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An Analysis of the Turkish Railway Transport by Comparison with European Countries

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Abstract
The fact that transportation infrastructure has a great impact on economic development reveals the necessity of more economical, comfortable, and environmentally friendly transportation between transportation systems. With the rapid development of technology, the importance of the railway transportation system, which can carry high-capacity, economical and safe cargo, in the transportation sector is increasing. Although railway transportation has been used for many years in our country, it is not at the desired level in terms of both freight and passenger transportation. For a more balanced and systematic distribution of transportation infrastructure, transportation systems should be analyzed. In this study, the development of railway transport in Turkey, its ratio among other types in terms of freight and passenger transport, and its status in railway transport compared to European countries have been analyzed. In line with this information, the deficiencies in rail transport and the investments that need to be made have been determined.

1. Introduction

Transportation is defined as the transportation of cargo or passengers from one place to another and has developed depending on the needs and infrastructure technologies from the past to the present [1]. Transport, which has a close relationship with other sectors, shows the level of economy and welfare level of a country. With the increasing population, rapid urbanization, and industrialization, the demand for transportation is increasing. While meeting this demand, the most reliable, comfortable, fast, and environmentally friendly transportation systems should be preferred for the sustainability of economies. When these priorities were taken into consideration, railway transportation is far ahead of all transportation systems. In terms of price, it is known that railway transportation is 40-50% cheaper in passenger transportation and 70% cheaper in freight transportation compared to other transport modes [2].

Railway transportation is a clean, quiet system with very high energy efficiency, which requires less land use in cities and between cities. The fact that the rail systems are less affected by the climate and fast and have the ability to transfer high volumes in urban and intercity transportation make railways the most convenient transportation mode [3]. Being cheap and fixed price is among the advantages of the railway, while the disadvantages are that it is not appropriate for slope lands, cannot deliver from door to door, and has lots of handlings [4]. Although the railway seems expensive in terms of infrastructure and operation, it is a transportation system that can be profitable even in a short time [5]. With the increasing number of wagons, transportation capacity in terms of passengers and freight can increase. Moreover, when the transport system increases its shipping capacity, its average cost will decrease too. Railway transportation, which is generally used low-value products, decreases waiting time because of the absence of traffic. In this way, more accurate

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information about transportation time can be obtained [6].

2. The Railway Systems in the World

Railways are environmentally friendly transportation systems, and for this reason, the mode of the railway will be in more demand in the next coming years, since railway CO_2 emissions are quite low compared to the road. Transportation activities are the only sector in the European Union where greenhouse gas emissions have increased since 1990 and road transport emissions account for 25% of total CO_2 [7].

CO_2 emission values of roads and railways are given in Figure 1 [8]. According to this figure, While the CO_2 emission value of road is the highest, the CO_2 emissions value of rail (electric) is the lowest. CO_2 emission value has increased by rail (diesel). The European Green Deal was developed to reduce emissions by 90% by 2050 and aims to significantly improve the sustainability of transport and promote zero and low emission vehicles and alternative fuels [7].

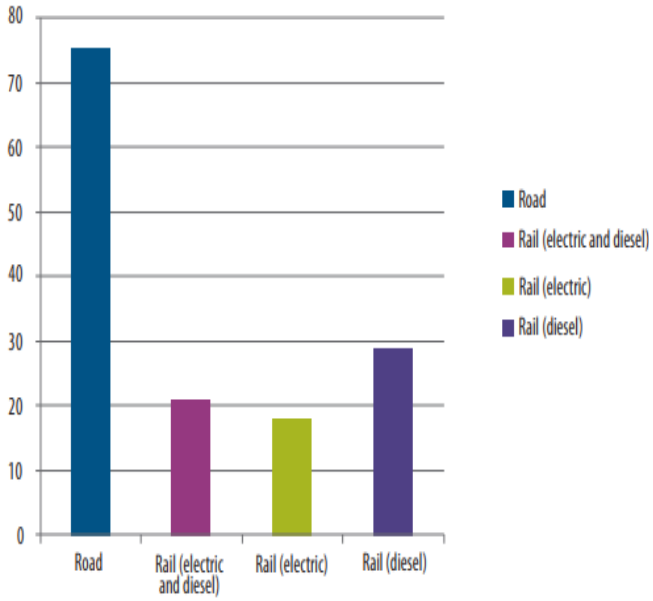


Figure 1: CO_2 emissions per tonne-kilometer in the EU in 2012 [8]

When the European railway system is studied properly, it is obvious that there are some deficiencies in its infrastructure capacity and quality, and there are also some difficulties in speed and loading due to these deficiencies. Infrastructure usage and pricing system implementations are needed to reorganize. t-This reorganization may increase the earnings of the railways to ensure fair competition with other modes and to have easy access between the modes. In other words, high-speed rail transport should be encouraged with financial incentives. For this reason, strong actions are needed to open market forces to railways [9].

The liberalization of the European rail freight market creates more competition and foresees a reduction in costs by transferring transportation from road to rail [10].

In order to meet the demand for railway transport in Europe better, network management is also required to be re-regulated. Passenger lines among railway operators, diversification of services, and further expansion of EU rail transport may create great opportunities for rail transport in the long run. Network management should be better regulated in order to better meeting of the demand for transport in Europe [11]. Europe went through many reforms to improve the railway. These reforms are shown in Figure 2 [12]. Although these reforms have been created in many places in the world such as the USA, Latin America and Asia, they have not been implemented so consistently anywhere [10].

When the transportation activities in Europe are evaluated, it is seen in Table 1 that automobile and bus transportation is ahead of the railroad [13]. According to Table 1, Austria has the highest rate with 12.9% and the lowest rate belongs to Greece with 0.9% in terms of railway usage by passengers. In Turkey, this rate is calculated as 2.7%. In the Americas, on the other hand, transportation by automobile and bus, which belongs to road transportation, has a large proportion and this rate is 99.6% in total. Passenger transportation by rail in the USA is 0.4%.

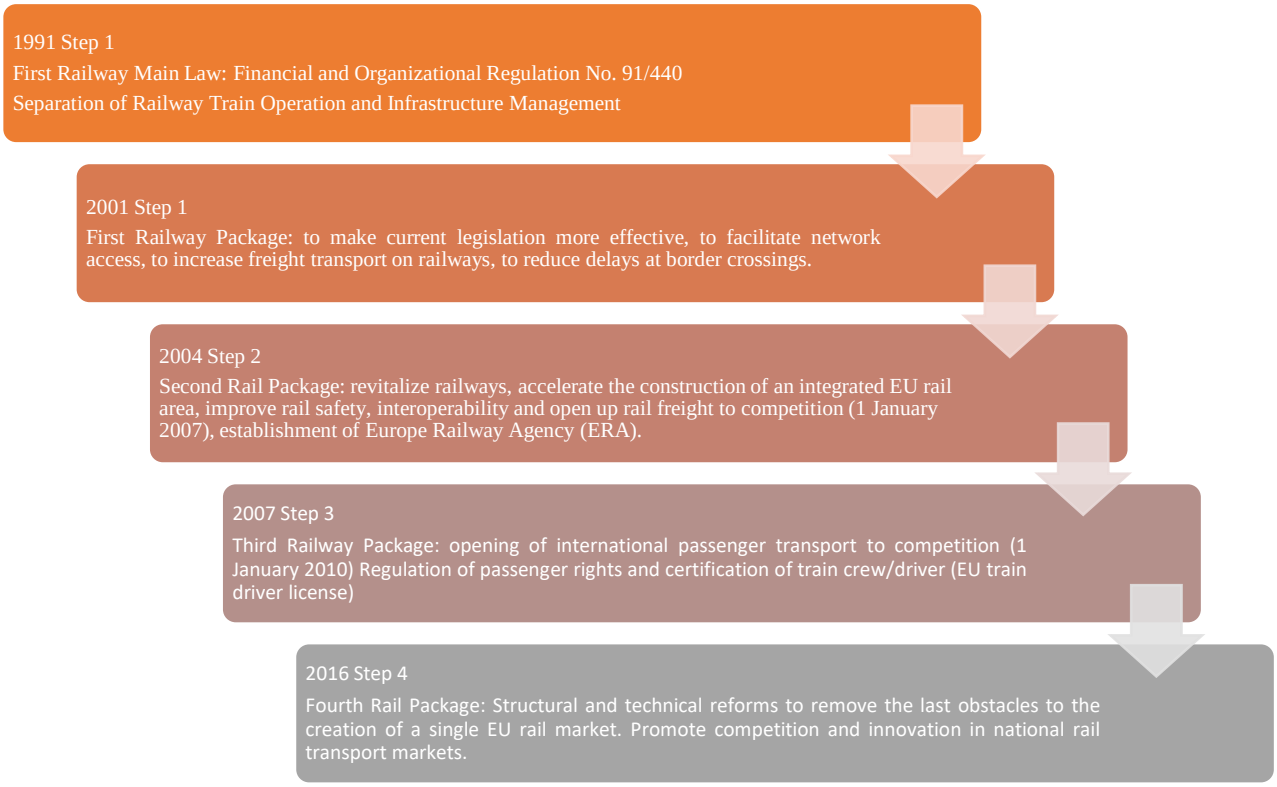


Figure 2: EU railway legislations

Table 1: Passenger transport by countries and transport systems (Passenger-Km) [13]

	Railway		**Passenger Car**		**Bus**		**Total**
	Billion	**%**	**Billion**	**%**	**Billion**	**%**	**Billion**
Turkey	**8.9**	**2.7**	**229.4**	**70.2**	**88.3**	**27.0**	**326.6**
England	69.7	8.9	672.7	86.3	36.8	4.7	779.2
Greece	1.1	0.9	103.4	82.7	20.5	16.4	125
Germany	98.1	9.1	920.2	85.1	62.5	5.8	1080.8
Italy	55.5	6.3	722.9	82.0	103	11.7	881.4
Spain	28.4	7.1	340.6	84.9	32.2	8.0	401.2
France	97.1	10.6	757.1	83.0	57.6	6.3	911.8
Austria	13.2	12.9	78.5	77.0	10.3	10.1	102
Czech Republic	10.2	9.6	78	73.4	18.1	17.0	106.3
Poland	21	7.8	212.4	79.3	34.5	12.9	267.9
Hungary	7.8	8.6	63.9	70.5	18.9	20.9	90.6
Bulgaria	1.5	2.2	57.2	83.4	9.9	14.4	68.6
Netherlands	18.9	11.2	144.7	85.7	5.3	3.1	168.9
Romania	5.6	4.3	103.8	80.3	19.9	15.4	129.3
European Union	476.9	8.1	4916.5	83.3	511.4	8.7	5904.8
USA	37.5	0.4	7804.1	92.2	624.7	7.4	8466.3

Since transportation is of a great importance in EU Economy, freight transportation activities related to transportation constitute 9% of the total gross value added and create 11 million jobs [14]. In Table 2, freight transport rates of countries by rail, road, inland waterway and oil line are given [13]. The share of freight transport in rail is higher than the share of passenger transport. According to this table, the country with the highest rate of freight transport by rail is Russia with 61.4%. According to the table, the country with the lowest share in rail freight transport is Greece with 2.1%. Among the transportation types in Table 2, the rate of freight transportation by rail in Turkey was found to be 4.5%.

Table 2: Freight transports by countries and transportation systems (Ton-Km)

	Railway		Road		Inland Waterways		Oil Pipeline		Total
	Billion	**%**	**Billion**	**%**	**Billion**	**%**	**Billion**	**%**	**Billion**
Turkey	**14.48**	**4.5**	**266.5**	**83.4**			**38.65**	**12.1**	**319.6**
England	17.21	8.9	165.3	85.8	0.10	0.1	9.97	5.2	192.6
Greece	0.41	2.1	19.4	97.8			0.03	0.2	19.8
Germany	124.62	19.3	458.6	70.8	46.90	7.2	17.23	2.7	647.3
Italy	22.07	12.4	146.1	81.8	0.10	0.1	10.33	5.8	178.6
Spain	10.70	4.8	203.6	90.9			9.70	4.3	224.0
France	32.04	9.6	283.4	84.5	7.30	2.2	12.45	3.7	335.2
Austria	22.00	28.1	46.3	59.1	1.50	1.9	8.58	11.0	78.4
Czech Republic	16.56	26.7	43.5	69.9			2.11	3,4	62.1
Poland	59.39	24.5	161.9	66.7	0.10	0.04	21.31	8.8	242.7
Hungary	10.58	25.4	27.0	64.8	1.60	3.8	2.50	6.0	41.7
Bulgaria	3.82	18.6	11.1	54.3	4.90	23.9	0.67	3.3	20.5
Netherlands	7.02	6.1	55.1	48.0	47.20	41.1	5.54	4.8	114.9
Romania	13.08	28.2	20.0	43.0	12.30	26.5	1.08	2.3	46.4
European Union	440.53	17.2	1874,2	73.1	135.10	5.3	114.01	4.4	2563,9
USA	2525.22	34.2	2969.5	40.2	463.00	6.3	1429.81	19.4	7387.5
China	2882.10	14.1	7124,9	34.9	9905.20	48.5	530.07	2.6	20442.3
Russia	2597.78	61.4	241.2	5.7	61,00	1.4	1331.62	31.5	4231.6

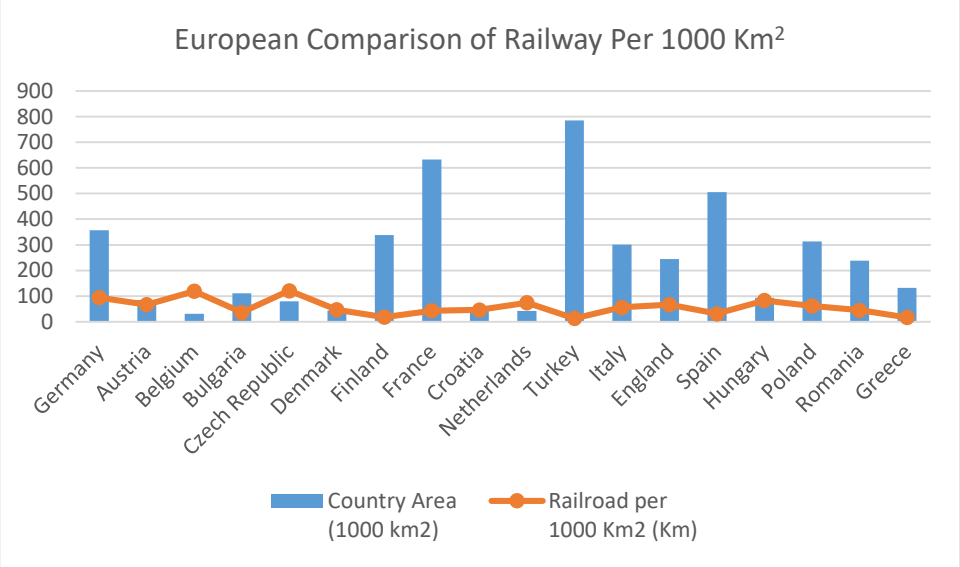


Figure 3: Comparison of rail length decreased to 1000 km^2

In Figure 3, the area values of the countries and the railway lengths per 1000 km^2 are given [13]. According to the figure, the Czech Republic has the highest rate, with 121 km of railways per 1000 km^2. In Turkey, on the other hand, there is 13 km of railways per 1000 km^2.

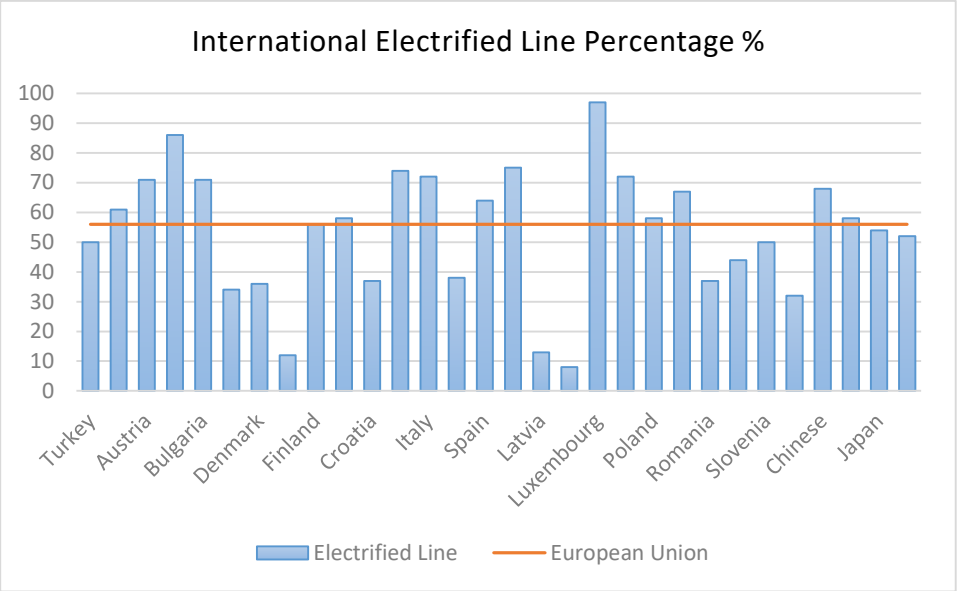
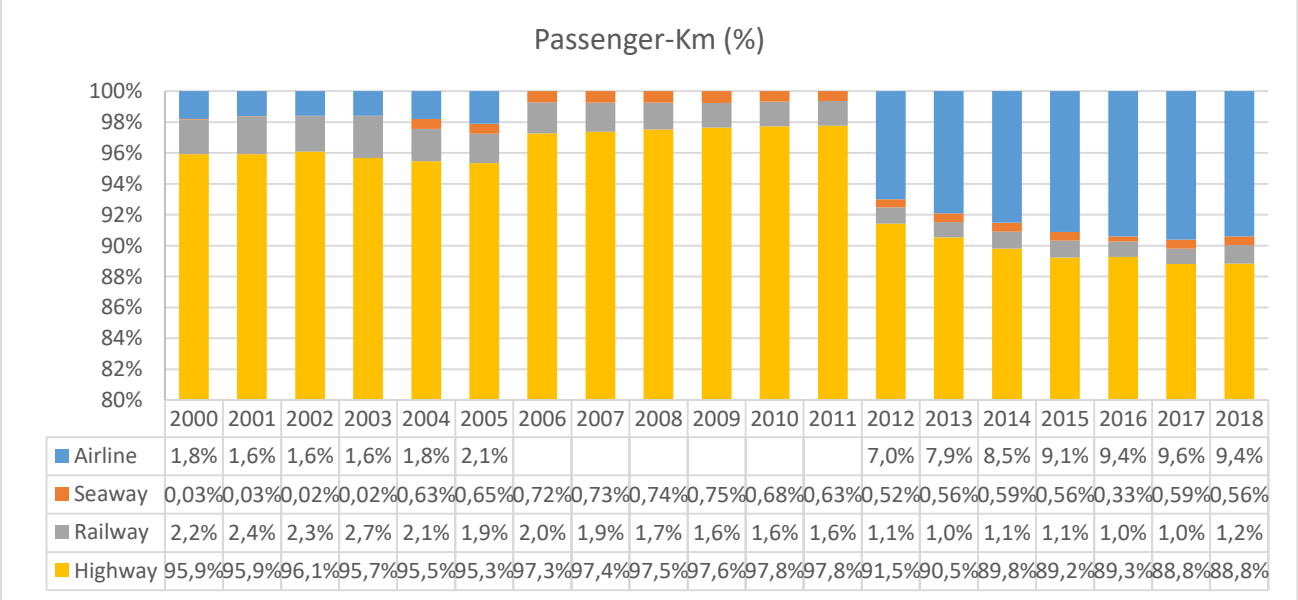


Figure 4: Percentage of international electric lines

Figure 4 shows the percentages of electrified lines owned by countries and the European Union [13]. According to this figure, Luxembourg has the highest share with 97%. Lithuania has the lowest share with 8%. Turkey's electrified line (electric rail system) rate is shown as 50%. In the European Union, this rate was detected as 54%.

3. Railway Systems in Turkey

Almost every person uses railways in European countries especially in Switzerland[6]. However, in Turkey, the share of railways in passenger transportation is very low. The shares of transportation systems in passenger transportation in Turkey by years is shown in Figure 5 [15].



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Airline	1,8%	1,6%	1,6%	1,6%	1,8%	2,1%							7,0%	7,9%	8,5%	9,1%	9,4%	9,6%	9,4%
Seaway	0,03%	0,03%	0,02%	0,02%	0,63%	0,65%	0,72%	0,73%	0,74%	0,75%	0,68%	0,63%	0,52%	0,56%	0,59%	0,56%	0,33%	0,59%	0,56%
Railway	2,2%	2,4%	2,3%	2,7%	2,1%	1,9%	2,0%	1,9%	1,7%	1,6%	1,6%	1,6%	1,1%	1,0%	1,1%	1,1%	1,0%	1,0%	1,2%
Highway	95,9%	95,9%	96,1%	95,7%	95,5%	95,3%	97,3%	97,4%	97,5%	97,6%	97,8%	97,8%	91,5%	90,5%	89,8%	89,2%	89,3%	88,8%	88,8%

Figure 5. Passenger transportation (Passenger-Km) by transportation systems in Turkey

When Figure 5 is examined, there is a remarkable increase in air transport, while road transport is at the forefront of passenger transport in all years. In maritime transport, the change has been fluctuating over the years. However, decreasing trend may easily be observed in the share of railways in passenger transport.

Nevertheless, according the recent studies, the rail share of passenger transportation has been increasing in recent years by high-speed train (HST). In HST Enterprises, better railway service can be provided by providing the best design and shortening the travel time. HST systems have been developed to increase the railway shipping capacity, thus its competitiveness against other modes will also be strengthened too [16]. In Table 3, the number of passengers by years is given [13]. High speed train usage rate is given in Figure 6.

Table 3: Main line and HST quantities (Passenger-Km Million)

	2009	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Main Line	3232	3017	3257	2035	1790	1833	1812	1397	1426	1762	2163	495
HST	237	476	665	914	1186	1555	1847	1871	2218	2551	2678	941
Total	3469	3493	3922	2949	2976	3388	3659	3268	3644	4313	4841	1436

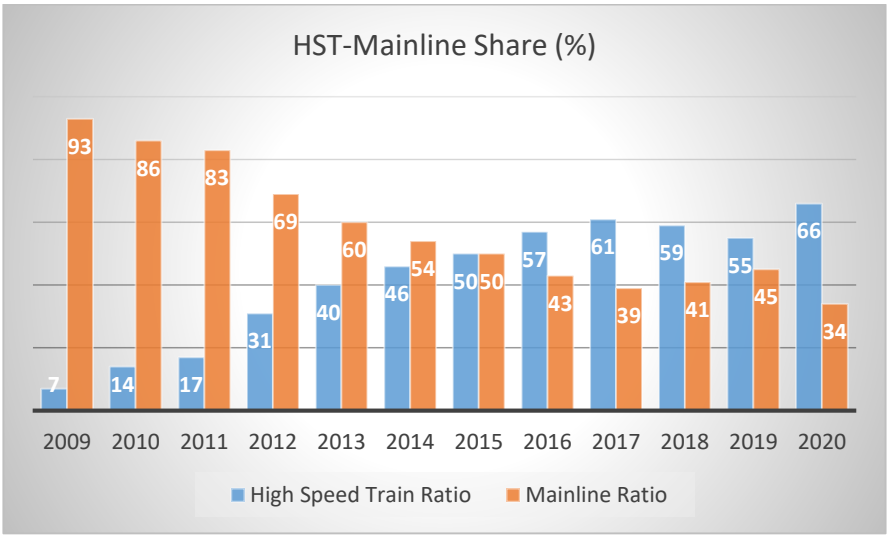
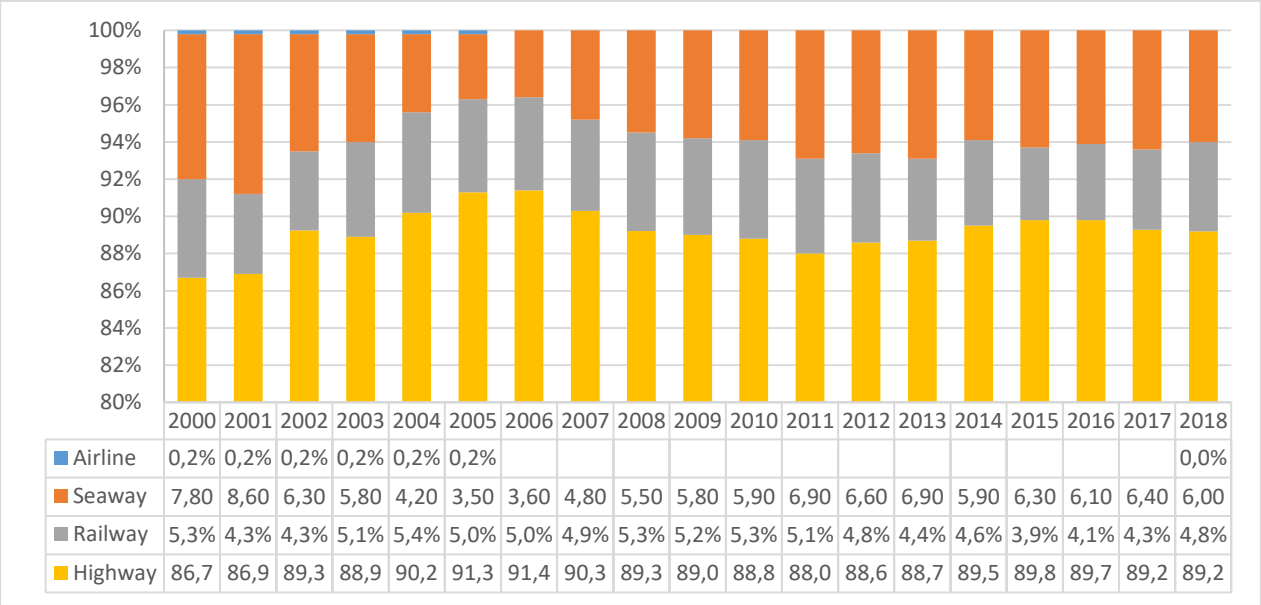


Figure 6: HST and mainline share

The most important thing about a transportation system is the providing of an environmentally friendly and efficient service without energy waste and without external dependency. An efficient transportation system requires swift operational and administrative activities, adequate planning, and qualified and sufficient personnel. There is an unbalanced distribution among the transportation modes in Turkey. In order to re-balance this distribution, it is necessary to decrease density of road transport and increase density of other transportation systems. By investing in high-speed train, Turkey tries to transfer its road passenger traffic to the railways, since density of road transport makes Turkey dependent on oil [17]. This situation can be avoided only by rail transport. In Figure 7, the amount of freight transport between transportation systems is given [15].



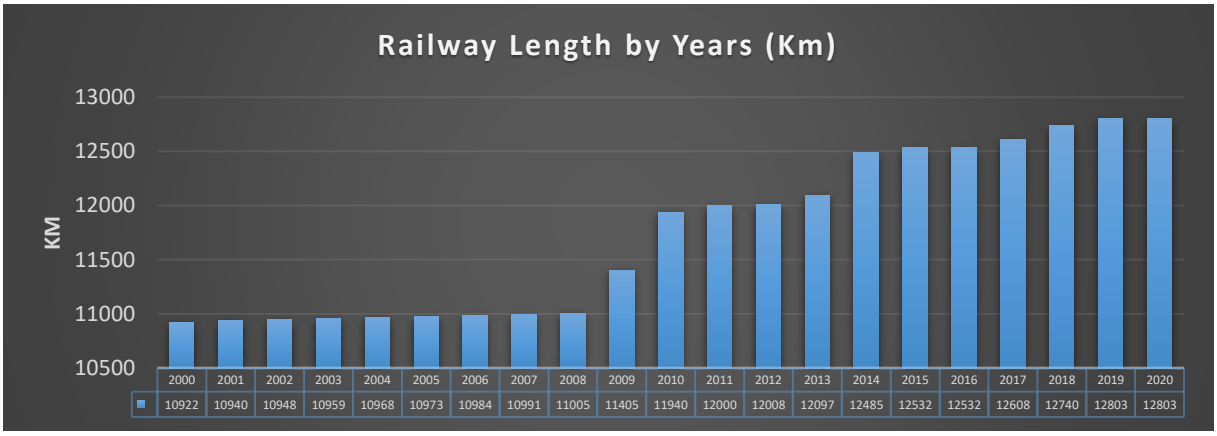
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Airline	0,2%	0,2%	0,2%	0,2%	0,2%	0,2%													0,0%
Seaway	7,80	8,60	6,30	5,80	4,20	3,50	3,60	4,80	5,50	5,80	5,90	6,90	6,60	6,90	5,90	6,30	6,10	6,40	6,00
Railway	5,3%	4,3%	4,3%	5,1%	5,4%	5,0%	5,0%	4,9%	5,3%	5,2%	5,3%	5,1%	4,8%	4,4%	4,6%	3,9%	4,1%	4,3%	4,8%
Highway	86,7	86,9	89,3	88,9	90,2	91,3	91,4	90,3	89,3	89,0	88,8	88,0	88,6	88,7	89,5	89,8	89,7	89,2	89,2

Figure 7: Freight carriage by transportation systems in Turkey (Tonne -Km)

According to Figure 7, highway has the largest share in freight transportation and its rank is the first. Airline, on the other hand, is not a system that has an important share in freight transportation and most importantly there has been no significant change in rail freight transport. In seaway, the rate freight of transportation has a higher rate than its share in passenger transportation, and there have been small increases and decreases in freight transportation over the years.

Railway transportation within the territory of today's Turkey can be splitted to three main periods. These periods are; The Ottoman Empire Period, New-republic period (1923-1950) and present period (1950-2022).

Since 1963, some development plans have been implemented in Turkey. These devolopment plans comprise of activities which are setting highway network which is complement to railway, making regulations that will increase its contribution to the economy, setting transportation which is contemporary and appropriate to neccesserities [5]. The target of Turkey's development plan is to increase the share of rail freight transport to 15% and the share of passenger transport to 10%. In the long term, the target is to increase the share of freight transport to 20% and the share of passenger transport to 15%. With a well-planned transportation system, the cities will grow in a balanced way and the demand for the railway transportation system will increase. As this demand increases, railway systems will provide more effective transportation service. In Figure 8, the railway length by years is shown. Increasing our railway network to 31,000 km is targeted in the long-term development plan [13].



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
	10922	10940	10948	10959	10968	10973	10984	10991	11005	11405	11940	12000	12008	12097	12485	12532	12532	12608	12740	12803	12803

Figure 8: Railway length by years

4. Conclusion and Evaluation

Rail transport, which improves the quality of life of people, paves the way for modern, fast and economical transport. With the technological developments, the distances between countries have shortened and countries have become closer to each other. In this context, the implementation of high-speed railway projects, the modernization of existing roads and terminals, the development of the railway industries will strengthen Turkey's position as a logistical base of its region [18].

The general reason of being less developed in railway system is so simple. There has been no enough investments for the railways since 1950. This negligence is being tried to be covered by the use of high-speed trains in passenger transportation. In line with this information obtained in both freight and passenger transportation, in order to ensure the balance between transportation modes, these actions should be taken:

- Infrastructure investments should be prioritized
- Necessary investments should be prioritized
- The deficiencies should be analyzed fully and accurately after that these deficiencies should be eliminated.
- High-speed train lines are constantly being updated and growing. It is obvious that the current situation is improving day by day and the line lengths are increasing.
- Rail transport investments should be more active in terms of modal balance
- In freight transportation, the number of wagons and the length of the main line should be increased.
- However, the necessary importance is not given to the freight transport lines in Turkey. As a result, the share of rail freight transport decreases, therefore, road freight transport and CO_2 emissions increase.
- In this regard, the length of the lines should be increased by increasing the maintenance and repair of freight transport lines and the construction of connection roads that do not exist.

However, although the railway is a sustainable mode of transportation, especially in developing countries, railway enterprises or companies need to strive to improve their performance in terms of sustainability [19].

Since Turkey is at a crossroads in providing the transition from Asia to Europe, it should renew and optimize its transportation systems. With a balanced and strong transportation system, the country's economy will switch its traffic from road transportation to the railway transportation. It is an important issue for Turkey's economical sustainability because road transportation makes the country dependent on oil imports. All in all, investments and regulations for railway mode is of great importance for the future of Turkish economy.

Contribution of the Authors

The article was produced with the joint contributions of the authors.

Conflict of Interest Statement

There is no conflict of interest between the authors.

Statement of Research and Publication Ethics

Research and publication ethics were complied with in the study.

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