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# Container Cargo Demand Forecast for Gemlik Bay Ports

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**Abstract**

A large part of world trade is carried out by maritime transport. In addition, ports are the only gates of maritime transport to international trade. In this sense, capacity and demand planning for ports, which are an important node of maritime transport, is necessary for both port operators and other logistics enterprises such as maritime trade fleets, foreign trade enterprises that are parties to international trade, intermediary institutions, third, fourth and fifth parties, and government institutions that It provides very important contributions in making efficiency analyzes and creating investment plans for. In this study, as stated above, container cargo demand forecasting analysis was carried out for the ports of Gemlik Bay, which is one of the important centers opened to foreign trade and located in the Marmara Region of the Republic of Turkey, in order to shed light on the capacity and investment plans for the port operators and other parties For this purpose, container handling data for the ports of Gemlik Bay between 2004-2021 were used as the dependent variable (estimate variable) and again for the same years, Turkey's gross national product data, import and export data, population amount and total container amount handled. were considered as independent variables and annual container handling data of Gemlik Bay ports have been forecasted until 2028 by multiple regression analysis method with 93,1% adjusted R square value.

## 1. Introduction

With the containerization, global commercial activities have affected the developing market economies as well as all over the World. As a result of this situation, containerization represents an important element between ports and vessels in the fulfillment of shipping services, which are the subject of commercial activities, due to its intense use in global transportation systems (Guerrero, and Rodrigue, 2014: 151). The nature of global trade on the basis of change causes some small island countries to be more affected by the changes in the global economy compared to other countries, due to their dependence on imports. In addition, in this rapidly changing competitive environment, port operations, construction of ports and improvement of port facilities are of critical importance. In this sense, governments and industries attach great importance to these issues related to ports. Because, the construction of a new port or the improvement of an existing port requires significant time and the availability of port facilities is significantly restricted during the construction process. In this context, information on the current and potential container volume is essential information for port infrastructure investments and construction and needs to be well analyzed for this irreversible investment decision (Bassan, 2007: 3). For this reason, in this study, cargo demand forecasting, which is an important factor for port establishment and improvement investments, is emphasized. For this purpose, a container handling forecasting model for the Gemlik Bay ports, which is the subject of the analysis, has been established.

## 2. Maritime Transportation in Turkey

First of all, if we look at the situation of the facilities in the port sector in Turkey, as of 2021, the number of coastal facilities serving maritime trade has reached 206 with the completion of Filyos Port. The number in question includes the pier, buoy, dolphin and platform in different forms and features. In the coming years, the number of ports will reach 208 with the commissioning of Rize Iyidere Port and Samsun Copper Enterprise Port. As of 2021,

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90 port facilities corresponding to 44% of the said coastal facilities in Turkey are in the Marmara Region, 50 port facilities corresponding to 24% are in the Mediterranean Region, 36 port facilities corresponding to 18% are in the Black Sea Region and 14% are in the Black Sea Region. 28 port facilities are in the Aegean Region.

Geographically a peninsula, Turkey is located at the crossroads of Europe, Asia and Africa (Utikad Report, 2020: 10-22). In 2019, approximately 95% of the cargoes transported for import purposes and 79% of the cargoes transported for export purposes were carried out by sea in Turkey (Ulaşan ve Erişen Türkiye, 2020). In 2020, approximately 94% of the cargoes transported for import purposes and 82% of the cargoes transported for export purposes were carried out by sea in Turkey. When the cargoes handled in Turkish ports are compared to 2003, as of 2021, container transportation has increased by 366% and reached 11.6 million TEUs (Ulaşan ve Erişen Türkiye, 2021). In addition, considering this rate of 12,591,470 TEU handled in 2021, compared to 2003, there was a 396.3 percent increase in container transportation (UAB Maritime Trade Statistics, 2021).

Considering the total cargo weights handled in the world and in Turkey in the last 10 years, the total cargo tonnage handled has increased by 20% in 2021 compared to 2011, while this increase rate is 35.8% in Turkey. The compound annual growth rate in total cargo tonnages is 2.3% and 3.8%, respectively. In the same period, when the total amount of containers handled worldwide and in Turkey is considered, the total amount of containers handled increased by 37.9% in 2021 compared to 2011; This increase rate in Turkey is 70.4%. The compound annual growth rate in total container cargo is 3.8% and 6.6%, respectively (Unctad, 2021: 8; Türklim, 2021: 59-78-94; *Adapted from:* Esmer, 2022: 12).

## 3. Gemlik Bay Ports

Located in the Southern Marmara Section of the Marmara Region, Gemlik is one of the developed districts of Bursa with an area of approximately 413 km². Ports in the region are located on the southern shores of Gemlik Bay, which is close to the developed industrial establishments, when taking into account their establishment and development (Koday, and Baki, 2014: 431). Gemlik Bay is, Located in the Marmara region which is a region with a high industrial density, is one of the regions with the largest foreign trade volume in Turkey, such as Ambarlı and İzmit bay. In this sense, Gemlik bay is also home to Turkey's leading ports with this high industrial density (Oral, and Esmer, 2011). According to the cargo handling data of the port authorities of 2020, the cargo handled within the borders of Gemlik Port Authority is over 14 million tons, and it is in the 8th rank among the other port authorities. In addition, according to the data of 2020, Borusan Port, which is one of the ports in the Gemlik Region, is in the 20th rank in the general cargo handling amount, while it has been in the 15th rank in the container handling amount. In the same year, in the container handling ranking of Turkish ports, Yılport Gemlik has been ranked 6th with 570,427 TEUs, while RodaPort has been ranked 19th with 82.226 TEUs (Türklim, 2021: 86-93-96).

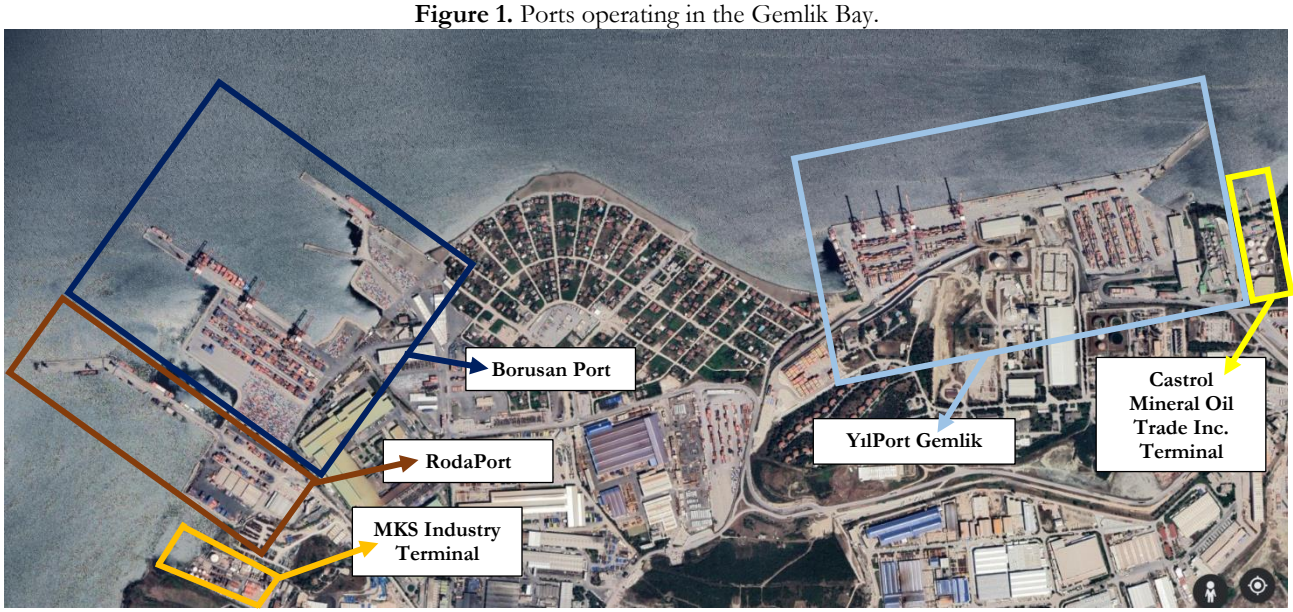
**Table 1.** Ports operating in the Gemlik bay and their main features.

| Port/Terminal Name | Types of Cargoes handled | Berth Length (m) | Handling Capacity (year) | Vessel Acceptance Capacity (number/year) | Water Draught on Berthing (m) |
|---|---|---|---|---|---|
| **Borusan Port** | Container,<br>General Cargo,<br>Finished Vehicle | 1773 | 450.000Teu<br>5.000.000Tonnes<br>350.000Units | 1500 | 14,5 |
| **Roda Port** | Container,<br>General Cargo,<br>Dry Bulk Cargo | 1200 | 200.000Teu<br>3.000.000Tonnes<br>- | 800 | 4-15 |
| **Gemport *(Yılport Gemlik, Gemlik Fertilizer Port)*** | Container,<br>General Cargo,<br>Finished Vehicle,<br>Liquid Bulk Cargo | 1980 | 600.000Teu<br>1.000.000Tonnes<br>450.000Units<br>- | 750 | 8-36 |
| **Castrol Mineral Oil Trade inc. *(BP pier)*** | Liquid Bulk Cargo | 58,5 | 600.000m3 | 150 | 11 |
| **Marmara Chemical Industry Terminal *(MKS Terminal)*** | Liquid Bulk Cargo | - | 6.000m3 | 15 | 10 |

**Source:** Compiled from various sources (borusanport.com; rodaport.com; yilport.com; gemport.com; gemlikliman.uab.gov.tr).

As can be seen in Table 1, there are 5 port facilities in the Gemlik bay according to the classification of the Port Authorities administrative audit and control regions implemented by the Ministry of Transport and Infrastructure of Republic of Turkey. It will be understood that these facilities are competing in the same hinterland with the same cargo groups they serve due to their location (as seen on Figure 1). The MKS industrial terminal and the petroleum products terminal operated by Castrol Mineral Oil trade inc. only serve liquid cargoes. In addition, MKS industrial terminal does not have the traditional dock and pier structure as it uses pipeline and oil float system. The port capacity information in Table 1 is up-to-date data as of May 2022 (www.gemlikliman.uab.gov.tr/limanlar). The ports of the Gulf of Gemlik can be compared to Hamburg-Le Havre range ports in terms of having different Terminals lined up one after the other. In this understanding, when the literature is examined, a study by Rashed, et al. (2017) on the cargo demand development of the Hamburg-Le Havre range ports has been revealed. Considering the similar terminal structures (although they contain different cargo capacities), it can be stated that the study of Rashed, et al. (2017) constitutes the motivation element of our study.

**Figure 1.** Ports operating in the Gemlik Bay.




**Source:** Google Earth screenshot.

## 4. Demand Forecasting Literature Related to Cargo Demand Analysis in Ports of Turkey

There are many load demand forecasting studies in the literature that have been studied using various methods. However, within the scope of this study, the demand forecast analyzes made specifically for Turkish ports are explained. As can be seen in Table 2, the methods used in the related literature, the variables and the information about the period it covers are given. In his study, Kara (2011) estimated the future freight traffic of İzmir (Alsancak) Port until 2016 by using the container and general cargo handling data in İzmir (Alsancak) port by time series method. In addition, the Autoregressive integrated moving average (ARIMA) method developed by Box and Jenkins was used in the this time series analysis, in which 60-month data estimations were made with 12-month periods forward and backward. In their study, Akar and Esmer (2015) forecasted the total container handling amount of Turkey between the years 2015-2023 using multiple lineer regression analysis. As a result of their analysis, they forecasted that Turkey's annual container handling amount will increase by 51.2% in 2023 compared to 2014. In the study of Gökkuş, et al. (2017), four forecasting models were implemented based on Artificial Neural Network with Artificial Bee Colony and Levenberg-Marquardt Algorithms (ANN-ABC and ANN-LM), Multiple Nonlinear Regression with Genetic Algorithm (MNR-GA), and Least Square Support Vector Machine (LSSVM). In this study, Gökkuş, et al. (2017) found that the Least Square Support Vector Machine (LSSVM) model predicted much better than other models. In addition, in this study, it is estimated that 60%, 67% and 95% cargo handling demand will be realized respectively in İzmir Alsancak port, Mersin Port and Istanbul Ambarlı port in 2023 compared to 2015. Akyar, and Çelik, (2018), in their exploratory study, used the simple linear regression method to estimate the cargo demand of Bandırma port between 2017-2022. According to the results of the study, it is estimated that the amount of cargo handling in Bandırma port will increase by 8.5% in terms of tons in 2022 compared to 2017. Guzey and Akansel, (2019) used monthly container, general cargo and vehicle handling data between 2012-2017 in their study and forecasted the cargo demand that will occur in a Turkish port in the 12-month period between 2018-2019. Altın and Çelik Eroğlu, (2021), in their study, used the Gray estimation method and the Autoregressive integrated moving average (ARIMA) method developed by Box and Jenkins, using the

Antalya port (As of 2021, its new name is QTerminals Antalya, whose ex-name was Port of Akdeniz-Global Port Group) container analyzed the handling data. Doğusel (2021), using the data between 2009-2020 in the multiple linear regression analysis included in his study, created a forecasting model for the total cargo (tons) and total handled container data in Turkey. İncaz and Karaköprü (2021) performed a forecasting analysis for the future of container transportation in Ambarlı port. In the applied analysis, it has been determined that there will be no significant increase or decrease in container handling of Ambarlı Port in the next five years between 2022 and 2027. Özdemir (2021) created a forecasting model for the monthly container handling data of 2022 by using the container handling data of Turkey between 2005-2018. In Özdemir's study, artificial neural networks used Autoregressive integrated moving average (ARIMA) and Seasonal Exponential Smoothing methods developed by Box and Jenkins. Solak Fiskin, et al. (2022) developed a cargo demand model for Turkey's Domestic shipping volume loadeded in their study. In this study, five hybrid methods based on Seasonal autoregressive integrated moving average (SARIMA) and Artificial neural networks (ANN) were used. Methods used in this study are Seasonal autoregressive integrated moving average with exogenous variables (SARIMAX), Multilayer perceptiron (MLP), short-term memory (LSTM), Nonlinear autoregressive network with exogenous inputs (NARX) and SARIMAX-ANN hybrid models. In addition, this study is a very interesting study in terms of the methods it contains and the current approaches used.

**Table 2.** Studies related to seaport cargo demand analysis of Turkish Ports.

| **Authors, Title of The Study and Type of The Study** | **Methodology** | **Predicted Variables** | **Predictor Variables** |
|---|---|---|---|
| Kara, (2011) **İzmir (Alsancak) Limanı Gelecek Talep Tahmini İçin Bir Yöntem Önerisi** *(Master of Thesis)* | Time Series; Box-Jenkins (B-J) methods; ARIMA | Monthly Loading and Unloading data (tons) General cargo handling from January September 2011 to August 2014 in Port of Alsancak (60 Months) | Monhly Loading and Unloading data (tons) General cargo handling from January 1998 to August 2011 in Port of Alsancak (164 Months) |
| Akar, and Esmer, (2015) **Cargo Demand Analysis of Container Terminals in Turkey** *(Research Article)* | Multiple Linear Regression | Yearly Container (Teu) handling data from 1998 to 2014 (17 Years) | GDP, Foreign Trade and Population data of Turkey between 1998 and 2014 (17 Years) |
| Gökkuş, et al. (2017) **Estimation of Container Traffic at Seaports by Using Several Soft Computing Methods: A Case of Turkish Seaports** | Artificial Neural Network with Artificial Bee Colony (ANN-ABC); and Levenberg-Marquardt Algorithms (ANN-LM), Multiple Nonlinear Regression with Genetic Algorithm (MNR-GA); and Least Square Support Vector Machine (LSSVM) | Yearly Container (Teu) handling data for Port of İzmir-Alsancak, Port of Ambarlı-İstanbul, and Port of Mersin from 2016 to 2023 | Yearly GDP, Export and Population data of Turkey between 1989 and 2015 (27 Years) |
| Akyar, Çelik, (2018) **Bandırma Limanı Yük Talep Tahminlemesi** *(Conference Proceeding)* | Simple Linear Regression | Yearly Drybulk cargo (tons), Container (Teu) handling data from 2017 to 2022 (6 Years) | GDP data of Çanakkale, Bursa and Balıkesir from 1997 to 2016 (17 years) |

**Table 2(Continue).** Studies related to seaport cargo demand analysis of Turkish Ports.

| Authors, Title of The Study and Type of The Study | Methodology | Predicted Variables | Predictor Variables |
|---|---|---|---|
| Guzey, and Akansel, (2019) **A Comparison of SVM and Traditional Methods for Demand Forecasting in a Seaport: A case study** *(Research Article)* | Exponential Smoothing Methods; Holt Method; Holt-Winters (HW) Methods; ARIMA; Simple Linear Regression; Multiple Linear Regression; Support Vector Machine | Monhly General cargo, Container, Vehicle cargo handling data from the period of January 2018 to December 2019 in One of The Turkish Ports (24 Months) | Monhly General cargo (Tons), Container (Teu), Vehicle cargo (Unit) handling data from the period of January 2012 to December 2017 in One of The Turkish Ports (72 Months) |
| Altın, and Çelik Eroğlu, (2021) **Monthly Container Demand Forecast For Port of Antalya Using Gray Prediction And Box-Jenkins Methods** *(Research Article)* | Gray Estimation and Box-Jenkins (B-J) methods | Monhly Container (Teu) handling data from January 2008 to December 2019 (24 months) of Port of Akdeniz (Global Port Antalya) | Container handling data from January 2008 to December 2017 (120 months) of Port of Akdeniz (Global Port Antalya) used as Seasonal decomposition of Dataset |
| Doğusel, (2021) **Cargo Demand Forecast for Kocaeli Ports** *(Research Article)* | Multiple Linear Regression | Yearly cargo (tons) and Container (Teu) handling data from 2009 and 2020 (12 Years) | GDP, Import, Export and Population data of Turkey between 2009 and 2020 (12 Years) |
| İncaz, Karaköprü, (2021) **Impact of COVID-19 Pandemic on Ambarlı Port in Container Handling and a Forecasting Analysis for Future** | Single Exponential Smoothing method | Yearly Container (Teu) handling data for North Port of Ambarlı from 2021 to 2025 | Yearly Container (Teu) handling data for North Port of Ambarlı from 2010 to 2020 |
| Özdemir, (2021) **Model Proposal for Future Estimates in Maritime Industry: The Case of Container Handling in Turkish Ports** *(Research Article)* | Augmented Dickey-Fuller tests; Artificial Neural Network | 12 Month Container handling data in Turkish Ports for the year of 2022 | Monhly Container handling data from January 2005 and December 2018 in Turkish Ports (168 Months) |
| Solak Fiskin, et al. (2022) **Time series forecasting of domestic shipping market: comparison of SARIMAX, ANN-based models and SARIMAX-ANN hybrid model** *(Research Article)* | SARIMAX; Artificial Neural Network | No future projections have been made. Only a very consistent forecasting model has been developed. | Monthly Industrial production index, Import, Export and Crude oil Brent FOB UK ports; data of Turkey between January 2004 to September 2018 (177 of 188 Months) |

## 5. Methodology

### 5. 1. Scope and Data Set

In this study, a demand forecasting model has been established for the annual container handling amounts of the ports of Gemlik Bay located within the administrative borders of Gemlik Port Authority. Regarding the related demand forecasting model, the Gemlik Bay Container Handling data has been determined as the dependent variable. Turkey's annual total container handling data, total container handling data in the world, Turkey's annual Import and Export data and population Turkey have been used as independent variables. With the established model, a estimation model was created for the annual container handling data of the ports of Gemlik Bay between the years 2022-2028 in the 6-year period. The values of the independent variables, which are included as predictor variables in the estimation model for the years 2022-2028 have been included in the model by using the forecasting of the reference sources specified in Table 3. In addition, the data between 2022 and 2028 regarding the annual

container handling data in Turkey in the research model have been estimated with other independent variables and included in the final model.

**Table 3.** Sources of variables and definitions.

| Type of Variables | Name of The Variables | Data Range | Reference Sources* |
|---|---|---|---|
| **Dependent Variable *(Output)*** | Total Container Handling in Gemlik (TEU) | 2004-2021 | Republic of Turkey Ministry of Transport and Infrastructure, General Directorate of Maritime Trade |
| **Independent Variable *(Input)*** | Total Container Handling in Turkey (TEU) | 2004-2021 | Republic of Turkey Ministry of Transport and Infrastructure, General Directorate of Maritime Trade |
| | Total Container Handling Projection in Turkey (TEU) | 2022-2028 | ******Forecasted by using other Independent Variables |
| **Independent Variable** *(Input)*** | Turkey Yearly GDP (constant 2015 US$) | 2004-2020 | WorldBank Country Indicators |
| | Turkey Yearly GDP Projection (constant 2015 US$) | 2021-2028 | OECD Economic Forecast Statistics; Trading Economics; International Monetary Fund Country Statistics |
| **Independent Variable** *(Input)*** | Foreign Trade of Turkey in Import (constant 2015 US$) | 2004-2020 | WorldBank Country Indicators |
| | Foreign Trade Projection of Turkey in Import (constant 2015 US$) | 2021-2028 | OECD Economic Forecast Statistics; Trading Economics; International Monetary Fund Country Statistics |
| **Independent Variable** *(Input)*** | Foreign Trade of Turkey in Export (constant 2015 US$) | 2004-2020 | WorldBank Country Indicators |
| | Foreign Trade Projection of Turkey in Export (constant 2015 US$) | 2021-2028 | OECD Economic Forecast Statistics; Trading Economics; International Monetary Fund Country Statistics |
| **Independent Variable** *(Input)*** | Total Population of Turkey | 2004-2020 | TURKSTAT |
| | Projection of Total Population of Turkey | 2020-2028 | World Population Review |

**Source: ***Compiled from various sources included in the reference list column of the table.

### 5. 2. Multiple Lineer Regression Analysis

Regression analysis is an essential mathematical method "to examine the relationship between a given variable and one or more variables" (Brooks, 2010). Multiple lineer regression is a standard statistical technique that allows researchers to analyze a link in a single dependent variable by considering the contributions of multiple independent variables to the variance. And also, Multiple lineer regression *(1)* is the extension of simple lineer regression *(2)* that examines the relationship between one independent and one dependent variables. According to another definition, simple linear regression is a linear regression model with a single explanatory variable (Nathans, et al. 2012). In this study, multiple lineer regression analysis has been used for forecasting the container cargo handling in the Ports of Gemlik Bay.

**Figure 2.** Simple and multiple lineer regression formulas.

*(1)* $Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots + \beta_i x_i + \varepsilon$

***Y:*** *Dependent variable*

$\beta_0$***:*** *Population y intercept*

$\beta_i$***:*** *Slope for Xi*

$x_1$***:*** *Independent variable*

**ε:** *Random error term*

*(2)* $Y = \beta_0 + \beta_1 x + \varepsilon$

***Y:*** *Dependent variable*

$\beta_0$***:*** *Population y intercept*

$\beta_1$***:*** *Population slope coefficient*

***x:*** *Independent variable*

**ε:** *Random error term*

### 5. 3. Forecasting Inputs and Output

Input variables subject to multiple regression analysis in the study were taken from the sources indicated in Table 3, and the values of these input variables between the years 2017-2021 are summarized in Table 4 below. Regarding the data of Turkey container handling variable in Table 4, the possible container handling data between 2022-2028 have been forecasted by other independent variables. The forecasted total container handling data have been used in the forecasting of the total container handling data of the ports of Gemlik Bay administrative area, which is the main purpose of the study. The adjusted R square value for the forecasted total container handling data of Turkey was obtained as 0,985 which means independent variables explain 98,5% of the variability of dependent variable. According to F-ratio in the ANOVA table shows that the independent variables statistically significantly predict the dependent variable. Also, significance (p) value is 0,000 and 0,000 is smaller than 0,05 *(,000<,05)* which means regression model is a good fit of the data.

**Table 4.** Forecasting inputs and output *(2017-2021).*

| Year | Dependent Variable (Output) | Independent Variables (Inputs) | | | | |
|---|---|---|---|---|---|---|
| | Total Container Handling in Gemlik (TEU) | Total Container Handling in Turkey (TEU) | Turkey Yearly GDP (constant 2015 US$) | Foreign Trade of Turkey as Import (constant 2015 US$) | Foreign Trade of Turkey as Export (constant 2015 US$) | Total Population of Turkey |
| **2017** | 799.122 | 10.010.536 | 960.034.377.547,43 | 261.558.695.965,55 | 234.187.480.200,35 | 81.116.451 |
| **2018** | 854.698 | 10.843.998 | 988.642.300.211,80 | 245.389.311.888,09 | 254.828.024.600,96 | 82.340.090 |
| **2019** | 861.657 | 11.591.838 | 997.437.115.405,82 | 232.177.099.900,07 | 266.451.160.373,05 | 83.429.607 |
| **2020** | 843.119 | 11.626.650 | 1.015.326.662.715,27 | 249.789.403.513,24 | 227.027.611.000,04 | 84.339.067 |
| **2021** | 911.612 | 12.591.470 | 1.045.380.331.931,64 | 260.372.980.540,09 | 284.624.515.910,75 | 85.042.736 |

**Source:** Compiled from the various sources included in the reference list column of the Table 2.

### 6. Research Findings

According to regression analysis results, the multiple correlation coefficient (R) calculated 0.97,5 indicates a good level of prediction, coefficient of determination (R2) is 0.93,1 which means independent variables explain 93,1% of the variability of dependent variable (Adjusted R2 is 0.93,1). According to F-ratio in the ANOVA table shows that the independent variables statistically significantly predict the dependent variable, $p < .005$ which means regression model is a good fit of the data.

According to F-ratio in the ANOVA table shows that the independent variables statistically significantly predict the dependent variable. Also, significance (p) value is 0,000 and 0,000 is smaller than 0,05 *(,000<,05)* which means regression model is a good fit of the data.

**Table 5.** Model summary for total container handling in Gemlik Bay.

**Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | R Square Change | F Change | df1 | df2 | Sig. F Change |
| 1 | 0,975a | 0,951 | 0,931 | 52336,488 | 0,951 | 46,618 | 5 | 12 | 0,000 |

a. Predictors: (Constant), Total Population of Turkey, Foreign Trade of Turkey in Import, Foreign Trade of Turkey in Export, Total Container Handling in Turkey, Turkey Yearly Gdp Constant 2015 US$.
b. Dependent Variable: Total Container Handling in Gemlik Bay.

**Source:** Prepared by the authors.

The general form of the equation to predict total container handling volume of the ports in the Administrative area of Gemlik Bay from Total Container Handling in Turkey, Yearly GDP of Turkey, Foreign Trade of Turkey in Import, Foreign Trade of Turkey in Export, and Total population of Turkey is:

**Equation 1.**

Container Handling volume in Gemlik Bay= -1196673,420 + (0,077*x1) + (-1,776E-006*x2) + (3,408E-006*x3) + (3,228E-007*x4) + (0,024*x5)

**Table 6.** Coefficients table for total container handling in Gemlik Bay.

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | Correlations | | |
|---|---|---|---|---|---|---|---|---|
| | B | Std. Error | Beta | | | Zero-order | Partial | Part |
| **(Constant)** | -1196673,420 | 1602465,797 | | -,747 | 0,040 | | | |
| **Total Container Handling in Turkey *(x1)*** | 0,077 | 0,039 | 1,174 | 1,940 | 0,046 | 0,958 | 0,489 | 0,124 |
| **Turkey Yearly Gdp Constant 2015 US$ *(x2)*** | -1,776E-006 | 0,000 | -1,709 | -1,893 | 0,043 | 0,937 | -0,479 | -0,121 |
| **Foreign Trade of Turkey in Import *(x3)*** | 3,408E-006 | 0,000 | 0,699 | 2,510 | 0,027 | 0,937 | 0,587 | 0,160 |
| **Foreign Trade of Turkey in Export *(x4)*** | 3,228E-007 | 0,000 | 0,086 | 0,231 | 0,022 | 0,927 | 0,066 | 0,015 |
| **Total Population of Turkey *(x5)*** | 0,024 | 0,028 | 0,735 | 0,875 | 0,039 | 0,943 | 0,245 | 0,056 |

**Source:** Prepared by the authors.

## 7. Forecast Results and Capacity Evaluation

According to the total container forecasting obtained as a result of the study, the container demand in the ports of Gemlik Bay is expected to reach approximately 1.36 million TEU in 2028 as seen on Table 7. In addition, as can be seen in Table 1, the total capacity of the container-handling ports located within the Gemlik Harbour Master Administrative area in the Gemlik Bay as of 2022 is 1.25 million TEU. In this sense, when compared with the results of the research, it has been determined that the container handling capacity of the Gemlik Bay ports will not be sufficient as of 2026 according to the normal scenario. Also, according to the pessimistic scenario, container handling capacity of the region will not be sufficient as of 2027, whereas, according to the optimistic scenario, the container handling capacity shortage will start in 2025. Cargo demand forecasts for ports are important for making critical future decisions, reducing emerging uncertainties, and accurately determining investment decisions regarding port management and its improvement and development. In this study, which emphasizes the importance of ports for international trade from the perspective of maritime trade, the container cargo demand that will occur until 2028 for the ports of Gemlik Bay, which is one of the important industrial and commercial centers of Turkey, is modeled.

**Table 7.** Container handling forecast results of ports in administrative area of Gemlik Bay.

| Year | Forecast Results of Ports in Gemlik Bay (TEU) | | |
|---|---|---|---|
| | **Pessimistic Scenario** | **Normal Scenario** | **Optimistic Scenario** |
| **2022** | 927.913 | 976.750 | 1.074.425 |
| **2023** | 990.204 | 1.042.320 | 1.146.552 |
| **2024** | 974.491 | 1.025.780 | 1.128.358 |
| **2025** | 1.053.831 | 1.109.296 | 1.220.226 |
| **2026** | 1.145.109 | 1.205.378 | 1.325.916 |
| **2027** | 1.222.467 | 1.286.807 | 1.415.488 |
| **2028** | 1.298.028 | 1.366.345 | 1.502.980 |

**Source:** Prepared by the authors.

In addition, the current port activities and comparative statistics regarding the ports of Gemlik Bay are included in the study. As stated in the findings section, there will be a 39,88% increase in container cargo demand by 2028 compared to 2022. In this sense, according to the normal scenario, the container cargo demand that will occur in 2028 for the ports of Gemlik Bay will reach 9,3% above the container handling capacity of 2022. Also, according to the optimistic scenario, the container cargo demand that will occur in 2028 for the ports of Gemlik Bay will reach 20,2% above the container handling capacity of 2022; whereas, according to the pessimistic scenario, the container cargo demand that will occur in 2028 for the ports of Gemlik Bay will reach 3,84% above the container handling capacity of 2022. The ports of Gemlik Bay along with the ports of South Marmara and especially the ports of Southeastern Marmara, and companies that carry out foreign trade activities by seaway, need to make their own capacity plans regarding this capacity increase. Also, it is important for the efficient development of international trade and logistics that the relevant public institutions, authorities consider the necessary improvements and developments regarding the infrastructure and equipment for this increase in cargo flow which will take place between the hinterland and foreland of the Gemlik Bay. In addition, if we look at the global situation, as a result of the needs that emerged during the Covid-19 epidemic period, The fact that the effects of the pandemic conditions on the world markets were lower than expected, led to the revision of the estimates made in the first periods and to make more moderate estimates. According to regional container estimations, it is predicted that the Far East will grow by an average of 3.9% every year until 2024, and it will increase from the current 433 million TEU to 526 million TEU in 2024. Container handling in Europe is expected to reach 167 million TEU in 2024 with a rate of 2.4% (Türklim, 2021: 63). Looking at these global forecasting, it has been calculated that the container demand development of Gemlik Bay ports will be slightly above the world average. It can be stated that this situation arises from the fact that the ports of the Gemlik Bay are located in an area with intense industry. In addition, due to the line changes caused by the Ukraine-Russia war and the cargoes and ports in Turkey being seen as alternatives, the container demand forecast of the ports of Gemlik bay is much more likely to be realized as calculated in the optimistic scenario expressed in Table 7.

### 7. 1. Discussion

The most important limitation within the scope of the study is that the possible capacity increase plans after 2022 of the relevant ports in the sample where the research was conducted could not be reached. In this sense, the forecasting results can be interpreted much better if the possible future capacity increase plans of the relevant ports are known. In addition, in this study, it is not known whether the cargoes of the ports included in the sample are the cargoes of the lines that are customers of other ports, and likewise, the cargo volumes situations of the customers attracted by other ports.

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