# Effects on Istanbul Traffic of the Eurasia Tunnel and Removal of Additional Lanes

Esma DİLEK[1], Yunus Emre AYÖZEN[2], Mehmet ERŞAHİN[3], Orhan AKICI[4], Prof. Dr. Ali Osman ATAHAN[5]

[1]Istanbul Metropolitan Municipality, Istanbul, Turkey, esma.dilek@ibb.gov.tr
[2]Istanbul Metropolitan Municipality, Istanbul, Turkey, yunusemre.ayozen@ibb.gov.tr
[3]Istanbul Metropolitan Municipality, Istanbul, Turkey, mehmet.ersahin@ibb.gov.tr
[4]Istanbul Metropolitan Municipality, Istanbul, Turkey, orhan.akici@ibb.gov.tr
[5]Istanbul Technical University, Istanbul, Turkey, atahana@itu.edu.tr

**ABSTRACT**

*Eighteen percent of Turkey's population lives in Istanbul, one of the largest and traffic congested cities in the world. The most significant investments that have been made in this area include projects connecting the European and Asian continents by rail and roads. In recent years, Istanbul Metropolitan Municipality (IMM) and the Turkish Ministry of Transport, Maritime Affairs and Communications have undertaken three major projects to alleviate traffic congestion in the city. The first, Marmaray, makes a significant contribution to public rail transportation between the two continents by way of a tunnel under the Bosphorus strait. The second, Yavuz Sultan Selim highway bridge, is used by cars and heavy trucks for passenger and goods transit. Finally, the Eurasia Tunnel allows passenger cars to drive between the continents under the Sea of Marmara. This paper investigates the impact of the recently opened Eurasia Tunnel on traffic conditions in Istanbul. The effects of discontinuing the use of extra lanes during peak hours on the existing two bridges is also considered. Intercontinental travel times before and after the opening of the Eurasia Tunnel, changes in average speeds and the volumes of vehicles passing over the bridges are also reported.*

**Keywords**: Effects of Eurasia Tunnel, Additional Lane, Traffic, Bluetooth-Smart Sensor, IMM.

## 1 INTRODUCTION

The daily increase in the population of Istanbul, combined with the boost in private vehicle ownership due to rising incomes, and the consequent growth in the number of new vehicles added daily to the city's traffic. These factors give rise not only to an increment in the intensity of urban traffic, they also lead to insufficient access to the existing transportation network and to traffic queues. When the urban transport movements in Istanbul are examined, it demonstrates that a bottleneck effect is created especially during bridge crossings between two continents where the number of daily commutes are high.

Existing bridges that provide transit between two continents play an important role in regulation of mobility and urban traffic in Istanbul which flows on the east-west axis. In this paper, we examine the effects of the Eurasia Tunnel, which reduces the traffic load of existing bridges and contributes to a more balanced urban transport, and the parallel effects of removing the additional lanes that had previously been applied on the bridge crossings during peak hours. The scope of this examination covers the impact of the Eurasia Tunnel and the removal of additional traffic lanes on the D100 Highway and the TEM (E-80) Express way and on traffic using the July 15 Martyrs Bridge and Fatih Sultan Mehmet Bridge crossings. Technical information about the Eurasia Tunnel is presented first, followed by information including changes in average travel times and average speeds on D100 Highway and the TEM Expressway between Atatürk Airport → D100 Kozyatağı and D100 Kozyatağı → Atatürk Airport routes, before and after the opening of the Eurasia Tunnel. Changes in the number of vehicles crossing bridges and travelling through the Eurasia Tunnel are

also addressed.

## 2 THE EURASIA TUNNEL PROJECT

The Eurasia Tunnel (Istanbul Strait Road Tube Crossing Project), which connects the continents of Europe and Asia, is constructed between Kazlıçeşme and Göztepe on a 14.6km route. It is a two-storey tunnel under the Bosphorus with a length of 5.4km. The Eurasia Tunnel is intended to contribute to relieving traffic problems on this congested route and reducing travel times between the two continents. In the Eurasia Tunnel Project, the two continents have been connected by a tunnel boring machine (TBM) over a 3.344-km section underneath the Bosphorus.[1]

Within the scope of this project, road expansions and improvement works were carried out over a route totaling 9.2km across the European and Asian continents. Access roads between Sarayburnu-Kazlıçeşme and Harem-Göztepe were expanded, and new intersections, underpasses and pedestrian overpasses were constructed.[2] The Eurasia Tunnel, as seen in Figure 1, is the first two-storey highway tunnel in the world which is under the sea.

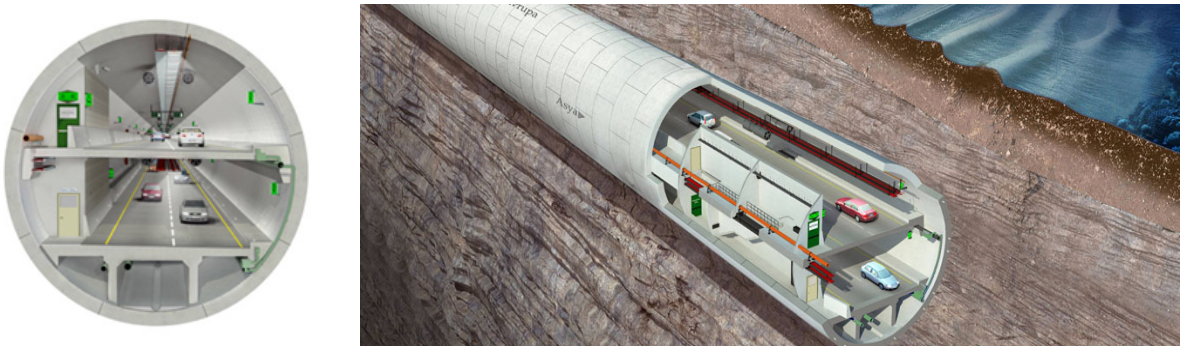


Figure 1. Eurasia Tunnel

### 2.1 Goals of the Project

There is a heavy traffic along the east-west axis in Istanbul, especially on the bridge crossing routes during peak hours. The Eurasia Tunnel aims not only to reduce the traffic loads on the July 15th Martyrs Bridge and Galata and Atatürk Bridges which are located above the Golden Horn, but also to distribute the traffic between the two continents more evenly and to contribute to more balanced urban transportation overall.

Average travel time between the start and end points of the project is about 42 minutes, rising to a range of 60–100 minutes when traffic density is high. This project, which caters for a daily capacity of 130,000 vehicles, aims to reduce this travel time to 15 minutes, and to minimize the emission of harmful gases into the atmosphere, including CO, PM, NOx, $SO_2$ and exhaust gases caused by extended travel times in congested traffic. Reducing the number of vehicles entering the historic peninsula and decreasing the total number of transit trips within the peninsula are also among the project goals.[3]

### 2.2 Project Route

The total length of the Eurasia Tunnel is 14.6km, comprising three main parts:

**Europe Section:** A U-turn was constructed on Kennedy Street to provide entrance to the underpass section from Kazlıçeşme to Sarayburnu, and a disabled-accessible pedestrian bridge was constructed as an overpass. The current road, which is about 5.4km in length, was widened to have 2x4 lanes from the 2x3 and 3x2 lanes that existed prior to the Eurasia Tunnel Project.

**Bosphorus Crossing:** The toll gates and operation center are located at the western entrance of the 5.4km long two-storey tunnel which passes under the sea floor of Bosporus. Ventilation chimneys are situated at both ends of the tunnel. The tunnel has been constructed with two lanes on each level.

**Anatolian Peninsula:** Two interchanges were constructed on the D100 Highway towards Göztepe, with disabled-accessible pedestrian overpasses. The current road, which is about 3.8km long, was widened to have 2x4 and 2x5 lanes, as compared with 2x3 and 2x4 lanes before the Project.

Route of Eurasia Tunnel Project is seen in Figure 2.


Figure 1.Route of Eurasia Tunnel Project ***Error! Bookmark not defined.***

## 3 METHODS USED IN IMPACT ANALYSIS

There have been noticeable improvements in Istanbul's urban traffic, especially in intercontinental transits, following deployment of the Eurasia Tunnel Project. Average speed and travel time data obtained from bluetooth sensors were used to calculate and compare these improvements. These sensors have been installed on the inner-city road network of Istanbul by Department of Transportation of IMM. The number of vehicles crossing the bridges was obtained from IMM's traffic measurement sensors and the General Directorate of Highways; the number of vehicles crossing through the Eurasia Tunnel was provided by the DLH Marmaray Regional Directorate. The analyses used traffic measurement data from bluetooth sensors located on the TEM Expressway, the O-6 Northern Marmara Expressway, the D100 Highway and on the coastal road on the European side (Eurasia Tunnel route).

In this work, average speeds and travel times of analysis routes were examined. The impact of the Eurasia Tunnel and the removal of additional traffic lanes on the analysis routes was studied. Changes in average speeds and travel times between Atatürk Airport and D100 Kozyatağı were calculated and compared with the D100 Highway crossing the July 15th Martyrs Bridge; the TEM Expressway crossing the FSM Bridge, and the European coastal road crossing through the Eurasia Tunnel in both directions. Changes in traffic during the morning and evening peak hours and during the daytime were analyzed. Routes used in the analyses and comparisons on D100 Highway (Figure 3), on TEM Expressway (Figure 4) and on coastal road routes (Figure 5) are shown in the figures below.

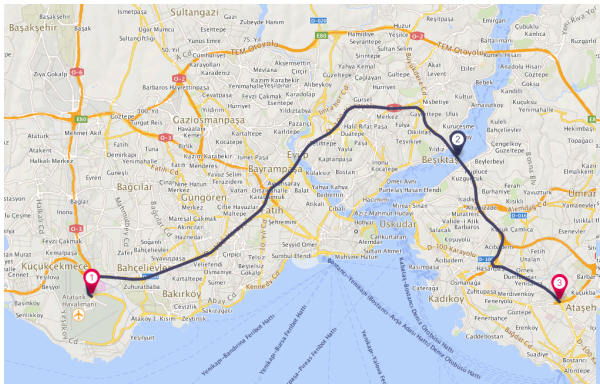


Figure 2. D100 Highway Analysis Route (34 km)

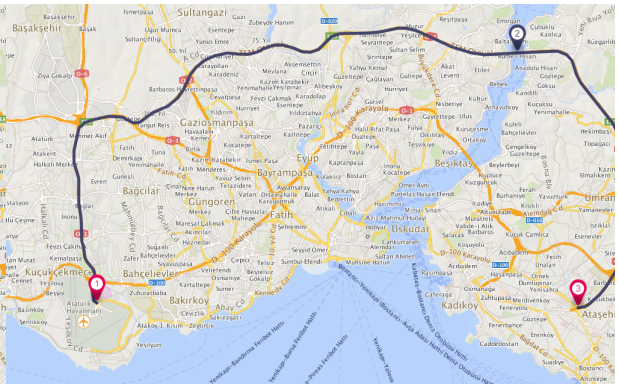


Figure 3. TEM Expressway Analysis Route (48 km)

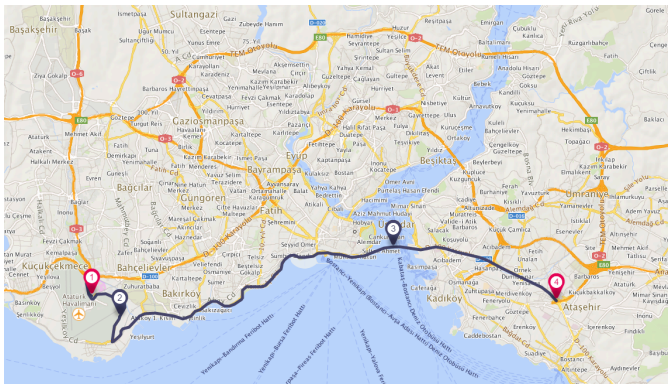


Figure 4. Coastal Road Analysis Route (30km)

## 4 TRAFFIC STATUS OF THE EURASIA TUNNEL

The Eurasia Tunnel, which was opened on December 20, 2016, operated as single lane between 07:00am - 09:00pm until January 31, 2017. Full operation of all lanes without any time constraint commenced on February 1, 2017. Use of the Eurasia Tunnel as an alternative crossing between the continents is growing daily as can be seen in Figure 6 and Figure 7.

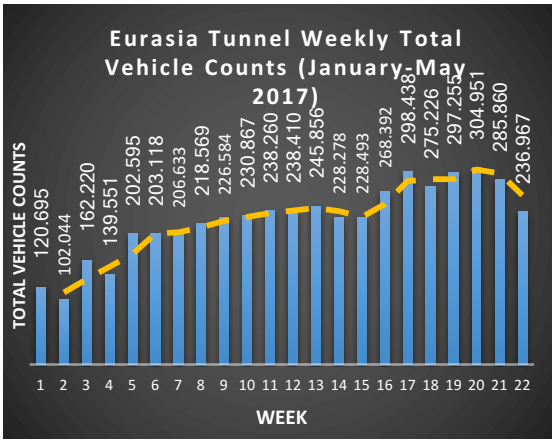



Figure 6. Eurasia Tunnel Weekly Total Vehicle Counts (January-May 2017)

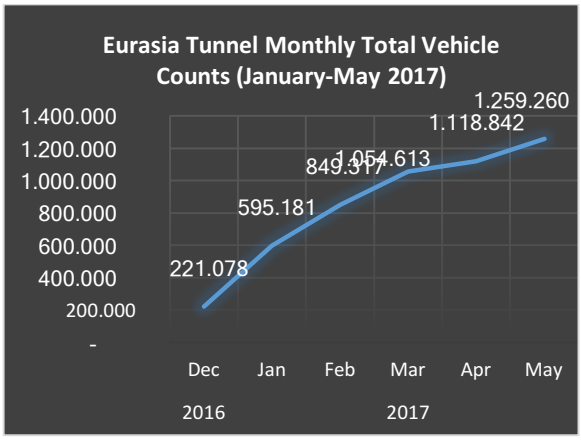



Figure 7. Eurasia Tunnel Monthly Total Vehicle Counts (January-May 2017)

As with the July 15th Martyrs Bridge and the Fatih Sultan Mehmet Bridge, the Eurasia Tunnel is most widely used by drivers in the Asia-Europe direction during morning peak hours; and in the Europe-Asia direction during evening peak hours, as can be seen in Figure 8 and Figure 9.

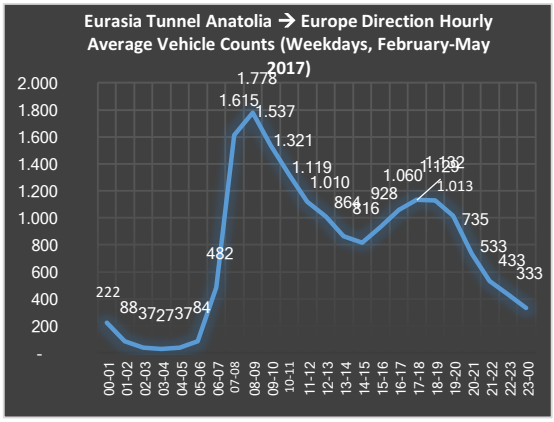



Figure 8. Eurasia Tunnel Anatolia →Europe Direction Hourly Average Vehicle Counts (Weekdays, February-May 2017)

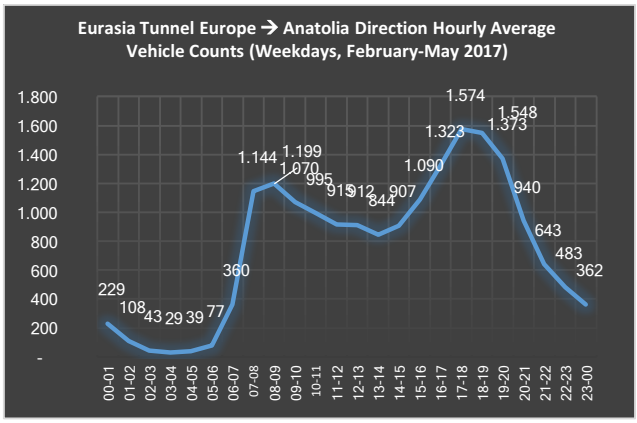



Figure 9. Eurasia Tunnel Europe→Anatolia Direction Hourly Average Vehicle Counts (Weekdays, February-May 2017)

## 5 EFFECTS OF THE EURASIA TUNNEL PROJECT

This study takes traffic measurement data of October-December 2016 as its baseline for analyzing the period before the Eurasia Tunnel opened. The post-tunnel analysis uses traffic measurement data of February-May 2017. In the analyses, traffic measurement data between 06:30am-09:00am is used for morning peak hours. For daytime, traffic measurement data between 09:00am-04:30pm, and for the evening peak hours, traffic measurement data between 04:30pm-08:00pm has been used.

### 5.1. Hourly Average Vehicle Counts

Figure 10 shows the hourly average number of vehicles crossing bridges and coming through the Eurasia Tunnel from Europe to Asia in February and March 2017. The number of vehicles traversing both bridges and the Eurasia Tunnel are at their highest between 05:00pm-09:00pm during evening peak hours.

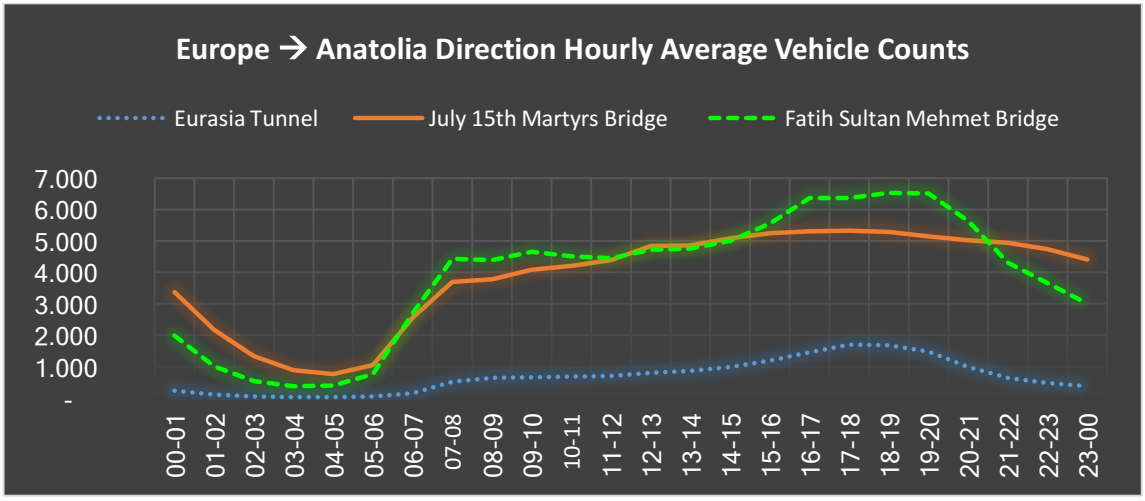



Figure 10. Europe→Anatolia Direction Hourly Average Vehicle Counts

5.2. Europe →Anatolia Direction Hourly Saturation Flow Rates

Figure 11 shows the hourly saturation flow rate in the Europe-Asia direction, using the HCM 2000[3] 1900 Vehicles/Hour/Lane value published by the Transportation Research Board (traffic data between February and March 2017). As shown in Figure 11, the observed traffic flow rate is at approximately full capacity on the July 15th Martyrs Bridge and the Fatih Sultan Mehmet Bridge at all times except at night, whereas the Eurasia Tunnel peaks at 44% of capacity.

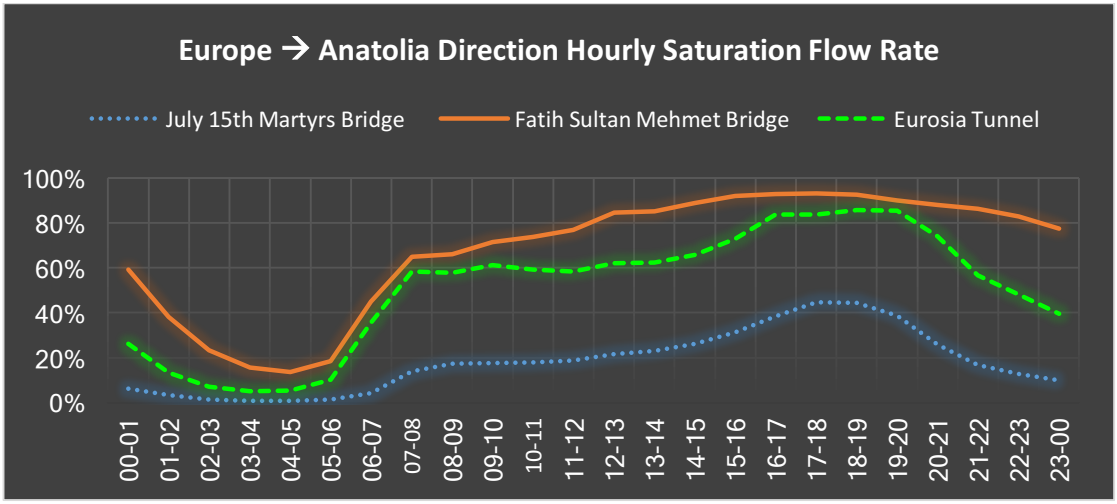
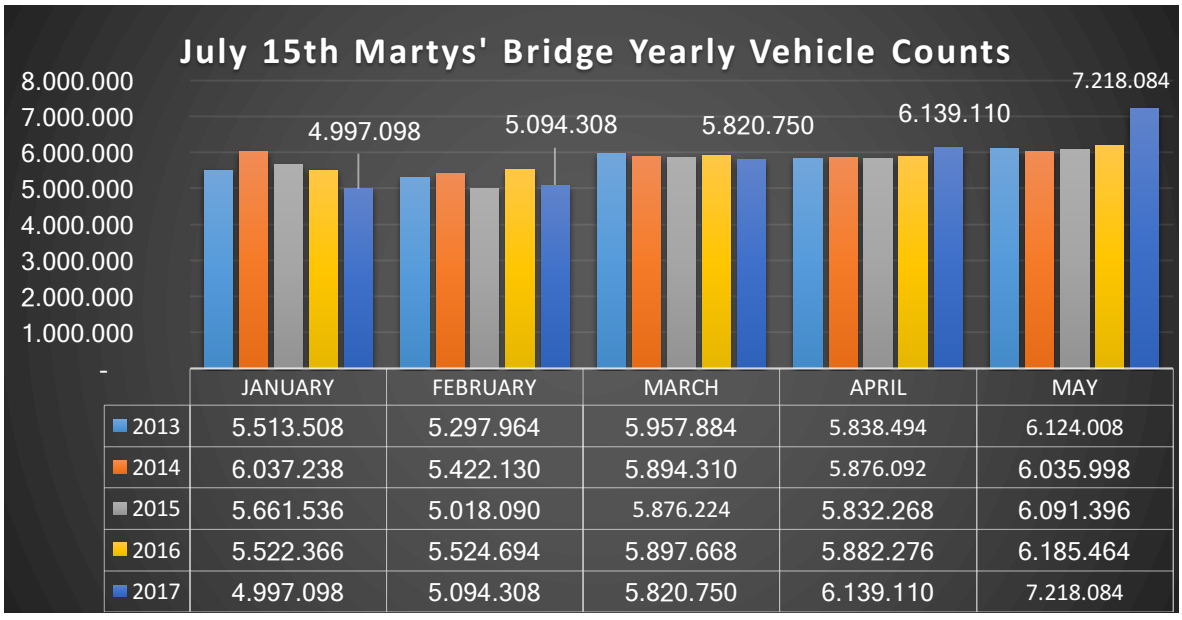



Figure 11. Europe→Anatolia Direction Hourly Saturation Flow Rate

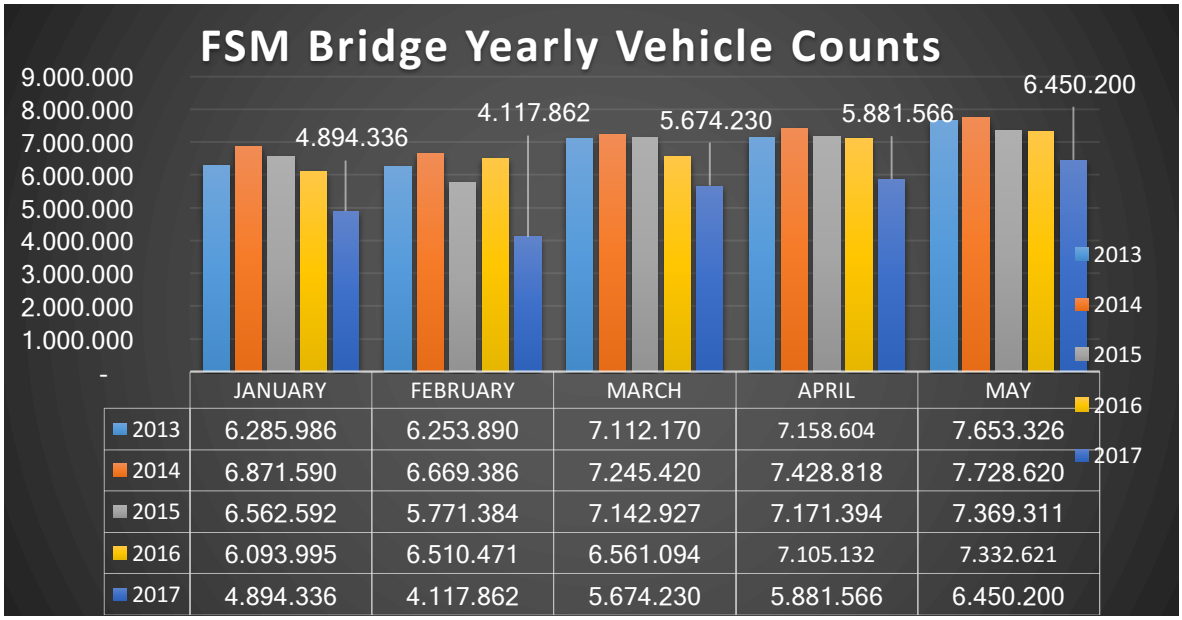
5.3 Effects of the Eurasia Tunnel on Vehicle Counts Crossing Bridges

Figures 12 and 13 show the number of vehicles crossing July 15th Martyrs Bridge and FSM Bridge, obtained from the General Directorate of Highways. Figure 14 shows the number of vehicles crossing the Yavuz Sultan Selim (YSS) Bridge, collected from IMM's traffic measurement sensors network. Based on these figures, the monthly average number of vehicles on the July 15th Martyrs Bridge after the opening of Eurasia Tunnel fell about 6% in the first quarter of 2017 compared with the first quarter of 2016. The total number of vehicles crossing the FSM Bridge fell by about 23% in the first quarter of 2017 compared to the first quarter of 2016 due to the use of the YSS Bridge by heavy tonnage vehicles.




| | JANUARY | FEBRUARY | MARCH | APRIL | MAY |
|---|---|---|---|---|---|
| 2013 | 5.513.508 | 5.297.964 | 5.957.884 | 5.838.494 | 6.124.008 |
| 2014 | 6.037.238 | 5.422.130 | 5.894.310 | 5.876.092 | 6.035.998 |
| 2015 | 5.661.536 | 5.018.090 | 5.876.224 | 5.832.268 | 6.091.396 |
| 2016 | 5.522.366 | 5.524.694 | 5.897.668 | 5.882.276 | 6.185.464 |
| 2017 | 4.997.098 | 5.094.308 | 5.820.750 | 6.139.110 | 7.218.084 |

Figure 12. July 15th Martyrs Bridge Yearly Vehicle Counts




| | JANUARY | FEBRUARY | MARCH | APRIL | MAY |
|---|---|---|---|---|---|
| 2013 | 6.285.986 | 6.253.890 | 7.112.170 | 7.158.604 | 7.653.326 |
| 2014 | 6.871.590 | 6.669.386 | 7.245.420 | 7.428.818 | 7.728.620 |
| 2015 | 6.562.592 | 5.771.384 | 7.142.927 | 7.171.394 | 7.369.311 |
| 2016 | 6.093.995 | 6.510.471 | 6.561.094 | 7.105.132 | 7.332.621 |
| 2017 | 4.894.336 | 4.117.862 | 5.674.230 | 5.881.566 | 6.450.200 |

Figure 13. Fatih Sultan Mehmet Bridge Yearly Vehicle Counts

When the average number of vehicles making intercontinental trips in 2016 and in January-May 2017 are compared; a decrease of about 2% is observed as seen in Figure 14.

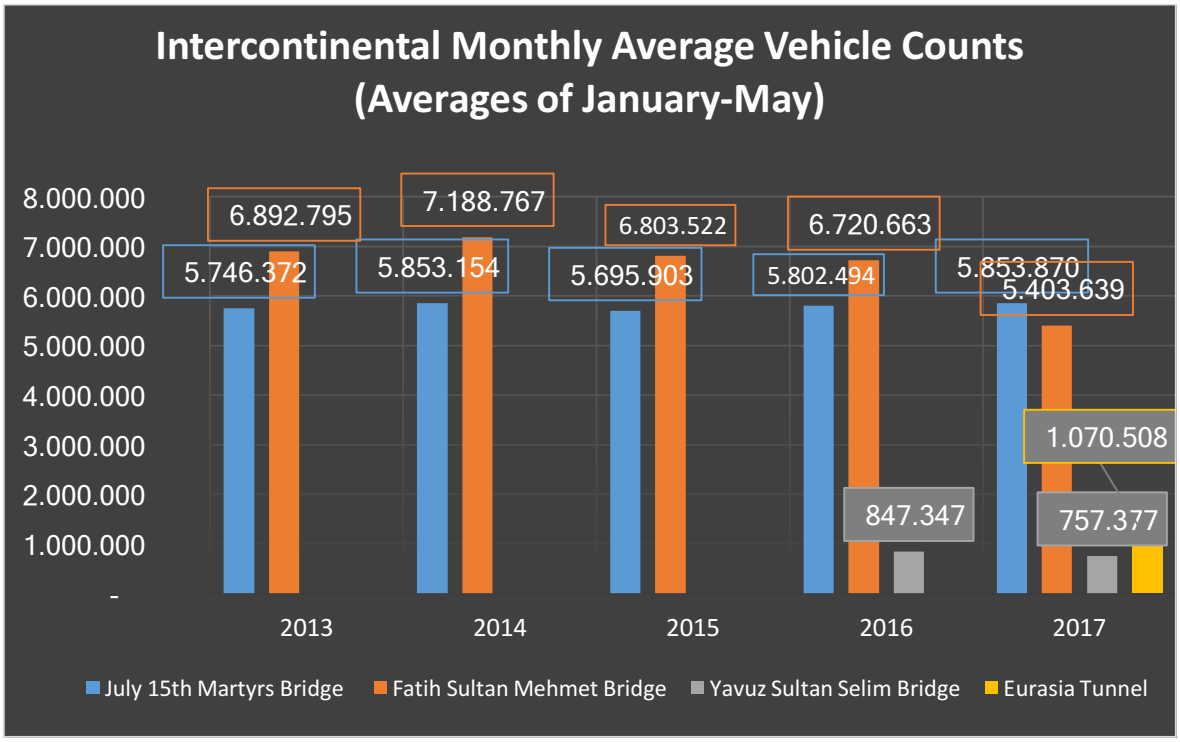



Figure 14. Intercontinental Monthly Average Vehicle Counts (Averages of January-May 2017)

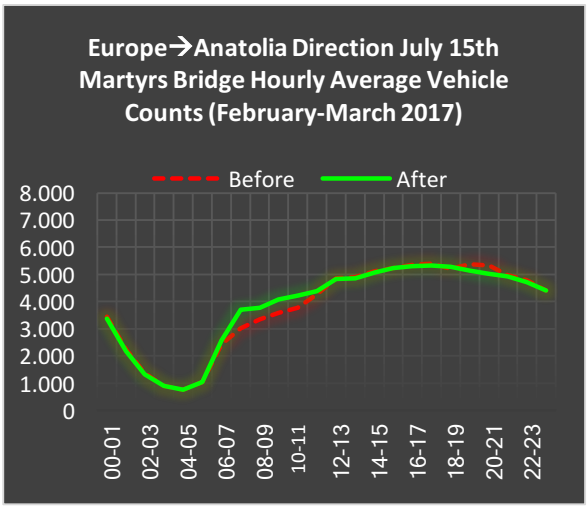



Figure 15. Europe→Anatolia Direction July 15th Martyrs Bridge Hourly Average Vehicle Counts (February-March 2017)

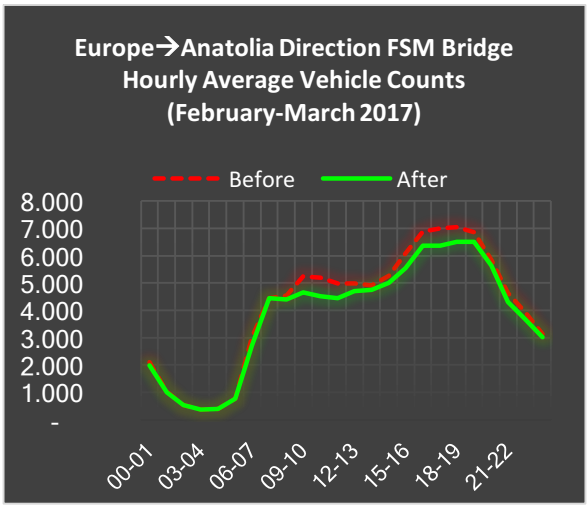



Figure 16. Europe→Anatolia Direction FSM Bridge Hourly Average Vehicle Counts (February-March 2017)

After the opening of the Eurasia Tunnel, no significant change was observed in the number of vehicles crossing the July 15th Martyrs Bridge, as seen in Figure 15, while the number of vehicles crossing the FSM Bridge fell slightly due to the impact of the YSS Bridge, which is seen in Figure 16.

### 5.4 The Impact of the Eurasia Tunnel on Travel Times

Based on traffic measurement data of February-May 2017, the average travel time between Kozyatağı and Atatürk Airport, normally around 75 minutes in the morning peak hours, decreased to 40 minutes when crossing through the Eurasia Tunnel. On the same route in the opposite direction, the average travel time of approximately 85 minutes in the evening peak hours fell to 54 minutes. Thus it can be seen that drivers save up to 35 minutes during peak hours on the Kozyatağı-Atatürk Airport route.

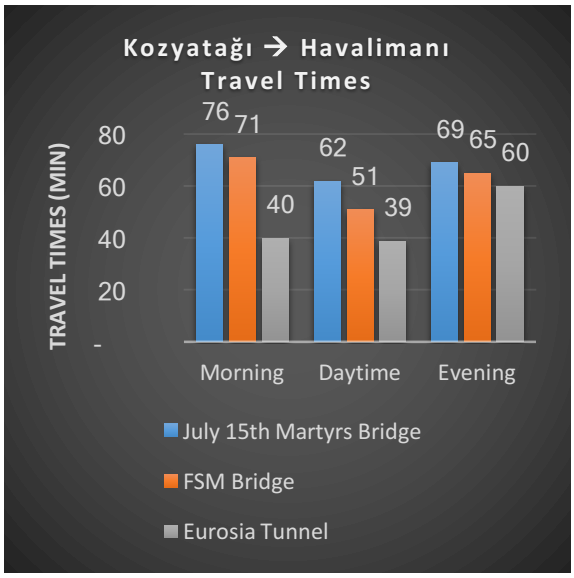



Figure 17. Kozyatağı→Havalimanı Travel Times (February-May 2017)

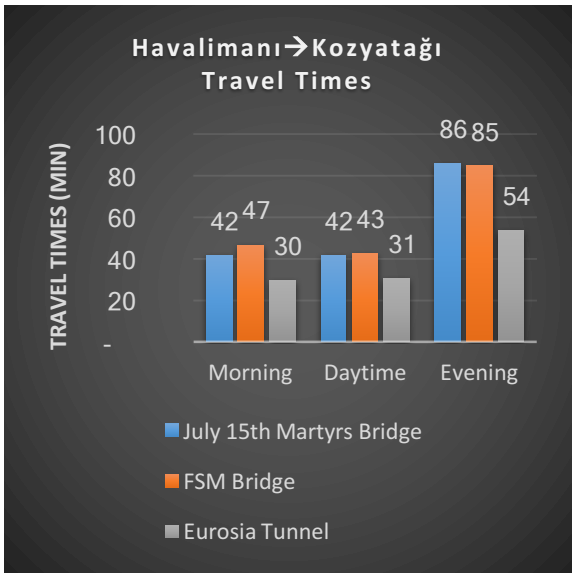



Figure 18. Havalimanı → Kozyatağı Travel Times (February-May 2017)

5.5 The Impact of the Eurasia Tunnel on Traffic on the D100 Highway

As seen in Figure 19 and Figure 20, an increment in average speeds up to 43% in the Anatolia →Europe direction and up to 63% in the Europe → Anatolia direction was observed on the D100 Highway following the opening of the Eurasia Tunnel and the removal of additional lanes during peak hours on the bridge crossings. Improvement in traffic conditions on intercontinental transits also positively affected travel times on the D100 Highway. Average travel times fell by up to 30 minutes in the Anatolia→Europe direction during the evening peak hours and by up to 26 minutes in the Europe→Anatolia direction during the morning peak hours.

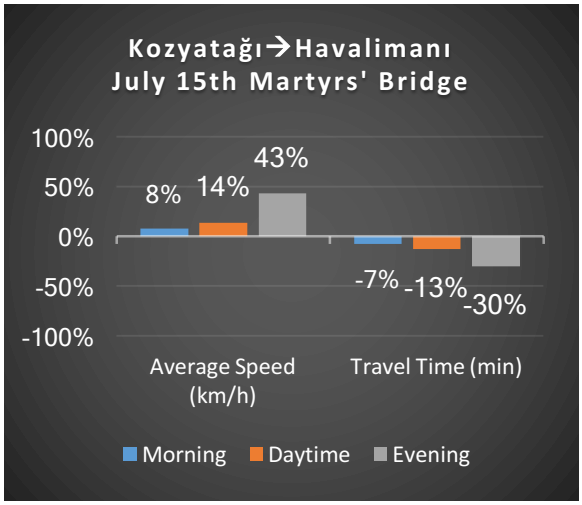



Figure 19. Kozyatağı→Havalimanı via July 15th Martyrs Bridge

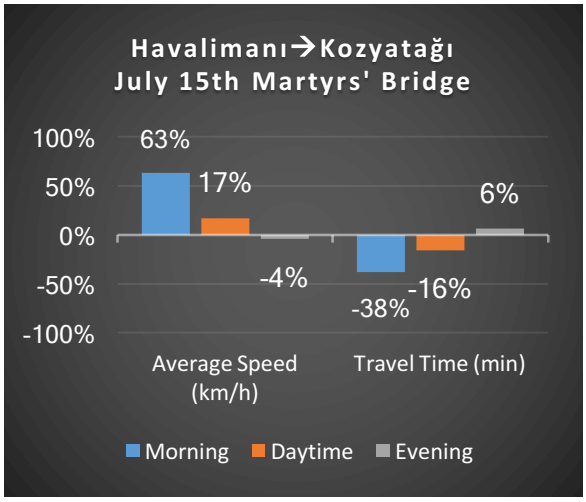



Figure 20. Havalimanı→Kozyatağı via July 15th Martyrs Bridge

Table 1. Comparison of (October-December 2016) with (February-May 2017)

| Average Speed | Morning | Daytime | Evening |
|---|---|---|---|
| Before | 25 | 29 | 21 |
| After | 27 | 33 | 30 |
| **Average Speed (km/h)** | **8%** | **14%** | **43%** |

| Travel Time | Morning | Daytime | Evening |
|---|---|---|---|
| Before | 82 | 71 | 99 |
| After | 76 | 62 | 69 |
| **Travel Time (min)** | **-7%** | **-13%** | **-30%** |

Table 2. Comparison of (October-December 2016) with (February-May 2017)

| Average Speed | Morning | Daytime | Evening |
|---|---|---|---|
| Before | 30 | 41 | 25 |
| After | 49 | 48 | 24 |
| **Average Speed (km/h)** | **63%** | **17%** | **-4%** |

| Travel Time | Morning | Daytime | Evening |
|---|---|---|---|
| Before | 68 | 50 | 81 |
| After | 42 | 42 | 86 |
| **Travel Time (min)** | **-38%** | **-16%** | **6%** |

5.6 The Impact of the Eurasia Tunnel on Traffic on the TEM Expressway

As seen in Figure 21 and Figure 22, an increment in average speeds of up to 31% in the Anatolia →Europe direction, and of up to 36% in the Europe → Anatolia direction was observed on the TEM Expressway following the opening of the Eurasia Tunnel and the removal of additional lanes during peak hours on bridge crossings. Improvement in traffic conditions during intercontinental transits also positively affected travel times on the TEM Expressway. Average travel times fell by up to 20 minutes in the Anatolia→Europe direction during the evening peak hours and by up to 18 minutes in the Europe→Anatolia direction during the morning peak hours.

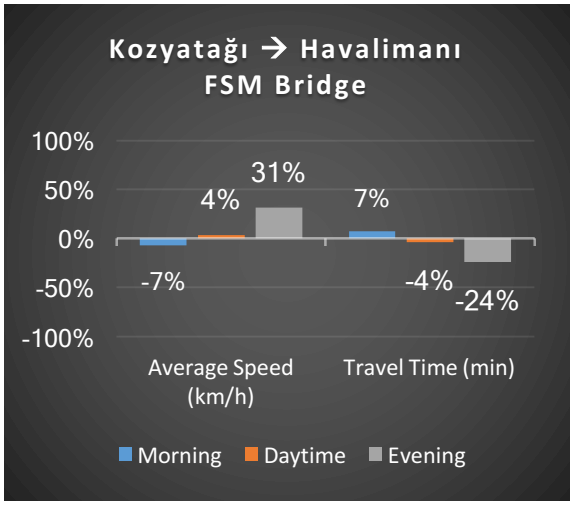



Figure 21. Kozyatağı→Havalimanı via FSM Bridge

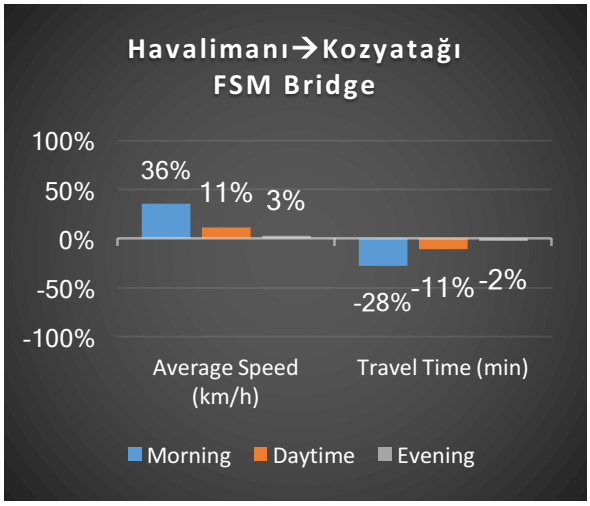



Figure 22. Havalimanı→Kozyatağı via FSM Bridge

Table3.Comparison of (October-December 2016) with (February-May 2017)

| Average Speed | Morning | Daytime | Evening |
|---|---|---|---|
| Before | 42 | 56 | 35 |
| After | 39 | 58 | 46 |
| **Average Speed (km/h)** | **-7%** | **4%** | **31%** |
| **Travel Time** | **Morning** | **Daytime** | **Evening** |
| Before | 70 | 52 | 83 |
| After | 75 | 50 | 63 |
| **Travel Time (min)** | **7%** | **-4%** | **-24%** |

Table 4. Comparison of (October-December 2016) with (February-May 2017)

| Average Speed | Morning | Daytime | Evening |
|---|---|---|---|
| Before | 45 | 63 | 35 |
| After | 61 | 70 | 36 |
| **Average Speed (km/h)** | **36%** | **11%** | **3%** |
| **Travel Time** | **Morning** | **Daytime** | **Evening** |
| Before | 65 | 46 | 84 |
| After | 47 | 41 | 82 |
| **Travel Time (min)** | **-28%** | **-11%** | **-2%** |

Contribution of the opening of the Eurasia Tunnel and the removal of additional lanes at bridge crossings for the optimization of the traffic on the July 15 Martyrs Bridge was higher compared to the FSM Bridge.

5.7 The Impact of the Eurasia Tunnel on Traffic on the European Coastal Road

As seen in Figure 23 and Table 5, following the opening of the Eurasia Tunnel, no traffic density is observed on the European Coastal Highway on the Atatürk Airport - Samatya route. Average speeds on this route rose by up to 55% and travel times fell by up to 35%.

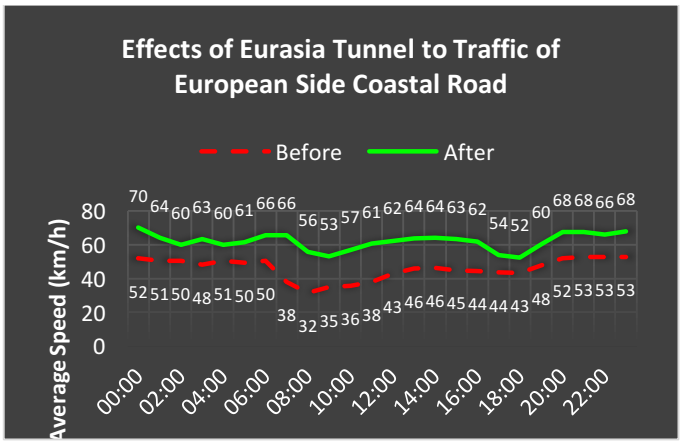



Figure 23. Effects of the Eurasia Tunnel on Traffic of the European Coastal Road

Table 5. Atatürk Airport → Samatya Comparison of (October-December 2016) with (February-May 2017)

| Average Speed | Morning | Daytime | Evening |
|---|---|---|---|
| Before | 40 | 42 | 45 |
| After | 62 | 61 | 56 |
| **Average Speed (km/h)** | **55%** | **45%** | **24%** |
| **Travel Time** | **Morning** | **Daytime** | **Evening** |
| Before | 23 | 22 | 20 |
| After | 15 | 16 | 18 |
| **Travel Time (min)** | **-35%** | **-27%** | **-10%** |

## 6 CONCLUSIONS

This paper has examined the effects of the opening of the Eurasia Tunnel and the removal of additional lanes during peak hours on traffic crossing the intercontinental bridges and on urban traffic in Istanbul. The results show that travel times have fallen by 7%–38% on the July 15th Martyrs Bridge and by 2%–28% on the FSM Bridge. Average speeds rose by up to 63% on the July 15th Martyrs Bridge and by up to 36% on the FSM Bridge during peak hours.

No significant change was observed in number of vehicles crossing the July 15th Martyrs Bridge and the FSM Bridge as a result of the opening of the Eurasia Tunnel, while traffic flow in intercontinental transits was effected positively overall. Moreover, it is observed that densities in traffic disappeared completely on the European coastal road so that smooth traffic flow was achieved.

According to the analysis results, the hourly saturation flow rate is approximately at full capacity on the July 15th Martyrs Bridge and the FSM Bridge at all times except at night; however, it peaks at 44% in the Eurasia Tunnel. Thus, some adjustments to encourage drivers to use the Eurasia Tunnel could result in improved distribution of vehicles as between the bridges and the tunnel (Figure 11. Europe→Anatolia Direction Hourly Saturation Flow Rate).

The average travel time on the D100 Kozyatağı → Atatürk Airport route –100 minutes before the opening of the Eurasia Tunnel – fell by up to 40 minutes during peak hours after it opened.

The Eurasia Tunnel has cut the time of intercontinental transits by increasing the alternatives for drivers. It has lowered the cost of travelling time by increasing transport capacity and resulted in a more comfortable travel experience. The reduction in bridge crossing times has also started to bring down the associated costs of tiredness, stress and loss of business productivity that are caused by traffic delays. [4]

Thanks to the Eurasia Tunnel Project, travel times are reduced with corresponding falls in fuel consumption and vehicle maintenance costs, thus contributing to the national economy. The project has enabled Istanbul to achieve a green transportation infrastructure that does not damage the city's natural beauty and skyline, or the aquatic life of Bosporus, while also protecting ecological balances. The link between the two airports provided by the tunnel will make a significant contribution to Istanbul's position in international air transportation, since it is the most practical route between Atatürk Airport in Europe and Sabiha Gökçen Airport on the Anatolian Peninsula.[1]

## 7 REFERENCES

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