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APPLICATION METHOD FOR MAKING DECISION IN COMBINED TRANSPORT: THE PROCESSING OF THE CASE STUDIES[1]

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Abstract

The thesis analyzed the problem of multi-criteria analysis of combined transport. This paper describes the problem of multi-criteria decision-making in case of selection of optimal transport routes. Based on the large number of criteria and factors that influence a choice, each option transport routes will be scored and ranked, with each criterion carries a certain weight, or influence on a choice. In addition to processing theoretical assumptions for decision-making treated concrete case studies of: optimal transmission times.

Keywords -Combined transport; container terminals; multi-criteria analysis; decision making criteria

INTRODUCTION

New transport technologies of integrated transport systems as part of the overall transport chain for the transportation of goods from producers to consumers require necessary rationalization in the overall economy and directly affect the competitive ability for the integration of the national economy in the international division of labor. In order to decrease the costs of transport, storage and transshipment and consequently the price of the final product, it is necessary to find the most appropriate transport route. The choice of the most appropriate route plan is a problem that cannot be solved in quantitative nor qualitative way. The most effective method for selecting the transport route is the use of multiple criteria decision analysis.

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[1] Original scientific paper

Container transport is a major component of intermodal transportation and international trade and its importance is reflected in this paper. Intermodal transport is not only about containers and intercontinental trade, as a significant part of international trade which moved to the containers does not include ocean shipping. Land transportation represents an extension of the intermodal chain. [1]

This study applies multiple criteria decision making to the selection of optimal routes for intermodal transport of manufactured goods. It identifies fifteen potential routes of intermodal transport for the transportation of one full 40-foot standard container on its way from the port of Shanghai to a distribution center in Bedford, Pennsylvania. For all the selected routes, the cargo is transported from the port of Shanghai to a US port by ocean freighters. The main criteria for the selection of optimal transport routes are price, duration of transport and environmental pollution i.e., CO2 emissions into the atmosphere. The objective of multiple criteria decision making was to choose the cheapest option for the transport route.

In season 2011 the transport of products proceeded from the port of Shanghai by overseas transport to the port of Baltimore on the Atlantic coast, continuing from there by road transport to Bedford. This route was used as a basic transportation route (main alternative). In addition, for the purpose of this study, a 40-foot standard container is taken as a functional unit load (or two equivalent TEU units).

On the basis of the collected data we obtained fourteen different combinations of alternative routes and means of freight transport which provided the basis for our analysis and the choice of the most appropriate route plan. (Table 1.)

Table 1. Routes and modes of transportation for data collection

Origin	Destination	Mode	Carrier
Route 1			
Port of Shanghai	Port of Seattle	ocean	Maersk
BNSF Seattle	BNSF Chicago	rail	BNSF
BNSF Chicago	CSXT Cleveland	rail	CSXT
CSXT Cleveland	Bedford DC	road	N/A
Route 2			
Port of Shanghai	Port of Seattle	Ocean	Maersk
BNSF Seattle	BNSF Chicago	rail	BNSF
BNSF Chicago	CSXT Columbus	rail	CSXT
CSXT Columbus	Bedford DC	road	N/A
Route 3			
Port of Shanghai	Port of Seattle	ocean	Maersk

BNSF Seattle	BNSF Chicago	rail	BNSF
BNSF Chicago	CSXT Northwest Ohio	rail	CSXT
CSXT Northwest Ohio	Bedford DC	rail	N/A
Route 4			
Port of Shanghai	Port of Oakland	ocean	Maersk
BNSF Oakland	BNSF Chicago	rail	BNSF
BNSF Chicago	CSXT Cleveland	rail	CSXT
CSXT Cleveland	Bedford DC	road	N/A
Route 5			
Port of Shanghai	Port of Oakland	ocean	Maersk
BNSF Oakland	BNSF Chicago	rail	BNSF
BNSF Chicago	CSXT Columbus	rail	CSXT
CSXT Columbus	Bedford DC	road	N/A
Route 6			
Port of Shanghai	Port of Oakland	ocean	Maersk
BNSF Oakland	BNSF Chicago	rail	BNSF
BNSF Chicago	CSXT Northwest Ohio	rail	CSXT
CSXT Northwest Ohio	Bedford DC	road	N/A
Route 7			
Port of Shanghai	Port of Long Beach	ocean	Maersk
BNSF Long Beach	BNSF Los Angeles Hobart	rail	BNSF
BNSF Los Angeles Hobart	NS Harrisburg	rail	BNSF-NS
NS Harrisburg	Bedford DC	road	N/A
Route 8			
Port of Shanghai	Port of Long Beach	ocean	Maersk
BNSF Long Beach	BNSF Los Angeles Hobart	rail	BNSF
BNSF Los Angeles Hobart	CSXT Cleveland	rail	BNSF-CSXT
CSXT Cleveland	Bedford DC	road	N/A
Route 9			
Port of Shanghai	Port of Long Beach	ocean	Maersk
BNSF Long	BNSF Los	rail	BNSF

Beach	Angeles Hobart		
BNSF Los Angeles Hobart	NS Columbus-Rickenbacker	rail	BNSF-NS
NS Columbus-Rickenbacker	Bedford DC	road	N/A
Route 10			
Port of Shanghai	Port of Long Beach	ocean	Maersk
BNSF Long Beach	BNSF Los Angeles Hobart	rail	BNSF
BNSF Los Angeles Hobart	CSXT Northwest Ohio	rail	BNSF-CSXT
CSXT Northwest Ohio	Bedford DC	road	N/A
Route 11			
Port of Shanghai	Port of Miami	ocean	Maersk
Port of Miami	FEC Miami	road	N/A
FEC Miami	CSXT Baltimore	rail	FEC-CSXT
CSXT Baltimore	Bedford DC	road	N/A
Route 12			
Port of Shanghai	Port of Savannah	ocean	Maersk
Port of Savannah	CSXT Savannah	road	N/A
CSXT Savannah	CSXT Baltimore	rail	CSXT
CSXT Baltimore	Bedford DC	road	N/A
Route 13			
Port of Shanghai	Port of Charleston	ocean	Maersk
Port of Charleston	CSXT Charleston	road	N/A
CSXT Charleston	CSXT Baltimore	rail	CSXT
CSXT Baltimore	Bedford DC	road	N/A
Route 14			
Port of Shanghai	Port of Newark	ocean	Maersk
Port of Newark	Bedford DC	road	N/A
Route 15 (baseline)			
Port of Shanghai	Port of Baltimore	Ocean	Maersk
Port of Baltimore	Bedford DC	road	N/A

METHOD

Multiple criteria decision making is one of the most popular branches in decision-making and is widely used in solving real life problems. Since classical optimization methods use only one criterion in making a decision, this significantly reduces the possibility of their application in solving real life problems. Models of multiple criteria decision making facilitate the adoption of optimal decisions in situations where a large number of various, often conflicting criteria, are present.

The selection and description of the factors that influence the choice of optimal transport chain were performed in the second phase of the multiple criteria analysis of the observed situation. This phase focused on gathering information and data for the purpose of detailed description of the transport routes defined in the first part of the analysis.

Data were collected on:[2] distance, costs, transit times, GHG emission factors.

Emission factors that are related to ocean transport were obtained from Maersk and refer to 2011 and partly to 2010. While the emission factors for freight transport are mainly expressed in relation of the mass of CO2 and ton-km, emissions for container transport are usually expressed through the relative weight of CO2 and TEU-km. Of course, as an ocean carrier, Maersk Line follows this practice of expressing greenhouse gas emissions.

Data on the prices of overseas transportation of goods were taken from the Maersk Web Site (Maersk Line), and refer to November 2012. Maersk's tariffs refer to container and different rates apply for different types of containers. The costs of road transport were taken from PC*Miler software application. We used the basic settings of PC*Miler software, with major components determining the price of road transport being: fuel, tolls and driver costs. It was assumed that these costs are charged per container, regardless of the type of container.

Transit times for overseas and rail transport were obtained from the schedule published on the web site of the carriers for each mode of transport individually (Maersk Line); (BNSF Railway Company, 2012); (CSX Transportation, 2012). As for the rail transport, one additional day of transit time was added on the directions that do not have seamless exchange ofcargo.

RESULTS

The aim of the applied method of multiple criteria decision in choosing the best transport route from the available 15, was the observance of the principle of minimal value of the three observed criteria: costs, transit times and emissions. The study applied a simple adding model for this multicriteria problem. [2] As already mentioned above, the goal was to calculate the utility of each route by using the following equation in (1):

$$U_r = W_C U_{rc} + W_t U_{rt} + W_e U_{re} \quad (1)$$

First, outcomes of each attribute were converted to rankings as listed in Table 2.

Table 2. Ranking of attributes

Route	Costs	Transit time	GHG Emissions
1	8	6	2
2	10	7	3
3	11	5	6
4	12	9	7
5	13	10	9
6	14	8	10
7	15	3	8
8	6	4	1
9	7	2	4
10	9	1	5
11	5	11	15
12	4	12	14
13	2	13	13
14	1	14	12
15	3	15	11

Next, a range of best and worst levels were defined for each attribute. The levels could simply be set at the best and worst outcomes of the alternatives under consideration, or chosen otherwise. For the purpose of this study, the former was employed as described in Table 3. [2]

Table 3. Range of attributes

	Cost (USD)	Transit Time (d:hh:mm)	GHG Emissions (kg CO_2)
Best	5,999	13:13:06	2,086
Worst	8,547	41:14:26	2,521

CONCLUSION

Multiple criteria decision analysis is a very important area that has found its application in transport. Specifically, in this study, multiple criteria decision analysis has been used in the case of making decision about the optimum transport route. In making the decision, three most common criteria that affect the transport chain were considered: transportation costs, transit time and GHG emission. Multiple criteria decision making was applied to the case study of selecting optimal route for the transportation of goods from Shanghai port to the distribution center in Bedford (United States). Each route involved the transportation of goods by sea container from the port of Shanghai to the US ports. The subsequent transport to the distribution center depended on the US port where the goods arrived from Shanghai. The most optimal route for transportation in the analyzed case was from the Shanghai port to the US port Newark by maritime container transport and then by road transport to the distribution center in Bedford.

Serbia's geographic position has the advantage of being at the crossroads of corridors and in the hinterland of many ports (Thessaloniki, Rijeka, Bar, Koper, Constanta, Varna). In addition, a few navigable rivers flow through Serbia, the largest and most exploited being the Danube, which is the European corridor VII. However, due to poor infrastructure, especially the railway, poor utilization of waterways and the lack of logistics centers and terminals, the share of combined transport is very small. It is mainly based on the transit transport, with no direct contact with our ports or the available terminals. The development and improvement of railway infrastructure and transshipment terminals, both road and river, would make Serbia a serious competitor in the region and exploit its position in South Eastern Europe as a "gate" between East and West. The construction of distribution centers and the increased share of combined transport would influence shippers, both domestic and foreign, and their decisions to use our infrastructure in choosing the optimum transmission routes. In addition to the advantages of Serbia's geographical position, major investments are needed in order to enable combined transport to advance and reach the level of the highly developed European countries.

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