
Technical and economic analysis and evaluation of multimodal terminals with a focus on performance of port (Case Study of Noshahr Port)

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Received: 9th Feb 2017, Accepted: 22nd Feb 2017, Published: 15th April 2017

Abstract

Multimodal transportation is currently one of the transportation approaches that using it in the transportation network reduces the freight transportation lag. Creating goods transportation terminals plays an important role in the formation and development of multimodal transport system. Ports as multimodal terminal of goods and products are considered as incoming and outgoing gates of each country and they play an important role in the national economy. The rate of loading and unloading of goods at the Noshahr Port that has no significant difference with other northern ports in terms of performance indices is very low. Therefore, by analyzing the port performance indices in the Noshahr port and evaluating it with other ports, we can identify the effective parameters in order to improve the loading and unloading of goods. This paper aims to compare the performance of northern Iranian ports (Noshahr, Anzali, Amirabad) using the Analytic Hierarchy Process (AHP) method. According to findings of the study, the score of Noshahr, Anzali, Amirabad ports was 0.085, 0.797, and 0.112, respectively. It indicates that Anzali port had higher performance than other ports in northern Iran, but Noshahr port as the focus of this study had low performance despite having necessary facilities and equipment. In addition, we can reduce this much gap with Anzali port by providing some solutions.

Key Words: multimodal transportation Terminal, analytical hierarchical analysis AHP, port performance

Introduction

Transportation plays a special role in global economic development and it is considered as basic human need and as an effective factor in the economic life of nations. In developed countries, with development of trade and commerce, transportation methods were also developed and traditional methods were replaced by modern methods that multimodal transportation is one of them. There are various types of multimodal terminals in internal waterways lines with regional markets, ownership structure, strategy, and different features around the world. Terminals are important in terms of performance, cost, and

quality. It is mostly argued that the costs of multimodal transportation in multimodal terminal increase (Smith et al., 2016). Ports are an important part of logistical system in international trade. In our country, ports are considered as incoming and outgoing gates of some of the goods imported and exported. In any port, cargoes are discharged from vessels and they are stored in the area before transferring by rail or road to the domestic terminals of storage. (Imai et al, 2009). In addition, domestic terminals of ports are locations for storage of exported goods transferred to this location for loading in vessels. The process of transportation of the goods is effective when it is necessary to stop vessels in port. In many developed countries, in order to improve the efficiency and throughput of the ports, transportation planning is used in ports, loading and unloading terminals of goods. The performance of multimodal terminals in ports is one of the major issues that have been taken into consideration. Due to fact that the performance of a port is influenced by the performance of all of its facilities and equipment and other resources available in each of terminals of the port, the performance of each port can be evaluated by evaluating the performance of each terminal (Kennedy, 2001). If it is necessary to increase the efficiency of infrastructure and networks, to reduce the patrol ship time, and to reduce the waiting time, new infrastructure and transportation terminals should be built.

2- Port Terminal:

One of the major challenges of the ports is to improve its facilities in order to increase the efficiency of cargo ships in the ducts and time and place pressures in this region. If the size of vessels is larger, higher investment will be needed for the deployment of larger cranes in order to collect goods on the vessels, which are farther away from the wharf. Ports are under pressure by transportation companies investing in facilities and companies that have been deprived from major East - West lines. Ports do not need to build other wharfs, unless they want to transfer goods for vessels simultaneously. Accordingly, deeper access channels, wider deviation basins, more facilities should be constructed in the port terminals to guide vessels (Watchtower), strengthen the larger

storage areas and more complex operating systems. (Yeo, 2015). Ports play an important role in managing supply storage. Each of the ports plays distinct role in supply chain systems. A port may provide facilities compatible with rail transportation modes, while the other port may provide marine modes. Access to domestic ports areas is a stage of correlation between infrastructures available and port users. Terminal service providers, whether public or private, should provide sustainable value to their users, compared with competitive values of supply chain. Many port terminals and hinterlands cause reduced transportation time from source to destination and ultimately reduced cost of transportation. Quick and safe access in domestic transportation system is a basic requirement for port users to evaluate options in choosing the desired port. A port is at the center of multimodal transportation services. Ports are part of value chain that hinterlands are passing through it, or attached to it, and many great ports connect internal fittings to each other (Yeo, 2015). Assessing the rate of loading and unloading in the terminal of Noshahr port requires knowing criteria to compare performance based on it. Therefore, having statistics available at the port of Noshahr and other northern ports of Iran, the current status of the Noshahr port was compared with other northern ports (Anzali and Amirabad) and its strengths and weaknesses were examined.



Figure 1: port terminal

3- Review of literature

Zhuoyi Wang (2008) modeled the port of Jebel Ali and provided the general plan for this port. The objective of his study was to develop a general plan for the port of Jebel Ali in 2030, including environmental changes, evaluation of possible options, cost estimation, and computer simulation. The author of the thesis introduced a simulation model to analyze the behavior of the container wharf and to determine length of wharf by considering the number of cranes. He used a simple method of prediction for the time of 2030. Using container transportation values during 1991 and 2006, the trend

lines to find the most reasonable prediction have been outlined. After several attempts, a second-degree polynomial with coefficient of determination (R^2) of 0.968 was obtained (Wang, 2008). Mukhtar et al provided a regression model for vessel patrol time. Patrol time in port reflects the container terminal capacity and capability in providing services. The objective of this paper is rapid development in container terminal of ports to provide efficient and effective service and achieve high efficiency at the port, with a view to achieve an optimal performance of port. The basic idea of the paper has been adopted from issues between the performance of the port (for example, rate of goods transportation) and port facilities (for example wharf cranes, basic movements, etc.). For this reason, the authors of this paper provided a regression model that relates factors of patrol time and port facilities to each other (Mukhtar et al., 2013). Mullner (2014) in his thesis analyzed and evaluated the structure multimodal structure and duties of railway and transportation departments. The objective of his study is to examine the need to use more than one effective model in road infrastructure and transportation and to use a multimodal transportation model. Van den Berg et al (2012) have considered development of multimodal connection important in ports. This paper has referred to Barcelona Port traffic statistics as well as distance and they way to communicate with other ports in Europe. The objective of the research is rail economic development, especially domestic terminals of ports to improve the multimodal transportation.

4. Method

In issues related to traffic and transportation, more than one factor is involved, including economic, social, and technical factors. Therefore, we cannot pay attention to only one factor and consider it in the process of solving the problem (Ferreira and Lake, 2002). Therefore, to analyze it, a solution is needed that could analyze several considered factors simultaneously and to provide a reasonable result. One of the mostly used and most useful methods used nowadays in the world for analysis of qualitative and quantitative indices in the process of a problem is multi-criteria decision-making methods (MADM). Decision-making models have been always considered by mathematicians and industry insiders since industrial revolution in the world, especially since World War II. In recent years, researchers have paid much attention for complex multi-criteria decision-making models (Geo et al, 2012, Zheng et al 2005. Asensun et al 1991, Lavasani et al 2012).

In general, decision making process in a multi-criteria decision-making methods is as follows:

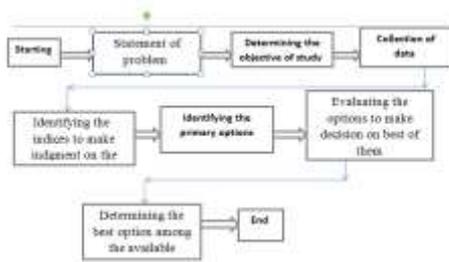


Figure- Steps of research

5- Analytical Hierarchy Process (AHP):

To evaluate ports, we need indices to analyse their performance based on them. One of the important methods in the multi-criteria models is Analytic Hierarchy Process (AHP), which uses hierarchical structure or a network structure to indicate the decision-making problem. This method was introduced in the 1970s by Saati. Hierarchy analysis process is based on three principles of "analysis, comparative judgment, and combination of priorities". This method has two outstanding properties including:

- Contribute to the classification of incompatible variables for making decision
- Enabling the decision makers to determine the simultaneous and mutual effects of complex situations

These two properties make that decision makers to regulate their goals, knowledge and experience in a way that consider their feelings and judgments thoroughly. Based on the main objective of the research, that is evaluating and improving the port performance, the method of study must be designed and organized so that required information is identified and analysed and the final accurate planning leads to realized objectives. As a result, the effective criteria in the port performance to be identified.

6-Identifying and selecting criteria to examine the performance of the ports

In order to select the criteria effective in prioritizing the ports in terms of their performance, after studying the literature of the study as well as face-to-face interviews with senior port executives, 7 effective criteria were identified. They includes area, the number of wharfs, length of wharf, land facility, marine facility, waiting time, and service time. Figure below shows the Analytic Hierarchy Process (AHP) diagram to evaluate the ports.

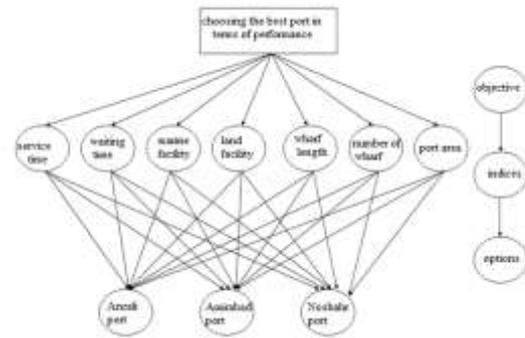


Figure 3: Hierarchy of decision

The importance of each of the mentioned indices in the figure above has been mentioned according to the evidence available in ports by using weights of effective indices with regard to loading and unloading of goods using qualitative values of each index. Then, using Excel software and AHP method, weight of each index relative to each other was obtained. Indices should be compared in pair compared to each other markers should be paired.

7- Investigating the status of the northern ports of Iran:

7-1- Noshahr port position:

Port of Noshahr with over 70 years of experience was initiated with the arrival of the first commercial vessel carrying parts and machinery of Karaj Zobahan Factory. Covering an area of 45 hectares and having commercial and service wharfs, and appropriate land and marine facility and with depth of 5.5 meters, Noshahr port receives annually 500 vessels in average from the Caspian Sea countries. With regard to the reconstruction and development of the wharfs of this port, it will reach to depth of 5.6 meters in near future, making the arrival of vessels with higher capacity possible. In the realm of global trade, it has always played undeniable role in the transportation economy of the country. At present, about 500 vessels are commuting in this port annually. This port, as the nearest commercial port of country to capital (200 km), has access to important commercial, industrial centers of the country through four paths of Kandovan, Haraz, Firouzkuh, and Rasht-Qazvin road. The distance of this port to Noshahr airport is 2 km. One of the factors that cause a lack of willingness of commercial companies to use this port for the delivery of their goods in recent years is lack of separate access path to this port and access road of the city in the metropolitan area is Noshahr city and has too much traffic.



Figure 4- Noshahr port

7-2- Amirabad port position

Amirabad Port Special Economic Zone is located in the East of Mazandaran province and 51 km distant from Sari city. This special economic zone plays important role at national and regional dimensions in light of having wide support land area of 1060 hectares (can be increased to 2120 hectares), being located in the international corridor of North – South transit, and having exceptional and special position. Considering the strategic importance of the Caspian Sea and great markets around it with much economic and commercial potential such as mining and swap of energy resources, transportation, communications and transit of goods, development of this massive port complex has been considered specially. It is expected that with the implementation of the development plan in future years this port to play more pronounced role in international trade area, especially by activation of North-South corridor and increased investment in the support lands. This port can provide grain, general and oil goods, container, scooter, maintenance, and processing of goods for goods owners and the public sector .Some of important benefits of this port include connection to Imam Khomeini Port and Shahid Rajai Port through rail network, easy access through air, land, and marine communication networks with other parts of the country and Central Asian countries, Russia, the Middle East and the far East, proximity to the 2100-megawatt power plant of Neka Shahid Salimi, and permanent and reliable supply of energy required for industries, and proximity to provincial capital and the use of appropriate urban facilities.



Figure 5- Amirabad port

7-3- Anzali port position

Anzali port is one of the active ports among Caspian Sea countries and it has high importance, as it is located at transit route of North-South corridor. This port is subject to the rules and regulations of industrial-commercial free trade zones and provides the right conditions to attract domestic and foreign investment. In light of having appropriate infrastructures, multi-functional storages and diverse terminal and having the most modern loading and unloading facility, it has provided a variety of services to customers. In addition, marine traffic system has made this port to be distinct from the neighboring ports of Caspian Sea. With the arrival of rail lines into port areas and connection of Anzali port to highway network of railway of Islamic Republic of Iran, this port plays an important role in the country's marine transport industry. The area of this port is about 132 hectares and it has a nominal capacity of 11 million tons. This port ranked third among Iran's ports after Shahid Rajaei and Imam Khomeini ports.



Figure 6- Anzali port

8- Evaluation of Iran's northern ports using Analytic Hierarchy Process (AHP)

To determine the port to ports in terms of performance and to compare ports with each other, effective indices should be compared with each other. The evaluation of ports and selection of superior option were performed by using AHP method. Accordingly, ports are placed in paired comparison matrix of each evaluated index. Therefore, for each of the seven indices, ports should be compared with each other.

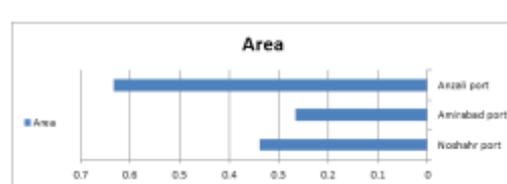


Figure 7- performance weight of ports relative to area index

Figure 9- performance weight of ports relative to length of wharf index

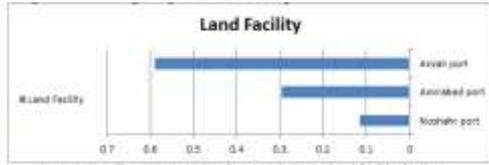


Figure 10- performance weight of ports relative to land facility index.

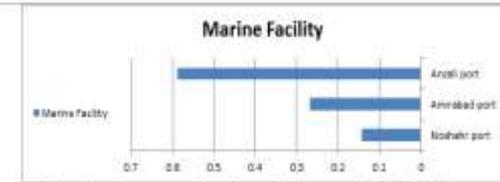


Figure 11- performance weight of ports relative to marine facility index.



Figure 12- performance weight of ports relative to waiting time index.



Figure 13- performance weight of ports relative to service time index.

Figure 13- performance weight of ports relative to service time index

With regard to the evaluation of ports in paired comparison matrix for each index affecting the performance of port, ports weight matrix based on normalized matrix can be obtained according to the Table below.

Table 2: Weight performance of ports relative to indices

	area	Number of wharf	Length of wharf	Land facility	Marine facility	Waiting time	Service time
Noshahr port	0.339	0.136	0.125	0.115	0.142	0.0606	0.0983
Amirabad port	0.266	0.206	0.188	0.295	0.269	0.0815	0.126
Anzali port	0.634	0.658	0.686	0.590	0.589	0.858	0.755

In addition, according to the weights of indices, it is seen that waiting time has higher weight compared to other indices. In the following Chart, the weight of each effective index is shown. The results of normalization of paired matrix of indices relative to each other are shown in Figure 7:

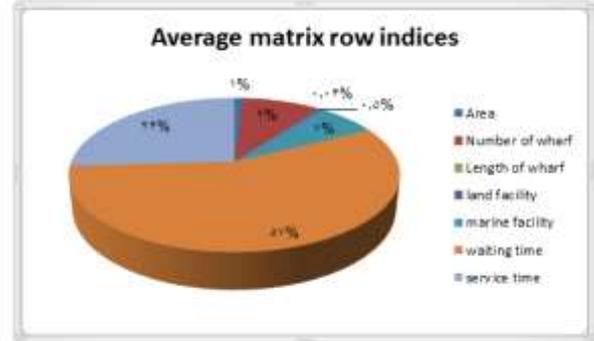


Figure 14- weight of effective parameters in the paired matrix of indices

As a result, weight of each of the ports is multiplied in weight of each of the effective indices according to parameters affecting it. As a result, new weights obtained for each port should be summed with each other so that final weight of each port to be obtained. Table below shows the final weight of each port along with the weight of its indices.

Table 2: final weight of ports performance relative to indices

Therefore, it can be concluded that the Anzali port has much better conditions than other ports and Noshahr port despite having needed and proper facilities has low performance, and this indicates the weakness and dysfunction of the port. Table below shows the final weight of each port and choosing the superior port in terms of performance.

Table 3: prioritization of options (choosing the best port) based on AHP method

	area	Number of wharf	Length of wharf	Land facility	Marine facility	Waiting time	Service time	Final weight
Noshahr port	0.00257	0.0118	0.00006194	0.000579	0.00967	0.0347	0.0256	0.085
Amirabad port	0.000202	0.0178	0.0009376	0.00503	0.183	0.0466	0.0529	0.121
Anzali port	0.00481	0.0569	0.000339	0.00297	0.0401	0.419	0.202	0.798

Port	weight	Priority
Noshahr	0.085	3
Amir abad	0.121	2
Anzali	0.797	1



Figure 15: prioritization of ports based on performance

9- Conclusion

The performance of the ports is a subject that has not been studied so much compared to other stages of research in the ports. The proposed framework can provide appropriate conditions for future decision making in the area of port performance and it can be developed in future studies. In addition, investigating the effect of adopting different policies in ports on general performance of the port is innovation of this study that its applied results can be used by port managers. AHP method was used in this study to evaluate performance of ports in the north of the country. Accordingly, seven effective parameters affecting the performance of the port were identified and they were placed in paired comparison matrix of ports. According to Table 3 and evaluation of options by using AHP method, it was found that Anzali port has higher scores compared to other northern ports of Iran and it has better performance status compared to other ports in the northern geographical area of Iran. Noshahr port as the focus of this study ranked third after Amirabad and Anzali ports. It should be noted that Noshahr port did not rank first in any of the indices assessing the performance of the ports. Therefore, it is necessary to increase the performance of the Noshahr port by improving and developing these indices. The indices of waiting time and service time had the greatest impact on the performance of the port, so it is important to improve these indices. Despite having the high facilities as well as large area for port operations, Amirabad port had not a good performance and it can be concluded that this port, as Noshahr port, has great difference with Anzali port in terms of rate of loading and unloading of goods. Therefore, it is necessary to adopt required policies to increase the rate of loading and unloading of goods in two important ports of Mazandaran province.

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