

# An Evaluation and Efficiency Analysis of Railways Safety: A Case Study of EU and Turkey

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## ABSTRACT

The rail industry is faced with rising competitive and cost pressures that call for considerable improvements in consistency, operating efficiency, and rail safety. In this article, Turkey's rail safety was evaluated by using a data envelopment analysis model with CRS (CCR), VRS (BCC) analysis in comparison to the EU countries. A section of input-oriented analyses was performed, and efficiency scores were ranked in two different ways to verify the different rail parameters with the aim of minimizing the number of rail accidents and the number of fatalities in accidents. The study concluded that Turkey is more capable than the EU countries in terms of exploiting its railway indicators.

## KEYWORDS

Data Envelopment Analysis, Efficiency, European Union, Rail Transportation, Safety Performance, Turkey

## 1. INTRODUCTION

Rail transportation plays an important role in creating a sustainable future for transport, and it's one of the safest modes of transport, even so it is an essential to maintain and improve the current level of safety for the benefit of citizens. A safe railway is more efficient and also a more attractive transport choice, enabling society to address the environmental and economic challenges of the 21st century.

Safety performance measurement is vital to ensuring that organizations consider and address safety issues, and Safety performance dimension not only informs policies, procedures, practices, and continuous improvement, but can also aid in the understanding of negative safety outcomes. Moreover, safety performance measurement can aid in preventing deleterious safety outcomes through increased understanding and measurement of hazards and risks associated with safety outcomes.

European Union countries have paid attention to the railway and its network developments, which is very helpful for transportation development and growth, the overall level of railway safety in Europe, as deliberate by fatal railway and derailments per billion train-kilometers, has steadily enhanced since 30 years, although there is significant improvement from year to year, the estimated overall trend since 1990 is a reduction in the accident rate of 4 % per year, and the average number of fatal train collisions and derailments per billion train-kilometers was about 4.8 in 1990 and 1.1 in 2015. in spite of an encouraging long-term trend in the risk of fatal railway and derailments over the past two decades, the development has been slowing down, in particular since 30 years (Evans and Morrison 1997); (Eurostat 2013) (European Union 2012). (European Commission 2009-2017).

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Investment in railway infrastructure is one of the top priorities of the Turkish government, with the existing network being modernized and expanded to accommodate additional traffic. Turkish rail has 11,052 km of conventional line and 888 km of high speed line, equaling a total of 11,940 km. The share of transport by the railway network at present is low: less than 2% of passengers, While the government strives to transfer a portion of traffic from road to rail thus the share of the rail network is expected to reach 15% for freight and 10% for passengers by 2023(Banar and Özdemir 2015). According to General Directorate of Turkish State Railways the total number of railway accident decreased from 636 in 2001 to 120 in 2016 including number of accident, train hit a person and collisions at level crossing and decreased to, total fatalities including passengers, railway employees, train hit a person and collisions at level crossing decreased from 165 in 2001 to 81 in 2016 and total injuries decreased from 385 in 2001 to 72 in 2016 (General Directorate of Turkish State Railways 1970-2016).

In the next years Turkey is likely to become a member of European Union, thus comparison between these countries is inevitable to examine whether Turkey as a candidate for the EU membership and utilizes its railway performance to help policymakers design strategies of railway as long as improve Eco-efficiency of transportation sector. This study investigates whether Turkey utilizes its rail transportation safety, and it aims to analysis turkey's current situation to European Union countries by performing efficiency analysis on railway safety. In the study two different ways were shaped to verify the different rail transportation parameters with the aim of minimizing the number of rail accidents and the number of fatalities in accidents. For this purpose, four inputs are considered in the conducted analysis, and different outputs variables are distinguished.

## **2. LITERATURE REVIEW**

The purpose of the researches of the authors in the field of transportation is to provide a measurement of productivity and justify a system of regulation for transportation effectiveness, to analyze the factors for technical change in different modes. Many mathematical models which have been applied are pricing models (Arrigo and Di Foggia 2014), cost function (Loizides and Tsionas 2002);(Urdánóz and Vibes 2013), distance functions(Coelli and Perelman 2000)(Lan and Lin 2006) Malmquist productivity model (P. Cantos, Pastor, and Serrano 1999), nonparametric frontier model, data envelopment analysis(Pedro Cantos, Pastor, and Serrano 2002);(Yu and Lin 2008), regression analysis by quadratic function and requirement function, analysis by operational and technical indicators(de Jorge and Suarez 2003) , but regarding to the newest studies using alternative methodologies, it is not possible to evaluate efficiency precisely, so we can only use these studies to define good or bad operations(Cowie and Riddington 1996) .

Few studies have been conducted about analyzing and estimating safety performance in railway , The study carried out by (Mooren et al. 2014) on safety management for heavy motor vehicle documented an elements of safety management which were connected with a superior safety performance. The shaping work of (Kyriakidis, Hirsch, and Majumdar 2012) focused on accidents and fatalities as well as safety maturity and their interaction for the set of the major global metro railways for the period 2002-2009, The research presented the behavioral, attitudinal culture, technical, operational and methodological elements and actual achievements in terms of safety outcomes, they concluded a optimistic association between injuries and top events .

The research carried out by (Elvik 2006) conducted the actual accident rates in the period before and after the safety inspectorates and its effect to safety performance and published a combination of verification from evaluation studies of the effect of transport economic deregulation on safety, The research presented statistical relationships indicating that safety performance has enhanced. (Evans 2010) added and examined the empirical evidence by analyzing train accidents in Japan before and after the privatization of the Japanese National Railways in 1987, he found out The Japanese railways achieved a decline in the train accident rate in the 16 years up to privatization in 1987 of about 5.0%

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