination forecast of port cargo throughput based on time series and causality analysis. Journal of Industrial Engineering and Management, 6(1), 124-134. http://dx.doi.org/10.3926/jiem.687.
- Zhang, W., ve Lam, J. S. L. (2013). Maritime cluster evolution based on symbiosis theory and Lotka-Volterra model. Maritime Policy ve Management, 40(2), 161–176.

**İZMİR DEVELOPMENT AGENCY**

Megapol Çarşı Kule, Halkapınar Mahallesi,
1203/11. Sk. No: 5-7, Kat: 19, 35170 Konak/İzmir

**T.** +90 232 489 81 81 **F.** +90 232 489 85 05

www.izka.org.tr