THE LESS THAN TRUCKLOAD HUB NETWORK DESIGN WITH SERVERLESS ARCHITECTURE

[1]Tuğçe ELÇİ, [1]Deniz KANTAR, [1]Ahmet Yesevi TÜRKER, [1]Hasan GÜNEY

[1]Borusan Logistics, Data and Artificial Intelligence Services, Istanbul, Turkey, EU, tugce.elci@borusan.com, deniz.kantar@borusan.com, ahmetyesevi.turker@borusan.com, hasan.guney@borusan.com

https://doi.org/10.37904/clc.2022.4526

Abstract

The characteristics of land are important for network optimization problems in logistics. Due to its large area and atypical geographical type, Turkey is good for testing and implementing network optimization in the European logistics sector. The main objective of this paper is to present a network optimization model and interfaces developed on the Borusan Logistics Less Than Truckload (LTL) management system, namely ATLAS LTL. The Model offers a new LTL Hub if necessary or selects the most suitable one by looking at the current province-district matches, operational volumetric weight flows, and current transfer center locations. To minimize infrastructure expenses and be adaptive to different transportation management systems, Azure Serverless Architecture is used. Moreover, the model outputs are served in HTML format as graphics, this enables the interpretation of the model outputs easily by end-users. Besides, the system works with more than one infrastructure element communicating with each other and it uses serverless architecture that provide, the cloud service automatically provides, scales, and manages the infrastructure needed to run the code. Because of these features, the system is useful, accessible and sustainable. The importance of this study is to calculate the volumetric weight distributions in the province-district distribution centers and try to minimize the cost while making this calculation.

Keywords: LTL hub analysis, supply chain management, less than truckload hub management, serverless architecture, cloud system

1. INTRODUCTION

As a result of globalization, products, raw materials, materials, semi-finished products, production tools and free transportation activities at the international level have become indispensable for their technological development. Transportation can be expressed as the reasons that allow the transportation of raw materials, materials, semi-finished products, products or people from one point to another [1]. Transportation from a broad perspective: It can be defined as the transfer of loads consisting of raw materials, materials, semi-finished products and products from one point to another without damaging the cargo, at low cost, in appropriate times, in a traceable way and in a way that ensures customer satisfaction [2]. Transportation activities, which are the most important point of supply chains, both domestic commercial activities and international commercial activities are of critical importance. Freight transportation, which provides door-to-door transportation due to the widespread road network and suitable size transportation vehicles throughout the world, is a research area that should be emphasized in terms of the commercial development of countries [3]. From the perspective of Turkey, researches reflect the importance of road transport [4]. The daily planning of freight operations is one of the biggest challenges in transport logistics. Successfully managing the whole LTL operations requires the correct selection of transfer centers. This study proposes a method to generate the correct inferences for load distribution by selecting the best transfer centers or the best options for potential transfer centers. Being able to make these inferences quickly and easily can be beneficial in terms of efficiency as well as in terms of finance. For this reason, this study also presents easy-to-understand displays and dashboards that are critical to act fast.In this study, the solution methodology is developed that will optimize the company's daily LTL operations planning in a centralized manner and within an acceptable time frame [5]. While designing this methodology, it includes the selection of the most suitable transfer center or the selection of the most suitable candidate transfer centers, taking into account the amount of city-district volumetric weight.

2. METHODOLOGY AND RESULTS

LTL network analysis provides the user with the most advantageous location for a new transfer center based on operational volumetric weight flows, current transfer center locations, and current center-district matches [8][10].

2.1. LTL Modelling Stages

The system works on "Serverless Architecture". Firstly, files are read from Atlas Portal that is operated as user-interface. Then, inputs are read by the model after they are loaded to Atlas Portal in Azure Data Lake. After that, Atlas Portal triggers Azure Function to run model. Started response is returned to Atlas Portal. If user select the option of live data, a connection to Atlas DB is provided to fetch live volumetric weight data. Pipeline in data factory is triggered by pipeline trigger in Azure Functions. Following that, the inputs are written in Azure Data Lake. After then, Batch trigger function is set off and batch task starts. Code files are taken over from Azure Blob Storage that is defined as a storage folder in cloud. Azure Batch activate the Linux Server and then, the model runs. When the task is completed, output files are written in Azure Data Lake. Paths of output files and analysis completed response are sent to Atlas Portal and then, Atlas Portal send the completed message to user. The general architecture of the system is indicated in the block diagram in **Figure 1**.

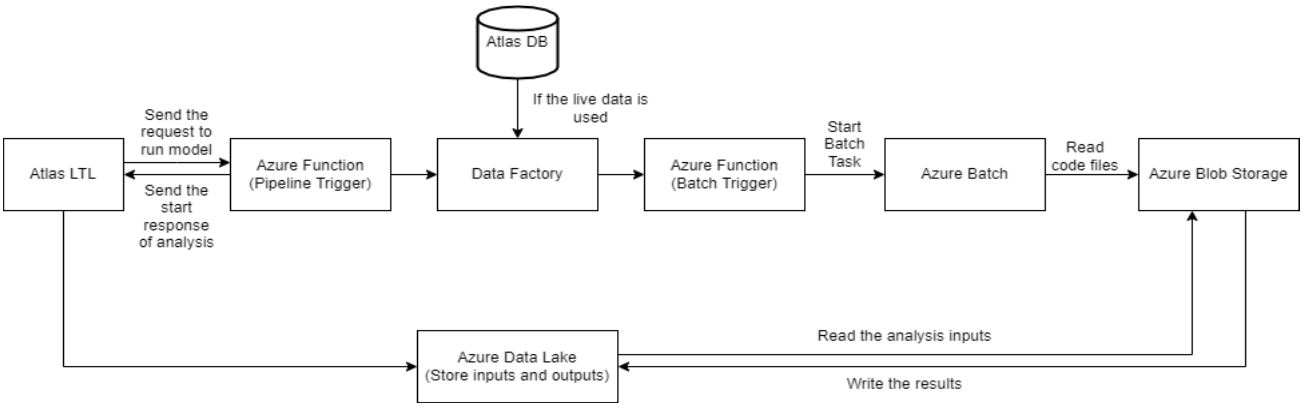

Figure 1 Block diagram of LTL hub design with serverless architecture

2.2. Analysis Methodology

Two types of analysis are offered: "The Capacity of Transfer Center" and "New Transfer Center" [6,9,10].

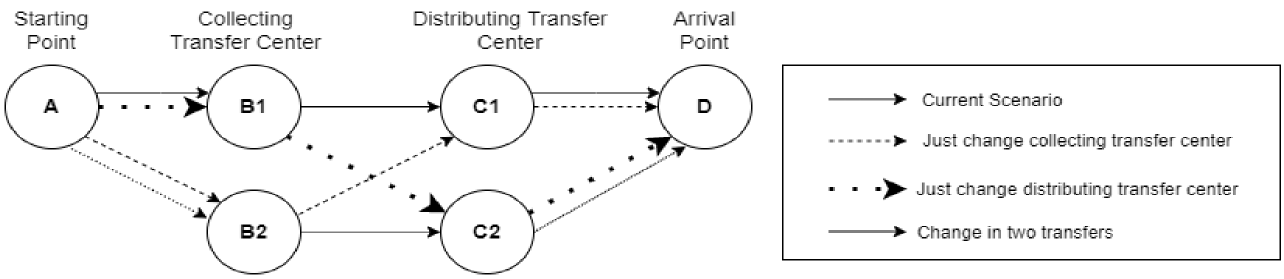

Figure 2 Transportation scenario

The analysis includes four steps. Firstly, Volumetric weight data, district - transfer center mappings are combined with hub data. The distances are then matched over the distance table. Then, for "The Capacity of Transfer Center" analysis, the volumetric weight amount passing through each center is calculated on a monthly basis and the analysis is completed. Thirdly, for the New Center analysis, each candidate district is analyzed one by one. Lastly, distance and financial advantage for collection, baseline and distribution are calculated, taking into account new flow routes. The general scenario structure is shown in **Figure 2**.

2.2.1. Whether or not to come to the transfer center

- **Local Transfer:** Volumetric weight can be transferred by stopping at the transfer center in local transportation. For example, let's consider that there is a lot of volumetric weight flow between districts in X center. If these volumetric weights are considered to come to the transfer center and are included in the analysis that may suggest opening a center in X center.
- **Local Direct:** Considering that the urban flows do not come to the transfer center, this type of data will not affect the analysis and as in the case of X center, the transfer center will not provide extra advantages with it [11].

Figure 3 shows an example of local direct and local direct transfer.

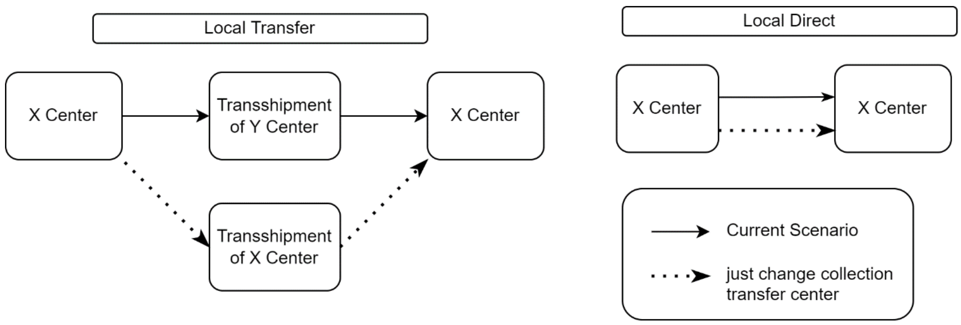

Figure 3 Structure of local transfer and local direct transfer

2.2.2. The situation where the new transfer center can remove a single district from a city

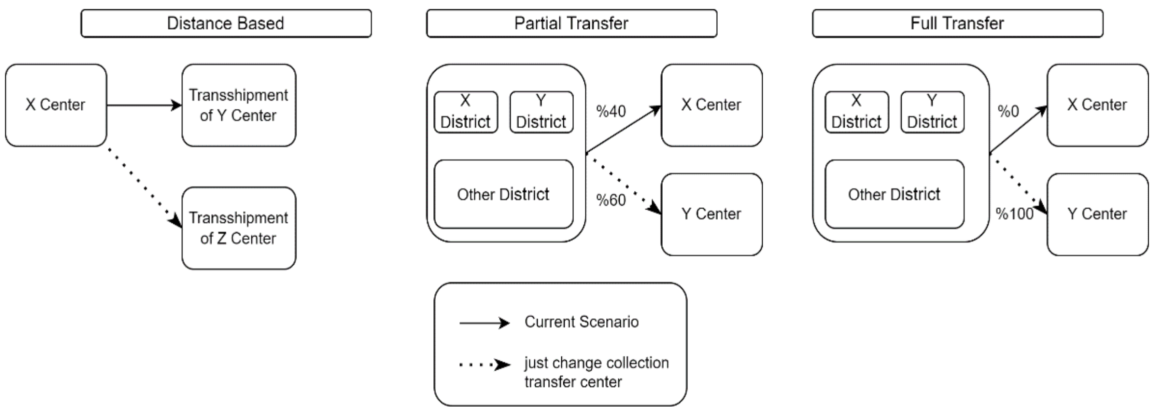

Figure 4 Transfer scenarios

In normal cases, a newly opened transfer center from a city is evaluated by considering distance and radius (Radius can be defined as services area for distribution and collection operations) when choosing a district. However, the direct removal of a single district from a city is not preferred by the operation because of being cost and time-consuming operations. Therefore, two more scenarios are created in addition to the normal one [7,11]. In this case, distance based scenario is standard scenario. Partial scenario can be explained that a district can be removed from a city if the new center can receive the majority volumetric weight flow of that city. Moreover, full transfer can be explained that it has the same logic as partial transfer, but if the new center receives the majority from a city, the whole of that city is connected to the new center. **Figure 4** shows an example of Distance based, partial transfer and full transfer situations.

2.3. Results

The outputs of the LTL optimization algorithm are analysis parameters, volumetric weight distribution map, city-district total volumetric weight distribution, city-district center mapping and new transfer center map. As part of the analysis parameters, the LTL program determines the settings files, the run time, a volumetric weight interval, fuel prices, and details of the transfer centers.

2.3.1. Volumetric weight distribution map

The graph in **Figure 5** shows the distribution of volumetric weights by city on the map. Details about the points can be accessed when hovering over them. Control of volumetric weight data is done on this graph.

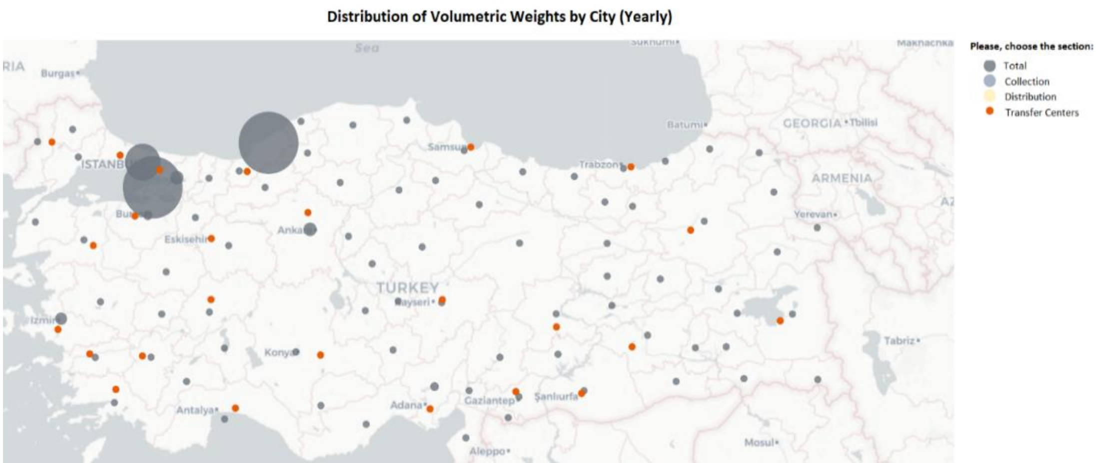

Figure 5 Distribution of volumetric weights by city on the map

2.3.2. City and district total volumetric weight distribution

Table 1 shows the top three cities with most volumetric weight. This table can be used to calculate, comparison can be made according to collection, distribution and total volumetric weight. The distribution of the districts of the city can be seen.

Table 1 Volumetric weight distribution by cities

Cities	**Istanbul**	**Izmir**	**Ankara**
Total Volume (m³)	318,183,601	63,581,381.80	58,025,409.00
Collection Volume (m³)	252,514,753.10	27,227,196.00	18,073,721.10
Distribution Volume (m³)	65,668,847.90	36,354,185.80	39,951,687.90
Percantage	39%	8%	7%

2.3.3. City-District center mapping

District-based volumetric weight distribution is seen in the graph in **Figure 7**. The center to which districts are connected is shown with gray lines. The color of the dots shows the range in which the total decimals in the district. A single range can be displayed by selecting or double-clicking on the legend. The purple lines next to the dots show the direction of the volumetric weight originating from or arriving with that city. The length of the purple line symbolizes how dominant that direction is. **Figure 7** shows the volumetric weight distribution by cities. This table can be used to calculate, comparison can be made according to collection, distribution and total volumetric weight. The distribution of the districts of the city can be seen.

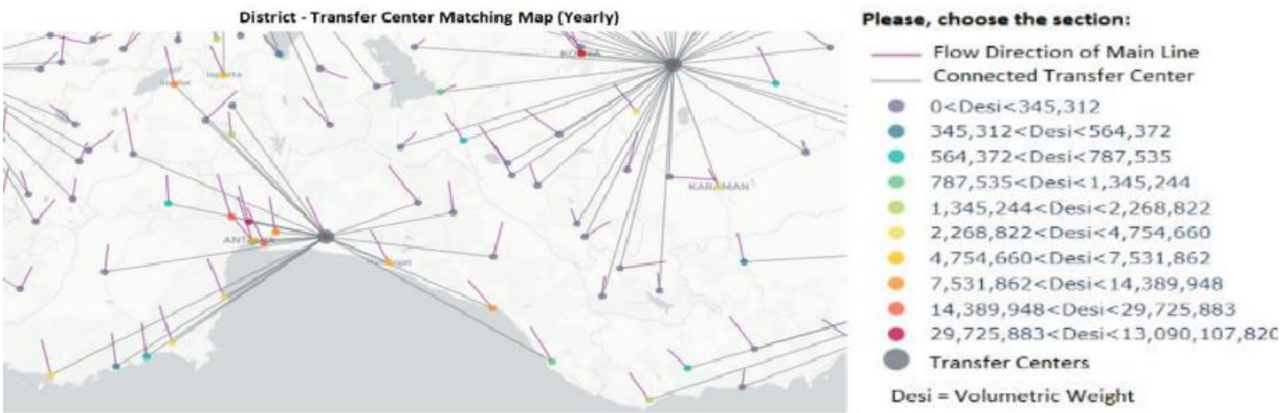

Figure 7 District-based volumetric weight distribution

2.3.4. New center results map

The graph in **Figure 8** summarizes the scenario for a new center on the map. As you can see, the new center (orange) affected previous centers (blue) and districts that are connected to it. Detailed information is displayed when the cursor is hovered over the points. The chart includes only the best candidates of each province and includes the maximum and minimum scenarios of those candidates.

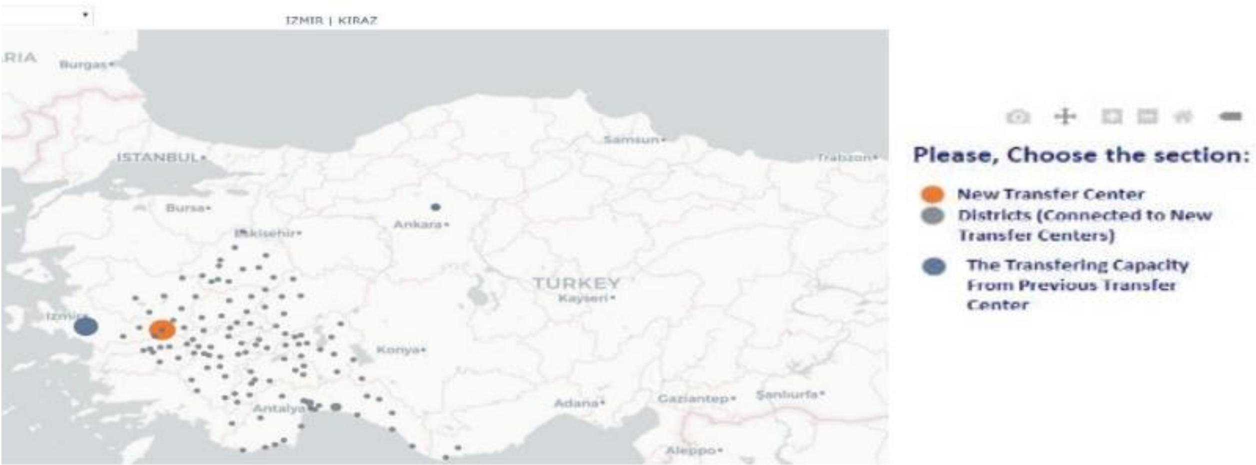

Figure 8 Scenario for a new center on the map

3. CONCLUSION

In this study, Turkey's domestic LTL network modeling and the effective operation of this modeling are based on. The main purpose is to calculate the total volumetric weight distribution in cities and districts, to calculate fuel prices, to evaluate transfer centers and capacity information, to calculate the costs that may occur during the total city-district transfer and to minimize the cost according to these results. In addition to these optimizations, the most suitable transfer center is selected in order to prevent problems that may arise from volumetric weight amount in the city and district. While these process steps are taking place, each candidate district is analyzed one by one for the new center analysis. The distance and financial benefits are calculated for the baseline and distribution when evaluating the new flow route. This system works in completely different blocks and that is designed wholistic as a single system on the Azure cloud side. It is protected against failure situations that may occur due to data security, backup and system density provided by cloud systems. The system has a high potential to be developed because it has high access, configuration and sustainability.

ACKNOWLEDGEMENTS

Tuğçe Elçi, Deniz Kantar, Ahmet Yesevi Türker and Hasan Güney are members of Data and Artificial Intelligence Services in Borusan Logistics.

REFERENCES

[1] GÖRÇÜN, Ö. F. *Ulaştırma sistemlerine giriş*. Köksal Büyük (Ed.), Ulaştırma sistemleri ve yönetimi. Eskişehir: Anadolu Üniversitesi Açıköğretim Fakültesi Yayını, 2018, pp. 2-35.

[2] TUZKAYA, U. R. *Taşımacılık yönetimi*. Vecihi Yiğit (Ed.), Lojistik yönetimi. Erzurum: Atatürk Üniversitesi Açıköğretim Fakültesi Yayını, 2020, pp. 31-50.

[3] KOBAN, E., & KESER, Y. H. Dış ticarette lojistik. (6. Baskı). Bursa: Ekin Yayınevi, 2015.

[4] ÖZOĞLU, B., & BÜYÜKKEKLIK, A. (2013). The transportation and logistics sector in Turkish economy: A review about growth potential and education infrastructure. *The International Journal of Transport & Logistics*. 2013, vol. 13, pp. 1–10.

[5] ÖZOĞLU & DEMİRCİ - Ömer Halisdemir Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi, 2021.

[6] D., AMBROSINO and M. G., SCUTELLÀ. Distribution network design: New problems and related models. *European Journal of Operational Research*. 2005, vol. 165, no. 3, pp.610-624.

[7] E., ANGELELLI and M. G., SPERANZA. The periodic vehicle routing problem with intermediate facilities. *European Journal of Operational Research*. 2002, vol. 137, issue. 2, pp. 233-247.

[8] B. M., BEAMON. Supply chain design and analysis. *International Journal of Production Economics*. 1998, vol. 55, issue.3, pp. 281-294.

[9] T. G., CRAINIC and G., LAPORTE. Planning models for freight transportation. *European Journal of Operational Research*. 1997, vol. 97, issue. 3, pp.409-438.

[10] T. G., CRAINIC, N., RICCIARDI, and G., STORCHI. Advanced freight transportation systems for congested urban areas. *Transportation Research Part C: Emerging Technologies.* 2004, vol. 12, issue. 2, pp.119-137.

[11] J. F., CORDEAU, G., LAPORTE, M., SAVELSBERG, and D., VIGO. Vehicle Routing. *Transportation*. 2007, pp. 367-428.