PROCESS BOT AUTOMATION SELECTION WITH MCDM IN AIRLINE CARGO SECTOR

(HAVA KARGO SEKTÖRÜNDE ÇOK ÖLÇÜTLÜ KARAR VERME YÖNTEMLERİ İLE SÜREÇ BOTU SEÇİMİ)

By

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Thesis

Submitted in Partial Fulfillment
of the Requirements
for the Degree of

MASTER OF SCIENCE
In
LOGISTICS AND FINANCIAL MANAGEMENT
In the
GRADUATE SCHOOL OF SCIENCE AND ENGINEERING
Of
GALATASARAY UNIVERSITY

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June 2020

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ACKNOWLEDGEMENTS

Firstly; I would like to thank to my thesis advisor Associate Prof. A. Çağrı Tolga who always showed his support with his knowledge during my thesis process. I am also grateful for spending his precious time.

I would like to thank to my dear family, specially my aunt and my sister, for their spiritual support and motivation they provided in this work, as in all of my study.

Lastly, I would like to thank to all my related managers and colleagues who never withhold their support that guided me with their experience.

June 2020
Gül DURAK

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LIST OF SYMBOLS

AHP : Analytic Hierarchy Process
AVI : Live Animal (Special Cargo Code)
AWB : Airway Bill
CC : Charges Collect
CRA : Cargo Rate Audit
CRM : Customer Relationship Management
CRR : Cargo Reservation Rebooking
COMIS : Cargo Operational Management Information Systems
DWH : Data Warehouse
EBYS : Electronical Document Management System
ERP : Enterprise Resource Planning
FSU : Freight Status Update
HUM : Human Remain (Special Cargo Code)
IATA : International Air Transport Association
MADM : Multi Attribute Decision Making
MCDA : Multi Criteria Decision Aid
MCDM : Multi Criteria Decision Making
PP : Prepaid
PTT : Postal and Telegraph Service
RPA : Robotic Process Automation
SAP : Systems Analysis and Program
SCC : Special Cargo Code
SCM : Stock Check Message
TGS : Turkish Ground Service
TODIM : Iterative Multi-Criteria Decision Making
RRY : Radioactive Cargo (Special Cargo Code)

ULD : Unit Load Device

VAL : Valuable Cargo (Special Cargo Code)

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ABSTRACT

Sectors are growing rapidly today. In such an environment, companies include technology in their business processes. The airline cargo sector is also a sector that benefits from technology. Robotic Process Automation is one of the most up-to-date technologies used today and works as a kind of service task automation. Companies that opt for using Robotic Process Automation software need to spend money to incorporate technology into their business at the start of the business, but in the future, companies become more profitable. The investment compensates itself and companies start to profit from this investment. The "robot" helps repetitive tasks to be implemented rightly by interpreting the application, this is when the Robotic Process Automation program implements the instructions determined by the developer to interact with the systems by using screen recording and variables. There are many companies in the field of Robotic Process Automation and therefore it is difficult for the airline to choose. The choice of Robotic Process Automation for companies serving internationally refers to an area with many criteria and expectations. That's why, it could be considered to utilize Multi Criteria Decision Making methods as being one of the best ones to support decisions. In this study; new Multi Attribute Decision Making Methods; The WEDBA and TODIM methods are used to make a decision. One of the most important benefits of using WEDBA method is taking into account both qualitative and quantitative attributes to propose a novel Multi Attribute Decision Making method. Because it uses three kind of weights. On the other hand; TODIM uses Expectation Theory when making decision.

Keywords: Robotic Process Automation, Multi Attribute Decision Making, Weighted Euclidean Distance Based Approach, Robot Selection, TODIM

RÉSUMÉ

Dans un environnement de secteurs à croissance rapide, il est inévitable pour les entreprises de bénéficier de technologies de pointe. Le secteur du fret aérien est l'un de ces secteurs. L'automatisation des processus robotiques est l'une des dernières technologies de notre temps et c'est une forme d'automatisation des tâches de service. Les entreprises qui choisissent d'utiliser le logiciel Robotique Procès Automation doivent investir de l'argent dans la technologie au début, mais avec le temps, cela devient très bénéfique car elles commenceront bientôt à réaliser des bénéfices. Le «robot» permet d'effectuer des tâches répétitives avec précision en interprétant l'application, c'est à ce moment que le programme Robotique Procès Automation exécute les instructions définies par le développeur en communiquant avec les systèmes à l'aide de l'enregistrement à l'écran et des variables. Cependant, la présence de nombreuses sociétés Robotique Procès Automation rend difficile le choix de la compagnie aérienne. Sélection d'automatisation de processus robotique pour les grandes entreprises internationales; considérant combien ils ont leurs processus d'affaires et leurs partenaires commerciaux; il représente un univers avec de nombreux critères et attentes. Par conséquent, il peut être envisagé d'utiliser les méthodes de prise de décision multicritères comme l'une des plus grandes méthodes d'aide à la décision. Les problèmes réels sont souvent très critiques, car ce problème est un problème réel et il est logique d'appliquer des méthodes de prise de décision multicritère. Dans cet article; une nouvelle méthode de prise de décision multi-attributs; La méthode de l'approche basée sur la distance euclidienne pondérée (WEDBA) et le TODIM ont été utilisés pour prendre une décision. L'un des plus grands avantages de l'utilisation de la méthode WEDBA est; il envisage à la fois des attributs qualitatifs et quantitatifs pour proposer une nouvelle méthode de prise de décision multi-attributs.

Mots-clés: Automatisation des processus robotiques, prise de décision multi-attributs, approche basée sur la distance euclidienne pondérée, sélection de robots, TODIM

ÖZET

Hızlı büyüyen sektörlerin bulunduğu bir ortamda şirketlerin ileri teknolojiden faydalanması kaçınılmazdır. Büyük verilerin işlendiği ; bilgi güvenliğinin üst düzeyde tutulduğu hava yolu kargo sektörü bu sektörlerden biridir. Hava yolu kargo sektörü en büyük avantajı hızı ve geniş uçuş ağı olan yapısından dolayı saldırılara elverişli bir sektördür. Hava yolu kargoda canlı hayvanlardan medikal kargolara kadar bir çok ürünün taşınması gerçekleşmektedir. Uygulamanın yapıldığı hava yolu kargo şirketi halihazırda dünya çapında yedinci sıradadır. 2019 yılı Pazar payı ise %7.1'dir. Ancak her sektörde olduğu gibi bu sektörde de rekabet son yıllarda üst düzeye çıkmıştır. Şirket hem ulusal hem uluslararası rekabetle başa çıkabilmek için son dönemde inovasyon projelerine ağırlık vermektedir. Robotik Proses Otomasyonu da şirketin en çok ilgilendiği projedir. Şirketin robotları kullanmaya başlaması ile hız, doğruluk, verimlilik ve buna bağlı olarak da müşteri memnuniyeti artacaktır. Robotik Proses Otomasyonu zamanımızın en son teknolojilerinden biridir ve bir hizmet görevi otomasyonu biçimidir. Robotik Proses Otomasyon yazılımını kullanmayı tercih eden şirketlerin öncelikle teknolojiye para yatırması gerekmektedir, ancak zamanla yakında kar görmeye başlayacakları için çok faydalı olmaktadır. "Robot", uygulamayı yorumlayarak tekrar eden görevlerin doğru bir şekilde yapılmasına izin verir, Robotik Proses Otomasyonu programı, ekran kaydı ve değişkenleri kullanarak sistemler ile iletişim kurarak geliştirici tarafından belirlenen talimatları gerçekleştirir. Burada bahsedilen robotlar son zamanlarda bot olarak adlandırılmışlardır. BOT kendisine verilmiş olan görevleri ve hizmetleri gerçekleştiren programlara verilen addır. Web sitelerinin içerdiği bilgilere ulaşmayı, gün içinde e-posta gönderen uygulamaları incelemeyi ve bunun gibi farklı işlevleri içermekte olan bus anal asistanlar bilgi ve istenilen verilere erişimdeki hızı oldukça artırmıştır. Fakat genel anlamı ile bu çalışmada Robotik Proses Otomasyonu yani kısaca RPA olarak bahsedilecektir. Bununla birlikte, birçok Robotik Proses Otomasyon şirketinin varlığı, havayolunun seçim yapmasını zorlaştırmaktadır.

Robotik Proses Otomasyonunun veri kopyalama, iş akışı otomasyonu ve yapay zekaya dayalı üç temel ilkesi bulunmaktadır. Robotik proses otomasyonu şu ana kadar birçok alanda faaliyet göstermektedir. Uluslararası, büyük ölçekli şirketler için Robotik Proses Otomasyonu seçimi; iş süreçlerine ve iş ortaklarına ne kadar sahip olduklarını göz önünde bulundurarak; birçok kıstas ve beklentileri olan bir evreni temsil eder. Tüm bu yararların ışığında firmayı bekleyen problemlerden birisi karar verme problemidir. Çok kriterin ve çok alternatifin olduğu bu durumda şirketin belirlediği tüm kriterleri en büyük ölçüde karşılayacak firmayı bulması gerekmektedir. Şirket bu konuda bilimsel metotları kullanmak istemiştir. Bu nedenle, çok kriterli karar verme yöntemlerinin en büyük karar destek yöntemlerinden biri olarak kullanılması düşünülebilir. Bu çalışmada; şirkete destek olarak göreli olarak yeni sayılabilecek çok nitelikli karar verme yöntemleri olan ağırlıklı Öklid uzaklık temelli yaklaşım olan WEDBA ve iteratif çok kriterli karar verme yöntemi olan TODIM yöntemleri kullanılmıştır. WEDBA yöntemini kullanmanın en büyük avantajlarından biri; yeni bir çok nitelikli karar verme yöntemi olması ve kullanılabilmesi için hem niteliksel hem de niceliksel nitelikler göz önünde bulundurulmasıdır. Ayrıca WEDBA yönteminde üç tür ağırlık kullanılmaktadır. Bu ağırlıklar objektif sübjektif ve her ikisini de kullanan entegre ağırlıklardır. Bu da çalışmayı daha önceki yöntemlerden farklı kılmaktadır. WEDBA yönteminde olurlu çözümün anlamı; ideal diye tanımlanan noktalara en yakın olan başka bir deyişle en kısa mesafede olan çözümdür. Bu yöntemde ideal ve ideal olmayan noktalar bulunmaktadır. Öte yandan TODIM metodu karar aşamasında Beklenti Teorisini kullanır ve risk faktörünü ele alır. Beklenti teorisi Nobel Ekonomi ödüllü bir çalışmadır. Kayıplar ve kazançları her bir alternatif için ikili karşılaştırmalar yolu ile hesaplar. Yapılan araştırmalar sonucunda bu iki yöntemin bir arada literatürde hiç kullanılmadığı görülmüştür. Her iki yöntem de matematiksel, mantıklı ve anlaşılması kolaydır. Ayrıca her iki yöntem de benzer adımlar içerir. Yöntemlerin bu nedenle karşılaştırılmaları kolaydır. İlk olarak karar matrisi oluşturulması ile başlanacaktır. Niteliksel olan kriterlerin sayısallaştırılması için literatürde bilinen bir yöntem olan yedi noktalı ölçek metodu kullanılmıştır. TODIM metodu için ise 1'den 5'e ölçek kullanılmıştır.

Çünkü bu yöntemlerin uygulanabilmesi için tüm verilerin sayısal olması gerekmektedir. Öte yandan tüm veriler şirketin belirlediği kriterler ve yaptığı teknik gezilerle belirlenmiştir.

Anahtar Sözcükler: Robotik süreç otomasyonu, çok nitelikli karar verme, Ağırlıklı Öklid uzaklık bazlı yaklaşım, robot seçimi.

1. INTRODUCTION

If companies choose Robotic Process Automation, they experience positive developments in terms of efficiency and speed. This success of firms can also be evaluated as the return of investment to them (Asquit, 2019). In today's business world, it is feasible to do lots of things with the help of robots. This includes the air cargo sector. But it is difficult to choose from many alternatives. Therefore, this thesis aims to choose the most suitable robot firm for air cargo department.

Robotic Process Automation (RPA) works via using of a programmed robot. After the recognition of a software-based job that could be procedurally reproduced, RPA goods are used to program a robot which could implement the similar series of software interactions required for job completion. RPA is the most appropriate for methodical styled jobs which are steady and recurrent. One of the benefits of RPA software is that only people can see the software that interacts with the presentation layer. The presentation layer makes data translation, compression and encryption between implementations (Asquit, 2019).

In this study; among Multi Attribute Decision Making Methods; Weighted Euclidean Distance Based Approach and TODIM methods are implemented to pick the most appropriate Robotic Process Automation Company.

The decision-making method (MADM), which has a multi-attribute feature, is a method that determines how information about the characteristics it possesses is refined to choose the most logical among the feasible options (İlbahar, 2019).

2. LITERATURE REVIEW

Some scholars have studied on the subject of Multi Criteria Decision Making Methods and some of them are mentioned below.

2.1. Multi Criteria Decision Making

MCDM is an approach which utilizes to resolve complicated situations in engineering and other areas of life that deal with the problems of selection (Huang et al., 2011). This approach divides the existing problem into steps and makes the necessary analysis so that the decision maker can reasonably solve the problem (Fatemi and Razei-Moghaddam, 2019). Lots of engineering choosing methods utilize MCDM to solve issues that require fast decision processes.

Ohunakin and Saracoglu (2018) used five multi-criteria methods to find suitable places for solar power plants in the field of energy production. Masebinu et al. (2018) used MCDA method to recover solid waste from some of the organic products. MCDM / A is a management science field that is relevant to situations involving multiple and contradictory criteria (Masri, 2018).

MCDM / A methods provide guidelines and a general framework for employees whose decision-making process is very complex, where they have a specific set of actions (these strategies can be) and some criteria (evaluation measures) to distinguish them. One of the benefits of applying the WEDBA approach is that it offers a new perspective on the MADM problem and considers both quantitative and qualitative features.

In addition, this method helps to find more reasonable results utilizing objective, subjective and integrated weights. Furthermore, this method utilizes fuzzy logic to transform the qualitative features into the quantitative features. On the other hand, the feature that distinguishes TODIM method from other MCDM methods is that it uses the expectation theory when making decisions.

2.2. Multi Criteria Decision Making Methods

2.2.1. Expectation Theory

The theory of expectation was suggested by Kahneman and Tversky (1979) on decision making at risk. Like the expectation theory, the TODIM method has a value function and graph. There is a certain approach of people to taking risks, winning or losing. It depends on how it remains. The theory classifies these approaches as risk avoidance in the case of gain and tendency to take risk in case of loss.

When Figure 2.1 is examined, it can be seen that the benefits decrease as the earnings increase. Likewise, as losses increase, the effect of losses decreases gradually.

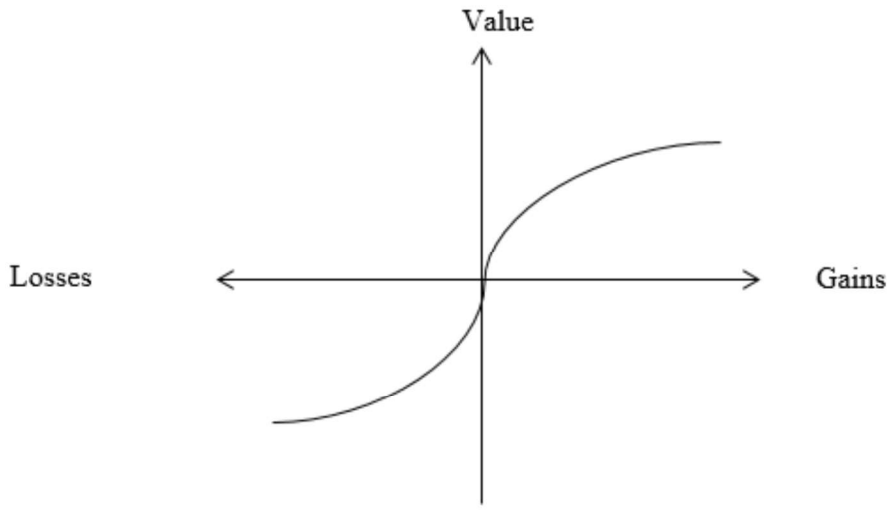


Figure 2.1: Expectation theory value function graphic

2.2.2. TODIM

TODIM is a MCDM approach dependent on the expectation idea and incorporates the risk factor in the decision-making process. (C. Tolga, Z. Turgut, 2018). The TODIM method uses a nonlinear valuation mission with a form alike to the gains/losses duty of Cumulative Prospect Theory. It is a distinct multi-criteria way of Kahneman and Tversky in1979, which won the Nobel Prize for Economics in 2002 (Roux, 2002).

Expectation approach was put forward by Kahneman and Tversky in 1979 as a descriptive model, as another option for the theory of utility on decision taking in case of risk. The expectation theory basically tries to explain how people make decisions at risk. As a result, it is considered that people do not always make sense when making decisions, and alternatives that are likely to occur and promise less benefits are preferred, even if one of the alternatives promises much higher benefits as a final outcome. Accordingly, the authors acknowledge that people exaggerate the situations with definite consequences and make their choices according to those whose results are not certain. This feature of the theory of expectation contradicts the theory of utility because the theory of utility presumes that people always make rational decisions by trying to maximize their profits. Where the graph is concave, it means risk aversion when it comes to gain, and where it is convex refers to the tendency to take risk (risk propensity) when confronted with loss (Rangel et al., 2011). In the graph of the value function, the slopes of the concave and convex parts are not equal, and the loss curve is drawn more upright. This leads to the conclusion that the same amount of gains and losses do not have an equal impact on people, and that the sadness of losing outweighs the joy of winning. These findings of Kahneman and Tversky brought them the Nobel Prize for Economics in 2002. In TODIM, the gains and losses of alternatives are calculated for each criterion. As a result of binary comparisons, the best option is reached. Like the expectation theory, the TODIM method has a value function, and the

function has the same graph as in theory. The TODIM method is one of the relatively new MCDM method and therefore it is not generally included in the literature.

However, many studies performed lately on fuzzy TODIM in recent years; has enriched the literature in this way. Later, these applications continued; studies have been carried out in different fields such as energy, economy, education and technology (Gomes et al., 2010) (Gomes et al., 2009) (Adalı, 2016) (Rangel et al., 2011). Nobre and Trotta (1999) realized the first fuzzy application of TODIM. They applied the fuzzy model to the healthcare sector in Brazil and conducted the process of prioritizing eight technologies to be purchased for the hospital. Krohling and Souza (2012) did one of the case studies of the fuzzy cluster integrated model of the method. Lourenzutti and Krohling (2013) developed the TODIM method with intuitive fuzzy clusters by adding random situations that will affect the performance of alternatives. Liu and Teng (2014) proposed a model integrated with 2 dimensional uncertain linguistic variables by applying another development method. It presented this model to the benefit of multi-purpose decision making problems on a group basis. Li et al. (2015) made an application on distributor evaluation and chose using the intuitive fuzzy TODIM method. Yanwei Li et al. (2015) likewise combined the TODIM method with intermittent intuitive fuzzy clusters and included the field selection application for airport terminals with this technique at the end of the study. Araujo (2015) applied the fuzzy TODIM method to determine the retail location.

Ekhtiari et al. (2016) used TODIM technique in uncertain conditions to rate the risks that may arise in non-profit financial investment initiatives. Ren et al. (2016) integrated a fuzzy cluster into the TODIM method and created a model and cited investment bank selection as an example to demonstrate the applicability of the model. Qin et al. (2017) conducted another intuitive fuzzy TODIM study, using an intuitive triangular fuzzy number, presented a sample study on choosing a renewable energy source to demonstrate the validity and feasibility of this method. Qin et al. (2017) also used the TODIM method to evaluate China's energy performance contract models that were

accepted across the country. By combining this model with entropy measurements, it implemented an application on the campus project. Hanine et al. (2016) compared fuzzy AHP method with fuzzy TODIM method for solid waste site selection. TODIM method is integrated with fuzzy clusters, as well as studies in which it is used in combination with different methods and MCDM techniques were contained in the literature (Gomes et al. 2010; Ruzgys et al. 2014; Gomes et al. 2015).

2.3. Weighted Euclidean Distance Based Approach (WEDBA)

The approach situated in the weighted Euclidean distance depends on the weighted distance of the options from the most desired and least desirable circumstances, in order. According to this approach, the most desired circumstance is explained as the ideal point (that is, the optimum), and the least affirmative circumstance is explained by the non-ideal point. Ideal and anti-ideal points are expressed as the best and worst valuations. The ideal point is the option with the best values, and vice versa, the anti-ideal point includes the worst. Related numerical distinctions resulting from the comparisons show the efficiency of the alternate order of the alternatives defined as index score. The decision problem is to determine the possible solution that is closest to the ideal point.

This method helps the decision maker take both objective and subjective weights into account when making his/her decision. If the decision maker is not certain about how crucial are attributes; he/she uses objective weights; otherwise nominative weights are used. Integrated weights are suggested to contain both subjective and objective weights. Euclidean distance is a known term in the branch of Mathematics. (Dattorro, 2008; Gower, 1982). That's why, the main goal in this method is to find an application resolve that is as close as can be to the ideal point. According to this approach, three different property weights are acceptable: objective weights, subjective weights, and integrated weights.

2.4. Robotic Process Automation (RPA)

RPA is the automation of duties that were formerly implemented by people. Madakam et al. (2019) defines RPA as a new business process and automation technique dependent on software and artificial intelligence concepts. RPA has become the new way of business. This technology is stronger if comparing it with other 21st century technologies. The robot interprets the implementation and provides that the repetitive tasks are done correctly. The RPA program communicates with systems utilizing screen recording and variables and follows specified instructions. RPA takes over by using a robot that is configured and programmed to perform its assigned tasks. (Asquith, Horsman, 2019). RPA products can be utilized to program a robot that is able to implement the same sequence of software interactions required to finish the job given. RPA is not smart but it makes basic iterative logical jobs.

Using software to automate processes is not a new idea, but the trend in service automation has definitely increased with RPA methods (The Outsourcing Unit Working Research Paper Series, April 2015).

More than 35 percent of automation of heavy services has been automated. Although Robotic Process Automation is known as expressing physical bots that serve offices at first glance; in fact, this term also means the automation of services former done by people. The term RPA refers to configuring the software to do the work to be done by humans, such as transferring data from multiple input sources to data recording systems, mostly email and spreadsheets.

RPA is a one tool which contains process elimination, process advancement, and other business process tools. RPA does not mean the unique solution to everything; but it is certainly an amazing tool in the repertoire.

RPA is an expression used for tools that make the user interface of other computer systems the way a person does (Aalst et al.,2018). The goal of RPA is to work with automation, leaving people a little more out of the task. In this method, the information system; unlike traditional workflow techniques; remains unchanged. According to

After performing a software-based task that can be replicated procedurally, RPA products can work to program a robot that can do the same set of coactions necessary to complement the task. As a result, RPA is the most practical for consistent and repetitive method jobs. It is very important to distinguish RPA from traditional types of automation, such as screen automation, scraping and macros, which are typically considered the starting point of this technique. The main function of RPA is the task definition within an interface.

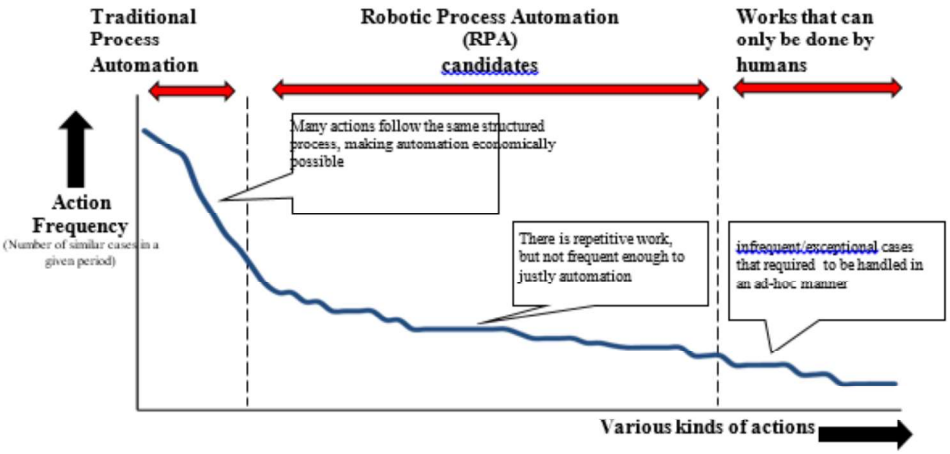


Figure 2.2 : Positioning RPA

3. SELECTION CRITERIA

The criteria in the literature review were determined by discussing with the evaluation committee and the relevant departments. Here are some criteria which used in robot selection. It can be said that there are main and second criteria for some of them.

- Speed: This feature resorts to the approximate time the robot takes to complement an operation in minutes.
- Cost: It refers to how much the robotic company selection will cost the firm.
- Security: If unauthorized access to some company information occurs, security and privacy are highly compromised. This is why security is one of the features of the choice. Security criteria also have three sub-criteria. They are given below:
  - Recording and reporting of all logs
  - Recording and reporting of all data
  - Work and manage on the cloud.
- Modularity: Modularity: With high modularity, bots can increase workspaces. Modularity is thought to be used in many departments to improve service quality, information accuracy and decrease risk. Modularity is useful only if a division is precise and unambiguous. Today, the use of modular robots in air cargo is limited. In this example, modularity also means how many processes robot can make. There are maximum 26 process that bots can make in a company.

Modularity attribute has two sub–criteria

- Ability to define independent coordination (product is not effective when coordination changes)
- RoboForm infrastructure support

- Flexibility: It means easily adaptation to change.
  - DB - SQL connection capability
  - Attended and unattended interoperability

  - Ability to define independent coordination (product is not effective when coordination changes)
- Life Cycle: It shows how much time the bot will use. And this feature is represented by hours.
- Power Consumption: It is explained as the total power required by the robotic structure.
- Labor Hour: It means how much workforce Bot can create equal to the capacity of the employees.

4. PROCESS TO BE USED WITH BOTS

There are many processes in the airline cargo company. Those that will be compatible with RPA from these processes are listed below.

4.1.1. AWB Data Entries

Data of all transit airway bills (AWBs) which coming from abroad and going to abroad are checked and executed in center (Istanbul). The data of AWBs which come with missing information is entered or corrected meanwhile if they are incorrect.

4.1.1.1. Process Steps

1- The cargo document envelopes of all flights to Istanbul are opened and one copy of each AWB is taken and a document set belonging to the expedition is created.
2- A list of documents is transmitted to the AWB information team.
3- AWBs which come from region owner of related flight are displayed on the COMIS system one by one and their information is checked.
4- Missing information are entered, necessary corrections are made and AWB is executed.
5- When the data entries are completed, the AWBs are transmitted to the scanning team for scanning them to the e-archive.

4.1.1.2. Managements Effected By Process

- Cargo Financial Management
- All Abroad Region Vice President
- Customs Management

How many staff perform the operation? 32

Allocated man/hour (monthly): 4928
Frequency of process: Daily
Programs used in process: COMIS, PDF

4.1.2. Cargo Reservation Rebooking

Cargo Capacity Control Department provides management by planning maximum capacity of cargo which offered by cargo planes and passenger planes that belongs to company and departed from Istanbul. After flight is set up, for the cargos which their status are confirmed; operation process begin. During the operation, the flights may not be executed as planned. In this case, the Cargo Reservation Rebooking unit checks that the flight is "finalized" or not and the "Irregularity Code" is entered in the reservation. It then receives reservations for the remaining cargo (which cannot be shipped on schedule) to the nearest expedition, which only meets the restrictions for certain "Irregularity Codes".

4.1.2.1. Process Steps

1- If the cargo remains in the warehouse during the operation due to over capacity, CRR unit checks the reservation via COMIS and updates the reservation. For this process AWBs and pallets are checked from Load Plan Reference List in the Export Manifest screen. The weight / volume / piece information of the cargos which are not taken are checked and re-booked on Maintain Booking screen. The weight / volume / pieces information of the cargoes that are not taken to the flight is checked and re-booked on Maintain Booking screen. During this process, if a part of the cargo is flown at the scheduled time, only the remaining part is booked for the first time.
* In case there is available capacity in the cargo size received in the reservation, the reservation will be confirmed in the flight.

* In case there is no available capacity, an e-mail explaining AWB number, flight number, date and status is sent to the Capacity Control Department for reservations that receive "queue" status on the flight.

On the Export Manifest screen, scheduled cargos will be manifested after the necessary operational process is completed and shipped under the aircraft. Although these cargos are shipped under the aircraft, they may not be loaded for various reasons (capacity, under load, incorrect preparation etc.). In this case, the remaining cargo will go from the bottom of the aircraft to the Check-In area on the apron, or to the 10500 area if bulk is shipped. Counts are done. Subsequently, the offload mail sent to the CRR by TGS and other relevant units transmits the number of pieces / kg / volume of the remaining cargo. The CRR unit updates the information from COMIS on the COMIS Maintain Booking screen the first time available.

* In case there is an available capacity in the time of booking, the reservation will receive "confirmed" status at the time.

* In the absence of available capacity, the reservation will receive "queue" status at once. An informative e-mail explaining AWB no, flight number, date and status is sent to the Capacity Control Department.

3- Date / Time No / AWB no / SCC / Total Parts / Number of Parts / Total Weight / Remaining Weight / Reservation Received time for shipments with HUM, AVI, VAL, and RRY coded offloads at the end of each shift. An Excel document containing the information is saved to the archive and an e-mail is sent to the Capacity Control Department.

4.1.2.2. Managements Effected by Process

- Special Cargo Management
- Cargo Customer Relationship Management
- Domestic and International Cargo Sales Organization
- Cargo Hub Operations Management

- Cargo Hub Operations Sentry Management
- Cargo Apron Management

How many staff performs the operation? 17

Allocated man/hour (monthly): 3468

Frequency of process: Daily

Programs used in process: COMIS, Excel, Outlook

4.1.3. Cargo Rate Audit (CRA)

From the COMIS CRA072 screen, the AWBs of the respective country to be checked are selected for the period which will be closed. Then by selecting one AWB and press Rate Audit key the CRA073 screen will be displayed. This is the page where all edits are made for an AWB.

4.1.3.1. Process Steps

1- The part which will be checked in CRA073 is; the accuracy of the fees defined in the system and the equality with the kg part on AWB. Sometimes the dimensions entered in the weight calculation bring the wrong CW. For this reason, the dimension control is controlled with the AWB information. If there is no dimension information on the AWB, the system is considered as correct.

2- When it is looked AWB in example; it is found that CW is the same as the copy, since AWB PP is used for Rate control, we see that the market charge is charged over promo rate. From View TRF018 screen, control is done.

3- There are cases where the spots entered in one are not reflected to the CRA screens after the execution. It is used the TRF007 to check.

4- Some countries also have changes to the IATA Rate, even if not for each country. For Mexico, IATA and market charge should be synchronized. The reason of difference is the tax applied in this state. This is not applied to all countries that are valid. It can be shared countries with such necessity.

5- If AWB was CC, the freight fee would be invoiced at IATA rate and not at market rate. To do this, IATA rate and other chargers should be the same as above AWB.

4.1.3.2. Managements Effected By Process

- Cargo Hub Operations Management
- Cargo Revenue and Price Management
- Accounting and Financial Control Directorate

How many staff perform the operation? 25
Allocated man/hour (monthly): 2750
Frequency of process: Daily
Programs used in process: COMIS, PDF

4.1.4. Setting Invoice Amount / Mail

In the account closing period, invoices are issued to the postal administrations on a monthly basis. This is achieved through integration between SAP and COMIS systems.

4.1.4.1. Process Steps

1- Specific parameters and filters are selected for filters in Comis System and it is checked whether there is a bag with billable status in the previous periods.
2-The wrong company to withdraw the mail bag to the right company, the old dates to the right month to withdraw mail bags.
3- The comparison of the manifest documents sent from the mail companies and the COMIS system is done by matching. It is tried to be contacted with the operation about unmatched mail bags.
4- After the price control of Postal Administrations is done, it is checked through COMIS System whether the invoiced mail falls to the previous periods before the invoice is issued. (Due to COMIS System error)

5- The mail manifest sent by PTT is compared with the excel list received from COMIS System. After sorting by date, it is checked whether the numbers are the same or not.

4.1.4.2. Managements Effected By Process

- Cargo Financial Management
- Special Cargo Management
- Cargo Hub Operations Management
-All Vice Presidents of International Sales
- Accounting and Financial Control Directorate
- Cargo Data Analysis and Reporting Management

How many staff perform the operation? 8
Allocated man/hour (monthly): 1056
Frequency of process: Monthly
Programs used in process: COMIS, Excel, PDF

4.1.5. SAP Transfer of Cost / Expense Invoices from Companies

Registration of invoices, E-Invoice and E-Archive invoices issued for goods and services received from outside the Company into the SAP system.

4.1.5.1. Process Steps

1- Receiving incoming invoices (as E-Invoice / E-Archive) from the E-Invoice pool.
2- Creation of automatic record on SAP side.
3- The SAP record is processed and sent to the EBYS system for approve of accounting.

4.1.5.2. Managements Effected By Process

All Cargo Departments

How many staff perform the operation? 4
Allocated man/hour (monthly): 560
Frequency of process: Daily
Programs used in process: SAP, EBYS

4.1.6. Price and Duplicate Control

In COMIS System, it is checked whether the mail bags carried monthly for each postal administration receives the correct price. In addition, the system checks whether there is a duplicate mail bag. This can be done by taking the excel list from COMIS or directly from the system.

4.1.6.1. Process Steps

1- From COMIS screens, the country code of the postal administration and the monthly period will be checked are entered in the filter section.
2- When filtering is done, the list of the carried mail bags of the relevant postal administration is displayed within the searched month.
3- According to this list, bags are charged at different prices according to the origin-destination distinction.
4- The personnel examine the mail bags in the excel list or system according to their origin and destination and checks whether they are charged from the fee included in the system.
5- It is also checked whether there is a double from any record in the same way.

4.1.6.2. Managements Effected By Process

- Special Cargoes Mail Express Product Chief
- Cargo Hub Operations Post and Express Chief

How many staff perform the operation? 8
Allocated man/hour (monthly): 480
Frequency of process: Daily
Programs used in process: COMIS, Excel

4.1.7. Reservation Control

All pallets in storage areas are checked in every shift.

4.1.7.1. Process Steps

Reservation checks which are based on AWB are done by pulling relocation operations from the COMIS screen, and e-mail is sent to the related unit for cargos which are not booked.

4.1.7.2. Managements Effected By Process

- Cargo Apron Management
- Cargo Capacity Planning and Control Management
How many staff perform the operation? 4
Allocated man/hour (monthly): 360
Frequency of process: Daily
Programs used in process: COMIS, Excel

4.1.8. Generating Operation Reports

The process of preparing and sharing operational reports that are formed by operational performance team at different periods share with much management. (Since there are many different but standard reports, it can be handled the general process instead of writing them all separately).

4.1.8.1. Process Steps

1-Data extraction from DWH and COMIS
2-Analysis of received reports in excel
3-Summarizing the results in excel or PowerPoint.
4-Mail bodies are updated according to the results and if any, attachments are added and shared with the distribution list determined at the end of the specified period.

4.1.8.2. Managements Effected by Process

- Cargo Operational Performance Management
- All Cargo Assistant General Management

How many staff perform the operation? 4
Allocated man/hour (monthly): 352
Frequency of process: Daily, Weekly, Monthly
Programs used in process: Outlook, DWH, COMIS, Excel

4.1.9. Data Transfer to COMIS Screen to Be Live In SAP

Transfer of some operational data from related files and / or systems to the ZSCOPE screen.

4.1.9.1. Process Steps

1-Taking the FSU report on the 15th of every month via DWH and FSU Times report at the end of each month and uploading the captured reports to this screen. (Taking reports also has some processing steps in itself.)
2- At the end of each quarter, the results of the handling evaluation form will be updated by the relevant excel and the results will be uploaded to this screen for use in the scorecard.
3- Dimension control and cargo message reports accessed from the public folder are uploaded to the COMIS screen at the end of the month.
4-COMIS screen of the daily report is drawn, determined by the e-mail to the station for the e-mail confirmation of the station, if a reply is not received within a week, the e-mail in response to the scanned Excel file in response (confirmation / rejection reason) COMIS screen processing.

4.1.9.2. Managements Effected By Process

Cargo Operational Performance Management

How many staff perform the operation? 5
Allocated man/hour (monthly): 300
Frequency of process: Daily, Monthly, Quarter
Programs used in process: Outlook, DWH, Excel, SAP

4.1.10. Importing Mail Bags to the Right Companies

It includes mixing mail bags from the same origin and distinguishing route / save.

4.1.10.1. Process Steps

1- Company of origin and destination is found.
2- The mails of the company's mail bags are taken from the countries by saving.

4.1.10.2. Managements Effected By Process

- Cargo Hub Operations Management
- Cargo Customer Relationship Management
How many staff perform the operation? 8
Allocated man/hour (monthly): 240
Frequency of process: Daily
Programs used in process: COMIS

4.1.11. Price Definition

COMIS system has a price line for each postal administration or company. In these price lines, certain parameters are filled and fees are activated.

4.1.11.1. Process Steps

1- In COMIS, price screen is opened from MRA Screens and the price line of the related postal administration or company is selected in related year.
2- Three types of price definition can be made in the opened fee line.
3- These price definitions are made by placing certain parameters in the tabs in the system.
4-Charges are forwarded to the unit in excel list. And login to the COMIS system is done.

4.1.11.2. Managements Effected By Process

- Special Cargoes Mail Express Product Chief
- Cargo Hub Operations Post and Express Chief

How many staff perform the operation? 8

Allocated man/hour (monthly): 192

Frequency of process: Prices are renewed during the expiry of the contract periods.

Programs used in process: COMIS, Excel

4.1.12. Control of Station Stocks (SCM)

All stations that have ULD in stock send a SCM (Stock Check Message) at least once a week. The ULD Unit compares these messages and the system stocks of the station and reports the missing excess ULDs to the station.

4.1.12.1. Process Steps

1- Station sends SCM.

2- ULD Tracking officer, compare system and SCM message.

3- Missing / excess ULDs are detected.

4- An inquiry e-mail is sent to the stations for missing / excess ULDs.

4.1.12.2. Managements Effected By Process

Cargo Facility, Equipment and Logistics Management

How many staff perform the operation? 2

Allocated man/hour (monthly): 180

Frequency of process: Weekly

Programs used in process: COMIS, Excel

4.1.13. COMIS System Comparison with Barcode Information

The barcode information sent by the postal administration is compared with the information in COMIS system.

4.1.13.1. Process Steps

1- The mail manifest sent by PTT is compared with the excel list received from COMIS system. After sorting by date, it is checked whether the numbers are the same or not.
2- Barcodes that are not listed are included in the list.

4.1.13.2. Managements Effected By Process

- Special Cargoes Mail Express Product Chief
- Cargo Hub Operations Post and Express Chief

How many staff perform the operation? 8
Allocated man/hour (monthly): 160
Frequency of process: Daily
Programs used in process: COMIS, Excel

4.1.14. Adjusted Weight Control

There may be adjusted weight error in the operations performed by the sales organization. These errors affect the whole process (capacity planning, operations, etc.). Thanks to the adjusted weight control process, overhang (OHG) shipments, which are important in terms of providing utilization in our aircraft, are monitored. As a result of these follow-up and controls; any deficiencies or errors detected (amount of missing or incorrectly adjusted weight, parts-weight which will be updated, volume information, exit-arrival station information, etc.) are eliminated by intervening or communicating. These bugs and deficiencies are fixed; because they are reducing customer satisfaction.

4.1.14.1. Process Steps

1- By opening the List Bookings screen in COMIS, date range is entered and by typing OHG in SCC section; if the "Origin" part is full, it can be deleted.
2- AWBs which Destination and Status section are removed to obtain AWBs to be checked.
3- The document that has been created and applied by unit called Adjusted Weight Guide according to dimensions, weight, volume information in COMIS via (List Bookings) or CAP018 (Maintain Booking) screen via AWB numbers listed in Excel. Shipments are checked and their accuracy is examined.
4- If errors or deficiencies are detected, correction mail is sent to the exit station of the cargo, reminder mail is sent if there is no response at the end of a certain period of time.

4.1.14.2. Managements Effected By Process

- Cargo Capacity Control and Planning Management
- Cargo Overseas Sales Organization
- Cargo Revenue and Price Management
- Cargo Hub Operations Management

How many staff perform the operation? 1
Allocated man/hour (monthly): 140
Frequency of process: Daily
Programs used in process: COMIS, Excel, Outlook

4.1.15. Spot Price Confirmation

Spot fees are sent by the region. The evaluation approving the spot fee requests received in the form of a table is made via e-mail. Therefore, the expectation from this

automation batch IDs, specifying the IDs of the desired ones, automation program COMIS system to enter the process of confirming the individual spot.

4.1.15.1. Process Steps

1- Spot fee requests are sent by the regions.
2- Spot requests are evaluated by e-mail by the payer friends and the spot fees to be approved are entered into the COMIS system and approved.
3- After entering the COMIS system via internet and entering the user name and password, select the "TRF007 - List Spot Rate Request" screen from the menu. In this screen, Spot Rate ID, ID of the spot price to be approved is entered and List button is clicked. Then select the information displayed on the screen and click the "View Spot Rate" button.

4- The place under the name Requested Spot is copied to the Offer Spot section and after the systematic restrictions on whether or not the spot can be approved, the spot is confirmed by pressing the "Approve below" button. This process described as one by one for each spot must be made.
5- The systemic restrictions on whether or not to confirm the spot are as follows: a- The AWB of the spot is specified in the AWB / UBR details section. This means that if there is a letter (D) next to AWB, it means that it is detached and the spot should not be confirmed. Likewise, if "awk" appears next to "(executed)", the spot should not be confirmed. If the error message appears that the finalized spot is being acknowledged, the spot must not be confirmed again.

4.1.15.2. Managements Effected By Process

- Cargo Revenue and Price Management
- Price Chief

How many staff perform the operation? 14

Allocated man/hour (monthly): 100
Frequency of process: Daily
Programs used in process: COMIS, Outlook

4.1.16. Receipt Control

Daily check of receipts is collected at warehouse, order and paper acceptance services.

4.1.16.1. Process Steps

1- Extract from the bank is taken daily.
2- Bank receipts are checked with the receipts used.

4.1.16.2. Managements Effected By Process

- Cargo Financial Management

How many staff perform the operation? 2
Allocated man/hour (monthly): 100
Frequency of process: Daily
Programs used in process: Finansbank, Excel

4.1.17. Weekly Debt to Credited Customers

The debts of 150 companies that worked on credit are sent via COMIS system and sent via e-mail 3 days a week.

4.1.17.1. Process Steps

1- The current debit is taken from each customer from COMIS. (Excluding creditor and 0 balance)

2- Excel is processed and automatic mail is sent.

4.1.17.2. Managements Effected By Process

- Cargo Financial Management

How many staff perform the operation? 1
Allocated man/hour (monthly): 50
Frequency of process: Three times a week (Monday, Wednesday, Friday)
Programs used in process: COMIS

4.1.18. Requesting Excess Stock ULDs from stations

The COMIS system has maximum ULD quotas set for each station. The ULD Monitoring Department checks the station stocks on the 2nd and 4th day of each week and requests that the excess ULDs be sent back by e-mail from the stations exceeding the ULD quota.

4.1.18.1. Process Steps

1. Station stocks are checked.
2. Excess ULDs are detected.
3. Excess ULDs are requested back from the station.

4.1.18.2. Managements Effected By Process

- Cargo Facility, Equipment and Logistics Management

How many staff perform the operation? 1
Allocated man/hour (monthly): 40
Frequency of process: Two times a week
Programs used in process: COMIS, Excel

4.1.19. Requesting Special Cargo ULDs from stations

In order to return the ULDs to the center after being used, the ULD Tracking Chief checks the stocks of the stations on the 2nd and 4th days of each week and requests that the special ULDs in the station be returned by mail.

4.1.19.1. Process Steps

1. Station stocks are checked.
2. Special cargo ULDs are detected.
3. The ULDs are requested back from the station.

4.1.19.2. Managements Effected by Process

Cargo Facility, Equipment and Logistics Management
How many staff perform the operation? 1
Allocated man/hour (monthly): 40
Frequency of process: Two times a week
Programs used in process: COMIS, Excel

4.1.20. Flight Change

Change bookings with manual trigger in case of cancellation or multiple changes.

4.1.20.1. Process Steps

1- Getting the necessary details with Excel
2- Updating the details transmitted from the CAP018 screen

4.1.20.2. Managements Effected By Process

- Cargo Capacity Planning and Control Management

How many staff perform the operation? 34
Allocated man/hour (monthly): 30
Frequency of process: Daily
Programs used in process: COMIS

4.1.21. Export Declaration "Customs"

It is the process that filling in declaration software.

4.1.21.1. Process Steps

- The information that is created in evolution is drawn from COMIS and transferred to the program.

4.1.21.2. Managements Effected By Process

- Cargo Customs Management

How many staff perform the operation? 3
Allocated man/hour (monthly): 50
Frequency of process: Daily
Programs used in process: COMIS

4.1.22. Message Transmission to Customs with COMIS

FWB, FHL messages are sent in XML file format to the customs using electronic manifesto system.

4.1.22.1. Managements Effected By Process

All overseas Departments (85 points transmitted by system)
How many staff performs the operation? 40
Allocated man/hour (monthly): 120
Frequency of process: Daily
Programs used in process: COMIS

4.1.23. AWB Information Inputs Message Transmission Control

Reporting error messages in message transmission and eliminating errors with COMIS Control.

4.1.23.1. Managements Effected By Process

- All overseas Managements

4.1.24. AWB Data Quality Reporting

It is noted the regular withdrawal of CRA reports and reporting of COMIS, e-archive data and incomplete transactions.

4.1.24.1. Managements Effected by Process

All overseas Managements and Cargo Financial Affairs Management.

5. MULTI-CRITERIA DECISION-MAKING APPROACHES

5.1. TODIM Approach

In this method; there are *n* alternatives to be ranked and m criteria which are quantitative or qualitative; and it is assumed that one of these criteria is selected as reference criteria. In this Technique, the values of alternatives dependent on criteria should be numerical and normalized. As a result, attributive canon thought in verbal context are converted to cardinal measure (Gomes, Rangel, & Maranhão, 2009; Gomes & Rangel, 2009).

By examining the variables according to all criteria, an evaluation matrix is created in which all valuations are numerical. Their normalization is in this situation, made by utilizing each criterion, which is the separation of the valuation of one alternative by the sum of all the alternatives. As a result of the normalization of each criterion, a matrix with all amounts between zero and one is obtained. It is called the matrix of scores of normalized alternatives according to canon. **P** = $[P_{nm}]$, with n referring to the number of options and m to the number of criteria, as illustrated in Table 5.1.

Table 5.1: Normalized alternatives' scores against criteria

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	C_8
A_1	P_{11}							
A_2	P_{21}.....							
A_3	P_{31} …..							
A_4	P_{41}.....							
A_5	P_{51}.....							
A_6	P_{61}.....							
A_7	P_{71}.....							
A_8	P_{81}.....							
A_9	P_{91}.....							
A_{10}	P_{101}.....							

First, the weights of the criteria are correlated and then normalized. After these steps, fractional matrices of domination and the last domination matrix are calculated. In accordance with the relative value given for each criterion, it is decided which criterion *r* value will be selected as the reference criterion for computations.

Therefore, the criterion with the highest relative weight is generally preferred as the reference criterion. The AHP approach is preferred to find out the weight of every criterion and is then normalized. That's why, w_{rc} is found by dividing the weight of criterion c by the weight of r of the reference criteria. The use of w_{rc} ensures that all pairs of differentiations between performance evaluations are converted to a similar size, that is, to reference criteria. The final computation of the dominance of each option A_i that is now included in the probability theory on each alternative A_j, is explained by the mathematical definition in the Equation (5.1). (Gomes et al., 2009; Gomes & Rangel, 2009).

$$V(x) = \begin{cases} x^{a} & if\ x \geq 0 \\ -\theta(-x)^{\beta} & if\ x < 0 \end{cases} \quad (5.1)$$

At this point, profits and losses are found according to the starting point. Algorithmically, a TODIM implementation follows the steps given (all symbols are explained immediately after mathematical formulas):

Step 1: First of all, the decision matrix related to the problem is created.

Step 2: The decision matrix is normalized separately with Equation (5.2) and Equation (5.3) for the benefit and cost criteria.

$$R_{ij} = \frac{x_{ij} - \min(x_{ij})}{\max(x_{ij}) - \min(x_{ij})} \quad (5.2)$$

$$R_{ij} = \frac{\max(x_{ij}) - x_{ij}}{\max(x_{ij}) - \min(x_{ij})} \quad (5.3)$$

Step 3: After the weight (w_j) of each criterion is calculated, the reference criterion is decided by the decision maker. The reference criterion is the most important one. The relative weight (w_{jr}) of the criteria to the reference criterion (C_r) is calculated by Equation (5.4).

$$W_{jr} = w_j / w_r \quad (5.4)$$

Step 4: The dominance score of each criterion according to the other criterion is calculated.

$$\delta (A_i , A_j) = \sum_{c=1}^{m} \varphi_c (A_i , A_j) \qquad i,j = 1,\ldots\ldots,n \tag{5.5}$$

$$\varphi_c (A_i , A_j) = \begin{cases} \sqrt{\frac{w_{rc}(P_{ic}-P_{jc})}{\sum_{c=1}^{m} w_{rc}}} \; if \; (x_{ic} - x_{jc}) > 0 \\ 0 \qquad \text{if } (x_{ic} - x_{jc}) = 0 \\ \frac{-1}{\theta} \sqrt{\frac{(\sum_{c=1}^{m} w_{rc})(P_{jc}-P_{ic})}{w_{rc}}}, \; otw \end{cases} \tag{5.6}$$

Step 5: In the last step, a ranking related to alternatives is obtained. For this, the general dominance score (ξ_i) of the A_i alternative is found by Equation (5.7) by normalizing the dominance scores calculated in the previous step:

$$\xi_i = \frac{\sum_{j=1}^{n} \delta(A_i , A_j) - min_i \sum_{j=1}^{n} \delta(A_i , A_j)}{max_i \sum_{j=1}^{n} \delta(A_i , A_j) - min_i \sum_{j=1}^{n} \delta(A_i , A_j)} \text{ , (i = 1, 2, 3, ……., n)} \tag{5.7}$$

where ,

$\delta (A_i , A_j)$ = measurement of dominance of alternative A_i over alternative A_j ;

n = the total number of alternatives ;

m = the total of criteria;

c = a generic criterion ;

w_{rc} = relative weight of the criterion and any other , generic criterion c. The r identifies a reference criterion. That can be, for instance, the criterion that the most important one. Any criterion can be chosen as the reference criterion. And this particular selection does not affect the last results from the calculations.

P_{ic}, P_{jc} = evaluations of alternatives i and j with respect to criterion c ;

θ = attenuation factor of the losses ; various preferences of θ lead to different forms of the prospect theoretical value function in the negative quadrant;

$\Phi_c(A_i , A_j)$ = contribution of criterion c to function $\delta (A_i , A_j)$, when we compare alternatives A_i and A_j ,

ξ_i = normalized overall performance of alternative A_i, when we compare against all other alternatives.

5.2. WEDBA

The steps followed in this method are as given below (Rao & Singh, 2011).

Step 1: Decision matrix

The decision matrix contains a set of feature data for each option. It means determining the decision matrix, determining the qualities or canon and evaluating the qualities performance for various alternatives. For a multi attribute decision making issue, with *m* options and *n* features, the *ith* option may be stated as $Y_i = (y_{i1}, y_{i2}, \ldots, y_{ij}, \ldots, y_{in})$ in decision matrix , where y_{ij} is the performance assessment (or measurement of performance) of attribute *j* ($j = 1,2,3,\ldots,n$) for alternative *i* ($i = 1,2,3,\ldots,m$).

The usual pattern of decision matrix *D* is represented as below:

$$D = \begin{pmatrix} y_{11} & \cdots & y_{1j} & \cdots & y_{1m} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ y_{i1} & \cdots & y_{ij} & \cdots & y_{jm} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ y_{n1} & \cdots & y_{nj} & \cdots & y_{nm} \end{pmatrix} \tag{5.8}$$

The attributes can be objective or subjective or integrated. The subjective attributes are showed in lingual expressions and these are needed to be turned into accordant crisp scores.

Formerly a qualitative feature is signified on a platform measure then the other options can be assessed with one another on this feature in the same mode manner as that for quantitative features.

Step 2: Standardization

In the decision-making period, standardization of features is done to facilitate operations and obtain more objective data. The values of standard attribute data are also titled as standard scores. The essential thing of standard score is that it has a mean of zero and a variation of 1 that computations for the name normalized. The normalized decision matrix D^* is represented as below:

$$D^* = \begin{pmatrix} Z_{11} & \cdots & Z_{1j} & \cdots & Z_{1n} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ Z_{i1} & \cdots & Z_{ij} & \cdots & Z_{in} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ Z_{n1} & \cdots & Z_{nj} & \cdots & Z_{mn} \end{pmatrix} \quad (5.9)$$

Where,

$$Z_{ij} = \frac{x_{ij} - \mu_j}{\sigma_j} \quad (5.10)$$

$$X_{ij} = \frac{y_{ij}}{max_j(y_{ij})} \quad ; \quad if\ j^{th}\ attribute\ is\ benefical \quad (5.11)$$

$$X_{ij} = \frac{min_i(y_{ij})}{y_{ij}} \quad ; \quad if\ j^{th}\ attribute\ is\ \text{non} - benefical \quad (5.12)$$

$$\mu = \frac{1}{m}\sum_{i=1}^{m} x_{ij} \quad (5.13)$$

$$\sigma_j = \sqrt{\frac{\sum_{i=1}^{m}(x_{ij} - \mu_j)^2}{m}} \quad (5.14)$$

Z_{ij} is the normalized valuation of x_{ij}; μ_j is the awaited valuation or mean value of *jth* feature and σ_j is the standard deviation of the feature *j*. Finding the distances from ideal and non-ideal points is easier with the help of standardized decision matrix.

Step 3: Ideal and anti-ideal points

Optimal points are the cluster of the most favorable attributes for the solution. Non-ideal points are the cluster of attributes that are undesirable or least desired in the solution. Optimal points, indicated by *'a*'* and anti-ideal points, denoted by '*b**' are subtracted from normalized decision matrix.

$$a^* = \{ a_j^* \} \quad \text{and} \quad b^* = \{ b_j^* \} \text{ where } j = \{ 1,2,\ldots..,n \} \tag{5.15}$$

Step 4: Attribute weights

The weights of the notional importance of the features are determined by the attribute data (i.e. objective weights) for the different alternatives represented in the decision matrix by the decision maker for the recommended mathematics, or a compound of objective weights and subjective choices which are named as integrated weights.

i. Objective weights of importance of the attributes

In this suggested method, the entropy method is suggested for the computation of objective weights (Rao, 2007). If it has similar property values among alternatives, it is dependent on the theory of knowledge, which places a small weight on a property, because it does not help to change alternatives.

The value of the decision data included in the decision matrix and related to each attribute can be calculated by the entropy value *Ej* as,

$$E_j = \frac{-(\sum_{i=1}^{m} p_{ij} \ln p_{ij})}{\ln m} \quad ; (j = 1,2,\ldots,n) \tag{5.16}$$

Where ,

$$P_{ij} = \frac{y_{ij}}{\sum_{k=1}^{m} y_{kj}} \tag{5.17}$$

'y_{ij}' is the valuation of feature *'j'* for alternative '*i'* and '*m*' is the number of alternatives. Divergence degree of the approximate element data covered by every feature (dj);

$$d_j = 1 - E_j \, , \; (1 \leq j \leq n) \tag{5.18}$$

The more different the asses values p_{ij} (i= 1, 2, …, m) for the feature j, the higher its coincident d_j, and the more crucial the feature j for the decision-making issue is deemed (Rao, 2007). The objective weight for each feature '*j'* is computed with Equation (5.19).

$$W_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{5.19}$$

ii. Subjective weights of importance of the attributes

The subjective weights solution depends on the decision maker's choice over the features of the proposed implementation. Depending on their choice, they can assign importance partial weights or use any of the systematic methods to assign relative

importance, such as the analytical hierarchy process (AHP) (Saaty, 2000), points method (Edwards & Newman, 1986), digital logic method (Manshadi et al., 2007), etc.

iii. Integrated weights of importance of the attributes

If decision makers want to use both their objective and subjective weights, integrated weights come into play. It is assumed that w_j^o and w_j^s are the objective and subjective weights severally of *jth* attribute and the integrated weights are determined as:

$$w_j^I = \frac{w_j^o \; x \quad w_j^s}{\sum_{k=1}^{n} w_k^o \; x \quad w_k^s} \tag{5.20}$$

Where, w_j^I is the integrated weight of the *jth* attribute

Step 5: Weighted Euclidean distance, index score and rankings

WEDBA is a method in which the optimum option is the most imminent one to the ideal resolution and farthest from the non-ideal resolution. All measurements ensure that the alternative is closest to the ideal result and farthest from the non-ideal resolution. Euclidean interval is the shortest distance between two points. The total index score of an alternative depends on the ideal solution and the Euclidean distance to non-ideal resolutions. This distance is related to the weights of the features and should be included in the distance measure. The reason for that is that all alternatives are similar to ideal and anti-ideal resolutions, not between themselves.

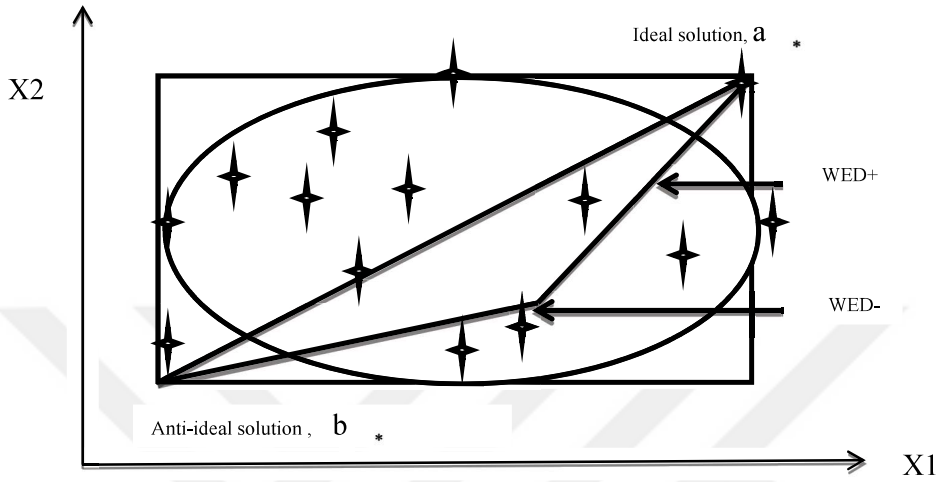


Figure 5.1: Euclidean distance of an alternative to ideal and anti-ideal solutions in 2D space (case of two attributes)

In Figure 5.1 an alternative to ideal and anti-ideal resolutions has been shown to be in 2D space if the Euclidean distance is two properties X_1 and X_2. The real area is given inside the rectangular box. The Euclidean interval between spots P and Q in the 'n' dimensional space is the length of the line section (PQ). In Cartesian coordinates, if $P = (p_1, p_2, \ldots, p_n)$ and $Q = (q_1, q_2, \ldots, q_n)$ are two points in Euclidean n-space, then the interval

From P to Q is given by $d(PQ) = \sqrt{\sum_{i=1}^{n}(p_i - q_i)^2}$ (5.21)

Weighted Euclidean interval (WED) between an alternative *'i'* and ideal spot 'a^*' is defined by WED_i^+ and between an alternative 'i' and anti-ideal point 'b^*' is defined by

$$WED_i^+ = \left[\sum_{j=1}^{m}\{w_j.(Z_{ij} - a_j^*)\}^2\right]^{1/2} \quad \text{For (i = 1, 2, …..,m)} \qquad (5.22)$$

$$WED_i^- = \left[\sum_{j=1}^{m}\{w_j.(Z_{ij} - b_j^*\}^2\right]^{1/2} \text{For (i=1, 2,…, m)} \quad (5.23)$$

The index score is computed by usimg Equation (5.24) :

$$Index\ Score_i = \frac{WED_i^-}{WED_i^- + WED_i^+} \quad (5.24)$$

The index score indicates the relative proximity of an alternative to the ideal resolution. The biggest the index score of an alternative, the closer it is to the ideal solution. The index score is the best solution to the highest alternative decision-making issue.

The last decision can be taken by thinking about practical issues. All obstacles that may be gone through by the user are evaluated at this point. These issues can be presence, economy and administration, and social and political limitations. On the other hand, compromise can only be in part of an alternative with a high index score.

6. REAL CASE APPLICATION

In these applications which will be made with two multi-criteria decision-making techniques, an airline cargo company is trying to choose the most suitable company for Robotic Process Automation.

In this study, an air cargo firm should choose the Robot Company software. And there are 10 alternative firms and 8 Features. Attributes are shown in Table 6.1. Alternatives are represented in Table 6.2. In the TODIM method, when the risk, ie theta, increases, the A1 alternative is the best. This means that when the risk increases, it is the same result as the WEDBA method.

Table 6.1: Attributes

No	Attributes
C1	Speed
C2	Cost
C3	Security
C4	Modularity
C5	Flexibility
C6	Life Cycle
C7	Power Consumption
C8	Labor Hour

Table 6.2: Alternatives

No	Alternatives
1	Company 1
2	Company 2
3	Company 3
4	Company 4
5	Company5
6	Company 6
7	Company 7
8	Company 8
9	Company 9
10	Company 10

6.1. WEDBA

There are 10 robot companies that the airline cargo company has chosen as an alternative and 8 attributes that it has set as the criterion.

Step 1: First, a decision matrix is created, as in other MCDM techniques. As a result of all values of attributes for the bot company choice, decision matrix is represented in Table 6.3.

Table 6.3: Decision matrix for WEDBA

Alternatives	**C1**	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**
1	100,30	20.419,65	1,00	0,667	0,86	80.874	98,00	4.928
2	99,80	19.730,94	0,67	0,136	1,00	98.746	87,00	5.478
3	80,20	17.641,86	0,33	0,333	0,50	85.418	85,00	3.489
4	75,11	18.456,31	0,50	0,500	0,13	80.145	98,00	3.697
5	120,55	15.964,11	0,13	0,500	0,50	95.364	51,00	5.547
6	157,88	12.458,11	0,86	0,136	0,67	92.147	64,00	5.974
7	87,97	14.965,87	0,13	0,136	1,00	88.743	77,00	3.687
8	110,58	21.478,96	0,50	0,500	0,67	81.114	97,00	3.695
9	154,78	13.345,67	0,50	0,667	0,86	80.123	44,00	6.419
10	122,54	22.557,63	0,67	1	0,50	87.459	58,00	3.547

Due to the nature of the method, all values in the decision matrix must be numerical. But neither in real life nor in this problem are all data numerical. It is seen that the attributes C_3, C_4 and C_5 are qualitative. Therefore, to convert linguistic values into numerical values, The Seven-Point Scale Method (Figure 6.1) (a method known in the literature) was used. For other numerical attributes, there is no need to do anything in the decision matrix. Only the values of the alternative for that attribute are included.

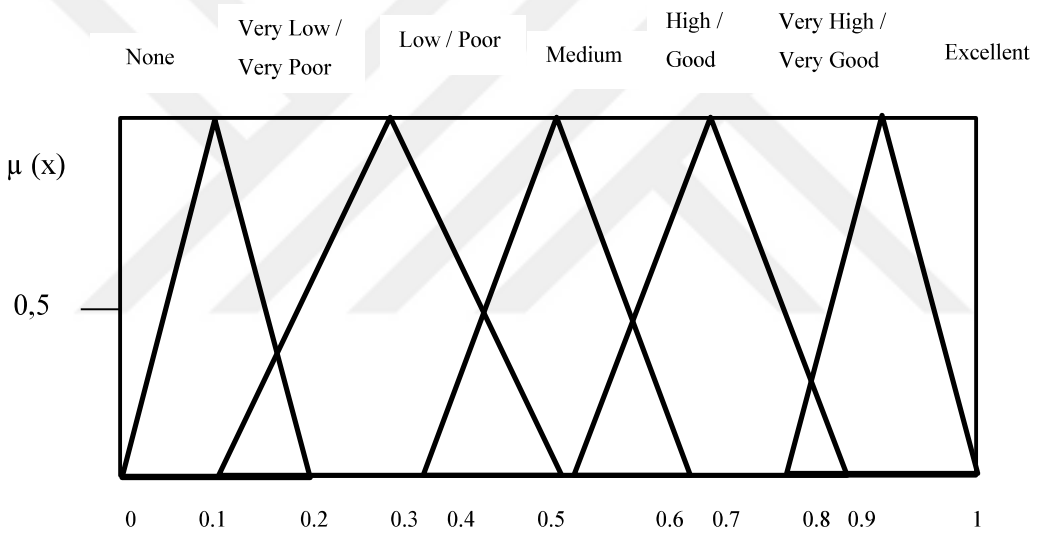


Figure 6.1: Linguistic terms to fuzzy numbers conversion

Seven Point Scale:

The basis of this method is dependent on the study of Chen and Hwang. The crisp score of a fuzzy number 'M' is found as follows:

$$\mu_{max}(x) = \begin{cases} x, & 0 \leq x \leq 1 \\ 0, & otherwise \end{cases} \tag{6.1}$$

$$\mu_{min}(x) = \begin{cases} 1-x, & 0 \leq x \leq 1 \\ 0, & otherwise \end{cases} \tag{6.2}$$

For fuzzy numbers, the left, right and total scores are computed as follows:

$$\mu_L(M_i) = Sup_x\left[\mu_{min}(x)\hat{}\mu_{M_i}(x)\right] \quad (6.3)$$

$$\mu_R(M_i) = Sup_x\left[\mu_{max}(x)\hat{}\mu_{M_i}(x)\right] \quad (6.4)$$

$$\mu_T(M_i) = \frac{[\mu_R(M_i)+1-\mu_L(M_i)]}{2} \quad (6.5)$$

Step 2: After decision matrix, standardization has been implemented to ease process. Standardized values are calculated based on whether attributes are beneficial or non-beneficial. As an example, standardized score of C_1 attribute was calculated. C_1 is non-beneficial attribute. Because the increase of C_1 worsens the solution of the problem. Therefore Equation (5.12) will be used. First; x_{ij} is calculated. For this, the smallest of the relevant row in the decision matrix is divided by the value of that row and column. (For beneficial ones, the number is divided by the largest number in the decision matrix). μ_j is the average of the column. After the standard deviation is found, standardized values are found with Equation (5.14). Values for C_1 attribute are (0.191, 0.213, 1.308, 1.686, -0.558, -1.435, 0.815, -0.224, -1.378, -0.618). All the standardized values are represented in Table 6.4.

Table 6.4: Standardized data of decision matrix

Z_{ij1}	Z_{ij2}	Z_{ij3}	Z_{ij4}	Z_{ij5}	Z_{ij6}	Z_{ij7}	Z_{ij8}
0,190	-0,830	1,749	-1,098	0,752	-0,962	-0,958	0,259
0,213	-0,682	0,508	-1,498	1,281	1,839	-0,650	0,767
1,307	-0,165	-0,733	-0,099	-0,658	-0,250	-0,585	-1,066
1,685	-0,381	-0,112	0,299	-2,069	-1,077	-0,958	-0,875
-0,557	0,347	-1,467	-0,299	-0,658	1,309	1,288	0,830
-1,434	1,866	1,241	-0,499	-0,011	0,805	0,336	1,224
0,815	0,707	-1,467	-0,699	1,281	0,271	-0,293	-0,884
-0,223	-1,038	-0,112	0,899	-0,011	-0,925	-0,933	-0,876
-1,378	1,406	-0,112	1,098	0,752	-1,080	2,034	1,634
-0,618	-1,229	0,508	1,898	-0,658	0,069	0,723	-1,013

Step 3: Ideal and anti-ideal points are the biggest and smallest amounts of the attributes in the decision matrix created in step 2, respectively. According to this, ideal points : a^* = (1.685, 1.866 , 1.749 , 1.898 , 1.281 , 1.839 ,2.034 , 1.634) and anti-ideal points are b^* =(-0.618 , -1.229 , -1.467 , -1.498 , -2.069 , -1.080 , -0.958 , -1.066).

Step 4: Attribute Weights

Objective Weights: Entropy method was utilized for objective weights. Equations (5.16), (5.17), (5.18) and (5.19) will be applied. When it is talked about C_1 attribute again, first it is needed to find p_{ij}. P_{ij1} is calculated by dividing C_1 attribute for each alternative to sum of these values. P_{ij1} values are: 0.09, 0.09, 0.072, 0.068, 0.109, 0.142, 0.079, 0.100, 0.139 and 0.110. ln (P_{ij1}) values are: -2.404, -2.409, -2.627, -2.693, -2.220, -1.950, -2.535, -2.306, -1.970, -2.203. In the equation (5.16); N means number of alternatives. Since all the information requested is obtained; first E_j; then d_j and last w_j which means the objective weight, called dj and the most recent Wj, is calculated. It is 0.075.

Subjective Weights**:** For subjective weights, AHP was used. A binary comparison matrix is created for 8 attributes. The values (subjective weights) resulting from the calculations are as follows.

Table 6.5: Subjective weights of attributes

Attribute	Subjective Weight
1	0.199
2	0.340
3	0.120
4	0.118
5	0.026
6	0.050
7	0.079
8	0.066

Integrated Weights: It is needed to use both objective and subjective weights to find integrated weights. Equation (5.20) was used. Integrated weights are shown in Table 6.6.

Table 6.6: Integrated weights of attributes

Attribute	Integrated Weight
1	0.141
2	0.143
3	0.411
4	0.148
5	0.042
6	0.003
7	0.066
8	0.046

Step 5:

Finding index scores that will determine the ranking is also separate for the three types of weights. Equation (5.22), (5.23) and (5.24) was used. For A_1 alternative WED^+ ; WED^- and index score values for objective weights are shown in Table 6.7.

Table 6.7: Index score for A_1 alternative

WED^+	0.527
WED^-	1.855
Index Score	0.716

Index scores are calculated for all alternatives and weights, and ranking are created. As a result of WEDBA method, final Index Scores and ranks are given in Table 6.8.

Table 6.8: Index scores and rankings

Alternatives	Objective Weights	Rank	Subjective Weights	Rank	Integrated Weights	Rank
1	0,716	1	0,299	7	0,669	1
2	0,598	3	0,280	9	0,497	5
3	0,314	9	0,398	6	0,300	8
4	0,547	6	0,405	5	0,555	4
5	0,249	10	0,423	4	0,192	10
6	0,672	2	0,619	1	0,655	2
7	0,381	8	0,508	3	0,218	9
8	0,472	7	0,232	10	0,412	7
9	0,561	5	0,596	2	0,480	6
10	0,567	4	0,292	8	0,556	3

For subjective weights of attribute; the ranking of alternatives are 1 - 6- 2- 10 – 9- 4- 8- 7- 3- 5 and for the objective and integrated weights rankings are 6 – 9 – 8 – 5 – 4 – 3 – 1 – 10 – 2 – 7 and 1 – 6 – 10 – 4 – 2 – 9 – 8 – 3 – 7 – 5.

6.2. TODIM

In this study; Robotic Process Automation companies are evaluated for Airline Cargo Company. This assessment was dependent on ten RPA companies with eight criteria thus is a real-life problem.

Step 1:

In the evaluation of criteria containing qualitative data, a 5-point scale was used (1: very bad, 5: very good). The corresponding numbers of the quantitative ones are placed in the matrix just like in the WEDBA method. Decision matrix for TODIM method is shown in Table 6.9.

Table 6.9: Decision matrix for TODIM

Alternatives	C1	C2	C3	C4	C5	C6	C7	C8
1	100,30	20.419,65	5	1	4	80.874	98,00	4.928
2	99,80	19.730,94	3	1	3	98.746	87,00	5.478
3	80,20	17.641,86	2	3	2	85.418	85,00	3.489
4	75,11	18.456,31	4	3	1	80.145	98,00	3.697
5	120,55	15.964,11	1	2	2	95.364	51,00	5.547
6	157,88	12.458,11	4	2	3	92.147	64,00	5.974
7	87,97	14.965,87	1	2	5	88.743	77,00	3.687
8	110,58	21.478,96	5	3	3	81.114	97,00	3.695
9	154,78	13.345,67	4	4	4	80.123	44,00	6.419
10	122,54	22.557,63	3	5	4	87.459	58,00	3.547

Step 2:

The decision matrix is individually normalized for benefit and cost criteria. Equation (5.2) and (5.3) was used for calculations. When it is talked about C_2 criteria (attribute), since it is cost criteria, Equation (5.3) must be used. To do this, from the maximum value of Column, each C_2 column value is subtracted from the decision matrix. And then it divides difference of maximum and minimum column values. Normalized values of C_2 criteria are shown in Table 6.10.

Table 6.10: Normalized value of C_2 criteria

Alternative	Normalized Value
1	0.212
2	0.280
3	0.487
4	0.406
5	0.653
6	1.000
7	0.752
8	0.107
9	0.912
10	0.000

Normalized value for all criteria is shown in Table 6.11.

Table 6.11: Normalization

	C1	C2	C3	C4	C5	C6	C7	C8
A1	0,695	0,211	1,000	0,000	0,750	0,040	0,000	0,491
A2	0,701	0,279	0,500	0,000	0,500	1,000	0,203	0,678
A3	0,938	0,486	0,250	0,500	0,250	0,284	0,240	0,000
A4	1,000	0,406	0,750	0,500	0,000	0,001	0,000	0,070
A5	0,451	0,652	0,000	0,250	0,250	0,818	0,870	0,702
A6	0,000	1,000	0,750	0,250	0,500	0,645	0,629	0,848
A7	0,844	0,751	0,000	0,250	1,000	0,462	0,388	0,067
A8	0,571	0,106	1,000	0,500	0,500	0,053	0,018	0,070
A9	0,037	0,912	0,750	0,750	0,750	0,000	1,000	1,000
A10	0,426	0,000	0,500	1,000	0,500	4,696	0,740	0,019

Step 3:

Criterion weights are calculated with the Analytical Hierarchy Process. The reference criterion is the most crucial criterion for the person who makes the decisions. Equation (5.4) must be used. In this study C_2 is reference criterion. Because its relative weight is 1. The outputs are given in Table 6.12.

Table 6.12: Results of AHP

	C1	C2	C3	C4	C5	C6	C7	C8	W_j	W_{jr}
C1	1	1/3	3	4	3	1/4	1	1/4	0,098	0,288
C2	3	1	5	7	9	5	3	4	0,339	1
C3	1/3	1/5	1	3	3	1	1	1/4	0,071	0,210
C4	1/4	1/7	1/3	1	1	1/5	1/4	1/5	0,029	0,085
C5	1/3	1/9	1/3	1	1	1/2	1/5	1/7	0,029	0,084
C6	4	1/5	1	5	2	1	1/3	1/4	0,100	0,295
C7	1	1/3	1	4	5	3	1	1/3	0,114	0,337
C8	4	1/4	4	5	7	4	3	1	0,220	0,650

Step 4: The dominance scores of the alternatives are calculated according to each other. Equation (5.5) and (5.6) must be used. In the above Table 6.13 there is only dominance score of A_1 alternatives. Other dominance scores exist in Appendix A.1.; A.2.; A.3.; A.4.; A.5; A.6.; A.7.; A.8., and A.9.

Table 6.13: Dominance scores for A1 alternative for $\theta = 1$

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A1,A2	-0,248	-0,440	0,188	0,000	0,084	-3,090	-1,350	-0,920	-5,776
A1,A3	-1,570	-0,900	0,231	-4,160	0,119	-1,560	-1,460	0,320	-8,980
A1,A4	-1,764	-0,756	0,133	-4,160	0,146	0,060	0,000	0,300	-6,041
A1,A5	0,154	-1,140	0,266	-2,940	0,119	-2,780	-2,780	-0,970	-10,071
A1,A6	0,260	-1,520	0,133	-2,940	0,084	-2,460	-2,370	-1,270	-10,083
A1,A7	-1,230	-1,260	0,266	-2,940	-2,960	-2,050	-1,860	0,305	-11,729
A1,A8	0,110	0,188	0,000	-4,160	0,084	-0,360	-0,412	0,304	-4,246
A1,A9	0,253	-1,430	0,133	-5,100	0,000	0,060	-2,980	-1,51	-10,574
A1,A10	0,162	0,268	0,188	-5,890	0,084	-6,820	-2,570	0,322	-14,256
								A1	- 81,756

Step 5: In the last step; overall dominance scores and rankings are obtained. To do this, Equation (5.7) was used.

According to Table 6.14; ranking is A_9, A_{10} , A_6, A_7 , A_8 , A_2 , A_2 , A_5 , A_3 and A_4. It means that number 9 alternative is the best alternative to TODIM.

Sensitivity Analysis

Dominance scores for A1 alternative for $\theta = 1$

θ is flexible value and it can be changed in the formula in step 4. The rankings according to different θ values are as follows (Table 6.15). Also, as the θ value changes, the shape of the expectation value function changes in the negative region of the coordinate system. The results for other theta values are specified in Appendix A.10 and A.13.

Table 6.14: Overall dominance scores for θ = 1

	Dominance Scores	Minimum of Dominance Score	Maximum of Dominance Score	ζ
A1	-81.756	-95.164	-40.710	0.246
A2	-70.954			0.444
A3	-86.093			0.166
A4	-95.164			0.000
A5	-82.985			0.223
A6	-51.374			0.804
A7	-60.642			0.633
A8	-68.551			0.488
A9	-40.710			1.000
A10	-46.465			0.894

Table 6.15: Solutions with different θ

Values	θ=1	θ=2	θ=2.25	θ=3.4	θ=5.6	θ=7.8
Rankings						
1	A9	A5	A2	A1	A1	A1
2	A8	A4	A4	A9	A5	A5
3	A5	A10	A3	A7	A9	A9
4	A2	A7	A1	A6	A7	A3
5	A6	A3	A7	A5	A6	A7
6	A3	A2	A10	A3	A10	A6
7	A4	A9	A9	A10	A2	A2
8	A1	A6	A8	A8	A8	A10
9	A10	A8	A5	A4	A4	A8
10	A7	A1	A6	A2	A3	A4

The increase in the theta value means the risky situations ascend. So, when there is no or less risk the alternative A_9 could be selected, however if there is more risk in the decision-making process the alternative A_1 should be selected actually.

7. COMPARISON OF THE METHODS

First of all, it should be noted that the results of the two methods used in this study are different from each other. According to WEDBA method, Alternative 1 must be selected for Integrated and Objective Weights, but for subjective weights Alternative 6 is the most suitable one. On the other hand, in TODIM method, Alternative 9 must be selected for the value of $\theta = 1$. It is seen that if θ changes, rankings change as well. The company does not have to buy one of the prominent robotic companies. It can diversify the robots by taking a few of them.

Both of the methods are MCDM methods and use decision matrix as first step. But unlike other MCDM methods, TODIM uses expectation theory as well. And gains and losses are defined in TODIM.

8. CONCLUSION

As a conclusion, the air cargo sector, which is specific and critical in the worldwide, provides superiority especially in terms of speed compared to other logistics sectors. When considering air cargo companies, competition becomes more prominent. Increasing the speed, which is the biggest advantage of the air cargo sector will make the companies in a better position against their competitors. At this point, it is reasonable to use RPA technology, which is one of the latest technologies of today. But as with many real-life problems, it is possible to say that this selection problem has a very critical and complex structure. At this point, MCDM methods, which are widely used in the literature, have been used.

In this study, approaches between WEDBA and TODIM's multi-feature decision making methods were used to address the process bot selection problem of the airline cargo industry. The reason why these two methods are preferred is that both are relatively new and include other techniques such as AHP and the Seven Point Scale. In WEDBA, both objective and subjective weights are utilized to achieve integrated weight. The conclusion is that Alternative 1 (Firm 1) is the base alternative for integrated and objective weights. As can be seen from here, the outputs are consistent with each other. The inimitableness of this method is that it also provides resolving to wider selection problems. On the other hand, according to TODIM method, Alternative 9 (Firm 9) is the most suitable company when θ is selected as 1. Sensitivity analysis means that when θ increases (risk increases) results are similar to WEDBA approach's result.

The features presented in this research are general for choosing RPA. On the other hand, scholars can arrange the features to their specific areas. Besides, other MADM methods can be utilized in this processing to find the sturdiness of the consequence. Also, in this

thesis, other MCDM approaches may be utilized to this processing to state the sturdiness of the consequences. On the other hand, Metropolitan metrics can be used instead of Euclidean distance. It can be said that these findings can also be considered in Tactical and Strategic decisions.

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APPENDIX

Table A.1.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A2,A1	0,024	0,151	-2,650	0,000	-2,96	0,3	0,152	0,203	-4,78
A2,A3	-1,550	-0,781	0,133	-4,160	0,084	0,267	-0,754	0,386	-6,375
A2,A4	-1,747	-0,609	-1,870	-4,160	0,119	0,316	0,152	0,366	-7,433
A2,A5	0,156	-1,048	0,188	-2,940	0,084	0,132	-2,41	-0,33	-6,168
A2,A6	0,261	-1,457	-1,870	-2,940	0	0,188	-1,93	-0,875	-8,623
A2,A7	-1,210	-1,180	0,188	-2,940	-4,19	0,231	-1,27	0,367	-10,004
A2,A8	0,113	0,242	-2,650	-4,160	0	0,307	0,145	0,366	-5,637
A2,A9	0,254	-1,360	-1,870	-5,100	-2,96	0,316	-2,63	-1,206	-14,556
A2,A10	0,163	0,308	0,000	0,000	0	-6,07	-2,16	0,381	-7,378
								A2	-70,954

Table A.2.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A3,A1	0,154	0,305	-3,240	0,120	-4,190	0,156	0,165	-1,490	-8,020
A3,A2	0,152	0,260	-1,870	0,120	-2,960	-2,670	0,065	-1,755	-8,658
A3,A4	-0,790	0,165	-2,650	0,000	0,084	0,168	0,165	-0,560	-3,418
A3,A5	0,218	-0,699	0,133	0,082	0,000	-2,310	-2,340	-1,780	-6,696
A3,A6	0,302	-1,230	-2,650	0,082	-2,960	-1,900	-1,840	-1,960	-12,156
A3,A7	0,095	-0,880	0,133	0,082	-5,130	-1,330	-1,130	-0,555	-8,715
A3,A8	0,189	0,358	-3,240	0,000	-2,960	0,151	0,159	-0,560	-5,903
A3,A9	0,296	-1,120	-2,650	-2,940	-4,190	0,168	-2,570	-2,130	-15,136
A3,A10	0,223	0,406	-1,870	-4,160	-2,960	-6,640	-2,090	-0,300	-17,391
								A3	-86,093

Table A.3.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A4,A1	0,172	0,256	-1,870	0,120	-5,130	-0,624	0,000	-1,380	-8,456
A4,A2	0,170	0,206	0,133	0,120	-4,190	-3,160	-1,330	-1,660	-9,711
A4,A3	0,077	-0,480	0,188	0,000	-2,960	-1,680	-1,450	0,125	-6,180
A4,A5	0,231	-0,850	0,231	0,080	-2,960	-2,850	-1,470	-1,690	-9,278
A4,A6	0,312	-1,320	0,000	0,080	-4,190	-2,530	-2,090	-1,870	-11,608
A4,A7	0,123	-1,010	0,231	0,080	-5,920	-2,140	-2,950	0,025	-11,561
A4,A8	0,204	0,310	-1,870	0,000	-4,190	-0,720	-2,090	0,014	-8,341
A4,A9	0,306	-1,220	0,000	-2,940	-5,130	0,010	-2,560	-2,050	-13,584
A4,A10	0,236	0,370	0,133	-4,160	-4,190	-6,850	-2,090	0,106	-16,445
								A4	-95,164

Table A.4.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A5,A1	-1,580	0,386	-3,740	0,084	-4,190	0,278	0,311	0,215	-8,236
A5,A2	-1,600	0,350	-2,650	0,084	-2,960	-1,340	0,273	0,072	-7,771
A5,A3	-2,230	0,237	-1,870	-2,940	0,000	0,231	0 ,265	0,393	-5,914
A5,A4	-2,370	0,289	-3,240	-2,940	0,084	0,285	0,311	0,372	-7,209
A5,A6	0,209	-1,010	-3,240	0,000	-2,960	0,131	0,164	-0,810	-7,516
A5,A7	-2,000	-0,540	0,000	0,000	-5,130	0,188	0,231	0,374	-6,877
A5,A8	-1,100	0,430	-3,740	-2,940	-2,960	0,276	0,308	0,373	-9,353
A5,A9	0,200	-0,870	-3,240	-4,160	-4,190	0,286	-1,070	-1,160	-14,204
A5,A10	0,048	0,470	-2,650	-5,100	-2,960	-6,220	0,120	0,387	-15,905
								A5	-82,985

Table A.5.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A6,A1	-2,670	0,516	-1,870	0,084	-2,960	0,246	0,268	0,280	-6,106
A6,A2	-2,680	0,494	0,133	0,084	0,000	-1,880	0,220	0,192	-3,437
A6,A3	-3,100	0,417	0,188	-2,940	0,084	0,190	0 ,210	0,430	-4,521
A6,A4	-3,200	0,448	0,000	-2,940	0,119	0,253	0,268	0,413	-4,639
A6,A5	-2,140	0,342	0,231	0,000	0,084	-1,310	-1,450	0,179	-4,064
A6,A7	-2,940	0,289	0,231	0,000	-4,190	0,000	0,165	0,414	-6,031
A6,A8	-2,410	0,550	-1,870	-2,940	0,000	0,135	0,264	0,414	-5,857
A6,A9	-0,615	0,172	0,000	-4,160	-2,960	0,243	-1,790	-0,830	-9,940
A6,A10	-2,090	0,582	0,133	-5,100	0,000	0,254	-0,985	0,427	-6,779
								A6	-51,374

Table A.6.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A7,A1	0,120	0,427	-3,740	0,084	0,084	0,205	0,210	-1,380	-3,990
A7,A2	0,118	0,400	-2,650	0,084	0,119	-2,310	0,145	-1,660	-5,754
A7,A3	-0,980	0,299	-1,870	-2,940	0,146	0,133	0 ,130	0,122	-4,960
A7,A4	-1,260	0,342	-3,240	-2,940	0,168	0,214	0,210	-0,110	-6,616
A7,A5	0,196	0,183	0,000	0,000	0,146	-1,880	-2,050	-1,690	-5,095
A7,A6	0,287	-0,855	-3,240	0,000	0,119	-1,350	-1,450	-1,880	-8,369
A7,A8	0,163	0,467	-3,740	-2,940	0,119	0,202	0,200	-0,110	-5,639
A7,A9	0,280	-0,680	-3,240	-4,160	0,084	0,215	-2,310	-2,050	-11,861
A7,A10	0,202	0,504	-2,650	-5,100	0,119	0,215	-1,750	0,102	-8,358
								A7	-60,642

Table A.7.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A8,A1	-1,130	-0,550	0,000	0,120	-2,960	0,036	0,046	-1,380	-5,817
A8,A2	-1,150	-0,710	0,188	0,120	0,000	-3,070	-1,270	-1,660	-7,552
A8,A3	-1,930	-1,050	0,231	0,000	0,084	- 1,519	-1,390	0,124	-5,450
A8,A4	-2,090	-0,930	0,133	0,000	0,119	0,072	0,046	-0,067	-2,716
A8,A5	0,108	-1,260	0,266	0,084	0,084	-2,760	-2,730	-1,690	-7,898
A8,A6	0,236	-1,620	0,133	0,084	0,000	-2,430	-2,310	-1,870	-7,777
A8,A7	-1,670	-1,370	0,266	0,084	0,000	-2,020	-1,790	0,025	-6,475
A8,A9	0,228	-1,540	0,133	-2,940	-2,960	0,072	-2,930	-2,050	-11,987
A8,A10	0,118	0,190	0,188	-4,160	0,000	-6,810	-2,510	0,106	-12,878
								A8	-68,551

Table A.8.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A9,A1	-2,590	0,480	-1,870	0,147	0,000	-0,630	0,337	0,334	-3,792
A9,A2	-2,600	0,460	0,231	0,147	0,084	-3,160	0,301	0,265	-4,272
A9,A3	-3,030	0,379	0,000	0,084	0,119	-1,680	0,294	0,469	-3,365
A9,A4	-3,140	0,414	0,224	0,084	0,146	-0,100	0,337	0,452	-1,583
A9,A5	-2,059	0,296	0,231	0,120	0,119	-2,860	0,121	0,256	-3,776
A9,A6	0,060	-0,509	0,135	0,120	0,084	-2,540	0,205	0,183	-2,262
A9,A7	-2,870	0,232	0,058	0,120	-2,960	-2,150	0,264	0,453	-6,853
A9,A8	-2,330	0,522	0,182	0,084	0,084	0,072	0,334	0,452	-1,392
A9,A10	-1,990	0,556	0,133	-2,940	-2,960	-6,850	0,172	0,464	-13,415
								A9	-40,710

Table A.9.

	C1	C2	C3	C4	C5	C6	C7	C8	TOTAL
A10,A1	-1,650	-0,790	-2,650	0,169	-2,960	0,682	0,290	-1,460	-8,369
A10,A2	-1,670	-0,900	0,000	0,169	0,000	0,607	0,247	-1,720	-3,267
A10,A3	-2,290	-1,190	0,133	0,120	0,084	0,664	0,238	0,060	-2,181
A10,A4	-2,420	-1,090	-1,870	0,120	0,119	0,680	0,290	-0,481	-4,652
A10,A5	-0,495	-1,380	0,188	0,147	0,084	0,622	-1,060	-1,760	-3,654
A10,A6	0,204	-1,710	-1,870	0,147	0,000	0,636	0,112	-1,930	-4,411
A10,A7	-2,060	-1,480	0,188	0,147	-4,190	0,650	0,200	-0,466	-7,011
A10,A8	-1,210	-0,561	-2,650	0,120	0,000	0,681	0,287	-0,481	-3,814
A10,A9	0,195	-1,640	-1,870	0,084	-2,960	0,685	-1,500	-2,100	-9,106
								A10	-46,465

Table A.10. (θ = 7.8)

Alternative	OVERALL
A1	-0,015
A2	-2,259
A3	-1,386
A4	-6,584
A5	-0,546
A6	-2,183
A7	-1,459
A8	-4,349
A9	-0,682
A10	-2,664

Table A.11. (θ =2)

Alternative	OVERALL
A1	-8,113
A2	-5,149
A3	-4,911
A4	-3,138
A5	-2,895
A6	-6,912
A7	-4,724
A8	-7,700
A9	-2,358
A10	-3,890

Table A.12. (θ =2.25)

Alternative	OVERALL
A1	-3,497
A2	-2,609
A3	-2,688
A4	-2,632
A5	-5,753
A6	-6,876
A7	-3,564
A8	-5,678
A9	-4,079
A10	-3,582

Table A.13. (θ =5.6)

Alternative	OVERALL
A1	-1,497
A2	-4,009
A3	-6,688
A4	-5,632
A5	-1,753
A6	-2,876
A7	-2,844
A8	-5,458
A9	-2,079
A10	-3,580

BIOGRAPHICAL SKETCH

The author of this thesis was born in 1991 in Samsun, Turkey. She has graduated Bursa Anatolian Boys High School in 2009, and started her undergraduate education in the Industrial Engineering Department of the Engineering and Architecture Faculty of Uludag University in 2009-2013 term, she has a business work experience of 6 years. Since 2014, she has been working in Air cargo sector as a specialist.

PUBLICATIONS

Conference Papers

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