EVALUATION OF RAIL FREIGHT TRANSPORTATION IN TURKEY PRIOR TO DEREGULATION

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submitted by **ALPER CEBECİ** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy** i**n Civil Engineering, Middle East Technical University** by,

Prof. Dr. Halil Kalıpçılar

Dean, Graduate School of **Natural and Applied Sciences**

Prof. Dr. Ahmet Türer

Head of the Department, **Civil Engineering**

Assoc. Prof. Dr. Hediye Tüydeş Yaman

Supervisor, **Civil Engineering, METU**

Examining Committee Members:

Prof. Dr. Ela Babalık Sutcliffe

City and Regional Planning, METU

Assoc. Prof. Dr. Hediye Tüydeş Yaman

Civil Engineering, METU

Assist. Prof. Hande Işık Öztürk

Civil Engineering, METU

Assist. Prof. Fikret Zorlu

City and Regional Planning, Mersin Uni.

Assist. Prof. Meriç Gökdalay

Aviation Management, Turkish Aeronautical Ass. Uni

Date: 16.03.2019

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Alper Cebeci

Signature :

ABSTRACT

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Cebeci, Alper
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Rail freight is a major component of industrial development in a country, as it provides very cheap transportation opportunities for raw materials, such as coal, ores, etc. However, due to its stop-to-stop nature, it always requires a first- and last-mile connection with another mode, thus, has relatively longer total travel times. As a results, it can hardly earn the revenues necessary for its operations and has been heavily subsized by govermnets in many countries. To overturn this situation, deregulation of the rail freight which could bring more competition, thus efficiency, has been tried in different countries in the world, including the EU region. As a candidate for EU membership, Turkey has also developed the legal framework for deregulation of the rail freight sector, which has been put into action in 2017. However, there has been no predictions on the potential impacts of this reform, so far, which is the main focus of this study.

Due to the lack of disaggregate freight data from various modes (road, rail, etc.), performing a traditional four-step analysis with mode choice model is very challenging in developing countries like Turkey. Thus, evaluation of the effects of rail freight deregulation can be only achieved by monitoring the trends and shifts in the total rail commodity flow data, as proposed in this study. Using the digitially

recorded commodity flow data for 4 years period before the deregulation (2011-2014), two years of transition period (2015-2016), which included major renovations along many rail corridors, and first two years after the reform (2017-2018), it was possible to determine the spatial distribution of the major rail freight demand in terms of net-tonnes in Turkey, using Geographical Information Systems (GIS). Similarly, cost information was used to determine rail corridors with higher revenue levels. Aggregation of station level freight and revenu data enabled the determination of the city-based total production and attraction values, which was also determined for 20 commodity types defined in (NST 2007). While before analyses showed that the rail freight demand in Turkey was distributed unevenely over the geograph, as it was mainly governed by the location of natural resources and major heavy industrial settlements (i.e, steel manufactoring factories, etc.). The major shifts to private sector after deregulation are also observed along these corridors, where single commodity type is carried in large volumes.

Keywords: Railway Freight, Transportation Planning, Demand Analysis, Geographical Information Systems (GIS)

ÖZ

DEMİRYOLU REFORMU ÖNCESİ TÜRKİYE'DE DEMİRYOLU YÜK TAŞIMACILIĞININ DEĞERLENDİRİLMESİ

Cebeci, Alper
Doktora, İnşaat Mühendisliği
Tez Yöneticisi: Doç. Dr. Hediye Tüydeş Yaman

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Demiryolu yükü, bir ülkenin endüstriyel kalkınmasının önemli bir unsurudur, çünkü kömür, demir cevheri gibi ham maddeler için oldukça ucuz taşıma fırsatları sunmaktadır. Ancak duraktan durağa niteliğinden ötürü her zaman başka bir taşıma türü ile ilk ve son nokta bağlantısı gerektirmektedir ve bu sebeple taşıma süreleri nispeten daha uzundur. Sonuç olarak operasyonları için gereken gelirleri güçlükle kazanabilmektedir ve çoğu ülkede hükümetler tarafından büyük ölçüde sübvanse edilmektedir. Bu durumu tersine çevirmek için daha fazla rekabet ve dolayısıyla verimlilik getirmek üzere AB bölgesi dahil olmak üzere dünyanın farklı ülkelerinde demiryolu yükünün serbestleştirilmesi denenmiştir. Türkiye, AB üyeliğine aday bir ülke olarak demiryolu yük sektörünün serbestleştirilmesine yönelik hukuki çerçevesini oluşturmuş ve 2017 yılında bunu yürürlüğe koymuştur. Ancak bu reformun potansiyel etkileri konusunda şimdiye kadar hiçbir tahmin yapılmamıştır ki bu durum, bu çalışmanın ana odak noktasıdır.

Çeşitli taşıma türlerine (karayolu, demiryolu vb.) ait ayrı ayrı yük verilerinin bulunmamasından ötürü Türkiye gibi gelişen ülkelerde taşıma türü seçme modeliyle dört aşamalı bir analiz yapmak oldukça zordur. Dolayısıyla demiryolu yükünün

serbestleştirilmesinin etkilerine yönelik bir değerlendirme ancak bu çalışmada önerildiği gibi toplam demiryolu yük akışı verilerindeki eğilimler ve kaymaların izlenmesi yoluyla sağlanabilmektedir. Serbestleşmeden önceki 4 yıla (2011-2014), çoğu demiryolu koridorunda büyük yeniliklerin yer aldığı geçiş dönemindeki iki yıla (2015-2016) ve reformdan sonraki ilk iki yıla (2017-2018) ait dijital olarak kaydedilen yük akışı verileri kullanılarak Coğrafi Bilgi Sistemi (CBS) vasıtasıyla Türkiye'deki önemli demiryolu yük taleplerinin net/ton açısından yer olarak dağılımını belirlemek mümkün olmuştur. Aynı şekilde, daha yüksek gelir seviyeleri olan demiryolu koridorlarını belirlemek üzere maliyet bilgileri kullanılmıştır. İstasyon seviyesindeki yük ve gelir verilerinin bir araya getirilmesi, NST 2007'de tanımlanan 20 mal türü için tayin edilen şehir esaslı toplam üretim ve çekim değerlerinin belirlenmesine olanak tanımıştır. Analizler, Türkiye'deki demiryolu yük talebinin, esas olarak doğal kaynakların ve büyük ağır sanayi yerleşimlerinin (örn. çelik üretim fabrikaları vb.) konumuyla yönlendirildiğinden coğrafya genelinde dengesiz olarak dağıldığını göstermiştir. Serbestleşme sonrasında tek tip mal türünün büyük hacimlerde taşındığı koridorlar boyunca özel sektöre önemli kaymalar olduğu gözlemlenmiştir.

Anahtar Kelimeler: Demiryolu Taşımacılığı, Ulaşım Planlaması, Talep Analizi, Coğrafi Bilgi Sistemleri (CBS)

to my Family

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INTRODUCTION

1.1 Motivation

Transportation, basically, is defined as movement of goods (freight) or people (passengers) from one place to another adhering them an added value. This, in a broad sense, means timely delivery of goods, which are produced with the intention of fulfilling customer needs, to the required regions and centers with minimum damage at a reasonable price. Despite basic similarities between passenger transportation, freight transportation has its own distinct aspects. It is more challenging to develop an analysis model for freight demand, due to sector complexity and plurality of effective factors, resulted from a demand structure combined of spatial, physical, economic and social factors.

Freight transportation is considered as an extremely important activity for the country's economy. Freight transportation has evolved into a very comprehensive sector, which includes variety of services. Main steps include i) transportation of unprocessed raw materials from the production sites (mines, farms, etc.) to the processing facilities (factories, refineries, etc.), followed by ii) transportation of manufactured goods from the processing facilities to the distribution centers/wholesale traders, and finally iii) delivery of goods to the consumers. The type of the cargo (bulk, containers etc.) and nature of the transportation (such as domestic versus international) are critical aspects affecting transportation modal shares.

Sstatistics show a major problem in the modal distribution of freight transportation systems; approximately 90% of the total freight in Turkey transported by road, 5% of it by railway and 5% of it by maritime (see Table 1.1). Whereas, in the European

Union (EU) countries, about 50% of total freight transportation is realized via road, 33% of it via sea, 12% of it via rail and 5% of it via inland waterways (EUROSTAT, 2017). The highest percentages of the rail freight transport are belonging to Russia and the USA with 45.7% and 32.6% respectively. On the other hand, Spain and the UK have a dominance in road freight transport with highest percentages (86.6% and 82.5% respectively) all around the world (see Table 1.2).

Table 1.1 Freight Modal Share of Transport in Turkey (TCDD, 2018)

Years	Freight Modal Share (%)				
	Road	**Railway**	**Sea**	**Airways**	**Pipelines**
2003	88.9	5.1	5.8	0.2	10.6
2004	90.2	5.4	4.2	0.2	6.9
2005	91.3	5.0	3.5	0.2	3.1
2006	91.4	5.0	3.6	NA	3.0
2007	90.3	4.9	4.8	NA	6.4
2008	89.3	5.3	5.5	NA	17.9
2009	89.0	5.2	5.8	NA	22.8
2010	88.8	5.3	5.9	NA	18.5
2011	88.0	5.1	6.9	NA	19.4
2012	88.6	4.8	6.6	NA	15.3
2013	88.7	4.4	6.9	NA	10.6
2014	89.5	4.6	5.9	NA	NA
2015	89.8	3.9	6.3	NA	NA
2016	89.7	4.1	6.1	NA	NA
2017	89.2	4.3	6.4	NA	NA
…					
2023*	NA	10.0	NA	NA	NA

Two main reasons behind the dominance of road transport are i) road transport advantage of door-to door service, and ii) improvements in the capacity of vehicles, the safety issues and the supply chain management (Ozen, 2013). Thus, it is difficult for other transportation modals to compete with road transport especially on short distances. Similar to other countries, there have been several studies and policy documents suggesting the increase in the modal share of railway transport in Turkey. In the 11th Development Plan (T.C. Cumhurbaşkanlığı, Strateji ve Bütçe Başkanlığı, 2019) railway share in freight transportation was planned to exceed 10% (with passenger transportation share increasing from 1.3 to 3.8%, as well), as shown in the target modal shares for 2023 in Table 1.1, which are hard to achieve, recently.

Table 1.2 Modal Shares of Freight in Selected Countries in 2016 (TCDD, 2019)

Country	Modal Shares* (%)			
	Railway	Road	Inland Waterways	Oil Pipeline
TURKEY	3.7	79.7	0.0	16.6
UK	9.7	84.5	0.1	5.4
GERMANY	25.2	58.9	12	3.9
ITALY	15.9	76.4	0.1	7.2
SPAIN	6.6	87.3	0.0	6.4
FRANCE	16.6	73.4	4.3	5.9
EU-28	22.3	63.5	6.1	4.8
USA	33.0	42.1	5.8	15.7
CHINA	12.8	32.8	52.2	2.6
RUSSIA	59.3	5.9	1.2	48.4

* excludes air

1.2 Research Objectives

In Turkey, rail freight transport is preferred in case of high freight quantity and long haulage distance in domestic freight transportation. The expectation in the rail freight transport sector is that rail reforms increase efficiency and modal share. In addition, according to the eleventh development plan, it is aimed to increase the competition in rail freight transport and to support rail freight transport with logistics villages. A recent significant development has been the establishment of Directorate General of Railway Regulation with the Decree Law No. 655 in 2011 and the enactment of the Railway Reform Law No. 6461 in 2013. It is important to determine national policies in freight transport as well as to carry out national master plan studies on freight transport.

Performing a four-step modelling analysis and generating mode choice as a result is a challenging process especially in countries like Turkey, where the disaggregate commodity flow data are lacking. Although some studies regarding the modelling of road transport demand, commodity characteristics and freight determination in Turkey are available within the literature, there is no comprehensive study on railway

transport in similar perspectives due to limited data on rail freight. The rail freight transport data have started to be recorded digitally and reliably as of 2011 and an average of 6,000 data have been recorded for each year. The aim of this study is to determine the dynamics of rail freight transport for the pre-liberalization and post-liberalization periods in Turkey and to produce spatial analyzes that can shed light on the future studies.

The main research question on the basis of this study can be summarized as

- Did railway reform have an early statistical impact on the rail freight transport in Turkey?
- If yes, was it positive or negative and how strong was the impact on the production-attraction centers and railway traffic density?"

To investigate the answers for this focus, the following periods have been determined and analyzed (via freight production-attraction centers analysis, line density analysis and commodity-based analysis) in terms of their railway freight characteristics within the scope of this study: Pre-liberalization period (2011-2016) which is divided as Pre-reform period (2011-2014) and Transition period (2015-2016); and Early Post-liberalization period (2017-2018). Due to the absence of a complete digital railway network map, a railway network with all the rail stations and corridors was coded for this study as a base for an internet-based GIS tool. Network assignment between given origin-destination pairs is performed by Djkastra algorithm embedded in the web-based tool, as well.

After investigating the rail freight transportation sector prior to the deregulation, periods before and after the railway reform have been compared to derive basic conclusions on the early impact of rail deregulation in Turkey. In addition, the impacts of railway reforms on the railway-based intermodal transports in the conclusion part.

1.3 Limitations

This study, which is concentrating on the field of rail freight transportation only, some limitations have been encountered. The most challenging among these restrictions has been the difficulty of accessing the rail data. Similarly, accessing to road data is also limited if mode choice analysis is desired. The freight trends could have been analyzed better, if the reliable and appropriate data prior to 2011 had used. The possibility that the railway line used has been under the maintenance or operated with restricted traffic is ignored.

Secondly, due to the lack of detailed freight data (e.g. the date of transport and the duration of transport), seasonal, monthly, weekly or daily analyzes could not be made. More importantly, unavailability of reliable and sufficient road data available, mode choice (logistic regression) analysis was not performed within the scope of this study. Moreover, performed analyses have been based on the annual total statistics of TCDD Taşımacılık A.Ş. (TCDD-T) and TCDD only, and comparative analysis of pre-liberalization and post-liberalization periods have been made by using incumbent operator (TCDD-T) data only.

Lastly, the since there is a lack of detailed data regarding with the logistic villages and their connection to the existing stations, it was not impossible to analysed the performance of the logistic villages in terms of their location, capacity etc.

1.4 Thesis Structure

The structure of this study is made of seven chapters as follows: following the introduction in this chaper, Chapter 2 mainly presents the background required to study railway reforms by providing examples from the EU countries. Chapter 3 describes the characteristics of Turkish rail freight sector prior to deregulation, and chapter 4 proposes methodology for analyzing the dynamics of railway freight transport. Chapter 5 consists of three main parts. The first part analyses the pre-reform period between 2011-2014 in detail. The second part mainly focus on the

transition period between 2015-2016. The last part concentrates on the comparative analysis and provides general overview for the pre-liberalization (2011-2016) dynamics. Chapter 6 includes the analysis of the early post-liberalization period (2017-2018), and forecast study for the seven-years period (2017-2025) after the railway reform has been put in practice. In the same Chapter, the impact of the railway reforms on the intermodal transportation is analyzed. Chapter 7 provides general overview of the thesis study, conclusion based on the findings of analyses and recommendations for future studies.

CHAPTER 2

RAILWAY LIBERALIZATION

To understand possible future impact of the railway liberalization in Turkey, it is important to review the concept itself as well as observed impacts in other countries, where it has been in use already. In this chapter, first, railway reform process towards railway liberalization is introduced and followed by brief summary of historical evolution in the world. Critical concepts such as reform, liberalization, privization, deregulation are introduced to show the similarities as well as differences between them clearly. In the second half, literature on the railway liberalization is summarized focusing on discussion about pre-liberalization and post-liberalization experiences, to shed light for the upcoming sections on similar discussion for Turkish case.

2.1 The Need for Reforms in Railways Sector

In today's world, the so-called mixed economic system is employed by the most of the modern economies. In this system, the roles of private and public sectors are highly significant in terms of the economic activities of countries. Liberalization, privatization, nationalization and other relevant subjects are the themes that have considerably been discussed and have been accompanied by the change of ideas in the course of time (Bergotto, 2016).

The national railway markets have acted as closed monopolies for a great number of decades. The public corporations that served those monopolies were incapable of meeting the market demands in a satisfactory way. That is why thriving freight markets could not witness the growth of rail freight sector whose market position could not be maintained within the passenger market, either. As a result, the share of railways within passenger and freight transport markets decreased. An assessment

aiming to analyze the opening of rail freight market in an economic perspective is required to address the results of liberalization of that market and the economy altogether (Eisenkopf, 2006).

In 1980s, the political pressure on the developed countries to deregulate, privatize and open their rail market to competition has started. The deregulation operations have received intellectual aid via the contestable markets. In order to make their national railway companies more efficient, a lot of countries in Europe resorted to a great variety of reforming activities including formation of independent regulatory bodies, provision of network access to third parties and separation of infrastructure and operation. Meanwhile, the developing countries and those in transition were promoted by the World Bank to liberalize their national rail transport systems. The following were the main targets: financially sustainable rail sector, lower-carbon and greener economies and growing share of rail transport sector through shift of traffic volumes from roads to railways. (Togan, 2016)

The European railway reforms which were presented in the beginning of 1990s aimed to achieve the following fundamental targets: (i) using the capacity of infrastructure more efficiently, (ii) growing competition, (iii) integrating the international rail freight services in a more considerable and better way, (iv) assisting the progress of a single rail space in Europe and (v) increasing the share of railways within other transport modes. The Directives which were published in 1991, 1995 and 1996 started the reforms and they were followed by the four Railway Packages (2001, 2004, 2007 and 2016). The proposal for the fourth Railway Package was accepted by the Commission in January 2013. Upon acceptance of this Railway Package, the rail transport services in the EU will completely be liberalized (Togan, 2016). The technical and market pillars of the package have adopted by the European Parliament and the Council respectively in April 2016 and December 2016 (Commission, 2016).

2.2 Overview of Railway Reform Experience in the World

Within the scope of this section, railway reforms of the Non-EU countries will be focused on and particularly the railway reform process of the North American countries (USA, Canada and Mexico) as well as Russia and Japan will be briefly reviewed.

2.2.1 Railway Reforms in North America (USA, Canada and Mexico)

In the USA, with the enactment of Staggers Act in 1981, the restrictions on railways has been abolished and government intervention in rail freight tariffs and services has been greatly reduced. Railways in the USA have been liberalized to set tariffs, provided that they will subject to restrictions on market power abuse. The contract tariffs, in which railway operator companies and customers discuss the multi-year tariffs, volume commitments, investments for equipment and facility, are started to be used widely. Railway operator mergers have been kept under strict rules. However, most of the merger practices have been generally approved under conditions that require competitive access to certain markets. There are seven Class I rail freight lines in the USA. Two major western rail freight companies (UP and BNSF) have paired up with two major eastern rail freight companies (CSX and NS) on multiple railway connections. In addition, these companies have intersected with Canadian rail freight companies on common section of the line. The developments that took place between 1980 and 2008 have been very positive. The most unexpected consequence of abolition of the restrictions on railways is the fact that the tariffs have fallen more than 50% in real terms. The reason behind this fall was mainly due to the large increases in both labour and investment efficiency, and the abolition of restrictions on trucking, which has led to the stricter competition between trucking and rail freight transport.

After the liberalization of railways, railway labour productivity has increased 5.4 times, freight wagon efficiency has increased 2.3 times, and locomotive efficiency

has increased 2.2 times. In addition, railway freight traffic has increased by 93%, while its market share has risen from 37% to 43% (Reforming railways, 2011). After 2008, capacity problems started to emerge in the USA railway companies. Accordingly, “Preliminary National Rail Plan (PNRP)” of the Federal Railway Administration (FRA) and “Strategic Plan for Fiscal Years 2010–2015” of the United States Department of Transportation have been published. (https://railroads.dot.gov/rail-network-development/planning/national-rail-plan)With this strategic plan, it has aimed to improve the land use of railways, to reduce traffic density and energy use and to increase safety.

Similar developments have occurred in the Canadian railway sector with the privatization of the Canadian National Railway (CN) in 1996. Canada has two rail freight carriers: Canadian National (CN), a state-owned company, and Canadian Pacific (CP), a private company. Since CN had to operate in remote and less profitable areas of Canada, it was remained as a low-efficiency company. CN was fallen a bit behind of CP in efficiency and traffic growth until the privatization. In 1996, the Canadian government has sold CN shares with a successful public offering. Since the privatization, CN has outperformed CP in terms of profitability and efficiency, and is now regarded as one of the best managed railways in North America. After the implementation of the North American Free Trade Agreement (NAFTA), rail networks of the USA and Canada have been completely combined (Canadian Railways, 2018).

Ferrocarriles Nacionales de México (FNM) was struggling with the poor efficiency, decreased freight volumes and fiscal deficits back in 1980s. In order to overcome these problems, Mexican government have made several attempts to restructure the vertically-integrated FNM but these attempts have been failed. After this unsuccessful restructuring process, the Mexican government decided to open Mexican railway sector to the private railway operators. In this direction, three major concessions, which were designed in order to increase competition among private railway operators, have been granted between 1996 and 1999. Concessionaires have started to operate on different regions under 30-year exclusive operating rights. As a

result of the Mexican railway reform, the rail freight tariffs have been decreased and the efficiency of the railways have been increased. Beside these positive changes, private railway operators' access to the railway network in a competitive environment have been challenging. Therefore, the Mexican government has decided to establish a Railway Regulator Authority in 2016 to regulate network access rights and tariff issues in a competitive market. Since it is a new organization, its effect on the Mexican railway sector will be found out in the upcoming years.

2.2.2 Railway Reforms in Russia

Russia has followed a slightly different strategy for railway reforms comparing to other countries. The national railway has been transformed into a state-owned enterprise (RZD), which is not a very unusual step in railway reform. However, in the last decade, the Russian railways has been subjected to a different vertical separation comparing to other countries. For instance; monopoly network services do not only cover maintenance of railway lines, dispatching of trains and managing the traffic but also includes locomotives and their drivers. At the same time, both public and private sector have started to purchase and operate rolling stock, and serve the customers directly. This extraordinary vertical separation was accompanied by the emergence of several RZD affiliated railway operators (both in passenger and freight services), and many private companies that operate passenger and freight trains. The Russian railway reforms are not completed yet. The Russian Government has plans to undertake more comprehensive reforms such as allowing operators to own and operate their own locomotives, allowing private sector to operate some short sections of the national rail network, and allowing some operators to have their own loco drivers and locomotives to carry out transportation business on the national rail network. In fact, this is already happening to a limited extent. Tariff reforms have attracted private capital to rolling stock investments, therefore more reforms are planned for the tariffs. This section presents a brief history of railway reforms in Russia and discusses reforms that are still in the planning phase. In Russia, rail

freight has dominated the most of the railway sector, therefore the reforms are mostly concentrated on the freight transportation field.

It is highly likely that the strong economic condition of RZD and Russia will support the liberalization of the Russian railway market, and private sector's investment in rolling stock, for the upcoming years. The reforms made so far have attracted many private companies into the railway sector, and nowadays a significant part of the Russian freight wagon fleet is financed and operated by the private sector. It is likely that these trends will continue and the private locomotive fleet will increase substantially, over the next few years. At this stage, it is difficult to estimate how quickly private leasing companies and rail transport companies will expand.

2.2.3 Railway Reforms in Japan

After the World War II, in 1949, the Japanese National Railways (JNR) started to operate as a "public institution" and hold the dominant share of the domestic transportation market for many years. However, JNR's domestic transportation market share has decreased sharply by approximately 30% between 1960-1987 due to the development of road transport after 1960s (Reforming Railways, 2011). As part of the Japanese railway reforms launched in 1987, JNR has officially been bankrupted, and divided into six rail passenger and one rail freight companies. Since many freight movements have carried out over long distances, rail freight was established as a single company nationwide and it was also decided to separate freight train operations from infrastructure management. Since many freight movements are carried out over long distances, freight rail transportation has been established as a single company nationwide and it has also been decided to separate freight train operations from infrastructure management. Within the framework of this structure, freight trains are operated on passenger rail infrastructure by paying track usage fees to passenger rail companies, which were established to cover additional costs of freight operations. These seven new companies have been established under private laws (including the JNR Reform Law and JR Law) as

private public companies with the JNR investment (100%). Each company has started to operate with predetermined assets, was responsible for predetermined obligations and recruited a certain number of employees from JNR.

As a result of JNR's separation into small-scale companies, customers were able to compare between these new companies and major private railway companies, which has naturally created a sense of competition in Japanese railway sector. In addition, the elimination of foreign intervention has been a key feature of JNR reforms, especially through the reduced government intervention and the expansion of business areas to carry out various and flexible business activities. Japan Railways (East), which is one of the seven companies established after the reforms, has become the most successful company after the reforms (Reforming Railways, 2011).

Within the scope of this section, railway reforms of the Non-EU countries will be focused on and particularly the railway reform process of the North American countries (USA, Canada and Mexico) as well as Russia and Japan will be briefly reviewed.

2.3 A Detailed Review of Railway Reforms in Europe

Focusing on the realization of the Single European Railway Area (SERA) goal, the progress of the common EU rail legislation, which is the main pillar of the SERA, can be summarized in three basic steps. Firstly, separation of railway infrastructure management and train operations (freight, passenger and rolling stock maintenance); secondly, marketization and liberalization of rail services; and thirdly, building an integrated railway system aiming to the SERA. The main objective of EU railway reforms is to build customer-oriented, cost-effective and energy-efficient SERA by promoting greater competition among the railway sector. It is proved that railways were not in favor of liberalization at the early stages of reform process comparing to other transport modes. The first significant step towards SERA was the Directive 91/440/EEC, which had little impact on the railway sector in the first place, as it can

be seen from the limited number of new railway service providers entered into the market. However, the introduction of four regulatory railway packages (2001, 2004, 2007 and 2016) have intended to accelerate the reform process and facilitate market development by combining and updating former EC Directives (UNECE, 2018).

The first railway package, highlights that both infrastructure management and train operation are required to have separate accounts of profit and loss as well as individual balance sheets. The package also does not permit the transfer of state funds between the infrastructure manager and the railway operator. The objective of such separation is to allow for competition in market by providing new operators access to railway network which is controlled independently by infrastructure manager. In order to support such separation, the rules for allocation of time slots and infrastructure usage fees for different railway undertakings were established under the supervision of independent regulation. The previous state monopolists which were performing service in a neighboring EU member state were also included in the new operators (e.g. Rail Cargo Bulgaria). The national supervisory authorities (NSA) were established as a new regulatory board for railway sectors. The field of activity of those NSAs were then restricted by new European Railway Agency (ERA) which was founded under the second railway package in 2004. The ERA is entrusted with a task to establish a competitive and single railway area in Europe through improving the interoperability of national rail systems by ensuring that the technical standards are reciprocally recognized and harmonized. In addition, the ERA ensures that the necessary level of safety is achieved in terms of technical and working standards. Moreover, the ERA is charged with drawing up the Technical Standards on Interoperability for the entire railway market within the EU.

The legal proposals for reforming the European railways were collected under the Directive 91/440/EEC dated 29 July 1991, which was the first step for establishing the SERA. This Directive necessitated separation of the state railway monopolies that were vertically integrated in the Member States. Moreover, the Directive has made possible for railway companies of all Member States to perform passenger and freight operation on the rail infrastructure of any Member States. A White Paper

regarding the future of European transportation was published by EC in 2001. The revival of poor transport sector was intended by requiring clearer separation between infrastructure and operations in order to ensure extended access rights as well as fair and transparent infrastructure usage fees. The program has targeted to fully liberalize the border-crossing freight operations till 2007 and domestic passenger operations till 2012. Further market opening and establishment of the SERA were aimed within the scope of first railway package in 2001, which was the second step. Since the former Directives were not applied satisfactorily, the Commission found it necessary to adopt this railway package which contained three Directives allowing for fair access to infrastructure. These Directives included 2001/12/EC to develop the railways in Europe, 2001/13/EC to regulate railway licensing, and 2001/14/EC to regulate allocation of capacity, charging of rail infrastructure and certification of safety. An additional Directive 2001/16/EC is made to ensure interoperability of railway systems by application of joint technical specifications.

The second railway package is adopted in April 2004 constituted the third step, which included the principles regarding railway safety and amended the interoperability Directives 96/46/EC and 2001/16/EC. This package is aimed to ensure that the extent of interoperability was expanded across the whole European rail network and a European Railway Agency (ERA) was established. The technical support was assumed to be provided by the ERA for interoperability and safety of the railway sector in Europe.

The fourth step was taken by the adoption of third railway package in 2007. The open access for international transport operations was offered within the scope of this package. Meanwhile, the European Parliament and the Council approved the recast of the first railway package, and it was published at the end of 2012.

As the fifth step, the European Commission proposed a fourth package in January 2013. The technical and market pillars of the package have adopted by the European Parliament and the Council respectively in April 2016 and December 2016. This package contains the following issues: Rolling stock-related standards and their

authorization; independent management of rail infrastructure; assurance of labour force qualifications; decrease of administrative costs related to approvals of rolling stock; and complete liberalization of domestic passenger transportation till December 2019. This package also grants the ERA more authority in terms of administration of European railway systems, in order to provide environment-friendly and cost-efficient railway transport.

In order to provide a more comprehensive understanding and evaluation of the reform works on railway liberalization in the European countries, railway reform experiences of the selected European countries are discussed in the next section.

2.3.1 Experiences in Sweden

The railway reform and liberalization process in Sweden has launched from 1960s in order to convert Swedish railway sector from a state-owned freight and passenger monopoly to a competitive market, which is not centralized and closed. As a public administration, the Swedish State Railways (SJ) was a monopoly for both rail passenger and freight services and it was protected against the competition. In addition to rail transport, SJ has also provided other long-distance passenger services such as bus and ferry. The financial problems experienced by SJ required regulatory modifications within the Swedish rail sector. Since the use of private cars became widespread, the number of passengers has reduced, which caused some rail passenger services to bring in no profit. Nevertheless, political matters made it difficult to shut these services down.

The Transport Policy Act that was adopted in 1963 has divided the SJ's network into two parts, the first part was supported with state subsidies, and the second part was commercialized. The rising of operational costs, political obstacles to price increases and line shutdowns as well as decline of revenue have led to financial troubles for SJ throughout the 1970s. The Transport Policy Act that was issued in 1979 has targeted to regulate fees between the competitive transport modes in order to bear

the marginal social and infrastructure costs. The growing liability for the infrastructure investments was undertaken by the state. In accordance with this, SJ has become responsible from the following: Separating the accounts of infrastructure from the other business activities (e.g. passenger and freight services), and paying network access charges. The regulatory modifications did not turn out to be sufficient for the economic viability of SJ, hence a new Transport Policy was adopted in 1988.

The Transport Policy Act that was issued in 1988 has divided infrastructure from the operations. As a new administrative authority, Banverket (Swedish Rail Administration) was established. Banverket was completely liable for investments and maintenance of infrastructure. At the same time, SJ (Statens Järnvägar) has become a railway operator company which was responsible for bearing the network access fees on the basis of marginal maintenance costs. The responsibilities of SJ were expanded by the County Public Transport Authorities (CPTA) in a way to cover the non-profit regional rail services. In addition, the state subsidies that amounted to the operating deficits had been provided to SJ, which operated on the Banverket network. Moreover, the transfer of rolling stock to CPTA has realized. The fact that infrastructure was vertically separated from operations and the responsibility of regional rail services was spread to CPTAs have made it possible to procure via competitive tendering.

During the 1990s, Swedish Government has aimed to ensure that railways would be opened to more competition. Accordingly, the first action was to ensure that tendering would be lodged for rail traffic more frequently. In 1992, after the lodging of a tender for regional services, it has allowed to implement competitive tendering for inter-regional services too, via a regulatory change. In the same framework, the responsibilities of SJ related to control of train traffic and allocation of track capacity have transferred to Banverket in 1996. Furthermore, other train operators were allowed to benefit from common facilities under equal conditions. Open access was provided for the whole railway network for freight transport services. The Transport Policy Act that was issued in 1998 has reduced the track access fees with the purpose of providing more equal conditions for competitive transport modes. Rikstrafiken, a

new administrative authority liable for competitive rendering of public transport services that were provided inter-regionally without bringing profits, has established in 1999 within the scope of this Act.

After the adoption of the Transport Policy Act in 2000, the organizational structure of SJ has been transformed from a single-business management to several public companies, which are engaged in specific segments of railway business such as Green Cargo (freight services), SJ (passenger services), EuroMaint and SweMaint (rolling stock maintenance services). Some reforms with respect to modernization of regulatory framework have been made in order to achieve compliance with the EU Directives. With the adoption of a new Railway Regulation and Law in 2004 public railway infrastructure access has been adjusted and a new regulatory entity (Swedish Rail Agency) has been established. In 2009, this Agency has incorporated into Swedish Transport Agency (Transportstyrelsen), which is liable for drawing up regulations of road, air, sea and rail transports in Sweden. In 2010, full liberalization of domestic passenger rail services and removal of the remaining SJ rights has been realized. Furthermore, Swedish Transport Administration (Trafikverket), which is responsible for long term planning of the transport system for all types of traffic, as well as for building, operating and maintaining public roads and railways, has been established with the merger of Banverket (Swedish Rail Administration) and Vagverket (Swedish Road Administration).

As seen in Figure 2.1, Sweden, which launched the railway reform process in the first place, has successfully carried on liberalization process that began after 1988. Particularly after 1990, with the beginning of market competition, a significant increase has observed in passenger transport.

Between 1988 and 2008, especially the high demand for regional services has been influential on the increase of passenger transport (passenger-kilometer) on the average of 65% while the freight volume (ton-kilometer) grew by 24%. Approximately 4% increase has been observed in passenger transport after 2008. The rail passenger-km, which was 6.1% in 1988, has risen up to 8.4% in 2012 (from 3%

to 6% for short-distance and from 15% to 16% for long-distance). However, share of rail freight has reduced from 25% to 23% (Alexandersson & Hultén, 2011).

Despite some adversities, after the liberalization of the Swedish railways, especially the rail passenger traffic has showed a continuous increase. For example, the number of passenger/km, which was recorded as 6.132 in 2012, has increased to 6.396 in 2019, and this can be considered as a significant increase in a short period of 7 years (UIC, 2020).

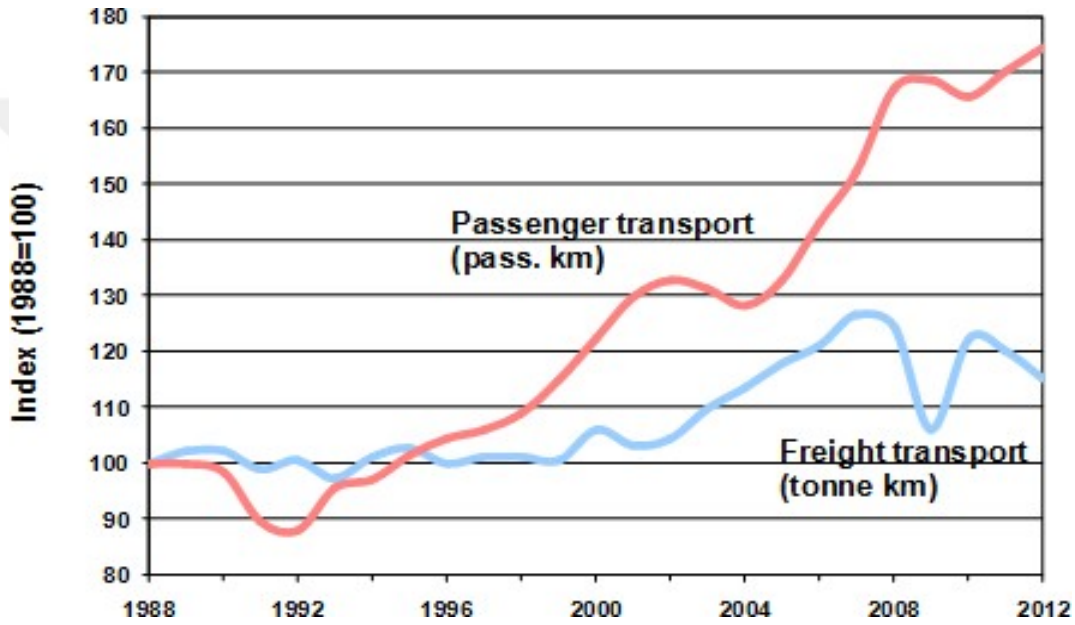

Figure 2.1. Sweden Rail Development 1988-2012 (Alexandersson & Hultén, 2011)

2.3.2 Experiences in United Kingdom

The British Railways has experienced a fundamental change between 1994 and 1997, with the separation of operations from infrastructure as well as the privatization of passenger services and freight operations by franchising and outright sale respectively. The reforms that were made from 1994 to 1997 and the accompanying deregulations in the succeeding years constitute the most drastic restructuring pattern in any rail system of Europe.

Railtrack, which was established as a new state-owned company back in 1994 has separated fixed assets of railway infrastructure including tracks, stations, tunnels, bridges, maintenance-repair facilities, level crossings etc. from the British Rail (BR) prior to privatization process. Nevertheless, Railtrack has been sold in 1996 via public offering. On the other hand, after the transfer of railway infrastructure to the Railtrack, track maintenance and renewal services of the BR, has been sold to 13 companies (7 maintenance and 6 renewal) across the rail network. In addition, BR's passenger trains have been transferred into three Rolling Stock Operating Companies (ROSCOs) in order to lease them to the Train Operating Companies (TOCs). Moreover, BR's freight trains have been passed into the six Freight Operating Companies (FOCs), which are sold to the EWS (which is bought by DB in 2007 and rebranded as DB Cargo UK in 2016) and Freightliner later. British government has targeted to introduce competition as much as possible in railway passenger franchises, railway freight operations, track renewal and maintenance as well as provision and maintenance-repair of rolling stock. While it was possible to grant monopolies franchise of rail passenger services for a specified time period, only the supply and operation of infrastructure has considered as a natural monopoly.

In order to regulate and supervise the aforementioned railway passenger franchises as well as the British railway sector, two regulatory entities (ORR and OPRAF) have been established. The Office of Rail Regulator (ORR) has established in 1993 as the independent regulator based on single-person model, then it was replaced with nine-member board called the Office of Rail Regulation (ORR) in 2004 and finally improved as the Office of Rail and Road (ORR) in 2015. The current responsibilities of the ORR are the economic and safety regulation of the British railway sector and economic monitoring of the British highways. Furthermore, the Office of Passenger Rail Franchising (OPRAF) has established in 1993. OPRAF was liable for granting of railway passenger franchises, regulation of fares, payment of subsidies and supervision of the Train Operating Companies (TOCs), who acquire franchises. Upon the expansion of OPRAF in a way to assume the duty of ensuring strategic development of the British railway sector, its name changed as the Strategic Rail

Authority (SRA) in 2001. On the other hand, SRA has abolished in 2006 and its functions have been shared between the Department for Transport and the ORR. Furthermore, the Health and Safety Executive (HSE) of the British government was responsible for railway safety between 1990 and 2006, but with the transfer of Railway Inspectorate to the ORR, which is responsible for the safety regulation of railways, HSE's function has over.

Franchising has been selected as the privatization model of the British Rail passenger operations and hence there was not any requirement to regulate the TOCs within the traditional context. Instead, Franchise Agreements and Plans between the OPRAF and the TOCs were used for formalizing the regulatory relations between the private train operators and the government. Due to the anticipation that adequate competition would preserve the freight users' rights, privatization of freight sector has been realized within the framework of open access model. With the purpose of separating the responsibility of making economic regulations from the liability for establishing the services and therefore levels of subsidies, the double structure of regulatory bodies, e.g. OPRAF and ORR, was chosen. On the other hand, this double structure has evolved into today's model by time as mentioned above (OPRAF was closed and hence its functions were transferred to other public authorities, and the ORR's scope of authority has been expanded).

In an effort to create competition and deliver suitable incentives in the British railway industry, the BR restructuring process has cautiously planned. Nevertheless, the concerns related to well-integrated operation of the heavily-fragmented sector have caused by the complex structure of the industry and related contractual arrangements. These concerns have openly expressed, particularly, when the system capacity has been forced by the traffic growth and the role of railways has been desired to be highly increased by the new government.

The incentive attributes of fees are quite significant for the train operators and open access. At the beginning, a considerable fixed factor, and a variable factor that is determined only by wear-and-tear costs but made distinct in order to represent the

comparative loss assumed by different rolling stock types, have constituted the infrastructure access fees for passenger franchisees. Nevertheless, this structure has caused several problems. For instance, although it has provided considerable incentive for TOCs to enhance their services even if there is scarcity of capacity, it has not granted any incentive to Railtrack for the extension of its capacity. Consequently, Railtrack has provided, in the periodic review of 2000, an incentive payment on the basis of traffic volume and congestion charge. Since then, a definite scarcity charge to distribute the capacity as rations has been considered but it has not accepted due to its complexity. Figure 2.2 shows a rapid increase in the passenger traffic for the post-privatization period. Although the significant reasons behind such an increase have been associated with economic development, traffic congestion on the roads and increasing fuel costs, there is still one undetermined factor that need to be considered along with its results, which is the privatization.

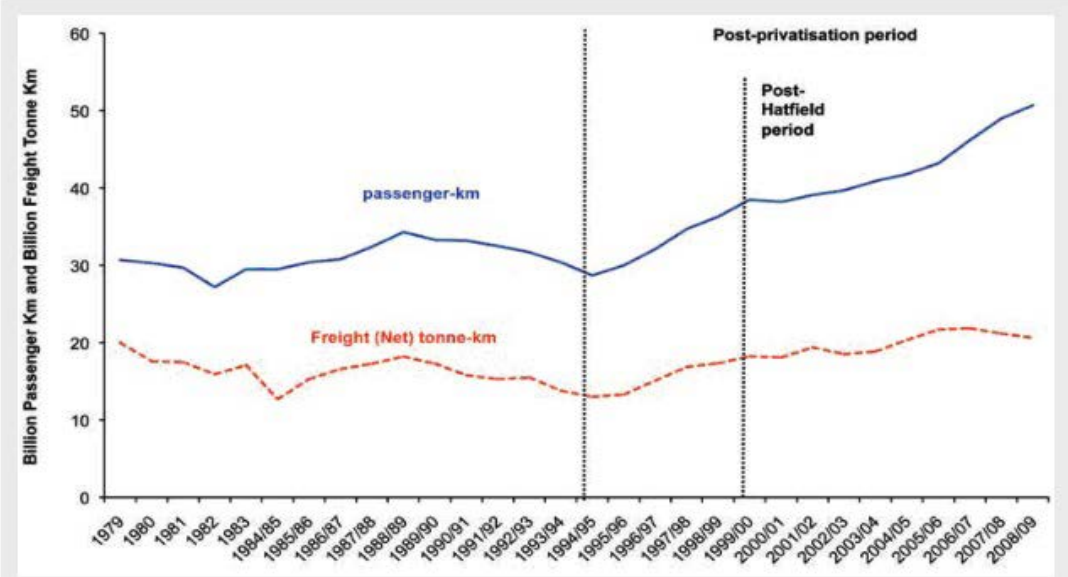

Figure 2.2. Freight and Passenger Volume between 1979 and 2009 (Nash & Smith, Britain, 2011)

It is required to be considered that the quality improvements via brand new rolling stock have been related with the increase in the railway costs of Britain. The average

age of rolling stock, which was 20 years in the time period of 2002-2003, reduced to 13 years in 2005-2006.

Despite the early positive effects of privatization on the TOCs, such as decline of costs and increase of traffic, the costs of TOCs has started to increase again due to the great rise of infrastructure costs. Although the motives behind such a rise could not be comprehended completely, the associated factors may include the actions of the Strategic Rail Authority to subject TOCs to cost-plus contracts, and considerable renewal of rolling stock as well as external factors like increase in the fuel costs.

The competition on the track, where the TOCs with open access have newly entered and the franchisees have coincided with one another, has been limited. The franchisees' on-track competition has usually been in the following way: The operator of a slower service has proposed lower fares while the new entrants compared to the franchisees have always proposed lower fares. Since the railway reforms in Britain have led to not only vertical separation of infrastructure and operations and opening-up of the market to competition but also full privatization of operations and infrastructure, they are more drastic compared to the ones in any European country.

Privatization of infrastructure proved to be evidently unsuccessful. A heavy crisis regarding performance and costs emerged, which was followed by the bankruptcy of Railtrack in 2002. After suffering major financial difficulty, most of the Railtrack's operations have been transferred to the state-owned non-profit infrastructure managing company Network Rail. It is not obvious whether more strict arrangements and more efficient management might have avoided such a failure. Despite the existence of problems between infrastructure manager and train operators, there is no ground to consider these problems as the reason for this failure and also consider this failure to be the result of vertical separation.

The Independent / BMG has made a survey in order to determine whether public think privatization of the BR is successful or not. It is concluded that, six out of ten

respondents think that privatization of the BR is unsuccessful (BMG Research Poll, 2020).

There are several causes behind the citizen's perception that privatization of the BR has been failure. For instance, financial collapse of Inter-City East Coast railway operator, failure to complete big infrastructure projects on time by the Network Rail railway budget problems (IRJ Journal, 2020). As a result of this negative perception, the idea of renationalizing the British railways and abandoning the EU Laws and Regulations, which caused a failure in privatization of the BR, has been supported by majority of the public. According to Anti-EU transportation unions, almost two-thirds of the public has perceived rail transport as a state-owned non-profit public service. Anti-EU transportation unions have also argued that, the EU's Fourth Railway Package have been designed to experience mistakes made in the rest of the EU in terms of railway sector, and railway privatization in the UK was laboratory experiment of the EU. Furthermore, these unions have also stated that thanks to the EU Laws and Regulations, British passengers are paying the highest fares in Europe (EU Seals mass rail privatisation, 2020).

As a result of the financial collapse and service interruption of the East Coast train line for the third time in row, it has been announced that passenger rail franchise of the related TOCs will be ended and the line will be put back under state control in 2018. This incident has intensified the call for the renationalization of the British railways, which found a strong public support in the 2017 National Election. At this stage, reunification of the British railways has needed to be negotiated with the EU because it means that the UK will abandon the EU's competitive market policies. Nevertheless, it is emphasized by the studies that majority of the railway sector in the UK should be renationalized (The Conversation, 2020).

2.3.3 Experiences in Germany

German railway sector has been fundamentally reformed and in this direction third parties have been gradually provided with open access to the national railway network. Although reunification of Germany realized on 3 October 1990, it took four more years to reunite German Railways due to administrative and operational problems. The public railway carrier of the West Germany 'Deutsche Bundesbahn' and the public railway undertaking of East Germany 'Deutsche Reichsbahn' have merged under the newly established public enterprise of Federal Republic of Germany 'Deutsche Bahn AG' with the 'Bahnreform' railway reform, which came into effect on 1 January 1994. The Deutsche Bahn AG (DB AG) has formed as a joint stock company with the option of privatization in accordance with the German Constitution. Meanwhile, competition has introduced in German railway sector. DB AG is a state-owned holding company, which is subject to a private law (Deutscher Bundestag, Article143a). DB AG is composed of three divisions, which are infrastructure (DB Netze), passenger services (DB Bahn) and logistics (DB Schenker and DB Cargo), all of which are semi-autonomous. In addition to DB AG, which has assumed the responsibilities of the former East Germany and West Germany railways for infrastructure and train operations, the Eisenbahn-Bundesamt (EBA, Federal Railway Authority), an independent federal authority for the regulation of the railways, has been established in order to audit and license the majority of rolling stock and railway infrastructure companies in Germany. Furthermore, the Bundeseisenbahnvermögen (BEV, Federal Railway Assets), which is a special fund subject to public law, has been established in order to handle the health insurances and pensions of all former federal railway employees as well as the united legacy debts and non-required railway assets. The local and regional rail passenger services have been transformed throughout the 1996. In this regard, liability of organizing and financing the regional transport has been passed from federal to state level. The regional passenger market and open accessed rail freight sector have been provided via tendering, public procurement and franchising. Except few exceptions, long

distance passenger services have been under the monopoly of DB AG up to date. Pursuant to Directive 91/44/EEC, which has been integrated into the German Law, all German railway undertakings as well as those from the EU members were granted open access to the network in a non-discriminatory and unrestricted way. As a result of the German railway reform, which might be also seen from the Figure 2.3, transport volumes have risen by 58% in freight operations and 36% in passenger services (deutschebahn outline, 2019).

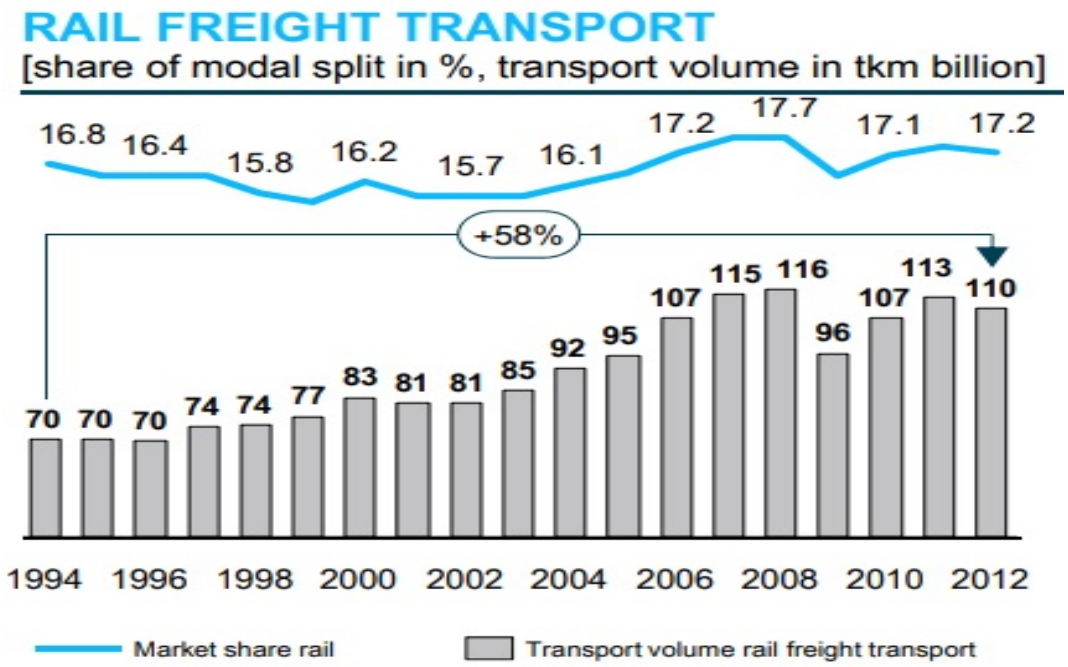

Figure 2.3. The Development of Rail Freight Volume Following German Railway Reforms (UNECE, 2018)

Furthermore, German railway reform has brought great relief to the government budget, by reducing the annual budget need almost 4 billion Euros. The relief from this burden on the government budget has contributed to both the economy of the country and other areas in the transport sector, by allowing more budgetary allocations, which in return has given rise to positive thinking towards the reform. Due to the positive developments seen after the reform, there have been significant

progress in the development and renewal of railway network. The infrastructure projects are given importance in terms of ensuring the connection of the railway network to different parts of the country and to other countries and regions.

2.3.4 Experiences in France

As is required by the Directive 91/440, rail operations and rail infrastructure in France have been separated from each other with the enacting of the Act 97-135 on 13 February 1997. As a result of the Act, state-owned entity Réseau Ferré de France - French Rail Network (RFF) has been established as the new rail infrastructure manager. In this regard, French rail network has been owned and maintained by RFF whereas SNCF has become the new national railway operator. On the other hand, the ownership of all train stations in France has continued to be kept by SNCF via its division 'Gares & Connexions'. Moreover, the SNCF Infra has performed maintenance of tracks and other infrastructure facilities, signaling and rail traffic control on behalf of the RFF. On January 2015, the RFF, renamed as SNCF Réseau, has become the part of SNCF Holding, as a result of the financial debts and the failure of transferring all infrastructure services and facilities from the SNCF to the RFF. As of 2015, the SNCF consists of three main divisions, which are infrastructure (SNCF Réseau), transport (SNCF Mobilités) and stations (SNCF Immobilier).

The trend in freight volumes transported by rail in tonne-kilometre in France is worrisome. Since 2000, it has steadily declined, with the exception of an uptick between 2006 and 2007. With a drop of more than 44% in nine years, it has lost more traffic than any other transport modes (see Figure 2.4) in France. In 1996 the year before rail reform, 50 billion tonne-km of freight was transported by rail. In comparison to this, only 43 billion tonne-km of freight in 2007 and 32 billion tonne-km of freight in 2009 were transported by rail under the heavy impact of the economic crisis, which shows declines of 15% and 36% respectively.

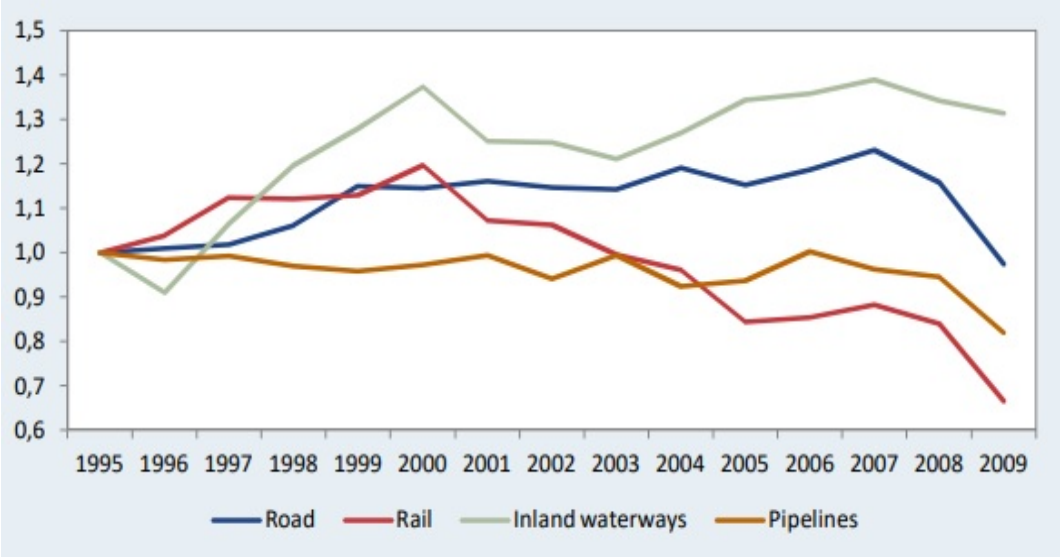

Figure 2.4. Freight Transport Trends in France (index based on tonne-km, 1995 = 100)(CER, 2011)

French railway reform has created a unique system of sharing tasks between the newly established infrastructure manager (RFF) and the railway operator (SNCF). The way tasks are shared has raised doubt upon whether there is a real separation between the two functions as required by the EU Directive, given the fact that both are largely carried out by SNCF, as is mentioned above. With respect to freight sector, on the other hand, competition has been developed rapidly since 2007, which is driven by the Euro Cargo Rail (subsidiary of Deutsche Bahn) and the Europorte France (subsidiary of Getlink). Despite an overall decrease has been observed in French rail freight traffic, the volume of goods transported by the new entrants (private rail freight operators) is rising every year. In 2010, their market share has been shifted between 16% and 24%, depending on the measurement is used. At the financial level, the French railway reform has enabled the incumbent operators to significantly reduce their debts and improve their outcomes. The SNCF Group has established a leading rail operator that is to be reckoned with in Europe, through an acquisition strategy (in the freight market) and partnerships (in the international passenger transport sector). On the other hand, the SNCF freight division (SNCF Logistics – FRET SNCF) still struggles to earn a profit, and it has only brought profit of 117 million Euros in 2018 (SNCF Mobilities Group Report, 2018). For the French

rail sector overall, the reorganization has resulted in higher debt and ever-increasing subsidies (Deville & Verduyn, 2012).

Due to the aforementioned problems in French railway system, a new railway reform law has come into effect on 28 June 2018 in order to change the organizational structure of France's national railway company "SNCF". After the adoption of this Law, SNCF, under a fully integrated group structure with its own subsidiaries, has become a public limited company wholly owned by the State similar to Deutsche Bahn AG. As of today; passenger, freight and infrastructure divisions are reorganized under the SNCF Group. In addition, French state will facilitate this reorganization by giving financial support to SNCF for its 55 billion Euros debt. Moreover, it is expected that, SNCF's monopoly on French rail passenger transport will be end in the near future due to EU requirements set in the Fourth Railway Package (DB Cargo, 2020).

2.3.5 Experiences in Italy

Similar to other European countries, Italy has been extremely diligent and has tried to apply the EU regulations and directives in the best possible way. Nevertheless, the implementation of these policies has been quite slow. Even though these delays have been witnessed in the most of the other EU Member States, these countries have been able to quickly implement the policies and, in some cases, have already completed their railway liberalization process. The Italian railway liberalization case is a clear demonstration that European policies faced with many difficulties during their implementation process, as a result of national oppositions. Indeed, for a country like Italy, where railway transport has always perceived as an essential public service, it is very hard to leave behind the traditional nationalized structure of railways. The Italian Railway Regulator / Ufficio di Regolazione dei Servizi Ferroviari (URFS) has made significant changes by reorganizing the Italian State Railways / Ferrovie dello Stato (FS), which was, and still is, the principal public train operator in Italy, having the monopoly of infrastructure access and rail services (Cambini & Perrotti, 2015).

In fact, Italy has chosen a model of vertical legal separation between the infrastructure manager and the rail transport service provider, which are both under the same state-owned holding company FS. In this regard, Trenitalia has established as a railway operator in 2000 and Rete Ferroviaria Italiana (RFI) has established as infrastructure manager in 2001. However, the reorganization of the FS has not put in discussion the monopolistic nature of the market and the public presence in the sector. For that reason, it has not led to a genuine liberalization.

The implementation of the EU Directives on the Italian railway industry and thus its effects on the traffic volumes of the Italian freight and passenger transport has been quite modest. Italy is substantially below the performances of other EU Member States in terms of railway liberalization. The implementation and adoption of the three Railway Packages have not rendered in an effective railway liberalization and have not created a truly competitive environment. The privatization of Ferrovie dello Stato has been only formal, since it is still controlled by the state.

Italy has failed to accomplish the main objective present in the First Package by being unsuccessful to establish a concrete independence between RFI and Trenitalia. In fact, from an organizational and decisional point of view, it is seen that there is only a mere corporate distinction without effective independence between RFI and Trenitalia. FS, which is renamed as the Ferrovie dello Stato Italiane S.p.A., is still keeping its dominance over the Italian railway sector. RFI manages the national rail network in a monopoly position while Trenitalia serves as the main national railway company holding monopoly powers in each of the different passenger rail transport services. In 2016, Mercitalia a new freight transport and logistic services provider has been established as a subsidiary of FS. The freight divisions of Trenitalia have been merged into Mercitalia in January 2016. With the exception of some new entrants into the Italian freight transport market and the Italian high-speed passenger transport sector, the Italian railway industry is still vastly unaffected by significant competition developments. In addition, the recourse to competitive tendering to allocate the railway services under Private Service Operator (PSO) is very limited (Bergotto , 2016).

Even though the Italian railway sector is still characterized by high barriers of technical and economic nature, the establishment of the Transport Regulation Authority / Autorità di Regolazione dei Trasporti (ART) in 2011 has represented a significant progress for the railway liberalization in substantial and effective terms. It will provide an important contribution to the completion of the Italian transport regulation system and to the improvement of competition in the transport sector (Bergotto, 2016). However, the protracted delay of its establishment and the significant control of the public sector in the industry, are all elements that reveal the difficulty for the Italian State to give up its control in the sector and abandon the traditional model.

The competition in Italian railway system has started with the entrance of privately owned NTV Italo into the Italian high-speed rail network. NTV Italo has become the first PSO entering into the Italian railway market as a result of the Italian railway liberalization process. NTV Italo has begun to compete against state-owned passenger train operator Trenitalia on the Italian high-speed network. As a result of the competition between NTV Italo and Trenitalia the rail market share has increased up to 80% whereas rail ticket prices has decreased by 40%. This competitive market has also affected the airline sector. With the introduction of discounted ticket prices, short travel times and comfortable journey experience, high-speed train transport has become a true alternative against the air transport. This worthy alternative has led customers to choose high-speed trains instead of airplanes for the Europe's busiest route from Milan to Rome. As a result of this change, low-cost air carriers have started to reduce or cancel their flight routes between Milan and Rome (Morgo, 2018).

With the competitive environment emerged in Italian passenger transport market as a result of the private HST services provided by NTV Italo, Italy has become a great example to show all the benefits of railway liberalization process. This example has also proved that utilization of new technologies and innovative systems are substantial for railway undertakings to compete against air carries.

2.3.6 Literature on Railway Liberalization Studies

Some studies argued the benefits of the vertical separation and marketization on the high fixed costs, high intermodal competition and productivity in detail. Other studies focus on the impact of open access competition on modal share of railways. The Asmild et al. (2009), Fribel et al. (2010), Cantos Sanchez et al. (2012), and Bougna and Crozet (2016) claim that railway reforms generally increase efficiency. In addition, Sanchez (2001), Cantos Sanchez et al. (2010), and Van de Velde et al. (2012) mainly focus on the impact of the horizontal separation and find out that only horizontal separation increases the efficiency. Moreover, Driessen et al. (2006), Fribel et al. (2010), and Cantos Sanchez et al. (2010), reveal that the vertical separation of the railways has positive impact on the railway undertakings.

Cantos et al. (1999) have analyzed the European railways productivity for the period of 1970–1995 by showing the determinants of the efficiency. The autonomy and the financial independence of the separated companies have a great impact on the higher efficiency level. Campos and Cantos (2000) have studied on the advantages and disadvantages of the vertical integration by considering the tariffs, infrastructure planning and traffic. Their study has revealed that three main disadvantages may emerge after the vertical integration of railways as follow: decrease of infrastructure investments by infrastructure owner, loss of the attraction of the new clients and the potential loss on the scope of economy. Sanchez (2001) has revealed a key question on the European railway industry: What is the impact of vertically integrated structure of the European Railway Companies as infrastructure owner and operator? Sanches (2001) has conducted this study by using trans-logarithmic cost function. The results of the study indicate that the cost of the infrastructure and operation highly effected in case of vertical integration of the railway companies. In the same study, it is detected that there is sharp contrast and independence on the railway operational cost of freight and passenger transport. Furthermore, Di piteriona and Pelkman (2004) have examined the main economic aspects of EU railway reform. It is certain that railway reforms will bring competition to railway freight transport

market. The success of railway reforms can only be achieved if policies, prospective investment plans, regulatory reform and appropriate supervision are consistently supported. Similarly, Wetzel and Growitsch (2006) conducted a performance efficiency analysis of European railways by focusing on vertical integration economies. They have tested the hypothesis that integrated railways achieve common production economies and thus provide rail services with higher efficiency. Within the scope of this study, 50 railway companies from 27 European countries were analyzed by utilizing Data Envelopment Analysis methodology for the period between 2000-2004. As a result of the study, it is found out that most European Railway Companies have scope economies. This finding shows that companies reduce their costs by using their strategic advantages. Therefore, this study has revealed the negative effect of vertical separation of railways on productivity. In contrast with this study, Driessen et al. (2006) have experimentally examined the relationship between the competitive design and the productivity in the railway industry. Data Envelopment Analysis was used as a methodology to generate productivity scores and as a result, it is shown that competition had positive contributions to productivity.

Pittman (2007) claims that in very rare cases, the vertical separation of the railway operators from infrastructure managers is sufficient enough to overcome losses from the vertical separation process itself. Thus, the EU argues that vertical separation of railways would be beneficial to reduce costs. Wetzel (2008) has examined the effects of vertical separation of EU railways on technical efficiency. A panel data set of 31 railway companies from 22 European countries was analyzed using the Stochastic Frontier Analysis methodology for the period between 1994-2005. The results indicated the positive and negative productivity effects of different regulatory reforms. Furthermore, the estimation of models with and without regulatory and environmental factors clearly shows that, neglect of environmental factors such as network density greatly changes parameter estimates and thus leads to the biased estimation results. As a result of the study, the impact of railway reforms has not been clearly identified.

Asmild et al. (2009) have discussed the railway operations in 23 European countries, where the railway reform initiatives started by the European Commission between 1995 and 2001, and analyzed whether these reform initiatives increase the efficiency of railway systems or not. The main finding in this research is that all reform initiatives adversely affect the increase in both material and personnel costs by improving the technical efficiency of railway systems.

Drew (2009) has analyzed the benefits of the two main models in terms of bringing competition to mainline rail networks for rail freight customers. Within the scope of the study, the vertical separation of the railway infrastructure and railway operations as well as the initiation of competition that provides open access for private operators to the network were examined. As a result of the study, Drew (2009) concluded that vertical separation would beneficial for rail freight customers as it provides open access to network. Cantos et al. (2010) have examined the impact of railway reforms on productivity, efficiency and technical changes in 16 national railway systems in Europe for the period between 1985–2005. The results of their study have showed that, the railway reforms seem to be beneficial in terms of efficiency and productivity, and in particular, when the vertical separation measures are combined with the entry of new operators to the railway freight sector. Fribel et al. (2010) have estimated the impact of railway reforms on rail efficiency in Europe, using a 20-year panel data set covering some of the EU countries. The analysis, using a production frontier model, found that productivity has increased with railway reforms such as vertical separation of railways. Another fundamental result of this study is that when the railway reforms are implemented in step by step process, more positive results can be obtained. Drew & Nash (2011) have analyzed the descriptive statistics of 25 European countries within the period between 1998-2008 and have found no significant correlation between vertical separation and modal share of rail transport.

Cantos et al. (2012) have estimated productivity from 2001 to 2008, by utilizing a set of data from 23 European national rail systems. Within the scope of this study, the effects of the inadequacies of the reforms have tried to be estimated. In

conclusion, unlike previous studies, it is argued that the best way to increase productivity is by combining vertical and horizontal reforms in the railway industry.

The effect of railway reforms on the freight transportation, which also forms the basis of this study, is discussed in the literature. Velde et al., (2012) have analyzed 26 European countries for the period between 1994-2010 and have not found any significant impact of structural or competitive indicators in the freight sector. Thus, it is concluded that, there is no evidence that vertical separation is superior to vertical integration for the impact of the rail transport on modal shares.

Laabsch and Sanner (2012) have conducted an experimental study taking into account Western European countries that had experienced vertical integration between 1994-2009. In this study, it has analyzed whether vertical separation affects the modal share of railways or not. As a result of this study, it is shown that vertical separation has a negative effect on the passenger transport modal shares. However, in the same study, it is concluded that vertical separation had no effect on the freight transport. Within the scope of this study, it is argued that different effects of vertical distinction in passenger and freight sectors may result from different competition scope in both of the sectors.

Mizutani and Uranishi (2012) have conducted an empirical study between 1994 and 2007 using the total cost function of 30 railway organization, among them 23 EU and 7 OECD countries. The aim of this study is to investigate the effect of vertical and horizontal separation on total cost of railways. As a result of the study, it is showed that horizontal separation reduces rail costs. Alternatively, in vertical separation, costs vary according to railway line density. It is found out that, while vertical separation tends to reduce the total cost in railway enterprises with low railway density, higher railway density has been shown to increase the total cost of vertical separation.

Another thesis study conducted by Kougioumtzidis (2014), provides an analysis of 28 European countries for the period between 2003-2011. In this study, it is comprehended that, vertical separation had no significant impact on the freight

sector, which is explained by higher sensitivity to prices and lower sensitivity to quality. Boskovic and Bugarinovic (2015) have studied on how and with which parameters the process of liberalization and restructuring of railways in South East Europe (SEE) should be managed. As a result, it has been proposed that railway restructuring processes and market liberalization in this region should be carried out quickly but in step by step process. Bougna and Crozet (2016) have analyzed the railway productivity of the EU countries for the period between 1997-2011. As a result, it is argued that competition and general liberalization have no effect on productivity. It is also suggested that, European policymakers should give priority to efficiency gains rather than focusing on the process of railway liberalization.

Kleinova (2016) has examined the extent to which further liberalization of railway transport by the EU and national governments will affect railway technical performance. In this study, only passenger transport data are taken into consideration. As a result of the study, it is found out that national governments were aware of the indirect negative effects of liberalization and that higher competition did not automatically mean higher technical efficiency. As is mentioned above, Republic of Turkey has legally enacted the railway liberalization law in 2013. Subsequently, this law was put into practice by the end of 2016. Therefore, there is no literature covering the performance analysis and efficiency of Turkish railways after the liberalization process. Thus, this study will make an important contribution to the literature.

2.4 An Overview of Impacts of Railway Reforms

From the economic point of view, liberalization means the mitigation of legal constraints on public services which are enforced by the State (Brose, 2015). In this case of liberalization, the public assets such as premises, services, lands and organizations usually transferred or sold to private or voluntary sector. As to the former regulations of the railway system in Europe, the State Railways of the Member States used to govern the railway infrastructure and train services under an

extensive monopoly. Therefore, through the liberalization and deregulation, railway market has opened to private companies, in such a way that allows competition. On the other hand, if the railway infrastructure has opened to competition, superfluous infrastructure would be built due to the competition between companies, which would also lead to irrelevant investments. That is why it is feasible and realistic to promote competition just in transport operations.

The term “yardstick competition” refers to the competition between a state company and a private one (Brose, 2015). In yardstick competition, since the agents (i.e. railway companies within the scope of this study) are granted low incentives in order to encourage productivity, there is a poor or no competition. In this regard, the agents are subsidized by the public authority based on their performance in comparison with the other agents that are engaged in the same field (see Figure 2.5) (Nash & Rivera-Trujillo, 2004). After the yardstick competition is achieved, franchising can be implemented according to the operation type of the railway (passenger or freight). The European Union member states generally use the franchising system for passenger transport. The UK has become the most significant implementer of this system from the mid-1990s.

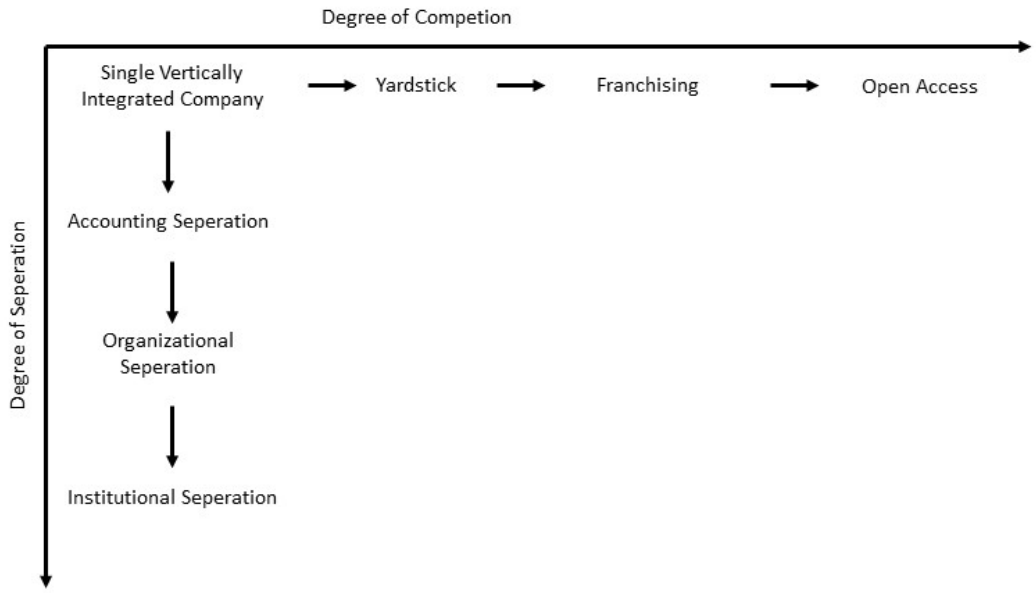

Figure 2.5. Degree of Competition-Degree of Separation (Nash & Rivera-Trujillo , 2004).

Railway franchising means that the passenger or freight transport operations are assigned to the private companies, following a competitive public tendering, by the state, via granting the licenses for operation under a contract. To put it another way, State as a franchisor provides privilege of passenger or freight transport to Private companies as franchisees. Similar developments to those in the railway sector can be observed in the field of civil aviation in terms of franchising. For instance, a well-rooted owner of airports and the competition among several airlines. Following the successful implementation of liberalization and deregulation processes, privatization and marketization processes can be realized.

"Privatization", which is closely associated with liberalization but a separated term, means that the possession of a public entity is transferred from state to private sector. In case of railway market liberalization, private companies are granted access to the railway network which is under the monopoly of state before. On the other hand, marketization refers to the process of restructuring, allowing for imposition of market forces upon the public services, in which the planning, provision and financing have conventionally been performed by state.

Considering the literature review and experiences from the selected countries, it is seen that the European railway undertakings have experienced lack of efficiency in management and poor perspective on trade and financial losses for the most of 20th century. As a consequence of this situation, the EU Member States have made reforms on their national railway sector based on the railway packages of the European Commission. Some of the objectives those reforms tried to achieve are summarized as follows (Brose, 2015):

- Decreasing the requirement for the state subsidies and elimination of corporate debts (Nash, 2008),
- Allowing third parties access to the rail infrastructure and hence improving the efficiency or railway system (Wetzel, 2008),
- Separating the infrastructure management from the train services and hence improving the competitiveness,

- Establishing independent railway supervisory and regulatory authorities for allocation of capacity and access to fundamental facilities.

Railway undertakings around the world utilize three basic model for their company structure: Government-owned monopolies (e.g. Russia and India), private-vertical integrated companies (e.g. USA and Japan), and separated infrastructure manager and railway operator companies (e.g. European Countries) (Nash, 2016; Tomes, 2017). When the liberalization studies in European countries are examined in depth, it can be better understood how this structuring has or could have consequences. For the revitalization of railways, the EU Member States have begun to reorganize their rail structures in accordance with EU legislation, following the EC Directives, which separate accounting systems of railway infrastructure and operations and include four railway packages, between the period of 2001-2016. However, there have been significant differences between countries in practice. These differences can be seen in Table 2.1.

In general, countries have adopted one of two organizational structures: horizontal separation, which separates the rail freight transport and rail passenger transport from each other by several vertically integrated networks, and vertical separation, which separates railway infrastructure management from railway transport services and allows multiple private railway operators to access the network (Pittman et al., 2007; Pittman, 2011).

When the vertical and horizontal structures of European railway systems are reviewed in depth, the following changes can be observed: Vertical separation of the railways have started with EC Directive 91/440, which separates railway infrastructure and train services in terms of management and account keeping. After the adoption of EC Directive 91/440, most of the EU countries have implemented the Directive in two steps: firstly, establishing separate managements for both rail infrastructure and rail operations and secondly, a complete vertical separation of former state monopoly. Sweden was the first country that fully implemented the separation of rail infrastructure and rail operations back in 1988; when former state

monopoly (Swedish State Railways) split into two independent entity as Banverket, which maintained the rail infrastructure, and Statens Järnvägar, which operated passenger and freight trains. As of 2005; Italy, Ireland, Austria and Belgium are still utilizing the vertically integrated structure for their national railway systems (Cantos, Pastor, Serrano, 2010).

Table 2.1 Separation Model for EU Member States (Aslan, 2012)

Regulation Type	Category	Member States
Case A	Fully independent infrastructure manager	Great Britain, Finland, Denmark, Netherlands, Norway, Spain, Sweden, Portugal, Slovakia, Lithuania, Romania, Czechia, Greece, Bulgaria
Case B	Independent infrastructure manager that delegates companies for certain functions	France, Estonia, Hungary, Slovenia, Luxembourg, Latvia
Case C	Legally independent infrastructure manager act as a Holding company which have its own railway operator company	Germany, Austria, Belgium, Italy, Poland,
Case D	Infrastructure manager in charge of capacity and railway undertaking are still integrated	Ireland, Northern Ireland

However, reforms towards the horizontal separation of railways are rarer. Except for the case of Great Britain, where a comprehensive railway restructuring process took place, various changes have been emerged as a result of horizontal separation of railways. For instance, the Netherlands have horizontally divided its national railway system and introduced tender system for its passenger services in different regions as well as provided third party access for the freight sector. Similarly, Sweden has utilized tender system for passenger services in 1989 and has opened its freight sector

to new operators in 1996. Accordingly, Denmark has permitted private operators to access its freight network in 2001, whereas Norway has divided its railway freight and passenger operations in 2002 (Cantos, Pastor, Serrano, 2010).

In order to examine structural changes more holistically and to draw an analysis on their results, it will be useful to examine the railway reforms in European countries in a historical integrity. The details of the reform-studies on railway liberalization in European countries and the consequences of these works are discussed. In this context, the developments emerged as a result of railway reforms in Sweden, which showed a significant improvement in rail transport after liberalization, as well as in United Kingdom, which is a different country in terms of transport between countries and regions due to being an island country and experienced some negative impacts after liberalization, are discussed. In addition, the consequences of railway reforms in Germany, which came to the forefront in rail transport in Europe by adapting a holding structure after liberalization, in France, where the reunification issues on the railroads came to the fore as a result of the fluctuating developments after liberalization, and in Italy, where reform work is progressing very slowly and still cannot give up the traditional model, are addressed. In this context, the developments emerged as a result of railway reforms in Sweden, which showed a significant improvement in rail transport after liberalization, as well as in United Kingdom, which is a different country in terms of transport between countries and regions due to being an island country and experienced some negative impacts after liberalization, are discussed. In addition, the consequences of railway reforms in Germany, which came to the forefront in rail transport in Europe by adapting a holding structure after liberalization, in France, where the reunification issues on the railroads came to the fore as a result of the fluctuating developments after liberalization, and in Italy, where reform work is progressing very slowly and still cannot give up the traditional model, are addressed. There are also other remarks stated on the literature as key comperative points mainly focus on the freight transportation;

- Deregulation Experience as of 2020 (years)
- Type of Seperation
- Franchcising or State Owned (Freight)
- Number or Passenger Operators
- Number or Freight Operators
- Number of Total Employee
- Total Number of all Rolling Stock
- Volume of Tonne*Km
- Revenue per ton.km
- Train Km per Employee
- Modal Share (Freight)

CHAPTER 3

RAIL FREIGHT TRANSPORTATION IN TURKEY

In this section; overall position of the freight transportation, railway network, existing rolling stock types and characteristics of the transported goods are addressed from Turkey's perspective.

3.1 Railway Transportation in Turkey

TCDD was founded as a subsidiary of Ministry of Transportation, Maritime Affairs and Communication (MoTMC) after the nationalization of railroads back in 1924. TCDD has seven regional directorates around the country. In addition to the railway and maintenance operations, TCDD also has an extensive manufacturing capability in both rolling stock and track components. The construction of Turkish railroads began in 1856 within the borders of Ottoman Empire. During the Ottoman Empire era, 8530 km long railroad has constructed. After 1923, approximately 4000 km long railroad has built for Republic of Turkey. Some of the sections of railroad that were built during the Ottoman Empire had the primary goal of strengthening political connections between the provinces and the capital. Other sections of railroad were constructed by private companies in order to link manufacturing cities with trade cities and transportation of manufactured goods and raw materials.

Investments for the construction and maintenance of railroads have gradually declined as the automobile industry expanded greatly in the 1950s. Turkey has built an average of only 10 km of railroad per year between 1950 and 2000. After 2000, the renovated attention towards railroad development has been started due to the intense traffic congestion, safety measures, environmental sustainability, a steadily increasing transportation demand, and requirements for the EU accession. The

government has invested $6 billion in TCDD. However, officials estimate that the total investment has been made is $20 billion until 2017.

Taking into account all these impacts, many countries have set important goals to increase the modal share of rail transport. In particular, European, American and the Far Eastern railway undertakings try to be successful by supporting policy changes. As in many EU countries, in Turkey, due to both environmental concerns and the desire for integration into international transport networks, there has been a policy change in favor of rail transport (Babalik-Sutcliffe, 2007).

3.2 Railway Network

The total length of conventional lines throughout the TCDD network is 9,023 km, which consists of 8,432 km long mainlines and 591 km long second, third and fourth lines. The total conventional line length reaches 11,395 km when 2,372 km long auxiliary tracks, which includes 1,939 km long station tracks and 433 km long branch lines, is added. The total length of the high-speed line (HSL) in Turkey is 1,213 km. Moreover, the total length of railway lines in Turkey is 12,608 with both the conventional and high-speed lines. Of the TCDD lines, 4,660 km has been electrified and 5,534 km has been signalled and the ratio of electrified and signalled lines to the total track length is 37% and 44% respectively. In the electrified network, there are 61 transformers and 10 tele-command centers. Tele-command centers remotely control the transformers. After the publication of Law No. 6461 on the Liberalization of Turkish Railway Transportation in 2013. TCDD transferred its responsibility of freight and passenger train operations to the newly established TCDD Taşımacılık A.Ş. (TCDD-T) at the end of 2016. Current responsibility of TCDD is to be manager of railway infrastructure as it is stated in above. Considering the existing railway lines in Turkey, railway freight wagons and locomotives can only be operated on the conventional lines due to their technical deficiencies. Furthermore, high speed lines are only used for passenger transport with HST sets. In the past years, TCDD has carried out rehabilitation, signalling and electrification works on the railway

network. Although these refurbishment works will lead to an increase in performance in the future, they have caused serious losses in railway transportation rates in the last decade. In particular, the intensity of the railway traffic on Irmak-Karabük-Zonguldak, Malatya-Narlı, Adana-Mersin and such other railway line segments have decreased sharply until rehabilitation projects are completed. Furthermore, when assessing the Turkish railway network, it's signalling and electrification features mentioned above should be considered. As is known, signalling systems increase the railway line capacity whereas electrification systems provide significant savings in energy costs. Another issue is the railway lines within the railway network. These short railway lines increase the efficiency in freight transportation and save time. Industrial companies, which carry high amounts of rail freight transport, generally use the inclination lines for ease of loading and unloading activities.

3.3 Rail Freight Transport

The freight types carried by TCDD usually consist of bulk, shipping containers, liquids and goods. As of 2015, 25.7 million tons of freight is transported by rail in Turkey. TCDD has transported 4.5 million tons of iron ore and coal in 2015 for its top two customers Erdemir and Kardemir steel factories. In addition, 2.1 million tons of rail freight carried in international traffic. Most of international traffic is between Turkey and Europe, which is connected by Kapikule border gate. Several container trains as well as conventional trains operate on the route between Turkey and Europe.

Containers are widely used both in international and domestic transportation. 7.6 million tons of freight is carried in containers. TCDD mainly supports container transportation. Thus, almost all of the private railway companies have invested in container wagons, and they carry 20% of total rail freight by their own wagons. TCDD has plans to strengthen its freight traffic by constructing 4,000 km long conventional railway lines until 2023. These plans also include new international rail connections with Georgia, Iraq and Iran. In addition, TCDD also builds 18 logistic centers to enable transportation of more loads by rail. TCDD aims to increase its

transit traffic by “Iron Silk Road” connecting Europe and Asia. Marmaray is the most fundamental part of the “Iron Silk Road” project, which is completed on 12 March 2019 with the opening of Gebze-Halkali section. A first international freight train has passed Marmaray on 7 November 2019, which was 850-meter-long and carrying electronics in 42 containers from Xi’an (China) to Prague (Czechia). Another significant project is Baku–Tbilisi–Kars (BTK) railway, which is opened on 30 October 2017. TCDD wants to have a big share from the freight traffic between Europe and Asia via BTK railway line and the Middle Corridor. (see Figure 3.1)

Figure 3.1. International Freight Transport Destinations (TCDD, 2019)

As is shown in Figure 3.2 below, Turkish rail freight statistics (TCDD, 2005), (TCDD, 2010), (TCDD, 2015), (TCDD, 2017) has showed fluctuating performance from early 2000s up to 2016. The lowest freight transport was made in 2002, whereas the highest one was carried out in 2014 with approximately 37 million tons (19 billion ton-km). As a result of the temporary closure and rehabilitation of railway lines between Istanbul and Bulgarian Customs as well as Samsun-Sivas corridor, a sharp decrease in total net freight transport has observed during the period between 2014-2015. During these renewal works, Turkish rail network had lost approximately 3 million tons freight capacity per year. The freight revenue and

expenditure are shown in Figure 3.3 have been calculated by excluding the VAT. Nevertheless, TCDD did not increase its freight transportation fees (rates) between 2011 and 2016. This has caused great amount of loss, which is clearly reflected in the revenue-expenditure graph below.

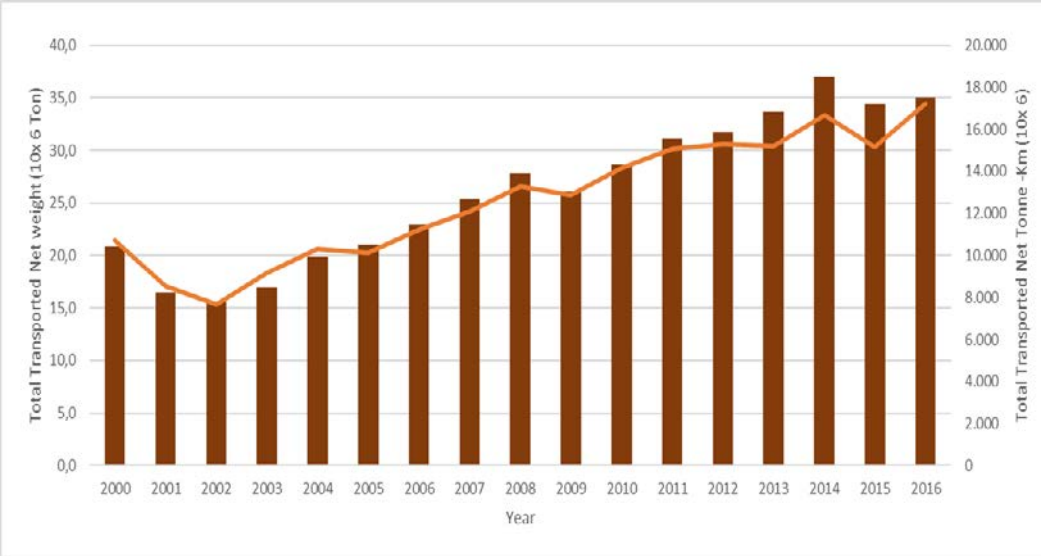

Figure 3.2. Annual Transported Net Weight and Net Tonne-km Statistics for Rail Freight in Turkey (TCDD Statistics 2000-2016)

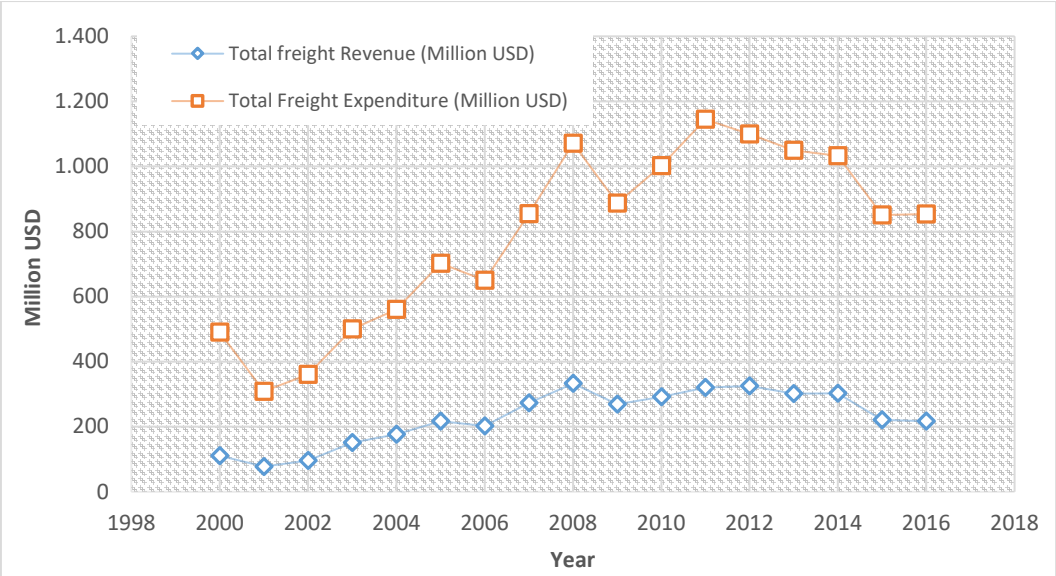

Figure 3.3. Total Freight Revenue and Total Freight Expenditure by TCDD (TCDD, 2017)

Over the years, Turkish governments have failed to make major investments in Turkish railway system, resulting in a decline in both railway passenger and freight operations. For many years, TCDD has tried to balance substantial damages caused by passenger transport with the revenue generated from the freight transport. The revenues of the last five-year period (in TL currency) prior to railway liberalization process have showed an annual increase in freight transport by 1.5% and in passenger transport by 11.5%. When the corresponding values in TL have converted to USD to eliminate the impact of high inflation rate, it has been found out that the both freight and passenger transports have respectively decreased by 6.65% and 0.3% per year (TCDD, 2018). Similar situation has been observed in some EU member states, before they have realized their railway liberalization processes. Such examples include pre-deregulation period of the UK and Sweden railway systems too. The Turkish railway liberalization legislation (Law No 6461) has been issued in May 2013, which has facilitated the process to make the Turkish railway sector fully open to private companies by the end of 2016. The private companies have begun to operate their own trains on the state railway lines, by paying infrastructure access fees to TCDD.

During this study, it is found out that some of the major railway lines have been completely closed or operated with traffic restriction due to rehabilitation of railway lines between 2015 and 2016. It is seen that especially the Kırıkkale-Karabük-Zonguldak, Samsun-Sivas and İstanbul-Edirne railway lines with high traffic density has been closed to freight operations for maintenance-repair activities.

3.4 Rail Freight Vehicle Characteristics

While determining the railway freight capacity, it is important to define the railway vehicles (a.k.a. rolling stock). It is compulsory to examine the types of locomotives and freight wagons separately, while performing the freight transport analysis. In terms of performing railway business in Turkey, selection of locomotive type is very important due to the lack of electrification in some sections of the network. In

addition, the number of wagons to be used during the operation and the total load amount are also taken into account while defining the power of locomotives to be selected. In the Turkish railway network, 7 different types of locomotives are used (see Table 3.1). The most commonly used locomotive type for non-electrified lines is the DE 24000 model whereas the least used one is the DE36000 model. In addition, DE 68000 model locomotives are the most popular ones used on the electrified lines.

Apart from locomotive types, the second part that needs to be analyzed while the railway vehicles are being characterized is the railway freight wagons. The freight wagons, used in the railway business within Turkey, are classified in 10 categories in terms of maintenance, repair and pricing issues. Currently, the most commonly used one in Turkey is the S type of container wagons. K, R type, G type and Z type wagons.

As it can be seen in Table 3.2 below, the wagons used in freight transportation differ in terms of capacity. Although Uaa-type wagons have the highest loading capacity, there are few available and not used in recent years by TCDD-T. Additonally, S type wagons can carry a maximum load of 80 tons and can usually loaded with 2 containers. In addition, closed G and H type wagons are used for transportation of precious goods and products. In these wagons, the wagon can carry a maximum load of 60 tons depending on the axle number. In addition, Z-type wagons are generally used for military liquid fuel transportation. Z-type wagons can carry a maximum load/volume of 63 tons/69 m^3.

Table 3.1 Locomotive Characteristics of Turkish State Railways (Ref: TCDD)

Model	Picture	Under Operation	Type	Power
DE24000		418	Diesel Electric	2160 hp (1600 kW)
DE18100		20	Diesel Electric	1800 hp (1320 kW)
DE22000		86	Diesel Electric	2000 hp (1470 kW)
E43000		45	Electric	4260 hp (3180 kW)
DE33000		89	Diesel Electric	3000 hp (2220 kW)
E68000		80	Electric	6800 hp (5000 kW)
DE36000		20	Diesel Electric	3600 hp (2680 kW)

Table 3.2 Types and Specialties of the Freight Cars (Ref: TCDD)

Type of Wagon	Sample	Max. Loading (tonne)	Transported Commodities
G-Gabs (Closed Cars)		137 m3 ; 61.5 ton	All sort of freight such as household goods, food product, bagged cement etc.
H (Slidable Side wall Closed Car)		137	Freight tracked items
E(high Sided Car)		36	Coal, all sort of ores, tiles sand etc.
K, R(Platform Car)		-	Vehicles, agricultural Machines, Containers etc.
S(Platform Car)		-	Containers, Tanks heavy duty vehicles etc.
F(high Sided Car)		55	Coal, all sort of ores, railway materials (ballasts etc.)
Ug (Special Type Car)		78	Bulk grain etc.
Z(Tank Car)		69	All sort of fuels and liquids
Uaa (Heavy Duty Car)		-	Heavy and balloon cargos of 120,180 and 250 tonnes such as generators, transformers etc.

3.5 Intermodality in Rail Freight Transportation in Turkey

In today's world, multimodal transport systems, which ensure transport activities to be performed with the most efficient way, have started to be used widely due to the effect of ever-growing international trade. Intermodal transport, which is a special type of multimodal transport, can be defined as the transportation of freight that carried out with single loading, within the same transport unit, without any handling, and using multiple transport modes. In other words, intermodal transport refers to container transportation; opening of the container at the destination, which is closed/sealed/stamped after loading and transported by at least two modes such as road, rail, air, inland water and maritime transports. The intermodal transport network is a distributed system, which consists of loading terminals, warehouses, transfer points, transport corridors and logistics centers/villages (see Figure 3.4).

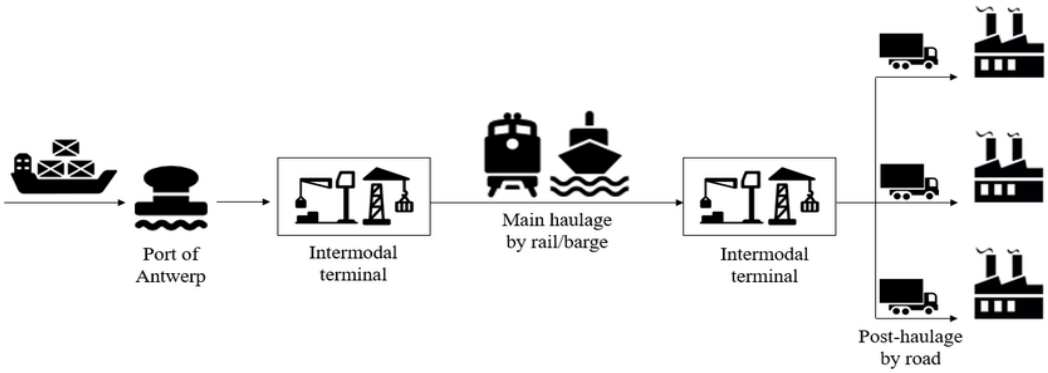

Figure 3.4. An Example of Intermodal Transportation in Belgium

Intermodal transport provides many advantages by combining several transport modes and benefiting from the flexibility of road transport, the high volume of rail transport and the low costs of maritime transport. Intermodal transportation in Turkey has especially improved in terms of Road-Rail, Road-Sea and Rail-Sea transport modes. Turkish state railways have attached importance to the construction of logistics villages as well as the construction of rail-port connections in order to increase their share in intermodal transportation during the recent years (see Figure 3.5). In this part of the study, Road-Rail and Sea-Rail intermodal freight transport in

Turkey will be examined and the early effects of Turkish railway reform will be revealed in accordance with the statistics.

Figure 3.5. Railway Connections and Ports (Operated by TCDD and Private Companies)

The modal share of railways within the freight handled in ports with rail connection has been relatively small compared to the other transport modes. This situation has been emerged as a result of placing the hinterland of the rail infrastructure connections to the narrow spaces in the past. Since the final destinations of inward and outward freight are located in short-distances and the distribution network consists of multiple points, the railways could not benefit from the big freight potentials. Therefore, road-oriented connections have become more effective. Other reasons of the modal share of railways to be relatively small in Turkish transport sector compared to other modes can be summarized as follow: The availability of small number of rail freight forwarder companies in comparison to 2,000 international road transport companies operating in Turkey with 43,000 vehicles; more improved highway infrastructure; and realization of the half of Turkish exports via road transport mode (Arpacıoglu, 2020).

With the changes in their scopes and services, the ports have become extremely significant areas where commercial affairs and legal procedures took place, beyond being places where ships are docked and freight are handled. Ports are important in terms of rail connections too. Particularly the export freight with large tonnages are

carried from various part of the country to the ports by rail, and then shipped abroad by sea. Likewise, imported freight arrived to the ports by sea are distributed to the country by rail. In other words, the Rail-Sea type intermodal transportation is very important for the Turkish economy. Container transportation, which has the largest share in intermodal transportation, also widely preferred for the Rail-Sea type intermodal transportation. Since the containers are produced in standard sizes, they can be loaded in variety of ways and carried by different types of vehicles, thus ensuring efficient transportation. The fact that the containers can be loaded (without breaking their seal) on ships, cargo aircrafts, trains or vehicles suitable for road transport has enabled them to be widely used in international transport market.

Logistics centers, which are known with different names (logistics base, freight village, logistics field, logistics park, distribution center etc.) in several countries and which are defined diversely within several studies, have been defined by TCDD as follows: Logistics centers are the specific areas, which contain logistics and transport companies as well as relevant public enterprises; which have effective connections with all kinds of transport modes; which provide opportunities to carry out activities related to storage, maintenance, repair, loading-unloading the freight, handling, weighing, dividing-combining the loads, packing etc.; and which have low cost, fast, safe freight-transit areas and equipment between the transport modes (TCDD, 2018). In this study, logistics center and logistics village concepts have been used in the same sense.

Logistics centers are specific areas, where all national and international logistics and related activities can be performed by various business enterprises. Logistics centers are generally established at locations, which are close to major and significant production centers (organized industrial zones, business centers, etc.), cities, main railway and highway corridors and the ports (if possible), without directly affecting the daily traffic.

The services offered in logistics centers can be summarized as follows: long-distance transportation, distribution of the goods, freight classification, warehousing, sorting

and other related transactions (such as banking, insurance, etc.). Furthermore, since all the logistics services are gathered under the single area, it provides important advantages in terms of speed and costs (Koldemir & Kudu, 2015).

The commissioning of logistics centers leads to the development of combined transportation by increasing the competition among the commercial companies in the region and by contributing significantly to the commercial potential and economic progress of the region in which they are located. The establishment of logistics centers have become mandatory as they are the centers, which provide all freight transportation related services in the best way possible, fulfil the administrative, technical, social and all needs of customers, and perform the transportation activities in the best manner to keep customer satisfaction at maximum level. With the establishment of logistics centers, organized industrial zones will be able to move their products more efficiently and quickly. All kinds of activities from loading to customs can be carried out at these centers and the costs can be reduced significantly by ensuring that the products reach the consumers faster. Therefore, it is important to build logistics centers to the locations, which are the closest to all transport modes (railway, highway, ports, airports) to ensure efficient freight transportation. The location of the logistics center is a key factor for all transport operators, who will move the goods from one point to another by using different types of transport modes. Therefore, a logistics center should be able to coordinate all transport modes by providing the flow between transport links.

The logistics village concept has been raised for the first time in Turkey in 2005. TCDD have begun to work on the establishment of logistics villages in 2006 and this concept has been subsequently supported by the private logistics sector too. However, the fact that logistics villages in Turkey are still not fully operational, indicates that their projects have not been completed yet. As of 2011, logistics villages have been started to be called as logistics centers. As in European countries, it has been planned to establish logistics centers, which have efficient land (highway and railway) and sea (ports) access; which is established at a location preferred by transport, logistics, shipper and loader companies; which is primarily designed to

meet logistics needs in a modern, technological and economic way; and which are closely located to Organized Industrial Zones (OIZ) and the regions with high freight potential. Turkey's first logistics village has been built in Gelemen (Samsun) and its first stage has been commissioned in 2007. Thereafter, 8 more logistics centers, which are Uşak, Denizli (Kaklık), İzmit (Köseköy), Eskişehir (Hasanbey), Balıkesir (Gökköy), Erzurum (Palandöken), İstanbul (Halkalı) and Kahramanmaraş (Türkoğlu), have been put into operation. Project, expropriation and construction tenders of other logistics centers are still ongoing (TCDD, 2018). (See Figure 3.6)

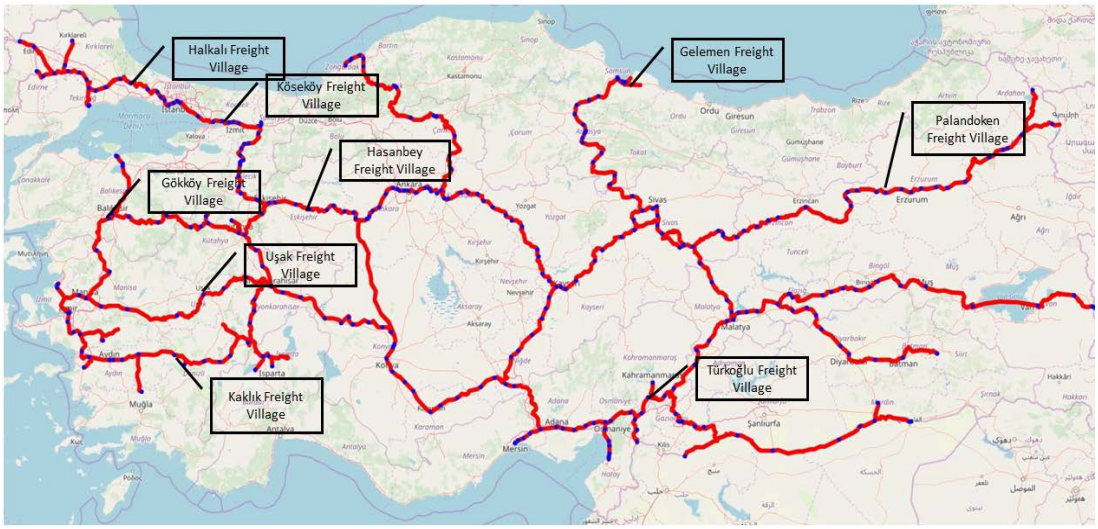

Figure 3.6. Freight Villages and Railway Connections (under operation)

3.6 Liberalization Process in Turkey

TCDD, which is a state-owned and vertically-integrated company, is predominant in the Turkish railway sector, where it renders passenger and freight services via its subsidiary company TCDD Taşımacılık A.Ş. and provides infrastructure management and maintenance. Having monopoly rights to offer rail services in Turkey, TCDD performs operation and renewal of railways and ports, coordination of its subsidiary companies (such as TCDD-T, TÜLOMSAŞ, TÜVASAŞ and TÜDEMSAŞ) and realization of the additional rail transport activities including

operation of ferries as well as production of rolling stock and construction of passenger facilities, depots and warehouses.

In 2005, the EU has formally agreed to start accession negotiations with Turkey. The Turkish Government has decided to restructure the Turkish railway system, which was remained as one of the few sectors that is not undergo a reform process, with a desire to comply with the EU rail policy. The EU, in close cooperation with the World Bank, has begun providing technical assistance to the Turkish Government for the preparation of railway reform, by aiming to reduce financial losses of TCDD and meeting the EU accession requirements (Koning, 2012).

Based on the harmonization policies in the EU accession process, "The Third National Program of Turkey for the Adoption of the Acquis" was published in the official gazette no 27097 dated 31 December 2008. The goals and priorities for railway transportation were determined in that National Program. The main goal for railway transportation is to open the Turkish railway transportation market for competition. In order to achieve this, it was aimed to gradually liberalize the Turkish railway sector by structuring the railway infrastructure management and railway operation as separate functions.

It was aimed to enact the Railway Framework Law and TCDD Law drafts and to complete the complementary regulation drafts regarding railway safety, license, interoperability and access to the railway infrastructure by the end of 2009. It was planned to make regulations regarding all these goals after adoption of the Railway Framework Law and TCDD Law. Strategic goals and objectives were determined for the period between 2010 and 2014 in line with all policy documents and financing opportunities (TCDD, 2015)

With the support of the European Union, the Railvet Project was carried out collectively by the Ministry of National Education, TCDD, the Hak-Is Confederation and the International Union of Railways as well as universities and non-governmental organizations teaching rail system technologies in Italy, Slovakia and the Czech Republic. The Railvet Project, which made it possible to revise framework

training programs about European railway traffic occupations for the first time, is considered to be an important step for sustainable operation among countries. Within the scope of the Railvet Project that was realized with an EU grant of 462,000 Euros, it was aimed to adapt operation and traffic curricula in the field of rail systems to the European Credit System for Vocational Education and Training (TCDD, 2012).

It was planned to set up logistics centers complying with the European standards in modern structures suitable for technological developments to meet logistics requirements in a location that has efficient sea and highway connections and can be preferred by contractors as in European countries. A structure was set up that complies with the joint safety indicators published by the Directorate General of Railway Regulation as well as the EU and UIC norms in order to investigate, examine and report rolling stock accidents of TCDD. In this context, the accidents reported by TCDD that took place before 2017 were evaluated and classified in accordance with the new structure (TCDD, 2017).

Furthermore, some objectives were determined in the 2015-2019 Strategic Plan of TCDD within the framework of adaptation to the EU accession. Making railways more attractive than other transportation methods for private sector investments and turning railways into centers of attraction through adjustments such as separating infrastructure managers and railway operators in terms of structure and opening a national passenger market are among these objectives. Making sure that the 2020 European Railway Traffic Management System is used is among these objectives. In this context, it is aimed to make the train planning and optimization system compatible with the EU and to make it possible to monitor and manage the traffic on the high-speed train lines with new software systems (TCDD, 2019).

The General Directorate of TCDD is a public economic enterprise (PEE) subject to decree-law no 233 responsible for putting the railway network and rolling stock into service, building new railway lines and connections, ensuring efficient management of the railway traffic and offering railway transportation services integrated with other transportation systems (TCDD, 2018).

Until November 2011, the Turkish railway legislation was based on the law no 3348 dated 1987 regulating duties of the Ministry of Transportation, the decree-law no 233 dated 1984 defining the legal status of state-owned enterprises (SOE) and the Main Status of the General Directorate of Turkish State Railways dated October 28. 1984 (Togan, 2016).

TCDD did not carry out any works related to business principles; it was a monopoly in both railway infrastructure management and railway transportation services and there was no independent regulatory authority in the railway transportation sector. Due to the undesirable consequences of this structure, it became important to form a new structure in order to make railway transportation more competitive and qualified and increase its share among other sectors as well as making it suitable for the EU harmonization process.

Steps started to be taken for liberalization of railways after the accession partnership document was signed in 2001 between Turkey and EU. It was planned to restructure the Turkish railways and make ports independent within the scope of the Turkish National Program for the Adoption of the Acquis that was put into effect with the decree no 2129 of the Council of Ministers dated 19 March 2001. Restructuring TCDD was included in the Pre-Accession Economic Program for 2020 and it was regarded as one of the reform areas for EU harmonization (T.C. Dışişleri Bakanlığı, 2019).

TCDD prepared a new Railway Law Draft in early 2002. It was planned in this law draft to prepare a framework for operation of the railway sector and to make railway operations completely commercial (DPT, 2012). The State Planning Organization clearly stated in the Five-Year Development Plan for 2001 to 2005 and the Seven-Year Development Plan for 2007 to 2013 that infrastructure management would be separated from transportation services, TCDD would be restructured with a commercial mentality and their performance would be increased. Those objectives also included enabling private sector enterprises to compete for transportation services. The TCDD Business Plan for the period between 2005 and 2010 included

improving the financial status of TCDD, making it customer-oriented, increasing its competitive power and market share, integrating the railway network with the Asian and European networks and offering safer and more economical services (Togan, 2016).

The Immediate Action Plan of the 58th Government of the Republic of Turkey that was released in 2003 stated that the State Railways would be divided as Infrastructure and Operation. The infrastructure institution would be responsible for electrification, signalization and maintenance of railways and it would be under the Ministry of Transportation as a Directorate General. Operating activities would be carried out by a joint-stock company.

The Turkish National Program was prepared on 23 June 2003 after the immediate action plan and it was decided that the EU legislation would be adopted and implemented for railways. Accordingly, an action plan was prepared for the period between 2003 and 2008 in order to enable harmonization with EU in the railway sector. With this action plan, the "Project for Restructuring and Strengthening the Railway Sector" was prepared in order to carry out works necessary for privatization of railway services and TCDD (Demirelli, 2014).

This project is a restructuring project worth 4.2 million Euros funded by the EU in 2005. There are three main components of the project: twinning with Germany, technical support-service procurement project and a financial management information system project. The goals of this project are: to establish a legal and institutional framework for railway accession in line with the EU accession, to define a stable financial relationship fulfilling the accession requirements between TCDD and the Turkish government and to provide the necessary information technologies platform, to measure the financial performance and to develop a financial management information system in order to monitor the actual performance. The project also includes objectives such as increasing knowledge of TCDD managers and providing them with new skills for commercial conditions, preparing suggestions in order to improve capacities of employees, training programs and

budgets, defining employees and resources to be transferred to new business units and scheduling this staff mobility, defining objectives of business units and the management, defining business unit budgets and five-year activity plans, defining public service agreements between the government and TCDD and preparing agreement drafts, and defining separate accounting for infrastructure, operations and public service obligations based on the principles of not transferring funds among services (Togan, 2016).

The abovementioned Twinning Project is about restructuring the railway services. The project was put out to tender between by the Ministry of Transportation and German Railways and it was executed by the German company that won the tender. Having a budget of 836, 000 Euros, the project started on 1 February 2005 and ended on 31 October 2006 (Demirelli, 2014).

Two law drafts were prepared within the scope of the twinning project (Railway Law and TCDD Law). The first law proposes a legal framework for railway activities while the second one supports separating subsidiary companies and port operations, privatizing and restructuring them. Arrangements such as railway safety, interoperability, licensing and access to the railway infrastructure were a part of those activities (Togan, 2016).

The second component is the Project for Technical Support-Service Procurement for restructuring of TCDD and it was carried out by Euromet between 16 January 2006 and June 2007. Draft agreements covering different practices such as public service agreements regulating efforts for organization of railways and the relationships between TCDD and the government were prepared within the scope of this project. A loan of €143,700,000 was obtained from the International Bank for Reconstruction and Development (IBRD) with an agreement signed in 2006 to finance these activities. Drafts of the General Railway Framework Law and TCCD Law setting out the restructuring process for liberalization of the railway sector and regulation drafts complementing those drafts (access to the infrastructure, license etc.) were

prepared and submitted to the Ministry of Transportation, which is the relevant ministry, on 25 January 2007 (Demirelli, 2014).

The first concrete regulation related to the restructuring process of TCDD is the Decree Law No 655 on the Organization and Duties of the Ministry of Transportation, Maritime Affairs and Communication that was adopted in 2011. The decree law includes significant innovations regarding restructuring of the railway services (Demirelli, 2014). This law also defined the duties of the Directorate General of Railway Regulation (DDGM) which is the regulatory authority for railway services and stated that the provisions regarding the duties of this authority related to liberalization of the railway sector would be carried out after the regulations for eradicating the monopoly of the railway sector were put into effect. The job definition of DDGM stated that it would be the regulatory authority, safety authority and executer of public service obligation agreements. In addition, the duties of the Railway Coordination Board, which would assume important duties during and after the restructuring process, were determined as ensuring harmony and cooperation among railway infrastructure operators, train operators and the Directorate General of Railway Regulation and making decisions necessary for this.

The job definitions of the Accident Research and Investigation Board, General Directorate of Infrastructure Investments, Directorate General for Dangerous Goods and Combined Transport Regulation were also made in Law No 655 and some of the duties and responsibilities under the monopoly of TCDD were transferred to these authorities. The Law No 6461 regarding the Liberalization of Railway Transportation in Turkey was adopted in May 2013. With this law, the General Directorate of Turkish State Railways was structured as the railway infrastructure manager; a company titled "Directorate General of Turkish State Railways Transportation Joint Stock Company" was founded as a train operator; provisions were made for legal and financial structures, activities and personnel of the railway infrastructure manager and the train operator of "Directorate General of Turkish State Railways Transportation Joint Stock Company" as well as other relevant provisions. Furthermore, the law made it possible for legal entities and companies

registered at the commercial registry office to build railway infrastructure, use this infrastructure and perform railway infrastructure operations and railway train operations.

TCDD acts as a railway infrastructure manager at the part of the railway infrastructure transferred to it that was within the national railway infrastructure network and at the disposal of the state under the said law. The other duties of TCDD specified in the law are as follows:

- To manage the railway traffic at the national railway infrastructure network as a monopoly
- To determine the traffic management fees at the railway infrastructure at its disposal in an equal and non-discriminatory manner for all train operators, to accrue and collect such fees from the relevant railway train operators
- To determine the traffic management fees on the national railway infrastructure network which is not at its disposal in an equal and non-discriminatory manner for all railway infrastructure operators, to accrue and collect such fees from the relevant railway infrastructure operators
- To operate, have operated or lease the areas of the railway infrastructure at its disposal that are not related to the railway traffic
- To improve, renew, expand, maintain and repair the railway infrastructure at its disposal
- To build railway infrastructure for high-speed and express train transportation
- To establish, develop, operate communication facilities or have them established or operated.

Turkish State Railway Transportation Joint Stock Company (TCDD Taşımacılık A.Ş.) became a subsidiary of TCDD in addition to TÜLOMAŞ (Turkish Locomotive and Engine Industry JSC), TÜVASAŞ (Turkish Wagon Industry JSC) and TÜDEMSAŞ (Turkish Railway Machines Industry JSC) that are already subsidiaries of TCDD.

TCDD Taşımacılık A.Ş. that started its operations after being registered on 14 June 2016 signed a protocol with the Directorate General of TCDD about personnel and vehicle transfer and allocation of real estate on 28 December 2016.

The process for liberating railway transportation and opening it for competition started on 1 January 2017. Accordingly, the company provides freight and passenger transportation, logistics services, and transportation of freight and passengers by ferry. High-speed trains, conventional trains, suburban trains, Marmaray, Başkentray are operated by TCDD Taşımacılık A.Ş. The vehicle fleet and procurement of such vehicles are also under the responsibility of the company. TCDD Taşımacılık A.Ş. incorporates 15 Departments, 7 Regional Directorate (İstanbul, Ankara, İzmir, Sivas, Malatya, Adana, Afyonkarahisar) and two Operational Directorate: HST Operation and Marmaray Operation (TCDD Taşımacılık A.Ş., 2019).

CHAPTER 4

METHODOLOGY FOR EVALUATION OF RAIL FREIGHT REFORMS IN TURKEY

4.1 Framework for Evaluation of Railway Reforms

Within the scope of this thesis study, the analyses to be conducted for the railway liberalization/reforms has been assessed in four different time periods as follows:

- 2011-2012 before-reform period 1 (BP1)
- 2013-2014 before-reform period 2 (BP2)
- 2015-2016 transition period (TP)
- 2017-2018 after-reform period (AP)

For this case, the framework of the analysis shown on the Figure 4.1 which is began with commodity flow database formation followed by railway network digitization. Afterthat the categorization of the huge number of TCDD commodity list from 753 to 21 in accordance with The Standard goods classification for transport statistics abbreviated as NST (2007). In the step 4, the rail freight network assignment done by exploit the Djkastra Shortest path function in order to prepera the dataset for analysis which are shown on step 5.

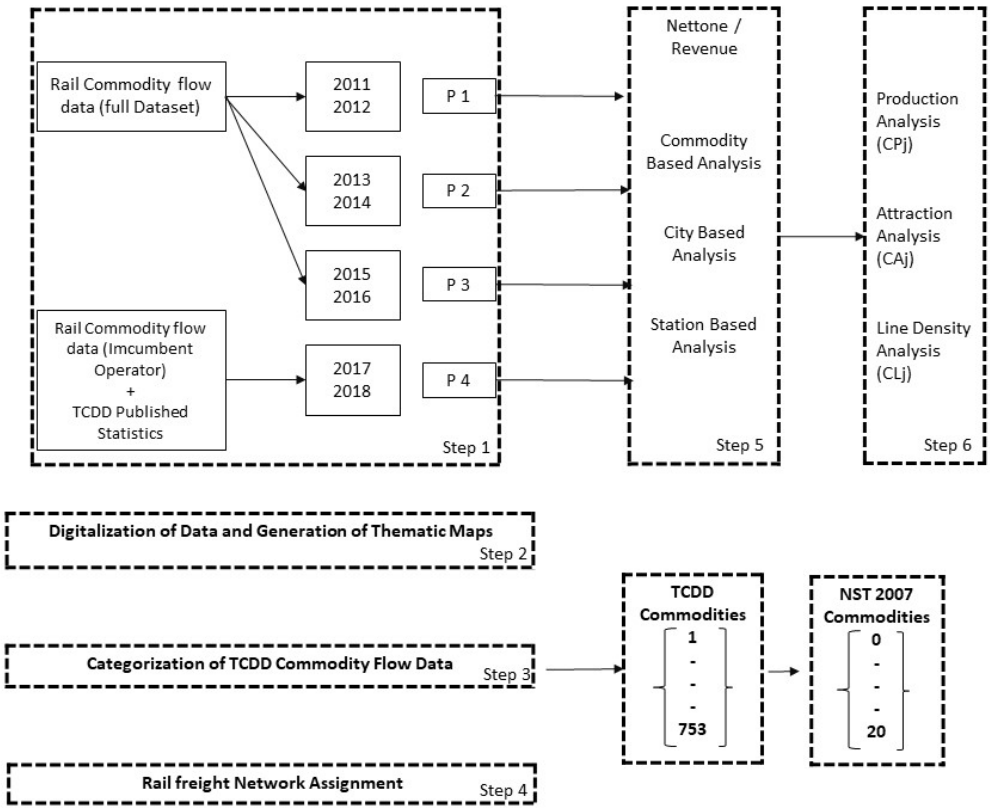

Figure 4.1. Framework to Analyze Rail Freight Transport

The database behind the GIS interface has allowed several aspects and has enabled thematic mapping of different states of rail freight as follows:

i) At a disaggregate level, it has been possible to generate rail freight maps for any selected O-D pair and analysis period, and it has been even possible to generate it by freight type, separately.

ii) Aggregation of freight of all the stations in a province has enabled calculation of Production (CPj) and Attraction (CAj) values.

iii) Assignment of selected freight type(s) to any analysis period of the whole network has generated line densities (CLj) for different railway corridors. In this way, it has also been possible to display the freight on rail network corridors.

iv) Further aggregation at the province level has provided calculation of total net weights (transported, produced or attracted values).

Furthermore, the aforementioned analyses could be performed for transportation cost, which provides revenue maps by station and/or freight type. The revenue-based analysis, which has conducted within the scope of this thesis study are based on the "total revenue" values from the invoices that also include other revenue items. For instance; long-term parking revenues, container rental fees and any penalties imposed on container transport.

4.2 Commodity Flow Database Collection

TCDD was the responsible authority for collection of the statistical information regarding commodity flow and classification data through railway network before the deregulation has been realized. In order to fulfil this responsibility, Turkish State Railways Corporate Resource Management Project (TCDD-CRM) has been developed and put into service by the HAVELSAN to effectively and efficiently manage and conduct all resources and activities of TCDD. The Railways Operations Management Information System, which consists of Management Information System, Project, Material and Stock Control, Vehicle Maintenance, Infrastructure Assets, Human Resources, Financial Resources Management System and International Ticket Sales and Reservation Systems, have been localized and exported to other countries as a package solution for the specific needs. This project was completed in 2010 and it has been in the service since 2011. TCDD-CRM project consists of several databases but its main focus is the data related to freight and passenger operation of TCDD. This study benefits from the freight data recorded by this system. The freight database records the station name-code, net weight, tare weight, commodity type of the transported materials, number of wagons and year. Each transport data represents the cumulative data, which has the same origin-destination and commodity type within the same year. In this case, approximately 6000 transport data entries have made in each year. For the analysis, 50,000 datasets

have been examined, which are recorded between 2011 and 2018. 1311 stations have been identified for being used in passenger, freight and other service operations within the TCDD network. These stations are mainly classified under 11 different groups (see Table 4.1).

Only the ISGMD, ISGMDT, ISGSF ISLIM and ISLIM type stations are utilized in freight transportation services. Except the outland transport stations, TCDD freight database includes only 568 stations in total. These stations are located in the city centers, towns or villages and they have specific codes in the database. These codes represent the railway section and region. Furthermore, there are 1144 different commodity types identified in the TCDD database for the both definition of commodity characteristic and the unit rate of transportation. As is shown in, all the commodity types have their own codes in the system.

Table 4.1 Type of Station in TCDD database

Type	Explanation
ISDUR	Stop (No officer available)
ISDURM	Stop (Officer available)
ISGMD	Terminal Management Office
ISGMDT	Terminal Management Office (Formation Yard)
ISGSF	Terminal Chief Office
ISIST	Station Chief Office
ISKAP	Non-Operational Station
ISLIM	Port Station
ISLOJ	Logistics village
ISSAN	Pseudo-Station
ISSAY	Siding

Table 4.2 Sample Commodity Types in TCDD Database

#	Freight Class	Name
1	1001	Wheat
2	1002	Rye
3	1003	Barley
4	1004	Oat

In this study, the rail freight commodity flow data of the last six-year period (2011-2018) to Turkish railway reform has been utilized, because these datasets were digitally recorded. However, as the earlier records (pre-2011 data) has been archived for general statistics purposes, it was not possible to retrieve data from them, except for the basic yearly statistics published by TCDD. It should be noted that the rail freight data in this thesis study was mainly from the invoices, which means that even a 8.000-ton freight of the same product might be shown as one single entry in the records, whereas there could be very small quantities of freight depending on the specification of the customer order. This is the most critical barrier to study on the train-based analysis (train-km, etc.). Moreover, the lack of any further details on the freight transportation (i.e. exact date) have not allowed to conduct in-depth analysis based on monthly or daily movements.

4.3 Rail Freight Network Digitization

The data, which is explained in detail above, has been analyzed with web-based software and digitalized. The first missing point is the lack of digital TCDD network map, which should have created by coordinates of each stations and railway link with their alignment, in the literature. Therefore, a digital map for TCDD network has been created within the scope of this thesis.

A web-based GIS-digital map with the coordinates and railway connections has been generated specifically for this thesis study due to the absence of a complete digital map showing the Turkish national rail network. For the geographical pre-processing, first of all, rail corridors and stations have been geocoded in GIS environment, where the international origins/destinations (O-D) have been denoted by pseudo-stations generated at the borders. Only 335 out of 572 stations, which are registered in the Turkish rail network (including sidings, closed stations, stops only for passengers and high-speed train stations) and connected by 20 railway segments (corridors between major junctions), have been actively recorded in the freight invoice records.

Figure 4.2. Digitalized Map for Railroad Network and Stations in Turkey

The 568 stations, which are utilized for freight transportation in Turkey, has been illustrated on the digital map (see Figure 4.2).These stations are grouped in accordance with the map of official city borders of the Republic of Turkey. Additionally, the international transport data is grouped with location of 6 border gates as follows:

- BG 001: Bulgaria Border Gate (Kapıkule): Kapıkule border crossing is the most known and used one in Turkey. It links Turkey to Europe via Bulgaria. It connects to the Svilengrad Terminal on the other side of the Turkish-Bulgarian border.
- BG 002: Iran Border Gate (Kapıköy): Kapıköy is the second densest railway border crossing in Turkey. Railroads passing through Kapıköy do not only connect Turkey to Iran also to Central Asian countries. It links to the Razi Station on the other side of the Turkish-Iranian border.
- BG 003: Syria Border Gate (Islahiye): Islahiye is one of the three railway crossings between Turkey and Syria. At the opposite side of the Islahiye Station, which is 24km from the border, the Meydanekbez Station is located. The border crossing is 100km away from Syria's second largest city Aleppo (as of 2009), and is the best way to reach western and northern parts of Syria. The border crossing is closed due to the civil war in Syria.

- BG 004: Syria Border Gate (Nusaybin): Nusaybin is the second border crossing between Turkey and Syria, and at the same time it is the only way to reach Iraq via railway connection. The border crossing is closed due to the civil war in Syria.
- BG 005: Greece Border Gate (Uzunköprü): This is the second railway border crossing between Turkey and Europe, it is located within 10km from the Turkish-Greek border. This border crossing connects Turkey to Greece. Pythio Terminal is located on the Greek side of the border. The Greek Railway Operator *Trainose* transports the wagons between the two terminals. The border crossing is still open, but due to its limited use, *Trainose* passes to border only if certain number of wagons are accumulated. At the moment, this border crossing is only used by the freight trains. The Friendship Express (*Dostluk Treni / Filia Express*), which used to run between Istanbul and Thessaloniki via Uzunköprü, is no longer in service.
- BG 006: Samsun-Kavkaz Railway line: This border crossing provides train-ferry combined transportation between Turkey / Samsun and Russia / Kavkaz ports by freight wagons and containers. The wagons coming from Russia and beyond can easily access Turkish national network via the Rail-Ferry Ramp and the Bogie Exchange Station built in Samsun Port.

Another step that emerged after the completion of the digital TCDD railway network map was to integrate the stations and the railway line as polyline. There are 64 different line codes and names identified in the TCDD database. These have been defined as nodes in the new digital map.

4.4 Commodity Categorization

For the sake of simplicity, 753 commodity types recorded in the dataset by TCDD have been re-categorized in order to implement the internationally accepted standardized goods classification system (NST-2007) while entering the data to GIS environment (see Table 4.3). In this context, many similar products with different

price codes have been classified under one category. For example, while weight (ton) and revenue values are added, barley, oats, rye and beekeeping products are grouped under one category of “products of agriculture, hunting and forestry” (Type 1).

Table 4.3 Standard Goods Classification for Transport Statistics (Eurostat, 2019)

Type	Commodity Type	Type	Commodity Type
0	Empty		
1	Products of agriculture, hunting, and	**11**	Machinery and equipment N.E.C.
2	Coal and lignite; peat; crude	**12**	Transport equipment
3	Metal ores and other mining products	**13**	Furniture; other manufactured goods
4	Food products, beverages and	**14**	Secondary raw materials
5	Textiles and textile products	**15**	Mails and parcels
6	Wood and products of wood and cork	**16**	Equip. and mat. utilized in the
7	Coke, refined petroleum products	**17**	Goods moved in the course of
8	Chemicals, chemical products	**18**	Grouped goods
9	Other non-metallic mineral products	**19**	Unidentifiable goods
1	Basic metals; fabricated metal	**20**	Other goods N.E.C.

4.5 Rail Freight Network Assignment

Finding the shortest path between two intersections on a road map or railway map may be modelled as a special case of the shortest path problem in graphs, where the vertices correspond to intersections and the edges correspond to road segments, each weighted by the length of the segment. In this thesis study, the shortest path problem has occurred while conducting the line density analysis. Distance-base has found as the path with the shortest travel distance, which has simply calculated as the sum of the lengths of the links on a path. The shortest path between a given O-D pair can be found using a well-known Dijkstra SP algorithm (Dijkstra, 1959).

Figure 4.3. Sample Dijkstra SP algorithm

In the Figure 4.3 above, the green dot shows the origin whereas the red dot indicates the destination. The algorithm, which finds the path from the start (green dot) to end point (red dot) in yellow color, has shown the working principle practically.

4.6 Evaluation Railway Reforms

As seen in Figure 4.1, the analyzes made within the scope of this study were made at both station and city level. These analyzes;

- **Net Weight Based Analysis:** The net load amount obtained by subtracting the weight of the empty wagon from the total transported load is taken as basis. The transport unit of the load is tons.
- **Revenue Based Analysis:** The total of the revenues (Transport revenues + other revenues) obtained from the cargo carried is taken as basis. Transportation revenues are revenues determined by the operating company and obtained on a distance basis. Other revenues consist of additional

revenues such as down-loading, loading, parking fee and shunting fee. The unit of revenues obtained is Turkish lira.

- **Commodity based:** Commodity based analyzes are made. As mentioned earlier, the 753 commodity groups determined by the operator company have been re-grouped according to NST 2007 (21 commodity groups) and analyzes will be made in this framework.

For each analysis mentioned above, both production and attraction sub-analyzes performed separately.

4.6.1 Production Analysis

The production analysis that have been performed within the scope of this thesis study represents the total railway freight produced by cities or stations. The purpose of this analysis is to group the railway freight that have been produced in a station or city and distributed to other destinations.

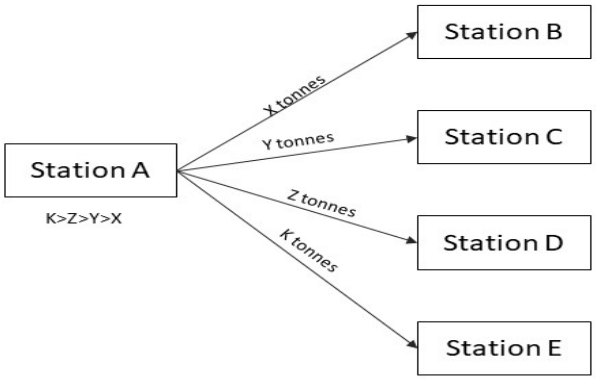

Figure 4.4. Sketch for Production Analysis Logic

Following the creation of O-D pairs for the freight that departs from Station A and arrives at Station B, C, D and E, the production weight value of Station A has been calculated as X+Y+Z+K tons (see Figure 4.4).

4.6.2 Attraction Analysis

The second analysis conducted within the scope of this study is the Attraction Analysis. The purpose of this analysis is to identify the freight attraction centres while generating the O-D pairs of rail freight. Especially the cities/stations, where large industrial organizations are located, perform transportation of raw materials. For instance, fuel and raw materials (non-processed iron), which are needed by iron-steel processing facilities, are transported by rail due to the dimensions and volumes of the freight. In addition, railway operators may offer advantageous prices for certain quantities of freight.

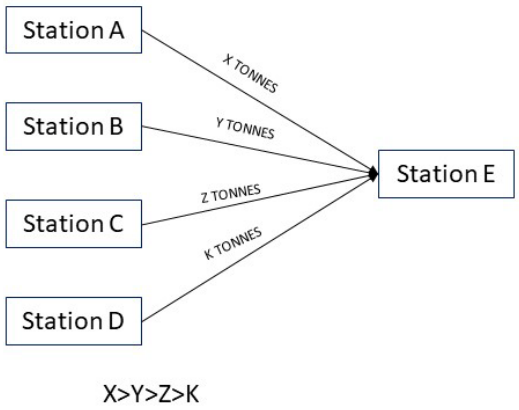

Figure 4.5. Sketch for Attraction Analysis Logic

As it can be seen from the Figure 4.5 above, the aggregate quantity of the freight coming from other stations (A, B, C and D) to Station E produces the total Attraction Weight while the revenue obtained from these transports generates the Attraction Revenue.

4.6.3 Line Densisty Analysis

The railway density analysis has been performed on the digital railway map formed within the scope of this study. The total line length used for these analyses has been

calculated as approximately 8,000 km. During the analysis, the shortest rail line used for the freight transportation has been assumed by using Djkastra Shortest Path formulas, since the used railway route could not be determined exactly. In this assumption, unoperated railway lines and international combined freight transportation have been ignored.

The thematic map shown in Figure 4.6 below has been created with cumulative nettonne values between 2011 and 2014 as an example. This shows that the Malatya-Hatay line is the busiest line with 18 million tons of freight transport in total for the related time period. The major factors behind the intensity of freight transport on this line are İskenderun Port and İskenderun Iron and Steel Co. The second busiest railway line has been determined as Niğde-Adana-Osmaniye railway line with approximately 11 million tons of freight transport. Additionally, Sivas-Malatya, Irmak-Karabük-Zonguldak and Niğde-Adana railway lines have carried over 10 million tons freight in total.

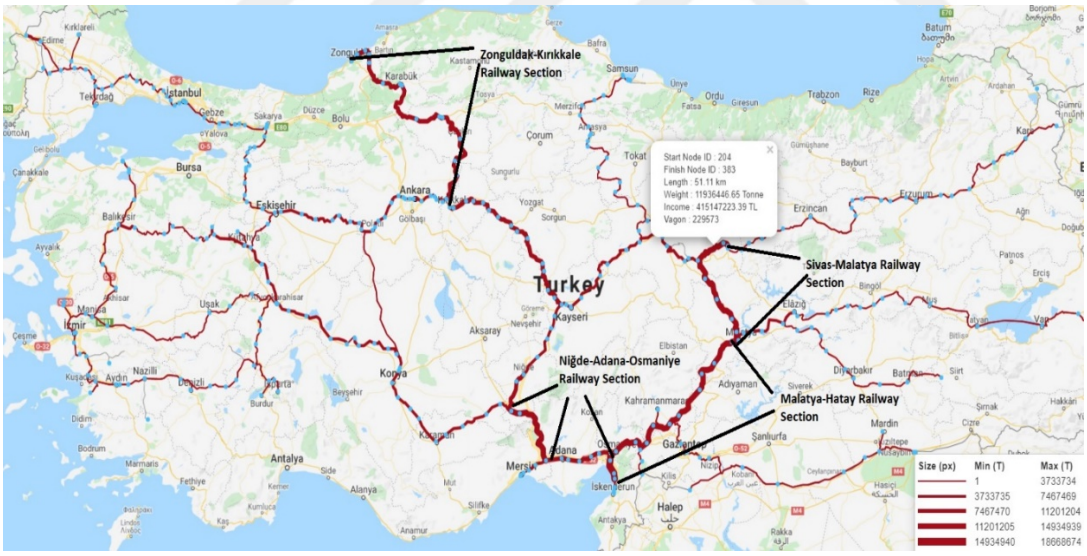

Figure 4.6. Railway Network Line

CHAPTER 5

RAIL FREIGHT TRANSPORTATION STATISTICS

Within the scope of this chapter, rail freight transportation statistics are shown in detail. These statistics cover the years 2011-2018 that are examined in three different periods as Prior period or Before Period (2011-2014), Transition Period (2015-2016) and post reform period (2017-2018), as stated in chapter 4.

5.1 Rail Freight Transport Prior to Railway Reform

5.1.1 Commodity based rail freight Statistics

It has mentioned above that the existing commodity types have been classified according to NST 2007 while performing the analyses within the scope of this study. The Table 5.1 represent the transported net weight for each year between 2011 and 2014 which show the avarage of each 2 years and percentage this value over the total transported net weight in the same year. The most transported freight group for the 4 year-period is type 3 “Metal ores and other mining products”. This freight group accounts for around 28% and 32% respectively in Before Period 1(2011-2012) and Before Period 2 (2013-2014) of the total quantity of freight. It has been followed by type 9 “Other non-metallic mineral products” and type 2 “Coal and lignite, peat, crude petroleum” with 19% and 15% respectively. Also, as can be seen in the same Table, commodity type14-20 are not transported by rail, while Type 1, Type 4, Type 5 and Type 13 commodities are negligible. Similarly, the total revenue and transportation unit prices for each commodity type for the years 2011-2014 are shown in Table 5.2. Since the transportation distances are also taken into account while calculating the total revenue, the unit cost are not listed in a similar order.

Table 5.1 Transported Net weight- Commodity for Before Period

	Net weight (tons) x10^6							
Type	**2011**	**2012**	**Avg. BP1**	**BP1 (%)**	**2013**	**2014**	**Avg. BP2**	**BP2(%)**
0	<0.01	<0.01	<0.01	0.0	0.01	<0.01	0.01	0.0
1	0.35	0.36	0.36	1.4	0.30	0.31	0.30	1.1
2	**3.72**	**4.10**	**3.91**	**15.4**	**4.12**	**4.16**	**4.14**	**15.1**
3	**6.74**	**7.53**	**7.13**	**28.0**	**7.96**	**9.22**	**8.59**	**31.2**
4	0.18	0.17	0.17	0.7	0.20	0.36	0.28	1.0
5	0.08	0.09	0.08	0.3	0.09	0.11	0.10	0.4
6	0.51	0.43	0.47	1.9	0.35	0.35	0.35	1.3
7	1.88	1.58	1.73	6.8	1.32	1.46	1.39	5.0
8	2.55	2.22	2.39	9.4	2.10	1.92	2.01	7.3
9	**4.73**	**4.36**	**4.54**	**17.9**	**4.62**	**5.48**	**5.05**	**18.4**
10	1.83	1.91	1.87	7.3	1.60	1.38	1.49	5.4
11	0.47	0.58	0.52	2.1	0.78	0.71	0.75	2.7
12	**1.94**	**1.84**	**1.89**	**7.4**	**2.62**	**2.72**	**2.67**	**9.7**
13	0.22	0.29	0.25	1.0	0.29	0.28	0.28	1.0
14	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01	0.0
15	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01	0.0
16	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01	0.0
17	0.01	0.01	0.01	0.0	0.01	<0.01	0.01	0.0
18	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01	0.0
19	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01	0.0
20	0.09	0.08	0.09	0.3	0.08	0.08	0.08	0.3

Table 5.2 Transport Revenue -Unit Cost - Commodity for Before Period

	Revenue(x10^6) (TL)				**Unit cost(TL/Tonne)**			
Type	**2011**	**2012**	**2013**	**2014**	**2011**	**2012**	**2013**	**2014**
0	0.96	1.27	0.27	0.11	24.04	29.27	38.18	32.32
1	8.88	9.45	6.13	7.93	25.40	25.92	20.23	25.97
2	**56.37**	**77.35**	**82.14**	**88.16**	**15.13**	**18.88**	**19.93**	**21.18**
3	**156.20**	**203.68**	**207.01**	**256.46**	**23.19**	**27.04**	**26.02**	**27.82**
4	5.51	6.87	6.43	7.61	30.24	41.25	32.12	21.24
5	3.68	2.13	1.85	2.22	48.98	22.94	20.01	19.86
6	19.24	17.85	15.15	14.80	37.37	41.05	42.68	42.25
7	34.95	34.30	33.18	34.56	18.59	21.76	25.17	23.71
8	**43.48**	**42.18**	**43.00**	**39.34**	**17.03**	**18.99**	**20.48**	**20.46**
9	**52.80**	**47.25**	**39.26**	**43.58**	**11.17**	**10.83**	**8.49**	**7.95**
10	38.49	48.85	35.99	31.39	21.05	25.61	22.55	22.72
11	12.56	11.52	14.76	14.43	26.81	19.90	18.88	20.23
12	**34.96**	**40.69**	**47.16**	**57.50**	**17.98**	**22.11**	**18.03**	**21.12**
13	4.66	5.77	6.59	4.88	20.99	20.23	22.93	17.63
14	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
15	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
16	0.01	0.03	0.05	<0.01	17.18	22.77	17.26	0.48
17	0.27	0.35	0.26	0.09	24.30	26.03	25.61	17.39
18	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
19	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
20	5.73	6.13	6.16	6.72	62.06	78.85	77.96	87.23

5.1.2 City based rail freight Statistics

Within the scope of this study, the transport data given at the station / logistics center level in the dataset are grouped according to the cities they are connected to. While there is a station within the borders of some cities, in some cities this number reaches ten stations. Within the scope of Table 5.3, important cities in terms of railway freight transportation were determined by indexing in terms of total freight carried. Attraction Net Nalue and Production Net values are shown separately for each year. In addition, these values are summed and Total ANV (T-ANV) and Total PNV (T-PNV) are revealed. The CrIndex value used when sorting is calculated by taking the average T-ANV and T-PNV percentages over total values.

As can be seen in the same Table, some cities come to the front with high rail freight mobility which is defined as CrIndex especially important industrial cities; Hatay, Karabük and Sivas have high CrIndex. Some of these cities stand out with their ANV value while others stand out with their PNV values. In this study, the cities which has high critical index (CrIndex) more than 1% from Hatay to Tokat considered as major cities.

Table 5.3 Transported Net Values- Cities for Before Period

	Attraction Net Value ($x10^6$tonnes)						Production Net Value($x10^6$tonnes)						
City	**2011**	**2012**	**2013**	**2014**	**T-ANV**	**%**	**2011**	**2012**	**2013**	**2014**	**T-PNV**	**%**	**CrIndex**
HATAY	4.17	4.22	4.97	5.49	18.85	17.89	1.32	1.39	1.48	1.81	6.01	5.73	11.81
KARABUK	3.43	4.37	4.07	4.81	16.68	15.83	0.25	0.18	0.32	0.22	0.97	0.92	8.38
SIVAS	0.23	0.33	0.29	0.35	1.20	1.14	3.42	3.46	3.39	4.13	14.40	13.74	7.44
KAYSERI	1.08	0.92	1.19	1.26	4.45	4.22	2.55	2.73	2.53	2.71	10.52	10.04	7.13
ZONGULDAK	0.82	0.58	0.58	0.56	2.54	2.41	2.08	2.47	2.46	2.83	9.84	9.39	5.90
MERSIN	1.55	1.82	1.72	2.19	7.28	6.91	0.90	0.90	1.27	1.39	4.46	4.25	5.58
IZMIR	1.23	1.37	1.45	1.02	5.07	4.81	1.21	1.28	1.74	1.11	5.33	5.09	4.95
KUTAHYA	0.48	0.44	0.43	0.35	1.70	1.61	1.94	1.78	1.75	1.48	6.95	6.64	4.13
BALIKESIR	1.24	0.89	0.84	0.74	3.70	3.51	1.00	0.87	0.78	0.50	3.14	3.00	3.25
KIRIKKALE	0.81	0.51	0.25	0.28	1.86	1.76	1.20	1.09	1.07	1.02	4.39	4.19	2.97
MALATYA	0.24	0.24	0.48	0.43	1.39	1.32	0.77	0.75	1.33	1.61	4.45	4.25	2.78
ANKARA	1.10	1.04	1.09	1.07	4.29	4.07	0.48	0.27	0.33	0.35	1.43	1.36	2.72
SAMSUN	0.57	0.85	0.87	0.89	3.18	3.01	0.49	0.62	0.55	0.69	2.35	2.24	2.63
KONYA	0.45	0.58	0.83	0.69	2.55	2.42	0.29	0.49	0.71	0.52	2.01	1.92	2.17
NIGDE	0.26	0.11	0.11	0.20	0.67	0.63	0.92	1.02	0.91	1.00	3.85	3.67	2.15
ESKISEHIR	0.36	0.35	0.30	0.34	1.36	1.29	0.85	0.78	0.47	0.66	2.75	2.62	1.96
ELAZIG	0.49	0.41	0.52	0.48	1.90	1.80	0.43	0.53	0.64	0.47	2.08	1.98	1.89
KOCAELI	0.97	0.60	0.06	0.13	1.75	1.66	0.97	0.61	0.01	0.15	1.73	1.65	1.66
AFYON	0.41	0.16	0.21	0.70	1.47	1.39	0.23	0.34	0.29	0.52	1.38	1.32	1.35
TEKIRDAG	0.31	0.36	0.49	0.57	1.74	1.65	0.12	0.26	0.31	0.36	1.05	1.00	1.32
ISTANBUL	0.73	0.57	0.34	0.10	1.74	1.65	0.51	0.25	0.21	<0.01	0.97	0.92	1.29
MANISA	0.14	0.11	0.39	0.28	0.91	0.87	0.37	0.36	0.42	0.50	1.65	1.57	1.22
TOKAT	0.18	0.19	0.19	0.20	0.77	0.73	0.36	0.43	0.34	0.25	1.38	1.31	1.02
MARDIN	0.40	0.43	0.39	0.25	1.46	1.39	0.09	0.08	0.09	0.07	0.32	0.31	0.85
GAZIANTEP	0.21	0.21	0.33	0.46	1.21	1.15	0.10	0.06	0.13	0.22	0.51	0.49	0.82
ERZURUM	0.21	0.27	0.19	0.29	0.96	0.91	0.07	0.07	0.06	0.34	0.55	0.52	0.72
BINGOL	0.10	0.02	0.10	0.31	0.53	0.50	0.05	<0.01	0.09	0.72	0.86	0.82	0.66
DIYARBAKIR	0.31	0.23	0.28	0.16	0.98	0.93	0.10	0.12	0.11	0.06	0.38	0.37	0.65
YOZGAT	0.16	0.07	0.08	0.07	0.37	0.35	0.27	0.18	0.28	0.27	0.99	0.95	0.65
VAN	0.10	0.19	0.14	0.32	0.75	0.71	0.20	0.15	0.09	0.16	0.60	0.58	0.64
DENIZLI	0.11	0.10	0.24	0.23	0.68	0.65	0.02	0.10	0.26	0.25	0.63	0.60	0.62
BILECIK	0.24	0.19	0.25	0.20	0.87	0.83	0.12	0.15	0.06	0.11	0.44	0.42	0.62
BATMAN	0.11	0.19	0.35	0.24	0.90	0.85	0.07	0.08	0.14	0.09	0.39	0.37	0.61
ERZINCAN	0.16	0.19	0.17	0.45	0.97	0.92	0.04	0.18	0.05	0.02	0.29	0.28	0.60
ISPARTA	0.12	0.21	0.29	0.26	0.89	0.84	0.02	0.07	0.10	0.13	0.31	0.30	0.57
BURDUR	0.17	0.22	0.29	0.34	1.03	0.97	0.01	0.02	0.05	0.05	0.13	0.12	0.55
ADANA	0.15	0.10	0.15	0.08	0.47	0.44	0.27	0.09	0.18	0.13	0.67	0.64	0.54
USAK	0.04	0.05	0.17	0.24	0.50	0.47	0.07	0.07	0.16	0.29	0.59	0.56	0.52
KARS	0.17	0.18	0.26	0.08	0.69	0.66	0.05	0.13	0.13	0.05	0.37	0.35	0.50
BITLIS	0.23	0.20	0.10	0.32	0.86	0.82	0.03	0.03	0.06	0.05	0.16	0.16	0.49
AMASYA	0.04	0.03	0.03	0.03	0.13	0.12	0.22	0.24	0.21	0.22	0.89	0.85	0.48
SAKARYA	0.15	0.04	0.11	0.04	0.34	0.32	0.20	0.14	0.14	0.10	0.58	0.55	0.44
AYDIN	0.07	0.06	0.06	0.10	0.29	0.27	0.15	0.12	0.07	0.15	0.49	0.47	0.37
SIIRT	0.19	0.12	0.12	0.10	0.53	0.50	0.08	0.04	0.06	0.02	0.20	0.19	0.34
MARAS	0.14	0.05	0.09	0.09	0.38	0.36	0.10	0.05	0.07	0.13	0.34	0.33	0.34
KIRKLARELI	0.11	0.07	0.12	0.20	0.51	0.48	<0.01	0.02	0.02	0.06	0.10	0.10	0.29
EDIRNE	0.25	0.11	0.12	0.09	0.56	0.54	0.01	0.02	0.01	<0.01	0.03	0.03	0.28
URFA	0.27	0.07	0.08	0.05	0.47	0.45	0.01	0.01	<0.01	0.02	0.04	0.04	0.24
CANKIRI	0.10	0.01	0.04	0.03	0.18	0.17	0.01	0.05	0.13	0.06	0.26	0.25	0.21
MUS	0.07	0.08	0.07	0.06	0.28	0.27	<0.01	0.01	0.01	0.13	0.15	0.15	0.21
OSMANIYE	0.03	0.02	0.02	0.07	0.15	0.14	0.05	0.12	0.08	<0.01	0.26	0.25	0.19
KARAMAN	0.01	0.01	0.09	0.09	0.19	0.18	0.08	0.04	0.01	0.02	0.15	0.15	0.16
ADIYAMAN	0.01	0.02	0.06	0.13	0.23	0.21	<0.01	<0.01	0.03	<0.01	0.04	0.04	0.13

Table 5.4 Transport Revenue- Cities for Before Period

	Attraction Revenue($x10^6$ TL)						Production Revenue ($x10^6$ TL)						
City	**2011**	**2012**	**2013**	**2014**	**T-AR**	**%**	**2011**	**2012**	**2013**	**2014**	**T-PR**	**%**	**CrIndex**
HATAY	84.7	103.0	117.6	268.9	574.1	21.8	19.3	27.7	29.4	74.0	150.4	5.6	13.7
SIVAS	5.2	8.6	6.6	13.9	34.3	1.3	91.5	115.1	111.6	296.5	614.6	22.7	12.0
KARABUK	71.1	102.0	90.2	233.1	496.5	18.8	4.9	6.9	8.1	18.7	38.6	1.4	10.1
KAYSERI	19.5	20.4	22.9	50.7	113.5	4.3	60.5	74.1	70.7	150.5	355.8	13.2	8.7
MERSIN	19.7	22.5	26.7	59.8	128.6	4.9	21.5	23.0	29.6	62.0	136.1	5.0	5.0
KUTAHYA	5.7	6.1	5.7	8.6	26.1	1.0	35.0	41.5	43.7	87.3	207.5	7.7	4.3
SAMSUN	11.3	17.0	19.1	42.1	89.5	3.4	10.7	16.3	15.3	32.3	74.6	2.8	3.1
KIRIKKALE	15.8	11.6	5.3	11.0	43.7	1.7	16.7	19.2	24.1	45.0	105.0	3.9	2.8
BALIKESIR	18.2	16.1	16.7	30.0	80.9	3.1	15.1	15.6	13.5	21.4	65.7	2.4	2.7
MALATYA	5.3	8.0	12.3	27.1	52.7	2.0	7.4	10.7	17.7	49.0	84.8	3.1	2.6
MANISA	1.2	0.9	1.7	3.9	7.7	0.3	15.6	24.7	26.9	60.8	128.0	4.7	2.5
ZONGULDAK	4.6	4.7	4.6	8.7	22.6	0.9	16.4	20.5	22.0	52.3	111.2	4.1	2.5
ANKARA	14.4	13.5	15.0	32.3	75.1	2.8	8.4	6.9	7.1	16.0	38.4	1.4	2.1
IZMIR	5.2	8.5	9.2	18.7	41.5	1.6	10.4	14.7	13.8	25.2	64.1	2.4	2.0
ELAZIG	8.4	10.5	12.4	19.9	51.2	1.9	5.2	9.0	12.0	11.7	37.9	1.4	1.7
KOCAELI	17.2	8.5	0.3	3.8	29.7	1.1	24.5	20.3	0.6	10.4	55.8	2.1	1.6
KONYA	6.9	8.7	10.4	22.8	48.8	1.9	5.0	6.9	7.5	13.6	33.0	1.2	1.5
MARDIN	12.6	18.4	16.1	19.8	66.9	2.5	1.7	1.9	2.0	2.9	8.5	0.3	1.4
ESKISEHIR	5.0	4.0	3.9	8.2	21.2	0.8	12.7	11.0	10.6	20.2	54.4	2.0	1.4
ERZURUM	8.4	12.1	12.3	28.7	61.4	2.3	0.8	0.8	1.0	4.7	7.3	0.3	1.3
BATMAN	3.1	9.6	15.2	22.3	50.2	1.9	2.6	2.8	3.8	4.7	13.9	0.5	1.2
GAZIANTEP	7.6	7.5	10.5	23.9	49.4	1.9	2.0	1.7	1.8	6.2	11.7	0.4	1.2
VAN	7.3	10.9	7.0	29.1	54.3	2.1	1.1	1.5	0.6	2.9	6.1	0.2	1.1
BITLIS	9.8	13.5	7.5	24.8	55.6	2.1	0.3	0.4	0.2	0.5	1.4	0.1	1.1
TEKIRDAG	3.5	4.5	7.3	18.9	34.3	1.3	2.2	1.8	3.0	10.7	17.7	0.7	1.0
NIGDE	3.1	1.8	1.3	4.6	10.7	0.4	7.1	8.2	8.4	13.9	37.5	1.4	0.9
ISTANBUL	11.7	9.7	6.0	0.1	27.5	1.0	11.0	5.0	3.2	0.1	19.3	0.7	0.9
AFYON	3.4	1.5	2.1	12.9	19.9	0.8	3.8	4.4	3.6	9.3	21.1	0.8	0.8
DIYARBAKIR	8.3	7.1	5.4	10.0	30.8	1.2	1.2	1.1	1.3	1.8	5.4	0.2	0.7
TOKAT	1.7	2.5	2.2	4.3	10.7	0.4	4.5	6.1	6.0	8.1	24.7	0.9	0.7
BINGOL	0.8	1.5	3.6	11.0	16.9	0.6	<0.1	<0.1	1.3	16.0	17.3	0.6	0.6
KARS	6.7	6.7	6.3	9.7	29.5	1.1	0.5	0.7	0.5	1.0	2.7	0.1	0.6
BILECIK	3.3	3.1	3.5	6.2	16.1	0.6	3.2	4.3	2.5	4.2	14.2	0.5	0.6
ISPARTA	1.5	2.5	3.8	7.9	15.7	0.6	1.6	1.5	2.2	8.3	13.6	0.5	0.5
ERZINCAN	2.3	5.2	4.1	10.7	22.2	0.8	0.5	1.9	0.6	0.8	3.8	0.1	0.5
AMASYA	0.7	1.1	1.1	2.4	5.3	0.2	6.6	4.9	3.7	5.6	20.8	0.8	0.5
SAKARYA	1.0	1.6	1.4	3.0	7.0	0.3	2.5	3.5	2.7	6.8	15.6	0.6	0.4
ADANA	1.9	2.3	1.3	1.5	6.9	0.3	3.9	2.9	2.7	5.8	15.3	0.6	0.4
DENIZLI	0.8	1.4	3.1	5.2	10.6	0.4	0.6	1.5	3.0	6.1	11.2	0.4	0.4
BURDUR	1.5	2.4	2.4	5.7	11.9	0.5	0.6	0.7	0.9	2.3	4.5	0.2	0.3
AYDIN	1.5	1.4	1.2	1.5	5.7	0.2	2.3	2.4	1.9	4.0	10.5	0.4	0.3
YOZGAT	1.5	0.8	0.8	1.7	4.8	0.2	2.3	2.1	2.3	4.6	11.3	0.4	0.3
SIIRT	1.9	2.3	2.6	5.4	12.2	0.5	0.9	0.8	0.5	1.2	3.4	0.1	0.3
MUS	0.8	3.3	3.3	7.5	14.9	0.6	<0.1	0.1	0.1	0.2	0.5	<0.1	0.3
USAK	0.6	0.7	0.7	1.4	3.4	0.1	2.0	2.4	2.0	4.6	11.0	0.4	0.3
MARAS	2.1	1.9	1.6	3.9	9.4	0.4	1.5	0.8	0.4	0.7	3.5	0.1	0.2
OSMANIYE	0.5	0.5	0.8	3.2	5.0	0.2	0.2	3.5	1.3	0.2	5.3	0.2	0.2
SANLIURFA	2.3	3.2	1.8	1.4	8.6	0.3	0.1	0.3	<0.1	0.2	0.6	<0.1	0.2
KIRKLARELI	0.6	0.6	1.0	3.8	5.9	0.2	0.2	0.2	0.2	2.4	2.9	0.1	0.2
ADIYAMAN	0.6	1.1	2.0	2.0	5.8	0.2	0.1	0.0	<0.1	<0.1	0.2	<0.1	0.1
KARAMAN	0.2	0.1	0.2	1.6	2.2	0.1	0.7	0.9	0.3	0.6	2.6	<0.1	0.1
EDIRNE	1.1	0.8	0.8	1.3	4.0	0.2	0.2	0.3	<0.1	<0.1	0.5	<0.1	0.1
CANKIRI	0.2	0.2	0.6	0.9	2.0	0.1	0.1	0.2	1.0	1.3	2.6	0.1	0.1

5.1.3 Station Based Rail Freight Statistics

In this section, the statistics of station which produce or attract freight transported on the railway network defined both net transported value and revenue level. The stated period between 2011 and 2014 include freight transport from 298 stations. In the scope of the study, TNV (Million Tonne and TNR (Million TL) values represent the total transported net weight and revenue respectively. Also, the percentage of the these values over the total numbers indicated. Lastly, the Critical index defined to explain the importance of station on the railway freight transport. The Table 5.5 and 5.6 shows major station (CrIndex>1.00%) production and attraction net value-revenue.

Demirdağ Station (Sivas) and Yeşilhisar Station (Kayseri) are the stations that produce the most railway freight. (see Table 5.5) Both Stations supply the iron-steel sector's need with raw materials. Other major stations, Zonguldak (Zonguldak) and Tunçbilek (Kütahya) play an important role for transportation of coal mine. Lastly, as it can be seen from the same Table below, Bulgarian Border Gate, which is defined as BG001 Station, has produced 1 million tons of freight per year. In BG001, singular freight diversity is higher compared to the other stations. Singular freight diversity can be demonstrated with the excessive number of wagons. Additionally, Payas (Hatay) and Ülkü (Karabük) attract the almost 18% and 16% of the total attracted freight in terms of Critical Index (CrIndex)

Table 5.5 Produced Transport Net Weight ($x10^6$ tonnes)- Revenue ($x10^6$ TL)-Stations

Origin Station	City	TNV	TNR	TNV%	TNR%	CrIndex
Demirdag	Sivas	10.29	345.95	9.71	15.76	12.74
Yesilhisar	Kayseri	6.8	181.57	6.42	8.27	7.35
Tuncbilek	Kütahya	4.5	116.8	4.24	5.32	4.78
Zonguldak	Zonguldak	5.62	48.41	5.3	2.21	3.76
BG001	Edirne	4.17	68.6	3.93	3.13	3.53
Payas	Hatay	3.78	71.95	3.56	3.28	3.42
Yahsihan	Kırıkkale	3.41	74.48	3.22	3.39	3.31
Hekimhan	Malatya	3.86	54.13	3.64	2.47	3.06
Mersin	Mersin	2.67	68.74	2.52	3.13	2.83
Catalagzi	Zonguldak	4.12	32.87	3.89	1.5	2.70
Soma	Manisa	1.07	79.32	1.01	3.61	2.31
Degirmenozu	Kütahya	1.88	38.09	1.78	1.74	1.76
Divrigi	Sivas	1.15	49.71	1.08	2.26	1.67
Gomec	Balıkesir	1.36	44.13	1.28	2.01	1.65
Halkapinar	İzmir	2.96	5.34	2.8	0.24	1.52
Muratbagi	Elazığ	1.81	29.29	1.71	1.33	1.52
Bogazkopru	Kayseri	1.47	31.44	1.38	1.43	1.41
Bicerova	İzmir	1.26	34.14	1.19	1.56	1.38
Taskent	Mersin	1.31	29.84	1.23	1.36	1.30
Cukurhisar	Eskişehir	1.56	24.2	1.48	1.1	1.29
Cetinkaya	Sivas	1.17	31.5	1.1	1.44	1.27
Erzin	Hatay	1.32	20.91	1.24	0.95	1.10

Table 5.6 Attracted Transport Net Value ($x10^6$ tonnes) and Revenue($x10^6$ TL)- Stations

Destination Station	City	TNV	TNR	TNV%	TNR%	CrIndex
Payas	Hatay	17.36	415.06	16.38	18.91	17.645
Ulku	Karabük	16.42	378.58	15.49	17.25	16.37
Mersin	Mersin	3.29	64.53	3.1	2.94	3.02
BG002	Van	1.29	99.24	1.22	4.52	2.87
Bogazkopru	Karabük	2.39	56.83	2.25	2.59	2.42
Alsancak	İzmir	3.84	15.62	3.63	0.71	2.17
Marsandiz	Ankara	2.46	38.91	2.33	1.77	2.05
BG001	Edirne	1.94	34.58	1.83	1.58	1.705
Yahsihan	Kırıkkale	1.68	36.24	1.59	1.65	1.62
Liman	Samsun	1.54	36.79	1.45	1.68	1.565
Bandirma	Balıkesir	1.61	29.27	1.52	1.33	1.425
Tatvan Gar	Van	0.82	43.22	0.77	1.97	1.37
Taskent	Mersin	1.61	24.77	1.52	1.13	1.325
Halkali	İstanbul	1.53	25.57	1.45	1.16	1.305
Batman	Batman	0.85	39.08	0.8	1.78	1.29
Yenice	Mersin	2.25	7.61	2.13	0.35	1.24
Isikveren	Zonguldak	1.9	14.24	1.79	0.65	1.22
Kuscenneti	Balıkesir	1.23	27.31	1.16	1.24	1.2
Van Gar	Van	0.64	39.32	0.6	1.79	1.195
Elazig	Elazığ	1.11	26.14	1.05	1.19	1.12

5.2 Rail Freight Transport for the Transition Period (TP)

Transition period (TP) defined for year between 2015 and 2016 in case of the irregularities since the preratory works on the railway network. In this section, the commodity, city and station based statistics indicated smilarly with Before Period (BP).

5.2.1 Commodity based rail freight Statistics

The commodity types defined in the TCDD database grouped into the 21 types as its shown in NST 2007 for the stated period. According to the material type-based transport data of the transition period (2015-2016), the most transported rail freight has been the “Metal ores and other mining products (Type 3)”. As in the pre-reform period (2011-2014), this freight group is followed by the “Other non-metallic mineral products (Type 9)” and the “Coal and lignite, peat, crude petroleum (Type 2)”. However, compared to the pre-reform period, around a 10-15% decrease could be seen in Type-3, Type-9 and Type-12 freight groups (See Table 5.7 and 5.8).

Table 5.7 Transported Net weight- Commodity for Before Period

	Net weight x10^6(tonnes)			
Type	**2015**	**2016**	**Avg. TP**	**TP(%)**
0	<0.01	<0.01	<0.01	0.0
1	0.13	0.11	0.12	0.5
2	3.41	3.35	3.38	13.7
3	7.55	7.08	7.32	29.7
4	0.19	0.18	0.18	0.7
5	0.08	0.05	0.07	0.3
6	0.26	0.23	0.24	1.0
7	2.11	2.19	2.15	8.7
8	1.46	1.95	1.70	6.9
9	4.46	4.53	4.49	18.2
10	1.43	1.47	1.45	5.9
11	0.54	0.50	0.52	2.1
12	2.62	2.74	2.68	10.9
13	0.25	0.25	0.25	1.0
14	<0.01	<0.01	<0.01	0.0
15	<0.01	<0.01	<0.01	0.0
16	<0.01	<0.01	<0.01	0.0
17	0.01	<0.01	<0.01	0.0
18	<0.01	<0.01	<0.01	0.0
19	<0.01	<0.01	<0.01	0.0
20	0.07	0.07	0.07	0.3

Table 5.8 Transport Revenue -Unit Cost - Commodity for Before Period

	Revenue(x10^6 TL)				Unit cost (TL/Tonnes)		
Type	2015	2016	Avg. TP	TP(%)	2015	2016	Avg. TP
0	0.12	0.18	0.15	0.6	33.13	69.92	51.52
1	3.59	2.80	3.20	13.0	28.62	25.14	26.88
2	69.13	90.77	79.95	324.6	20.26	27.07	23.66
3	208.62	207.89	208.25	845.5	27.64	29.35	28.49
4	3.45	2.58	3.02	12.2	18.11	14.52	16.31
5	1.44	1.28	1.36	5.5	17.17	26.95	22.06
6	10.29	8.90	9.59	38.9	39.55	39.19	39.37
7	57.13	72.84	64.99	263.9	27.12	33.19	30.16
8	29.13	39.55	34.34	139.4	19.94	20.30	20.12
9	34.20	32.10	33.15	134.6	7.68	7.09	7.38
10	41.21	44.08	42.65	173.2	28.90	29.99	29.44
11	12.51	9.56	11.04	44.8	23.32	19.08	21.20
12	50.27	53.43	51.85	210.5	19.16	19.48	19.32
13	5.07	5.95	5.51	22.4	20.69	23.52	22.11
14	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01
15	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01
16	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01
17	0.24	0.04	0.14	0.6	44.28	26.07	35.17
18	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01
19	<0.01	<0.01	<0.01	0.0	<0.01	<0.01	<0.01
20	6.85	9.10	7.97	32.4	102.34	132.85	117.59

5.2.2 City based rail freight Statistics

City based stastics shown with transported net values and revenues on the tables 5.9 and 5.10 for all cities that have rail freight mobility. During the transition period, similar with before period, Hatay and Karabük show the highest rail freight mobility in terms of transported net value. Hatay come to front with highest attracted net freight, while this city has lower producted net value. Karabük and Mersin also has higher attracted net value with 15% and 6% respectively. Additionally, Sivas, reaches the highest net weight by producing 14% and followed by Kayseri and Zonguldak with almost 10% of the total production value. (See Table.9)

The transport revenue for both production and attraction of the cities during the transition period shown on the Table 5.10 with unit of million Turkish Liras. The sequences of the major cities in terms of the critical index (CrIndex) changed compare with net values. The highest freight mobility shown in the Hatay with 14% followed by Sivas and Karabük. (See Table 5.10)

Table 5.9 Transported Net Values- Cities for Transition Period

	Attraction Net Value x10^6(tonnes)				Production Net Value x10^6(tonnes)				Avarage
City	**2015**	**2016**	**TotANV**	**%**	**2015**	**2016**	**TotPNV**	**%**	**CrIndex**
HATAY	4.17	4.22	8.40	16.65	1.48	1.81	3.29	6.06	11.35
KARABUK	3.43	4.37	7.80	15.46	0.32	0.22	0.54	1.00	8.23
SIVAS	0.23	0.33	0.56	1.11	3.39	4.13	7.52	13.83	7.47
KAYSERI	1.08	0.92	2.00	3.96	2.53	2.71	5.24	9.65	6.80
ZONGULDAK	0.82	0.58	1.40	2.77	2.46	2.83	5.29	9.73	6.25
MERSIN	1.55	1.82	3.37	6.68	1.27	1.39	2.66	4.90	5.79
IZMIR	1.23	1.37	2.60	5.16	1.74	1.11	2.84	5.23	5.19
KUTAHYA	0.48	0.44	0.92	1.83	1.75	1.48	3.23	5.94	3.88
BALIKESIR	1.24	0.89	2.13	4.21	0.78	0.50	1.28	2.35	3.28
KIRIKKALE	0.81	0.51	1.33	2.63	1.07	1.02	2.09	3.85	3.24
MALATYA	0.24	0.24	0.48	0.95	1.33	1.61	2.94	5.40	3.18
ANKARA	1.10	1.04	2.14	4.24	0.33	0.35	0.68	1.25	2.75
SAMSUN	0.57	0.85	1.42	2.81	0.55	0.69	1.24	2.28	2.54
KONYA	0.45	0.58	1.03	2.04	0.71	0.52	1.23	2.26	2.15
NIGDE	0.26	0.11	0.37	0.72	0.91	1.00	1.91	3.51	2.11
ESKISEHIR	0.36	0.35	0.71	1.41	0.47	0.66	1.13	2.07	1.74
ELAZIG	0.49	0.41	0.90	1.78	0.64	0.47	1.12	2.06	1.92
KOCAELI	0.97	0.60	1.57	3.12	0.01	0.15	0.16	0.29	1.70
AFYON	0.41	0.16	0.57	1.12	0.29	0.52	0.81	1.49	1.31
TEKIRDAG	0.31	0.36	0.68	1.35	0.31	0.36	0.66	1.22	1.28
ISTANBUL	0.73	0.57	1.30	2.57	0.21	<0.01	0.21	0.40	1.48
MANISA	0.14	0.11	0.25	0.49	0.42	0.50	0.91	1.68	1.09
TOKAT	0.18	0.19	0.37	0.73	0.34	0.25	0.59	1.09	0.91
MARDIN	0.40	0.43	0.83	1.64	0.09	0.07	0.16	0.29	0.96
GAZIANTEP	0.21	0.21	0.42	0.83	0.13	0.22	0.35	0.64	0.74
ERZURUM	0.21	0.27	0.48	0.95	0.06	0.34	0.40	0.74	0.85
BINGOL	0.10	0.02	0.12	0.24	0.09	0.72	0.81	1.49	0.86
DIYARBAKIR	0.31	0.23	0.55	1.08	0.11	0.06	0.16	0.30	0.69
YOZGAT	0.16	0.07	0.22	0.44	0.28	0.27	0.55	1.01	0.72
VAN	0.10	0.19	0.29	0.58	0.09	0.16	0.25	0.47	0.52
DENIZLI	0.11	0.10	0.21	0.42	0.26	0.25	0.52	0.95	0.68
BILECIK	0.24	0.19	0.42	0.84	0.06	0.11	0.17	0.31	0.57
BATMAN	0.11	0.19	0.30	0.60	0.14	0.09	0.24	0.43	0.51
ERZINCAN	0.16	0.19	0.35	0.69	0.05	0.02	0.07	0.13	0.41
ISPARTA	0.12	0.21	0.33	0.66	0.10	0.13	0.22	0.41	0.53
BURDUR	0.17	0.22	0.39	0.78	0.05	0.05	0.10	0.19	0.48
ADANA	0.15	0.10	0.24	0.48	0.18	0.13	0.31	0.56	0.52
USAK	0.04	0.05	0.09	0.18	0.16	0.29	0.45	0.83	0.51
KARS	0.17	0.18	0.35	0.69	0.13	0.05	0.18	0.33	0.51
BITLIS	0.23	0.20	0.43	0.86	0.06	0.05	0.11	0.20	0.53
AMASYA	0.04	0.03	0.07	0.14	0.21	0.22	0.43	0.79	0.47
SAKARYA	0.15	0.04	0.19	0.38	0.14	0.10	0.24	0.43	0.41
AYDIN	0.07	0.06	0.13	0.26	0.07	0.15	0.22	0.40	0.33
SIIRT	0.19	0.12	0.31	0.61	0.06	0.02	0.08	0.14	0.38
MARAS	0.14	0.05	0.19	0.38	0.07	0.13	0.20	0.36	0.37
KIRKLARELI	0.11	0.07	0.18	0.36	0.02	0.06	0.08	0.15	0.26
EDIRNE	0.25	0.11	0.36	0.72	0.01	<0.01	0.01	0.01	0.37
URFA	0.27	0.07	0.34	0.67	<0.01	0.02	0.02	0.03	0.35
CANKIRI	0.10	0.01	0.11	0.23	0.13	0.06	0.20	0.36	0.29
MUS	0.07	0.08	0.15	0.29	0.01	0.13	0.14	0.26	0.28
OSMANIYE	0.03	0.02	0.05	0.10	0.08	<0.01	0.08	0.15	0.13
KARAMAN	0.01	0.01	0.01	0.03	0.01	0.02	0.03	0.06	0.04
ADIYAMAN	0.01	0.02	0.03	0.07	0.03	<0.01	0.04	0.07	0.07

Table 5.10 Transport Revenue- Cities for Transition Period

	Attraction Revenue x10^6(TL)				Production Revenue x10^6(TL)				
City	**2015**	**2016**	**T-AR**	**%**	**2015**	**2016**	**T-PR**	**%**	**CrIndex**
HATAY	122.33	109.17	231.50	21.60	38.33	35.38	73.70	6.58	14.1
SIVAS	8.16	9.71	17.88	1.67	117.56	112.79	230.35	20.56	11.1
KARABUK	88.31	107.82	196.14	18.30	6.86	8.39	15.26	1.36	9.8
KAYSERI	21.90	16.02	37.92	3.54	59.79	58.72	118.51	10.58	7.1
KIRIKKALE	16.36	19.24	35.60	3.32	36.88	53.88	90.76	8.10	5.7
MERSIN	27.16	27.86	55.02	5.13	27.99	27.88	55.87	4.99	5.1
KUTAHYA	3.51	3.70	7.21	0.67	36.17	50.79	86.96	7.76	4.2
KOCAELI	13.62	32.48	46.10	4.30	15.22	24.20	39.42	3.52	3.9
MANISA	1.50	1.50	3.00	0.28	23.96	32.89	56.85	5.07	2.7
ZONGULDAK	3.43	2.05	5.47	0.51	26.42	22.61	49.04	4.38	2.4
BALIKESIR	12.95	18.56	31.51	2.94	10.38	9.09	19.47	1.74	2.3
ANKARA	18.51	15.14	33.65	3.14	7.45	6.97	14.42	1.29	2.2
MALATYA	9.56	6.74	16.30	1.52	18.07	12.83	30.91	2.76	2.1
ELAZIG	8.95	13.12	22.07	2.06	6.78	15.78	22.56	2.01	2.0
KONYA	13.34	10.67	24.01	2.24	7.56	7.37	14.94	1.33	1.8
GAZIANTEP	11.12	19.94	31.06	2.90	3.43	3.30	6.73	0.60	1.7
ERZURUM	18.65	14.17	32.82	3.06	1.63	3.21	4.84	0.43	1.7
IZMIR	8.22	9.37	17.59	1.64	10.19	10.36	20.55	1.83	1.7
BATMAN	10.51	14.38	24.89	2.32	3.37	3.60	6.97	0.62	1.5
BINGOL	4.54	5.29	9.83	0.92	8.89	12.98	21.88	1.95	1.4
VAN	14.57	9.95	24.52	2.29	1.98	3.09	5.07	0.45	1.4
ESKISEHIR	4.27	6.35	10.62	0.99	9.35	8.81	18.15	1.62	1.3
SAMSUN	13.39	0.18	13.56	1.27	9.01	1.59	10.60	0.95	1.1
SAKARYA	1.80	6.33	8.13	0.76	7.34	8.76	16.10	1.44	1.1
KARS	6.71	12.48	19.20	1.79	0.35	0.96	1.31	0.12	1.0
ERZINCAN	7.17	11.32	18.50	1.73	0.76	0.77	1.53	0.14	0.9
BITLIS	6.60	9.96	16.56	1.54	0.23	0.41	0.64	0.06	0.8
NIGDE	2.32	3.08	5.39	0.50	5.52	5.94	11.45	1.02	0.8
OSMANIYE	1.84	2.65	4.49	0.42	3.12	7.89	11.02	0.98	0.7
DIYARBAKIR	6.88	6.07	12.95	1.21	0.70	0.39	1.09	0.10	0.7
DENIZLI	3.01	2.78	5.79	0.54	3.58	3.98	7.56	0.67	0.6
TEKIRDAG	0.61	0.43	1.04	0.10	7.26	4.33	11.60	1.04	0.6
BILECIK	2.25	5.07	7.32	0.68	1.69	2.20	3.89	0.35	0.5
AFYON	2.18	1.86	4.04	0.38	3.92	1.88	5.80	0.52	0.4
MARAS	2.39	5.22	7.61	0.71	0.30	0.88	1.18	0.11	0.4
ISPARTA	2.75	2.72	5.46	0.51	1.78	1.63	3.41	0.30	0.4
YOZGAT	1.87	1.20	3.08	0.29	2.19	1.66	3.85	0.34	0.3
ADANA	0.64	0.74	1.38	0.13	2.60	2.71	5.32	0.47	0.3
AYDIN	1.35	1.41	2.76	0.26	1.83	1.78	3.61	0.32	0.3
MUS	2.34	3.05	5.39	0.50	0.09	0.04	0.14	0.01	0.3
ISTANBUL	0.01	1.17	1.18	0.11	0.11	3.77	3.88	0.35	0.2
BURDUR	1.59	0.94	2.53	0.24	0.85	0.83	1.67	0.15	0.2
ADIYAMAN	1.14	2.81	3.95	0.37	<0.01	<0.01	<0.01	<0.01	0.2
KIRKLARELI	0.28	0.04	0.32	0.03	1.74	1.80	3.54	0.32	0.2
TOKAT	1.43	<0.01	1.43	0.13	1.98	<0.01	1.98	0.18	0.2
SIIRT	1.26	0.97	2.23	0.21	0.33	0.01	0.35	0.03	0.1
AMASYA	0.87	<0.01	0.87	0.08	1.41	<0.01	1.41	0.13	0.1
USAK	0.15	0.10	0.25	0.02	1.05	0.78	1.83	0.16	0.1
EDIRNE	0.11	0.25	0.36	0.03	0.12	1.40	1.53	0.14	0.1
CANKIRI	0.41	0.45	0.87	0.08	0.09	0.67	0.76	0.07	0.1
KARAMAN	0.10	0.19	0.29	0.03	<0.01	<0.01	<0.01	<0.01	<0.1
SANLIURFA	0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1
MARDIN	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1

5.2.3 Station Based Rail Freight Statistics

With the production analyses that have been conducted for the transition period between 2015-2016, the stations that produced the freight have been identified and shown in Table 5.11 below. The Demirdağ station (Sivas) has produced the most rail freight with a yearly average transport volume of 2.23 million tons, which is quite close to the figures that Demirdağ station has produced in the period of 2011-2014 (2.57 million tons). Demirdağ station is followed by Yahşihan (Kırıkkale) and Çatalağzı (Zonguldak) stations with a yearly average transport volume of 1.49 million tons and 1.32 million tons respectively. With yearly average revenue of 87.14 million TL, Demirdağ Station has generated the most revenue by producing the rail freight, compared to the other stations. When the pre-reform period (2011-2014) is compared with the transition period (2015-2016), it can be observed that significant increases and decreases have occurred in the yearly freight production of stations. For example, Yahşihan station has produced 0.85 million tons of freight yearly on average in the pre-reform period, whereas its production has increased to 1.49 million tons freight in the transition period. For instance, Tunçbilek Station has produced 1.12 million tons of freight yearly on average in the pre-reform period, whereas its production has decreased to 0.60 million tons of freight in the transition period.

The lists of the stations, by the annual average freight volume they have attracted, during the transition period between 2015 and 2016 shown on the Table 5.11 and 5.12. In parallel with this, Ülkü Station (Karabük) has attracted the most freight with annual average transport volume of 4.17 million tons, whereas Payas Station (Hatay) ranked second with 4.08 million tons. Both Alsancak station (İzmir) and Mersin station has attracted less than 1 million tons of freight on average. Payas and Ülkü Stations have generated the most rail revenue by attracting freight, which amount for 110 million TL and 98 million TL respectively.

Table 5.11 Produced Transport Net Value -Revenue for Transition Period x10^6(Tonne-TL)

Origin Station	City	TNV	TNR	TNV%	TNR%	CrIndex
Demirdag	Sivas	4.47	174.27	9.05	15.56	12.30
Yahsihan	Kırıkkale	2.99	87.75	6.05	7.83	6.94
Yesilhisar	Kayseri	2.61	90.35	5.29	8.06	6.68
Zonguldak	Zonguldak	2.63	25.44	5.34	2.27	3.80
Catalagzi	Zonguldak	2.64	22.82	5.35	2.04	3.69
Hekimhan	Malatya	1.84	28.53	3.73	2.55	3.14
Tuncbilek	Kütahya	1.22	41.92	2.46	3.74	3.10
Mersin	Mersin	1.43	35.03	2.89	3.13	3.01
Payas	Hatay	1.51	32.85	3.07	2.93	3.00
Soma	Manisa	0.58	52.43	1.18	4.68	2.93
Divrigi	Sivas	0.82	34.72	1.66	3.10	2.38
Suveren	Malatya	1.27	21.82	2.57	1.95	2.26
Degirmenozu	Kütahya	1.00	20.52	2.04	1.83	1.93
Yarimca	Izmit	0.94	21.65	1.91	1.93	1.92
Taskent	Mersin	0.68	14.77	1.37	1.32	1.35
Bicerova	İzmir	0.67	13.57	1.37	1.21	1.29
Iskenderun	Hatay	0.45	18.36	0.92	1.64	1.28
Muratbagi	Elazığ	0.72	11.12	1.45	0.99	1.22
Bogazkopru	Kayseri	0.59	13.92	1.20	1.24	1.22
Seyitomer	Kütahya	0.24	20.48	0.48	1.83	1.15
Cukurhisar	Eskişehir	0.68	9.05	1.38	0.81	1.09

Table 5.12 Attracted Transport Net x10^6(tonnes) Value and Revenue x10^6(TL) for Transition Period

Destination Station	City	TNV	TNR	TNV%	TNR%	CrIndex
Payas	Sivas	8.16	220.23	16.53	19.66	18.10
Ulku	Karabük	8.34	196.07	16.90	17.50	17.20
Mersin	Mersin	1.68	36.64	3.41	3.27	3.34
Yarimca	İzmit	1.44	39.52	2.92	3.53	3.22
Yahsihan	Kırıkkale	1.39	33.31	2.83	2.97	2.90
Bogazkopru	Kayseri	1.09	24.59	2.21	2.20	2.20
Alsancak	İzmir	1.70	8.01	3.45	0.72	2.09
BG001	Edirne	1.03	21.96	2.09	1.96	2.02
Marsandiz	Ankara	1.01	22.37	2.05	2.00	2.02
BG002	Van	0.53	26.77	1.07	2.39	1.73
Batman	Batman	0.44	24.85	0.89	2.22	1.55
Yenice	Mersin	1.31	4.11	2.66	0.37	1.51
Kuscenneti	Balıkesir	0.66	15.69	1.33	1.40	1.36
Taskent	Mersin	0.66	13.61	1.34	1.21	1.28
Van Gar	Van	0.18	24.41	0.36	2.18	1.27
Erzincan	Erzincan	0.60	14.39	1.21	1.28	1.25
Cumra	Konya	0.77	10.28	1.56	0.92	1.24
Baspinar	Antep	0.70	10.20	1.42	0.91	1.17
Bandirma Gar	Balıkesir	0.63	11.32	1.27	1.01	1.14

5.3 Overall Charachteristics of Rail Freight during Before Periods

In this part, the characteristics of the period between the commencement of digital storage of the rail freight transportation data (2011) and the actual implementation of liberalisation (end of 2016), will be addressed. In the previous parts, pre-liberalisation period has been divided into two sections, as pre-reform (2011-2014) and transition (2015-2016), in order to provide convenience for comparative analyses. In addition, as is seen from the following graph (see Figure 5.1), there are significant differences between the two sections of the pre-liberalization period in terms of the total net transported weight and total net generated revenue. While a 5% to 10% increase has been observed in annual total freight transportation between 2011 and 2014, a significant decrease of approximately 15% has been emerged between 2015 and 2016. Such decrease in the transport volumes has reflected on the revenue accordingly.

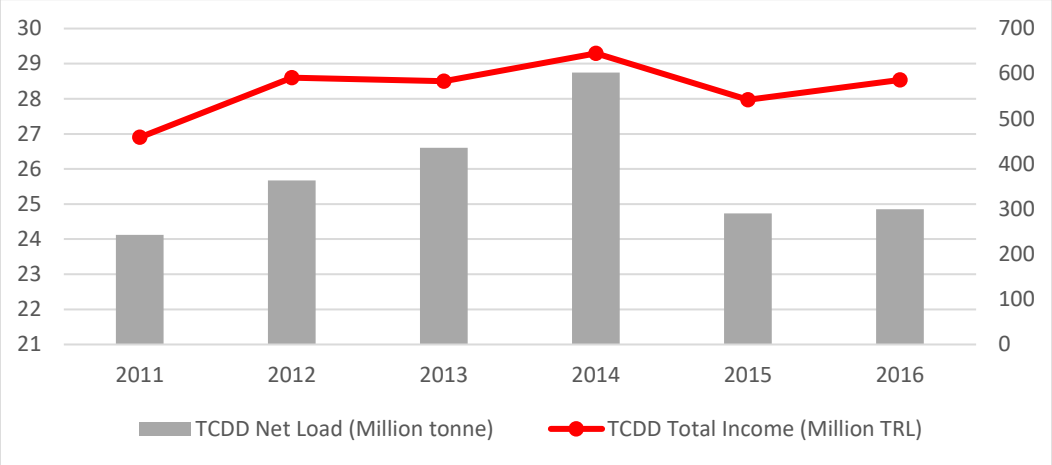

Figure 5.1. TCDD Transported Net Weight-Revenue Graph

The first period (2011-2014) has been analyzed as the period, when rail freight transportation could be performed regularly. The second period (2015-2016) has been analyzed as the period, when the rail freight transportation could not be performed as highly as the previous period due to restricted traffic or closed sections of the rail network. In order to conduct analyses uniformly for both of the pre-reform

and the transition periods and compare them with each other, similar parameters have been calculated averagely and yearly as a whole.

Within the scope of this study, the following analyses have been carried out:

i. Nettonne / Revenue Production Analysis (City and Station based)
ii. Nettonne / Revenue Attraction Analysis (City and Station based)
iii. Line density Analysis (Sectional based)
iv. Commodity based Production/Attraction Analysis

The results that have been obtained from the aforementioned analyses will be presented by being compared with the pre-reform period. It will be possible to use comparative analyses in the following periods. During the production analyses, which have been conducted first, the stations that produced the most rail freight have been identified by the parameters of the total net weight, total net revenue and number of wagons. While conducting the analyses, it has been seen that some stations generated low revenue although they produced considerable amount of freight. This situation might have been caused by two potential reasons. The leading reason is the fact that different transport distances of rail freight affect the total transport revenue. For instance, if rail freight has been transported to short distance, it may lead to generate lower revenue, although its net weight is high. The second reason is that each rail freight groups have different transport charges. Similarly, despite the fact that some stations have produced the same quantity of rail freight, the number of wagons they have used may vary. The reason behind this situation may be nature of the freight transported and use of different wagon types based on the railway section (lower axle load has to be used on some of the sections of the railway).

In this section, to provide a overall characteristics of the rail freight transport in Turkey, first the major producer and attractor cities defined regarding with the statistics. Then, the major cities evaluated by considering the Gross Domestic Product (GDP) values for related period in order to check the symetries on the GDP values and rail freight mobilities. This study provide a overall understandings for the

major cities which have fixed railway modal share and other cities that needs to be supported by the state in order to increase rail freight modal share.

5.3.1 Major Production Cities

In the analyses conducted under this study, cities have been assessed as the supra-groups that are created by adding up the total freight produced or attracted by many stations within the borders of each city in question. Moreover, since each city center has a main station named after the city, the stations within the borders of city in question have been combined under the supra-group with their city name. The analyses have showed that there are 272 stations/logistics villages available in 56 cities, where railway freight transportation is performed. The following GIS map indicates the cities (supra-groups) which have produced net weight and coloured as per legend system defined on the map. Sivas, Kayseri and Zonguldak produced the highest rail freight in total in between 2011 and 2014 (Before Period). These cities have more than 1.73 Mtonne net production in avarage and followed by İzmir, Kütahya, Kırıkkale, Hatay, Malatya and Mersin (İçel) with more than 3.8 Mtonne in total.(see Figure 5.2) Additionally, there is a similarity between the transported net weight and renenue (see Figure 5.3) in general. The total revenue which come from the production of the Sivas and Kayseri is more than 10 million TL in total four year period. These cities followed by Zonguldak, Kütahya and Hatay.

To sum up with, Sivas, Kayseri, Mersin Hatay, Zonguldak, İzmir, Kırıkkale are considered as major production cities in before period with more than 5% of the total production revenue and net weight.

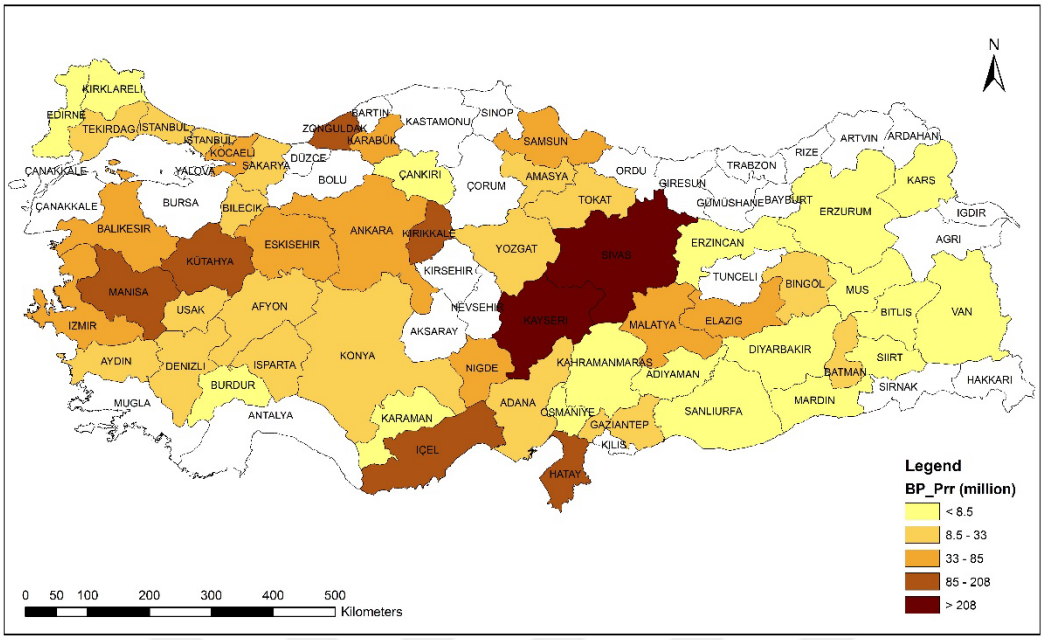

Figure 5.2. Map of Total Production Net Weight for Before Period

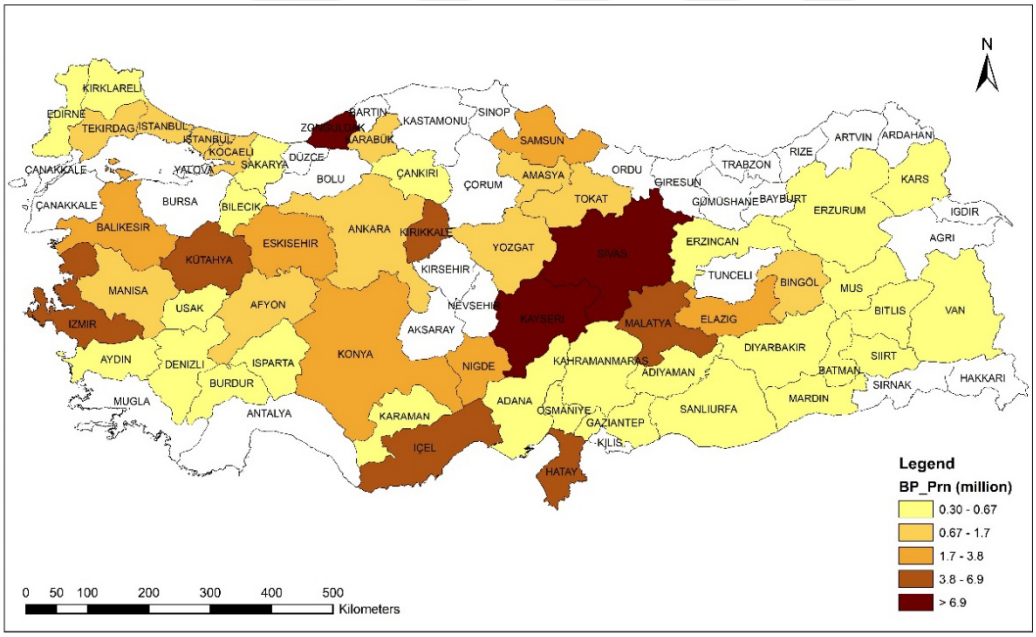

Figure 5.3. Map of Total Production Revenues for Before Period

5.3.2 Major Attraction Cities

The stations or logistic centers which attracted commodity analysed and grouped into the cities. This section provide an overview on the major cities, that have high mobility in term of rail freight attraction revenue and net weight during the before period. Hatay and Karabük have highest attraction weight and revenue with more than 15% each of them in four years period between 2011-2014. These cities followed by Mersin, İzmir and Ankara with almost 5% of the total attracted net weight. (see Figure 5.4) Moreover, Similar with the attraction net weight, the attracted freight revenue of Hatay and Karabük show the highest rate over the total attraction revenue with 22% and 19% respectively. The total attraction revenue of the Mersin, Kayseri and Samsun are more than 100M TL in four year period. (see Figure 5.5) In brief, Hatay, Karabük, Mersin, İzmir, Ankara, Kayseri and Samsun defined as major attraction cities.

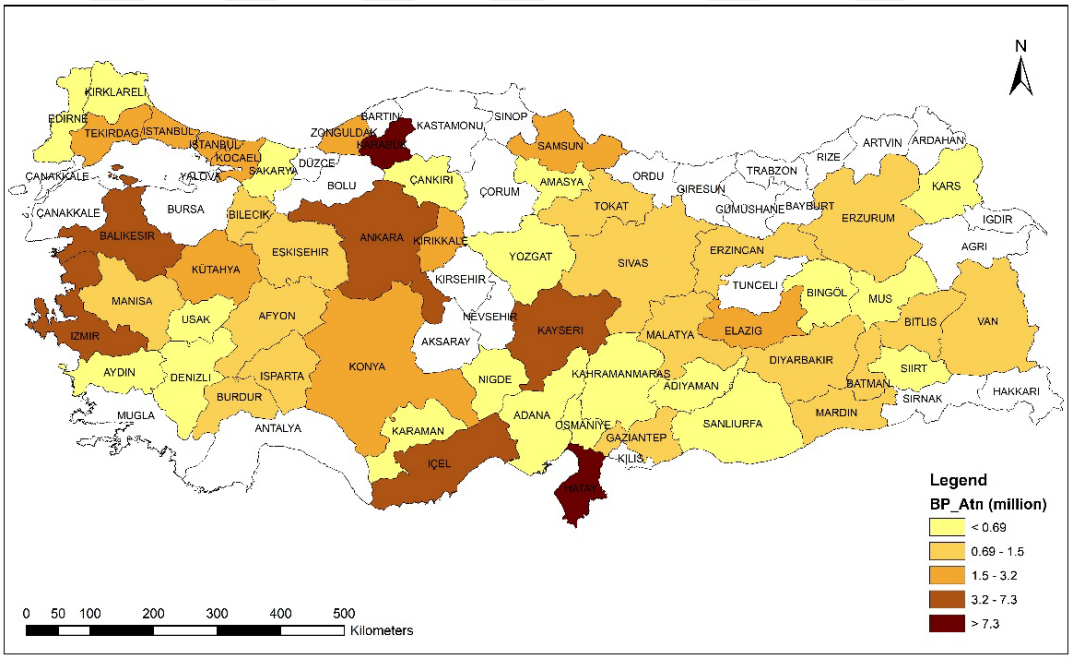

Figure 5.4. Map of Total Attraction Net Weight for Before Period

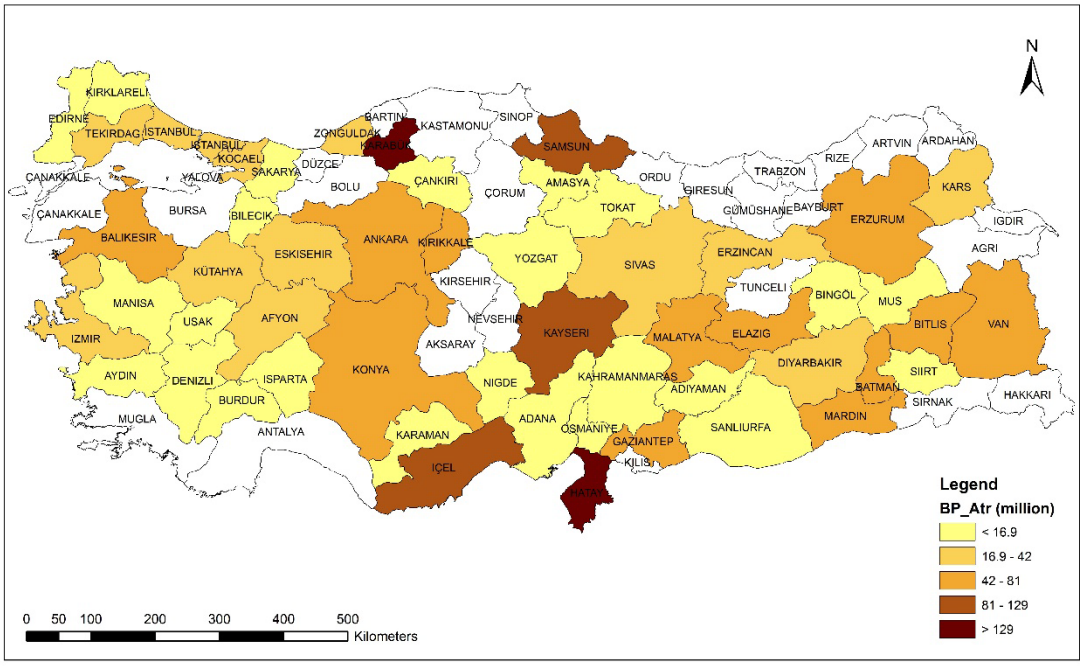

Figure 5.5. Map of Total Attraction Revenues for Before Period

5.3.3 The Values of City GDP and Rail Freight Evaluation

As is known, it is possible to find the city's rail freight production quantity by adding up the freight quantity of all stations located within the borders of the city in question. In this regard, Figure 5.6 below shows the comparison of the cities with the most rail freight production, along with their Gross Domestic Product (GDP) data. While generating the graph, the most current data between 2011 and 2014 (GDP data of 2014), has taken as a basis. In addition, for the selection of the cities that produced the most rail freight, the average of the values between 2011 and 2014 has been taken into consideration, and the cities have been sorted in accordance with these values. The rail freight production values of the cities with the highest GDP values across the country have been indicated on the same graph. According to this graph, it has seen that the cities with limited contribution to the national economy in terms of GDP such as Sivas, Zonguldak and Kırıkkale produce considerable amount of rail freight. On the other hand, the graph also shows that the cities with high GDP values such as İstanbul and Ankara have poor performance in terms of the production of

rail freight. As it can be seen from this graph, only the rail freight values of only İzmir and Manisa show parallelism with their GDP values.

Figure 5.6 also indicates the total rail freight attracted by cities, along with their GDP values, within a graph. The total attraction analysis has been made based on the total freight that has attracted by the railway stations located within the city borders. In parallel with the findings of production analyses made for the period between 2011 and 2014, no proportional relation has been found between the attracted weight and the GDP of the cities, except for Konya and İzmir. While the average freight quantity attracted by some cities is very high (e.g. Hatay, Karabük, Mersin), their GDP values remain at low level compared to it. Again, in parallel to the findings of production analyses performed for the period between 2011 and 2014, the rail freight quantity attracted by such large cities as Ankara and Istanbul is at low level compared to their GDP values.

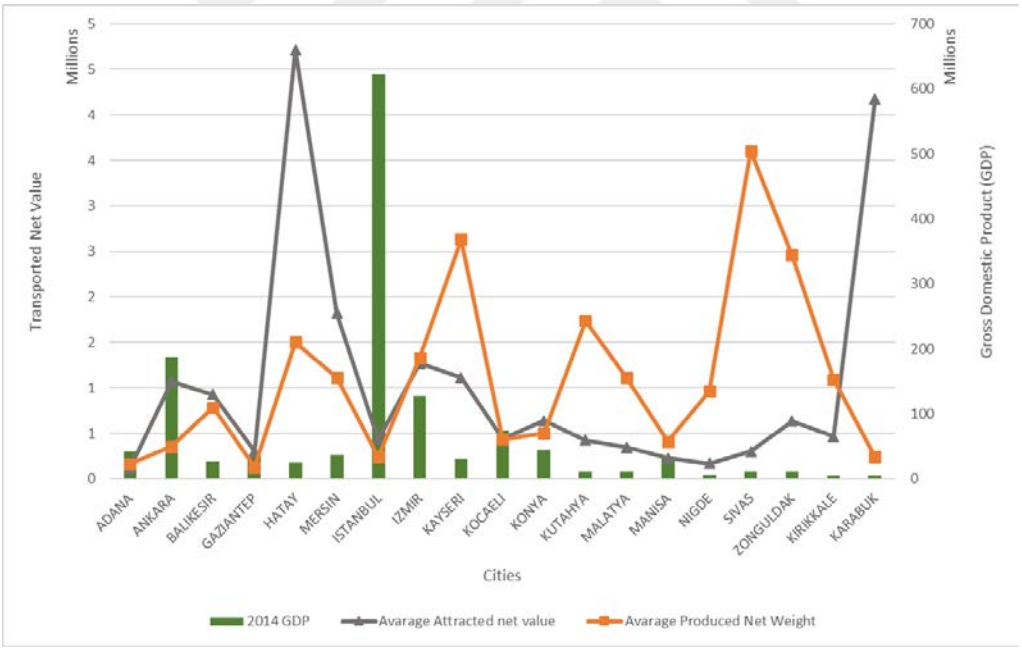

Figure 5.6. City based Production-Attraction –GDP Chart

5.3.4 Material and Location Specific Rail Demand Sector in Turkey

It has mentioned above that the existing commodity (freight) types have been classified according to NST 2007 while performing the analyses within the scope of this study. In this context, 7 different freight groups that have been transported the most for the pre-reform period between 2011 and 2014. In addition, since other freight types reflect small quantities in total, they have been grouped as “Others”. As can be seen from the Table 5.13, the most transported freight group for the 4 year-period is “Metal ores and other mining products”. This freight group accounts for around 32% of the total quantity of freight that have been transported in 2014. It has been followed by “Other non-metallic mineral products” and “Coal and lignite, peat, crude petroleum” with 19% and 15% respectively. The above-mentioned freight groups have been examined in terms of the origin cities where they are carried from. Table 5.14 indicates the “Metal ores and other mining products (Type 3)” freight group, which has been the most transported on the railway network, in detail. This bulk-type freight group has mainly produced in Sivas and Kayseri, where the highest number of mine sites are available. Since this freight group is required to be carried in vast quantities in a single run, it is the most loyal customer of railways. For this group, the net freight ton per wagon has been determined as 53 tons based on the transports performed. Moreover, Sivas is the city, which has produced the most rail freight transport revenue with 34TL/ton per unit freight. The most important reason of this revenue is the fact that, the freight loaded in Sivas is carried to longer distances.

Table 5.13 Yearly Material based Production (million tonne)

Material Code	Material Type	2011	2012	2013	2014
3	Metal ores and other mining products	6.83	7.53	7.96	9.22
9	Other non-metallic mineral products	4.72	4.35	4.61	5.40
2	Coal and lignite, peat, crude petroleum	3.72	4.19	4.17	4.30
12	Transport equipment	1.85	1.85	2.63	2.70
8	Chemicals, chemical products	2.18	1.82	1.72	1.64
7	Coke refined petroleum products	1.97	1.66	1.40	1.53
10	Basic metals, fabricated metal products	1.92	1.87	1.50	1.34
NA	Others	2.02	2.02	2.20	2.07

As it can be seen from Table 5.15, the second most transported freight group on the railway network between 2011 and 2014 is the “other non-metallic mineral products” (Type 9). This freight group accounts for approximately 20% of the total transported freight. City-based distribution of the Type-9 freight is more linear compared to the Type-3 freight. Type-9 freight group has been produced by İzmir, Niğde and Eskişehir the most. The rail freight produced by İzmir generates less rail revenue compared to the other cities. The most important reason of this is the transportation distance. The most rail revenue has been obtained from this products produced in Eskişehir.

The third most transported freight group on the railway network between 2011 and 2014 is the “Coal and lignite, peat, crude petroleum (Type 2)”, which has been mainly loaded in Zonguldak and Kütahya. As is known, both Zonguldak and Kütahya cities contribute to the national economy with their rich coal mines. The freight produced in Zonguldak and Kütahya have been particularly carried to the cities, where thermal power plants, cement factories and iron-steel processing

facilities are located. Considering the rail freight revenue, Kütahya is the city that has generated the most rail revenue from the Type-2 freight. This is followed by Manisa and Zonguldak with a yearly average revenue amounting around 20 million TL and 14 million TL respectively. Manisa is the city, which the produced rail freight is transported to the longest distance.(see Table 5.16)

Table 5.14 City based Material Production Analysis for Type 3

Origin City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Sivas	3.24	111.83	60,611
Kayseri	2.07	58.46	37,486
Malatya	0.93	13.20	16,795
Zonguldak	0.47	3.46	9,633
Elazığ	0.45	7.33	8,122
Kırıkkale	0.29	5.15	5,422
Bingöl	0.15	2.12	2,622
İzmir	0.12	2.64	2,064
Karabük	0.05	0.28	987

Considering the freight group “Transport equipment (Type 12)”, Mersin and Balıkesir have played a leading role between 2011 and 2014. In addition, it is seen that this freight type has mostly produced in the cities with a port connection. Based on this information, it can be said that Type-12 freight is essentially important for maritime-railway intermodal transportation. For Type-12 freight group, the most rail revenue has obtained in Mersin and Hatay. (see Table 5.17)

The annual production of “Chemical and Chemical Product (Type 8)” freight group by the cities. This freight type is mostly transported in the form of acid-fertilizer, which is used in the production of agricultural pesticide and explosives. It is seen that Kütahya, BG 001 and Mersin have produced highest amount of commodity rail freight by the impact of the acid-fertilizer factories in Kütahya. Type-8 rail freight to be transported the most and generate the most rail revenue from this type of rail

freight. The chemical products that are imported via Mersin Port have the longest transport distance and the highest ton/TL unit price. (See Table 5.18)

Table 5.15 City based Material Production Analysis for Type 9

Origin City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
İzmir	0.79	1.58	12,570
Niğde	0.63	1.98	10,725
Eskişehir	0.53	6.28	10,057
Tokat	0.28	4.58	7,575
Yozgat	0.23	1.49	4,314
Kırıkkale	0.21	1.77	3,941
Amasya	0.17	2.87	3,667
Afyon	0.14	1.47	4,596
Uşak	0.13	2.14	2,989

Table 5.19 and 5.20 reflect the rail freight production quantities of the cities in terms of Type-7 and Type-10 freight groups respectively. In both freight types, Hatay, an industrial city, (especially Payas Station) has played a leading role. The refinery in Kırıkkale (Yahşihan Station) and the İskenderun Port in Hatay have increased the production of “Coke refined petroleum products” type of rail freight considerably.

Table 5.16 City based Material Production Analysis for Type 2

Origin City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Zonguldak	1.83	14.23	40,986
Kütahya	1.14	29.88	24,968
Konya	0.27	2.74	5,774
Manisa	0.27	20.04	8,112
Samsun	0.24	4.04	4,767
Hatay	0.13	2.32	3,009
Izmir	0.03	0.56	584

Table 5.17 City based Material Production Analysis for Type 12

Origin City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Mersin	0.34	8.25	35,655
Balıkesir	0.31	2.60	13,231
Hatay	0.21	4.72	20,733
Izmir	0.19	1.62	21,135
Ankara	0.16	3.19	12,586
Kayseri	0.15	3.15	11,230
Tekirdağ	0.08	0.50	2,944

Table 5.18 City based Material Production Analysis for Type 8

Origin City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Kütahya	0.58	11.29	12,219
BG001	0.34	4.96	7,229
Mersin	0.33	6.94	7,774
Niğde	0.27	4.37	6,109
Balıkesir	0.17	2.23	3,475
Hatay	0.09	1.72	2,085
Eskisehir	0.07	1.31	1,266
Sivas	0.07	1.19	1,243

Table 5.19 City based Material Production Analysis for Type 7

Origin City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Kırıkkale	0.51	12.72	10,096
Hatay	0.50	8.89	9,587
Kocaeli	0.22	4.48	3,971
Mersin	0.19	4.46	3,452
Batman	0.06	2.51	1,269
Afyon	0.06	0.79	798

Table 5.20 City based Material Production Analysis for Type 10

Origin City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Hatay	0.53	9.77	12,600
Samsun	0.13	4.41	3,134
Balıkesir	0.12	3.58	2,421
Karabük	0.12	3.03	4,225
Zonguldak	0.11	2.34	1,927
BG001	0.10	1.72	2,260
Istanbul	0.08	1.53	2,153

The purpose of attraction analyses is to find out the cities which attract the certain type of rail freights most on the national railway network. It will be possible to reveal the rail freight quantity that have been gained or lost by the incumbent train operator, by observing the freight type changes attracted by the industrial cities and comparing between the “transition period” and the “post-reform period”. In this regard, first of all, the Type-3 “Metal ores and other mining products” rail freight group, which has been attracted the most by the cities on the national railway network, has been analyzed in Table 5.21 below and this commodity type rail freight has been mainly attracted by cities of Hatay and Karabük. As it is mentioned before, major iron-steel factories of Turkey (i.e. İsdemir and Kardemir) are located within the borders of both cities, and their raw material logistics need are satisfied by railways. These two industrial cities are followed by port cities of Samsun and Mersin. With its annual rail revenue, which is more than 100 million TL per year, Hatay is the city which generates the most rail revenue by attracting Type-3 freight group. The second most revenue generator is Karabük with 84 million TL per year.

Table 5.21 City based Material Attraction n Analysis for Type 3

Destination City	Yearly Average net weight (MTonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Hatay	4.21	101.35	77,327
Karabük	2.74	84.56	51,665
Samsun	0.40	12.07	7,530
Mersin	0.21	3.33	3,748
Kayseri	0.14	2.86	2,465
Zonguldak	0.05	0.26	973
İzmir	0.02	0.16	433

The second major freight group “Other non-metallic mineral products (Type 9)” has been mostly transported to Izmir with a total transport volume of 0.78 million tons per year. Izmir is followed by Mersin and Ankara with 0.69 and 0.53 million tons respectively. The annual revenue generated by transporting Type-9 freight type to Ankara is 4.66 million TL, which is the highest amount among the other cities that Type-9 freight has been transported to. Ankara is followed by Mersin and Samsun with 4.07 and 4.04 million TL respectively (see Table 5.22).The destination cities, where the freight group “Coal and lignite, peat, crude petroleum (Type 2)” has been mostly transported to. Even though both Karabük and Zonguldak are closely located to the coal mine sites, Type-9 freight group has been transported to them via railways. Karabük imports the coal-type fuel needed especially by the iron-steel factory and uses Filyos Port in Zonguldak as a transhipment hub for the intermodal transport. Karabük, which has attracted approximately 1.3 million tons of Type-2 freight per year, has earned around 9.8 million TL yearly on average. Karabük is followed by Zonguldak with 0.47 million tons of Type-2 transport volume per year (see Table 5.23)

Table 5.22 City based Material Attraction Analysis for Type 9

Destination City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
İzmir	0.78	1.66	12,504
Mersin	0.69	4.07	11,620
Ankara	0.53	4.66	10,327
Samsun	0.33	4.04	7,797
Kayseri	0.20	0.88	3,892
Afyon	0.19	1.58	4,510
Elazığ	0.15	2.41	5,503
Kocaeli	0.15	1.28	2,848
Erzincan	0.13	1.06	3,214
Malatya	0.13	2.16	4,303

Table 5.23 City based Yearly Average Material Attraction Analysis for Type 2

Destination City	Net weight (M tonne)	Revenue (MTL)	Wagon
Karabük	1.32	9.81	30,166
Zonguldak	0.47	3.56	10,260
Konya	0.43	5.52	8,666
Burdur	0.23	2.20	4,309
Ankara	0.20	2.36	3,638
Isparta	0.18	2.37	3,417
Tokat	0.13	1.31	2,520
Elazığ	0.12	3.58	2,964
Van	0.09	7.86	2,850
Sivas	0.09	2.38	2,084

Table 5.24 City based Material Attraction Analysis for Type 12

Destination City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Kütahya	0.37	5.28	26,259
Hatay	0.17	3.18	16,548
Kayseri	0.16	4.09	15,594
Malatya	0.14	5.70	16,712
İzmir	0.14	2.10	13,838
Kırıkkale	0.13	1.28	5,616
Bg001	0.12	1.43	6,104
Mersin	0.12	3.04	8,870
Eskişehir	0.10	1.88	8,847
Niğde	0.10	1.46	9,550

Table 5.25 City based Material Attraction Analysis for Type 8

Destination City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly average Wagon
Balıkesir	0.59	10.96	12,579
Hatay	0.25	3.99	5,465
Bilecık	0.17	3.01	3,167
İstanbul	0.17	2.61	3,587
Tekirdağ	0.16	2.37	3,518
Gaziantep	0.15	2.94	4,017
İzmir	0.12	1.43	2,451
Mersin	0.10	1.90	2,092
Bg001	0.08	1.55	2,103
Kocaeli	0.06	0.89	1,211

Table 5.26 City based Material Attraction Analysis for Type 7

Destination City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Kırıkkale	0.30	7.74	5,414
Ankara	0.20	4.07	3,767
Mardin	0.13	2.71	2,471
Mersin	0.12	2.95	2,076
Batman	0.12	6.14	2,377
Kocaeli	0.11	2.31	2,161
Diyarbakır	0.10	1.03	1,783
Siirt	0.09	1.41	1,599
Elazığ	0.07	0.89	1,416
Sivas	0.06	1.20	1,138

Table 5.27 City-based Material Attraction Analysis for Type 10

Destination City	Yearly Average net weight (M tonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Kayseri	0.45	10.72	10,415
Mersin	0.18	1.47	3,599
Balıkesir	0.11	2.72	2,776
Bg001	0.10	2.05	2,580
Bg002	0.09	5.54	3,101
Ankara	0.08	1.71	1,710
Tekirdağ	0.07	1.04	1,670
İzmir	0.06	0.79	1,896
Elazığ	0.04	0.95	1,127
Konya	0.04	0.95	881

The cities that have mostly attracted the Type-12 and Type-8 freight groups, which cannot be classified as bulk goods, are shown in Table 5.24 and 5.25 respectively. The freight group, “Transport equipment (Type 12)” has been mostly transported to Kütahya and has yielded 5.28 million TL annual revenue for Kütahya. As it can be seen from Table 5.24, other cities have attracted almost the similar average quantities of freight and have gained different rail revenues.Table 5.26 and 5.27 below show the freight groups, “Coke refined petroleum products (Type 7)” and “Basic metals, fabricated metal products (Type 10)” respectively. In both freight groups, no city plays a leading role as a rail freight attraction center.

5.3.5 Line Density Analysis

The railway density analysis has been performed on the digital railway map formed within the scope of this . The thematic map shown in Figure 5.7 below has been created for the period between 2011 and 2014. The total line length used for these analyses has been calculated as approximately 8,000 km. Line density analyses have been carried out for the period between 2011-2014 on the railway line considered within the scope of this study. During the analysis, the shortest rail line used for the freight transportation has been assumed by using Djkastra Shortest Path formulas, since the used railway route could not be determined exactly. In this assumption, closed railway lines and combined cargo transportation have been ignored.

After the aforementioned assumptions, it has found out that the Malatya-Hatay line is the busiest line with 18 million tons of freight transport in total for the related time period. The major factors behind the intensity of freight transport on this line are İskenderun Port and İskenderun Iron and Steel Co. The second busiest railway line has been determined as Niğde-Adana-Osmaniye railway line with approximately 11 million tons of freight transport. Additionally, Sivas-Malatya, Irmak-Karabük-Zonguldak and Niğde-Adana railway lines have carried over 10 million tons freight in total.

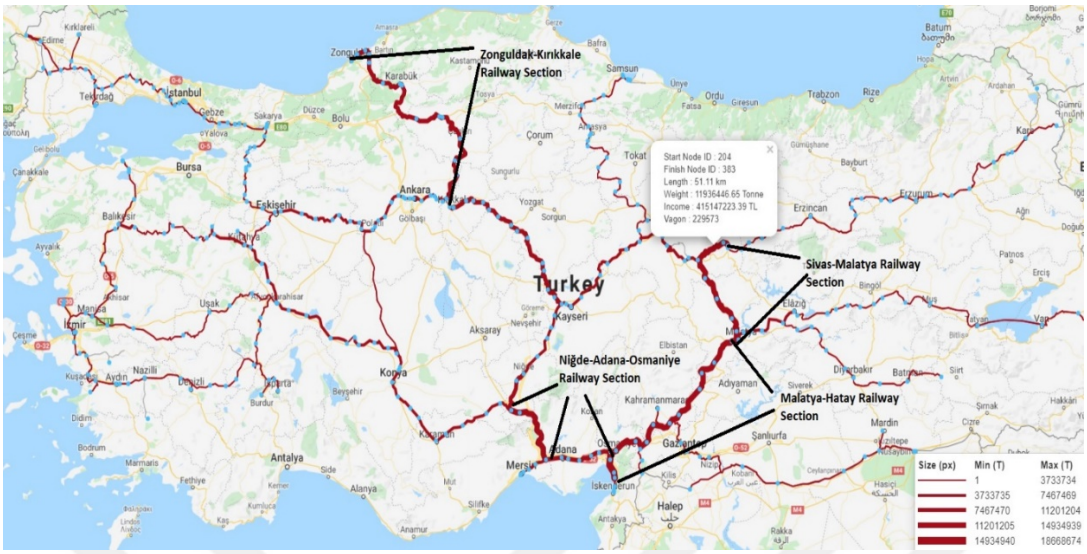

Figure 5.7. Line Density Analyse Result for Before Period

5.3.6 Trend Analysis for Rail Freight Sector

In this section, the trend analysis done for the before period by using the statistic between 2001 and 2014. Trend Analysis is a statistical technique that tries to determine future movements of a given variable by analyzing historical trends. In other words, it is a method that aims to predict future behaviors by examining past ones.The transported net tonne of transition period which is accepted as before period, does not considered in this analysis since irregular statistics recorded for the related process. In scope of the analysis, the data between 2001 and 2014 analysed and the best fits for the trendline created and shown on the Table 5.28.

As it is stated before that the Transition Period shown unexpected fall compare with prior years. There are three trendline analysis have been done in the scope of this chapter and clearly seen that non of them provide an approximate value for actual Transition period statistics. The polynomial (2^{nd} order) display the best performance for both time period (2001-2014) and Transition Period. The most suitable trendline formula (polynomial 2nd degree) transition period and the rail freight transport values that will occur until 2025 have been estimated in the absence of deregulation

(see Figure 5.8). The selected trendline formula generates 11% and 14% absolute errors for 2015 and 2016, respectively.

Table 5.28 The results obtained from the trend analysis for before period

			2015	**2016**
Actual Transported Net-tones (thousand)			25878	25886
Estimated Transported Net-tones (BAU-BP) (thousand)				
Trendline	**Formula**	**R^2**		
(1) Linear	$y = 1061.1x + 13402$	0.9721	29319	30380
(2) Exponental	$y = 14213e^{0.0514x}$	0.9564	30655	32267
(3) Polynomial	$y = -11.859x^2 + 1239x + 12927$	0.9737	28709	29580

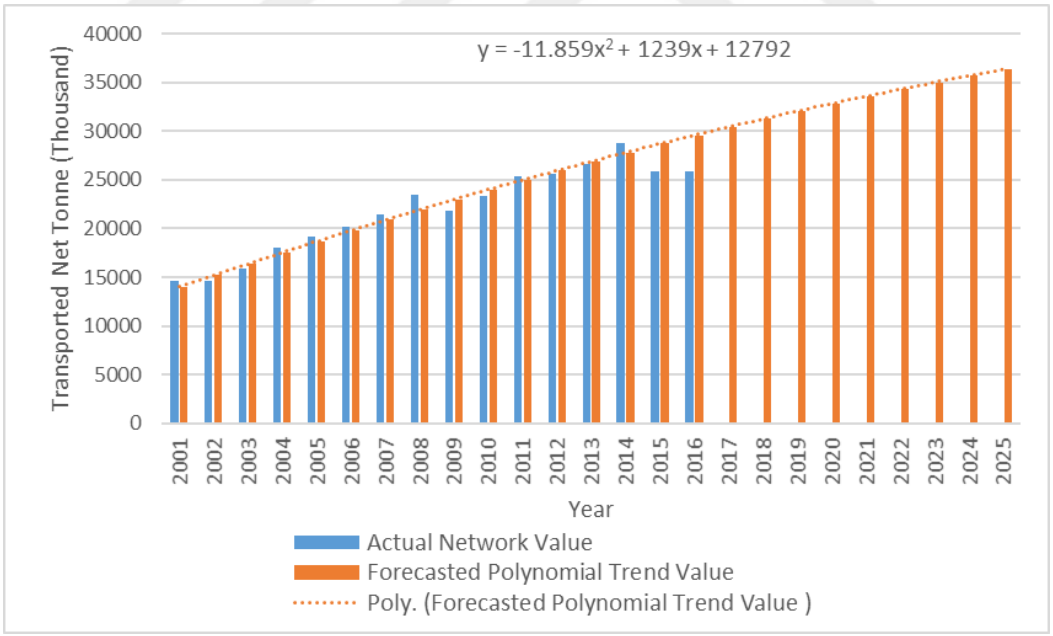

Figure 5.8. Forecasted Polynomial Trend Value

CHAPTER 6

CHARACTERISTICS OF RAIL FREIGHT IN TURKEY : IN THE LIGHT OF DEREGULATION

6.1 Rail Freight Transport for the Post-Liberalization Period

As is mentioned before, Turkish railway reform has passed into law in 2013 (Law No. 6461 on the Liberalization of Railway Transportation in Turkey) and put into effect as of 2017 (with the launch of TCDD Taşımacılık A.Ş.). With the enaction of Law No. 6461, Turkish State Railway (TCDD) has been divided into two organizations and TCDD Taşımacılık A.Ş. (TCDD Transport JSC) has been established. Within the scope of this restructuring, TCDD Taşımacılık A.Ş. (TCDD-T JSC) has become a train operator, which is responsible for freight and passenger services while TCDD has been assigned as the infrastructure operator. Unlike the previous Chapter 4, this Chapter includes the railway analyses of the data of TCDD-T. As of 2017, some private companies apart from TCDD-T, "the incumbent operator", have entered into the Turkish freight transport sector such as OMSAN Logistics. In this study, these private companies will be called as "new entrants". In this Chapter, firstly, the new period (2017-2018) performance of TCDD-T will be examined and comparison with TCDD's pre-reform period (2011-2014) will be made. Secondly, the new period performance of TCDD, the infrastructure manager, will be analysed. In this context, the total performance of both TCDD-T and the other new entrants will be analysed and post-reform performance will be predicted. Similar to the pervious section, this part will examine the early post-liberalization period (2017-2018), by performing production, attraction, line density and commodity-based analyses, in terms of the stations/cities that transport the most freight, as well as the commodity types that are transported the most. After that, the findings that are

obtained from these analyses will be used to compare pre-reform period (2011-2014) and the TCDD-T's performance in the early post-liberalization period (2017-2018).

6.1.1 Commodity Based Rail Freight Statistics

TCDD-T, the incumbent operator, has considerably lost its Type-3 freight transport potential. Since particular bulk-type freight are used as raw materials and they aren't so suitable for road transport, it is considered that the freight lost by TCDD-T has been transported by the new entrants. In addition, Type-2 and Type-10 commodity groups, which are also accepted as bulk-type freight, have lost almost 10% loss in their transportation by rail. Nonetheless, Type-9, Type-12, Type-8 and Type-7 freight transports have showed increase. Considering the obtained rail revenue by commodity groups, it has been observed that, Type-3 freight transports have generated the highest revenue with approximately 210 million TL. The second highest revenue has been earned via Type-2 freight transports with 115 million TL. Significant revenue loss has been seen in both commodity groups compared to previous periods (See Table 6.1 and 6.2).

Table 6.1 Transported Net Weight- Commodity for Post Reform Period

	Net weight (tons) $x10^6$			
Type	**2017**	**2018**	**Avg. AP**	**AP(%)**
0	0.01	0.01	0.01	0.0
1	0.16	0.36	0.26	0.9
2	3.53	3.91	3.72	13.6
3	8.21	6.88	7.54	27.5
4	0.26	0.43	0.35	1.3
5	0.06	0.06	0.06	0.2
6	0.27	0.19	0.23	0.9
7	2.25	2.12	2.19	8.0
8	1.85	2.42	2.13	7.8
9	4.74	5.34	5.04	18.4
10	1.23	1.31	1.27	4.6
11	0.95	0.90	0.93	3.4
12	3.07	3.56	3.32	12.1
13	0.29	0.35	0.32	1.2
14	<0.01	<0.01	<0.01	0.0
15	<0.01	<0.01	<0.01	0.0
16	<0.01	<0.01	<0.01	0.0
17	<0.01	0.01	0.01	0.0
18	<0.01	<0.01	<0.01	0.0
19	<0.01	<0.01	<0.01	0.0
20	0.05	0.05	0.05	0.2

Table 6.2 Transport Revenue and Unit Cost -Commodity For Post Reform Period

	Revenue($x10^6$)		**Unit cost(TL/Tonne)**	
Type	**2017**	**2018**	**2017**	**2018**
0	0.16	0.32	27.90	45.87
1	3.63	10.70	23.18	29.98
2	90.45	142.56	25.62	36.51
3	233.00	190.81	28.39	27.74
4	4.77	9.98	18.08	23.26
5	1.72	2.47	30.72	42.28
6	11.27	10.07	41.14	52.11
7	91.76	94.49	40.74	44.51
8	39.94	62.78	21.61	25.94
9	49.03	67.54	10.34	12.64
10	40.19	45.71	32.62	34.92
11	18.28	21.27	19.21	23.51
12	67.12	87.19	21.89	24.46
13	7.04	10.21	24.67	28.81
14	<0.01	<0.01	<0.01	<0.01
15	<0.01	<0.01	<0.01	<0.01
16	<0.01	<0.01	<0.01	<0.01
17	0.04	0.36	38.83	37.71
18	<0.01	<0.01	<0.01	<0.01
19	<0.01	<0.01	<0.01	3.10
20	6.12	6.67	130.49	129.18

6.1.2 City Based Rail Freight Statistics

This period shows the major difference compare with the before period for both revenue and net tone based level. Hatay and Karabük have almost similar portion on the rail freight mobility with more than 10%. Also, these cities in cumulative attract total 37% of the total attracted weight in the railway network. Additionally, Zonguldak come to front with highest production net value with 12% of the total produced net weight. (See Table 6.3)

Hatay and Karabük have also highest mobility in terms of the revenue with total 20% of the overall revenue for stated years. These cities bring this revenue from the attraction revenues. Kayseri and Kütahya also have major contribution to overall revenues different portion from the transported net value do. (See Table 6.4)

Table 6.3 Transported Net Values (x10^6 tonnes)- Cities for Post Reform Period

	Attraction Net Value				Production Net Value				
City	**2017**	**2018**	**T-ANV**	**%**	**2017**	**2018**	**T-PNV**	**%**	**CrIndex**
HATAY	4.91	3.52	8.42	16.69	1.59	1.74	3.33	6.13	11.41
KARABUK	4.73	5.61	10.33	20.48	0.23	0.27	0.49	0.91	10.69
ZONGULDAK	0.31	0.30	0.61	1.22	2.97	3.55	6.52	12.00	6.61
MERSIN	2.19	2.14	4.34	8.60	0.65	1.24	1.90	3.50	6.05
KAYSERI	0.74	1.00	1.74	3.45	2.14	2.30	4.43	8.16	5.81
IZMIR	1.44	1.18	2.62	5.19	1.29	0.97	2.26	4.17	4.68
SIVAS	0.38	0.28	0.66	1.30	3.11	1.22	4.34	7.98	4.64
KOCAELI	1.47	1.38	2.85	5.64	1.04	0.85	1.88	3.47	4.55
KIRIKKALE	0.75	0.74	1.49	2.95	1.74	1.37	3.11	5.72	4.33
KUTAHYA	0.26	0.30	0.56	1.11	1.71	2.03	3.74	6.88	4.00
ELAZIG	0.92	1.01	1.92	3.81	0.84	0.98	1.83	3.36	3.59
BALIKESIR	1.21	1.17	2.38	4.71	0.54	0.47	1.00	1.85	3.28
MALATYA	0.24	0.28	0.53	1.05	1.16	1.44	2.60	4.79	2.92
NIGDE	0.24	0.27	0.51	1.00	1.29	1.16	2.45	4.51	2.76
KONYA	0.78	0.78	1.55	3.07	0.49	0.59	1.08	1.99	2.53
BINGOL	0.20	0.25	0.45	0.90	0.98	1.02	1.99	3.67	2.28
MANISA	0.30	0.36	0.66	1.31	0.44	0.55	1.00	1.83	1.57
GAZIANTEP	0.50	0.61	1.11	2.20	0.13	0.11	0.24	0.43	1.32
VAN	0.21	0.40	0.61	1.22	0.47	0.26	0.73	1.34	1.28
ISTANBUL	0.17	0.66	0.84	1.66	0.18	0.24	0.42	0.76	1.21
ESKISEHIR	0.16	0.17	0.33	0.66	0.44	0.42	0.86	1.58	1.12
ANKARA	0.59	0.23	0.82	1.63	0.22	0.10	0.32	0.58	1.11
AYDIN	0.20	0.14	0.34	0.68	0.40	0.39	0.78	1.44	1.06
ERZURUM	0.20	0.17	0.37	0.73	0.28	0.33	0.61	1.12	0.92
MARAS	0.16	0.24	0.40	0.79	0.19	0.33	0.52	0.96	0.87
DENIZLI	0.22	0.14	0.36	0.72	0.28	0.27	0.55	1.01	0.87
TEKIRDAG	0.01	0.38	0.40	0.79	0.17	0.29	0.46	0.84	0.81
AFYON	0.19	0.15	0.34	0.67	0.22	0.25	0.47	0.87	0.77
ERZINCAN	0.31	0.35	0.67	1.32	0.05	0.07	0.11	0.21	0.77
DIYARBAKIR	0.11	0.39	0.50	0.99	0.06	0.12	0.17	0.32	0.66
EDIRNE	0.04	0.08	0.11	0.22	0.16	0.42	0.58	1.06	0.64
BATMAN	0.14	0.20	0.34	0.67	0.10	0.14	0.24	0.44	0.55
BITLIS	0.30	0.14	0.43	0.86	0.03	0.04	0.08	0.14	0.50
ADANA	0.10	0.13	0.22	0.44	0.14	0.11	0.26	0.47	0.46
ISPARTA	0.16	0.20	0.36	0.71	0.03	0.04	0.07	0.13	0.42
BILECIK	0.18	0.11	0.29	0.58	0.06	0.07	0.13	0.24	0.41
KIRKLARELI	<0.01	0.13	0.13	0.27	0.08	0.12	0.20	0.36	0.32
MUS	0.08	0.11	0.19	0.38	0.06	0.03	0.09	0.16	0.27
OSMANIYE	0.07	0.06	0.13	0.26	0.12	0.02	0.14	0.25	0.26
SAKARYA	0.09	0.02	0.11	0.21	0.11	0.05	0.16	0.29	0.25
BURDUR	0.10	0.08	0.17	0.34	0.02	0.02	0.05	0.09	0.21
CANKIRI	0.02	0.04	0.06	0.12	0.01	0.13	0.15	0.27	0.20
YOZGAT	0.03	0.03	0.05	0.10	0.13	0.02	0.15	0.28	0.19
USAK	0.04	0.07	0.12	0.23	0.03	0.03	0.05	0.10	0.17
KARS	0.06	0.05	0.12	0.24	0.01	0.01	0.02	0.04	0.14
SAMSUN	0.02	0.06	0.08	0.16	0.02	0.03	0.05	0.09	0.12
ADIYAMAN	0.03	0.06	0.09	0.18	<0.01	<0.01	<0.01	<0.01	0.09
SIIRT	0.04	0.02	0.06	0.12	<0.01	0.01	0.01	0.01	0.06
KARAMAN	<0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
AMASYA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MARDIN	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TOKAT	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SANLIURFA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Table 6.4 Transport Revenue (x10^6TL)- Cities for Post Reform Period

	Attraction Revenue				Production Revenue				
City	**2017**	**2018**	**T-AR**	**%**	**2017**	**2018**	**T-PR**	**%**	**CrIndex**
HATAY	134.04	75.02	209.06	15.40	39.66	43.27	82.93	5.91	10.65
KARABUK	105.35	129.79	235.14	17.32	14.04	14.90	28.94	2.06	9.69
KAYSERI	22.29	25.92	48.22	3.55	66.96	81.42	148.38	10.57	7.06
KUTAHYA	5.74	6.38	12.12	0.89	62.85	102.31	165.16	11.76	6.33
SIVAS	8.05	7.45	15.51	1.14	114.94	45.59	160.53	11.43	6.29
KIRIKKALE	20.18	29.22	49.39	3.64	69.10	54.32	123.41	8.79	6.21
KOCAELI	48.78	46.61	95.39	7.03	26.58	29.32	55.90	3.98	5.50
MERSIN	33.27	38.91	72.18	5.32	27.99	36.13	64.12	4.57	4.94
ELAZIG	18.40	23.84	42.24	3.11	16.55	20.09	36.64	2.61	2.86
BALIKESIR	27.02	28.22	55.24	4.07	12.13	10.48	22.61	1.61	2.84
MANISA	1.81	2.60	4.41	0.32	25.73	44.31	70.04	4.99	2.66
MALATYA	9.86	13.26	23.12	1.70	19.77	30.17	49.93	3.56	2.63
BINGOL	8.55	14.82	23.37	1.72	19.27	26.24	45.51	3.24	2.48
ZONGULDAK	2.78	2.80	5.58	0.41	27.39	35.96	63.34	4.51	2.46
VAN	15.20	38.50	53.69	3.95	6.94	4.60	11.55	0.82	2.39
KONYA	14.36	16.86	31.22	2.30	10.92	14.66	25.57	1.82	2.06
GAZIANTEP	18.73	22.71	41.44	3.05	5.35	5.81	11.16	0.80	1.92
IZMIR	11.62	12.12	23.73	1.75	14.35	14.51	28.86	2.06	1.90
BATMAN	10.94	14.47	25.41	1.87	5.65	8.03	13.67	0.97	1.42
ERZURUM	13.30	14.33	27.62	2.03	3.81	4.70	8.51	0.61	1.32
DIYARBAKIR	8.96	22.10	31.06	2.29	0.75	3.34	4.09	0.29	1.29
ANKARA	16.63	6.56	23.19	1.71	5.27	4.25	9.52	0.68	1.19
ISTANBUL	1.86	15.32	17.18	1.27	5.45	8.62	14.06	1.00	1.13
BITLIS	17.31	9.73	27.04	1.99	0.69	0.86	1.55	0.11	1.05
TEKIRDAG	0.75	12.14	12.90	0.95	5.09	10.97	16.06	1.14	1.05
NIGDE	3.88	4.53	8.41	0.62	10.71	9.68	20.39	1.45	1.04
ESKISEHIR	3.59	4.01	7.59	0.56	8.37	9.49	17.87	1.27	0.92
ERZINCAN	8.93	9.11	18.04	1.33	0.83	1.60	2.43	0.17	0.75
MARAS	4.31	7.72	12.03	0.89	2.74	4.91	7.65	0.54	0.72
MUS	7.17	10.82	17.99	1.33	0.44	0.79	1.23	0.09	0.71
AFYON	4.59	3.22	7.81	0.58	5.19	6.49	11.68	0.83	0.70
SAKARYA	3.29	0.58	3.87	0.29	8.67	5.37	14.04	1.00	0.64
ADANA	2.17	2.70	4.87	0.36	5.27	6.59	11.86	0.84	0.60
DENIZLI	3.70	3.08	6.78	0.50	4.28	4.62	8.90	0.63	0.57
KARS	5.98	6.89	12.87	0.95	0.54	0.90	1.45	0.10	0.53
CANKIRI	0.96	3.24	4.20	0.31	1.42	8.13	9.55	0.68	0.49
AYDIN	2.59	2.37	4.95	0.36	3.42	2.73	6.15	0.44	0.40
OSMANIYE	1.98	4.24	6.22	0.46	3.66	0.41	4.07	0.29	0.37
ISPARTA	2.78	3.94	6.72	0.49	1.04	1.46	2.50	0.18	0.34
KIRKLARELI	0.28	4.03	4.31	0.32	2.69	2.24	4.93	0.35	0.33
EDIRNE	1.36	1.39	2.75	0.20	1.76	4.66	6.42	0.46	0.33
ADIYAMAN	2.98	4.79	7.76	0.57	0.01	0.01	0.02	<0.01	0.29
SIIRT	2.64	2.29	4.92	0.36	0.01	0.33	0.35	0.02	0.19
YOZGAT	0.35	0.98	1.33	0.10	1.76	1.30	3.06	0.22	0.16
BILECIK	1.15	1.30	2.45	0.18	0.86	0.75	1.61	0.11	0.15
SAMSUN	0.30	0.96	1.26	0.09	0.94	1.67	2.62	0.19	0.14
BURDUR	1.18	1.01	2.19	0.16	1.07	0.33	1.40	0.10	0.13
USAK	0.39	0.78	1.17	0.09	0.75	1.06	1.80	0.13	0.11
KARAMAN	0.72	1.10	1.82	0.13	<0.01	0.04	0.04	<0.01	0.07
AMASYA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
MARDIN	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
TOKAT	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
SANLIURFA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

6.1.3 Station Based Rail Freight Statistics

The findings that are obtained as a result of the analyses conducted have shown significant changes in the rankings of the stations that transported the most freight in the period of 2017-2018 compared to previous period. It has seen that Çatalağzı (Zonguldak), Yahşihan (Kırıkkale) and Yeşilhisar (Kayseri) stations produced 1.89 million tons, 1.55 million tons and 1.49 million tons of freight respectively. Çatalağzı Station has started to play a leading role in the transportation of imported raw materials and fuel after Filyos Port in the region has been put into operation. However, it is known that the freight loaded in this station is transported to shorter distance (Çatalağzı Thermal Power Plant and Kardemir Iron-Steel Factory). Therefore, the revenue generated has not been parallel with the freight volume transported. Yahşihan (Kırıkkale) station has produced the second most freight and has generated the highest rail revenue for the period between 2017 and 2018. Yahşihan station has been used for the crude oil transport to the fuel processing plants located near-by, hence dangerous goods transportation has been performed in this station. It has seen that, Demirdağ (Sivas) Station, which has produced the most freight (yearly average transport volume of over 2.5 million tons) in the pre-reform period of 2011-2014 and even in the transition period of 2015-2016, could not keep its first place in the freight portfolio of TCDD-T (ranked 6th for the period between 2017-2018). Similarly, it can be clearly seen that Yeşilhisar (Kayseri) station has produced 0.3 million tons less freight yearly on average compared to the pre-reform period. It is also obvious that, the freight coming from BG001 Station, which represents the Bulgarian Border Gate, has lost almost half of its potential significantly (annual average of 1.04 Mtonne between 2011-2014 and yearly average of 0.52 Mtonne between 2017 and 2018). In addition, Suveren, Yarımca and Gümüş stations have ranked among the top 10 stations in terms of rail freight production compared to pre-reform period. Lastly, it is seen that Mersin and Halkapınar stations have not produced considerable amount of freight after the railway reform.

Table 6.5 Produced Transport Net Value (x10^6Tonnes) and Revenue(x10^6TL) for Post Reform

Origin Station	City	TNV	TNR	TNV%	TNR%	CrIndex
Yahsihan	Kırıkkale	3.10	123.18	5.65	8.55	7.10
Yesilhisar	Kayseri	2.98	106.79	5.42	7.41	6.42
Demirdag	Sivas	2.06	86.08	3.76	5.98	4.87
Catalagzi	Zonguldak	3.77	33.64	6.87	2.34	4.60
Hekimhan	Malatya	2.35	44.88	4.28	3.12	3.70
Zonguldak	Zonguldak	2.77	29.09	5.04	2.02	3.53
Tuncbilek	Kütahya	1.17	67.42	2.13	4.68	3.41
Suveren	Malatya	1.97	44.84	3.58	3.11	3.35
Payas	Hatay	1.73	46.35	3.15	3.22	3.18
Degirmenozu	Kütahya	1.86	42.72	3.39	2.97	3.18
Soma	Manisa	0.66	65.01	1.20	4.51	2.85
Yarimca	İzmit	1.35	39.78	2.46	2.76	2.61
Seyitomer	Kütahya	0.43	49.18	0.78	3.41	2.10
BG001	Edirne	1.04	32.49	1.89	2.26	2.07
Divrigi	Sivas	0.93	33.09	1.69	2.30	2.00
Mersin	Mersin	0.82	34.65	1.50	2.41	1.95
Bogazkopru	Kayseri	0.85	22.81	1.56	1.58	1.57
Bicerova	İzmir	0.92	19.65	1.67	1.36	1.52
Muratbagi	Elazığ	0.84	15.71	1.52	1.09	1.31
Ulku	Karabük	0.46	23.85	0.83	1.66	1.24
Kemaliye Calti	Erzincan	0.36	23.91	0.66	1.66	1.16
Gumus	Niğde	1.11	3.73	2.02	0.26	1.14

Table 6.6 Attraction Transport Net Value (x10^6Tonnes) and Revenue(x10^6TL) for Post Reform

Destination Station Name	City	TNV	TNR	TNV%	TNR%	CrIndex
Ulku	Karabük	10.31	235.07	18.77	16.32	17.54
Payas	Hatay	6.95	178.80	12.65	12.41	12.53
Yarimca	Izmit	2.06	81.36	3.75	5.65	4.70
Yahsihan	Kırıkkale	1.46	48.76	2.66	3.38	3.02
Mersin	Mersin	1.59	35.09	2.89	2.44	2.66
BG001	Edirne	1.12	42.64	2.04	2.96	2.50
Baspinar	Antep	1.05	36.74	1.91	2.55	2.23
Yenice	Mersin	1.97	11.80	3.59	0.82	2.20
BG002	Van	0.65	39.79	1.18	2.76	1.97
Van Gar	Van	0.35	45.08	0.64	3.13	1.89
Bogazkopru	Kayseri	0.93	29.55	1.69	2.05	1.87
Alsancak	Izmir	1.58	9.48	2.88	0.66	1.77
Bandirma Gar	Balıkesir	1.09	22.08	1.98	1.53	1.76
Kuscenneti	Balıkesir	0.83	24.79	1.50	1.72	1.61
Horozluhan	Konya	0.78	18.38	1.43	1.28	1.35
Tatvan Gar	Van	0.43	27.02	0.79	1.88	1.33
Tirmil	Mersin	0.65	18.17	1.18	1.26	1.22
Erzincan	Erzincan	0.66	17.26	1.20	1.20	1.20
Batman	Batman	0.34	25.41	0.62	1.76	1.19

In this chapter, the overall characteristic of the rail freight transport in the light of railway reforms both before and after periods. The transition period is not mainly considered for the overall evaluation since it is irregular performances. In the first section overall demand characteristics revealed by considering the production-attraction centres and major commodities during the before period between 2011 and 2014. After that, the early impact of the railway reforms shown in section 6.3. Finally, the predictions done by considering the period between 2019 and 2021.

Similar to the Chapter 5, this part examine the early post-liberalization period (2017-2018), by performing production, attraction, line density and commodity-based analyses, in terms of the stations/cities that transport the most freight, as well as the commodity types that are transported the most. After that, the findings that are obtained from these analyses will be used to compare pre-reform period (2011-2014) and the TCDD-T's performance in the early post-liberalization period (2017-2018).

Figure 6.1 Line Density Map for 2017-2018

The findings that are obtained as a result of the analyses conducted have shown significant changes in the rankings of the stations that transported the most freight in the period of 2017-2018 compared to previous period. It has seen that Çatalağzı (Zonguldak), Yahşihan (Kırıkkale) and Yeşilhisar (Kayseri) stations produced 1.89 million tons, 1.55 million tons and 1.49 million tons of freight respectively. Çatalağzı Station has started to play a leading role in the transportation of imported raw

materials and fuel after Filyos Port in the region has been put into operation. However, it is known that the freight loaded in this station is transported to shorter distance (Çatalağzı Thermal Power Plant and Kardemir Iron-Steel Factory). Therefore, the revenue generated has not been parallel with the freight volume transported. Yahşihan (Kırıkkale) station has produced the second most freight and has generated the highest rail revenue for the period between 2017 and 2018. Yahşihan station has been used for the crude oil transport to the fuel processing plants located near-by, hence dangerous goods transportation has been performed in this station. It has seen that, Demirdağ (Sivas) Station, which has produced the most freight (yearly average transport volume of over 2.5 million tons) in the pre-reform period of 2011-2014 and even in the transition period of 2015-2016, could not keep its first place in the freight portfolio of TCDD-T (ranked 6th for the period between 2017-2018). Similarly, it can be clearly seen that Yeşilhisar (Kayseri) station has produced 0.3 million tons less freight yearly on average compared to the pre-reform period. It is also obvious that, the freight coming from BG 001 Station, which represents the Bulgarian Border Gate, has lost almost half of its potential significantly (annual average of 1.04 Mtonne between 2011-2014 and yearly average of 0.52 Mtonne between 2017-2018). In addition, Suveren, Yarımca and Gümüş stations have ranked among the top 10 stations in terms of rail freight production compared to pre-reform period. Lastly, it is seen that Mersin and Halkapınar stations have not produced considerable amount of freight after the railway reform.

Table 6.7 The Stations with an Annually- Produced Freight Load

Origin Station	City	Yearly Average net weight (Mtonne)	Yearly Average Revenue (MTL)	Yearly Average Wagon
Çatalağzı	Zonguldak	1.89	16.82	38,522
Yahşihan	Kırıkkale	1.55	61.60	29,910
Yeşilhisar	Kayseri	1.49	53.40	27,553
Zonguldak	Zonguldak	1.38	14.54	27,001
Hekimhan	Malatya	1.17	22.44	26,300
Demirdağ	Sivas	1.03	43.04	18,966
Suveren	Malatya	0.98	22.42	17,576
Değirmenözü	Kütahya	0.93	21.36	17,584
Payas	Hatay	0.87	23.16	40,836
Yarımca	Izmit	0.67	19.87	20,511
Tunçbilek	Kütahya	0.58	32.61	13,616
Gümüş	Niğde	0.56	1.86	8,145
BG001	Edirne	0.52	16.24	14,458

Zonguldak is the city which produced the most freight in the period of 2017-2018 while Sivas produced the most freight in the period of 2011-2014. Zonguldak is followed by Kayseri, Sivas and Kütahya. In terms of the revenue generation, Kütahya, Sivas and Kayseri have gained the highest revenue. On the other hand, even though Zonguldak has produced the most freight (3.27 Mtonne), it has generated less revenue in parallel with the proximity of stations to the city. (see Figures 6.2 and 6.3)

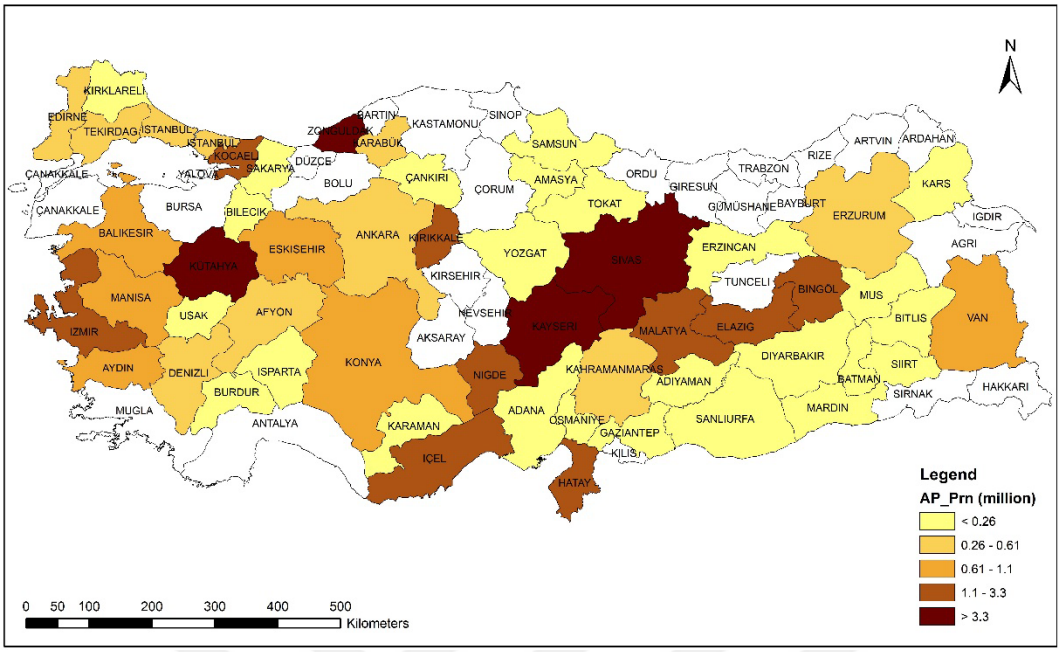

Figure 6.2 Total Production Net Weight Map for After Period

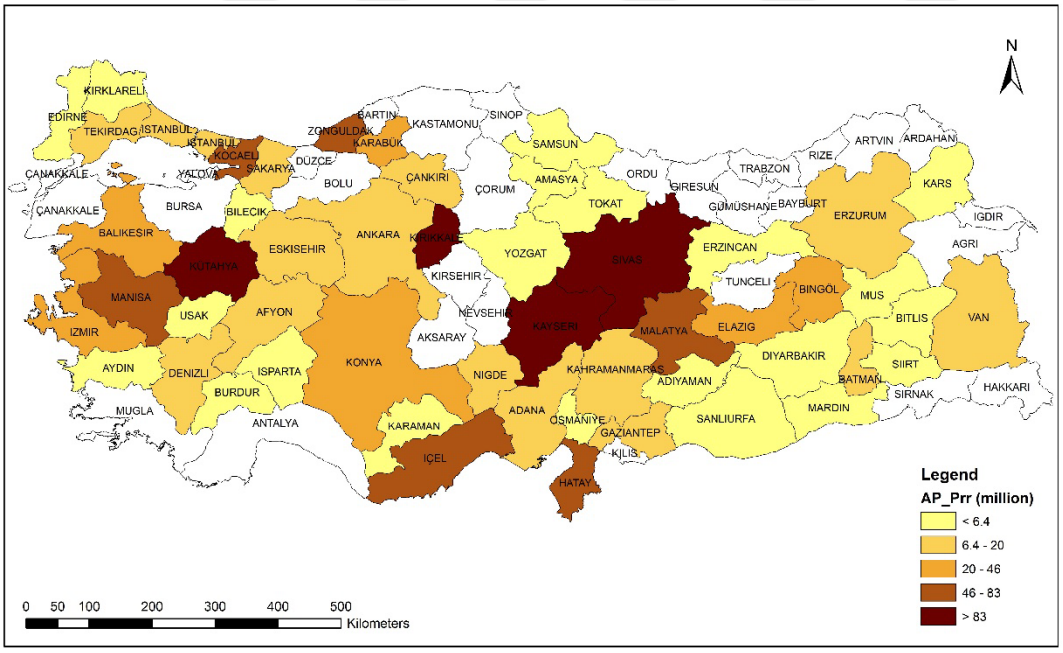

Figure 6.3 Total Production Revenue Map for After Period

Similar to pre-reform period (2011-2014), the attraction analysis has also been conducted at the station/city level, for the post-liberalization period (2017-2018). According to the findings of attraction analyses, Payas (Hatay) station, which has attracted the most freight and earned highest income with 4.34 Mtonne and 103.77 MTL for the pre-reform period (2011-2014), has lost its freight by 25% while attracting 3.47 Mtonne of freight and generating 89.37 MTL of income, during early post-liberalization period (2017-2018). Similarly, Ülkü (Karabük) station, which has attracted the second most freight (4,11 Mtonne) and has generated the second highest income (94.64 MTL) during the pre-reform period, has increased its freight attraction capacity to 5,16 Mtonne and income generation to 117,53 MTL in annual total during the early post-liberalization period. Whereas Yarımca and Yenice stations have attracted too small freight quantities to be considered in the period of 2011-2014, they have become important freight attraction centers for TCDD-T by attracting about 1 Mtonne of freight yearly on average between 2017-2018.

Considering the city-based analyses, Karabük (Ülkü station) and Hatay (Payas station) are the cities which have attracted the most freight in parallel with the station-based analyses. Both cities have generated over 100 million TL rail freight income on average per year. Also, as in the period of 2011-2014, Mersin, Kocaeli, İzmir and Balıkesir have attracted over 1 million tons of freight, which is more than the total freight quantity attracted by the other cities (See Figure 6.4 and 6.5)

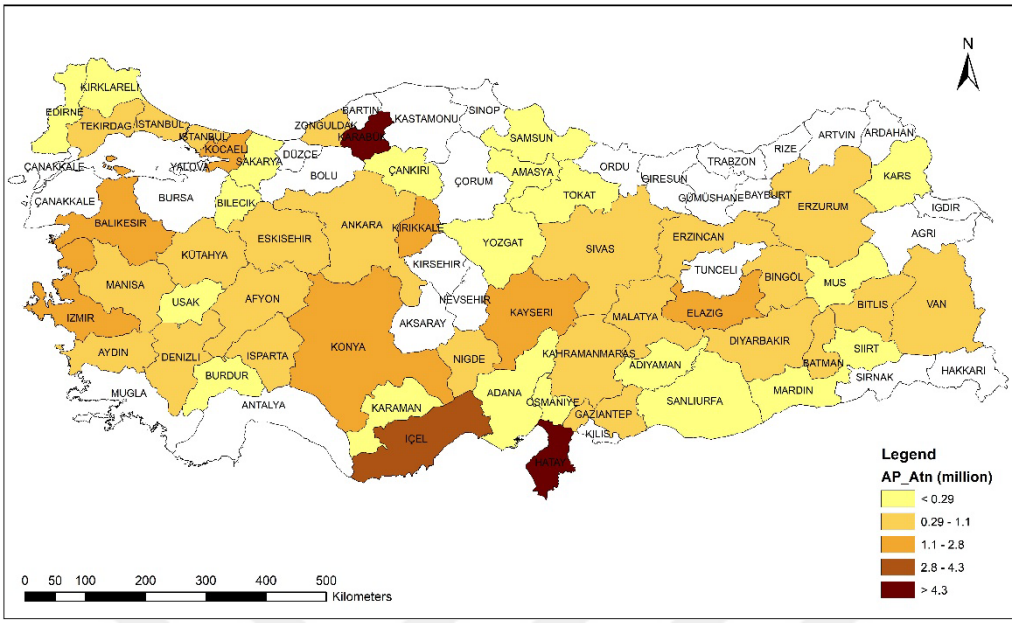

Figure 6.4 Total Attraction Net Value Map for After Period

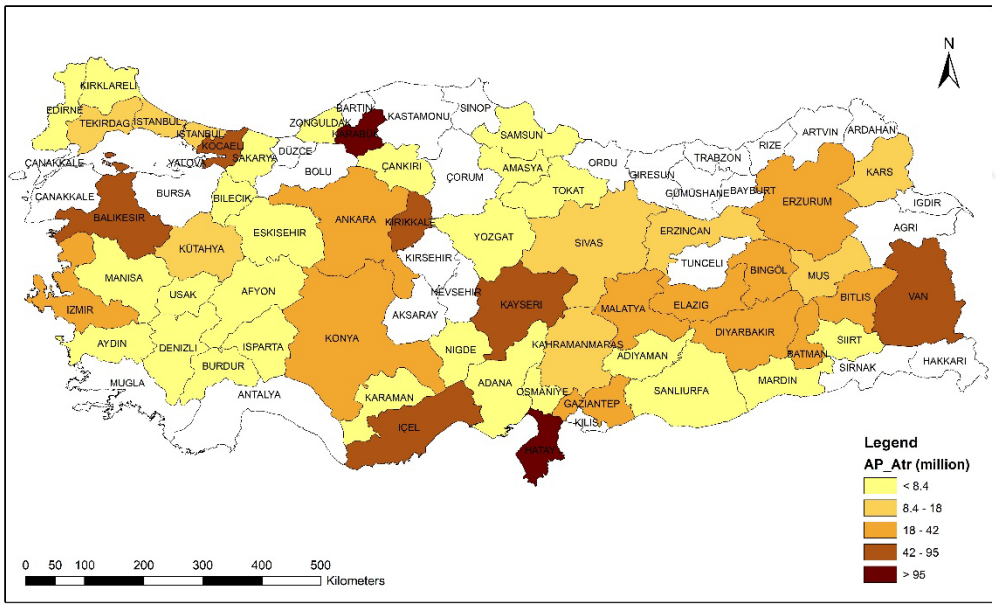

Figure 6.5 Total Attraction Revenue Map for After Period

TCDD-T, the incumbent operator, has considerably lost its Type-3 freight transport potential. Since particular bulk-type freight are used as raw materials and they are not so suitable for road transport, it is considered that the freight lost by TCDD-T has been transported by the new entrants. In addition, Type-2 and Type-10

commodity groups, which are also accepted as bulk-type freight, have lost almost 10% loss in their transportation by rail. Nonetheless, Type-9, Type-12, Type-8 and Type-7 freight transports have showed increase. Considering the obtained rail revenue by commodity groups, it has been observed that, Type-3 freight transports have generated the highest revenue with approximately 210 million TL. The second highest revenue has been earned via Type-2 freight transports with 115 million TL. Significant revenue loss has been seen in both commodity groups compared to previous periods.

Table 6.8 Yearly Material based Production

Commodity Group	Code	Yearly net weight (Mtonne)	Yearly total revenue (MTL)	Yearly total wagon
Metal ores and other mining products	3	7.54	211.94	138,961
Other non-metallic mineral products	9	5.05	58.49	106,591
Coal and lignite, peat, crude petroleum	2	3.71	115.53	83,129
Transport equipment	12	3.32	78.43	242,789
Coke refined petroleum products	8	2.19	94.42	41,017
Chemicals, chemical products	7	2.13	51.91	46,514
Basic metals, fabricated metal products	10	1.27	43.05	30,537
Others	NA	2.21	63.20	77,420

6.2 Predictions for the Early Liberalization Period

In this sub-chapter, predictions have been made for the period of 2019-2025 by performing trend analysis based on the transport data (in Net tonne) published from 2001 to 2018. In this respect, the statistical grouping made for Chapter 4 within the scope of this study. As mentined before that TCDD Taşımacılık A.Ş. (TCDD Transportation JSC / TCDD-T) has been established and registered as of 14 June 2016 and has started to render rail freight and passenger services as of 1 January 2017. After this date, the statistical forecast needs to be done individualy for both companies.

6.2.1 Forecast for Rail Freight Sector

The rail freight sector have several actor after de-regulation actualisation that are incumbent operator TCDD-T and private companies such as OMSAN Logistic, Korfez Taşımacılık A.Ş etc. (TCDD, 2018). The inftastructure owner TCDD keep the overall rail transport statistics including stated companies data. In this section, the rail freight movements analysed and made forecast until 2025 by using existing data between 2001 and 2018 excluding the transition period. In this analysis, there are three trend analyses, carried out and the result shown on the Table 6.9 below.

Table 6.9 The results obtained from the trend analysis for after period

			2017	**2018**
Actual Transported Net-tones (Thousand)			28469	31673
Estimated Transported Net-tones (BAU-BP) (Thousand)				
Trendline	**Formula**	**R^2**		
(1a) Linear	$y = 981.24x + 13863$	0.9666	30544	31525
(2a) Exponental	$y = 14765e^{0.0449x}$	0.9397	31602	33049
(3a) Polynomial	$y = -17.376x^2 + 1305.7x + 12792$	0.9742	29967	30665

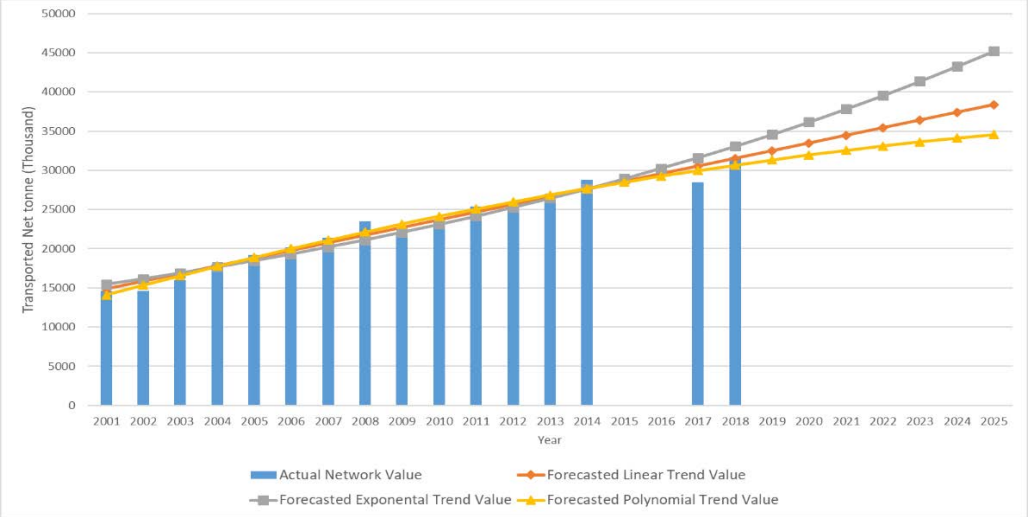

Figure 6.6: Transported Net Value- Predicted Trendlines

The best fit trendline on the observed data have been predicted by performing the second-degree polynomial trendline. According to this analysis, the best fitting curve on the data has been obtained primarily by transferring the existing data on the graph (see Figure 6.6). In parallel with trend analyses, the residual plot created with observed network value and forecasted network value by using the data from the selected trendline formula. (see Figure 6.7)

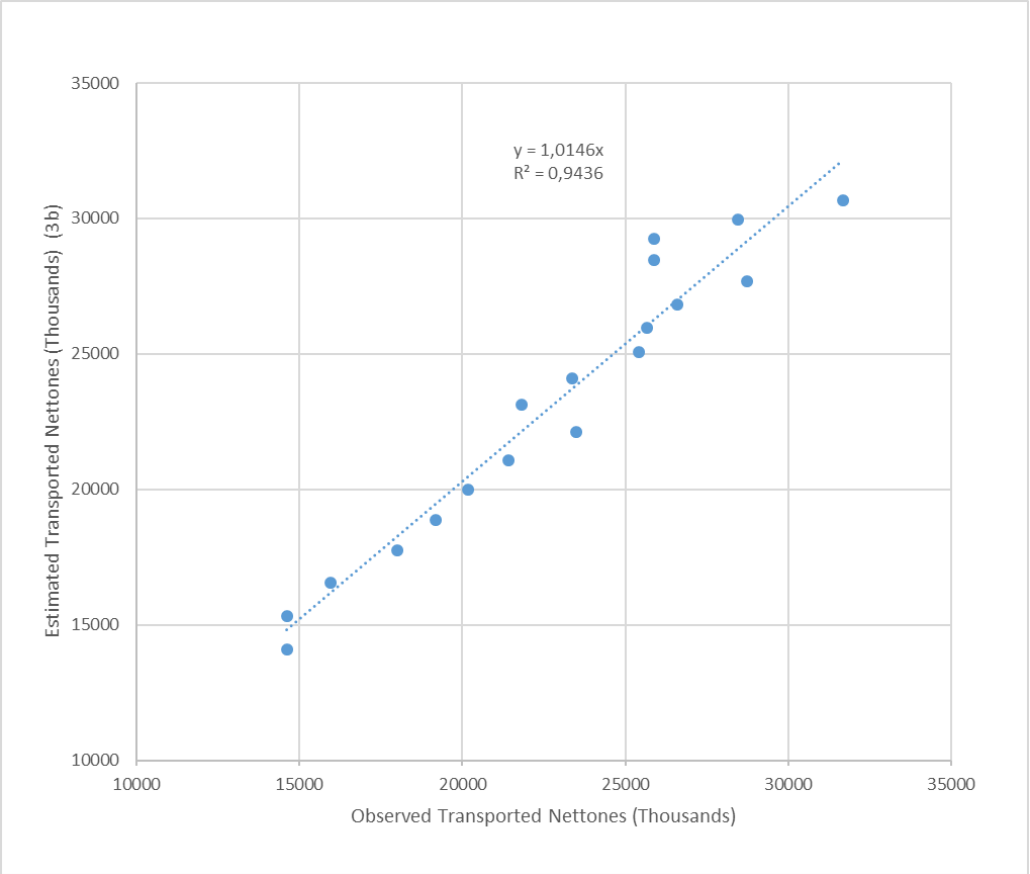

Figure 6.7: Estimated versus Observed Network Values

6.2.2 Forecast for the Incumbent Operator

The data belonging to TCDD-T, whose transportation data have been separated as of 2017, have been analyzed in Figure 6.8. similar with previous trend analyses. There are three main trendline formulas have used for the analyses. As a result of the

analysis shown on the Table 6.10, the polynomial (2nd degree) defined as the best fit in accordance with its highest R^2 value and 2017-2018 values.

Table 6.10 Trend Analysis of Incumbent Operator for After Period

			2017	**2018**
Actual Transported Net-tones (Thousands)			28430	28734
Estimated Transported Net-tones (BAU-BP) (Thousands)				
Trendline	**Formula**	**R^2**		
(1b) Linear	$y = 912.99x + 14274$	0.9467	29795	30708
(2b) Exponental	$y = 14967e^{0.0426x}$	0.9151	30810	32147
(3b) Polynomial	$y = -32.026x^2 + 15117x + 12300$	0.9757	28731	29122

Figure 6.8: TCDD-T Transported Net Value- Predicted Trendlines

Similar with overall rail freight sector trend analysis, the residual plot generated by using the observed data and forecasted values from the 2nd degree polynomial trendline formula. The resiudal values range is almost ± 2 million tonne. (see Figure 6.9)

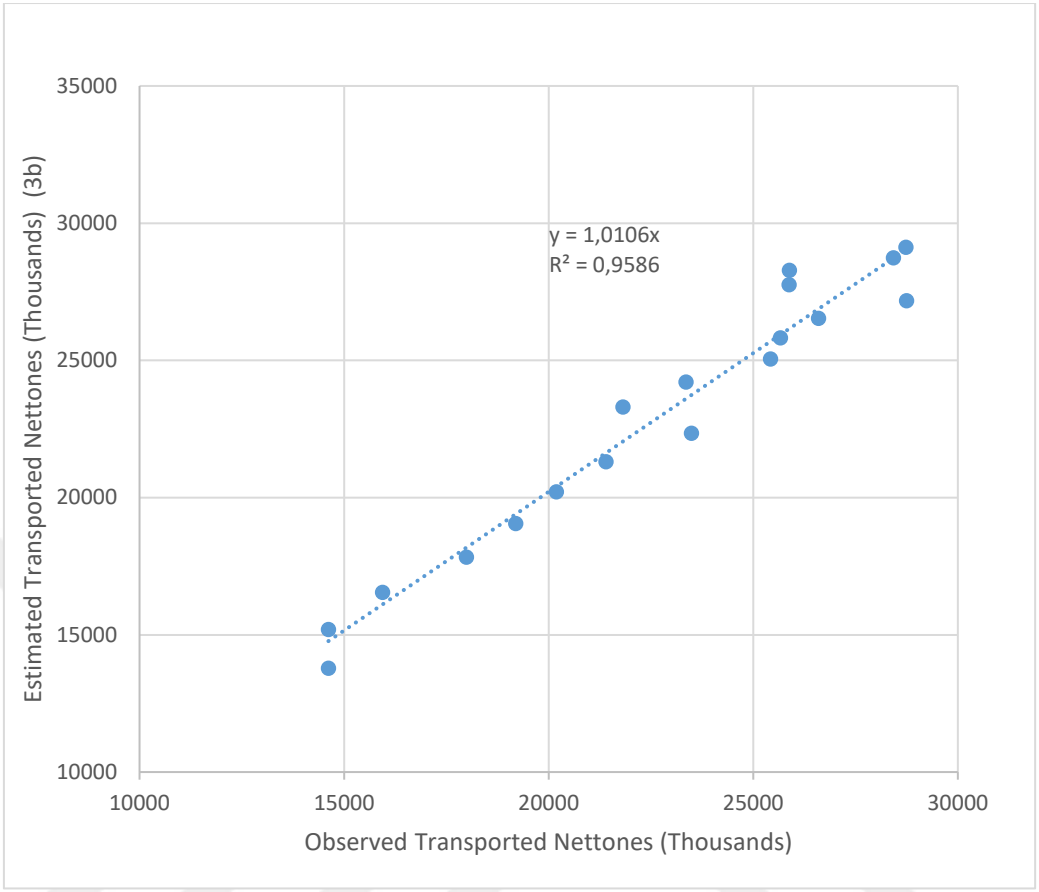

Figure 6.9: TCDD-T Estimated versus Observed Network Values

Net tonne-km values are one of the most widely-used data types within the transportation sector. These values are especially used by the sector because both the transported quantity (Net tonne) and the distance carried (Km) are significant for the cost accounting. Within the scope of this study, it has been revealed that the trends belong to the Net tonne values emerged in some years are different from the net tonne-km values. The results show the same trend in parallel with the transported net tonne values as well.

6.2.3 Impact of the Railway Reforms

TCDD and TCDD-T companies have started to show statistical differences as of 2017, with the complete realization of their organizational separation. While TCDD,

as the owner of railway network, were keeping transport data of all the railway operator companies, which carry out their freight and passenger transports on the rail infrastructure owned by TCDD, TCDD-T has recorded its own transport data only. As is seen from Table below, while 28.47 Mtonne freight have been carried out on the TCDD's network in 2017, 28.43 Mtonne of this have been transported by TCDD-T. The difference of approximately 40,000 tons of freight have been carried out by new entrants such as OMSAN Logistics.

There two different forecast methodology used in the analysis. The first one is business as usual estimations (BAU) made regarding the data for 2001 to 2014, the same results shown on the Table 6.11 since TCDD-T company did not incorporated. The result shows that BAU forecast is more appropriate for overall rail freight sector since its resource data and trends on 2017 and 2018. The second methodology for the forecast is after period (AP) demand for both TCDD and TCDD-T Companies. The resource of this forecast is the data of 2001-2018 (excluding Transition Period) and the difference has been respectively forecasted as 1.88 Mtonne, 2.25 Mtonne and 2.64 Mtonne for the years of 2019, 2020 and 2021 between two companies. This means that the new entrants companies might have higher transport rate in the future (see Table 6.11). In this process, it is expected that the existing railway transportation activities carried out by large industrial establishments will shift to new entrants companies. Railway reforms are predicted to decrease the performance and efficiency of TCDD-T while increasing the statistical performance of TCDD, which owns the infrastructure. Considering that the main goal of railway reforms is to increase the modal share rate and shift more freight from road transport, modal share calculations will be of great importance when measuring the rate of railway reform success in the near future.

Table 6.11 The Results Obtained from the Trend Analysis for After Period

	Year	Sector Total (Mtonne)	TCDD-T Total(Mtonne)	Private Total (Mtonne)	Private %
Realized					
	2017	28.469	28.430	0.039	0.14
	2018	31.673	28.734	2.939	9.28
Estimated (BAU-AP)					
	2019	31.328	29.448	1.880	6.00
	2020	31.956	29.710	2.246	7.03
	2021	32.549	29.908	2.641	8.11
	2022	33.107	30.041	3.066	9.26
	2023	33.631	30.111	3.520	10.47
	2024	34.120	30.117	4.003	11.73
	2025	34.575	30.059	4.516	13.06

6.3 Overview of Evaluation of Railway Reform in Turkey

Within the scope of the section 2.4,"*Overview of Impacts of Railway Reforms*", the key points that were revealed from the countries experiences has been summariesed. In this section first, these key point reviewed in parallel with Turkish De-regulation case. Then, the result of the analysis discussed. The de-regulation process starting from the 2013 officially shows that TCDD aimed first to vertically separate the operation and infrastructure similar with the several countries in Europe. In paralell with the figure 2.1, TCDD, single vertically integrated company started to accounting seperation and organizational seperation with transportation company, TCDD-T. Also the degree of the competition which is stated in the same figure, under the level of yardstick competition (two state owned company).

Also, the Separation Model for EU Member States (Aslan, 2012) shows the de-regulation cases in Europe in paralell with their experiences.Turkish railways de-regulation case might be put inside the regulation case C "*Legally independent infrastructure manager act as a Holding company which have its own railway*

operator company" similar with Germany, Austria, Belgium, Italy and Poland. Here the independent infrastructure manager is TCDD and under the same holding structure, it has own operator which is TCDD-T.

As a result of the analyses performed, the total quantity of freight produced by all stations within the Turkish railway network, the generated revenue, number of wagons that used in freight transport, commodity types, and destinations of the produced freight have been determined (production analysis). Secondly, the total quantity of freight attracted by all stations, the revenue generated, the number of wagons that carried the freight, commodity types, and the destinations of the attracted freight have been revealed in a similar manner (attraction analysis). As a result of the production and attraction analyses, the freight centers on the Turkish railway network have been determined, and findings of these analyses have been presented in order to be compared with post-liberalization period. In addition, the values that emerged as a result of these two analyzes have been grouped on a city basis, and the commodity types as well as the freight produced / attracted by the cities have been revealed. "Metal ores and other mining products (Type 3)" has been the highest transported commodity type prior to railway reform, with an annual transport quantity of 7.88 Mtonne. This has been followed by "Other non-metallic mineral products (Type 9)" and "Coal and lignite, peat, crude petroleum (Type 2)" commodity types with an annual transport quantity of more than 4 Mtonne. As is seen from the findings of the analyses, railway transport mode has been mostly preferred for the transportation of bulk-type freights within the Turkish freight transport sector. Railway mode has been less preferred for the commodity types that require door-to-door transport.

The stations with the highest freight production prior to railway reform have been determined as Demirdağ (Sivas), Yeşilhisar (Kayseri) and Zonguldak. These stations have been designated as freight production centers in terms of iron mine and coal mine transportation. The freight produced at these stations, which produce a large quantity of rail freight, have been mainly transported to Karabük and Hatay cities. Both destinations accommodate the country's largest iron-steel processing plants

within their borders. This situation has been proved with the determination of the stations that attracted the most freight. While Payas (Hatay) station, which is actively used by the İsdemir iron-steel factory, has attracted an average of 4.34 Mtonne of freight annually, Ülkü (Karabük) station, which is mainly used by the Kardemir iron-steel factory has attracted an average 4.11 Mtonne of freight annually. According to city-based analysis, it is found out that the cities that produced the most freight are Sivas, Zonguldak and Kırıkkale, whereas the cities that attracted the most freight are Hatay, Karabük and Mersin. Similarly, within the scope of line density analysis, O-D flow data routes have been determined by assuming with the Djkastra algorithm that freight trains have used the shortest route. In addition, the most intensive bottlenecks on the railway network have also been revealed with these analyses. Significant railway line densities have been observed on the transport routes of the above-mentioned commodity types, which have dominated rail freight transportation sector in Turkey. For instance, the densest segments of the Turkish railway network have been emerged as the Kırıkkale-Karabük-Zonguldak railway line, Sivas-Malatya-Hatay railway line and Adana-Mersin-Hatay railway line, on which more than 4.5 Mtonne of freight have been transported annually. Apart from these railway lines, high density can be also observed on the railway lines that connect to cities with ports or logistic villages, such as İzmir and Balıkesir. It is known that the railway lines determined to be used extensively via these analyses have operated rail traffic far below their maximum capacity. Particularly, the traffic capacity of these lines, which are reinforced with European railway signaling systems (ERTMS), can be increased up to 50% of the current situation in case of need.

The second time-period considered within the scope of this study is the transition (a.k.a. preparation) period between 2015-2016, when some of the densely used railway lines are closed or restrictively operated due to rehabilitation works on the tracks. The transition period (2015-2016) has also been analyzed in depth. However, it has found out that although there is a decrease in the total quantity of freight transported, there are no differences in freight trends or characteristics. For example, the station that produced the most rail freight has been the Demirdağ (Sivas) station

with 2.33 Mtonne of freight annually, while the most transported commodity type has been the “Metal ores and other mining products (Type 3)” with 7 Mtonne of freight on yearly average. However, although the characteristic of transport trends has not changed, the transition period (2015-2016) has not been used for comparison purposes with the early post-liberalization period (2017-2018).

Within the scope of this study, the early post-liberalization period of 2017-2018 has been analyzed to investigate the impacts of the Turkish railway reform, because the railway reforms have been put into practice as of 2017 and the early transportation data have become available as of 2018. Analyses of this period have been performed by using the data of TCDD Transport JSC (TCDD-T), and hence the overall performance of TCDD-T, the incumbent operator, has been revealed. As a result of the analyses carried out in Chapter 5, it has been observed that TCDD-T has lost some of the freight production and attraction centers to new entrant companies such as OMSAN Logistics. The most important reason for drawing this conclusion is the fact that although an increase has been seen in the infrastructure usage for the said period in accordance with the statistics published by TCDD, the increase has not been reflected in the statistics of TCDD-T by similar ratio. For instance, Demirdağ (Sivas) station, which has produced the highest freight quantity in the 2011-2014 period by 2.57 Mtonne on yearly average, while it has produced only an annual average of 1.03 Mtonne in the 2017-2018 period.

Finally, as a result of the forecast analysis, it has been predicted that the difference between the transportation data kept by the infrastructure manager TCDD and the transportation quantity actualized by the incumbent operator TCDD-T will increase in the coming years. In this case, it has been estimated that especially the new entrant companies will attract the high quantity of fixed freight transported by TCDD-T. As a result of the modal share analyses that will be made in the forthcoming years, it will be revealed that whether railway transport is attracting freight from road transport or not, after the railway liberalization realized in Turkey.

CHAPTER 7

CONCLUSIONS AND FURTHER RECOMMENDATIONS

In this chapter, general overview of the study is presented, conclusions are drawn from the findings of the analysis and recommendations for future studies are given.

7.1 General Overview and Findings

In the recent years, developed countries have been developing and implementing policies in order to increase the modal shares of railway, seaway and inland waterway transportation, which are environmentally friendly transportation types, due to environmental problems and global climate change. In addition, these countries have been aiming to ensure a balanced distribution between the transportation modes by reducing the high modal share of the road transportation.

Since the 19th century, freight and passenger transports by rail have begun, and railway transport have become an important sector, for which countries make reforms in order to increase its modal share due its efficient energy use, limited carbon emission and affordability. These reforms can be classified in two main categories: Property reforms such as practices to increase private sector participation, concession of services and the sale of public property; and Structural reforms that require the arrangement of vertical relations between infrastructure and superstructure services.

“Transport”, which has been one of the common policy areas of the European Union (EU), is always on the agenda of the EU, as it provides economic and social integration and accelerates the economic development of European countries. The EU continues its efforts to develop and implement new policies and practices regarding the transportation sector, which it sees as the key to modern economies,

with the aim of creating an integrated, competitive and sustainable transportation system that can meet the economic, environmental and social needs of the European society. Sustainability, liberalization, harmonization, legal-institutional liberalization, privatization, innovation works for more effective transportation, and mutual operability for uninterrupted transportation between countries can be counted among these new EU policies and practices.

The primary objective of railway reforms is to increase the market share of rail freight and passenger transport, by creating an environmentally friendly, economical and efficient transport policy. In the current situation, it might be so early to determine the impact of railway reforms by the analyses performed within the scope of this study. However, it is obvious that the freight shifts between the transport operators (incumbent and new entrants) will not be of any benefit to the rail freight transport sector. It is expected that the competitive environment to be experienced among these operators will decrease the transportation fees, provide high quality fast transportation, and increase the modal share of railways.

In the analyzes made within the scope of this study, it has not seen that the railway transportation has increased significantly in the cities or regions, where the ports or logistics villages are located. In particular, the location of the logistic villages built in the new period should be carefully examined and these regions should be determined after the feasibility studies to be conducted. In particular, the locations of the logistic villages to be built in the new period should be carefully examined and these locations should be determined after the feasibility studies to be carried out.

7.2 Recommendations for Future Studies

The studies carried out within the scope of this study will provide a basis and foundation for the future studies. In particular, GIS based digital maps generated

within the scope of this study will be utilized in the future studies. In addition, the following studies are recommended to be carried out in the future:

- Examining the impact of railway reforms on TCDD, TCDD-T and new transportation companies, which entered to the sector, by using the O-D pairs to be published in the forthcoming years; and comparing the findings with the previous periods in order to reveal the positive or negative impacts of railway reforms on the each actor of the sector;
- Investigating the impacts of the railway reform on the railway modal share and comparing with other EU countries, by using the O-D pairs to be published in the forthcoming years;
- In the following periods, performing logistic regression analysis on the O-D data of road and rail transportations to complete the mode choice modeling and route assignment phases;
- Revision / review of the transport master plan in the light of these studies.
- The current performance of logistic villages should be analyzed and their contribution should be made in terms of road and rail freight transport. In order to make these analyzes, logistic village based load data should be kept in detail;
- In order for the railway deregulation process to be successful, it is necessary to ensure that private sector companies carry loads in different load corridors and different load types.
- When all processes are examined, the institutional structure of TCDD-T needs to be changed in order to increase the rate of rail modal share, which is the main purpose of deregulation.

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CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Cebeci, Alper
Nationality: Turkish (TC)
Date and Place of Birth: 14 December 1987, Ankara
Marital Status: Married
Phone: +90 507 432 91 77
email: alper.cebeci@metu.edu.tr; alpcebeci@gmail.com

EDUCATION

Degree	Institution	Year of Graduation
MS	University of Birmingham, Railway System Engineering and Integration	2011
BS	Kırıkkale University, Civil Engineering	2009
High School	Elmadağ High School, Ankara	2005

WORK EXPERIENCE

Year	Place	Enrollment
2017 November	Yapı Merkezi Construction Co., Ethiopia	Lead Test and Commissioning
2017 January	Yapı Merkezi İnşaat, Turkey	Business Development Manager

2013 June	Ministry of Transport, Maritime affairs and Communication,Turkey	Project Manager
2013 January	UIC international Railway Organization, France.	Senior Railway Expert
2011 October	Turkish State Railways, Turkey.	Civil Engineer
2009 August	Fermak İnşaat, Turkey.	Civil Engineer

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Advanced English,

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2. Alper CEBECI, Hediye Tuydes-Yaman (2020) “Dynamics of the Rail Freight in Turkey under the effects of Railway Reforms”. Accepted for poster presentation at 34th International Geographical Congress (IGC2020), August 17-21, Istanbul, Turkey.

Football, Computer Technologies, Movies, Motor Sports