Investigation of the Effect of Rail Passenger Transport on Air Passenger Transport in Intermodal Transport: Samsun and Trabzon Example

Intermodal Taşımacılıkta Demiryolu Yolcu Taşımacılığının Havayolu Yolcu Taşımacılığına Etkisini Araştırılması: Samsun ve Trabzon Örneği

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ABSTRACT

Passenger transport demand is increasing rapidly with the globalization process. In order to meet the continuous increasing demand for transport services, it is necessary to combine all transport modes and technologies efficiently. In this regard, the integration of air transport, which is the fastest mode of transport, and rail transport, which is the safest mode of transport, is seen as the most ideal way out. In this context, the city of Trabzon was selected and it how the amount of air passenger transport will change if there is rail transport has been investigated. Within the scope of the study, regression analysis was performed to investigate the effect of rail passenger transportation on the air passenger transportation of Samsun, which was selected as a sample. Afterwards, the impact rates obtained from Samsun were included in the regression analysis results for Trabzon air passenger transportation. As a result of the analysis, it was determined that the effect of rail passenger transportation on Samsun airport passenger transportation was 1.44% in 2019, this effect will increase regularly to 21.03% in 2040. Also, it is estimated that there will be an increase of 65,142 passengers at Trabzon Airport in 2019 with the effect of rail transportation.

Keywords: Rail Transportation, Air Transportation, Air-Rail Integration, Intermodal Transportation, Passenger Transportation

ÖZ

Yolcu taşıma talebi küreselleşme süreciyle birlikte hızla ivme kazanarak artmaktadır. Sürekli artış gösteren ulaştırma hizmetlerine olan talebi karşılamak için, tüm ulaştırma mod ve teknolojilerinin verimli bir şekilde birleştirildiği sürdürülebilir ulaştırma sistemlerinin geliştirilmesi ve teşvik edilmesi gerekmektedir Bu doğrultuda en hızlı taşıma modu olan havayolu taşımacılığı ile en güvenli taşıma modu olan demiryolu taşımacılığının entegrasyonu en ideal çözüm olarak karşımıza çıkmaktadır. Bu bağlamda Trabzon şehri seçilerek, bu şehirdeki havaalanı yolcu taşıma miktarının ilde demiryolu taşımacılığı mevcut olması halinde nasıl değişeceği araştırılmıştır. Çalışma kapsamında örnek olarak seçilen Samsun ili havayolu yolcu taşımacılığına, demiryolu yolcu taşımacılığının etkisini araştırmak için regresyon analizi yapılmıştır. Daha sonra Trabzon ili havayolu yolcu taşımacılığı için yapılan regresyon analizi sonuçlarına, Samsun ilinden elde edilen etki oranları dâhil edilerek, demiryolu taşımacılığı yapılması halinde Trabzon havayolu yolcu taşımacılığının nasıl değişeceği tahminlenmiştir. Yapılan analizler sonucunda Samsun havaalanı yolcu taşımacılığına demiryolu yolcu taşımacılığının etkisi 2019 yılında % 1.44 iken, bu etkinin düzenli artış göstererek 2040 yılında % 21.03'e çıkacağı belirlenmiştir. Ayrıca 2019 yılında Trabzon Havaalanında demiryolu yolcu taşımacılığı etkisi ile 65.142 yolcu artışı görüldüğü tahmin edilmiştir.

Anahtar Kelimeler: Demiryolu Taşımacılığı, Havayolu Taşımacılığı, Hava-Demiryolu Entegrasyonu, Intermodal Taşımacılık, Yolcu Taşımacılığı

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1. Introduction

Transportation can be defined as the activity of carrying all kinds of products or services from the first point to the final point with the help of various transport modes (Sussman, 2000). Transportation has always had an important place in human history (Taylor, 2015). The demand for transportation in passenger and cargo movements is increasing rapidly with the industrial revolution, mass production and ultimately the globalization process (Small et al. 2007).

The transportation system consists of sub-systems (types) such as highways, railways, seaways, airlines and pipelines, each of which has its own characteristics (Etemad, 2018; Papacostas and Prevedouros, 1993; Tuzkaya, 2009). In order to meet the steady increasing demand for transport services, it is necessary to develop and promote sustainable transport systems in which all transport modes and technologies are efficiently combined (Vrenken et al., 2005). In this context, intermodal transportation, which is defined as the transportation of people or cargo from the place of to the destination with a series of at least two transportation modes (Crainic and Kim, 2007), is preferred in terms of the advantages it provides. In Turkey, 90.5% of intercity passenger transport and approximately 87.4% of freight transport is made by highways (Kalkınma Bakanlığı, 2013). As can be seen, the need for a balanced distribution between transport modes continues. This situation shows how important the widespread use of intermodal transportation is for Turkey.

Since the past centuries, human beings have tried and succeeded in various methods to move rapidly from their current position to another position in every period (Balabanova and Keschyan, 2020). Considering that time is very important today, the need for fast and reliable transportation has caused many modes of transportation to be used together and this usage has become more widespread (Roşça et al., 2020). Worldwide, rail and air passenger transport modes appear as the most preferred modes of transport after the road passenger transport mode (Darmawan and Chen, 2020).

Railway transport, which plays an important role in passenger services for long-distance transport in many countries, carries 8% of the world's passengers (Lin and Ku, 2014 ; Zeybek, 2021). In Turkey, it seems that 1.4% of passengers are transported by rail (TCDD, 2018). Most conventional rail networks today are located in North America, Europe, China, Russia, India and Japan, and these regions account for 90% of global conventional rail passenger transport (TCDD, 2019).

Considering the last 10 years in the world, it is seen that there has been a steady increase in airline passenger transportation since 2010 (Stecenko and Parkhimovich, 2020). According to the global airline passenger traffic data announced by the International Air Transport Association (IATA), there was an increase of 4.2% in 2019 compared to the previous year. Also, in 2019, passenger capacity increased by 3.4% and the passenger load factor increased by 0.7 points, reaching a record level of 82.6% (IATA, 2019). According to the Airports Council International (ACI) 2019 Airport Connection Report; Turkey, in 2019 in terms of number of passenger transport was ranked 5th in Europe (ICAO, 2019).

The integration of air and rail is often seen as a strategy to mitigate capacity constraints

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at airports, as well as an environmentally friendly way to avoid short-haul flights (Song et al., 2021). However, integration of both modes is particularly difficult due to the difficulties in developing attractive intermodal services (Qianli et al., 2020). In order for this integration to occur, the demands of passengers, who are the users of both systems, as well as the flows between the starting and destination points, are extremely important (Wang et al., 2020).

When the studies in the literature are examined in the light of all this information, many studies on rail passenger transport (Baumol, 1975; Due, 1997; Jing and Yin, 2020; Kulbovskyi et al., 2019) and air passenger transport (de Oliveira Dias, 2019; Demirhan et al., 2021; Goetz, 1992; Moura et al., 2020; Oleshko and Heiets, 2018; Wolle, 2021; Yang et al., 2018) have been found. Although there are studies using different methods that examine the two modes of transport together (Albalate et al., 2015; Chen, 2017; Clewlow, 2012; Erdogan et al., 2020; Grimme, 2007; Pagliara et al,. 2012; Zhao et al., 2021), there are no studies investigating the effect of rail passenger transport on airline passenger transport by performing regression analysis. When the results of the studies conducted with different methods are examined, it is understood that the railway-airline connection is beneficial, but it has also been shown that the process to introduce and operate a system like Air-Rail is complex and expensive.

In the study, the air and rail passenger transport situation in Turkey has been investigated. As a result of this examination, the cities of Samsun and Trabzon were selected as the study area. The reason for selecting the city of Trabzon, is that it ranks sixth in Turkey's transport of passengers performed airports list. In addition, while railway transportation is carried out in the cities that are in the top 5 in the list, there is no railway transportation in Trabzon. In other words, the main purpose of the study is to determine the railway need of Trabzon in the light of scientific research. In this context, Samsun, which is the closest city to Trabzon in terms of distance, geographically and culturally, has been determined as the most ideal city for comparison. There are very few cities in the world that are so close to each other that one has a rail connection while the other does not. This situation reveals the originality of the study.

Firtly, in the study conducted in the light of this information, regression analysis was performed to investigate the effect of rail passenger transportation on the air passenger transportation of Samsun. Then, by adding the impact rates obtained from Samsun to the results of the regression analysis for Trabzon air passenger transportation, it was attempted to predict how the Trabzon air passenger transportation would change with the effect of rail transportation.

2. Methodology

2.1. Selected Airports Information

Airports under study, shown in Figure 1, the most active airports in the country and located in the Black Sea region of Turkey (DHMİ, 2019). Samsun airport was put into service in 1998 and is located between 41°15`56 "north latitude and 36°32`55" east longitude in the Middle Black Sea section of the region. The airport, which has a terminal building

area of 11,500 m2, has an annual passenger capacity of 2 million (DHMİ, 2019).

Trabzon Airport, which was opened in 1957, is located in the eastern Black Sea section of the region between 40°59`45 "north latitude and 39°47`07" east longitude. The airport, which has a total terminal area of 23,745 m2 including 14,035 m2 domestic flights and 9,710 m2 international flights, has an annual passenger capacity of 5 million. The two airports mentioned are equipped with electronic systems where all kinds of aircraft can land in all conditions, including rainy and foggy weather (DHMİ, 2019).

Figure 1. The display and satellite images of Samsun and Trabzon airports, which are selected as the study area, on the world map.

2.2. Regression Method and Its Application to the Study

Regression method is a method that predicts the value of a variable (dependent variable) by using its relationship with the value of the other variable (independent predictive variable) (Akmut et al., 1999). Regression analysis can be simple and multivariate. Simple regression analysis examines the relationship between two variables, multivariate regression analysis examines the relationship between many variables (Chatterjee and Hadi, 2015). If the number of independent variables is two or more, it is called a multiple regression equation (Brook and Arnold, 2018). In order to apply regression analysis, variables should be separated as dependent and independent variables and a regression model should be established. A dependent variable is the variable whose value is affected by other variables and when the value of other variables changes. The independent variable is a variable whose value is determined according to random conditions, changes independently and affects the change of other variables. Whether the coefficients of a regression equation are significant is determined by the t test, and whether the regression equation is significant as a whole is determined by the F test (Özdamar, 2003). If the

calculated F or t statistics for each model or parameter is less than the determined critical value, it can be concluded that the established model is meaningful or the selected variable explains a large part of the variance and must be included in the model (Steppan et al., 1998).

In this study, SPSS (Statistical Package for the Social Sciences) 19.0 program was used for regression analysis. The curve estimation function in the SPSS program was used to determine the most appropriate regression equation for each airport. As a result of the statistical analysis, the parameters of the equation giving the passenger transport amounts of the airports for the next years were found.

Primarily, two separate regression analyses were conducted to investigate the effect of rail transportation on the amount of passenger transportation at Samsun airport. In the first regression analysis, the annual airport passenger transport (PTA) amounts, population, gross domestic product (GDP) for the transportation sector and the annual passenger transport (PTR) amounts by road were used as variables shown in Table 1. The amount of passengers carried by the airport is determined as the dependent variable. Population, GDP for the transport sector and the annual amount of passengers transported by road were selected as independent variables. The selected independent variables were chosen because they can vary independently and have an effect on the change of the passenger transport variable.

Table 1. Data used for the first regression analysis of Samsun city.

Years	PTA	Population	GDP (Thousand of USA Dollar)	PTR
2004	294,716	1,213,165	1,210,208	9,067,591
2005	384,434	1,218,424	1,496,623	9,072,834
2006	483,089	1,223,774	1,640,667	9,379,901
2007	555,796	1,228,959	1,970,079	11,459,779
2008	604,387	1,233,677	2,245,638	11,290,742
2009	866,862	1,250,076	1,677,248	11,859,926
2010	957,391	1,252,693	1,879.,153	12,302,100
2011	1,155,158	1,251,729	2,029,149	12,670,413
2012	1,237,691	1,251,722	2,112,871	12,813,268
2013	1,332,148	1,261,810	2,204,356	12,854,758
2014	1,522,058	1,269,989	2,213,921	13,297,506
2015	1,713,247	1,279,884	2,070,348	14,021,264
2016	1,783,839	1,295,927	2,114,319	14,506,881
2017	1,175,525	1,312,990	2,068,844	14,829,703
2018	1,735,522	1,335,716	1,830,230	15,541,665

In the second regression analysis, in addition to the data used in the first regression analysis, the annual passenger amount data transported by rail in the city were also used and shown in Table 2. In the second analysis, the amount of passengers transported at the airport was determined as the dependent variable. Population, GDP for the transport sector, annual passenger transported by road and annual passenger transported by rail (PTRW) were selected as independent variables.

Table 2. Data used for the second regression analysis of Samsun city.

Years	PTA	Population	GDP (Thousand of USA Dollar)	PTR	PTRW
2004	294,716	1,213,165	1,210,208	9,067,591	1,859,884
2005	384,434	1,218,424	1,496,623	9,072,834	1,848,980
2006	483,089	1,223,774	1,640,667	9,379,901	1,875,828
2007	555,796	1,228,959	1,970,079	11,459,779	1,969,021
2008	604,387	1,233,677	2,245,638	11,290,742	1,918,790
2009	866,862	1,250,076	1,677,248	11,859,926	1,940,719
2010	957,391	1,252,693	1,879,153	12,302,100	2,039,606
2011	1,155,158	1,251,729	2,029,149	12,670,413	2,936,570
2012	1,237,691	1,251,722	2,112,871	12,813,268	2,923,388
2013	1,332,148	1,261,810	2,204,356	12,854,758	2,608,383
2014	1,522,058	1,269,989	2,213,921	13,297,506	3,721,900
2015	1,713,247	1,279,884	2,070,348	14,021,264	4,428,456
2016	1,783,839	1,295,927	2,114,319	14,506,881	4,279,967
2017	1,175,525	1,312,990	2,068,844	14,829,703	4,429,207
2018	1,735,522	1,335,716	1,830,230	15,541,665	4,483,000

By using the parameters obtained from the two regressions analyses, an estimation of the amount of passenger transport with and without the effect of rail transport has been made for Samsun airport until 2040. Then the difference between these two estimates was calculated as a percentage.

In the next step, the regression model was created for the city of Trabzon, which does not have rail transport. In this regression model, the data of Trabzon city between 2004 and 2018, shown in Table 3, were used. These data are the annual passenger transport volumes of the airport, the population, GDP for the transport sector and the annual passenger transport by road. As in other regression models, the amount of passengers

Table 3. Data used in the regression analysis for the city of Trabzon.

Years	PTA	Population	GDP (Thousand of USA Dollar)	PTR
2004	775,699	732,221	821,981	4,575,731
2005	1,080,689	735,072	988,554	4,858,990
2006	1,472,957	737,969	1,104,953	4,745,504
2007	1,482,760	740,569	1,323,304	5,155,810
2008	1,469,713	748,982	1,510,862	5,149,458
2009	1,596,905	765,127	1,143,535	5,410,210
2010	1,963,169	763,714	1,357,681	5,482,128
2011	2,280,017	757,353	1,481,503	5,896,904
2012	2,404,150	757,898	1,587,618	6,181,264
2013	2,620,887	758,237	1,655,022	6,589,978
2014	2,777,536	766,782	1,636,027	6,970,749
2015	3,362,799	768,417	1,388,434	7,664,009
2016	3,713,994	779,379	1,393,870	7,830,487
2017	4,148,929	786,326	1,386,117	8,249,031
2018	4,028,563	807,903	1,285,503	8,769,380

transported at the airport is determined as the dependent variable. Population, GDP for the transport sector and the annual amount of passengers transported by road were selected as independent variables.

By using the parameter obtained as a result of the regression analysis, Trabzon airport passenger transportation amount was estimated until 2040. By adding the rail transport impact percentage calculated at Samsun airport to the results, the amount of passengers that can be transported at Trabzon airport in case of a railway is estimated.

In the study, the most appropriate method was used by comparing the arithmetic mean, geometric mean and exponential correction methods while estimating the independent variables.

3. Results and Discussion

According to the first regression analysis conducted for Samsun, it was determined that the significance level of the regression coefficient in explaining the dependent variable is significant according to the t test. It is seen that independent variables explain the dependent variable (PTA), at a rate of 83.8%. Since F = 19.04 and the significance level of the coefficients (Sig.) = 0.00011 < 0.05, it was concluded that the model was significant at the 95% significance level. Equation 1 was obtained as a result of the regression analysis.

$$PTA = -360774 + (-1,34 \times Population) + (0,008 \times GDP) + (0,25 \times PTR) \quad (1)$$

The amount of passengers to be transported by air until 2040, calculated according to the estimation equation obtained, is shown in Table 4.

Table 4. Passenger estimation for Samsun airport without rail transport impact.

Years	PTA	Population	GDP (Thousand of USA Dollar)	PTR
2019	1,892,508	1,349,073	1,903,439	16,318,748
2020	2,037,113	1,362,564	1,979,577	17,134,686
2021	2,188,048	1,376,190	2,058,760	17,991,420
2022	2,345,570	1,389,951	2,141,110	18,890,991
2023	2,509,949	1,403,851	2,226,755	19,835,540
2024	2,681,464	1,417,889	2,315,825	20,827,318
2025	2,860,407	1,432,068	2,408,458	21,868,683
2026	3,047,080	1,446,389	2,504,796	22,962,118
2027	3,241,798	1,460,853	2,604,988	24,110,223
2028	3,444,889	1,475,461	2,709,188	25,315,735
2029	3,656,693	1,490,216	2,817,555	26,581,521
2030	3,877,565	1,505,118	2,930,257	27,910,597
2031	4,107,874	1,520,169	3,047,468	29,306,127
2032	4,348,003	1,535,371	3,169,366	30,771,434
2033	4,598,351	1,550,725	3,296,141	32,310,005
2034	4,859,333	1,566,232	3,427,987	33,925,506
2035	5,131,381	1,581,894	3,565,106	35,621,781
2036	5,414,943	1,597,713	3,707,710	37,402,870
2037	5,710,485	1,613,690	3,856,019	39,273,013
2038	6,018,495	1,629,827	4,010,259	41,236,664
2039	6,339,477	1,646,126	4,170,670	43,298,497
2040	6,673,956	1,662,587	4,337,497	45,463,422

According to Table 4, it is seen that the change in the population, GDP and road passenger transportation amounts of Samsun city will increase the passenger transportation amount of Samsun airport. It is estimated that the amount of airline passenger transport in 2040 will increase by approximately 252% compared to 2019 amounts.

According to the second regression analysis conducted for Samsun, it was determined that the significance level of the regression coefficient in explaining the dependent variable is as important as in the first analysis according to the t test. It is seen that independent variables explain the dependent variable (PTA), at a rate of 87.6%. Since F = 17.82 and the significance level of the coefficients (Sig.) = 0.00015 <0.05, it was concluded that the model was significant at the 95% significance level. Equation 2 was obtained as a result of the regression analysis.

$$PTA = 5141948 + (-5{,}93 \times Population) + (0{,}003 \times GDP) + (0{,}221 \times PTR) + (0{,}22 \times PTRW) \quad (2)$$

Table 5 shows the amount of passengers to be transported by air until 2040, calculated according to the estimation equation obtained.

Table 5. Passenger estimation for Samsun airport with the effect of rail transport.

Years	PTA	Population	GDP (Thousand of USA Dollar)	PTR	PTRW
2019	1,919,742	1,349,073	1,903,439	16,318,748	5,379,600
2020	2,078,653	1,362,564	1,979,577	17,134,686	5,809,968
2021	2,250,144	1,376,190	2,058,760	17,991,420	6,274,765
2022	2,435,048	1,389,951	2,141,110	18,890,991	6,776,747
2023	2,634,257	1,403,851	2,226,755	19,835,540	7,318,886
2024	2,848,724	1,417,889	2,315,825	20,827,318	7,904,397
2025	3,079,470	1,432,068	2,408,458	21,868,683	8,536,749
2026	3,327,586	1,446,389	2,504,796	22,962,118	9,219,689
2027	3,553,284	1,460,853	2,604,988	24,110,223	9,957,264
2028	3,793,040	1,475,461	2,709,188	25,315,735	10,753,845
2029	4,047,590	1,490,216	2,817,555	26,581,521	11,614,153
2030	4,317,709	1,505,118	2,930,257	27,910,597	12,543,285
2031	4,604,210	1,520,169	3,047,468	29,306,127	13,421,315
2032	4,907,951	1,535,371	3,169,366	30,771,434	14,360,807
2033	5,229,836	1,550,725	3,296,141	32,310,005	15,366,064
2034	5,570,813	1,566,232	3,427,987	33,925,506	16,441,688
2035	5,931,883	1,581,894	3,565,106	35,621,781	17,592,606
2036	6,314,099	1,597,713	3,707,710	37,402,870	18,824,089
2037	6,718,570	1,613,690	3,856,019	39,273,013	20,141,775
2038	7,146,464	1,629,827	4,010,259	41,236,664	21,551,699
2039	7,599,009	1,646,126	4,170,670	43,298,497	23,060,318
2040	8,077,500	1,662,587	4,337,497	45,463,422	24,674,540

According to Table 5, it is seen that the change in the population, GDP, road passenger transport and rail passenger transport amounts of Samsun city increases the amount of passenger transportation to Samsun airport as in the first analysis. It is estimated that the amount of airline passenger transportation in 2040 will increase by approximately 320% compared to 2019 amounts with the effect of rail passenger transportation.

The comparison of passenger prediction with effective rail passenger transport and ineffective rail passenger transport for Samsun airport is given in Table 6.

Table 6. Samsun airport comparison table.

Years	Without Rail Transport Impact	With the Effect of Rail Transport	Difference between	Difference as percentage
2019	1,892,508	1,919,742	27,234	1.44
2020	2,037,113	2,078,653	41,539	2.04
2021	2,188,048	2,250,144	62,096	2.84
2022	2,345,570	2,435,048	89,478	3.81
2023	2,509,949	2,634,257	124,308	4.95
2024	2,681,464	2,848,724	167,260	6.24
2025	2,860,407	3,079,470	219,063	7.66
2026	3,047,080	3,327,586	280,506	9.21
2027	3,241,798	3,553,284	311,486	9.61
2028	3,444,889	3,793,040	348,151	10.11
2029	3,656,693	4,047,590	390,897	10.69
2030	3,877,565	4,317,709	440,143	11.35
2031	4,107,874	4,604,210	496,335	12.08
2032	4,348,003	4,907,951	559,948	12.88
2033	4,598,351	5,229,836	631,484	13.73
2034	4,859,333	5,570,813	711,479	14.64
2035	5,131,381	5,931,883	800,502	15.60
2036	5,414,943	6,314,099	899,157	16.61
2037	5,710,485	6,718,570	1,008,085	17.65
2038	6,018,495	7,146,464	1,127,969	18.74
2039	6,339,477	7,599,009	1,259,532	19.87
2040	6,673,956	8,077,500	1,403,544	21.03

As can be seen in Table 6, in the analysis made without the effect of rail passenger transportation, it was found that 1,892,508 passengers will be transported at Samsun airport in 2019, this number increased to 1,919,742 with the inclusion of rail passenger transportation in the analysis. When we look at the results of the year 2040, it is estimated that 6,673,956 passengers will be transported without the effect of rail passenger transportation, while this number has increased to 8,077,500 with the inclusion of railway transportation in the analysis.

According to the regression analysis made for Trabzon, it was determined that the significance level of the regression coefficient in explaining the dependent variable was significant according to the t test as in the other two analyses. It is seen that independent variables explain the dependent variable (PTA), at a rate of 97.4%. Since F = 140.85 and the significance level of the coefficients (Sig.) = 4.67E-09 <0.05, it was concluded that the model was significant at the 95% significance level. Equation 3 was obtained as a result of the regression analysis.

PTA = -3620798 + (1,25 × Population) + (0,33 × GDP) + (0,73 × PTR) (3)

The amount of passengers to be transported by air until 2040, calculated according to the estimation equation obtained, is shown in Table 7.

Table 7. Passenger estimation for Trabzon airport.

Years	PTA	Population	GDP (Thousand of USA Dollar)	PTR
2019	4,526,713	815,982	1,336,923	9,120,155
2020	4,821,941	824,142	1,390,400	9,484,961
2021	5,128,671	832,383	1,446,016	9,864,360
2022	5,447,361	840,707	1,503,856	10,258,934
2023	5,778,486	849,114	1,564,011	10,669,292
2024	6,122,539	857,605	1,626,571	11,096,063
2025	6,480,036	866,181	1,691,634	11,539,906
2026	6,851,509	874,843	1,759,299	12,001,502
2027	7,237,517	883,592	1,829,671	12,481,562
2028	7,638,635	892,428	1,902,858	12,980,825
2029	8,055,467	901,352	1,978,972	13,500,058
2030	8,488,636	910,365	2,058,131	14,040,060
2031	8,938,793	919,469	2,140,456	14,601,662
2032	9,406,614	928,664	2,226,075	15,185,729
2033	9,892,802	937,950	2,315,118	15,793,158
2034	10,398,089	947,330	2,407,722	16,424,884
2035	10,923,235	956,803	2,504,031	17,081,880
2036	11,469,030	966,371	2,604,193	17,765,155
2037	12,036,298	976,035	2,708,360	18,475,761
2038	12,625,893	985,795	2,816,695	19,214,791
2039	13,238,705	995,653	2,929,362	19,983,383
2040	13,875,659	1,005,610	3,046,537	20,782,718

According to Table 7, it is seen that the change in the population, GDP and road passenger transportation amounts of Trabzon city will increase the amount of passenger transportation at Trabzon airport as in Samsun airport. It is estimated that the amount of airline passenger transportation in 2040 will increase by approximately 206% compared to the 2019 amounts.

Table 8. Trabzon airport passenger prediction in case of a railway network

Years	Trabzon Estimation without Railway	Rate from Samsun (%)	Trabzon Estimation with Railway
2019	4,526,713	1.44	4,591,855
2020	4,821,941	2.04	4,920,267
2021	5,128,671	2.84	5,274,221
2022	5,447,361	3.81	5,655,165
2023	5,778,486	4.95	6,064,672
2024	6,122,539	6.24	6,504,441
2025	6,480,036	7.66	6,976,306
2026	6,851,509	9.21	7,482,242
2027	7,237,517	9.61	7,932,929
2028	7,638,635	10.11	8,410,620
2029	8,055,467	10.69	8,916,589
2030	8,488,636	11.35	9,452,182
2031	8,938,793	12.08	10,018,826
2032	9,406,614	12.88	10,618,024
2033	9,892,802	13.73	11,251,365
2034	10,398,089	14.64	11,920,525
2035	10,923,235	15.60	12,627,274
2036	11,469,030	16.61	13,373,474
2037	12,036,298	17.65	14,161,093
2038	12,625,893	18.74	14,992,200
2039	13,238,705	19.87	15,868,980
2040	13,875,659	21.03	16,793,733

The railway effect rates obtained in the analysis applied to Samsun airport were added to the estimation numbers found for Trabzon airport and shown in Table 8. As stated in Table 8, compared to normal conditions, Trabzon Airport has increased by 65,142 passengers in 2019 with the effect of rail passenger transportation, while this number is estimated to increase to 2,918,074 passengers in 2040.

4. Conclusions and Recommendations

In this study, the effect of rail passenger transportation on air passenger transportation has been investigated by using the data from Samsun city which was chosen specifically for having currently both kinds of transportation. In addition, it has been argued that how the air passenger transportation in Trabzon would be affected in the case of an integration of a railway network. The results obtained from the study are summarized below:

1. From the data of Samsun and Trabzon cities used for regression analysis, it has been determined that the amount of airline passenger transportation, population, road passenger transportation amount and rail passenger transportation amount increased regularly between the selected years. Although the transportation sector GDP data show a regular increase in Turkish Lira from these data, it has been determined that when it is converted to dollars, it has decreased in some years due to the changes in the dollar exchange rate.

2. In the first regression analysis for Samsun airport, it has been concluded that the variable that had the greatest impact was the amount of passenger transport by road and the amount of passenger transport by rail in the second analysis. In the regression analysis for Trabzon airport, it has been observed that the population independent variable was more effective than other variables.

3. It has been concluded that while the effect of rail passenger transportation on Samsun airport passenger transportation was 1.44% in 2019, this effect will regularly increase to 21.03% in 2040. Accordingly, it has been concluded that modes of transport in intermodal transport are extremely effective on each other.

4. It has been determined that Samsun Airport, which has an annual passenger carrying capacity of 3.5 million, will reach 3.553.284 passengers in 2027 and the airport will no longer meet the passenger capacity. Trabzon Airport, which has an annual passenger transport capacity of 5.5 million, is estimated to be unable to meet its passenger capacity as of 2022, even if rail passenger transport is not available.

5. The 2019 and 2020 data were not included in the study in order not to disruptively affect the results of the analyses due to the restrictions caused by the COVID-19 epidemic that affected the whole world. In this direction, when 2019 and 2020 data were compared with the predicted data; it was determined that the number of passenger transport in Samsun airport decreased by 29% in 2019 and 135.4% in 2020 due to the COVID-19 outbreak. It was determined that the number of passengers in Trabzon airport decreased by 20% in 2019 and 169.5% in 2020 due

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to the COVID-19 outbreak. The most important reason for this rate in 2020; the epidemic had a greater influence at the end of 2019 in Turkey.

When the variables selected for regression analysis are examined in the study; although the number of each of the independent variables used for Samsun is more than the independent variables used for Trabzon, it is seen that Trabzon air passenger transportation is more in use than Samsun passenger transportation. One of the most important reasons for this situation is; the people registered in the population of Trabzon usually live in other cities. Another reason for this situation could be that Trabzon attracts more tourists than Samsun in terms of its historical features. Therefore; organizing such studies using different variables in other provinces and other countries will highly contribute to the literature.

Rail transport, one of the safest modes of passenger transport, is one of the most preferred modes of transport to reach airlines in many parts of the world. However, when we look at the studies in the literature, we see that it cannot be used at the desired level due to many factors such as infrastructure costs and geographical negativities, both in many parts of the world and in Turkey. Therefore, more budget allocation to this transportation model - especially in developing countries like Turkey - will be very beneficial both to increase development and to ease transportation. It can be said that the railway connection is extremely important in terms of air transport, especially in winter conditions, in terms of transportation problems and people not being able to reach the airline on time.

Considering the characteristics of intermodal transportation such as providing reliable transit time, being less affected by external factors, being reliable and environmentally friendly, it will be beneficial for the transportation sector in all respects. In addition, the inclusion of more transport modes in the intermodal transportation line is extremely important in terms of using these features more effectively.

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