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Determining the Appropriate Transportation Option with the Decision Tree

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Abstract

Due to the fact that the population density in Turkey is concentrated in the Marmara region, many businesses are positioning their facilities in this region. For this reason, logistics companies, also called 3PL, serving these businesses are located in the same region. Logistics companies determine various transportation strategies according to the shipment volumes of the customers they serve. The main objectives of these strategies are based on cost minimization, productivity increase and improvement of customer service levels. In this publication, a decision tree was used to determine the transportation strategy of a customer of the logistics company whose case study was conducted. The costs of alternative options, including the current transportation option, were calculated and the transportation option with the lowest cost was preferred. In the study, real data was used and a case study was carried out in a logistics company serving in our country. The reason why the decision tree method is preferred is that it is easy to implement and can answer many basic logistics problems.

Keywords: Decision tree; transportatiın options; 3PL firms; logistics.

1. INTRODUCTION

Logistics companies, also known as third party logistics (3PL), the activities performed by outsourcing the logistics activities of the enterprises are called third party logistics. The reason why third party logistics is qualified as third can be understood by explaining first and second party logistics. The fourth party logistics emerged later.

• First-party logistics: Manufacturer, wholesaler, retailer or shipper,

• Second party logistics: It is the direct customer of the first party,

• Third party logistics: Logistics intermediaries; service provider, carrier, warehouse operator,

• Fourth party logistics: A logistics product is a business that coordinates and integrates information flow processes.

The international competitive environment forces businesses to transfer their activities outside of their areas of expertise to professional companies that are experts in their fields. Experienced logistics companies outside the company have great responsibilities in structuring this series of activities in a fast and economical way without disruption. In this understanding, called Third Party Logistics (3PL), the transportation of the raw material from the emergence to the factory, the internal processes and then the timely delivery of the finished products to the consumption centers and buyers requires a certain level of knowledge, experience and management skills. Third party logistics companies have the ability to provide services in material flow from the supplier industry to the enterprise, that is, in the physical supply stage, in the production processes, in the internal transactions stage, and in the material flow activities ranging from the enterprise to the buyers. Many manufacturers outsource

some or all of their supply chain management functions. It is possible to express the reasons for cooperating with third-party logistics service providers as follows [1]:

• Optimizing logistics capabilities,

• Reducing logistics costs,

• In order to increase customer satisfaction, to be more flexible towards customer requests and to have the capacity to respond to these expectations,

• Providing expertise and resources for talents that are not available,

• Concentrating on the company's core business,

• Avoiding employee problems and improving customer service,

• Developing core competencies for better service to customers,

• Developing operations,

• Avoiding tying capital,

• Avoidance of control, correction and new instruction costs,

• Gaining flexibility in the market and agility against the changing expectations of the market,

• Providing strategic solutions and obtaining strategic partners, apart from the advantages in operational activities,

• To meet demand fluctuations,

• Not having sufficient information and communication technology.

This study was carried out in a local 3PL company operating in Turkey. The company in question carries out transportation with 81 cities in Turkey and provides services with 27 logistics centers within the scope of domestic distribution operations. 25 logistics centers, excluding the logistics centers on the Anatolian and European Sides of Istanbul, distribute the products coming from these 2 logistics centers to the regions they are responsible for, and the products that are not received for various reasons are kept in the return area. When a certain vehicle occupancy is achieved, these returns are returned to one or both of the two logistics centers from which they came.

In these two logistics centers, there is more intensive work compared to other logistics centers. Due to the location of these two logistics centers, products from customers are accepted and these products are divided into lines according to the logistics centers they will go to. In front of the relevant line (for example, in front of the Adana line that will go to Adana Logistics Center), the products of the regions coming from all customers and entering the distribution network of Adana Logistics Center are kept.

This logistics network coming from customers and customer branches is called “Inbound Logistics (Supply Logistics)”. The concept of supply logistics is at the stage before the physical production of the product or service; It refers to all the activities such as the selection of raw materials or semi-finished products, their planning and storage between the suppliers and the manufacturer. Supply logistics with a wide range; operates in areas such as food, health, industrial sector, military ammunition production. With supply logistics, answers are sought to questions such as which material will be ordered from where, how much, which purchasing tools will be purchased, and how the products will be stored [2].

Inbound logistics operations continue between 09.00-22.00 in the mentioned 3PL company. All incoming products between 22.00 and 07.00 are loaded on the vehicles of the relevant lines. Vehicle allocation is made according to the volume of the products accumulating on the lines in deci units. The distribution network from the Anatolian and European side logistics centers to the remaining 25 logistics centers is called “Outbound Logistics (Distribution Logistics)”.

Distribution logistics, also called physical distribution, covers activities that involve the physical delivery of products to customers. Supply and distribution logistics can be called inter-enterprise logistics, and production logistics can be called intra-enterprise logistics [3].

Within the scope of inbound logistics operations, the products of many customers are collected together with their waybills during the day by Milk-Run vehicles, which make cyclical voyages, and are left to the relevant logistics center (Anatolian or European logistics center). Here, the products whose barcoding and system identification processes are completed are distributed to the relevant lines in the logistics center. This operation structure is determined for customers whose daily volume is relatively below a certain level and the share of this operation in the total operation is at the level of 30%.

A second operation within the scope of inbound logistics creates products from other warehouses of the said 3PL company. Some customers are provided with both storage and distribution services. The warehouse operation unit manages this operation of the customers who have storage, and the domestic distribution operations unit manages the distribution operation. The warehouse operation unit makes the products to be shipped according to the demands of the customer company. According to these demands, waybills are printed, products are barcoded and systematically defined. These products are distributed directly to the lines in the relevant logistics center without being barcoded again. The share of this operation in the total operation is around 15%.

Within the scope of inbound logistics operations, the third and final operation is the structure where branches are established for customers with high shipment volumes and dispatch, barcoding and systematic identification processes are carried out in these branches. Due to the fact that the circular voyage vehicles exceed the capacity, these volume shipments are carried out by ring vehicles that go between the branch and the logistics center. In this operation, which has a high share of 55% in the overall operation, branches are established for high-volume customers and the employees of the 3PL company working in this branch carry out the relevant processes of the products accepted from the customer.

The common point of all three types of operations within the scope of inbound logistics operations is that they require all products to visit logistics centers. However, in this study, it is aimed to direct some products directly to the target logistics center without visiting Anatolian or European Logistics centers by making an appropriate planning for the customers who have a branch of the 3PL company. Thus, one of the stages will be eliminated and it will be possible to eliminate the risk of damage caused by unnecessary handling, loss of time and unnecessary labor costs.

2. CASE STUDY

There are 18 customer branches affiliated to Anadolu Logistics Center and 25 customer branches affiliated to European Logistics Center of the 3PL company where the study was conducted. Since the products coming from these branches, the products collected by the circular voyage Milk Run vehicles and the products coming from the warehouse of the same 3PL company all come to these logistics centers, the density of these logistics centers reaches the line level. In this study, it is suggested that some bulky shipments go directly from the branch to the target logistics center, without visiting the logistics center, in order to both reduce the densities in these logistics centers and reduce the risk of damage and time-cost losses as mentioned before.

In Table 1, the volume information of a customer branch that is connected to the European Logistics Center and sends products there, according to January-November 2022 and their regions, is given in deci. The aim is to determine whether it is cost-effective to make shipments to the target branch without visiting the logistics center for the relevant branch. If a lower cost shipment is possible without visiting the logistics center, it will be possible to apply this situation to customer branches with other volume shipment values.

The customer served by the 3PL firm is expressed as "X" in Table 1. In this table, monthly shipment volumes of customer X by region between January - November 2022 are available in the table. For this customer, 4 different shipping regions have been determined according to their distances in the country. The location of customer X is in Kocaeli/Gebze, and the products are shipped from the branch of 3PL company in customer X to Anadolu Logistics Center and partial transportation is carried out by being shipped to the remaining 26 logistics centers by line vehicles.

Partial literally means part, not whole. Transportation services such as complete, partial, project and heavy transportation are offered in the transportation sector. The logistics of transporting the loads of different customers on the same route with the same truck, pickup truck or lorry is called partial transportation or partial goods transportation. The main purpose of partial cargo transportation is to bring the cargoes requested to be transported on the same route to an economical level by loading them on the same vehicle, even if the amount of cargo does not fill a complete vehicle [4]. Partial transportation can also be called LTL (Less Than Truck Load).

3PL companies offer various pricing options to their customers to whom they provide transportation and/or storage services. Factors affecting pricing can be listed as follows [5]:

- Vehicle - Equipment and Equipment Costs
- Transport Distances
- Vehicle Maintenance and Repair Costs
- Insurance Premium Expenses
- Warehouse - Warehouse Operation Expenses
- Communication Costs
- Material Handling Expenses
- Management Expenses
- Load Partition Status and Mandatory Waiting

As can be seen in Table 2, the 3PL company where the study was conducted offers the cost information of its customer named X in 4 different ways per deci, depending on the distance. As the distance from the first region to the fourth region increases, the cost also increases. According to Table 1 data, the products of this customer are shipped to the first and fourth regions at a rate of 26.2%, and to the second and third regions with a rate of 73.8%.

Table 1. Dispatch Volumes by Regions

CUSTOMER	DESTINATION	DATE	NUMBER OF TOURS	1. REGION DESI	1. REGION DESI RATIO	2. REGION DESI	2. REGION DESI RATIO	3. REGION DESI	3. REGION DESI RATIO	4. REGION DESI	4. REGION DESI RATIO	DESİ TOTAL
X	ANATOLIANLC	JANUARY	21	6.960	5,31%	69.924	53,31%	37.729	28,77%	16.543	12,61%	131.157
X	ANATOLIANLC	FEBRUARY	51	31.854	7,51%	200.918	47,39%	138.744	32,73%	52.408	12,36%	423.924
X	ANATOLIANLC	MARCH	56	32.288	6,52%	190.927	38,57%	199.440	40,29%	72.335	14,61%	494.990
X	ANATOLIANLC	APRIL	38	19.633	6,02%	92.766	28,42%	143.879	44,08%	70.091	21,48%	326.369
X	ANATOLIANLC	MAY	33	11.040	4,74%	72.358	31,07%	107.404	46,12%	42.066	18,06%	232.868
X	ANATOLIANLC	JUNE	17	3.732	6,51%	25.731	44,87%	19.947	34,78%	7.935	13,84%	57.345
X	ANATOLIANLC	JULY	7	1.828	10,17%	4.435	24,69%	8.010	44,58%	3.693	20,56%	17.966
X	ANATOLIANLC	AUGUST	17	5.036	4,72%	27.346	25,64%	42.678	40,01%	31.611	29,63%	106.671
X	ANATOLIANLC	SEPTEMBER	31	33.319	16,46%	84.708	41,85%	61.537	30,40%	22.834	11,28%	202.398
X	ANATOLIANLC	OCTOBER	40	77.474	24,98%	95.038	30,64%	88.755	28,62%	48.871	15,76%	310.138
X	ANATOLIANLC	NOVEMBER	29	40.370	25,28%	62.132	38,91%	43.585	27,30%	13.586	8,51%	159.673
TOTAL			340	263.534	%10,7	926.283	%37,6	891.708	%36,2	381.973	%15,5	2.463.799

Table 2. Deci Fee by Regions

Region	1 Deci Fee (₹)
1. Region	1,5
2. Region	1,8
3. Region	2,1
4. Region	2,5

Deci is a unit of measurement used by customers who receive cargo service and sellers who want to send their products to their customers. Deci calculation process is closely followed by sellers and customers who are especially interested in e-commerce. Deci is especially used by cargo companies to calculate the cargo cost of the product, the calculation is made quite easily if the right methods are used. Regardless of the shipping method, every carrier develops packaging strategies to maximize their revenue. It may be useful to use the deci calculation formula for products that are sent or received. Three important points should be noted when using the deci calculation formula:

1. The width of the package to be shipped
2. The size of the package to be shipped
3. Height of the package to be shipped

Deci refers to the total size of a package, deci calculation will become much easier once you have the three required measurements. If the width, height and height dimensions of the cargo are multiplied in centimeters and the result is divided by 3000, the decis of the package is obtained [6].

In the current operation structure, products are transported in partial. In this method, the expense information (cost) of this operation will be obtained by using the deci volumes in Table 1 and the deci costs in Table 2. When the expense situations for the current and alternative operation options are revealed, the most appropriate option can be determined with the decision tree structure. The alternatives to be used in the decision tree are as in Table

The complete shipment mentioned in Table 3 can also be named as FTL (Full Truck Load). FTL means full truck load. The concept of full truckload is used when the capacity of the truck or container is full and a single product or similar products of the company are carried at this capacity. FTL complete transport; It is used in almost every mode of transportation such as road, air, sea. This transportation, which is carried out by full filling of a truck on the road or the container on the ship on the sea route; It is a more cost-effective and easier method for every business line working in the transportation process. This system, which is also called full load transportation, has some advantages and disadvantages. It is important for the company to evaluate these advantages according to its own products and system and examine whether it is suitable for itself [7].

Table 3. Transportation alternatives and expressions

Alternatives	**Expression**
Alternative 1	Partial continuation of the operation
Alternative 2	Realization of 1st and 4th region operations with partial shipment, 2nd and 3rd region operations with complete shipment
Alternative 3	Performing the operation with complete shipment

Table 4 shows the costs per vehicle for the truck according to the dispatch regions from customer X. Because of its capacity advantage in intercity transportation, trucks are mostly preferred as a vehicle. The truck capacity is 25.000 deci, and it is also preferred for inter-country transportation from time to time due to the possibility of transporting large volumes of material in one go.

Table 4. Costs per vehicle by regions

Regions	**Costs per Vehicle (₹)**
1. Region	13.000
2. Region	17.000
3. Region	21.000
4. Region	22.250

The calculations for each alternative are as follows and the decision tree is as in Figure 1. Calculations for a simple decision tree image are also made below.

- Alternative 1 = 1. Region Deci Amount x 1. Region Deci Cost + 2. Region Deci Amount x 2. Region Deci Cost +3. Region Deci Amount x 3. Region Deci Cost + 4. Region Deci Amount x 4. Region Deci Cost (1)

A1 = 263.534 x 1,5 + 926.283 x 1,8 + 891.708 x 2,1 + 381.973 x 2,5 = **4.890.130 TL**

- Alternative 2 = 1. Region Deci Amount x 1. Region Deci Cost + 4. Region Deci Amount x 4. Region Deci Cost + (2. Region Deci Amount / 25.000) x 2. Region Vehicle Cost + (3. Region Deci Amount / 25.000) x 3. Region Vehicle Cost (2)

A2 = 263.534 x 1,5 + 381.973 x 2,5 + (891.708 / 25.000) x 21.000 + (926.283 / 25.000) x 17.000 = **2.729.140 TL**

- Alternative 3 = (1. Region Deci Amount / 25.000) x 1. Region Vehicle Cost + (2. Region Deci Amount / 25.000) x 2. Region Vehicle Cost + (3. Region Deci Amount / 25.000) x 3. Region Vehicle Cost + (4. Region Deci Amount / 25.000) x 4. Region Vehicle Cost (3)

A3 = (263.534 / 25.000) x 13.000 + (926.283 / 25.000) x 17.000 + (891.708 / 25.000) x 21.000 + (381.973 / 25.000) x 22.500 = **1.859.720 TL**

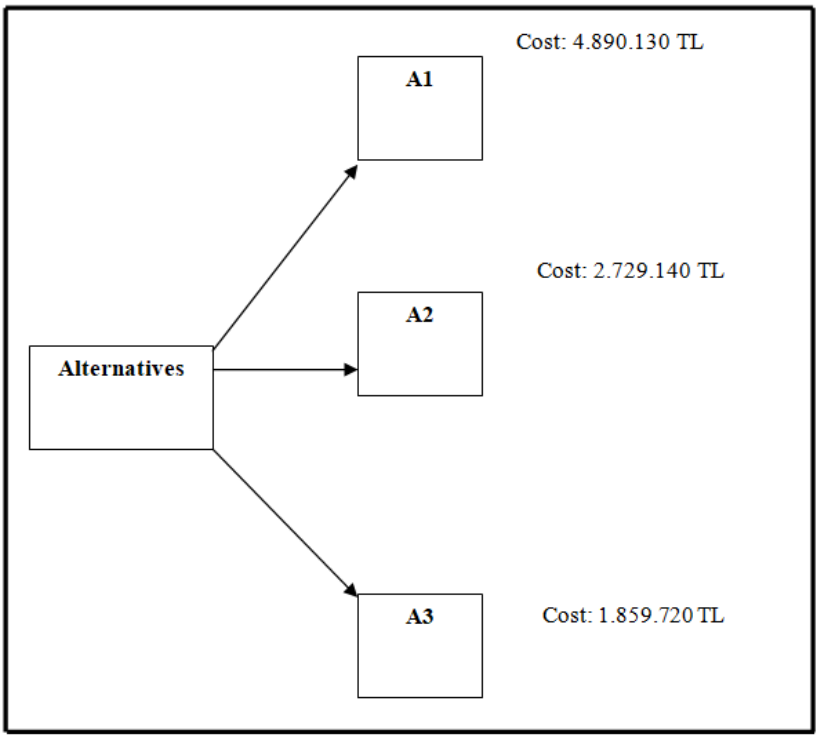

Figure 1: Decision tree

3. CONCLUSION

Due to the fact that the population in Turkey is concentrated in the Marmara region, many manufacturing companies are positioning their factories in these regions for the purposes of proximity to the market, ease of finding personnel and time-cost savings. In general, 3PL companies that provide B2B services also focus on the regions where their corporate customers are concentrated and place their facilities, personnel and transportation vehicles in these regions.

B2B, which is the abbreviation of business-to-business or frequently used English business-to-business phrase, is the name given to intercompany marketing or sales practices [8]. In order to provide better service to their customers, 3PL companies provide

services with storage facilities, customer-specific branches, large-sized distribution facilities and vehicle fleets in regions where their customers are concentrated and thus their shipment volumes increase.

In the 3PL company, where the study was carried out, a branch structure was decigned for bulky customers, and the products received from the manufacturer are made suitable for transportation and then transferred to the transfer center on the Anatolian side of Istanbul by complete transportation. However, with the further growth of the said shipment volumes, the option of sending the products directly to the destination transfer center instead of transferring them to the transfer center on the Anatolian side with complete transportation has come to the fore.

Thus, the workload in the transfer center on the Anatolian side will decrease somewhat and the risk of damage to the products arising from unnecessary handling and cost will be eliminated. In order to test these options, the shipment volumes of a customer, whose name we did not give due to the confidentiality policy of the company named X, were examined for the January-November 2022 period. As a result of the investigations, a hybrid option was developed in which to continue the operation in the current order through the transfer center on the Anatolian side, to deliver direct complete transportation to the target regions and to apply these two methods together.

In order to evaluate the options, the costs per deci according to the dispatch region and the transportation costs by truck according to the dispatch region were obtained according to the data of that period and the cost of each option was calculated. As a result, the cost of the option named A3 is the lowest and the cost of the current operating structure is the highest. In the proposed option, it is more cost-effective to send all the products of the relevant customers to the destination transfer centers with complete transportation.

In the decision tree in Figure 1, there are 3 alternatives and their costs. Alternative 1 represents the current operating structure and a calculation has been made on the transportation costs per deci. The cost of this alternative, in which partial transportation is foreseen, was calculated by multiplying the deci amounts in Table 1 and the deci costs in Table 2. Alternative 2 is an alternative that envisages partial transportation of the first and fourth regions, and complete shipments of the second and third regions. The cost of the first and fourth zones was calculated by multiplying the deci amounts in Table 1 and the transportation charges per deci in Table 4. The cost of the second and third regions was calculated by dividing the deci amounts of the second and third regions in Table 1 by 25,000, which is the carrying capacity of a truck. Thus, it will be clear how many trucks will be needed. These numbers are multiplied by the truck transportation costs according to the regions in Table 4. Alternative 3 is an approach that requires all transportation to be done with complete vehicles. Accordingly, the deci capacity of a truck with 25,000 deci in Table 1 was divided by its deci capacity and the number of vehicles required for each region was revealed. These numbers were then multiplied by the vehicle costs according to the regions in Table 4.

Decision trees can be preferred in terms of providing easy solutions to many basic problems in logistics. The fact that it is both easy and promises a quick solution makes decision trees advantageous. As a matter of fact, most of the problems that arise in logistics operations and require decision-making are not overly complex and decired results can be achieved with easy methods.

However, it is obvious that more advanced mathematical models should be preferred in solving more complex problems. Decision making methods contain a series of mathematical models from static methods to advanced dynamic methods. As in our study, the basic decision-making methods are in a structure that will answer many basic problems in business life in general and in the logistics sector in particular, and their importance levels should not be ignored.

Declaration of Competing Interest

The author confirms that there is no known conflict of interest or common interest with any institution/organization or person.

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