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Cost Analysis of Multimodal Freight Transportation: A Case of Iskenderun

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Abstract**—** *In this study from Iskenderun to the other Turkey's 80 cities to unimodal and multimodal freight transportation scenarios are being developed. Filter material which is widely used in İskenderun is chosen for the freight. Highway, maritime and railway transport types are used in route scenarios. The costs of the route scenarios are calculated. Cost calculations are based on 5, 10 and 14 freight tonnage. For the value of the 5 ton freight is 40 000 TL, for the value of the 10 ton freight is 145 000 TL and for the value of the 14 ton freight is 250 000 TL. After the cost analysis is done, the most appropriate route for each province is selected and entered into the geographic information system (GIS). Thus, for freight from Iskenderun, the cheapest mode of transportation can be chosen. It is seen that railway and multimodal transport is widespread in general when the cheapest routes are examined. Thus, along with the shift of freight transport to rail and multimodal transport, traffic density on the highway can be reduced.*

Keywords**— Geographic Information System (GIS), Logistic, Multimodal Transport, Route Planning, Unimodal Transport**

I. INTRODUCTION

Developing technology and new transportation networks increase passenger and freight transport between countries. The increase in intercountry shopping reveals the concept of logistics. Logistic involve storage, packaging and distribution all the way up to reaching the final destination of the product. There is a need for logistics companies to manage all these operational sequences in order to deliver the goods from the producer to the consumer. Logistics firms are working on the most efficient and least costly transportation in the arrangement of these activities. Thus the concept of multimodal transport is developing. Multimodal transport is the transportation of freight with at least two types of transport. Multimodal transport is classified in two groups as intermodal and combined transport according to different criteria. In intermodal transport, freight is transported in the transport unit without being handled [1]. In combined transport, freight is predominantly transported railway and maritime transport, and in the first and last units, highway transport type is used as much as possible [2].

A lot of studies have been done on multimodal and unimodal transportation. Atar [3] has reduced the intensity of unimodal transport by transferring to short distance shipping and combined transport. In order to make an evaluation, the criteria such as emission, fuel consumption, transportation costs and transportation time are taken as criteria. Cansiz etc. [4] have evaluated multimodal transport in terms of cost, time, and emission parameters in their work. Reşat etc. [5] modeled the optimization of different modes of transportation in the design and management of intermodal transport network in a geographical region. Time has been formulated as a problem that develops due to vehicle clogging. The study, which holds 50% of Turkey's industrial capacity products and services are used data taken from the Marmara region. Islam etc. [6] examined transport modes used in underdeveloped countries. By analyzing the modes of transportation used in Bangladesh, it has proposed combined transport for the development of the country in terms of transportation. Deveci [7] has done research for the development of multimodal transport in Turkey. It first examined the factors that constitute multimodal transport and the factors necessary for development. Fulser [8] examined the substructure for combined transport in Turkey and has been suggested to make the combined transport more effective. Atar etc. [9] emphasized the importance of combined transportation with short distance maritime transportation depending on various parameters. Fremont etc. [10] have evaluated the potential for highway transport from railway transport to freight transport in France. As a result, intermodal transport is effective for travels at least 200 kilometers from the port. Arnold etc. [11] developed a model to assess the minimum intermodal transport distance in Spain. They concluded that intermodal transport is not cost-effective at distances under 500 kilometers. Saatcioğlu etc. [12] have studied the parameters of railway-maritime route combination in

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intermodal transportation by considering time, cost, energy, distance, environment, traffic congestion parameters in freight transport. Cansiz etc. [13] developed a program which plans the best route for multimodal route choice in Turkey. There have been many studies on cost efficiency in transportation [14]. Cansiz etc. has examined the existing route, vehicle types and travel structure for public transportation in Hatay, and made suggestions for improving the existing situation [15].

When multimodal transport scenarios are examined, marine and rail transport types are used predominantly. Cansiz etc. emphasized that railway transport is advantageous in terms of energy consumption compared to road transport [16] [17].

II. MATERIAL AND METHODS

In this study are being developed unimodal and multimodal transport scenarios for transporting the produced filter materials in Iskenderun. The costs of the developed route scenarios are calculated considering various criteria and unimodal and multimodal transportation routes are compared according to their cost values.

Design of Routes

Unimodal transportation routes are being established with 80 highway, 48 railways and 10 maritime routes. When routes are created, the minimum distance in kilometers and miles is taken into account.

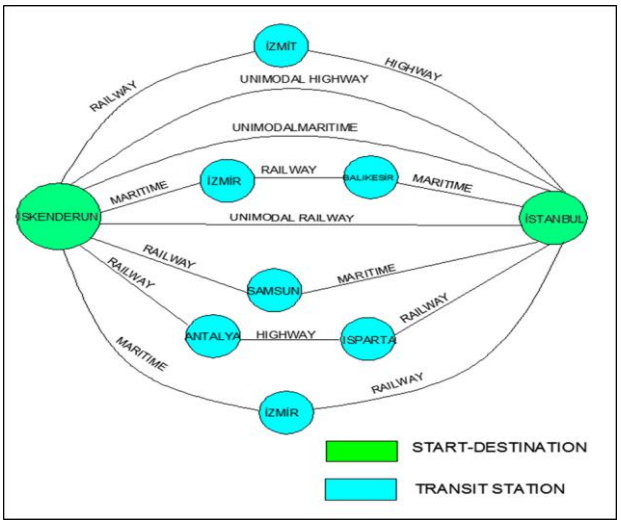

Fig. 1: Unimodal and Multimodal transport scenarios designed between Iskenderun and Istanbul

In the study, transportation scenarios are developed from Iskenderun with 80 cities, multimodal transportation can be done with only 71 in consideration of distance and transportation geography. Transport type change points when creating multimodal routes; harbors, railway finish points and logistic village areas. Fig. 1 gives an example of a route design.

Cost Account of Routes

The roadway cost account is based on fuel consumption, driver and indirect costs.

When calculating the railway transport, the unit prices per ton received from the TCDD's Distance between Stations and Transportation Fee Report are taken as basis and the value of the valuation is added account. 1/1000 of freight value up to 1000 km and 2/1000 of freight value for 1000 km excess distance are calculated [18].

Fuel consumption, handling charge, terminal service, port entry and exit fees are calculated for maritime route cost analysis. Cost items other than fuel consumption are calculated according to unit prices from TCDD Port Services Policy [19].

Entering the Best Routes to the Geographic Information System (GIS)

The Geographic Information System (GIS) is a system that collects, stores, processes, transforms, and displays spatial data [20]. In other words, GIS is a system that can process both graphical and numerical data together. GIS has a wide range of uses in many areas such as transportation, trade, security and politics [21].

In this study, unimodal and multimodal route scenarios are determined the lowest cost transportation types and these data are entered into ArcGIS. Thus, Iskenderun's logistic performance map is derived according to this data

III. RESULTS AND DISCUSSION

In this study, all other provinces of Turkey from Iskenderun are developed unimodal and multimodal route scenarios. The cost of the developed route scenarios is calculated. The route scenarios between the same exit and the same destination point are compared among themselves in terms of cost. Depending on the freight tonnage, the optimal routes to the GIS are shown in Fig. 2-3-4.

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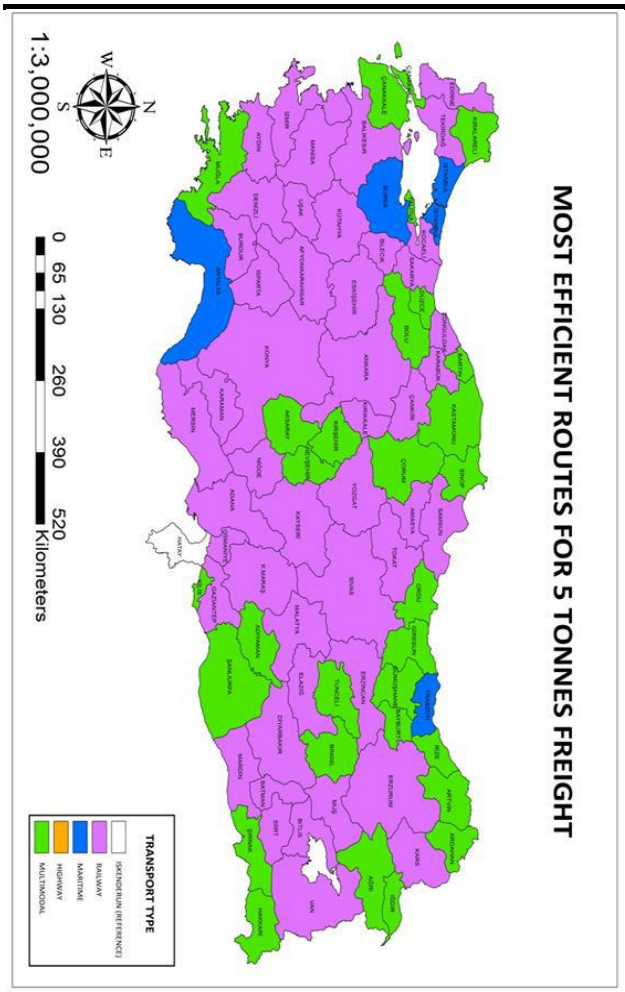

Fig. 2: Optimum transport modes for 5 tons freight

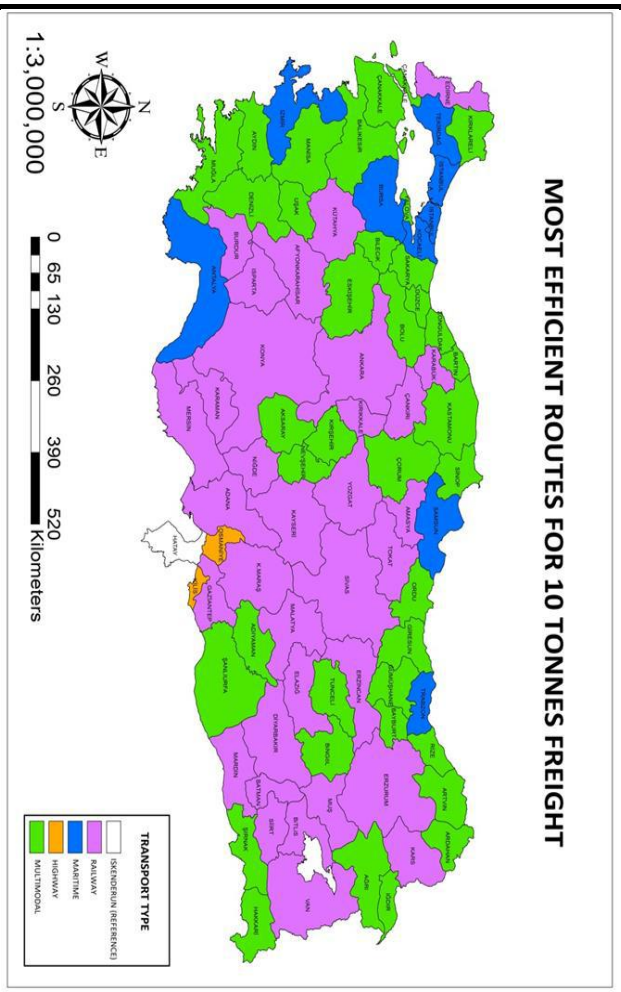

Fig. 3: Optimum transport modes for 10 tons freight

Fig. 2 is provided with the most economical routes to transport 5 tons freight. In general, it is clear from the map that railway transport is dominant. Maritime transport in Istanbul, Bursa, Trabzon and Antalya is more effective than other types of transportation. In 29 cities, multimodal transport is the most suitable according to the other routes. Railway transport is more economical in 47 cities for transporting 5 tons freight. 5 tons of freight transport Iskenderun from Turkey's other cities, multimodal transport in 36.25% of Turkey, railway transport in 58.75% of Turkey, maritime transport in 5% of Turkey stands out economically.

Fig. 3 is provided with the most economical routes to transport 10 tons freight. As the freight tonnage from 5 tons to 10 tons increased, the value of the freight increase from 40 000 TL to 145 000 TL increased. This increase in the value of freight negatively affects the costs of railway transportation, which is reflected in the map clearly. While the transportation of 5 tons of freight is economical in 47 cities, the number of cities in transportation of 10 tons of freight is 33. The number of cities where maritime transport is more economical is 4 out of 8. In the case of multimodal transportation, this number is 29 out of 37. 10 tons of freight transport Iskenderun from Turkey's other cities, multimodal transport in 46.25% of Turkey, railway transport in 41.25% of Turkey, maritime transport in 10% of Turkey and highway transport in 2.5% of Turkey stands out economically.

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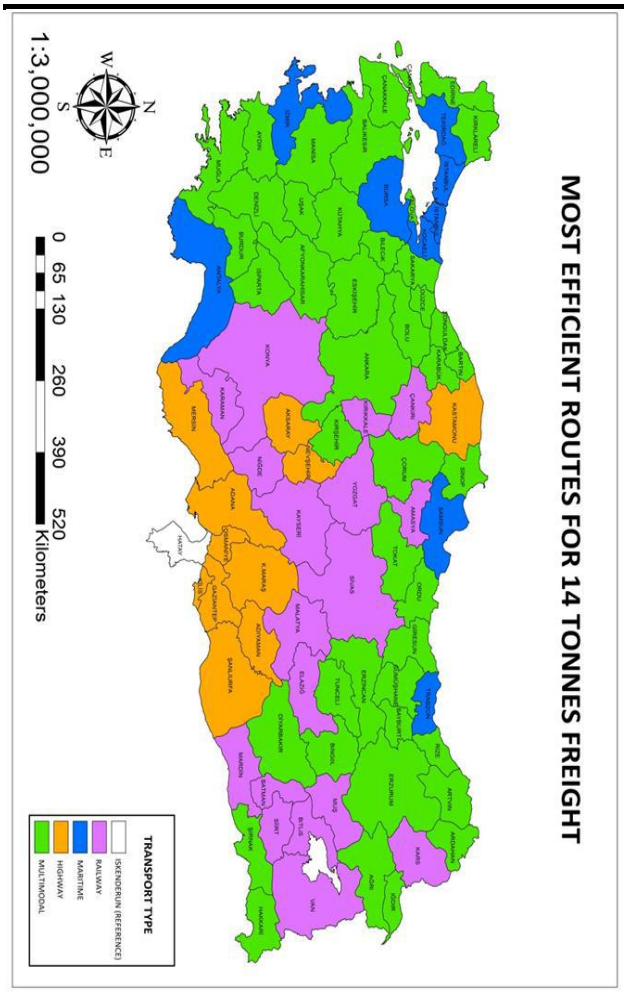

Fig. 4: Optimum transport modes for 14 tons freight

When the cost is examined according to the routes for 14 tons freight map in Figure 4, roadway transport in 11 cities is more suitable than the other routes. The number of cities where maritime transport is suitable is still 8. The number of cities that are efficient with a value of 250 000 TL for 14 tons of freight in railway transport falls to 18 cities. For multimodal transport for 14 tons of freight, 43 cities out of 37 cities are emerging according to 10 tons of the most efficient cities. Thus, multimodal transport is economically dominated for more than half of Turkey. 10 tons of freight transport Iskenderun from Turkey's other cities, multimodal transport in 53.75% of Turkey, railway transport in 22.5% of Turkey, maritime transport in 10% of Turkey and highway transport in 13.75% of Turkey stands out economically. As can be understood from this, as the freight tonnage and the value of the freight increase, the road transportation in the nearby cities and the multimodal transport in the more remote cities are the forefront.

IV. CONCLUSION

In this study, it was investigated how the transporting geography influences the choice of the route. The transportation geography varies greatly between the two points according to different types of transportation. This greatly influences route choice in logistics.

When the developed route scenarios are examined, it is seen that multimodal and unimodal freight transport dominate in Turkey. As the value of the freight increases, the railway transport is negatively affected in terms of cost.

As the value of the freight increases, short distance railway transport leaves the place to highway transportation

As the freight tonnage and value increase, the long distance also leaves the place of railway transportation to multimodal transport.

According to the map indicators, the choice of transport type depends on the freight tonnage and the transportation geography. When multimodal transport is compared with unimodal road, rail and maritime transport, it can be seen that the multimodal transport mode can eliminate the negative aspects of unimodal transport types.

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