Evaluation of Iran Rail Freight Transportation Efficiency in Comparison between the World Countries and the Middle East and Central Asia

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Abstract

The study of various countries rail transportation indicators is an appropriate criterion for evaluating the existing performance of Iranian railways. The experiences of other countries can be used to improve the efficiency of Iran's rail transportation. At the beginning of the study, in order to compare the Iranian railway performance with railways of other countries, various efficiency indicators have been defined. The comparison based on data from the International Union of Railways members in 2012. The Iranian railway performance indicators comparison with other countries around the world and in the Middle East and Central Asia show that the main priorities to meet the needs of Iran's rail freight transportation are increasing the number of the locomotives, developing railway lines and increase efficiency of fleet. In order to evaluate the efficiency of each of the areas listed above, nonparametric method of data envelopment analysis DEA (modified Output-oriented BCC) has been used. Based on the obtained results, the Iranian railway rank is 23 among 66 countries of the world with efficiency of 51 percent and its rank is 9 among 14 countries of the Middle East and Central Asia with efficiency of 55 percent. The efficiency of Iran railway wagons is low and the annual ton-km can be increased from 22604 to 41136. At the end of the study, time series performance index of countries from 2000 to 2012 were studied. And over these years, Iran has always had a constant downward trend with efficiency of 30 percent.

Keywords: Data Envelopment Analysis, freight transportation, rail transportation, efficiency indicators

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1. Introduction

High safety, reliability, low pollution, low energy consumption, capacity and other advantages of rail than road transportation caused world countries using rail to transport goods. Rail transport plays an important role in the economic development of a country. Most researchers are looking for assessing the efficiency of the rail transport system [Yu and Lin, 2008]. Efficiency (productivity) means more efficient use of resources and achieving more production with specific resources [Sink, 1985]. One way to determine the efficiency (productivity) is using indicators to measure the ratio of the volume of output to the volume of inputs and the benefits of this method are its simplicity and broad understanding. This method is incapable in determining the productivity of the entire system with multiple inputs and multiple outputs; so Charnes, Cooper and Rhodes suggested the data envelopment analysis (DEA) method in 1978 [Charnes, Cooper and Rhodes, 1978].

Chapin and Schmidt assessed the efficiency of American rail transport companies in 1999 [Chapin and Schmidt 1999]. The study on European Railways using the non-parametric techniques of data envelopment analysis (DEA) can be mentioned as one of the studies in this respect. In this study, the number of passengers to kilometer and ton to kilometer in one time; and once again the number of passenger trains to kilometer and the number of freight wagons to kilometer were considered as the outputs. The variables used as inputs in the study involved the number of employees, consumption of energy and raw materials, the number of locomotives, the number of passenger halls, and the number of freight wagons and main lines to kilometer. According to the results of this study, railways in Sweden, Switzerland, Finland, and the Netherlands had the highest efficiency and railways in Norway, Denmark, Ireland, and Greece had the lowest efficiency [Cantos et al, 1999]. Moreover, Cowie evaluated the efficiency of public and private railway in Switzerland via data envelopment analysis (DEA) [Cowie, 1999]. Christopoulos and colleagues examined the efficiency of rail systems in 10 European countries using the characteristics of rail services production factors. The results of the econometric (parametric) techniques for the periods of 1960 to 1993 showed that among the selected countries, France and Portugal had the highest and the lowest efficiency in terms of human resources and capital inventory respectively while the Netherlands and Denmark had respectively the highest and the lowest efficiency in energy use [Christopoulos, Loizides and Tsionnas, 2001]. Estache and others in 2002 evaluated the efficiency of rail freight transport companies in Argentina and Brazil. They concluded that the efficiency at the end of the period had a downward trend for operators [Estache, Gonzalez and Trujillo 2002]. Using non-parametric and parametric models in another study, the efficiency of the UK rail network was investigated. In this study, based on statistical data from 1996 to 2001, the efficiency of 7 regions in the UK was assessed in terms of geographical location including East, North West, West, Central, Scotland and North East London through data envelopment analysis (DEA) techniques [Kennedy and Smith, 2004]. Hilmola (2007) assessed the efficiency of European railways and their adaptation to shrinking demands, concluding that railways in the Baltic nations Estonia and Latvia are the most efficient for cargo transport [Hilmola 2007].

Yu and Lin, using the technique of data envelopment analysis (DEA), examined the efficiency and effectiveness of 20 international railway companies. In this selected model, the technical efficiency of the passenger and freight sector was employed for simultaneous assessment. The objective was to maximize the weighted sum of the process distance parameters with respect to a direction vector [Yu and Lin 2008]. Yu (2008) explores efficiency and effectiveness scores for a group of 40 global rail systems (passenger and freight) in 2002. Yu uses a two-stage network DEA model along with a one-stage DEA model to compute the efficiency scores and compare them. When the results of two different methods have been compared, it has been seen that magnitude of performance values turned out to be different, but the ranking of the railway firms has not changed by performance.

And relation between three performance criteria was studied and it has been found out that quality of the transportation services has made positive contribution to the development of performance and, in conclusion, network DEA method has given more descriptive results about reasons of the inefficiency [Yu 2008]. Jitsuzumi and Nakamura measured the efficiency of 57 companies in Japan Railways by means of data envelopment analysis (DEA) to determine causes of inefficiency in Japanese railways operations. This approach is also designed to compensate for railways' lack of complete discretion in changing location of their operations and increasing/decreasing these operations [Jitsuzumi and Nakamura 2010]. Hilmola (2010) studies public rail transportation systems in 52 large cities around the world using DEA. The author finds that public rail systems in large cities are not necessarily the most efficient ones [Hilmola 2010]. Nashand and Nash (2010) have applied two-stage DEA analysis to 43 railway organizations in Sweden, Germany and United Kingdom and then applied Tobit regress to the productivities. As a result of the analysis, it has been found that the transaction factors have been more determinative than the corporate factors in achieving technical efficiency [Merkert, Smith and Nash, 2010]. Teng et al. (2010) examines policies of Chinese freight railway operations from 1984 to 2007 using DEA [Teng et al. 2010]. Movahedi et al. (2011) compared the efficiency of passenger and freight rail in Iran with 59 member states of UIC in 2007. The model used in this study has been Output-oriented BCC model. Input variables included the number of locomotives, the number of passenger wagons, the number of freight wagons, number of employees, the length of lines and outputs variables were million passenger-km and million ton- km transported yearly in the network. According to this information the efficiency of Iranian railway has been equal to 0.564 [Movahedi, Abtahi and Motamedi, 2011]. Kim et al. (2011) in their study made a DEA analysis with a view of using other alternative ways, seaway, inland waterways and railways in order to reduce the environmental pollution in accordance with the Kyoto Protocol [Kim et al. 2011]. Kutlar et al. (2013) used the Tobit Regression to check which DEA model outputs were significant for the efficiency scores found in the DEA CCR and DEA BCC models, finding that the outputs were more significant in terms of explaining allocative efficiency [Kutlar et al, 2013]. Tahir (2013) analyzed the performance of Pakistan Railway in a multistage framework, and applied DEA method to estimate product, earning and financial efficiency to understand the decline in Pakistan Railway in comparison with Chinese and Indian railways [Tahir 2013]. Oum et al. (2013) found a proper methodology (Directional Output Distance Friction -DOFM) rather than the DEA model to measure social efficiency. They conducted an application study about both Japanese rail and airlines' social efficiency adopting input variables of labor, capital cost, variable cost, and passengers' time; an output variable of equivalent passenger-kilometers; and an undesirable output variable of life-cycle CO emissions. As a result, the overall rail firms show higher indices than airlines' performance [Oum et al. 2013]. Bhanot and Singh (2014) presented the performance indicators for Indian railways carrying containers in the period following the lifting of the monopoly held by the CONCOR state-owned enterprise. They found lower efficiency of the state-owned company during the period under analysis [Bhanot and Singh 2014]. Rayeni and Saljooghi (2014) developed a new secondary goal based on symmetric weight selection of cross-efficiency for ranking and measuring efficiency of railway in Iran [Rayeni and Saljooghi, 2014].

According to the position of Iran in the path of freight corridors, the use of high-capacity systems such as railways to transport freights is important. The main focus of this research is on freight rail transport and the analysis of passenger rail transport is not considered. World countries rail freight transportation indicators is a suitable criterion for evaluating the performance of the Iran's railroad. The experience of other countries can be used to improve the performance or efficiency of Iran' rail freight transportation. So the main purpose of current paper is to investigate the Iranian freight railway's efficiency comparing to other countries. Conclusions and future

planning on the basis of performance indicators in a specific year is not adequate and it is necessary to be analyzed system performance over a period of time. So this study compares the Rail freight transportation efficiency of different countries in the period between 2000 and 2012.

Following the data collection from Iran and other countries from the International Union of Railways UIC, operating indicators were introduced, measured and assessed to compare the position of Iran in the Middle East and Central Asia with a number of developed countries. Then the performance indicators of Iran's rail freight transportation (fact, the plan of next10 years), compared at two levels with 15 countries in the Middle East and Central Asia and the 66 countries. In order to evaluate the efficiency of each of the areas listed above, nonparametric method of data envelopment analysis DEA (modified Output-oriented BCC) has been used. Finally, based on time series data from 2000 to 2012 the rise and fall of performance indicators for some countries and Iran are studied. The importance of the method used in this study is to assess the relative efficiency of Iran compared to other countries as well as to replicate this method in other countries.

2. Data Envelopment Analysis Method

Measuring the efficiency because of its importance in evaluating the performance of a company or an organization has always been of interest to researchers. In 1957, Farrell attempted to measure the efficiency of a manufacturing unit by using a technique like measuring efficiency in engineering topics. Charnes, Cooper and Rhodes developed Farrell's view and presented a model which had the ability to measure the efficiency with multiple inputs and multiple outputs. This model is known as "data envelopment analysis". And for the first time it was used in doctoral dissertation of Edward Rhodes guided by Cooper and in 1978, it was presented in an article entitled "Measuring the efficiency of decision making units "[Charnes, cooper and Rhodes, 1978].Data envelopment analysis models consisted of the two types of constant returns to scale models (CCR) and variables returns to scale model (BCC). Constant returns to scale means that the increase in the amount of input leads to the increase in the amount of output in the same proportion. This model is right when all units act in optimal scale. In evaluating the efficiency of the units, when the atmosphere and the conditions of imperfect competition impose restrictions on the investment, it will lead to inactivity of units in optimal scale. In 1984, Banker, and Cooper Charnes proposed BCC model. In this model, if ur and vj are greater than zero or are assumed very little amount, the above model turns into an Output-oriented BCC model which is modified [Banker, Charnes and Cooper, 1984].

Input-oriented models are used to test if a DMU under evaluation can reduce its inputs while keeping the outputs at their current levels. Output-oriented models are used to test if a DMU under evaluation can increase its outputs while keeping the inputs at their current levels. In this study, due to constant resources of the railway, such as length of the lines, the number of freight wagons, and the number of locomotives (inputs), modified Output-oriented BCC model has been used.

$$\text{Min } Z_0 = \sum_{i=0}^{m} v_i x_{i0} + w \quad (1)$$

St:

$$\sum_{r=1}^{s} u_r y_{r0} = 1 \quad (2)$$

$$\sum_{i=1}^{m} v_i x_{ij} - \sum_{r=1}^{s} u_r y_{rj} + w \geq 0 \qquad j = 1,2,3,\dots,n \quad (3)$$

$$u_r , v_j \geq \epsilon \qquad randj = 1,2,3,\dots,n \quad (4)$$

3. Analysis of Indicators of Productivity Evaluation

The data and information have been extracted from the statistical yearbook of the International Union of railways during 2000, 2002, 2004, 2006, 2008, 2010 and 2012. The database includes information on population and area of the country, the length of rail lines, number of freight and passenger wagons, the number of locomotives and the amount of freight and passenger transported in the countries; as an example, the information about the countries in the Middle East and Central Asia in 2012 is shown in Table 1. [http://www.uic.org]. Also to complete UIC statistical tables, railway statistics from different countries such as Syria, Iraq, Saudi Arabia, United Arabic Emirates, Egypt and Jordan have been used [http://en.wikipedia.org, https://enr.gov.eg, https://www.saudirailways.org, Jordan Annual report].

Table 1. Information about countries in the Middle East and Central Asia

Country	Area (1000km^2)	Population (million)	The total length of lines (km)	two-lane lines (km)	The number of locomotives	The number of passenger wagons	The number of freight wagons	Tonnage of goods transported million	Ton- km (million)	passengers transported (million)	Passenger – km (million)
Iran	1648	77	9992	1625	778	2105	22230	34	22604	27	17172
Armenia	30	3	842	16	64	119	1900	2	346	1	50
Kazakhstan	2725	17	1914 6	4826	172 7	2270	99974	295	23584 6	23	18498
Turkey	784	74	1052 4	882	598	1353	18167	24	10691	70	4598
Saudi Arabia	2,150	27	1,412	...	65	...	2,293	4.032	1,852	0.994	297
Azerbaijan	87	9	2,068	815	437	765	17,971	23.116	8,212	2.668	591
Kyrgyzstan	200	5	417	...	45	434	1,779	6.913	923	0.549	76
Turkmenistan	488	5	3,115	40	370	549	14,125	26.839	11,992	6.468	1,811
Uzbekistan	447	28	4,192	150	306	717	28,016	80.910	22,482	15.952	3,025
Pakistan	796	176	9,074	1,283	528	1,774	18,468	2.616	1,757	64.903	20,619
Syria	185	21	2,139	...	188	358	5,133	8.505	2,206	3.572	1,857
Iraq	435	32	2,138	...	518	...	9,315	1.004	249	0.212	100
Jordan	89	7	508	...	23	...	335	2.126	344	0.040	504
Egypt	1,002	80	5,195	...	820	...	11,592	6.000	1,592	451.058	40,837
….											

Table 2 compares the performance of the railway in 2012 and projected plans and shows that Iran is located in a lower position in most operational indicators of the Fifth Development Plan of I.R.I. in rail transportation. Therefore to fulfill Iranian 2025 Perspective Document in railway, identifying investment priorities in order to achieve the best performance is essential and important.

An indicator is a variable which is used to measure the status and efficiency of the system and should be comparable. In this study, several indicators are defined whereby the status and efficiency of rail freight transport could be compared between various countries. Most of the variables of the database cannot be considered as an indicator, but significant and comparable indices could be created with their non-dimensionality and application of algebraic relationships between several variables. Definition of 7 indicators made by the database variables and how to calculate them are shown in Table 3. In this Table, the indicators are divided into four general parts including the development of railways, navigation development, exploitation of rail lines, and exploitation of rail fleet. The relative indicators of Iran, the Middle East, and Central Asia are compared in Figure 1 and 2.

Rank of Iran among the countries of the Middle East and Central Asia has been low for rail lines development indicators so that the indicators of density of the lines length in the area for Kazakhstan and Turkmenistan, which also have large areas, are in better conditions than Iran. However due to the dispersion of the population in Iran this indicator is in better condition compared to the indicator of rail fleet development. In indicators of rail fleet development, the number of wagons and locomotives has been much lower considering the length of country's rail lines. So that for indicator of number of locomotives to the length of lines, Iran is in the last position among the nine countries of the Middle East and Central Asia. For efficiency indicator of lines, Iran has a relatively adequate position with the rank of five among 15 countries in the Middle East and Central Asia. However, its distance from the higher countries such as Kazakhstan, Uzbekistan and Turkmenistan is great. Iran's performance has been appropriate regarding the efficiency indicators of rail fleet and only Kazakhstan and Uzbekistan have had better performance than Iran. However if we intend to increase the fleet, planning towards increasing the productivity in this sector will be so important.

Table 2. Comparing indicators of I.R.I. railway in 2012 with programs in 2012 and 2025 [consulting project report]

row	Indicator	Performance in 2012	Program in 2012	Program in 2025
1	The length of railway lines (km)	10223	10495	25000
2	The number of freight wagons in service	22230	22700	50393
3	The number of locomotives in service	341	463	1615
4	Tonnage of goods transported (million tons)	34.3	50.5	202
5	ton-kilometer of goods transported (1000 million tons)	22.6	31.4	121

Table 3. Sample of information about countries in the Middle East and Central Asia

Types of indicators	Indicators	Symbols and formulas
Railroads development indicators	Density of the length of lines in the area	$I_1=\frac{\text{The total length of rail road (km)}}{\text{Area (1000km}^2\text{)}}$
	The length of rail road per capita	$I_2=\frac{\text{The total length of rail road (km)}}{\text{Population (million)}}$
Wagons numbers	The number of freight wagons on the length of rail lines	$I_3=\frac{\text{The number of freight wagons}}{\text{The total length of lines (km)}}$
Locomotive numbers	The number of locomotives to the length of rail lines	$I_4=\frac{\text{The number of locomotives}}{\text{The total length of lines (km)}}$
Efficiency of lines	Annual ton-km per a rail road - km	$I_5=\frac{\text{Ton}-\text{km (million)}}{\text{The total length of lines (km)}}$
Efficiency of Wagons	Annual ton-km per a freight wagons	$I_6=\frac{\text{Ton}-\text{km (million)}}{\text{The number of freight wagons}}$
Efficiency of locomotives	Annual ton-km per a freight locomotives	$I_7=\frac{\text{Ton}-\text{km (million)}}{\text{The number of locomotives}}$

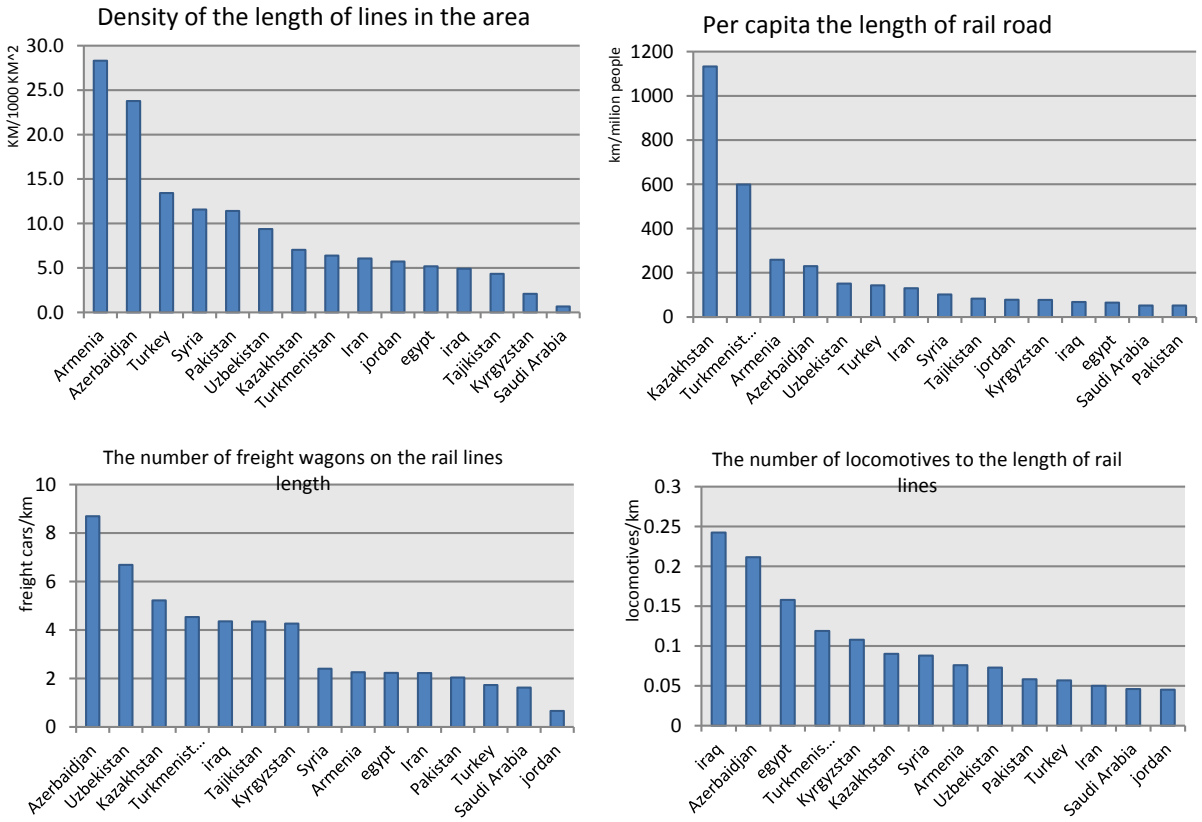

Figure 1. The status of Iran among countries of the Middle East and Central Asia by comparing indicators of development and fleet

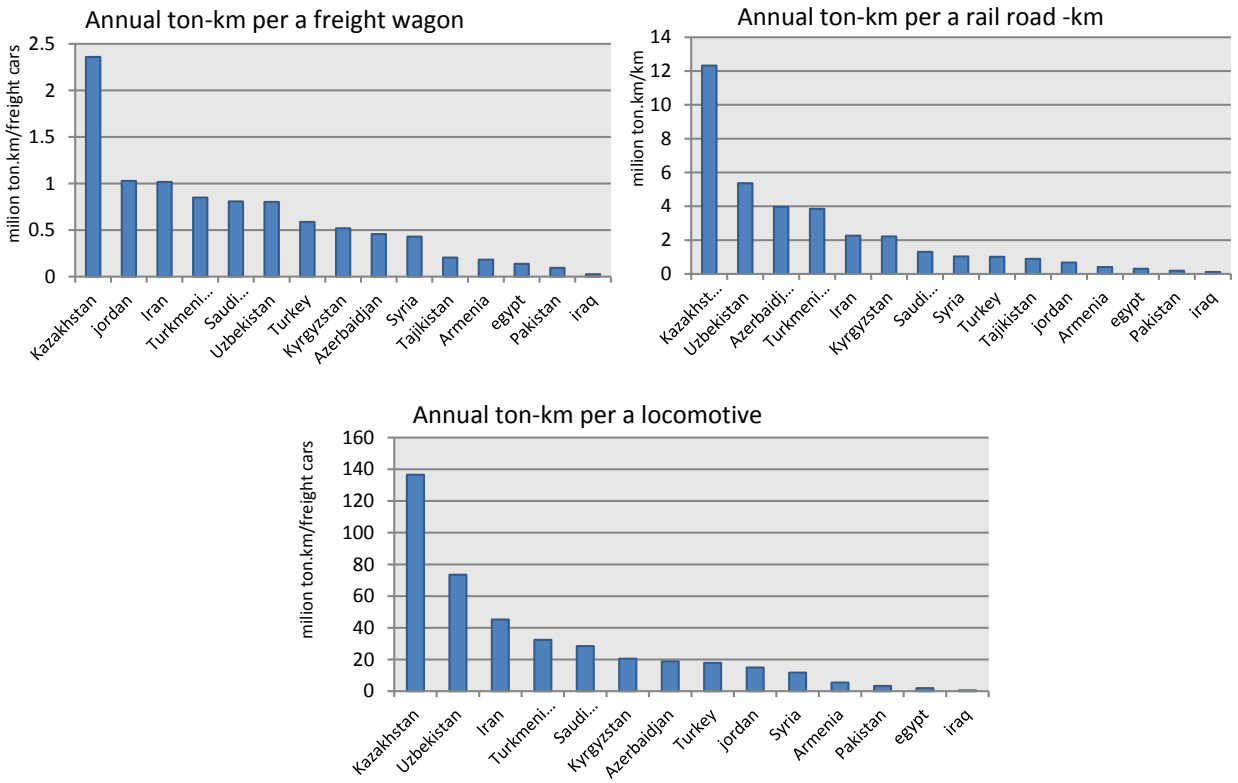

Figure 2. The status of Iran in among countries of the Middle East and Central Asia by comparing the efficiency indicator

Table 4. Summary of performance indicators of Iran's railway in relation to the Middle East and Central Asia

Type of indicator	Indicator	Number of compared countries	Iran's rank	Development priority
Lines development	I_1	15	9	3
	I_2	15	7	
Locomotive increase	I_3	15	13	1
Wagons increase	I_4	15	11	2
Efficiency of lines	I_5	15	5	4
Efficiency of Wagons	I_6	15	3	5
Efficiency of Wagons	I_7	9	3	

The summary of evaluation of indicators in Iran and the world is presented in Table 4. The number of locomotives to Iran in the region and the world is very low and annual ton-kilometers carried by every locomotives in Iran compared with countries of the world in a relatively high. By analyzing the table it can be concluded that the main priorities to meet the needs of Iran's rail freight transportation are increasing the number of the locomotives, developing railway lines and increase efficiency of fleet.

4. Determining Railway Freight Efficiency of IRI

In this section, the freight efficiency of Iran Railways is compared with other countries by making three data envelopment analysis (DEA) techniques. In the first and the second models, the

efficiency of Iran Railways was compared with 66 countries around the world and 14 countries in the Middle East, and Central Asia in 2012, respectively; in the third model this efficiency was compared with 53 countries in a time-series manner from 2000 to 2012. The inputs and outputs of the model are presented in Table 6.

The first model compares the efficiency of Iran Railways (fact and the plan) among 66 selected countries of the world in 2012. In this model, the railway freight efficiency of IRI has been to 51 per cent in 2012. In case of realization of Iranian programs of 2012, Iranian railway freight efficiency will be equal to 44 percent. Therefore, the performance of railway freight in Iran in 2012 was close to the designed program of 2012.

The U.S., China, Russia, Australia, Kazakhstan, and Hungary have achieved the best performance among the studied countries; also in this comparison, Iran has been in fourth place in the Middle East and Central Asia after Kazakhstan, Uzbekistan and India. Fifth (the image of the best tonnage performance) and seventh (the image of the best ton km performance) columns of this table show that for inefficient countries if input sources are constant, their output performance must reach these values in order to achieve maximum efficiency. For example, Iran with use of existing resources will achieve 100% efficiency if the tonnage transported by freight railroads increases from 34 million tons to 67 million tons and also increases from 22,604 million ton-km to 44,468 million ton-km. The sample of the efficiency results of the first model is shown in Table 5 (The all results are shown in Table A1).

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Table 5. The results of the efficiency of countries in the world in 2012 and the distance of their outputs from the best productivity efficiency

Country	Efficiency	Rank	Tonnage transported (million)	The image of the best tonnage performance (million)	Ton-km transported (million)	The image of the best ton km performance (million)
China	100	1	2859	2859	2518310	2518310
The U.S.	100	2	1710	1710	2524585	2524585
Russia	100	3	1440	1440	2222388	2222388
Australia	100	4	242	242	59649	59649
Kazakhstan	100	5	295	295	235846	235846
Hungary	100	6	10	10	1381	1381
Canada	96	9	314	326	352535	365609
Uzbekistan	83	13	81	97	22482	26991
India	79	14	922	1167	979972	1146434
Iran's Program in 2025	64	16	202	314	121000	187964
Iran's Program in 2012	54	22	51	94	31400	58319
Iran	51	23	34	67	22604	44468
Kyrgyzstan	39	26	7	18	2570	4007
Azerbaijan	19	42	23	121	8212	42826
Turkey	17	44	24	143	10691	63865
Pakistan	3	65	3	96	1757	64648

Table 6. DEA input and output variables

ID	variables	Type of variables
1	Length of railway lines in kilometers	input
2	Number of freight wagons in service	input
3	Number of locomotives in service	input
4	Tonnage of goods transported	output
5	ton-kilometers of goods transported	output

In the second model, the efficiency of Iranian railway freight transportation was compared with 14 countries in the Middle East and Central Asia. Among these countries Iran is in the ninth rank with the efficiency of 55%. Kazakhstan, Uzbekistan, had the best performance of rail freight transportation in 2012 among the countries of the Middle East and Central Asia. Larger networks (With large input and output values) than smaller networks (With low input and output values) have more complex planning, so increasing the efficiency in larger networks is more difficult than smaller networks. In reality the performance of an large efficient network cannot be considered as a small efficient network. So despite being Kyrgyzstan and Jordan in efficient DMU series, Due to their very low demand (ton and ton-km) in comparison with Kazakhstan and Uzbekistan, cannot be introduced them as an effective DMU. The results show that In the case of the realization of Iranian 2025 Perspective Document, Iran can stand in the first place in the Middle East and Central Asia. In this comparison, return to scale of Iran has been decreasing, and increasing in mentioned input sources does lead to an increase in the efficiency of railway freight transportation of IRR. The results of the efficiency of the second model are presented in table 7.

Review the Iran's program indicates that in case of realization of the program, Iran will be a successful country in the field of rail freight transport. The efficiency of Iran railway wagons is low and the annual ton-km can be increased from 22604 to 41136.

The third model has compared the efficiency of 53 countries during 2000 to 2012. This model shows that the efficiency of rail freight transportation of I.R.R had a constant downward trend from 2000 to 2012. To do so, the model of the countries that enjoyed an upward trend in recent years should be considered in order to address improvement of rail freight transportation of I.R.R. Countries such as Russia, China, and the U.S always had the best efficiency of rail freight transport. Kazakhstan, Uzbekistan, India and Hungary by following an upward trend during these years could achieve the highest efficiency performances in 2012. Also the European countries such as Austria, Belgium and France have experienced a downward trend, and in 2012 they achieved 20 to 30 percent efficiency. Figure 3 shows the changes in efficiency of railway freight for some countries.

5. Conclusion

Various countries rail transportation indicators comparison is an appropriate criterion for

evaluating the existing performance of Iranian railways. The Iranian railway rank is 25 among 66 countries of the world with efficiency of 51 percent and its rank is 9 among 14 countries of the Middle East and Central Asia with efficiency of 55 percent in 2012. In the case of the realization of Iranian 2025 Perspective program, Iran can stand in the first place in the Middle East and Central Asia in the field of rail freight transport.

The desired efficiency in prospect indicates the importance of adopting appropriate and effective policies in the future to achieve objectives of the Prospect.

Table 5. The results of the efficiency of countries in the world in 2012 and the distance of their outputs from the best productivity

Country	Efficiency	Rank	Tonnage transported (million)	The image of the best tonnage performance (million)	Ton-km transported (million)	The image of the best ton km performance (million)
Kazakhstan	100	1	295	45	235846	235846
Iran's Program in 2025	100	2	202	62	121000	121000
Uzbekistan	100	3	81	9	22482	22482
Kyrgyzstan	100	4	7	20	923	923
Jordan	100	5	2	73	344	344
Iran's Program in 2012	68	6	51	8	31400	45942
Azerbaijan	62	7	23	46	8212	13303
Turkmenistan	60	8	27	69	11992	19937
Iran	55	9	34	30	22604	41136
Saudi Arabia	46	10	4	45	1852	4018
Syria	42	11	9	62	6215	9301
Turkey	33	12	24	9	21269	43325
Armenia	21	13	2	20	1233	2545
Egypt	13	14	6	73	13790	24321
Pakistan	4	15	7	8	1757	43822
Iraq	3	16	1	46	2741	10015

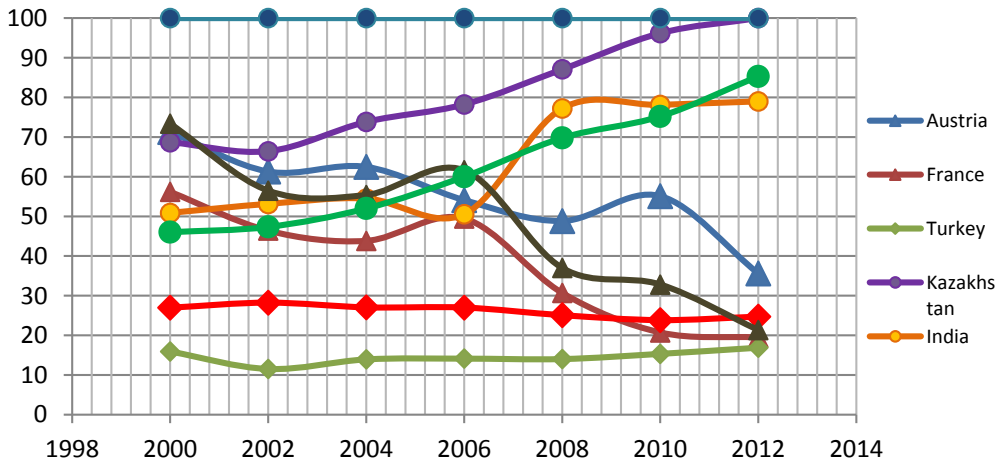

Figure 3. Comparison of the efficiency of countries from 2000 to 2012.

The Iranian railway performance indicators comparison with railways of other countries around the world and in the Middle East and Central Asia show that the main priorities to meet the needs of Iran's rail freight transportation are increasing the number of the locomotives, developing railway lines and increase efficiency of fleet. The number of locomotives in Iran compared to other countries in the region and the world is very low and annual ton-kilometers carried by every locomotives in Iran is relatively high. By the results of this paper can be concluded that by realization of the development program, Iran will be a successful country in the field of rail freight transport. The efficiency of Iran railway wagons is low and the annual ton-km can be increased from 22604 to 41136.

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7. Appendix

Table A1. The results of the efficiency of all countries

Country	Efficiency	Rank	Tonnage transported (million)	The image of the best tonnage performance (million)	Ton-km transported (million)	The image of the best ton km performance (million)
China	100	1	2859	2859	2518310	2518310
The U.S.	100	2	1710	1710	2524585	2524585
Russia	100	3	1440	1440	2222388	2222388

Country	Efficiency	Rank	Tonnage transported (million)	The image of the best tonnage performance (million)	Ton-km transported (million)	The image of the best ton km performance (million)
Australia	100	4	242	242	59649	59649
Kazakhstan	100	5	295	295	235846	235846
Hungary	100	6	10	10	1381	1381
Canada	96	7	314	326	352535	365609
Estonia	95	8	26	27	6185	6426
Latvia	94	9	61	65	16930	18090
Brazil	92	10	460	499	278521	301480
Uzbekistan	83	11	81	97	22482	26991
India	79	12	922	1167	979972	1146434
Mongolia	75	13	39	52	23561	31592
Gabon	74	14	6	7	2417	3280
Ukraine	67	15	457	684	414634	532334
Iran’s Program in 2025	64	16	202	314	121000	187964
Lithuania	63	17	49	78	14172	22486
Belarus	62	18	154	246	48351	77368
Mozambique	60	19	7	12	2957	3749
Germany	60	20	399	665	469083	539837
Morocco	59	21	37	63	11063	15297
Iran’s Program in 2012	54	22	51	94	31400	58319
Iran	51	23	34	67	22604	44468
Mexico	50	24	90	182	69185	139092
Israel	48	25	6	13	11637	12825
Kyrgyzstan	39	26	7	18	2570	4007
Malaysia	37	27	12	32	3071	8238
Austria	35	28	107	301	83049	122553
Indonesia	35	29	20	59	20810	34257
Slovenia	31	30	15	48	6094	13383
Chinese Taipei	30	31	11	35	32832	34795
Turkmenistan	29	32	27	91	11992	40836
Slovak Rep.	29	33	74	256	47254	81980
Poland	28	34	127	456	203640	289154
Peru	24	35	8	33	4899	7716
Luxembourg	24	36	6	25	5259	5865
Korea (Rep. of)	24	37	40	169	10271	43325
Bosnia-Herzegovina	23	38	13	58	9849	13926
Belgium	21	39	37	172	12321	42150
Georgia	20	40	20	101	5976	30012
Czech Rep.	19	41	62	325	128708	176757
Azerbaijan	19	42	23	121	8212	42826
Portugal	18	43	9	50	7211	16324
Turkey	17	44	24	143	10691	63865

Country	Efficiency	Rank	Tonnage transported (million)	The image of the best tonnage performance (million)	Ton-km transported (million)	The image of the best ton km performance (million)
Botswana	16	45	2	12	674	4107
FYROM	16	46	3	16	1854	4063
Spain	15	47	21	142	7507	50640
Cameroon	15	48	2	11	1057	7162
Argentina	13	49	24	179	12111	92026
Croatia	12	50	11	90	5212	21829
Thailand	12	51	11	89	4038	21748
Romania	12	52	48	407	131177	215056
Vietnam	12	53	7	60	3959	34405
Italy	11	54	39	368	175549	269247
Serbia	9	55	9	104	2769	30511
Moldova (Rep. of)	8	56	4	49	1606	11829
Bulgaria	7	57	12	163	17163	42913
Ireland	7	58	1	8	3881	5047
Greece	7	59	3	49	8887	16087
Armenia	7	60	2	24	842	5539
Algeria	5	61	5	95	1248	23723
Sudan	4	62	1	23	823	18689
Albania	4	63	0	9	2242	3373
Bangladesh	3	64	3	93	710	24437
Pakistan	3	65	3	96	1757	64648
Congo Dem. Rep.	2	66	0	24	170	8363