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THE FEASIBILITY STUDY ON CREATION OF FREIGHT VILLAGE IN HORMOZGAN PROVINCE

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Abstract. The purpose of the present study is to study the feasibility of creating a freight village (multimodal terminal) in patronage grounds of the special economic zone of Shahid Rajaie port in Hormozgan Province. To do so, first, some explanations have been presented in terms of familiarization and study of a freight village and its structural models in different countries of the world. Then, the current status of patronage grounds in the special economic zone of Shahid Rajaie port has been studied. Therefore, the proposed models for the special economic zone of Shahid Rajaie port have been implemented and have undergone sensitivity analysis, and finally the results of the analyses and the assessment of different options of sensitivity analysis on the present parameters in the model have been presented.

Keywords: multimodal transportation, freight village, total turnover, sensitivity analysis.

1. Introduction

The identity of transportation in the country's ports is mainly in a multimodal form. Since the transported cargo via sea should be transported into the country in one of the different forms of road or rail transportation. Or if it is transit cargo, the cargo must be transported to other countries. Thus, in ports, all multimodal terminals or, in other words, multi-purpose terminals which could serve ground transportation vehicles, loading and unloading have been available. In other countries, in order to satisfy this need, they have embarked on creating and making "freight villages". These villages (multimodal terminals) are able to offer storage services, transportation implementation, loading and unloading operations and the classification of cargo collection. Other services in these villages are: organization of final cargo delivery, coordination of cargo transportation flows, special storage and parking spaces which can satisfy the different needs of cargo transportation (Konings 1996).

2. Definition of freight villages (multimodal terminals)

A freight village is defined as an area in which all activities related to cargo transportation, logistics and distribution, domestic and international transportation are conducted by its different managers (Palšaitis and Bazaras 2004). These managers can be presented as proprietors or tenants of the buildings and their facilities (such as storage houses, centres for storing semi-bulk cargo, offices, parking). Also, for following the free competition rules, the freight village should have access to all companies related to the above-mentioned activities. A freight village should also be equipped with public facilities to serve the mentioned objectives. If possible, a freight village should include all public services for cargo and its users (RTD Programme … 2000).

In order to attract the multimodal transportation for loading and discharging cargo, a freight village should preferably be served by different modes of transportation (such as road, rail, domestic waters, and air). Finally, it is necessary for a freight village to be managed by the participation of both public and private sector. In other words, we can name a freight village as a terminal because a freight village is an appropriate example of different activities in the transportation chain. In fact, a freight village is created to concentrate the cargo transportation tasks in a vast space and area, also to prevent the excessive spread of storage houses, transshipment centres and preparatory bases of companies users (RTD Programme … 2000).

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3. The study of structural models of freight village

At present, the following main models have the most common use (Galloni 1999):

- the Urban model; which amalgamates the transportation activities around big cities and changes the ground transportation models from trucks to smaller vehicles;
- Italian model (Interporti model); which combines the freight village with a multimodal terminal of the Italian railway transportation;
- the combined port cargo transportation model; which merges with other port zones, samples of which already exist;
- The Simultaneous impressionability model in which all parameters are affected by the creation of freight village at the same time.

4. The study on the current status of the special economic zone of Shahid Rajaie port

The special economic zone of Shahid Rajaie port, because of its placement in a special geographic zone and as an edge relating to the southern sea borders, can be the reagent of the area's special performance with regard to climatic and cultural specifications. In conclusion, whatever makes up the appearance and facial features of a port, should be able to efficiently present the area's identity in a framework of general view to the observer. In fact, the urban view of Shahid Rajaie port defines the placement of applications related to the main performance of the port on the natural ground and the relation of the seashore on one side to the northern heights on the other side. At present, the view which Shahid Rajaie port offers to the observers who enter the port through the national road network (from north) and the observers who enter the port through the southern sea paths, is defined as a special view and presents the special identity of the port. Therefore, the study and investigation of the present situation can help to keep the present outlook before presenting the construction rules and regulations, and even in a mitigated case it can improve it (Final studies … 2003).

Consideration of patronage grounds in the special economic zone of Shahid Rajaie port as a freight village

Zone no. 5 which includes all storing lands of Shahid Rajaie port up to now consists of a two-part collection which is known as patronage grounds and 150-hectares grounds. The patronage grounds which have an area of about 750 hectares totally are predicted for and allocated to storage purposes. According to previous studies, the development and conduction of streets and areas for delivering to its applicants are under way. The above-mentioned areas have the capability to be used as a freight village (or multimodal terminal) because of the following reasons:

First, these grounds are vast enough for this use.

Second, from the transportation point of view and regarding the place of the Shahid Rajaie port it has the capability of multimodal transportation, and due to its access to different transportation types such as rail, land and sea transportations are related to one another. The existing railroad on patronage grounds is connected to Bafgh-Bandar Abbas railroad, and in terms of sea transportation it is connected to Persian Gulf waters, and land transportation is connected to the north-south transit corridor. Also, the access to air transportation is available as Bandar Abbas air port is close to Shahid Rajaie port.

Third, the terminals in the special economic zone of Shahid Rajaie port can be organized as multimodal terminals to transport the existing cargo to another mode of transportation in a way that the mentioned areas be a freight village as a centre to develop the multimodal transportation (Final studies … 2003).

5. Proposing the model

The objective of offering our proposed model is to study the degree of improvement in the efficiency of Shahid Rajaie port's performance in terms of the total number of loading and unloading activities (export, import and cargo transit), in the case of using the patronage grounds of Shahid Rajaie port as a freight village (multimodal terminal). In order to estimate the considerable effect in the port's total turnover, as mentioned earlier, the simultaneous impressionability model is used.

The simultaneous impressionability models include three famous mathematical models as follows (Tsamboulas and Kapros 2003; Konings 1996):

1. The Linear model with the general form of

$$y = a \cdot x_1 + b \cdot x_2 + ... + c.$$

2. Cruff model with the general form of

$$y = a \cdot x_1^{\,b} \cdot x_2^{\,c} ... .$$

3. Exponential model with the general form of

$$y = a \cdot b^{x_1} \cdot c^{x_2} ...,$$

where: y – dependent variable or total port's turnover to the separation of cargo groups; x_1, x_2, … – independent variables or the related specific features to each port, (including area, capacity , the number of cranes, etc,.); a, b, c, … – calibration coefficients.

The required features and characteristics for doing the modeling are variables which have a role in the port's total turnover. These variables are:

- the area of the port terminal;
- the capacity of terminal (container, general, and bulk);
- the number of cranes (rail crane and cranes in the area);
- the number and length of the existing docks in the port;
- the cargo loading and discharging time (service time and waiting time);
- the implementation of the proposed model in the special economic zone of Shahid Rajaie port.

6. Demodulation of proposed model for the special economic zone of Shahid Rajaie port

In order to conduct the modeling process, according to the related features of Shahid Rajaie port which were mentioned in the previous section, using the SPSS9 software, the mentioned models were calibrated for an 11-year period (1991–2001), then it was evaluated according to the 2002 data. It is worth mentioning that in some models because coefficients of single variables used in the model were not statistically significant, some integrated parameters such as dock length to the terminal area, the number of the cranes to the area of the terminal, etc. have been used.

All the parameters that are used in these models are presented in Table 1.

The modeling trend has been conducted in a way that the combination of different variables in the model has been used according to statistical tests including R2 (for determining the correlation between the independent variables and dependent variables), T-test (for determining the significance level of the combination of the model in relation to the dependent variables), F-test (for determining the significance level of the combination of the model variable in relation to the dependent variable), model evaluation according to the percentage of error compared to the reality has been measured and finally the best combination has been proposed as the optimum and best model.

The calibrated models for Shahid Rajaie port in two cases (linearity & nonlinearity) are presented in Tables 2 and 3.

Table 1. Several used parameters at modeling process

Parameter type	Title of parameter	Abbreviation	Comments
Single parameter	Terminal area	*Ta*	---
	Terminal capacity	*Tc*	---
	Total number of cranes	*Nc*	---
	Number of docks	*Nd*	---
	Length of Docks	*Ld*	---
	Service time	*St*	---
	Waiting time	*Wt*	---
Composed parameter	Terminal capacity to terminal area	*Tcu*	*Tc/Ta*
	Number of cranes to terminal area	*Ncu*	*Nc/Ta*
	Number of docks to terminal area	*Ndu*	*Nd/Ta*
	Length of Docks to terminal area	*Ldu*	*Ld/Ta*
	Average length of each Dock	*Lda*	*Ld/Nd*
	Service time to waiting time	*Swt*	*St/Wt*
Performance parameter	Total container turnover	*Cco*	---
	Total bulk turnover	*Bco*	---
	Total general cargo turnover	*Gco*	---

Table 2. Calibrated models for Shahid Rajaie port (nonlinear case)

Shahid Rajaie port general cargo	$gco = 4.6 \cdot 10^{19} \cdot ncu^{2.1} \cdot ela^{-7.2}$					R2	F test	Percentage of evaluation error
						0.8	good	15
t-test	constant value	1st variable	2nd variable	3rd variable	4th variable			
	good	good	good	---	---			
Shahid Rajaie port bulk cargo	$dbo = 3.327 \cdot 10^{-11} \cdot gdp^{6.24} \cdot ela^{-2.893}$					R2	F test	Percentage of evaluation error
						0.8	good	11
t-test	constant value	1st variable	2nd variable	3rd variable	4th variable			
	good	good	good	---	---			
Shahid Rajaie port container cargo	$co = 205 \cdot tc^{0.745}$					R2	F test	Percentage of evaluation error
						0.86	good	18
t-test	constant value	1st variable	2nd variable	3rd variable	4th variable			
	Good	Good	---	---	---			
Shahid Rajaie port Semi Bulk cargo	$sbo = 2.89 * 10^7 \cdot 1.004^{gdp} \cdot (5.9 \cdot 10^{-4})^{ncu} \cdot 0.88^{ela} \cdot (2.2 \cdot 10^{-20})^{enu} \cdot 1.45^{elu}$					R2	F test	Percentage of evaluation error
						0.75	good	22
t-test	constant value	1st variable	2nd variable	3rd variable	4th, 5th variable			
	good	good	good	good	good			

Table 3. Calibrated models for Shahid Rajaie port (linear case)

Shahid Rajaie port general cargo	$gco = 215.7 \cdot ncu + 49.38 \cdot ldu - 588.1 \cdot swt$					R2	F test	Percentage of evaluation error
						0/95	good	15
t-test	constant value	1st variable	2nd variable	3rd variable	4th variable			
	---	bad	good	good	---			
Shahid Rajaie port bulk cargo	$bco = 2.396 \cdot 10^{-2} \cdot tc + 11.632 \cdot ld - 2825 \cdot wt$					R2	F test	Percentage of evaluation error
						0/98	good	15
t-test	constant value	1st variable	2nd variable	3rd variable	4th variable			
	---	bad	good	good	---			
Shahid Rajaie port container cargo	$cco = 58717 \cdot ta - 35281 \cdot st - 8402 \cdot ldu$					R2	F test	Percentage of evaluation error
						0/98	good	1
t-test	constant value	1st variable	2nd variable	3rd variable	4th variable			
	---	good	good	good	---			

Having considered Table 2, in majority of models, R2 is lower than 0.8 and also percentage of evaluation error is very high. For this reason, all of the nonlinear models have been rejected. Having considered Table 3, R2 of all models are between 0.95 and 0.98 which shows an appropriate correlation between the dependent variable that is the total turnover of the ports and the independent variables(the port features). The value/amount of T-test and Freight village-test in all models regarding the significance of independent variables and correlation between each independent variable and dependent variable is completely appropriate. The low amount of average error of evaluation, that is, the difference between the results of model and observation in 2002 illustrates the accordance of model with the reality.

The total turnover of Shahid Rajaie port during the 1990's obtained from the model and observation is illustrated in Figs. 1–3.

Considering the presented graphs, the approximate accordance of the model curve with the observation curve for the three groups of cargo, that is, bulk cargo, general cargo and container cargo is a witness of the appropriate accuracy of the calibrated models for Shahid Rajaie port. The total turnover of Shahid Rajaie port has been shown in Table 4.

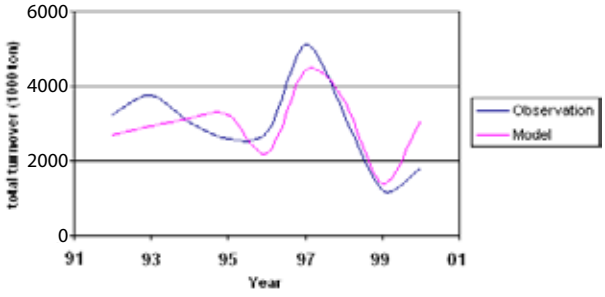

Fig. 1. The total turnover of Shahid Rajaie port during the 1990's obtained from model and observation (General cargo)

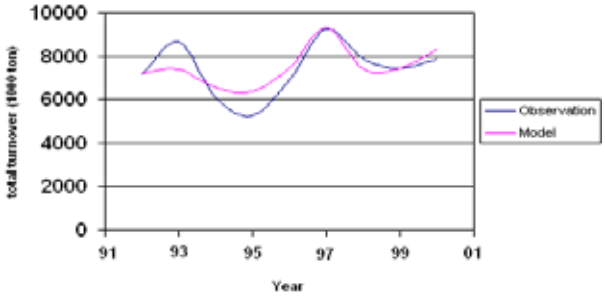

Fig. 2. The total turnover of Shahid Rajaie port during the 1990's obtained from model and observation (bulk cargo)

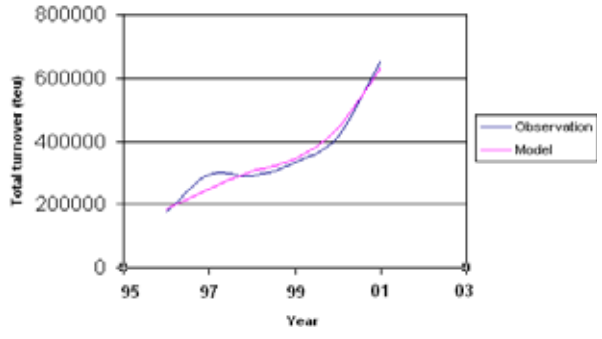

Fig 3. The total turnover of Shahid Rajaie port during the 1990's obtained from model and observation (Container cargo)

Sensitivity analysis

As it was mentioned before, creating a freight village on patronage grounds of the special economic zones of Shahid Rajaie port and increasing the loading and unloading facilities in it, could make an improvement in the port characteristics or features. These improvements include the number of cranes, terminal capacity, dock length, service time and waiting time. This improvement increases the first 3 characteristics and decreases the second 3 characteristics.

In order to study the effect percentage of each of the mentioned parameters in the total turnover in the project horizon, the calibrated models underwent the sensitivity analysis. To do this, first it is necessary to predict the year of project horizon. In order to predict the total turnover of Shahid Rajaie port in the project horizon year (2011),

Table 4. Total turnover of Shahid Rajaie port based on model & observation (2002)

Shahid Rajaie port	Bulk cargo (1000 ton)	General cargo (1000 ton)	Container cargo (Teu)
Observation		13302	809905
Model		11217	805022

Table 5. Sensitivity analysis of calibrated models at Shahid Rajaie port (2011)

General Cargo	20 % increase in number of cranes	20 % increase in Dock length	20 % decrease in service time
	4 % increase in total turnover	35 % increase in total turnover	18 % increase in total turnover
Bulk Cargo	20 % percent increase in admission capacity	20 % increase in Dock length	20 % decrease in waiting time
	4 % increase in total turnover	19 % increase in total turnover	3 % increase in total turnover
Container Cargo	20 %increase in terminal area	20 % decrease in service time	20 % increase in Dock length
	28 % increase in total turnover	1 % increase in total turnover	No change

first, the related characteristics of the port such as terminal area, its capacity, number of cranes, etc. considering the trend of its changes during the 1990's could be predicted. Then by using the calibrated models for Shahid Rajaie port, in the project horizon year 2011, the weight of bulk cargo groups is equal to 9930 thousand tons, general cargo group is 2900 thousand tons, and the container cargo group would be equal to 1404000 TEU.

The results of sensitivity analysis process are shown in Table 5.

Considering Table 5, in the case of implementation of a freight village and increasing in the loading and unloading facilities in Shahid Rajaie port, the 20 % increase in the dock length will increase both the bulk and general cargo more than the other parameters and will have a more considerable effect on the port's total turnover (35 %). The second parameter, that has the most effect is the average service time per ship (19 % increase in total turnover). In the case of container cargo, terminal area parameter with 28 % increase in the total turnover would have the highest increase in the total turnover of the port comparing to the other parameters, i.e. dock length and service time.

7. Conclusions

The results of the sensitivity analysis of the three: bulk, general and container cargoes show that parameters such as dock length, terminal area and average service time per ship can have a considerable effect on changing the total turnover of the port, but implementing improvement in the mentioned parameters at the same time would have a more considerable effect (for example, the 20 % increase in the dock length and 20 % decrease in the service time simultaneously would lead to 52 % increase in the total turnover of general cargo). This means that the creation of a freight village on patronage grounds of the special economic zone of Shahid Rajaie port without increasing the loading and unloading facilities (admission capacity, number and length of docks in the port) can only affect and decrease the cargo average waiting time in storage. This occurs because of the fast and quick transportation of cargo from port to a freight village and then to the final destination. This, considering the results of sensitivity analysis, could have a slight effect on the improvement of Shahid Rajaie port's total turnover. Also, increasing the loading and unloading facilities, (such as admission capacity, the length and number of the docks , etc., of the port) without creating the freight village and appropriate backshore facilities (for transporting unloaded cargo to the final destination and also quick transportation of the cargo into the port to load the ships) can considerably increase the average waiting time of the cargo in the storage and service time for each ship which results in lowering the port efficiency and its total turnover.

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