Discretionary and Non-discretionary Variables of and Rank Sum Test based on DEA in Performance Evaluation of Islamic Republic of Iran's Railway Stations

Mohammad Askari Sajedi [a,c], Mohammad Hossein Darvish motevally[b], Rosnah Mohd Yusuff [a1]

a. Department of Mechanical and Manufacturing Engineering, Engineering Faculty, University Putra Malaysia, Serdang, Selengor, Malaysia.

b. Department of Industrial Engineering, Engineering Faculty, I.A.U, Firozkuh branch, Iran.

c. Department of Management, Firozkuh branch, I.A.U, Firozkuh, Iran

Abstract: This paper based on DEA has analyzed efficiencies of 45 Islamic Republic of Iran's Railway Stations in 2013 years. Runway area of station and station area and terminal area have been considered as the input of railways, and the number of trips, the number of passengers, and cargo and mail freights as the outputs. In order to evaluate the performance of railway stations, hybrid measure of efficiency model with non-discretionary variables has been used in this study. Also, in order to analyze performance of railways properly, 45 evaluated railway stations were categorized into three categories of 15, 30 and 45. Besides, the designed model was implemented on every three categories in CRS mode, and the results were analyzed. Next, the performance of Islamic Republic of Iran's Railway Stations was assessed by basic CCR model, without selecting non-discretionary variable. Then, the efficiency measures which have been obtained by the two previous models have been analyzed with rank sum test.

Keywords: Data envelopment analysis, performance of railway stations, efficiency

1. Introduction

The valuable role of transportation in economic development of countries today is obvious. By creating economic growth, direct and indirect creation of job opportunities, improvement of standards, raising living standards, and reduction of poverty and bridging class gaps, sustainable transportation industry results in increased regional and national incomes and flourish of areas covered by it. The subsection of air transportation, briefly called rail industry, has special importance as the fastest and the most modern section of transportation network in world trade and tourism. Since the main objective of managers is to make optimal use of available resources to obtain the best result, therefore, operational efficiency of railway stations is very important and valuable in determining whether the future systems will be successful. Various researches, conducted using data envelopment analysis, have been published on efficiency of railway stations. These studies are very different and diverse in terms of their geographical scope. Most of these researches study railway stations of a single country; these researches are mostly conducted in the US, Brasilia, Taiwan, Japan, Australia, Italy and Spain. First literature on pattern identification studies of railway stations were published in early 1990 by Tolofari, Ashford, and Caves [16], reporting a series of initial studies of performance of railway stations, conducted by comparing the performance of a reference railway station in the UK with its nearby railway stations. Similarly, Gillen and Lall [10] studied in 1997 the measure of development of productivity and performance of railway station of the US, [14] Murillo-Melchor analyzed technical efficiency and productivity changes of railway stations of Spain in 1999, Fernandes et al [8] studied in 2002 the optimal use of capacity of Brasilia's railway stations, and Yoshida et al [18] and Barros et al [5], [6] analyzed pattern identification of Japan's railway stations and technical efficiency of Portugal's railway stations by data envelopment analysis method, respectively. Similar studies in this area include evaluations conducted by Lin and Hong [11], Martin and Roman [12], [13], Barros and Dieke [4] and [5], Schaar and Sherry [16], Yu et al [17], Pathomsiri et al [15], Fung MKY [9].

In second part of this paper, first, a review of primary concepts of data envelopment analysis is provided. In third part, considering selected inputs and outputs and the non-discretionary factors loaded on some of them, and categorization of railway stations, a model to evaluate railway stations is proposed, which is more accurate and sensitive, compared with other models previously used in this field. Finally, in fourth part, the results of the proposed model with CCR model (without taking into account non-discretionary factors loaded on inputs) will be studied using statistical non-parametric test of ranks sum.

2. Data Envelopment Analysis

Data envelopment analysis is a non-parametric method to calculate relative efficiency of a set of decision-making units through making comparisons between them and using mathematical programming. Efficiency of a decision-making unit is a function of intra-organizational factors and indices, which uses production function to evaluate its performance. Production function gives the maximum output for any combination of inputs. Because of multi-value nature of production function, complexity of production process, changes of production technology, etc., production function is not available. Therefore, an approximation of this function must be estimated. For this purpose, a set called production possibility set (PPS) is constructed, and part of its frontier is considered as an approximation of the production function. In other words, assume that x input vectors and y output vectors are considered for a decision-making unit, then, production possibility set will be defined as T= {(x, y) | if x>0 can produce y>0}. Besides, Charnes, Cooper and Rodes (1978), considering the axioms:

1) Observations inclusion (non-emptiness) axiom;

$$\forall \boldsymbol{j} \quad (\boldsymbol{x}_j, \boldsymbol{y}_j) \in T, \qquad j = 1,2,\dots,n$$

2) Ray unboundedness axiom (constant returns to scale):

$$\forall (x,y) \quad \forall \lambda \quad [(x,y)\epsilon T \ \& \ \lambda \geq 0] \Rightarrow (\lambda x, \lambda y)\epsilon T$$

3) Feasibility Axiom;

$$\forall (x,y) \quad \forall (\bar{x},\bar{y}) \quad \forall \lambda \quad [(x,y)\epsilon T \ \& \ \bar{x} \geq x \ \& \ \bar{y} \leq y] \Rightarrow (\bar{x},\bar{y})\epsilon T$$

4) Convexity axiom; and,

$$\forall (x,y) \ \forall (\bar{x},\bar{y}) \ \forall \lambda \ [(x,y)\epsilon T \ \& \ (\bar{x},\bar{y})\epsilon T \ \& \ \lambda \epsilon [0,1]] \Rightarrow \lambda(x,y) + (1-\lambda)(\bar{x},\bar{y})\epsilon T$$

5) Minimum extrapolation principle: Set T is the smallest set to which the four previous axioms apply,

Proposed production possibility TC or TCCR, derived from previous work of Farrel, as follows:

$$T_C = \left\{ (x,y) \middle| x \geq \sum_{j=1}^{n} \lambda_j x_j \ \ \& \ \ y \leq \sum_{j=1}^{n} \lambda_j y_j \ , \lambda_j \geq 0 \ , j = 1,2,\dots,n \right\}$$

Besides, frontier of set TC, which is fragmentarily linear, is called efficient frontier or Farell's frontier, and every DMU located on the frontier will be relatively efficient; otherwise, it will be called inefficient. Further, inefficient DMUs can be driven towards the frontier by different methods, the most important of which are:

a) Decreasing Inputs: means solving the following linear programming problem which is called input-oriented envelopment form CCR model:

$$\begin{aligned} & \min \theta \\ & s.t. \quad \sum_{j=1}^{n} \lambda_j x_j \leq \theta x_o \\ & \qquad \sum_{j=1}^{n} \lambda_j y_j \geq y_o \\ & \qquad \lambda_j \geq 0, \qquad j = 1,2,\dots,n \end{aligned}$$

In optimal answer of problem (3), if θ*<1, then, DMU0 is inefficient, and if θ*=1, then, DMU0 is placed on the frontier, and is efficient.

b) Increasing Outputs: means solving the following linear programming problem which is called output-oriented CCR model:

$$\begin{aligned} & \max \varphi \\ & s.t. \quad \sum_{j=1}^{n} \lambda_j x_j \leq x_o \\ & \qquad \sum_{j=1}^{n} \lambda_j y_j \geq \varphi y_o \\ & \qquad \lambda_j \geq 0, \qquad j = 1,2,\dots,n \end{aligned} \qquad (3)$$

Besides, in optimal answer of problem (3), if φ*=1, then, DMU0 is efficient, and if φ*>1, then, DMU0 is inefficient. Also, by adding convex constraint $\sum_{j=1}^{n} \lambda_j = 1$ to problem (2) and (3), output and input-oriented BCC model proposed by Banker, Charnes and Cooper will be constructed.

On the other hand, CCR and BCC models – whether output-oriented and input-oriented – are radial models, in which contraction of all inputs and extension of all output occur to the same proportion. Therefore, Cooper et al introduced additive model as follows, which is non-radial, and is both output-oriented and input-oriented.

$$\max z = \sum_{i=1}^{m} s_i^- + \sum_{r=1}^{s} s_r^+$$

$$s.t. \quad \sum_{j=1}^{n} \lambda_j x_{ij} + s_i^- = x_{io} \ , \qquad i = 1,2,.$$

$$\sum_{j=1}^{n}\lambda_j y_{rj} - s_r^{+} = y_{ro}\ , \qquad r = 1,2,\dots,s \qquad s^{+} \geq 0$$

$$\sum_{j=1}^{n}\lambda_j = 1 \qquad (4)$$

$$\lambda_j \geq 0\ , \qquad j = 1,2,\dots,n$$

In this model, maximum distance between decision-making unit and efficiency frontier is measured. Model (4) is additive BCC model, which is converted to additive CCR model by removing the constraint $\sum_{j=1}^{n}\lambda_j = 1$. Also, in additive model, the evaluated unit is efficient if and only if z*=0, where z denotes optimal value of target function.

To have a model which is at the same time radial, and non-radial, Tone (2001) proposed hybrid model as follows. In fact, this model drives evaluated model towards efficient frontier in a radial manner at some points and in a non-radial manner at other points.

$$\rho^* = min \frac{١ - \frac{m_١}{m}(١ - \theta) - \frac{١}{m}\sum_{i=١}^{m_٢} s_i^{NR-}/x_{io}^{NR}}{١ + \frac{s_١}{s}(\varphi - ١) + \frac{١}{s}\sum_{r=١}^{s_٢} s_r^{NR+}/y_{ro}^{NR}}$$

$$s.t. \qquad \sum_{j=١}^{n}\lambda_j x_j^{R} \leq \theta x_o^{R}$$

$$\sum_{j=١}^{n}\lambda_j x_j^{NR} + s^{NR-} = x_o^{NR}$$

$$\sum_{j=١}^{n}\lambda_j y_j^{R} \geq \varphi y_o^{R}$$

$$\sum_{j=١}^{n}\lambda_j y_j^{NR} - s^{NR+} = y_o^{NR}$$

$$\theta \leq ١$$

$$\varphi \geq ١$$

$$\lambda \geq ٠$$

$$s^{NR-} \geq ٠$$

$$s^{NR+} \geq ٠ \qquad (٥)$$

Where $X \in R_{+}^{m\times n}$ and $Y \in R_{+}^{s\times n}$ denote input and output data matrices, respectively, and n denotes the number of DMUs, m the number of inputs and s the number of outputs. Also, input matrix is divided into two radial $X^{R} \in R_{+}^{m_1\times n}$ and non-radial sections, where $X^{NR} \in R_{+}^{m_2\times n}$. Similarly, output matrix is divided into two radial $m = m_1 + m_2$ and non-radial sections, where $Y^{R} \in R_{+}^{s_1\times n}$. In fact, ρ decreases as θ decreases and φ and

$Y^{NR} \in R_{+}^{s_2 \times n}$ increase. The evaluated unit is hybrid-efficient if and only if ρ* = 1, that is, θ* = 1, φ* = 1, $s^{NR-^*} = 0$, and $s^{NR+^*} = 0$. However, it should be noted that the efficiency given by hybrid model is not Pareto efficiency, and model (5) is also nonlinear, which can be linearized using Charnes-Cooper's conversions.

In the paper, performance of Islamic Republic of Iran's railway station in 2008 will be evaluated.

3- Performance evaluation of Islamic Republic of Iran's railway station using non-discretionary factors of Iranian railway

Islamic Republic of Iran had 363 operational railway stations[1] in 2013, of which 11 are international railway stations[2], and the rest are national railway stations[3] [2].

Operational capabilities of the said company are as follows:

a) 16330 freight wagons of all kinds including covered, low wall, high wall, flat, tank, ballast, gas, crane wagons.

b) 1192 passenger wagons of all kinds.

c) 565 diesel-electrical, electrical and maneuver locomotives.

d) 363 main stations in RAI network.

e) Free international stations: Ahvaz, Sahlan, Tabriz, Jolfa, Nikpasandi, Tehran's Mehrabad, Tehran, Isfahan, Bandar Abbas, Sarbandar, Manhad (from Razi border).

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1 The station arrival and departure of airplane has been performed.

2 The station which meets the features and conditions set by International Train Organization for international stations.

3 The station licensed by the cabinet to perform international and national arrivals and departures.

In 2013, 20 million passengers and 30 tones of freight were transported by railway, and by the end of fifth development plan, annual passenger transportation and freight transportation capacities shall reach 36 million and 64 tones, respectively.

In this paper, 45 railway stations were considered as DMUs. In this paper, inputs include runway area of station, station area and terminal area, and outputs include number of trips, the number of passengers, and cargo and mail freights. Also, runway area of station, station area and terminal area which are among physical infrastructure of railway station are non-discretionary factors [1], changes of which can are not at the discretion of the manager or user. However, it is obvious even if these inputs are non-discretionary, it is very important to take them into account in performance evaluation [3]. To this end, Banker and Murray's model (1986) [1] is used in designing performance evaluation model of railway stations. Further, the basic model used is the hybrid model [7]. In other words, the following linearized model (model 6) is recommended for performance evaluation of railway stations.

$$
\begin{aligned}
\min \quad & t-\frac{1}{3}\left(\frac{ts_1^{NR-}}{x_{1o}}+\frac{ts_2^{NR-}}{x_{2o}}+\frac{ts_3^{NR-}}{x_{3o}}\right) & \\
s.t. \quad & t+(\varphi_1-t)+(\varphi_2-t)+(\varphi_3-t)=1 & \\
& \sum_{j=1}^{n}\lambda_j x_{ij}^{NR}+s_i^{NR-}=tx_{io}^{NR} & i=1,2,3 \\
& \sum_{j=1}^{n}\lambda_j y_{rj}^{R}\geq \varphi_r y_{ro}^{R} & r=1,2,3 \\
& \varphi_r \geq t & r=1,2,3 \\
& \lambda_j \geq 0 & j=1,2,\dots,n \\
& s_i^{NR-} \geq 0 & i=1,2,3 \\
& t \geq 0 & \qquad (6)
\end{aligned}
$$

In order to better analyze performance of Iran's railway stations, 45 studied railways were divided into three categories. The first category includes 15 railway stations that have less passenger reception capacity and fewer facilities compared with other railway stations. The second category consists of 30 railway stations; 15 of which are first class railway stations, and the rest are railway stations with average passenger reception and facilities compared with other railway stations. The third category includes all 45 evaluated railway stations; and DMUs of each of these three categories are evaluated at each stage.

Based on table (1), the results of application of this model to the first category shows that of 15 railway stations in the first category, 7 railway stations, that is, Bahregan (Imam Hassan), Tohid (Jam), Takestan, Sharafkhaneh, Sabzevar, Kashan and Khaf are efficient, and the rest are inefficient. It should be noted that Bahregan (Imam Hassan) railway station is reference railway station for Bandar Khorramshahr, Tohid (Jam) railway station for 4 railway stations (Sarbandar, Bandar Khorramshahr, Bandar Torkman, and Sirjan), Takestan for 3 railway stations (Bandar Khorramshahr, Bandar Torkman, and Sirjan) and Abumusa railway station for Jiroft, Karaj, Dorud, and Khoi railway station.

In application of the model to the second category, only two railway stations of Gorgan and Firuzkuh were efficient; and Gorgan railway station was only reference railway station for Ardebil railway station.

Similarly, Firuzkuh railway station was reference railway station for 28 railway station. That is, railway stations of Bahregan (Imam Hassan), Sarbandar, Bandar Khorramshahr, Tohid (Jam), Bandar Torkman, Ghazvin, Takestan, Sirjan, Sharafkhaneh, Karaj, Sabzevar, Kashan, Dorud, Khaf, Khoi, Garmsar, Maragheh, Yazd, Ardebil, Qom, Kashan, Pishva, Mianeh, Shiraz, Andimeshk, Sari and Shahr-e-Kord can follow Firuzkuh railway station as their point of reference.

In the third category in which performance evaluation of all railway station was conducted, only 2 railway stations of Firuzkuh and Tehran were efficient, and the rest were inefficient; and Tehran was reference for all evaluated railway station except for Firuzkuh railway station.

Table 1: Results of the model to analyze the performance of first-class railway stations

railway station reference		the efficiency of the railway station first-class	the name of the railway station	Row
1.000000	$\lambda^*_1 =$ 1.0000	**1.000000**	parand	1
0.003874	$\lambda^*_4 =$ 0.8597	0.003874	sarbandar	2
0.206158	$\lambda^*_1 =$ 0.1306	0.206158	bandar khoramshahr	3
1.000000	$\lambda^*_4 =$ 1.0000	**1.000000**	(tohid (jam	4
0.049935	$\lambda^*_4 =$ 0.2651	0.049935	Bandar torkaman	5
0.011600	$\lambda^*_{14} =$ 0.5454	0.011600	ghazvin	6
1.000000	$\lambda^*_7 =$ 1.0000	**1.000000**	takestan	7
0.143679	$\lambda^*_4 =$ 0.6226	0.143679	sirjan	8
1.000000	$\lambda^*_9 =$ 1.0000	**1.000000**	sharafkhane	9
0.115608	$\lambda^*_{14} =$ 0.8181	0.115608	karaj	10
1.000000	$\lambda^*_{11} =$ 1.0000	**1.000000**	sabzevar	11
1.000000	$\lambda^*_{12} =$ 1.0000	**1.000000**	kashan	12
0.001001	$\lambda^*_{14} =$ 0.9754	0.001001	dorod	13
1.000000	$\lambda^*_{14} =$ 1.0000	**1.000000**	khaf	14
0.001180	$\lambda^*_{14} =$ 0.6921	0.001180	khoy	15

Table 2: Results of the model to analyze the performance of second-class railway stations

railway station reference		the efficiency of the railway station second-class	the name of the railway station	Row
	$\lambda^*_{27} =$ 1.0472	0.004933	garmsar	16
	$\lambda^*_{27} =$ 1.0545	0.004098	maraghe	17
	$\lambda^*_{27} =$ 1.2663	0.008913	yazd	18
$\lambda^*_{27} =$ 0.2307	$\lambda^*_{22} =$ 0.0508	0.096083	kerman	19
	$\lambda^*_{27} =$	0.033246	ghom	20

	0.2513			
	λ^*_{27} = 1.2903	0.020190	kashan	21
	λ^*_{22} = 1.0000	**1.000000**	gorgan	22
	λ^*_{27} = 0.8863	0.005966	pishva	23
	λ^*_{27} = 0.6363	0.055439	varamin	24
	λ^*_{27} = 1.0752	0.041901	miane	25
	λ^*_{27} = 1.0909	0.003615	shiraz	26
	λ^*_{27} = 1.0000	**1.000000**	firozkoh	27
	λ^*_{27} = 1.3763	0.026545	andimeshk	28
	λ^*_{27} = 0.4090	0.000113	sari	29
	λ^*_{27} = 1.2924	0.007399	zanjan	30
	λ^*_{45} = 0.1021	0.052507	jolfa	31
	λ^*_{45} = 0.0817	0.125481	semnan	32
	λ^*_{45} = 0.0995	0.102426	arak	33
	λ^*_{45} = 0.1047	0.057663	zahedan	34
	λ^*_{45} = 0.2199	0.210341	ahyvaz	35
	λ^*_{45} = 0.1453	0.064990	sahlan	36
	λ^*_{45} = 0.0955	0.006912	oromie	37
	λ^*_{45} = 0.1545	0.079205	tabriz	38
	λ^*_{45} = 0.1217	0.214439	Bandar abas	39
	λ^*_{45} = 0.1822	0.013099	Mehr abadi	40
	λ^*_{45} = 0.3011	0.176671	Nik pasandi	41
	λ^*_{45} = 0.2756	0.114386	esfahan	42
	λ^*_{45} = 0.0576	0.076827	kgoramshahr	43
λ^*_{45} = 0.3698	λ^*_{27} = 0.4328	0.885205	mashhad	44
	λ^*_{45} = 1.0000	1.0000	tehran	45

Table 3: Results of the model to analyze the performance of third-class railway stations

railway station reference	the efficiency of the railway station third- هاي class	the name of the railway station	Row

4. Statistical non-parametric test of ranks sum

In section three, performance evaluation of railway stations is conducted using hybrid model and considering non-discretionary factors loaded on inputs. In this section, using CCR model and regardless of non-discretionary factors loaded on inputs, performance of railway stations is evaluated. Then, the results of CCR hybrid model, and envelopment form of CCR model using statistical non-parametric test of ranks sum [70], which is based on data ranking, are studied. Therefore, efficiency of railway station, which is obtained using CCR hybrid model, is placed in set A, and the results of CCR model regardless of non-discretionary factors are placed in set B. Then, we have set C entries of which are the same as entries of two sets A and B, arranged in descending order.

A = {0.002207, 0.000319, 0.009547, 0.020491, 0.003520, 0.000761, 0.002619, 0.009241, 0.000151, 0.005632, 0.000132, 0.000464, 0.000055, 0.018319, 0.000051, 0.001147, 0.000966, 0.002393, 0.025835, 0.017614, 0.008337, 0.060909, 0.001465, 0.015647, 0.011880, 0.000934, 1.000000, 0.009784, 0.000032, 0.001521, 0.052507, 0.125481, 0.102426, 0.057663, 0.210341, 0.064990, 0.006912, 0.079205, 0.214439, 0.013099, 0.176671, 0.114386, 0.076827, 0.485205, 1.000000}

B = {0.378091, 0.006210, 0.298716, 0.251087, 0.088739, 0.068400, 0.344620, 0.115820, 0.122915, 0.114877, 0.107953, 0.125119, 0.013552, 0.212784, 0.035902, 0.149673, 0.144182, 0.074211, 0.567590, 0.183186, 0.071468, 0.747877, 0.239149, 0.491612, 0.114262, 0.446364, 1.000000, 0.069003, 0.533741, 0.065641, 0.254720, 0.447360, 0.511835, 0.330486, 0.617486, 0.891649, 0.147122, 0.487999, 0.715688, 0.125283, 0.668112, 0.540709, 0.393894, 0.975723, 1.000000}

C = {1.000000, 1.000000, 1.000000, 1.000000, 0.975723, 0.891649, 0.747877, 0.715688, 0.668112, 0.617486, 0.567590, 0.540709, 0.533741, 0.511835, 0.491612, 0.487999, 0.485205, 0.447360, 0.446364, 0.393894, 0.378091, 0.344620, 0.330486, 0.298716, 0.254720, 0.251087, 0.239149, 0.214439, 0.212784, 0.210341, 0.183186, 0.176671, 0.149673, 0.147122, 0.144182, 0.125481, 0.125283, 0.125119, 0.122915, 0.115820, 0.114877, 0.114386, 0.114262, 0.107953, 0.102426, 0.088739, 0.079205, 0.076827, 0.074211, 0.071468, 0.069003, 0.068400, 0.065641, 0.064990, 0.060909, 0.057663, 0.052507, 0.035902, 0.025835, 0.020491, 0.018319, 0.017614, 0.015647, 0.013552, 0.013099, 0.011880, 0.009784, 0.009547, 0.009241, 0.008337, 0.006912, 0.006210, 0.005632, 0.003520, 0.002619, 0.002393, 0.002207, 0.001521, 0.001465, 0.001147, 0.000966, 0.000934, 0.000761, 0.000464, 0.000319, 0.000151, 0.000132, 0.000055, 0.000051, 0.000032}

Now, entries of set R1 show the ranks of data.

R_1 = {2, 2, 2, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25,26,27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90}

Also, ranks set (provided that repeated ranks are calculated only once) will be as follows:

Sum of ranks A: S_A= 2799

Sum of ranks B: S_B= 1293

In this case:

$$T = \frac{s - m(m+n+١)/٢}{\sqrt{mn(m+n+١)/١٢}}$$

$$T_A = ٢.٤٧٥٧٧٢٧١٧ \geq ٢.٣٢٦ = T_{٠.٠١} = T_{\frac{\alpha}{٢}}$$

$$T_B = -۲.۴۸۵۶۵۶۰۴۲ \leq -۲.۳۲۶ = T_{۰.۰۱} = T_{\frac{\alpha}{۲}}$$

$$\Rightarrow \alpha = ۰.۰۲$$

5. Conclusion

In this paper, technical efficiency of Islamic Republic of Iran's railway stations in exploiting their physical infrastructure is evaluated using data envelopment analysis. The new work on performance evaluation of railway stations was conducted using hybrid model regardless of non-discretionary factors loaded on inputs, which results in reflection of more precise results of efficiency score.

Also, categorization of railway stations and choice of the proper model are very important. Placing decision-making units in several categories in such manner that entries of each category have similar structures in terms of physical infrastructure, passenger reception capacity and other facilities of railway station will have remarkable results. For example, we can identify railway stations which make optimal use of their facilities while they have fewer facilities than other railway stations; which require more attention to be paid to their development; among such railway stations are Parand, Tohid (Jam), Takestan, Sharafkhaneh, Sabzevar, Kashan, Abumusa, Gorgan and Khark (Martyrs of Island) railway stations.

Additionally, efficiency of railway stations obtained by CCR model regardless of non-discretionary factors in inputs was calculated, and the results of application of CCR hybrid model were compared with those of CCR model, and their results were studied using statistical non-parametric test of ranks sum, which test gave α =0.02.

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