Performance Evaluation of the Provinces of Iran Reading To the Measures of Freight and Passenger Transportation

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Abstract

Freight and passenger transport are two main functions of the infrastructure and transportation networks in each country. It is required to efficiently utilize the transportation infrastructures to increase transportation-related performance measures. In this study, data envelopment analysis (DEA) model is used to evaluate performance of the Iranian provinces from the freight and passenger transport perspectives. In this regard, transportation infrastructures such as roads, freeways, highways and arterial roads are considered as inputs to the provinces that are Decision Making Units (DMUs) in this research. Also ton-kilometers of the crossing freight, ton-kilometers from the province, passenger-kilometers of the crossing passengers and passenger-kilometers from the province are considered as the main performance measures of the provinces in the freight and passenger transportation. Two main efficiency-related indicators including Freight Transportation Efficiency Indexes (FTEI) and Passenger Transportation Efficiency Indexes (PTEI) are obtained to provide the possibility to assess efficiency of the provinces. The results are obtained to compare efficiency of the provinces from two freight and passenger transport. Results indicate that the Tehran province is efficient in three perspectives including "combined freight and passenger", "freight" and "passenger". Ilam province efficiently utilize transportation infrastructures for passenger transport. The Sistan, Qom, Kohgiluyeh and Hormozgān provinces efficiently utilize transportation infrastructures for freight transport. Transportation efficiency indexes for a number of the provinces such as Ardabil, Zanjan, Qazvin, Kermanshah, Golestan, Mazandaran and Hamadan are similar in freight and passenger perspectives. In addition, Alborz, Ilam, Khorasan Razavi, Semnan and Gilan have greater Passenger Transportation Efficiency Index (PTEI) relative to the Freight Transportation Efficiency Index (FTIE).

Keywords: Data envelopment analysis; Freight Transportation Efficiency Indexes (FTEI); Passenger Transportation Efficiency Indexes (PTEI); freight; passenger

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1. Introduction

Transportation is a main function of business development in each country. Transportation involves two major disciplines that are freight and passengers transferring. There are a set of standard indicators for performance evaluation of the Transportation networks and infrastructures. It is important to analyze the indicators in an integrated and systematic framework.in this regard, efficiency evaluation in transportation is a main issue that investigated capability of the DMUs in utilization of the transportation infrastructures such as roads.

It is required to assess efficiency of transportation systems to specify efficiency of them. This provides the possibility to compare different DMUs and rank them. This led to identify strength and weakness points of the transportation systems. In addition, this led to suggest improvement areas in order to increase efficiency of the transportation-related DMUs.

This research is aimed to assess the provinces of Iran in accordance with their main transportation-related key performance indicators (KPIs). It causes to rank the provinces based on their efficiency scores in freight and passenger transportation. In addition, a classification algorithm is used to detect the relationship between FTEI and PTEI, and development level of the provinces.

Main research questions of this study are stated as follows:

- What are the efficiency scores of the provinces regarding to the freight transport?
- What are the efficiency scores of the provinces regarding to the passenger transport?
- Which provinces are efficient in utilizing the transportation infrastructure?

A number of previous research focused on different aspects of efficiency of transportation systems, networks, investments and infrastructures. For example, Jiang, Liu and Lv [Jiang, Liu and Lv, 2017] used DEA to assess transportation systems by considering investment in fixed assets, investment in line network scales and investment of equipment. Zhang, Jing and Sun [Zhang, Jing and Sun, 2016] applied three-stage DEA model to analyze efficiency of air transportation corporations that considered environmental and stochastic factors. Results of this research indicated that state-owned airlines involves less efficiency. Ji, Wu and Zhu [Ji, Wu and Zhu, 2016] adapted DEA model to meet stakeholders requirements to implement optimal transportation strategy in order to present specified transportation objectives with less resource consumption. In addition, reducing pollution emission was another objective of this study. Wu et al. [Wu et al. 2016] used DEA to assess environment and energy concerned performance of the transportation systems in China in line with sustainable development. They investigated subsystems of transportation networks for passenger and freight. They developed parallel DEA model to assess the efficiency of subsystems related to passenger and freight to provide the possibility to improve efficiency level of the considered subsystems. Rezaee, Izadbakhsh and Yousefi [Rezaee, Izadbakhsh and Yousefi, 2016] proposed a hybrid approach including DEA and Nash bargaining game to assess performance of transportation systems. The investigated measures were classified in a number of groups in line with the competitive environment. Zhao and Liu [Zhao and Liu, 2016] applied DEA model while investment in infrastructures as an input factor, and freight and passenger traffic as the output factors in order to evaluate the collaborative, development and the comprehensive validities in subsystems. The model was applied on three means of transportation including railway, highway and aviation in Beijing-Tianjin-Hebei. Azadi et al. [Azadi et al. 2015] developed two DEA models for two-stage transportation network structures in order to meet green supply chain management's requirements of an enterprise and its transportation service providers. Guo,

Gong and Hu [Guo, Gong and Hu, 2015] used DEA to obtain investment, technological and pure technological efficiency indicators for transportation projects. Cui and Li [Cui and Li, 2014] presented a novel three-stage virtual frontier Data Envelopment Analysis model to evaluate transportation energy efficiencies for thirty Chinese provincial administrative regions from 2003 to 2012. Cheng [Cheng 2014] used interval DEA and C2R models to provide a decision making framework for supply chain management of road transportation. Chang et al. [Chang et al. 2013] used non-radial DEA model to investigate the environmental efficiency of China's transportation industry. Chen and Han [Chen and Han, 2012] applied DEA to select the optimal solution of public transport operators from the perspective of efficiency and welfare increment simultaneously. Zhao et al. [Zhao et al. 2011] utilize a network-Data Envelopment Analysis model by considering intermediate input and output factors. The model was developed so that requirements of three stakeholders groups including transportation service providers, users and community. Rassafi, Jamour and Mirzahossein [Rassafi, Jamour and Mirzahossein, 2013] used Different network performance measures in a multi-objective traffic assignment problem. Goli, Ziari and Amini [Goli, Ziari and Amini, 2016] evaluated the performance of Crumb Rubber Modified Binders used in Isfahan Province. Ding, Xu and Yao [Ding, Xu and Yao, 2011] applied principal component analysis and CCR-DEA model to assess performance of China's transportation industry. Results indicated that China's transportation industry can be categorized into four improvement stages by considering a set of six input factors and five output factors. Michaelides et al. [Michaelides et al. 2009] calculated technical efficiency in International Air Transport corporations using Stochastic Frontier Analysis from 1991 to 2000. The results were compared with DEA method. Xiao-hong, Lei-shan and Bo [Xiao-hong, Lei-shan and Bo, 2008] modified DEA model to evaluate transportation hub of cities. Lishan, Jian and Futian [Lishan, Jian and Futian, 2007] used DEA to evaluate efficiency of urban public transportation terminals using import and export indicators.

The structure of this paper is as follows. After introduction in section 2 data envelopment analysis model is stated. Section 3 is dedicated to efficiency analysis of the provinces of Iran from the transportation perspective. Afterwards, Analysis the relationship between efficiency measures and development level of the provinces is explained in section 4. Finally, conclusions of this research is explained in section 5.

2. Data Envelopment Analysis Approach

In this research, data envelopment analysis (DEA) approach is used for efficiency evaluation that is developed by Charnes, Cooper and Rhodes [Charnes, Cooper and Rhodes, 1978]. Objective function and constraint of the DEA model are presented in continuation.

$$W_o = Max \sum_{r=1}^{s} u_r y_{r\circ} \quad (1)$$

$$s.t.: \sum_{i=1}^{m} V_i x_{i\circ} = 1 \quad (2)$$

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

$$u_r \ge 0 \qquad v_i \ge 0 \quad (4)$$

u_r : Weight of the r-th output
v_i : weight of the i-th input
o : index of a DMU that is under study , $o \in \{1,2,\dots,n\}$
y_{ro}: the amount of r-th output
x_{io} : the amount of i-th input
x_{ij} : the amount of i-th input for j-th unit
y_{rj} : the amount of r-th output for j-th unit
w_o: the efficiency indicator of the o-th DMU.
Objective function (1) of the DEA model aimed to maximize the weighted output factors.

Constraint (2) ensures that the weighted input factors of the DMUs are equal to one. Constraint (3) explains that the efficiency score is less than or equal to one, for each DMU. Constraint (4) states that all weights of input and output factors will be greater than or equal to zero.

3. Efficiency Analysis of Provinces of Iran from Transportation Perspective

In this study all provinces of Iran are considered to evaluate their efficiency levels by Lingo Software. Therefore, this provides the possibility to specify to what extent each province efficiently utilize transportation infrastructures to produces outputs. The investigated inputs and outputs related to the transportation perspective of the provinces are stated in the Table 1.

Three input factors of Table 1 are related to the lengths of different types of roads showing the most important factor of the transportation infrastructure. In addition, four output factors of Table 1 are related to the main performance measures of provinces in two main considered functions including Freight and passenger transportation. Data of Table 1 is given from official website of Ministry of Roads and Urban Development in Iran.

3.1 Analyzing Efficiency of the Provinces for all Infrastructures

Efficiency indexes of the provinces are obtained to determine their capability in transportation infrastructures utilization. For this purpose, the provinces are sorted in the Table 2 based on their transportation efficiency index (TEI).

Table 2 exhibits that the transportation efficiency indexes (TEI) of the Ilam, Tehran, Sistan, Qom, Kohgiluyeh and Hormozgān provinces are equal to one. This indicates that theses provinces efficiently make use of transportation infrastructures to present the transportation indicators. Half of the efficient provinces including Ilam, Sistan and Hormozgān are frontier provinces. Also it is obvious that all efficient provinces except Tehran are in the undeveloped provinces of Iran. Therefore, it is indicated that the undeveloped provinces despite of the insufficient infrastructures, efficiently utilize their transportation infrastructures and have the appropriate capability to efficiently use of the existing infrastructures. It is necessary to mention that data of development level of provinces is given from official website of Ministry of Interior in Iran.

Freight and passenger transport are two main functions of the infrastructure and transportation networks in each country. To provide the possibility to assess the performance of each disciplines, a specific efficiency-related measure should be defined. For freight transportation function, Freight Transportation Efficiency Indexes (FTEI) and for passenger transport function, Passenger Transportation Efficiency Indexes (PTEI) are defined. Calculation of them and the related analysis are presented in sections 3.2 and 3.3.

3.2 Efficiency Analysis for the Output Factors Related to the Freight

Freight Transportation Efficiency Indexes (FTEIs) are obtained so that ton-kilometers of the crossing freight and ton-kilometers from the province are taken into account as output factors and the length of roads, the length of freeways and highways and length of the arterial roads are assumed as the input factor. Afterwards, Freight Transportation efficiency indexes (FTEIs) are gotten and are shown in the Table 3 in a descending order. Table 3 indicates that the Freight Transportation Efficiency

Indexes (FTEI) of the Tehran, Sistan, Qom, Kohgiluyeh and Hormozgān provinces are equal to one. This indicates that theses provinces efficiently make use of transportation infrastructures from the freight transportation perspective. Two of the efficient provinces including Sistan and Hormozgān are frontier provinces. Also it is obvious that all efficient provinces in freight transportation except Tehran are in the undeveloped provinces of Iran. Therefore, it is indicated that the undeveloped provinces despite of the insufficient infrastructures, efficiently utilize their infrastructures in freight transport.

3.3 Efficiency Analysis for the Output Factors Related to the Passengers

Passenger Transportation Efficiency Indexes (PTEIs) are calculated so that passenger-kilometers of the crossing passengers and passenger-kilometers from the province are taken into account as the output factors and the length of roads, the length of freeways and highways and length of the arterial roads are assumed as the input factor. After that, passenger transportation efficiency indexes (PTEIs) are obtained while are displayed in the Table 4 in a descending order. Table 4 indicates that the Passenger Transportation Efficiency Indexes (PTEI) of the Ilam and Tehran provinces are equal to one. This indicates that theses provinces efficiently make use of transportation infrastructures from the passenger transport perspective. It is obvious that Ilam is a frontier and undeveloped province. However it efficiently utilize their infrastructures in passenger transport.

3.4 Comparison of the Provinces from the Freight and Passengers Performance Measures

In this section a comparative analysis and discussion is performed between transportation efficiency indexes (TEIs) of the performance measures of the freight and passengers perspectives in the Table 5. Table 5 indicates that only Tehran is efficient in three perspectives including “combined freight and passenger”, “freight” and “passenger”. TIE and PTIE of the Ilam is equal to one indicating it efficiently utilize transportation infrastructures for passenger transport. TIE and CTIE of the Sistan, Qom, Kohgiluyeh and Hormozgān are equal to one indicating that they efficiently utilize transportation infrastructures for freight transport. Transportation efficiency indexes for a number of the provinces such as Ardabil, Zanjan, Qazvin, Kermanshah, Golestan, Mazandaran and Hamadan are similar in freight and passenger perspectives. Some of the provinces such as Azerbaijan East, Azerbaijan West, Isfahan, Bushehr, Chahar Mahaal and Bakhtiari, Khorasan South, Khorasan North, Khuzestan, Sistan and Baluchestan, Fars, Qom, Kurdistan, Kerman, Kohgiluyeh and Boyer-Ahmad, Lorestan, Markazi, Hormozgān and Yazd Present more efficient performance in freight transport relative to the passenger transport. In addition, Alborz, Ilam, Khorasan, Razavi, Semnan and Gilan have greater Passenger Transportation Efficiency Index (PTEI) relative to the Freight Transportation Efficiency Index (CTIE).

The main advantage of the applying three mentioned approaches is providing the possibility to assess performance of provinces from three dimensions considering freight transportation, passenger and tranportarion and both of them, separately. Therefore, Table 5 shows that provinces such as Qazvin, Ardabil, Alborz, Kerman, Bushehr, Golestan, Gilan, Mazandaran and Hamadan should focus on efficiency increment in freight transportation. Also provinces such as Azerbaijan, Ardabil, Hormozgān, Hamadan and Yazd plan and implement improvement initiatives to increase efficiency of passenger transportation function.

Table 1. Description of the input and output factors related to the transportation in the provinces

Transportation infrastructures in the provinces (Input factors)	Transportation functions of the provinces (Output factors)
Length of roads (km)	Ton-kilometers of the crossing freight (Million)
Length of freeways and highways (km)	Ton-kilometers from the province (Million)
Length of the arterial roads (km)	Passenger-kilometers of the crossing passengers (Million)
	Passenger-kilometers from the province (Million)

Table 2. Transportation efficiency indexes (TEIs) for the provinces of Iran

Province	Transportation Efficiency index	Rank	Province	Transportation Efficiency index	Rank
Ilam	1.000	1	Azerbaijan, West	0.644	12
Tehran	1.000	1	Khorasan, South	0.605	13
Sistan and Baluchestan	1.000	1	Fars	0.591	14
Qom	1.000	1	Azerbaijan, East	0.560	15
Kohgiluyeh and Boyer-Ahmad	1.000	1	Qazvin	0.544	16
Hormozgān	1.000	1	Kermanshah	0.536	17
Lorestan	0.963	2	Khorasan, North	0.533	18
Khuzestan	0.950	3	Alborz	0.524	19
Yazd	0.941	4	Gilan	0.472	20
Semnan	0.868	5	Kerman	0.470	21
Kurdistan	0.818	6	Ardabil	0.460	22
Chahar Mahaal and Bakhtiari	0.754	7	Hamadan	0.429	23
Isfahan	0.696	8	Golestan	0.372	24
Markazi	0.689	9	Bushehr	0.301	25
Khorasan, Razavi	0.658	10	Mazandaran	0.269	26
Zanjan	0.651	11			

Table 3. Freight Transportation Efficiency Indexes (FTEIs) for the provinces of Iran regarding to the freight

Province	Freight Transportation Efficiency Index	Rank	Province	Freight Transportation Efficiency Index	Rank
Tehran	1.000	1	Azerbaijan, West	0.598	13
Sistan and Baluchestan	1.000	1	Fars	0.591	14
Qom	1.000	1	Khorasan, Razavi	0.573	15

Province	Freight Transportation Efficiency Index	Rank	Province	Freight Transportation Efficiency Index	Rank
Kohgiluyeh and Boyer-Ahmad	1.000	1	Azerbaijan, East	0.559	16
Hormozgān	1.000	1	Kermanshah	0.531	17
Lorestan	0.960	2	Khorasan, North	0.504	18
Khuzestan	0.950	3	Qazvin	0.485	19
Yazd	0.941	4	Kerman	0.470	20
Kurdistan	0.817	5	Alborz	0.434	21
Chahar Mahaal and Bakhtiari	0.754	6	Ardabil	0.429	22
Semnan	0.750	7	Hamadan	0.428	23
Ilam	0.722	8	Gilan	0.365	24
Isfahan	0.696	9	Golestan	0.340	25
Markazi	0.689	10	Bushehr	0.297	26
Zanjan	0.618	11	Mazandaran	0.269	27
Khorasan, South	0.602	12			

Table 4. Passenger Transportation Efficiency Indexes (PTEIs) for the provinces of Iran regarding to the passengers

Province	Passenger Transportation Efficiency Index	Rank	Province	Passenger Transportation Efficiency Index	Rank
Ilam	1.000	1	Azerbaijan, East	0.449	16
Tehran	1.000	1	Hamadan	0.418	17
Sistan and Baluchestan	0.882	2	Ardabil	0.409	18
Qom	0.841	3	Fars	0.396	19
Semnan	0.831	4	Lorestan	0.394	20
Kohgiluyeh and Boyer-Ahmad	0.705	5	Chahar Mahaal and Bakhtiari	0.392	21
Kurdistan	0.663	6	Golestan	0.370	22
Khorasan, Razavi	0.655	7	Khorasan, North	0.303	23
Zanjan	0.586	8	Isfahan	0.273	24
Markazi	0.537	9	Khuzestan	0.236	25
Alborz	0.524	10	Mazandaran	0.216	26
Qazvin	0.523	11	Yazd	0.196	27
Khorasan, South	0.483	12	Bushehr	0.164	28
Kermanshah	0.480	13	Kerman	0.164	29
Gilan	0.472	14	Hormozgān	0.130	30
Azerbaijan, West	0.462	15			

Table 5. Transportation efficiency indexes (TEIs) based on the performance measures related to freight and passengers

Province	Transportation Efficiency index	Freight Transportation Efficiency Index	Passenger Transportation Efficiency Index	Province	Transportation Efficiency index	Freight Transportation Efficiency Index	Passenger Transportation Efficiency Index
Azerbaijan, East	0/560	0/559	0/449	Fars	0/591	0/591	0/396
Azerbaijan, West	0/644	0/598	0/462	Qazvin	0/544	0/485	0/523
Ardabil	0/460	0/429	0/409	Qom	1/000	1/000	0/841
Isfahan	0/696	0/696	0/273	Kurdistan	0/818	0/817	0/663
Alborz	0/524	0/434	0/524	Kerman	0/470	0/470	0/164
Ilam	1/000	0/722	1/000	Kermanshah	0/536	0/531	0/480
Bushehr	0/301	0/297	0/164	Kohgiluyeh and Boyer-Ahmad	1/000	1/000	0/705
Tehran	1/000	1/000	1/000	Golestan	0/372	0/340	0/370
Chahar Mahaal and Bakhtiari	0/754	0/754	0/392	Gilan	0/472	0/365	0/472
Khorasan, South	0/605	0/602	0/483	Lorestan	0/963	0/960	0/394
Khorasan, Razavi	0/658	0/573	0/655	Mazandaran	0/269	0/269	0/216
Khorasan, North	0/533	0/504	0/303	Markazi	0/689	0/689	0/537
Khuzestan	0/950	0/950	0/236	Hormozgān	1/000	1/000	0/130
Zanjan	0/651	0/618	0/586	Hamadan	0/429	0/428	0/418
Semnan	0/868	0/750	0/831	Yazd	0/941	0/941	0/196
Sistan and Baluchestan	1/000	1/000	0/882				

4. Analyzing the Relationship between Efficiency and Development Level

All provinces of Iran is categorized into four groups based on their development level so that the classification is shown in Table 6.

In this section the relationship between development level and freight and passenger transportation indexes is investigated. Therefore, an effective classification algorithm called Classification and Regression Tree (CART) is applied so that development level is considered as the target variable, and Freight Transportation Efficiency Index (FTEI) and Passenger Transportation Efficiency Index (PTEI) are investigated as the input variables. In other words, it is aimed to provide the possibility to determine development level based on the values of the FTEI and PTEI. The obtained decision tree is shown in Figure 1.

Now each part of the decision tree (Figure 1) is accurately investigated to present the specific measures in order to state development levels of the provinces based on the FTEI and PTEI. Node 1 of the Figure 2 indicates that if Passenger Transportation Efficiency Index (PTEI) is less than or equal to 0.206 then, the related provinces are in the relative developed provinces (label B).

Node 3 of the Figure 3 indicates that if Passenger Transportation Efficiency Index (PTEI) is less than or equal to 0.288 and greater than 0.206 then, the related provinces are in the developed provinces (label A).

Node 7 of the Figure 4 indicates that most of the provinces that their Passenger Transportation Efficiency Index (PTEI) are less than or equal to 0.915 and greater than 0.288, and their Freight Transportation Efficiency Index (FTEI) are less than or equal to 0.980, are in the less developed provinces (label C).

Node 8 of the Figure 5 indicates that if the Passenger Transportation Efficiency Index (PTEI) is greater than 0.915 and the Freight Transportation Efficiency Index (FTEI) is less than or equal to 0.980 then, the related provinces are in the undeveloped provinces (label D).

Node 9 of the Figure 6 indicates that if the Passenger Transportation Efficiency Index (PTEI) is greater than 0.288 and is less than or equal to 0.941 and the Freight Transportation Efficiency Index (FTEI) is greater than 0.980 then, the related provinces are in the undeveloped provinces (label D).

Node 10 of the Figure 7 indicates that if the Passenger Transportation Efficiency Index (PTEI) is greater than 0.941 and the Freight Transportation Efficiency Index (FTEI) is greater than 0.980 then, the related provinces are in the developed provinces (label A).

Table 6. Development level of the provinces of Iran

Province	Development level	Label	Province	Development level	Label
Isfahan	Developed province	A	Khorasan, North	Less developed province	C
Tehran	Developed province	A	Zanjan	Less developed province	C
Khorasan, Razavi	Developed province	A	Semnan	Less developed province	C
Khuzestan	Developed province	A	Qazvin	Less developed province	C
Fars	Developed province	A	Kurdistan	Less developed province	C
Mazandaran	Developed province	A	Kermanshah	Less developed province	C
Azerbaijan, East	Relative developed province	B	Golestan	Less developed province	C
Azerbaijan, West	Relative developed province	B	Lorestan	Less developed province	C
Bushehr	Relative developed province	B	Markazi	Less developed province	C
Kerman	Relative developed province	B	Hamadan	Undeveloped province	D
Gilan	Relative developed province	B	Ilam	Undeveloped province	D
Hormozgān	Relative developed province	B	Chahar Mahaal and Bakhtiari	Undeveloped province	D
Yazd	Relative developed province	B	Sistan and Baluchestan	Undeveloped province	D
Ardabil	Less developed province	C	Qom	Undeveloped province	D
Alborz	Less developed province	C	Kohgiluyeh and Boyer-Ahmad	Undeveloped province	D
Khorasan, South	Less developed province	C			

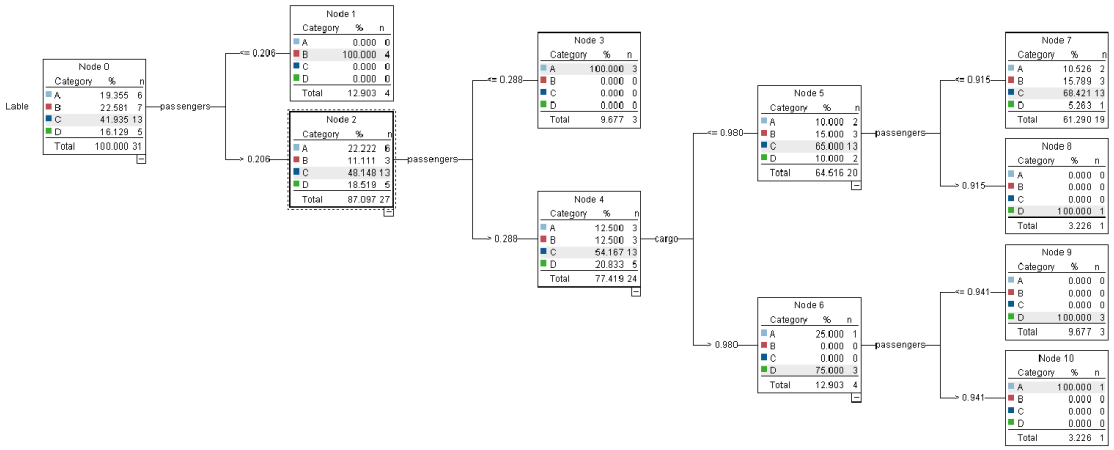

Figure 1. Decision tree indicating the relative of the PTEI and FTEI with the development level

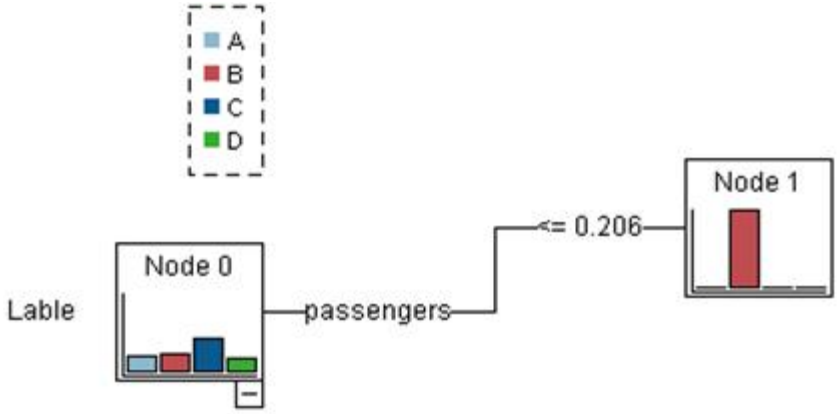

Figure 2. Node 1 indicating values of the PTEI in the relative developed provinces

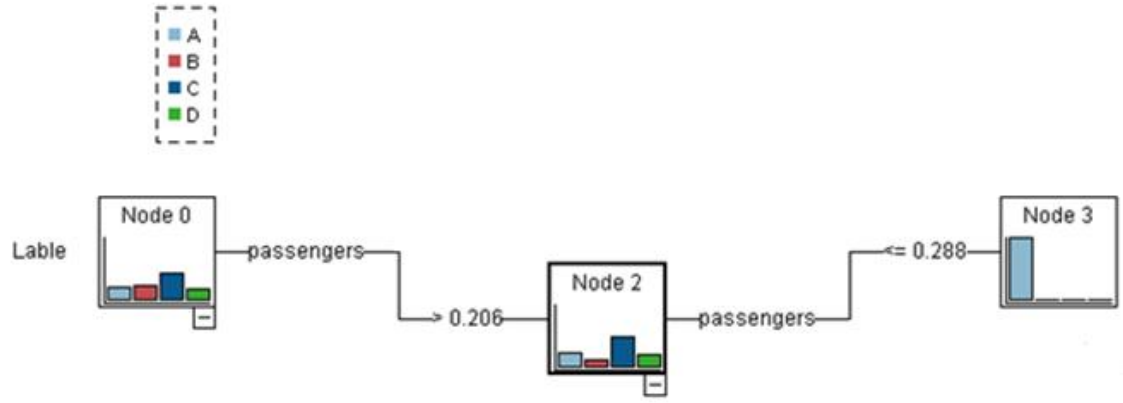

Figure 3. Node 3 indicating values of the PTEI in the developed provinces

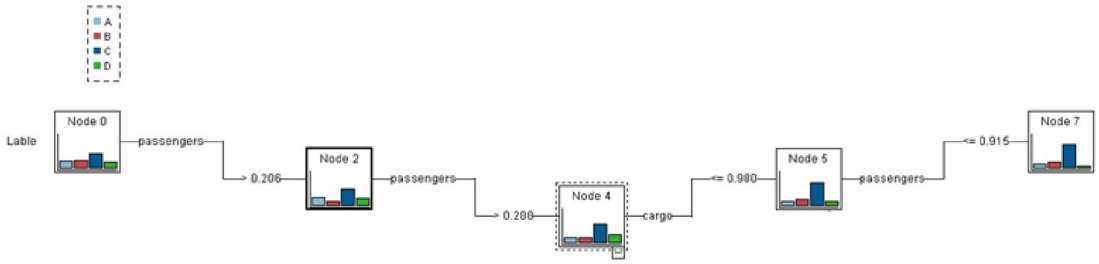

Figure 4. Node 7 indicating values of the PTEI and FTEI in the less developed provinces

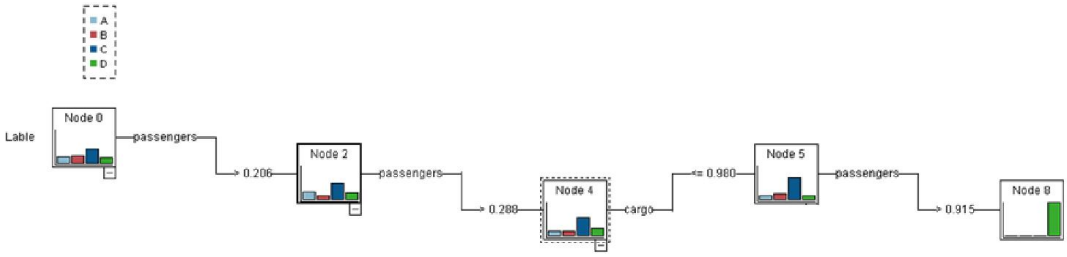

Figure 5. Node 8 indicating values of the PTEI and FTEI in the undeveloped provinces

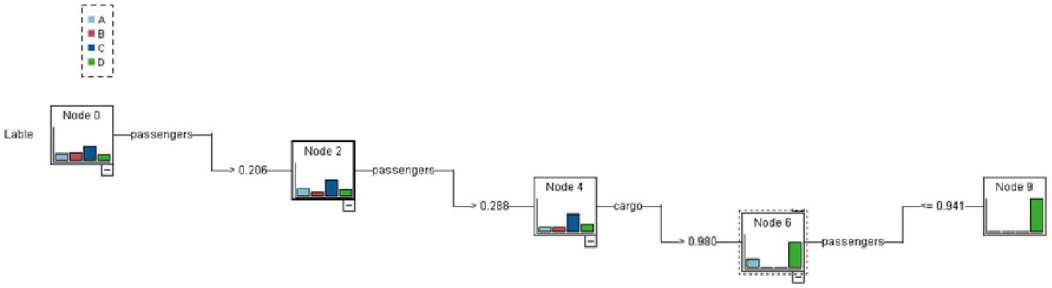

Figure 6. Node 9 indicating values of the PTEI and FTEI in the undeveloped provinces

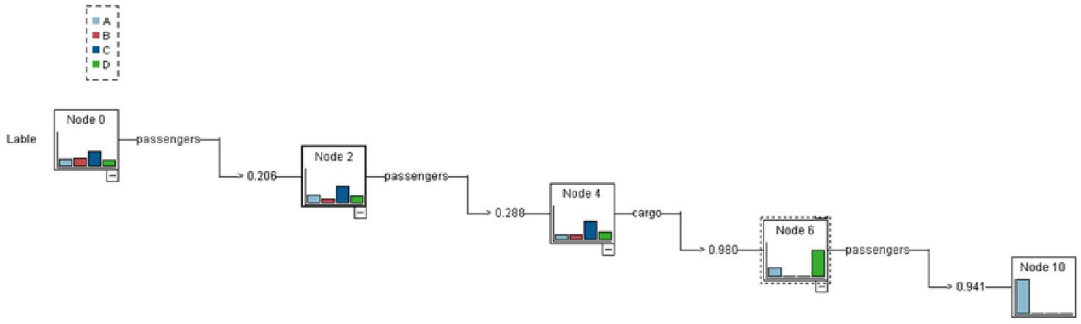

Figure 7. Node 10 indicating values of the PTEI and FTEI in the developed provinces

5. Conclusion

In this research, data envelopment analysis was applied to assess performance of the provinces in the considering freight and passenger transport. For this purpose, transportation infrastructures in the provinces including length of roads, length of freeways and highways and length of the arterial roads are considered as the input factors. Transportation performance measures of the provinces including ton-kilometers of the crossing freight, ton-kilometers from the province, passenger-kilometers of the crossing passengers and passenger-kilometers from the province are investigated as the output factors. Initially, DEA model was applied to calculate Freight Transportation Efficiency Indexes (FTEI) of the provinces and the results indicated that Tehran, Sistan, Qom, Kohgiluyeh and Hormozgān provinces are efficient from the freight transport perspective. Afterwards, Passenger Transportation Efficiency Indexes (PTEI) of the provinces were calculated so that Ilam and Tehran provinces were detected as efficient DMUs in passenger transport. Based on the FTEI and PTEI values, it was obvious that a number of provinces such as Azerbaijan East, Azerbaijan West, Isfahan, Bushehr, Chahar Mahaal and Bakhtiari, Khorasan South, Khorasan North, Khuzestan, Sistan and Baluchestan, Fars, Qom, Kurdistan, Kerman, Kohgiluyeh and Boyer-Ahmad, Lorestan, Markazi, Hormozgān and Yazd involves more efficient performance in freight transport relative to the passenger transport function. Finally, relationship between the efficiency indicators and development level of the provinces were illustrated and analyzed with CART as a classification algorithm.

6. References

- Azadi, M., Shabani, A., Khodakarami, M. and Saen, R. F. (2015) "Reprint of planning in feasible region by two-stage target-setting DEA methods: An application in green supply chain management of public transportation service providers", Transportation Research Part E: Logistics and Transportation Review, Vol .74, pp. 22-36.

- Chang, Y. T., Zhang, N., Danao, D., and Zhang, N. (2013). "Environmental efficiency analysis of transportation system in China: A non-radial DEA approach". Energy policy, Vol. 58, pp. 277-283.

- Charnes, A., Cooper, W. W. and Rhodes, E. (1978) "Measuring the efficiency of decision making units", European Journal Of Operational Research, Vol. 2, No. 6, pp.429-444.

- Chen, Y. and Han, B. (2012) "Regional public transportation scheduling model based on welfare economics and DEA", International Journal of Modelling, Identification and Control, Vol. 16, No. 3, pp. 272-276.

- Cheng, X. (2014) "Research on the performance evaluation of road transportation supply chain based on interval DEA method", BioTechnology: An Indian Journal, Vol. 10, No. 3.

- Cui, Q. and Li, Y. (2014) "The evaluation of transportation energy efficiency: An application of three-stage virtual frontier DEA", Transportation Research Part D: Transport and Environment, Vol. 29, pp. 1-11.

- Ding, X. D., Xu, L., and Yao, Z. G. (2011). "Performance evaluation of Chinese transportation industry based on DEA Method". Wuhan Ligong Daxue Xuebao(Journal of Wuhan University of Technology), Vol. 33, No. 3, pp.77-81.

- Goli, A., Ziari, H. and Amini, A. (2016) "Evaluating the performance of crumb rubber modified binders used in Isfahan Province", International Journal of Transportation Engineering, Vol. 4, No. 2, pp. 97-107.

- Guo, W., Gong, D. Q. and Hu, J. Z. (2015) "Applying Data Envelopment Analysis (DEA) approach to analyze investment efficiency of transportation projects", Advances in

Transportation Studies, Special Issue 2, pp. 139-150

- Ji, X., Wu, J. and Zhu, Q. (2016) "Eco-design of transportation in sustainable supply chain management: A DEA-like method". Transportation Research Part D: Transport and Environment, Vol. 48, pp. 451-459.

- Jiang, G. J., Liu, L. and Lv, H. D. (2017) "Transportation system evaluation model based on DEA", Journal of Discrete Mathematical Sciences and Cryptography, Vol. 20, No. 1, pp. 115-124.

- Lishan, S. U. N., Jian, R. O. N. G. and Futian, R. E. N. (2007). "DEA method for evaluating the transfer efficiency of urban public transportation terminal". Journal of Beijing University of Technology, Vol. 33, No. 12, pp.1289-1294.

- Michaelides, P. G., Belegri-Roboli, A., Karlaftis, M. and Marinos, T. (2009). "International air transportation carriers: evidence from SFA and DEA technical efficiency results (1991-2000)". EJTIR, Vol. 4, No. 9.

- Rassafi, A. A., Jamour, D. and Mirzahossein, H. (2013) "Different network performance measures in a multi-objective traffic assignment problem", International Journal of Transportation Engineering, Vol. 1, No. 1, pp. 47-58.

- Rezaee, M. J., Izadbakhsh, H. and Yousefi, S. (2016). "An improvement approach based on DEA-game theory for comparison of operational and spatial efficiencies in urban transportation systems", KSCE Journal of Civil Engineering, Vol. 20, No. 4, pp. 1526-1531.

- Wu, J., Zhu, Q., Chu, J., Liu, H. and Liang, L. (2016) "Measuring energy and environmental efficiency of transportation systems in China based on a parallel DEA approach", Transportation Research Part D: Transport and Environment, Vol. 48, pp. 460-472.

- Xiaohong, F. A. N. G., Lei-shan, Z. H. O. U. and Bo, Z. H. O. U. (2008) "Evaluation method of city comprehensive transportation hub based on permutable DEA model", Journal of Transportation Systems Engineering and Information Technology, Vol. 2, p. 017.

- Zhang, P.-W., Jing, C.-Y. and Sun, H. (2016) "Assessing air transportation enterprise efficiency based on three-stage DEA model", Jiaotong Yunshu Xitong Gongcheng Yu Xinxi/Journal of Transportation Systems Engineering and Information Technology, Vol. 16, No. 6, pp. 210-215.

- Zhao, L. and Liu, J. (2016) "DEA evaluation study about synergetic development of regional transportation in Beijing-Tianjin-Hebei", Beijing Jiaotong Daxue Xuebao/Journal of Beijing Jiaotong University, Vol. 40, No. 1, pp. 124-129.

- Zhao, Y., Triantis, K., Murray-Tuite, P. and Edara, P. (2011) "Performance measurement of a transportation network with a downtown space reservation system: A network-DEA approach". Transportation Research Part E: Logistics and Transportation Review, Vol. 47, No. 6, pp. 1140-1159.