GALATASARAY UNIVERSITY
GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

EVALUATING AIR FREIGHT FORWARDERS USING AN INTEGRATED MULTI-CRITERIA DECISION MAKING APPROACH

ELİF BERFİN KIZILTAŞ

Dec 2021

EVALUATING AIR FREIGHT FORWARDERS USING AN INTEGRATED MULTI-CRITERIA DECISION MAKING APPROACH

(BÜTÜNLEŞİK ÇOK ÖLÇÜTLÜ KARAR VERME YAKLAŞIMI KULLANILARAK HAVA KARGO ACENTELERİNİN DEĞERLENDİRİLMESİ)

by

Elif Berfin KIZILTAŞ, B.S.

Thesis

Submitted in Partial Fulfillment

of the Requirements

for the Degree of

MASTER OF SCIENCE

in

INDUSTRIAL ENGINEERING

in the

GRADUATE SCHOOL OF SCIENCE AND ENGINEERING

of

GALATASARAY UNIVERSITY

Supervisor: Assist. Prof. Dr. Zeynep ŞENER

Dec 2021

This is to certify that the thesis entitled

EVALUATING AIR FREIGHT FORWARDERS USING AN INTEGRATED MULTI-CRITERIA DECISION MAKING APPROACH

prepared by **Elif Berfin KIZILTAŞ** in partial fulfillment of the requirements for the degree of **Master of Science in Industrial Engineering** at the **Galatasaray University** is approved by the

Examining Committee:

Assist. Prof. Dr. Zeynep ŞENER (Supervisor)
Department of Industrial Engineering
Galatasaray University ----------

Assist. Prof. Dr. Orhan İlker BAŞARAN
Department of Industrial Engineering
Galatasaray University ----------

Assist. Prof. Dr. Melis Almula KARADAYI
Department of Industrial Engineering
Istanbul Medıpol University ----------

Date: ----------

ACKNOWLEDGEMENTS

First and foremost, I would like to express my gratitude to the esteemed Assist. Prof. Dr. Zeynep ŞENER, who helped me a lot with her significant experience, broad knowledge, and kindly guidance. Without her, everything would have become much more difficult and complicated and I would not have been able to finish my thesis.

I would like to express my special thanks to Ebru TURAN and Mehmet Harun CİVAN for their support while writing this thesis no mather how busy they were.

I would like to express my love and gratitude to my beloved Fatih KIZILTAŞ, who has been behind me and supported me in every step I have taken since the beginning. I would also like to thank our family elders who were with us in every sense.

December 2021

Elif Berfin KIZILTAŞ

TABLE OF CONTENTS

LIST OF SYMBOLS

DEMATEL : The Decision Making Trial and Evaluation Laboratory
TOPSIS : Technique for Order Preference by Similarity
AWB : Air Waybill
CW : Chargeable Weight
MCDM : Multi-Criteria Decision Making
RTK : Revenue Tone Kilometer
CTK : Cargo Tone Kilometer
3PL : Third-Party Logistics
IATA : International Air Transport Association
GDP : Gross Domestic Product

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Every step of the transportation process becomes more and more important for the players of the air cargo industry, which is growing both in importance and size. According to the report published by IATA (IATA, 2021), the air cargo sector has grown by 9.9% in cargo-ton kilometers (CTKs) basis in June 2021 compared to June 2019. Businesses are trying to take their strategic decisions more accurately and in a timely manner, due to both the global conflicts and crises in world trade and the aim of competing players to maintain their existence with higher contribution and performance.

The fact that air cargo is in a growth trend despite the pandemic conditions has made the capacities offered by carrier companies more valuable than in the past. Freight forwarder selection and evaluation is of great importance for airline carriers who want to use their limited capacities with the highest profit and efficiency. This study is based on an evaluation and ranking among 5 freight forwarders selected in terms of the largest air cargo carrier in Turkey. The aim of the study is to contribute to the subsidy-incentive system used by the company for freight forwarders based in Turkey from a different perspective.

In the study, there are 12 criteria determined for freight forwarder evaluation in line with the opinions of experts who play different roles in the business. These are total revenue, technology level, on-time delivery, payment reputation, global coverage, responsiveness, stability of supply, quantity of supply, e-AWB utilization rate, error-free documentation, quality of operation and annual growth rate. With 3 decision makers experienced in the air cargo industry, the criteria were weighted according to the DEMATEL (The Decision Making Trial and Evaluation Laboratory) method. On a scale between 0 and 4, decision makers make choices about the extent to which the criteria affect each other. Thanks to this method, the weights of freight forwarder evaluation criteria are determined.

Since linguistic expressions are used for the evaluation of freight forwarders, in the second stage of the method, alternatives are listed with the Fuzzy TOPSIS (Technique for Order Preference by Similarity) method. Thanks to this method, which is based on the determination of the alternatives closest to the positive ideal solution or the farthest from the negative ideal solution, freight forwarders are ranked from the perspective of an air cargo company. The criteria weights obtained as a result of the DEMATEL methodology are used in the Fuzzy TOPSIS process.

As a result, the air cargo company can apply a subsidy-incentive method with a more detailed but also a holistic evaluation, with the ranking that emerges as a result of the two-stage multi-criteria decision-making method. In the case of a subsidy-incentive evaluation in line with this method, freight forwarders are expected to fulfill the requirements in commercial, operational and sustainability fields rather than an attitude towards meeting only one or two criteria. This will contribute to the more efficient use of each unit of capacity by carrier companies in the long run.

ÖZET

Önemi ve büyüklüğü gittikçe artan hava kargo endüstrisinin oyuncuları için taşımacılık sürecinin her adımı giderek daha büyük önem kazanmaktadır. IATA'nın yayınladığı rapora (IATA, 2021) göre, hava kargo sektörü Haziran 2021'de kargo ton kilometre bazında Haziran 2019'a göre % 9.9 büyümeye imza atmıştır. Gerek dünya ticaretindeki küresel anlaşmazlıklar ve krizler gerekse rakip oyuncuların daha yüksek katkı ve performans ile varlıklarını sürdürme gayeleri sebebiyle işletmeler stratejik kararlarını daha isabetli ve zamanında almaya çalışmaktadırlar.

Hava kargonun pandemi koşullarına rağmen büyüme trendi içinde olması, taşıyıcı firmaların arz ettikleri kapasiteleri geçmişe kıyasla daha değerli hale getirmiştir. Sınırlı kapasitelerini en yüksek kar ve verimle kullanmak isteyen havayolu taşıyıcıları için hava kargo acentesi seçimi ve değerlendirmesi büyük önem taşır. Bu çalışma, Türkiye'de yer alan en büyük hava kargo taşıyıcısı açısından seçilen 5 hava kargo acentesi arasında bir değerlendirme ve sıralama yapılmasına dayanmaktadır. Çalışmanın amacı, firmanın Türkiye merkezli hava kargo acentesi için kullandığı prim teşvik sistemini farklı bir açıdan ele alarak katkıda bulunmaktır.

Çalışmada işletmede farklı roller üstlenen uzmanların görüşleri doğrultusunda hava kargo acentesi değerlendirmesi için belirlenmiş 12 adet ölçüt yer almaktadır. Bunlar; toplam gelir, teknoloji seviyesi, zamanında teslim, ödeme gücü, küresel kapsam, cevap verebilirlik, arz istikrarı, arz miktarı, e-AWB kullanım oranı, hatasız dökümantasyon, operasyon kalitesi ve yıllık büyüme oranıdır. Havacılık sektöründe tecrübeli 3 karar verici ile ölçütlerler DEMATEL (The Decision Making Trial and Evaluation Laboratory) yöntemine göre ağırlıklandırılmıştır. 0 ile 4 arasında yer alan bir skalada karar vericiler ölçütlerin birbirlerini ne ölçüde etkilendiğine dair seçim yapmaktadır. Bu yöntem sayesinde ölçütler arasında karşılıklı karışlaştırmalar yapılarak faktörlerin ağırlıkları belirlenir.

Hava kargo acentesi seçimi için belirlenen ölçütler arasında dilsel ifadelerin de yer alması sebebiyle yöntemin ikinci aşamasında Bulanık TOPSIS (Fuzzy Technique for Order Preference by Similarity) yöntemiyle alternatifler sıralanmıştır. Pozitif ideal çözüme en yakın veya negative ideal çözüme en uzak alternatiflerin belirlenmesi üzerine kurulu bu yöntem sayesinde bir hava kargo işletmesi gözünden freight forwarderlar sıralanmıştır.

Sonuç olarak, bahsi geçen iki aşamalı çok ölçütleri karar verme yöntemi neticesinde ortaya çıkan sıralama ile hava kargo firması daha detaylı ancak bir o kadar da bütünsel bir değerlendirmeyle bir prim-teşvik yöntemi uygulayabilir. Bu yöntem doğrultusunda bir prim-teşvik değerlendirilmesi yapılması durumunda hava kargo acentelerinin sadece bir ya da iki ölçütü sağlamaya yönelik bir tutumlarından ziyade, hem ticari, hem operasyonel hem sürdürülebilirlik alanlarında gereklilikleri yerine getirmeleri beklenmektedir. Bu da taşıyıcı firmaların uzun vadede her 1 birim kapasitelerinin daha verimli kullanmalarına katkı sağlayacaktır.

1. INTRODUCTION

Air freight transportation is the business line that provides good transportation within the country or between countries via 'airline'. Today, air transport is of great importance to the world economy. Although air cargo transportation based on tonnage is less than 1% of the world trade, it carries an average of more than 6 trillion dollars per year on a value basis and corresponds to more than 35% of the total overall commerce. The reason that air cargo has a high share in value is the transportation of computer equipment, machinery and electrical equipment products. The biggest difference in air cargo compared to other modes of transportation is that it is faster, more reliable and safer.

As shown in Figure 1.1, global air cargo growth largely depends on global trade, industrial production and gross domestic product (GDP). Therefore, the volume of air transportation may change due to reasons such as the production capacity of the countries, economic and political conditions, demand from importing countries, seasonality, global crises and pricing policy etc. In the last 40 years, world trade has grown by an average of 5% annually, while air cargo has grown by 5.3%, making remarkable improvement. The air cargo sector is expected to grow by an average of 4.2% over the next twenty years. This growth trend is estimated to be 4.7% in an optimistic scenario and 3.7% in a pessimistic scenario. Similarly, it is estimated that the sum of freighter fleets will rise by 70% in the coming 20 years, from 1870 to 3260 (BOEING Commercial Market Outlook 2019-2038).

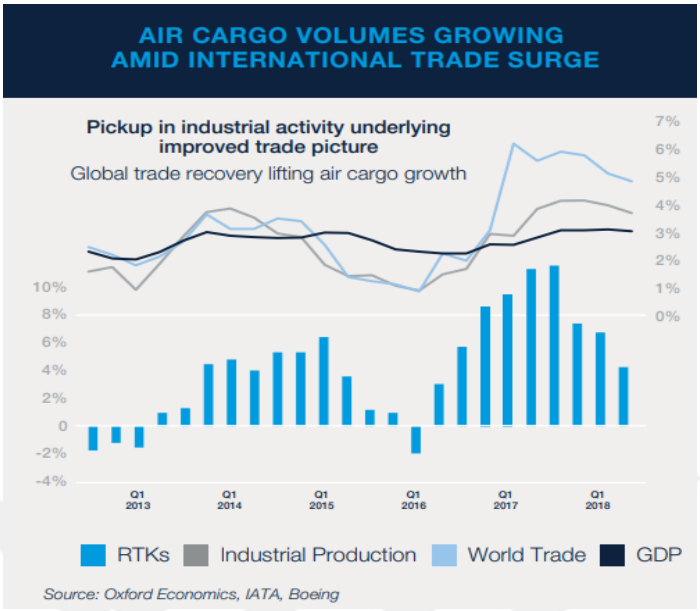

Figure 1.1: Growth Of Air Cargo By International Trade (Boeing, World Air Cargo Forecast, 2018-2037, 4)

The Coronovirus pandemic, which started in 2019 and is still ongoing, has had significant impacts on air cargo transportation as in every sector. Many scenarios were discussed on the spread rate and impact of the pandemic. Even in periods when passenger transport comes to a standstill, the continuation of air cargo, even with limited capacity, has led to positive results in this sector.

According to the report published in September 2020 by WorldACD, one of the most important organizations providing air cargo market data, there was a 17.2% year-over-year (YoY) decrease on chargable weight basis in August 2020, as shown in Figure 1.2. However, at the same time, the 65% increase in unit revenue resulted in a 37% increase in total revenue. According to the report published in January 2021, there is a major increase in rate per kg from 1.80 USD to 3.27 USD in 2020. The volume of air cargo is expected to increase in 2021, thanks to increased business confidence, lifting of travel restrictions and the possible active role of air cargo in the distribution of vaccines.

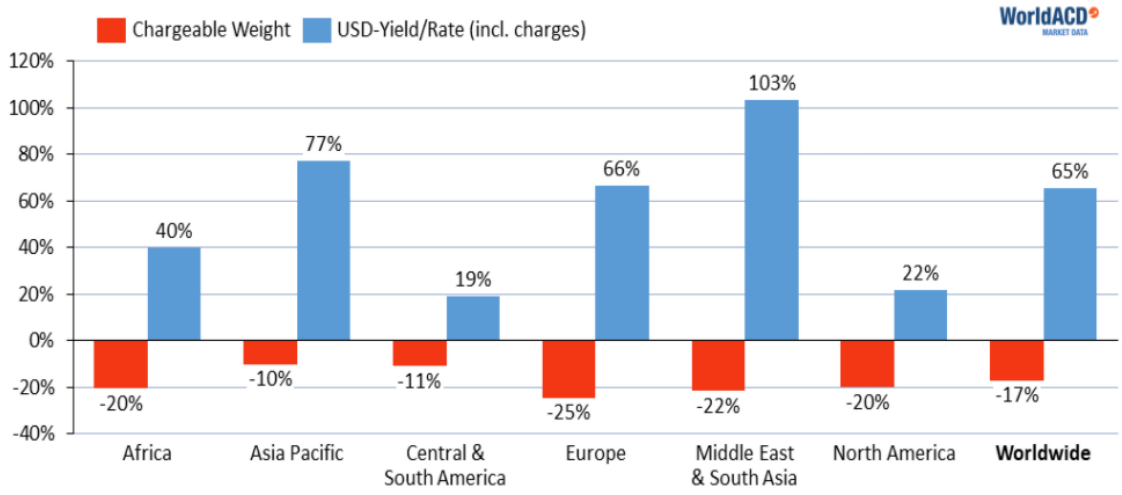

Figure 1.2 : YoY Change in volume and unit rate from August 2019 to August 2020 (WorldACD, August / mid-September 2020: air cargo before the 'second wave'…, Sep 2020)

Although international passenger flights have been halted in many countries due to the Coronavirus outbreak, the transport of commercial goods continues to secure the continuity of the supply chain. Even if there are problems in the world economy due to force majeure, countries have to carry out logistics activities to transfer products such as food, medicine, and social aid etc. Therefore, the limited capacity of airline companies becomes even more valuable in this type of pandemic. Airline companies have to cooperate with the right freight forwarders to use this limited capacity more profitably than ever.

Having a highly strategic place in world trade, air cargo transportation consists of various processes. The main actors of air cargo operations are shippers, freight forwarders, road transporters (trucking services), carriers (airlines) and consignees. The process of transporting goods from A point to B on a global scale is in a complex structure with the participation of more than one party. The structure of the supply chain in air cargo transportation is as shown in Figure 1.3.

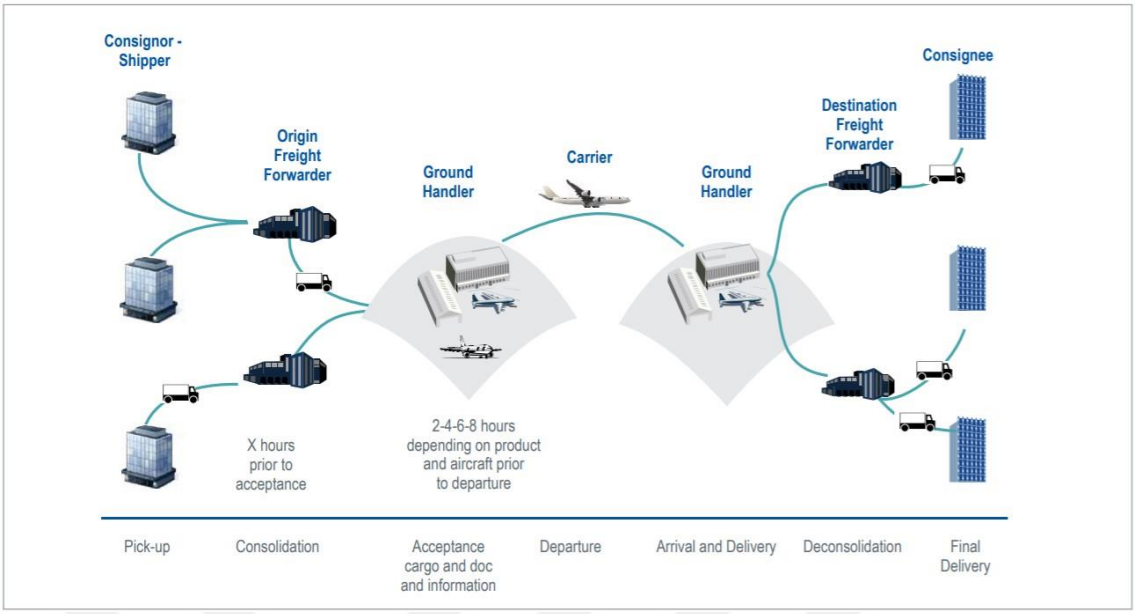

Figure 1.3: Air Cargo Movement Overview (ICAO, Moving Air Cargo Globally, 2016, 4)

Airline carriers can work with both 3PLs and freight forwarders. Freight forwarders, who make a great contribution to the transportation sector by transporting $5.4 trillion worth of goods every year, have a very important position in the sector (IATA, Freight Forwarders). Freight forwarders, which offer a wide range of services, take care of everything on behalf of customers. They reduce cost for their customers by consolidating small shipments. They undertake many issues such as arranging the accurate documents, determining the route and payments, choosing the mode of transport and meeting international shipping requirements. Freight forwarders are not working as 3PL companies. There are some differences between them. 3PL companies can carry out all physical logistics activities. While Freight forwarders have a limited storage area, 3PL companies also perform logistics activities such as packaging, storing, and delivering the shipment to the carrier on behalf of the customer. (Skender et al, 2016).

There are integrator companies such as Federal Express, DHL, TNT take on the role of both freight forwarders and carriers. These integrator companies can also carry out their transport by establishing a freight forwarder-carrier relationship with other carriers.

For a carrier airline, it is preferred for the company's efficiency that its customers bring cargo continuously, find high-priced products in the market, bring cargo on time and as declared, support that airline in tenders and cooperate against any disruption that may arise from billing differences. It should not be understood that freight forwarders, which have a large share of CW or revenue in the market, will always be the main partner for airline companies (Feng and Lai, 2014a). Such freight forwarders and integrators have a strong bargaining ability and they also want to be exempted from some airline ancillary income.

The evaluation of freight forwarders is important for increasing utilization in air cargo transportation, which is critical for world trade. In this thesis, an evaluation study will be presented through the eyes of a leading air cargo carrier company in Turkey, which will serve as an example for the companies to determine their strategic partners by using verbal and numerical criteria.

In this study, the literature review will be examined in the next section, we will explain and interpret the criteria of the studies in the literature.

2. LITERATURE REVIEW

Freight forwarders are not considered as 3PL (Third-party Logistics) in the air cargo industry. Therefore, this thesis should not be seen as a 3PL evaluation study, but as a freight forwarder evaluation. However, 3PL evaluations in air cargo were also examined in order not to leave a missing field while scanning the literature. In this section, which areas in the available literature are examined and reference articles are included.

Topics such as evaluation, ranking and measuring the success of 3PL companies are a extensively used and successful research area in the literature. The main purpose of all these studies on 3PL companies is to rise the efficiency and effectiveness of the institutions receiving services from these companies. Although there is a fairly large source in the literature for the evaluation of 3PL companies, studies on freight forwarders within the air cargo industry are very limited.

The research was started by going from general to specific. For this purpose, a listing was made in Web of Science between 1975 and January 2021 using the keywords "3PL evaluation" and "3PL selection". 3PLs serving in the air transport industry have been examined. Among the 193 articles, it was revealed that only Liu et al.'s (Liu et al., 2020) study was related to "air transport" and "airline industry" in the accessible literature.

The second phase of literature research consists of the articles with keywords "freight forwarder evaluation" and "freight forwarder selection" for all kinds of sectors, regardless of air, maritime, highway or railway transport. Out of 64 articles reached through this investigation, only 13 study meet the desired criteria. Of the 257 articles examined in total, 12 relevant and accessible articles are given in Table 2.1

Table 2.1: Literature Review

Authors	**Publication Year**	**Method/s**
Murphy, PR; Daley, JM	1997	Mail Survey
Liang, G.-S., Chou, T.-Y., Kan, S.-F.	2006	Fuzzy Quality Function Deployment (F-QFD)
Yang, YH; Hui, YV; Leung, LC; Chen, G	2010	ANP
Feng, B; Lai, FJ	2014	Aspiration-based Utility Function, Multi-Attribute Decision Making (MADM)
Maheshika, MDI; Abeysekara, B	2015	AHP
Zhang, XL; Xu, ZS; Wang, H	2015	Heterogeneous MCGDM
Kilibarda, M., Nikolicic, S., Andrejic, M.	2016	Reliability, Responsiveness, Assurance, Empathy, Tangibility (SERVQUAL)
Klumpp, M	2018	DEA Malmquist index
Kose, S; Ozkok, M; Demirel, FB; Kose, E	2018	Buckley's FAHP methodology
Sramkova, E; Kolar, P; Hunak, J	2018	Tangibles, Assurance, Reliability, Responsiveness (TARRQUAL)
Subhashini, S., Preetha, S.	2018	Reliability, Responsiveness, Assurance, Empathy, Tangibility (SERVQUAL)SERVQUAL
Liu, YM; Zhou, P; Li, LY; Zhu, F	2020	Hybrid Multi Criteria Decision Making (HMCDM)

In the literature, there are also studies investigating the criteria for the most suitable 3PL selection based on various data analyzes. Murphy and Daley (1997) determined the essential and key factors in the selection of an international freight forwarder by using statistical techniques in their studies. Contrary to popular belief, in this study, which used a 1-5 Likert scale, they determined that the criterion to be satisfied first is not price but expertise. Another finding obtained as a result of the study is that large firms give more importance to experience and reliability than small firms.

Liang et al. conducted a study on an ocean freight forwarder with Fuzzy QFD, which is a method that helps the customer understand how to meet the actual needs with the resources and capabilities of the enterprise (Liang et al., 2006). The criteria determined

in this study have emerged by taking the opinion of well-known Taiwan senders, as well as being frequently mentioned in the academic literature.

The study of Yang et al. (2010), which can be attributed as a pioneering study for freight forwarder evaluation in air transportation, is a comprehensive study based on the ANP method. Alternatives are grouped into integrators, integrators that partner with other airlines and widely known freight forwarders. In the study, which also takes into account the degree of dependency between the features handled using the ANP method, each alternative was determined by Saaty's (Saaty, 1996) supermatrix approach. The biggest deficiency of the study is that sensitivity analysis was not performed.

Feng and Lai (2014)'s study is based on an assessment made by the Air Cargo Transportation department of China Southern Airline's, one of the world's largest airlines. We have to say that the criteria they base this study on are quite guiding in determining the criteria of this thesis. Multi-attribute group decision making method was preferred in the study, which also considers the aspirations of the decision makers. This study contributes to the literature as it makes an optimization study to reduce the inconsistency between group and individual approaches, considers the concept of aspiration, and also determines the safety factor that facilitates the process of controlling the group decision of the administrators, and finally allows the use of numerical and linguistic terms.

Aguezzoul (2014) collected and analyzed 67 studies published between 1994 and 2013 related to 3PL selection and evaluation. In this comprehensive study, the most used criteria and methods were analyzed using the Pareto method. While the most used criteria are respectively; cost, relationship, services, quality, information/equipment system, flexibility, and delivery, the most used methods are respectively; MCDM, statistical approaches, mathematical programming and artificial intelligence.

In addition to evaluating freight forwarders in terms of carrier, there are studies where they are also evaluated in terms of exporters (Maheshika & Abeysekara, 2015). In the study of Maheshika and Abeseykara, where exporters from 22 different sectors such as apparel, fish and fisheries products, printing and stationery, petroleum products, wooden products etc., evaluated Sri Lanka freight forwarders, customer service was determined as the most important criterion. Then reliability, operational efficiency, IT orientation &

communication, rate and company backround & reputation comes, respectively. In addition, it has been revealed in the study that medium and large-scale exporting companies in Sri Lanka give more importance to reliability factors, while small-scale exporters take into account the pricing factors.

Zhang et al., (2015) sought a solution to the freight forwarder selection problem using a Heterogeneous MCGDM methods with using the criteria discussed by Feng & Lai. When they compare their work with the study of Li et al (2010), they state that they primarily work with more complicated data, such as intuitionistic fuzzy numbers, hesitant fuzzy element, hesitant fuzzy linguistic term sets etc. Secondly, the maximization deviation model is preferred to determine the criterion weights more clearly, and they have obtained more convincing results by ensuring the consistency between experts and group opinions. Then, the TOPSIS method was used in order to rank the alternatives from the closest to the positive ideal solution to the furthest.

One of the studies aimed at determining freight forwarder service quality using factor analysis and ANOVA is the study of Kilibarda et al. (2016). Production, trade and distribution companies were considered in the study. These companies were also classified according to the number of workers and the years they used the freight forwarder service. Within the scope of the SERVQUAL questionnaire, these companies were asked to choose the closest range to them using the Likert's scale of 1-7 for 22 different variables. These variables can be divided into 5 groups in total; reliability, responsiveness, assurance, empathy and tangibility. In this study, it was concluded that freight forwarders in Serbia are not satisfactory enough by evaluating the survey results from 120 import and export logistics professionals.

Klumpp (2018) used the DEA Malmquist index to evaluate 7 major European forwarders. His paper aims to determine factors for enhancement supply chain sustainability with comprehensive triple bottom line approach. In light of this method, mid-sized logistics service providers such as Panalpina, Kühne + Nagel are the sustainability leaders besides large-scale logistics service providers such as DHL, La Poste.

Kose et al., (2018) preferred Buckley’s Fuzzy Analytic Hierarchy Process (F-AHP) method for maritime freight forwarder evaluation. In this study, which can be attributed

to the pioneering study in the evaluation of shipping agencies, the most important criterion according to the evaluation made by the shippers is the service quality with a share of 37%. Financial condition and corporate reputation criteria are the second and third most important criteria, with a share of 19%.

In Sramkova et al., (2018)'s study, 250 responders from maritime managers in the Czech market and Kühne+Nagel Czech Republic customers evaluated 42 service factors. In the study, SERVQUAL method was not preferred for reasons such as not suitable likert scale of 7, focusing method on process rather than results, high degree of interrelationship between 5 SERVQUAL factors etc., and Tangibles, Assurance, Reliability, Responsiveness (TARRQUAL) approach was used instead. With the help of the Delphi method, the results revealed that pricing is the most crucial part in the selection of 3PL. Then, the most important factors are on-time delivery, price flexibility, information quality and arrival and delay notice, respectively.

Subhashini and Preetha (2018), used the SERVQUAL method with the five point Likert scale to determine the relationship between service quality factors of ocean freight forwarders and customer satisfaction. In the study, it was revealed that there is a strong relation between the ocean freight forwarding service in Chennai and the concepts of tangibility, responsibility, reliability and value to investigate customer fulfillment.

Liu et al, (2020) used hesitant fuzzy sets, intuitionistic fuzzy sets and real numbers with an unconventional approach to evaluate and rank 5 Chinese air cargo market's 3PL players. The interactive hybrid multi-criteria decision-making (HMCDM) method was preferred in the study, in which the preferences of the decision makers were also taken into consideration.

2.1. Criteria Used in Freight Forwarder Evaluation

In order to conduct comprehensive research, the literature has been examined not only for air freight forwarder evaluation, but also for freight forwarders operating on land, sea, and rail, and 3PL evaluations operating in the air transport and airline industry. Experts evaluated the studies in the literature and examined the criteria used, and determined new criteria with their own expertise. In addition to the criteria used in the literature, we suggest that the use of e-AWB and the annual growth rate criteria should be included in the forwarder evaluation problem. These criteria have an important place in increasing sustainability, process improvement and benefit. The criteria in the literature are given in Table 2.2.

Table 2.2: Evaluation Criteria

CRITERIA	REFERENCES
TOTAL REVENUE	Yang et al, 2010
TECNOLOGY LEVEL	Liu et al, 2020; Kose et al, 2018; Subhashini and Preetha, 2018; Kilibarda et al 2016; Maheshika and Abeysekara, 2015; Zhang et al, 2015; Liang et al., 2006;
ON-TIME DELIVERY	Sramkova et al, 2018; Subhashini and Preetha, 2018; Maheshika and Abeysekara, 2015; Zhang et al, 2015; Feng and Lai, 2014; Yang et al, 2010; Liang et al., 2006
PAYMENT REPUTATION	Kose et al, 2018; Subhashini and Preetha, 2018; Maheshika and Abeysekara, 2015; Zhang et al, 2015; Feng and Lai, 2014; Murphy and Daley, 1997
GLOBAL COVERAGE	Murphy and Daley, 1997
RESPONSIVENESS	Sramkova et al, 2018; Subhashini and Preetha, 2018; Kilibarda et al 2016; Maheshika and Abeysekara, 2015; Liang et al., 2006; Murphy and Daley, 1997
SUPPLY STABILITY	Zhang et al, 2015; Feng and Lai, 2014
SUPPLY QUANTITY	Zhang et al, 2015; Feng and Lai, 2014
ERROR FREE DOCUMENTATION	Sramkova et al, 2018; Kose et al, 2018; Maheshika and Abeysekara, 2015; Murphy and Daley, 1997;
OPERATIONAL QUALITY	Yang et al, 2010; Liang et al., 2006; Maheshika and Abeysekara, 2015; Kose et al, 2018; Sramkova et al, 2018

The criteria that we will consider in the study are explained in detail as follows;

Total Revenue: Total annual income of each freight forwarder.

Technology Level: Technical ability of monitor logistic activities and tracing&tracking cargoes. The degree of benefiting from the online service channels offered by the carrier is one of the factors that positively affect the technology level criterion.

On Time Delivery: It is the delivery of cargo to the carrier's warehouse within a certain period of time before the flight.

Payment Reputation; The reputation of freight forwarder for clearing up to the day of payment, the number of invoices that have been collected incomplete in the past, compliance with the contract dates and deadlines for contracts etc.

Global Coverage: Freight forwarder's worldwide trade provides an advantage for the carrier. A freight forwarder serving in 7 continents is expected to have a high product range and volume. Freight forwarders can also be found transporting large tonnages to certain destinations, but serving on more than one continent, that is, globally, is a preferred feature for carriers.

Responsiveness: Freight forwarders' strong communication, ability to respond quickly, accepting demands for direction or re-consignment of shipments are crucial features for carriers

Supply Stability; Airlines need freight forwarders to supply cargo in a stable and orderly manner. This helps airline companies to apply their long-term revenue management in a healthier way.

Supply Quantity: The low amount of supply may cause the capacity to be idle, while a large amount of supply may cause disruptions and delays due to capacity constraints.

E-AWB Usage: Each year, the need for an enormous volume of print output arises as invoices and other related documents need to be issued for hundreds of thousands of AWBs. Sending AWBs electronically is of great importance to reduce paper consumption.

Error Free Documentation: The gap between the declared cargo information and what actually exists may cause problems for the carrier. Incorrect kg-volume information will cause problems in terms of planning and also cause problems in pricing. Information that is also missing in the content of the product can cause problems in terms of work safety. Class numbers and types of hazardous substances must be specified both on the invoice and on the cargo. Shipments to the wrong destination are also very undesirable for the carrier and customer.

Operational Quality: High operational skills are important in terms of both timely departure in terms of safety, reducing the operational workload in the field and gaining man-hours. Incorrect palletization and livestock cages that do not comply with IATA requirements can cause disruptions in hub operation and the shipment not reaching the planned flight. The carrier company may completely cut off all commercial relations with freight forwarders with poor operational quality.

Annual Growth Rate: Businesses that tend to grow on the basis of income or chargeable weight are more suitable for incentives from the point of carriers. This indicates that the business may have the potential to generate more revenue in the coming years.

3. PROPOSED METHODOLOGY

Freight forwarder evaluation will be made by weighting the criteria evaluated from the perspective of the airline company with using the Decision Making Trial and Evaluation Laboratory (DEMATEL) method. Since the criteria were both verbal and numerical, fuzzy logic principles were used in the decision-making process. Ranking of the alternatives with weighted criteria will be carried out by the Fuzzy TOPSIS method. Overall method steps can be seen in Figure 3.1;

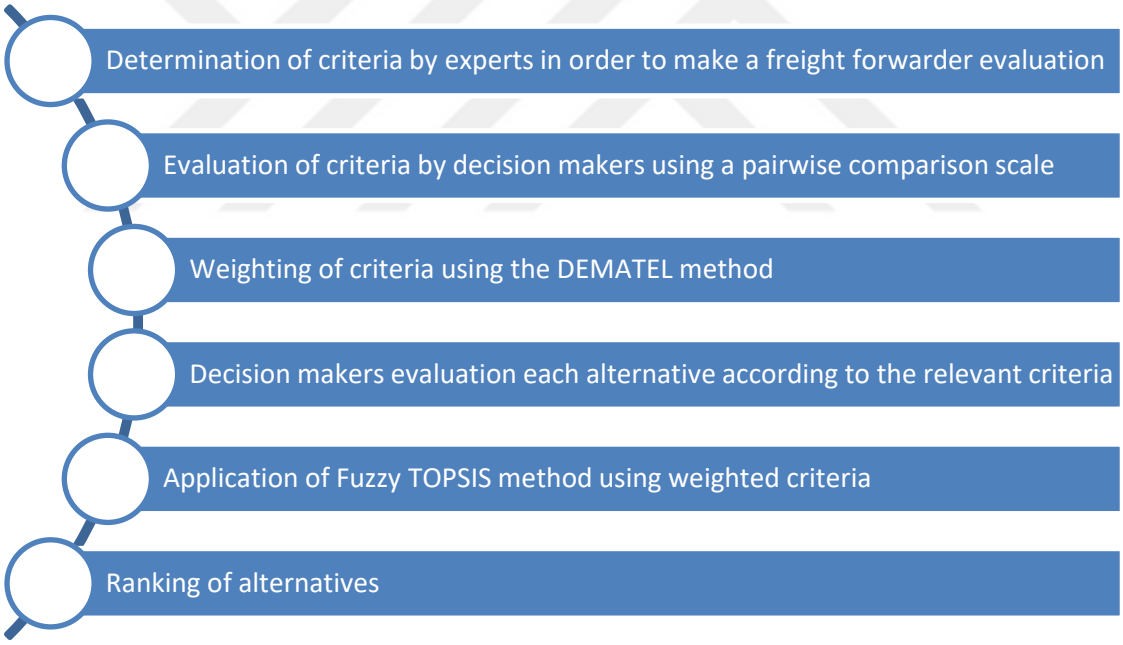

Figure 3.1: Evaluation steps of freight forwarder selection problem

In the literature, there are also studies on some different subjects in which DEMATEL and Fuzzy TOPSIS methods are used together. Karaatli et al. (2016) evaluated the performance of 23 sugar factories in Turkey in their study. The data used in the Fuzzy TOPSIS step covers the 2008-2012 date range. At the same time, Nilashi et al. (2019)

used the aforementioned integrated MCDM method to examine the factors affecting medical tourism. In the study, the decision to build medical hotels in Malaysia was evaluated by considering 4 main factors: organizational, environmental, technological and human readiness. These main factors were weighted with the DEMATEL method and it was concluded that technological and human factor are more essential than others. In the fuzzy TOPSIS step, the importance of the criteria of each main factor was calculated.

3.1. DEMATEL Method

The DEMATEL method was developed under the human affairs and Science Program at the Battelle Memorial Institute in Geneva between 1972 and 1976. DEMATEL method has been developed with the idea that it can be used in a hierarchical structure for the primary and effective use of scientific research methods in complex structure problems (Tzeng et al., 2010).

The steps of the method are listed as follows;

i. The method begins with the calculation of the initial matrix, known as the A matrix. Experts evaluate for n factors determined for freight forwarder evaluation in the study. All decision makers consider whether factor i has an effect on factor j and score this effect with the help of a scale. Influence level is scored on a scale from 0 to 4. The meaning of the point values of the mentioned scale is given in the Table 3.1.

Table 3.1: Pairwise Comparison Scale DEMATEL Method (Tzeng et al., 2010)

0	No Influence
1	Very Low Influence
2	Low Influence
3	High Influence
4	Very High Influence

ii. Matrix D is expressed as a normalized initial matrix and obtained by the following formula;

$$D = s \cdot A \tag{3.1}$$

where s is computed with the following formula (Yang et al., 2011);

$$s = \min\left[\frac{1}{\max_{1\le i\le n}\sum_{j=1}^{n}\left|a_{ij}\right|}, \frac{1}{\max_{1\le i\le n}\sum_{i=1}^{n}\left|a_{ij}\right|}\right] \tag{3.2}$$

iii. The calculation of the Total Relation Matrix, denoted by T, is as follows. Identity matrix represented by I .

$$T = D(I - D)^{-1} \tag{3.3}$$

iv. The vectors r and c represent 1xn and nx1 matrices, respectively, and are the sum of the rows and columns of the Total Relation Matrix T. The (r_i + c_j) and (r_i - c_j) values demonstrate the degree of impact of each criterion on the others and the degree of relationship with the others. By creating a threshold set by decision makers, a network relationship map can be determined that allows you to examine the structural relationships between factors (Tzeng et al., 2010).

If the (r_i - c_j) value is positive, the i factor has an effect on other factors, which can be interpreted as i factor is a net causer, but if (r_i - c_j) is negative, it can be interpreted that other factors have an effect on the i factor and therefore it is a net receiver.

v. In the last step, the following equations are used to find the criterion weights;

$$w_i = [\ (r_i + c_j)^2 + (r_i - c_j)^2\ ]^{1/2} \quad (3.4)$$

$$W_i = \frac{wi}{\sum_{i=1}^{n} wi} \quad (3.5)$$

3.2. Main Principles of Fuzzy Logic

Class or set terms may not express exact values in all cases. Fuzzy sets can be used in the absence of clearly defined class membership. At first, Zadeh (1965) introduced a new approach to the problem with the fuzzy sets theorem in cases where the decision makers could not express their preferences sharply and precisely or the evaluations were made in linguistic terms. According to this theorem, elements in a fuzzy set have continuous membership degrees belonging to a class and these degrees are between 0 and 1.

In definite sets there is no uncertainty about the membership status of objects, but in fuzzy sets there are tiers of the objects' membership states. To elaborate, x represents individual elements and A represents a particular set of these elements. As shown in (3.6), element x in crisp sets is either a member of crisp set A or not (Ross T. J., 2010).

$$\chi\, A(x) = \begin{cases} 1, & x \in A, \\ 0, & x \notin A \end{cases} \quad (3.6)$$

As a result of the equation shown above, it can be clearly stated whether the element x is a member of the set A. For example, let's imagine a cluster where the height of people is between $160 \leq x \leq 180$ cm. The membership of an individual with a height of 1.70 cm in this cluster is equal to 1. Considering the crisp numbers, an individual with a height 1.59 cm will not be included in set A, which means the membership of this individual in set A is 0, no membership valid. Membership in a set in discrete numbers either exists or does not exist, as shown in Figure 3.2.

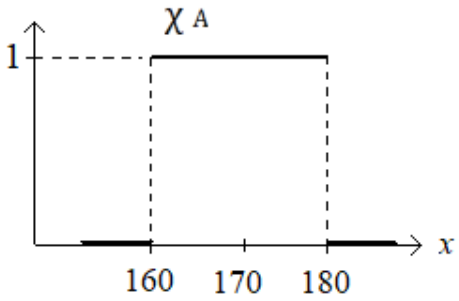

Figure 3.2: An example of a height member function for crisp set A (Ross, 2010)

In the fuzzy set theory put forth by Zadeh (1965), unlike the crisp numbers, the element x has a continuous degree of membership value between 0 and 1 in the set A. If we continue with the example of human height, the cluster of people with a height of around 170 cm can be formed with fuzzy numbers since it does not represent a definite value. The membership function of a fuzzy set can be as seen in Figure 3.3.

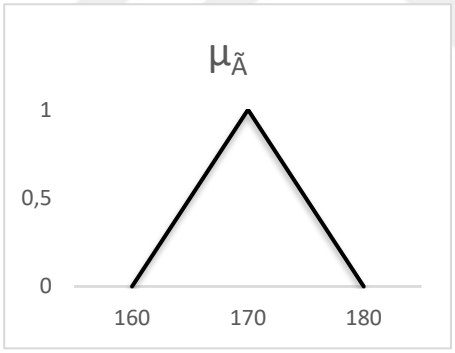

Figure 3.3: An example of a height member function for fuzzy set Ã (Ross, 2010)

The representation of the membership function is in the range of 0 to 1 as in equation (3.7), and respectively means no membership and full membership. The symbol $\mu_{\tilde{A}}(x)$ represents the membership degree of the element x in the fuzzy set Ã.

$$\mu_{\tilde{A}}(x) \in [0, 1] \tag{3.7}$$

Fuzzy sets are expressed with membership functions. The terms expressing the fuzzy set are valid for both discontinuous and continuous sets. The terms for fuzzy set are as seen in Figure 3.4.

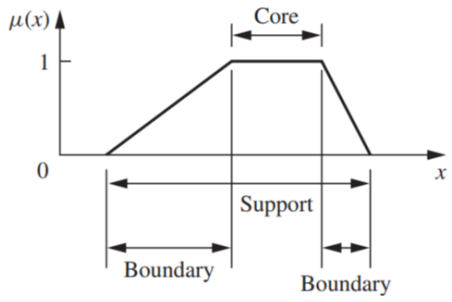

Figure 3.4: Boundaries, core and support of a fuzzy set

- The ***core*** of a membership function for a fuzzy set Ã is represented as complete and full membership of that region of the universe in the fuzzy set Ã. The core encompasses elements x of the universe such that $\mu_{\tilde{A}}(x) = 1$.
- The ***support*** of a membership function for a fuzzy set Ã is represented as non-null membership of that region of the universe in the fuzzy set Ã. The support includes elements x of the universe such that $\mu_{\tilde{A}}(x) > 0$.
- The ***boundaries*** of a membership function for a fuzzy set Ã is represented as non-null membership but not full membership of that region of the universe in the fuzzy set Ã. The boundaries includes elements x of the universe such that $0 < \mu_{\tilde{A}}(x) < 1$.

3.2.1 Fuzzy Set Operations

Before calculating on fuzzy sets, it is necessary to summarize how simple algebraic operations are performed. Let fuzzy set Ã and $\tilde{B}$ be fuzzy sets on the universe X. The union of these fuzzy sets is a fuzzy set $\tilde{C}$, written as $\tilde{C} = \tilde{A} \cup \tilde{B}$, whose membership function is associated to those of Ã and $\tilde{B}$ by, (Zadeh,1965),

$$\mu_{\tilde{c}}(x) = \text{Max}\,[\mu_{\tilde{A}}(x), \mu_{\tilde{B}}(x)], \qquad x \in X \qquad (3.8)$$

The intersection of these fuzzy sets is a fuzzy set $\tilde{C}$, written as $\tilde{C} = \tilde{A} \cap \tilde{B}$, whose membership function is associated to those of $\tilde{A}$ and $\tilde{B}$ by,

$$\mu_{\tilde{c}}(x) = \text{Min}\,[\mu_{\tilde{A}}(x), \mu_{\tilde{B}}(x)], \qquad x \in X \tag{3.9}$$

The complement of a fuzzy set $\tilde{A}$ is symbolized by A' and defined as below,

$$\mu_{\bar{\tilde{A}}}(x) = 1 - \mu_{\tilde{A}}(x), \qquad x \in X \tag{3.10}$$

3.3. Fuzzy TOPSIS Method

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method, which is one of the multi-criteria decision making methods, was developed by Hwang and Yoon (1981) in order to rank the alternatives with the shortest distance from the positive ideal solution. Assigning values to criteria under uncertainty or insufficient information by decision makers, as well as the frequent use of linguistic terms in the evaluations have led to the need to use MCDM methods together with fuzzy logic principles. Therefore, Fuzzy TOPSIS will be used in this study by expanding it with Zadeh (1965)'s fuzzy set theory.

The necessary steps for the fuzzy TOPSIS method are listed (Chen, 1997);

i. The criteria of the problem are determined by a committee.
ii. Appropriate linguistic variables are selected to determine the weight of importance. Select linguistic ratings for alternatives based on criteria.
iii. Aggregate the weight of criteria to obtain the aggregated fuzzy weight $\tilde{w}_j$ of criterion C_j. Then compound the decision makers' assessments to attain the aggregated fuzzy rating $\tilde{x}_{ij}$ of alternative A_i under criterion C_j.

The ranking of alternatives according to each criterion is calculated as in below, while K denotes the number of decision makers and $\tilde{x}_{ij}$ indicates the rating of K*th* decision maker for the i*th* alternative and $\tilde{w}_j$ indicates the rating of the jth criteria given by the K*th* decision maker.

$$\tilde{x}_{ij} = \frac{1}{K} [\tilde{x}_{ij}{}^{1}(+)\tilde{x}_{ij}{}^{2}(+) \dots (+)\tilde{x}_{ij}{}^{K}] \quad (3.11)$$

$$\tilde{w}_{j} = \frac{1}{K} [\tilde{w}_{j}{}^{1}(+)\tilde{w}_{j}{}^{2}(+) \dots (+)\tilde{w}_{j}{}^{K}] \quad (3.12)$$

iv. The fuzzy decision matrix $(\tilde{D})$ and the criteria weights $(\tilde{W})$ are shown in the equations below, where $\tilde{x}_{ij}$ ∀i,j and $\tilde{w}_{j}$, j = 1; 2…,n are linguistic variables.

$$\tilde{D} = \begin{bmatrix} \tilde{x}_{11} & \cdots & \tilde{x}_{1n} \\ \vdots & \ddots & \vdots \\ \tilde{x}_{m1} & \cdots & \tilde{x}_{mn} \end{bmatrix}, \quad (3.13)$$

$$\tilde{W} = [\tilde{w}_{1}, \tilde{w}_{2} \ \dots \ \tilde{w}_{n}] \quad (3.14)$$

xij and wij can be expressed as fuzzy triangular numbers. These are;

$\tilde{x}_{ij} = (a_{ij}, b_{ij}, c_{ij})$ and $\tilde{w}_{j} = (w_{j1}, w_{j2}, w_{j3})$

The normalized fuzzy decision matrix $(\tilde{R})$ is shown as equation (3.15),

$$\tilde{R} = [\tilde{r}_{ij}]_{mxn} \quad (3.15)$$

In order to determine the $\tilde{r}_{ij}$ value in this equation, it is necessary to calculate according to the benefit (B) and cost (C) criteria. It is calculated as follows, respectively.

$$\tilde{r}_{ij} = \left(\frac{a_{ij}}{c_{j^*}}, \frac{b_{ij}}{c_{j^*}}, \frac{c_{ij}}{c_{j^*}}\right), \qquad j \in \text{B}, \tag{3.16}$$

$$\tilde{r}_{ij} = \left(\frac{a_{j^-}}{c_{ij}}, \frac{a_{j^-}}{b_{ij}}, \frac{a_{j^-}}{a_{ij}}\right), \qquad j \in \text{C}; \tag{3.17}$$

$c_j{}^*$ indicates the $max_i\ c_{ij}$, if $j \in$ B and $a_j{}^-$ indicates the $min_i\ a_{ij}$, if $j \in$ C.

As a result of the above method carried out for normalization, the normalized values continue to be in the range of [0,1].

v. In order to obtain the weighted normalized fuzzy decision matrix $(\tilde{V})$, it is necessary to apply the following equations;

$\tilde{V} = [\tilde{v}_{ij}]_{mxn}$, i = 1,2,3,…,m,j =1,2,3,…, n, where;

$$\tilde{v}_{ij} = \tilde{r}_{ij} \otimes \tilde{w}_j \tag{3.18}$$

vi. To determine fuzzy positive-ideal solution (FPIS) and fuzzy negative-ideal solution (FPIS), it is necessary to execute the following equations. These are denoted as A* and A-, respectively;

$$\text{A}^* = (\tilde{v}_1{}^*, \tilde{v}_2{}^*, \dots, \tilde{v}_n{}^*) \tag{3.19}$$

$$\text{A}^- = (\tilde{v}_1{}^-, \tilde{v}_1{}^-, \dots, \tilde{v}_1{}^-) \tag{3.20}$$

Where, $\tilde{v}_j{}^*$= (1,1,1) and $\tilde{v}_j{}^-$ = (0,0,0)

The distance of each alternative to FPIS and FNIS is calculated as follows;

$d_i^* = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^*)$, $i = 1,2,3,\ldots,m,$ (3.21)

$d_i^- = \sum_{j=1}^{n} d(\tilde{v}_{ij}, \tilde{v}_j^-)$, $i = 1,2,3,\ldots,m,$ (3.22)

and

$$d(\tilde{A},\tilde{B}) = \sqrt{\frac{1}{3}[(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2]} \quad (3.23)$$

where d indicates the distance between fuzzy numbers, $\tilde{A} = (a_1, a_2, a_3)$ and $\tilde{B} = (b_1, b_2, b_3)$. The d value is used to calculate the closeness coefficient.

vii. The closeness Coefficient (CC_i) value is required for sorting the alternatives which is calculated with the below equation;

$$CC_i = \frac{d_i^-}{(d_i^* + d_i^-)} \quad i = 1,2,3,\ldots,m \quad (3.24)$$

viii. As the CCI value approaches to 1, the alternative closest to the FPIS value and farthest from the FNIS value is prioritized.

4. AIR FREIGHT FORWARDER EVALUATION PROBLEM

The study aimed to address the real life problem of one of the leading cargo airline companies in Turkey and the world. The aforementioned study offers an improved evaluation proposal to the company's existing incentive system. Based on the logic that the freight forwarder who gets the highest score in the evaluation receives the highest incentive, freight forwarders must be successful in terms of all the criteria explained in the previous section.

In the problem, weighted by 3 decision-makers (DM1, DM2, DM3) and an evaluation was made between 5 alternatives (A1, A2, A3, A4, A5) based on DEMATEL and Fuzzy TOPSIS methods. While the weighting section consists of real data based on the opinions and experiences of the decision makers, hypothetical data is used in the ranking section.

For simplicity, the representation of the criteria will be made through the abbreviations in Table 4.1.

Table 4.1: Criteria Abbreviations

CRITERIA	Label
Total Revenue	Cri1
Technology Level	Cri2
On-time Delivery	Cri3
Payment Reputation	Cri4
Global Coverage	Cri5
Responsiveness	Cri6
Supply Stability	Cri7
Supply Quantity	Cri8
E-AWB Usage	Cri9
Error-free documentation	Cri10
Operational Quality	Cri11
Annual Growth Rate	Cri12

4.1. Determining criteria weights with DEMATEL

The weighting of the criteria is made using the pairwise comparison scale of 3 decision makers. If we run the problem by following the steps described in Section 3.1.;

Step 1: The evaluation of each decision maker is as in the tables below.

Table 4.2: Evaluation of decision maker 1

C	Cri1	Cri2	Cri3	Cri4	Cri5	Cri6	Cri7	Cri8	Cri9	Cri10	Cri11	Cri12
Cri1	0	3	4	1	3	1	1	4	0	1	4	4
Cri2	2	0	3	0	2	3	2	2	3	3	3	3
Cri3	4	0	0	0	0	1	4	3	0	1	3	3
Cri4	4	1	1	0	2	0	1	1	0	0	0	2
Cri5	3	3	1	1	0	0	2	3	1	1	1	4
Cri6	2	0	2	1	0	0	0	0	0	2	2	0
Cri7	3	1	3	2	1	0	0	3	1	2	4	3
Cri8	3	2	2	3	3	3	3	0	2	2	3	4
Cri9	1	1	1	2	0	1	0	0	0	2	1	0
Cri10	2	0	3	2	1	0	1	2	0	0	4	1
Cri11	3	1	3	1	2	3	3	3	1	3	0	3
Cri12	4	3	2	4	4	2	3	3	2	2	3	0

Table 4.3: Evaluation of decision maker 2

C	Cri1	Cri2	Cri3	Cri4	Cri5	Cri6	Cri7	Cri8	Cri9	Cri10	Cri11	Cri12
Cri1	0	3	1	1	4	2	3	3	1	1	4	3
Cri2	3	0	3	1	3	3	1	3	4	3	4	2
Cri3	1	0	0	0	0	0	2	2	0	0	4	1
Cri4	1	0	0	0	0	0	1	1	0	0	0	1
Cri5	4	3	1	2	0	1	3	4	2	2	2	4
Cri6	1	0	2	0	0	0	2	2	0	3	1	0
Cri7	4	1	3	2	3	3	0	3	1	3	4	3
Cri8	4	3	2	2	3	3	3	0	2	2	3	3
Cri9	1	0	0	0	0	0	0	0	0	1	2	0
Cri10	2	2	3	1	0	0	1	0	1	0	4	1
Cri11	3	1	3	0	2	3	3	3	1	3	0	2
Cri12	3	3	1	1	4	1	4	4	1	2	2	0

Table 4.4: Evaluation of decision maker 3

C	Cri1	Cri2	Cri3	Cri4	Cri5	Cri6	Cri7	Cri8	Cri9	Cri10	Cri11	Cri12
Cri1	0	3	1	4	3	3	2	4	3	1	4	3
Cri2	3	0	4	3	2	3	2	3	4	3	3	2
Cri3	1	1	0	0	1	1	3	1	0	2	4	1
Cri4	1	1	1	0	2	0	1	1	0	0	1	1
Cri5	4	4	2	3	0	2	3	4	4	2	2	3
Cri6	2	2	4	0	0	0	1	2	1	3	4	1
Cri7	2	3	4	1	1	3	0	2	1	3	4	2
Cri8	3	3	3	3	3	3	2	0	3	2	3	3
Cri9	0	3	0	0	0	1	0	0	0	2	0	0
Cri10	2	1	3	0	1	1	2	2	1	0	3	1
Cri11	3	2	3	2	1	2	2	3	1	3	0	2
Cri12	4	3	2	3	3	2	3	4	2	2	3	0

The arithmetic mean of the scores given by the decision makers by comparing each criterion with the other criteria is calculated. Table 8 shows the arithmetic averages.

Table 4.5: Evaluation of criteria by three decision makers

A	Cri1	Cri2	Cri3	Cri4	Cri5	Cri6	Cri7	Cri8	Cri9	Cri10	Cri11	Cri12
Cri1	0,00	3,00	2,00	2,00	3,33	2,00	2,00	3,67	1,33	1,00	4,00	3,33
Cri2	2,67	0,00	3,33	1,33	2,33	3,00	1,67	2,67	3,67	3,00	3,33	2,33
Cri3	2,00	0,33	0,00	0,00	0,33	0,67	3,00	2,00	0,00	1,00	3,67	1,67
Cri4	2,00	0,67	0,67	0,00	1,33	0,00	1,00	1,00	0,00	0,00	0,33	1,33
Cri5	3,67	3,33	1,33	2,00	0,00	1,00	2,67	3,67	2,33	1,67	1,67	3,67
Cri6	1,67	0,67	2,67	0,33	0,00	0,00	1,00	1,33	0,33	2,67	2,33	0,33
Cri7	3,00	1,67	3,33	1,67	1,67	2,00	0,00	2,67	1,00	2,67	4,00	2,67
Cri8	3,33	2,67	2,33	2,67	3,00	3,00	2,67	0,00	2,33	2,00	3,00	3,33
Cri9	0,67	1,33	0,33	0,67	0,00	0,67	0,00	0,00	0,00	1,67	1,00	0,00
Cri10	2,00	1,00	3,00	1,00	0,67	0,33	1,33	1,33	0,67	0,00	3,67	1,00
Cri11	3,00	1,33	3,00	1,00	1,67	2,67	2,67	3,00	1,00	3,00	0,00	2,33
Cri12	3,67	3,00	1,67	2,67	3,67	1,67	3,33	3,67	1,67	2,00	2,67	0,00

Step 2: In order to create the D matrix, the s coefficient must be calculated first. The coefficient s is calculated with the help of equation (3.2);

s	0,032

Then, with the help of equation (3.1), normalized initial matrix D matrix is formed as in Table 4.6.

Table 4.6: Normalized Initial Matrix D

D	Cri1	Cri2	Cri3	Cri4	Cri5	Cri6	Cri7	Cri8	Cri9	Cri10	Cri11	Cri12
Cri1	0,00	0,10	0,07	0,07	0,11	0,07	0,07	0,12	0,04	0,03	0,13	0,11
Cri2	0,09	0,00	0,11	0,04	0,08	0,10	0,05	0,09	0,12	0,10	0,11	0,08
Cri3	0,07	0,01	0,00	0,00	0,01	0,02	0,10	0,07	0,00	0,03	0,12	0,05
Cri4	0,07	0,02	0,02	0,00	0,04	0,00	0,03	0,03	0,00	0,00	0,01	0,04
Cri5	0,12	0,11	0,04	0,07	0,00	0,03	0,09	0,12	0,08	0,05	0,05	0,12
Cri6	0,05	0,02	0,09	0,01	0,00	0,00	0,03	0,04	0,01	0,09	0,08	0,01
Cri7	0,10	0,05	0,11	0,05	0,05	0,07	0,00	0,09	0,03	0,09	0,13	0,09
Cri8	0,11	0,09	0,08	0,09	0,10	0,10	0,09	0,00	0,08	0,07	0,10	0,11
Cri9	0,02	0,04	0,01	0,02	0,00	0,02	0,00	0,00	0,00	0,05	0,03	0,00
Cri10	0,07	0,03	0,10	0,03	0,02	0,01	0,04	0,04	0,02	0,00	0,12	0,03
Cri11	0,10	0,04	0,10	0,03	0,05	0,09	0,09	0,10	0,03	0,10	0,00	0,08
Cri12	0,12	0,10	0,05	0,09	0,12	0,05	0,11	0,12	0,05	0,07	0,09	0,00

Step 3: With the help of equation (3.3), the Total Relation Matrix (T) is formed as in Table 4.7.

Table 4.7: Total Relation Matrix T

T	Cri1	Cri2	Cri3	Cri4	Cri5	Cri6	Cri7	Cri8	Cri9	Cri10	Cri11	Cri12
Cri1	0,28	0,29	0,30	0,22	0,30	0,25	0,29	0,37	0,19	0,24	0,41	0,33
Cri2	0,34	0,18	0,33	0,19	0,25	0,26	0,26	0,32	0,25	0,29	0,39	0,29
Cri3	0,23	0,13	0,14	0,09	0,13	0,13	0,23	0,22	0,08	0,16	0,29	0,19
Cri4	0,16	0,09	0,10	0,06	0,11	0,06	0,11	0,13	0,05	0,07	0,11	0,13
Cri5	0,38	0,30	0,27	0,22	0,19	0,21	0,30	0,36	0,22	0,25	0,34	0,34
Cri6	0,18	0,11	0,20	0,08	0,09	0,08	0,14	0,16	0,07	0,18	0,22	0,12
Cri7	0,35	0,23	0,32	0,20	0,23	0,23	0,21	0,32	0,16	0,27	0,40	0,29
Cri8	0,38	0,28	0,32	0,24	0,29	0,28	0,31	0,27	0,22	0,28	0,40	0,34
Cri9	0,08	0,08	0,06	0,05	0,04	0,06	0,04	0,05	0,03	0,10	0,09	0,05
Cri10	0,22	0,14	0,23	0,12	0,13	0,12	0,17	0,19	0,10	0,12	0,29	0,17
Cri11	0,33	0,21	0,30	0,17	0,22	0,24	0,28	0,31	0,15	0,27	0,26	0,27
Cri12	0,40	0,30	0,30	0,25	0,32	0,24	0,34	0,38	0,21	0,28	0,39	0,25

Step 4: Considering the T matrix, ($r_i + c_j$) and ($r_i - c_j$) values are calculated.

Table 4.8: ($r_i + c_j$) and ($r_i - c_j$) values

Criteria	r	c	($r_i + c_j$)	($r_i - c_j$)
Cri1	3,48	3,32	6,81	0,16
Cri2	3,36	2,34	5,70	1,02
Cri3	2,01	2,89	4,90	-0,88
Cri4	1,19	1,90	3,09	-0,71
Cri5	3,39	2,29	5,68	1,10
Cri6	1,61	2,16	3,78	-0,55
Cri7	3,21	2,67	5,89	0,54
Cri8	3,60	3,09	6,69	0,51
Cri9	0,73	1,75	2,48	-1,03
Cri10	2,00	2,51	4,50	-0,51
Cri11	3,01	3,60	6,61	-0,58
Cri12	3,67	2,75	6,42	0,92

Step 5: W_i and w_i values were calculated with the help of (3.4) and (3.5) equations and normalized. wi and Wi values and order of importance are as seen in the Table 4.9.

Table 4.9: W_i and w_i values

Label	CRITERIA	wi	Wi	Importance
Cri1	**Total Revenue**	6,81	10,8%	1
Cri2	**Technology Level**	5,79	9,1%	7
Cri3	**On-time Delivery**	4,98	7,9%	8
Cri4	**Payment Reputation**	3,17	5,0%	11
Cri5	**Global Coverage**	5,79	9,1%	6
Cri6	**Responsiveness**	3,82	6,0%	10
Cri7	**Supply Stability**	5,91	9,3%	5
Cri8	**Supply Quantity**	6,71	10,6%	2
Cri9	**E-AWB Usage**	2,68	4,2%	12
Cri10	**Error-free documentation**	4,53	7,2%	9
Cri11	**Operational Quality**	6,64	10,5%	3
Cri12	**Annual Growth Rate**	6,48	10,2%	4

4.2. Ranking the alternatives with Fuzzy TOPSIS

Step 1: The determination of the criteria, in which the 3 decision makers play a role, has been completed as explained in the previous section.

Step 2: The evaluation of alternatives according to the criteria with verbal rating is done as shown in Table 4.11. The linguistic variables in Table 4.10 were used while making the evaluation. In Table 4.12, there are triangular fuzzy numbers corresponding to linguistic variables.

Table 4.10: Linguistic variables for alternatives (Chen, 1997)

Linguistic scale for importance	Abbreviations	Triangular Fuzzy Numbers		
Very Poor	VP	0	0	1
Poor	P	0	1	3
Medium Poor	MP	1	3	5
Fair	F	3	5	7
Medium Good	MG	5	7	9
Good	G	7	9	10
Very Good	VG	9	10	10

Table 4.11: Linguistic ratings for alternatives

CRITERIA	DECISION MAKERS	ALTERNATIVES				
		A1	A2	A3	A4	A5
Cri1	DM1	VG	F	G	F	VG
	DM2	G	F	MG	MP	VG
	DM3	VG	F	MG	MP	VG
Cri2	DM1	VG	MP	G	MG	VG
	DM2	G	P	VG	F	VG
	DM3	G	P	MG	F	G
Cri3	DM1	MG	MG	MG	G	F
	DM2	MG	G	MG	MG	MG
	DM3	MG	G	G	G	MG
Cri4	DM1	VG	G	G	MG	VG
	DM2	G	MG	MG	G	VG
	DM3	VG	G	MG	G	VG
Cri5	DM1	VG	MG	G	MG	G
	DM2	G	G	MG	MG	G
	DM3	G	MG	MG	F	MG
Cri6	DM1	G	G	MG	P	F
	DM2	VG	G	G	MP	F
	DM3	VG	VG	G	MP	P
Cri7	DM1	G	MG	VG	VG	VG
	DM2	G	MG	VG	VG	G
	DM3	MG	G	G	G	VG
Cri8	DM1	G	MG	F	F	VG
	DM2	VG	MG	MG	F	VG
	DM3	VG	MG	F	F	VG
Cri9	DM1	G	F	G	VG	G
	DM2	VG	F	G	VG	G
	DM3	VG	F	G	VG	G
Cri10	DM1	P	P	MG	P	G
	DM2	MP	P	MG	VP	MG
	DM3	MP	MP	F	VP	G
Cri11	DM1	VG	MP	VG	VP	G
	DM2	VG	MP	G	P	VG
	DM3	G	P	G	VP	G
Cri12	DM1	G	MG	MG	MP	G
	DM2	MG	MG	MG	MP	G
	DM3	G	MG	MG	P	G

Table 4.12: Decision Makers' Evaluation in Fuzzy Triangular Numbers

CRITERIA	DECISION MAKERS	ALTERNATIVES														
		A1			A2			A3			A4			A5		
Cri1	DM1	9	10	10	3	5	7	7	9	10	3	5	7	9	10	10
	DM2	7	9	10	3	5	7	5	7	9	1	3	5	9	10	10
	DM3	9	10	10	3	5	7	5	7	9	1	3	5	9	10	10
Cri2	DM1	9	10	10	1	3	5	7	9	10	5	7	9	9	10	10
	DM2	7	9	10	0	1	3	9	10	10	3	5	7	9	10	10
	DM3	7	9	10	0	1	3	5	7	9	3	5	7	7	9	10
Cri3	DM1	5	7	9	5	7	9	5	7	9	7	9	10	3	5	7
	DM2	5	7	9	7	9	10	5	7	9	5	7	9	5	7	9
	DM3	5	7	9	7	9	10	7	9	10	7	9	10	5	7	9
Cri4	DM1	9	10	10	7	9	10	7	9	10	5	7	9	9	10	10
	DM2	7	9	10	5	7	9	5	7	9	7	9	10	9	10	10
	DM3	9	10	10	7	9	10	5	7	9	7	9	10	9	10	10
Cri5	DM1	9	10	10	5	7	9	7	9	10	5	7	9	7	9	10
	DM2	7	9	10	7	9	10	5	7	9	5	7	9	7	9	10
	DM3	7	9	10	5	7	9	5	7	9	3	5	7	5	7	9
Cri6	DM1	7	9	10	7	9	10	5	7	9	0	1	3	3	5	7
	DM2	9	10	10	7	9	10	7	9	10	1	3	5	3	5	7
	DM3	9	10	10	9	10	10	7	9	10	1	3	5	0	1	3
Cri7	DM1	7	9	10	5	7	9	9	10	10	9	10	10	9	10	10
	DM2	7	9	10	5	7	9	9	10	10	9	10	10	7	9	10
	DM3	5	7	9	7	9	10	7	9	10	7	9	10	9	10	10
Cri8	DM1	7	9	10	5	7	9	3	5	7	3	5	7	9	10	10
	DM2	9	10	10	5	7	9	5	7	9	3	5	7	9	10	10
	DM3	9	10	10	5	7	9	3	5	7	3	5	7	9	10	10
Cri9	DM1	7	9	10	3	5	7	7	9	10	9	10	10	7	9	10
	DM2	9	10	10	3	5	7	7	9	10	9	10	10	7	9	10
	DM3	9	10	10	3	5	7	7	9	10	9	10	10	7	9	10
Cri10	DM1	0	1	3	0	1	3	5	7	9	0	1	3	7	9	10
	DM2	5	7	9	0	1	3	5	7	9	0	0	1	5	7	9
	DM3	5	7	9	1	3	5	3	5	7	0	0	1	7	9	10
Cri11	DM1	9	10	10	1	3	5	9	10	10	0	0	1	7	9	10
	DM2	9	10	10	1	3	5	7	9	10	0	1	3	9	10	10
	DM3	7	9	10	0	1	3	7	9	10	0	0	1	7	9	10
Cri12	DM1	7	9	10	5	7	9	5	7	9	1	3	5	7	9	10
	DM2	5	7	9	5	7	9	5	7	9	1	3	5	7	9	10
	DM3	7	9	10	5	7	9	5	7	9	0	1	3	7	9	10

Step 3: The Fuzzy Decision Matrix of alternatives is obtained with equation (3.11).

Table 4.13: The Fuzzy Decision Matrix

CRITERIA	ALTERNATIVES														
	A1			A2			A3			A4			A5		
Cri1	7	9,67	10	3	5,00	7	5	7,67	10	1	3,67	7	9	10,00	10
Cri2	7	9,33	10	0	1,67	5	5	8,67	10	3	5,67	9	7	9,67	10
Cri3	5	7,00	9	5	8,33	10	5	7,67	10	5	8,33	10	3	6,33	9
Cri4	7	9,67	10	5	8,33	10	5	7,67	10	5	8,33	10	9	10,00	10
Cri5	7	9,33	10	5	7,67	10	5	7,67	10	3	6,33	9	5	8,33	10
Cri6	7	9,67	10	7	9,33	10	5	8,33	10	0	2,33	5	0	3,67	7
Cri7	5	8,33	10	5	7,67	10	7	9,67	10	7	9,67	10	7	9,67	10
Cri8	7	9,67	10	5	7,00	9	3	5,67	9	3	5,00	7	9	10,00	10
Cri9	7	9,67	10	3	5,00	7	7	9,00	10	9	10,00	10	7	9,00	10
Cri10	0	5,00	9	0	1,67	5	3	6,33	9	0	0,33	3	5	8,33	10
Cri11	7	9,67	10	0	2,33	5	7	9,33	10	0	0,33	3	7	9,33	10
Cri12	5	8,33	10	5	7,00	9	5	7,00	9	0	2,33	5	7	9,00	10

Step 4: Normalized Aggregated Fuzzy Decision Matrix is obtained via equation (3.16).

Table 4.14: Normalized Aggregated Fuzzy Decision Matrix

CRITERIA	ALTERNATIVES														
	A1			A2			A3			A4			A5		
Cri1	0,70	0,97	1,00	0,30	0,50	0,70	0,50	0,77	1,00	0,10	0,37	0,70	0,90	1,00	1,00
Cri2	0,70	0,93	1,00	-	0,17	0,50	0,50	0,87	1,00	0,30	0,57	0,90	0,70	0,97	1,00
Cri3	0,50	0,70	0,90	0,50	0,83	1,00	0,50	0,77	1,00	0,50	0,83	1,00	0,30	0,63	0,90
Cri4	0,70	0,97	1,00	0,50	0,83	1,00	0,50	0,77	1,00	0,50	0,83	1,00	0,90	1,00	1,00
Cri5	0,70	0,93	1,00	0,50	0,77	1,00	0,50	0,77	1,00	0,30	0,63	0,90	0,50	0,83	1,00
Cri6	0,70	0,97	1,00	0,70	0,93	1,00	0,50	0,83	1,00	-	0,23	0,50	-	0,37	0,70
Cri7	0,50	0,83	1,00	0,50	0,77	1,00	0,70	0,97	1,00	0,70	0,97	1,00	0,70	0,97	1,00
Cri8	0,70	0,97	1,00	0,50	0,70	0,90	0,30	0,57	0,90	0,30	0,50	0,70	0,90	1,00	1,00
Cri9	0,70	0,97	1,00	0,30	0,50	0,70	0,70	0,90	1,00	0,90	1,00	1,00	0,70	0,90	1,00
Cri10	-	0,50	0,90	-	0,17	0,50	0,30	0,63	0,90	-	0,03	0,30	0,50	0,83	1,00
Cri11	0,70	0,97	1,00	-	0,23	0,50	0,70	0,93	1,00	-	0,03	0,30	0,70	0,93	1,00
Cri12	0,50	0,83	1,00	0,50	0,70	0,90	0,50	0,70	0,90	-	0,23	0,50	0,70	0,90	1,00

Step 5: Weigted Normalized Aggregated Fuzzy Decision Matrix is obtained via equation (3.18).

Table 4.15: Weigted Normalized Aggregated Fuzzy Decision Matrix

CRITERIA	ALTERNATIVES														
	A1			A2			A3			A4			A5		
Cri1	0,08	0,10	0,11	0,03	0,05	0,08	0,05	0,08	0,11	0,01	0,04	0,08	0,10	0,11	0,11
Cri2	0,06	0,09	0,09	0,00	0,02	0,05	0,05	0,08	0,09	0,03	0,05	0,08	0,06	0,09	0,09
Cri3	0,04	0,06	0,07	0,04	0,07	0,08	0,04	0,06	0,08	0,04	0,07	0,08	0,02	0,05	0,07
Cri4	0,04	0,05	0,05	0,03	0,04	0,05	0,03	0,04	0,05	0,03	0,04	0,05	0,05	0,05	0,05
Cri5	0,06	0,09	0,09	0,05	0,07	0,09	0,05	0,07	0,09	0,03	0,06	0,08	0,05	0,08	0,09
Cri6	0,04	0,06	0,06	0,04	0,06	0,06	0,03	0,05	0,06	0,00	0,01	0,03	0,00	0,02	0,04
Cri7	0,05	0,08	0,09	0,05	0,07	0,09	0,07	0,09	0,09	0,07	0,09	0,09	0,07	0,09	0,09
Cri8	0,07	0,10	0,11	0,05	0,07	0,10	0,03	0,06	0,10	0,03	0,05	0,07	0,10	0,11	0,11
Cri9	0,03	0,04	0,04	0,01	0,02	0,03	0,03	0,04	0,04	0,04	0,04	0,04	0,03	0,04	0,04
Cri10	0,00	0,04	0,06	0,00	0,01	0,04	0,02	0,05	0,06	0,00	0,00	0,02	0,04	0,06	0,07
Cri11	0,07	0,10	0,10	0,00	0,02	0,05	0,07	0,10	0,10	0,00	0,00	0,03	0,07	0,10	0,10
Cri12	0,05	0,09	0,10	0,05	0,07	0,09	0,05	0,07	0,09	0,00	0,02	0,05	0,07	0,09	0,10

Step 6: FPIS (Fuzzy Positive Ideal Solution) and FNIS (Fuzzy Negative Ideal Solution) are obtained via equation (3.19) and (3.20), respectively.

Table 4.16: FPIS (Fuzzy Positive Ideal Solution) A*

A*	**A1**			**A2**			**A3**			**A4**			**A5**		
	0,08	0,10	0,11	0,05	0,07	0,10	0,07	0,10	0,11	0,07	0,09	0,09	0,10	0,11	0,11

Table 4.17: FNIS (Fuzzy Negative Ideal Solution) A^-

A^-	**A1**			**A2**			**A3**			**A4**			**A5**		
	0,00	0,04	0,04	0,00	0,01	0,03	0,02	0,04	0,04	0,00	0,00	0,02	0,00	0,02	0,04

Step 7: The distance to FPIS and FNIS of each alternative is obtained via equation (3.21) and (3.22).

Table 4.18: The distance to FPIS

	A1	**A2**	**A3**	**A4**	**A5**
di*	0,33	0,32	0,37	0,52	0,43

Table 4.19: The distance to FNIS

	A1	**A2**	**A3**	**A4**	**A5**
di-	0,53	0,42	0,37	0,41	0,59

Step 8: The closeness coefficent of each alternative is obtained viq equation (3.24) and ranking the alternatives.

Table 4.20: The closeness coefficent of each alternative (CC_i)

ALTERNATIVES	**CCi**	**RANK**
A1	**0,61**	**1**
A2	**0,57**	**3**
A3	**0,50**	**4**
A4	**0,44**	**5**
A5	**0,58**	**2**

According to the study, it is recommended that the air cargo company give the highest subsidy or incentive to Alternative 1 freight forwarder. Then, subsidy or incentives should be given to A5, A2, A3 and A4 freight forwarders, respectively.

5. CONCLUSION

The disruptions caused by the pandemic in world trade, the container crisis in maritime transport, the increasing temperature and time sensitive transports with the transport of medicines and vaccines have made the already limited and valuable air cargo capacity more valuable than ever. This study is carried out in order to enable managers to make decisions more quickly and easily, and to more accurately identify customers who will be given subsidy and incentives.

Decision makers who are experts in their fields first brainstormed the criteria with meticulous effort and endeavor. With the advice and contributions of senior executives, it was decided to use a total of 12 criteria in the selection of freight forwarders. We can state them as follows; total revenue, technology level, on-time delivery, payment reputation, global coverage, responsiveness, stability of supply, quantity of supply, e-AWB usage rate, error-free documentation, quality of operation and annual growth rate. Afterwards, these criteria were carefully weighted by the experts using the DEMATEL method. The weights obtained in this step were used during the evaluation in the Fuzzy TOPSIS method. Since the criteria include both numerical data and linguistic variables, it has become inevitable to apply fuzzy logic rules to rank or evaluate among alternatives. While benefiting from the ease and flexibility of the TOPSIS method, we tried to create a more suitable methodology for the problem by combining it with the Fuzzy method. According to the Fuzzy TOPSIS result, the highest incentive is given to the alternative that is closest to the positive ideal solution and farthest from the negative ideal solution.

As a result of the literature search carried out to solve the problem of this study, it has been realized that there are very scarce resources regarding the evaluation of air cargo freight forwarders. Among the hundreds of articles scanned in the accessible literature, the fact that there are only 3 studies on the same subject directly with this problem is an indication that this subject is open to development.

As the subject of air cargo freight forwarder evaluation continues to be the subject of future research, the possibility of making a healthier evaluation of carrier companies or other components in the sector will increase. Freight forwarders can be evaluated using different MCDM techniques or mathematical methods for further research.

In this study, it is a shortcoming that only freight forwarders originating from Turkey are considered, and it would be more appropriate for future studies to evaluate global-scale freight forwarders.

REFERENCES

Aguezzoul, A., 2014. Third-party logistics selection problem: A literature review on criteria and methods, Omega Volume 49, Pages 69-78

Chen, C. T. (1997). Extensions of The Topsis For Group Decision-Making Under Fuzzy Environment., Fuzzy Sets and Systems 114: 1-9.

Feng, B., Lai, F., 2014a. Multi-attribute group decision making with aspirations: A case study. Omega 44, 136–147. https://doi.org/10.1016/j.omega.2013.07.003

Hwang, C. L., & Yoon, K. (1981). Multiple Attribute Decision Making–Methods and Applications Springer-Verlag Berlin Heidelberg. New York.

J. L. Yang and G.-H. Tzeng, "An integrated MCDM technique combined with DEMATEL for a novel cluster-weighted with ANP method", Expert Systems with Applications, vol. 38, pp. 1417- 1424, 2011

Karaatli, M., Omurbek, N., Isik, E., Yilmaz, E. (2016) Performance Assessment in Turkish Sugar Plants By Using DEMATEL And Fuzzy TOPSIS Methods, Ege Academic Review, Volume 16, 1, 49-64

Kilibarda, M., Nikolicic, S., Andrejic, M., 2016. Measurement of logistics service quality in freight forwarding companies: A case study of the Serbian market. Int. J. Logist. Manag. 27, 770–794. https://doi.org/10.1108/IJLM-04-2014-0063

Klummp, M, 2018. How to Achieve Supply Chain Sustainability Efficiently? Taming the Triple Bottom Line Split Business Cycle, MDPI, Sustainability 2018, *10*(2), 397; https://doi.org/10.3390/su10020397

Kose, S., Ozkok, M., Demirel, F.B., Kose, E., 2018. Performance Indicators Considered for Selection of Agency in Maritime Industry |

Li, D.-F., Huang, Z.-G., Chen, G.-H., 2010. A systematic approach to heterogeneous multiattribute group decision making. Comput. Ind. Eng. 59, 561–572. https://doi.org/10.1016/j.cie.2010.06.015

Liang, G.-S., Chou, T.-Y., Kan, S.-F., 2006. Applying fuzzy quality function deployment to identify service management requirements for an ocean freight forwarder. https://doi.org/10.1080/14783360600587994

Liu, Y., Zhou, P., Li, L., Zhu, F., 2020. An Interactive Decision-Making Method for Third-Party Logistics Provider Selection under Hybrid Multi-Criteria. Symmetry 12, 729. https://doi.org/10.3390/sym12050729

Maheshika, M.D.I., Abeysekara, B., 2015. Evaluation of main factors affecting the choice of a freight forwarder: A Sri Lankan exporter's perspective, in: 2015 Moratuwa Engineering Research Conference (MERCon). IEEE, Moratuwa, Sri Lanka, pp. 199–204. https://doi.org/10.1109/MERCon.2015.7112345

Murphy, P.R., Daley, J.M., 1997. Investigating Selection Criteria for International Freight Forwarders. Transp. J. 37, 29–36.

Nilashia, M., Samad, S., Manaf, A. A., Ahmadi, H., Rashid, T.A., Munshi, A., Almukadi, W., Ibrahim, O., Ahmed, O.H. (2019). Factors influencing medical tourism adoption in Malaysia: A DEMATEL Fuzzy TOPSIS approach, Journal of Computers & Industrial Engineering, Volume 137, 106005

Ross, T. J. (2010). Fuzzy Logic. New Mexico: WILEY.

Saaty TL (1996). Decision Making with Dependence and Feedback: The Analytic Network Process. RWS Publications: Pittsburgh, PA

Sramkova, Kolar, Hunak, 2018. Container Shipping: The Evaluation of Quality Factors in Freight Forwarding Services. Transp. J. 57, 258. https://doi.org/10.5325/transportationj.57.3.0258

Subhashini, S., Preetha, S., 2018. An empirical analysis of service quality factors pertaining to ocean freight forwarding services. Marit. Bus. Rev. 3, 276–289. https://doi.org/10.1108/MABR-01-2018-0004

Tzeng, G. H., Chen, W. H., Yu, R., & Shih, M. L. (2010). Fuzzy decision maps: a generalization of the DEMATEL methods. Soft Computing, 14(11), 1141-1150.

Yang, Y.H., Hui, Y.V., Leung, L.C., Chen, G., 2010. An analytic network process approach to the selection of logistics service providers for air cargo. J. Oper. Res. Soc. 61, 1365–1376. https://doi.org/10.1057/jors.2009.111

Zadeh, L. A. (1965). Fuzzy Sets. Information and Control, 338-353

Zhang, X., Xu, Z., Wang, H., 2015. Heterogeneous multiple criteria group decision making with incomplete weight information: A deviation modeling approach. Inf. Fusion 25, 49–62. https://doi.org/10.1016/j.inffus.2014.10.006

Boeing: World Air Cargo Forecast, Commercial Market Outlook 2019-2038

URL: https://www.boeing.com/commercial/market/cargo-forecast/

IATA- Freight Forwarders

URL: https://www.iata.org/en/youandiata/freight-forwarders/

IATA, Air Cargo Market Analysis, June 2021

WorldACD, 2020. August / mid-September 2020: air cargo before the ‘second wave’…

URL: https://worldacd.com/trendssep2020

WorldACD, 2021. 2020 in perspective: how the pandemic changed the air cargo business

URL: https://worldacd.com/trendsjan2021

BIOGRAPHICAL SKETCH

Elif Berfin KIZILTAŞ was born in İstanbul, on August 9, 1994. She studied at E.C.A Elginkan Anatolian High School in 2012. In 2012, she completed her B.Sc. in the Industrial Engineering department of Kocaeli University with honour degree. In the last year of undergraduate education, she worked as a long-term intern in the marketing department of Pegasus Airlines. In 2017, she started her M. Sc. in Galatasaray University and started to work at Turkish Airlines. Currently, she is working towards master's degree in Industrial Engineering under the supervision of Assist. Prof. Dr. Zeynep ŞENER at the Institute of Science and Engineering, Galatasaray University and working as a Pricing Specialist in Turkish Cargo.

She is the co-author of the paper entitled "Evaluating Freight Forwarders in the Air Cargo Industry" which is presented in EconWorld XIII. International Conference on Economics on September 2021.

PUBLICATIONS

- Sener, Z., Kızıltas, E.B. and Dursun, M, (2021). Evaluating Freight Forwarders in the Air Cargo Industry., *International Journal Of Economics And Statistics:* Volume 9, 2021