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Iran Railway Efficiency Analysis, Using DEA: An International Comparison

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Abstract Efficiency measurement is critical for industries where firms do not face strong competition, as we cannot rely on the market to discipline the firms' efficiency. Railway is a typical example. At the same time the fact that railway produces multiple outputs using the common set of inputs calls for a delicate and sophisticated treatment in measuring the efficiencies. In this article, the DEA method is used to determine RAI (RahAhan Iran) efficiency comparison with other countries. The scale efficiency rate of RAI was calculated and showed the percentage of 0.564. Finally, by analyzing this performance, a suitability in inputs and outputs for reaching the efficiency boundary was resulted.

Keywords Efficiency, Railway, Data Envelopment Analysis (DEA), Iran.

1 Introduction

It is universally recognized that transport is crucial for sustained economic growth and modernization of a nation. Adequacy of this vital infrastructure is an important determinant of the success of a nation's effort in diversifying its production base, expanding trade and linking together resources and markets into an integrated economy (Puri). It is also necessary for connecting villages with towns, connecting market centers together, and in bringing remote and developing regions closer to each other. Transport, therefore, forms a key input for production processes and adequate provision of transport infrastructure and services which help in increasing productivity and lowering the production costs.

There have been a number of efficiency or productivity studies of railways. In this research we can refer to some of these studies. For example, among these studies we can find some studies in European railway efficiency measurement. Oum and Yu [1] found that railway systems highly depend on public subsidies which are significantly less efficient, and that systems with high degree of managerial autonomy achieve higher levels of efficiency. Gathon et al. [2] discovered that in the pre-liberalization period (1961- 1988), technical efficiency of European railways was negatively related to the degree of government influence. Also, Oum et al. [3], published a complete overview of productivity and efficiency in rail

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transport in which it was clear that the results of these estimates were very sensitive to outputs specification. Cantos et al. [4], obtained efficiency indicators using non-parametric approaches, Cowie and Riddington [5], used alternative methodologies. Regarding to the latest studies, it is not possible to evaluate efficiency precisely, so we can only use it for defining good or bad operations. In some studies you find some companies as efficient ones, but according to other studies they are not efficient. Cantos et al. [4] compared European railway companies by DEA non-parametric approach. In this study, passenger/km, ton/km load and also number of passenger trains/km, numbers of freight trains/km were considered as outputs. Here, applied variables as inputs were:1) number of staff, 2) fuel consumption and raw material, 3) number of locomotives, 4) number of passenger trains, 5) number of freight trains, and 6) length of main routes/km. By the use of Pierson coefficient examination and Spearman ranking coefficient, it was defined that statistically there is no significant difference between the efficiencies obtained through estimating each of outputs. Friebel et al. [6] concluded that sequential reforms have efficiency improving effects, whereas reforms introduced in a package have neutral effects at best. Driessen et al. [7] added by exploring the empirical relationship between competition design and productive efficiency. To do so, we construct efficiency scores using Data Envelopment Analysis (DEA), and regress these scores against variables reflecting institutional factors and competition design.

In this study, the main purpose is to investigate the Iranian railway's efficiency comparing to other countries. Other purposes are; specifying the percentage of the facility usage in railway, optimizing the situation, which and how many of inputs should be decreased or economized, and which outputs should be increased for upgrading the efficiency and reaching to a proper situation. In recent research, DEA mathematical method is used. For this reason, in next part, DEA model is briefly introduced.

2 Research framework

Here we work on description and definition of RAI comparing to other countries, railways. So, this can be a descriptive research. In the studies these matters are concerned: recognition of possible non-efficiency reasons in RAI through studying documents and existing records during the year 2007 and defining efficiency rate in RAI comparing to other railways by using CCR model in input and output natures [8-9].

3 Data

Statistical community of recent studies includes all railways in the world. Information and statistics of 60 UIC (International Railway Statistics, Union International des Chemins defer) member countries are gathered and used.

4 System inputs and outputs

Each factor with costing nature is considered as an input and each factor with incoming nature considered as an output. After a long discussion and investigation and also considering the above logic type and nature of information, the following five factors were defined as input:

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I_1: Equivalent locomotives that include main and marshalling locomotives per unit;
I_2: Passenger coaches per unit;
I_3: Freight wagons that include type of wagons per unit; and
I_4: Average number of staff per year per 1000 persons.
I_5: The total length of main routes which contain single track, double track and the length of electrified track per kilometer;

RAI services are carrying passengers and freights. Carried passenger per person kilometer and carried freight per ton kilometer are chosen and applied as system outputs as follows:

O_1: Carried passenger per million kilometer; and
O_2: Carried freight per million ton kilometer.

5 Results

Obtained information was given to the DEAP software for solving the problems and gaining the results. The model was investigated as output oriented. According to the results, in Tables 1, 2, we can find that Constant Return to Scale Technical Efficiency (CRSTE), Variable Return to Scale Technical Efficiency (VRSTE) and scale efficiency of RAI on 2007 [9], are 0.072, 0.128 and 0.564 respectively.

Results for firm: 19 (IRAN)
Technical efficiency = 0.128
Scale efficiency = 0.564 (irs)
PROJECTION SUMMARY:

Table 1 Results for RAI efficiency

Variable	Original value	Radial movement	Slack movement	Project value
Output 1	13.900	94.466	0.000	108.366
Output 2	20.229	137.479	0.000	157.708
Input 1	631.000	0.000	-189.885	441.115
Input 2	1.626	0.000	0.000	1.626
Input 3	21.633	0.000	0.000	21.633
Input 4	13.000	0.000	0.000	13.000
Input 5	7334.500	0.000	-7327.023	7.477

Table 2 Listing of Peers

Peer	lambda weight	Country
8	0.098	South Africa
16	0.152	Taiwan
18	0.008	India
38	0.742	Finland
15	0.001	China

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The railways efficiency of 60 countries on 2007, in CRSTE, VRSTE and scale efficiency, with maximizing production assumption is shown in table 3.The evaluation of CRSTE represents the performance of any country's railway in optimal production scale (i.e. horizontal or minimum of Long Run Average cost and technical efficiency in VRSTE pure technical efficiency). It shows the special manner of railway industry in any country, and shows the circumstances of inputs used; therefore, sometimes we point to it as pure management technical efficiency.

Table 3 The results for the world comparison the railway efficiency

Country	crste	srste	scale	Kind of rst	Country	crste	srste	scale	Kind of rst
Algeria	0.685	0.936	0.731	Drs	Vietnam	0.093	1	0.093	Irs
Cameron	1	1	1	-	Austria	1	1	1	-
Congo	1	1	1	-	Belgium	.095	0.117	0.817	Irs
Congo Republic	0.665	0.693	0.961	Irs	Bulgaria	0.744	1	0.744	Irs
Egypt	0.283	0.341	0.843	Irs	Czech	0.125	1	0.125	Irs
Maraca	0.012	0.012	0.979	-	Estonia	0.415	0.595	0.698	drs
Nigeria	0.356	0.381	0.935	Drs	Finland	0.04	1	0.04	Irs
South Africa	1	1	1	-	French	0.065	0.076	0.859	drs
Tunis	0.006	0.006	0.948	-	Germany	0.262	0.298	0.878	Irs
Canada	0.437	0.439	0.994	Irs	Greece	1	1	1	-
Mexico	0.677	1	0.677	Irs	Hungary	0.184	0563	0.327	drs
USA	1	1	1	-	Ireland	0.401	1	0.401	Irs
Australia	0.038	0.051	0.745	Drs	Italy	0.033	0.044	0.758	drs
Bengal	1	1	1	-	Latvia	0.965	1	0.965	drs
China	1	1	1	-	Lithuania	.0374	0.466	0.804	drs
Taiwan	1	1	1	-	Luxembourg	0.963	1	0.963	drs
Georgia	1	1	1	-	Poland	0.149	0.236	0.629	Irs
India	1	1	1	-	Portugal	0.118	1	0.118	Irs
Iran	0.072	0.128	0.564	Irs	Romania	0.28	0.477	0.587	drs
Israel	0.002	.003	0.835	-	Spain	0.61	1	0.61	drs
Japan	1	1	1	-	Slovakia	0.017	0.023	0.734	irs
Kazakhstan	1	1	1	-	Slovenia	1	1	1	-
Kyrgyzstan	1	1	1	-	Sweden	.008	0.015	0.506	drs
Korea	0.402	0.656	0.613	Irs	England	1	1	1	-
Malaysia	0.007	.007	0.999	-	Switzerland	0.432	0.731	0.591	drs
Mongolia	0.021	0.026	0.804	Irs	Albania	0.055	0.072	0.761	drs
Pakistan	0.133	0.15	0.884	Irs	Bosnia	1	1	1	-
S. Arabia	1	1	1	-	Croatia	0.005	0.006	0.873	drs
Syria	0.31	0.779	0.398	Drs	Serbia	0.454	0.774	0.587	drs
Turkmenistan	0.014	0.014	0.987	-	mean	0.484	0.619	0.785	
Uzbekistan	0.017	0.023	0.743	Drs					

The CRSTE of RAI is 0.072. In case of comparing to mean of performance of 60 countries, (0.454) shows that the performance of RAI according to optimal production scale is in very low level. The VRSTE or management efficiency of RAI on 2007 in comparison to the performance of other countries is 0/128, while the mean of VRSTE is 0.676. Hence, the performance of RAI about using and setting aside resources and inputs for production efficiency frontier on comparison to the performance of other countries is not suitable.

The scale efficiency of RAI was estimated o.564 and shows that it is in increasing return to scale; therefore, RAI in using of production resources and inputs is not in a suitable situation. However, the increase of inputs such as Locomotives, Passenger coaches, Freight

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wagons, Average number of staffs and Total length of main routs, could increase the outputs and could cause to the achievement of production efficiency frontier by RAI.

According to the value of radial movement and slack variables, we can conclude that the volume passenger kilometer can increase from 13.9 to 108.36, and the volume of ton kilometer can increase from 20.2 to 157.7 without increasing inputs, to cause RAI to reach the frontier production curve.

Finally, on the other hand, Finland and Taiwan, with weights 0.74 and 0.15 respectively, are as reference countries for Iran, and could be as a model to set inputs and recourses for Iranian Railway industry.

6 Conclusion

It should be mentioned that there are some other factors, affecting efficiency, different indexes of service quality or infrastructure and side indifferent. Another important factor is that the degree of straight character of the routes are developed in the way that trains move in curved routes like straight ones; then, passenger/kilometer or ton/kilometer would be decreased.

Lack of proper information for the variables makes it impossible to consider them in the studies. Another point that should be mentioned is that considering the number of passenger and hauled load rate as output variables instead of passenger/kilometer and ton/kilometer can affect the research result.

In this study RAI was compared to other railways in the world apart from considering their economical situation. Meanwhile, it should be mentioned that we con not reduce some inputs such as main roads. In next research it is recommended to compare RAI with railways with the same economical situation. Also, the use of the models, which stabilize some inputs and suggests decreasing the other inputs, would be done in future. The use of developed models is effective in this field.

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