INTERCONNECTED GRID FLIGHT NETWORK MODEL FOR CORPORATE SUSTAINABILITY IN AIRLINES

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ABSTRACT

Anadolu University is the only university in the world operating an international airport of its own. With this concept, Research carried out within the scope of the Hasan Polatkan Airport operated by Anadolu University is based on the idea of "Using public resources with higher capacity for public benefit". Thanks to this study, it is aimed to present new emerging optimum market to airlines. It will be new alternative with full opportunities in view of place, facilities, security level, city based advantages, supports of Anadolu University. The assessment and selection of the applicability of the developed interconnected flight model for sustainability has been dealt with as a multi-criteria decision problem, in which there are factors that are difficult to quantify and the optimizing of various stakeholders in the aviation sector is a necessary objective. In the construction of network models, specific criteria have been considered and the analysis have been based on BOCR criteria, which are defined as benefit, opportunity, cost and risk criteria based on the Analytical Network Process method, because of the relationship and interaction between the criteria. As a result of evaluation of the flight network scenarios, it is figured out that the best alternative is Eskişehir-İstanbul-Cologne (AOE-IST-CLG). Another notable result is that Germany has a high potential for sustainability for all of its cities included in the study. In the 13 scenarios submitted, the Brussels line has the qualities that can be characterized as a regular charter, while Prague is less advantageous compared to the other options. Similarly, the results of the evaluations and analyses show that flights to Cologne through Athens with a connection at Eskişehir are not as effective as the other scenarios.

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STRUCTURED ABSTRACT

Purpose: Research carried out within the scope of the Hasan Polatkan Airport operated by Anadolu University are based on the idea of "Using public resources with higher capacity for public benefit". The aim of this study is to provide an optimal alternative for flights to be carried out from Eskişehir according to the interconnected flight network model.

Design/Methodology/Approach: In this study, the analytical network process method was used. In the construction of network models, specific criteria have been considered and the analysis have been based on BOCR criteria, which are defined as benefit, opportunity, cost and risk criteria based on the Analytical Network Process method, because of the relationship and interaction between the criteria.

Findings/Results/Discussion: In order to solve this problem in this study, it is suggested to select the optimum flight alternatives by following the suggested pre-selection process steps and then using the developed Analytical Network Process (ANP) model. In this study, the Analytical Network Process was chosen as the most suitable choice among the alternatives of optimum flight routes, so that the Analytical Network Processor should be able to handle all the dependencies and feedback between the criteria and the qualitative, quantitative, abstract or concrete. It is the first and most comprehensive mathematical theory that makes it possible to use all kinds of data in the decision-making process and to make decisions as a group. On the other hand, today, airlines take care about the concept of sustainability in order to ensure the continuity of their development. The concept of sustainability has been built on three main dimensions: economic, environmental and social. If the concept of sustainability is taken up for business, it turns out that in order for a corporate's development to be sustainable, it must have not only economic but also environmental and social superior performance. After determining the relationships among all the elements included in the proposed ANP model and making related connections, pairwise comparisons were made by using expert opinions and the model was synthesized and the results were obtained. According to the results obtained from the proposed ANP model, the most suitable alternative is Eskişehir-İstanbul-Cologne. As a result of talks with the Eskişehir Chamber of Commerce and Eskişehir Chamber of Industry, the concentration of demand in Turkey for international flights to Germany is tied to the fact that many activities and events (fairs, etc.) take place in Germany. As a result, the most significant contribution of this study to the aviation sector is the creation of a comprehensive and extensible ANP model in the selection of optimum flight models in terms of benefit, opportunity, cost and risk criteria for sustainable development. Another notable result is that Germany has a high potential for sustainability for all of its cities included in the project. For further research, airlines can easily use this proposed ANP model by adapting to them by changing alternatives and adding specific criteria according to their needs.

As a result of this research, it is figured out that the Eskişehir-İstanbul-Cologne line is the best alternative. The second best line is the Eskişehir-İzmir-Cologne line and the third best line is the Eskişehir-İzmir-Frankfurt line. These are followed by the Eskişehir-İstanbul-

Brussels line. It is seen that there is a demand for the Eskişehir-Brussels line, which offers direct flights. However, the high intensity of demand for the Eskişehir-Brussels line is only for around six months of the season and it does not peak throughout the year. Another notable result is that Germany has a high potential for sustainability for all of its cities included in the project. In the 13 scenarios submitted, the Brussels line has the qualities that can be characterized as a regular charter, while Prague is less advantageous compared to the other options. Similarly, the results of the evaluations and analyses show that flights to Cologne through Athens with a connection at Eskişehir are not as effective as the other scenarios.

Considering current global economic conditions, as well as the current situation of the Turkish economy and the aviation sector, especially airlines, it is of utmost importance to use resources more efficiently and appropriately. This project, which has the potential to provide infrastructure for future work, has been designed to continue with new projects including other regions of the world.

Research Limitations/Implications: Atatürk International Airport is the most used airport for international connected flight in Turkey. But it has also some limitations about slots and intense traffics. According to previous study which is carried out by (Küçük Yılmaz & all, 2016), it is stated that the flight models includes İstanbul and İzmir, respectively. It is taken into account previous study's results while developing flight model suggestions.

Practical Implications: As a result of completed successfully this study, it is expected that the air transportation's potential passenger demand guidance to all airlines that will make commercial passenger flight. Connected flight network model suggestions developed in this research, provide contribution to airline's research and development activities.

Social Implications: As a result of this study, with determined the grid network flights, flights can be scheduled and this makes contribution to the city's improvements. Proposed flights was scheduled by the cooperation with Eskişehir Chamber of Commerce and Eskişehir Chamber of Industry as a management of Eskişehir Hasan Polatkan Airport. University's entrepreneurships will be improved and also Hasan Polatkan Airport' using rate will be increased.

Originality/Value: It is thought that with this research, Eskisehir and Airport feasibility and including current social, economic and cultural dynamics of the city, make significant contribution to academic literature and will also include capacity analysis by presenting findings belongs to Eskisehir's airline passenger demand. It has special feature that is the first study used in analytical network process with BOCR criteria to analyze which flight connections will be the correct one for passengers, city and airlines. Since strategic decisions taken in the aviation sector have international influence and expert opinions are consulted over the course of taking strategic decisions. The analysis has been conducted, based on expert opinions and referred to these pairwise comparisons.

HAVAYOLLARINDA KURUMSAL SÜRDÜRÜLEBİLİRLİK İÇİN BAĞLANTILI GRİD UÇUŞ AĞI MODELİ

ÖZET

Anadolu Üniversitesi dünyada uluslararası bir havalimanını kendi başına işleten tek üniversitedir. Bu bağlamda Anadolu Üniversitesi tarafından işletilen Hasan Polatkan Havalimanı kapsamında yapılan araştırma "kamu kaynaklarının kamu yararına daha yüksek kapasiteli kullanılması" fikrine dayanmaktadır. Bu çalışma ile Anadolu Üniversitesinin konumu, imkânları, güvenlik seviyesi, şehir merkezi avantajları ve sağladığı destekler açısından havayolu şirketlerine yeni bir alternatif olarak, optimum bir pazar sağlanması amaçlanmaktadır. Sürdürülebilirlik için dizayn edilen bağlantılı uçuş ağı modelinin seçimi ve uygulanabilirliğinin değerlendirilmesi süreci, havacılık sektöründe çeşitli paydaşların optimizasyonunu gerekli bir hedef olarak ortaya çıkarmakta bu ise ölçülmesi zor faktörleri içermektedir. Bu nedenle bu faktörlerin belirlenmesi ve analizi, çok kriterli karar verme problemi olarak ele alınmıştır. Ağ modelleri oluşturulmasında belirli kriterler göz önüne alınarak ve analiz kriterleri arasındaki ilişki ve etkileşim nedeniyle Analitik Ağ Süreci Yöntemine dayalı fayda, fırsat, maliyet ve risk kriterleri olarak tanımlanan BOCR kriterleri kullanılmıştır. Uçuş ağı senaryolarının değerlendirilmesinin sonucu olarak, en iyi alternatifin Eskişehir-İstanbul-Köln olduğu anlaşılmaktadır (AOE-IST-CLG). Bir diğer önemli sonuç, Almanya'nın çalışmaya dahil olan tüm şehirler için sürdürülebilirlik açısından yüksek bir potansiyele sahip olmasıdır. Sunulan 13 senaryoda, Brüksel hattının niteliklerinin düzenli seferler niteliğinde sınıflandırıldığı bununla birlikte Prag hattının diğer seçeneklere kıyasla daha az avantajlı olduğu görülmüştür. Benzer şekilde, değerlendirmeler ve analizlerin sonuçlarına gore, Atina üzerinden Köln'e, Eskişehir'den bağlantılı yapılan uçuşların diğer senaryolar kadar etkili olmadığı görülmüştür.

Anahtar Kelimeler: Havayolu, Havaalanı Yönetimi, Analitik Ağ Süreci, Uçuş Modelleme, Uçuş Tarifelendirme, Grid Ağı.

Introduction

Organizational behavior is a discipline that studies the interaction between individuals, groups and organizations in order to increase the efficiency and the productivity of the organization (Robbins & Judge, 2007: 9; Yıldız, 2013). Interaction in organizational behavior includes the official structure of the organization and the type of work, technology used and methods utilized when working, as well as human behavior, managerial process, and the external environment (Özkalp & Kırel, 2016: 3). In this respect, when considering airports the interaction of the activities of every system within the airport should be taken into consideration. Eskişehir Hasan Polatkan Airport, operated by Anadolu University, provides navigation and air traffic services to aircrafts that fly in

Turkish airspace and that land in and take-off from airports in Turkey, as well as to transit flights that pass through Turkish airspace (2016). In the airport;

- Pilot training courses offered by the university's Faculty of Aeronautics and Astronautics,
- Flights related to the maintenance of aircrafts under 5700 kg,
- Measurement flights of emergency landing and navigation equipment,
- Scheduled and unscheduled domestic commercial flights,
- Scheduled and unscheduled international commercial flights take place.

This study draws on the organizational and environmental parameters of Hasan Polatkan Airport, which is connected to Anadolu University. The interaction of the subjects of organizational behavior such as the individual, group or organization (Özkalp & Kırel, 2016: 3-4) have been taken into consideration for the study. The individual and the group exist within an official organization structure. This structure, which is constructed by the organization management, in developing the relations between the individual and the group, provides order, a system, and contributes to the realization of the organization's goals. Individuals within the official structure, by conducting organizational activities, also serve their own purposes. Each organization is a function of an external environment that surrounds it. The environment differentiates the organization by influencing it through technological and scientific developments, economic activities, cultural and governmental decisions. Organizations analyze these factors with specific tools. For a system to become successful, in other words for it to achieve its goals, it has to have knowledge of its environment and the factors constituting this environment (Koçel, 2014: 314-315).

An organization's work is reflected in the environment in different ways. The environment is the field where the organization's activities take place (Koçel, 2014: 310). By contributing to its structure, expectations, social and economic needs, the organization serves the development of the environment (Özkalp & Kırel, 2016: 3-4). Organizational behavior focuses on four fundamental approaches. These include the interdisciplinary approach, the open-system approach, the scientific method approach, the multiple analysis approach and the contingency approach. The approach tackled in this study is the open-system approach. It states that if it is considered the organization as an open-system, then this system requires several external resources (such as raw materials, labor force, information, financial support and tools) (Özkalp & Kırel, 2016: 10-13). In other words, systems are described as open-systems when there is an energy, information and material exchange between this system and its active environment. An open system takes from its environment and other systems energy, information and material, shapes them, and sends them back to its environment and other systems in several forms (products-services) (Koçel, 2014: 310).

The organization, via the feedback it receives from this environment, learns about the suitability and problems of these products and fixes them in the production process of future products (Özkalp & Kırel, 2016: 13). Enterprises, as they are open systems, do not function in a void but are related to other social systems (Yeşil, 2013: 21). The environment is extremely important for open systems (Koçel, 2014: 314). When an airport organization is approached from the system approach, the following picture emerges.
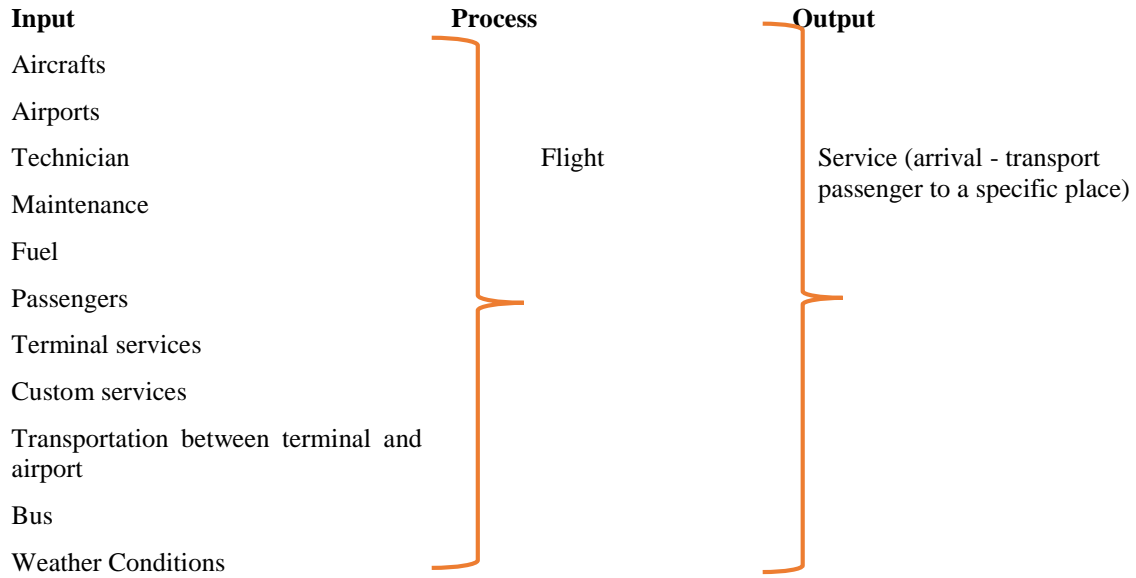
Input	Process	Output
Aircrafts		
Airports		
Technician	Flight	Service (arrival - transport passenger to a specific place)
Maintenance		
Fuel		
Passengers		
Terminal services		
Custom services		
Transportation between terminal and airport		
Bus		
Weather Conditions		

Figure 1: Service business as a system (*Koçel, 2014: 312)*

Airlines require airports for services. For this reason, the capacity and infrastructure of airports should be adequate. It is known that universities benefit from methodological studies based on a range of techniques, practices, organization and planning in the process of eliminating unlimited human needs, using limited resources. In this context, initially, the physical capacities of Eskişehir Hasan Polatkan Airport have been evaluated. Works have been conducted in order to provide convenient use of the airport and optimum flight service. At the outset, the sustainable passenger demand of Eskişehir Hasan Polatkan Airport was determined (Küçük Yılmaz & all, 2016).

Main Section-Anadolu University and the Environment

The environment or the external environment of the organization is constituted of elements that are outside of the organization and affect it. For instance, people, other organizations, economic factors and goals are part of the environment that is outside of it and that affects it. How does the organization adapt to the demands of the environment? This study focuses on Anadolu University. As is well-known, universities have to adopt to the conditions of their environment in order to achieve their goals. Uncertainty in environmental conditions brings about opportunities and hazards. In order to maximize opportunities and protect them from hazards, university administrators need to adapt to environmental conditions (Özgen & Yalçın, 2011: 8-12). The risks that organizations face have risen both in number and type. This created the necessity to manage risks more accurately and swiftly by way of full and timely analysis. In this respect, in order to support the development pace of Turkish civil aviation through sound allocation of limited sources, the managers take and implement effective risk management decisions according to time, cost and opportunity. The fact that today's environment is changing has forced businesses to change because of resource and energy dependence, as well as the necessity of responding to the demands of the environment. Organizations survive if they are able to constantly follow, evaluate and adapt to changes and developments in the external environment (Yeşil, 2013: 22). It is important to determine both the important and critical environmental factors that influence organizations and the degree to which organizations are influenced by them. These environmental factors change from organization to organization. For this reason, each organization has a specific environment and significant factors within this environment

that affect it. For convenience, the environment of the organization will be examined under two general headings. These headings are "internal" and "external" environments (Yeşil, 2013: 24).

The internal environment affects organizational life and poses limits to it. These include organizational schemas and manuals, limited finance and personnel, organizational politics, procedures and regulations, senior managers and traditions (Yeşil, 2013). Everything outside the system forms the external environment. Since closed systems are not related to the environment, the need for such systems is minimal. But for open systems, the environment is extremely important. External environmental factors in an airline operation are airport operations, meteorological conditions, oil production, spare parts production, laws relating to transportation activities, technological developments (Koçel, 2014: 315). In this context, Anadolu University has adequate physical capacities. Anadolu University, which has the first aviation faculty in Turkey and is a pioneer in the field of aviation, is also the first university in the world that has its own airport. International flights also take place from this airport. The slogan of Anadolu University is "Lifelong Education." A university with this vision inevitably leads developments in the field of aviation. Considering current global economic conditions, as well as the current situation of the Turkish economy and the aviation sector, especially airlines, it is of utmost importance to use resources more efficiently and appropriately. Projects carried out within the scope of the Hasan Polatkan Airport operated by Anadolu University are based on the idea of "Using public resources with higher capacity for public benefit."

Eskişehir is an "aviation city" with a high potential for sustainability due to its universities, social and cultural structure, as well as all its resources, abilities, knowledge, capacity and equipment. Strong and powerful findings about sustainable airline passenger potential in Eskişehir have been discovered: Eskişehir can be connected to all the regions of Turkey, as well as to other crucial points in the world, especially Europe, with cross-flights. These connections could be sustainable. It can increase all efforts related to sustainability and helps improve relations between countries.

A capacity analysis of all units (Air Traffic Control/ATC, Pist, Apron, Taxiway/PAT, Terminal, Air Rescue and Fire Fighting/ARFF) related to the airport and operation has been conducted. All units of Hasan Polatkan Airport are sufficient in terms of infrastructure and capacity and are constantly developed with the support of Anadolu University's Rectorate. Continuous efforts have been made to protect and develop the airport's qualities.

As has been determined in various research and projects, Eskişehir has a worldwide international potential. The potential of Anadolu University in terms of Europe is particularly noteworthy. There are specific areas that have an especially high potential in Europe, such as the OEF Cologne office that is affiliated with Anadolu University. In addition, trips are continuously organized through collaborations and agreements made with international universities. Trips are organized due to the meetings of both academic staff and students of our university with students and academics from the associated universities. These trips are distributed throughout the year. There are also extra possibilities (Küçük Yılmaz & all, 2016).

The increase in international activities and the effects of the international environment of organizations have rendered the international environment particularly important (Yeşil, 2013). While it was once enough for organizations to serve and grow only in local markets, this is no longer valid and it is unavoidable for them to participate in international activities. As transportation and communication technologies have developed, the whole world has turned into a single market (Dinçer, 2004:80).

The aspects that should be taken into consideration within the context of the international environment are explained as follows: The possibilities of war, free trade zones, customs union agreements, economic relations, globalization trends, embargoes and quotas, common market agreements, mergers and divergences between countries, and most favored country statuses (Ülgen & Mirze, 2013: 89-90).

In this context, top of the most visited European countries are Germany, Britain, France and the Netherlands that determined as a result of discussion with the presidents of Eskişehir chamber of commerce and Eskişehir chamber of industry. There are İstanbul, İzmir, Ankara and Antalya in domestic (Küçük Yılmaz & all, 2016: 69). In addition, there is a high potential for Brussels from Eskişehir and other cities on the periphery.

First of all, (2016) apart from measuring air transport and the potential demand in Eskişehir, the project has revealed the potential for interconnected grid network airline flights, which will contribute to the city's social and economic development.

Method of the Research

Strategic decisions taken in the aviation sector have international influence and expert opinions should be consulted over the course of taking strategic decisions. Since the modeling of interconnected flight network is also interrelated with issues such as flight planning, crew and fleet planning, strategies should be evaluated as risk-based and strategic human resource management must be accomplished successfully and effectively, as stated in Flouris and Küçük Yılmaz's article (2010). Connected flight is a second aircraft which a passenger should arrive on time to catch, and which will take him or her to the final destination. Instead of flying direct to London, take the flight to Amsterdam and then take a connecting flight to London Heathrow (Crocker, 2005). In this study expression of interconnected flight network have been used due to flight connections between domestic and international destinations (Burghouwt, 2007). To determine flight destinations, graph theoretical measures were frequently used for the description of airline and aviation networks and transport networks in general. Graph theory has contributed to the conceptualization of airline networks (Burghouwt, 2007: 7-8). A qualified connection is a commercially reasonable, competitive, operationally feasible, and sufficiently convenient transfer opportunity between arriving and departing flights (Goedeking, 2010: 8). For this reason, the assessment and selection of the applicability of the developed interconnected flight network model for sustainability has been dealt with as a multi-criteria decision problem. The graph theory occurs possibilities on flight destinations without considering the benefit, opportunity, cost and risk. In cases where statistical data is missing, ANP (Analytical Network Process) is a more effective method for use of multi-criteria decision-making problems dependent on concrete and abstract parameters requiring subjective evaluation, and for solving problems involving relations among system elements. While the ANP method uses an interactive structure, feedback and dependency properties make the decision-making process more effective. In the construction of network models, specific criteria will be considered and the analysis will be based on BOCR criteria, which are defined as benefit/the good things that would result from taking the decision, opportunity/ the potentially good things that can result in the future from taking decision, cost/ the pains and disappointments that would result from taking the decision and risk/ potential pains and disappointments that can result from taking the decision, criteria based on the ANP method, because of the relationship and interaction between the criteria (Saaty & Özdemir, 2005: 6).

Today, many techniques are used to solve multi-criteria decision-making problems. Besides the development of the techniques, the development of computer programs provides considerable ease for researchers, administrators and decision-makers who would like to solve the problem (Turan,

2015: 19). Multi-criteria decision-making problems can also be defined as problems where the best alternative is selected from possible solution sets in which multiple criteria are optimized (Turan, 2015: 16). Analytic Network Process is a method developed by Thomas L. Saaty for solving multi-criteria decision-making problems. The ANP method is an expanded version of the Analytic Hierarchical Process (Saaty & Özdemir, 2005: 1; Ishizaka & Nemery, 2013). The AHP method is a technique that combines many existing concepts. The AHP is actively used in the evaluation of decision alternatives and in the solution of decision-making problems. In order to solve complex decision-making problems, relative importance values are given to decision alternatives and criteria using the AHP technique. The decision-making process is therefore carried out by operating the managerial decision mechanism. The AHP method aims to establish a hierarchical structure for the solution of the problem of decision-making and calculate the priority values of the criteria in each level of the hierarchy (Önder & Önder, 2015: 22-23). The purpose of developing the ANP method is to get rid of the hierarchical structure of the AHP. The most important advantage of the ANP method over the other multiple criteria methods is that it is both suitable for both quantitative and qualitative data sets, and capable of overcoming the dependency and feedback problems between the criteria and alternatives. While it is emphasized that the criteria are independent of each other in the AHP, the interactions between these criteria are considered in the ANP (Önder, 2015: 75).

In the ANP, the importance value of the alternatives affects the priority values of the criterion The The ANP method contains the following;

- Definition of the decision problem

- Identification of dependencies

- Conducting paired comparisons

- Forming the super matrix

- Acquiring the limit super matrix

- The selection of the best alternative consists of six steps (Önder, 2015).

In the ANP, three dependencies are referred to. These are internal dependency, external dependency and feedback. The internal dependency will come into question if there is a relationship between the elements in the same cluster. If the expressions of a cluster depend on another cluster, the decision is externally dependent. A "feedback" cycle would occur if there is a bi-directional external dependency between the two clusters. The effect matrix shows the interaction between the nodes when determining the criteria and alternatives of the multi-criteria decision-making problem (Ishizaka & Nemery, 2013). There are target cluster and target node in target cluster. Target cluster is determining the best interconnected flight network for corporate sustainability. Target clusters can contain only one node that is shown as target node. Target node is determining the best interconnected flight network for corporate sustainability. Nodes (B1-B2-O1-O2-O3-O4-O5-C1-C2-R1-R2) must be set in the criteria cluster (BOCR). Nodes in benefits in Criteria Clusters are (B1) Anadolu University's expertise in aviation sector, (B2) Cultural flexibility openness, conscientiousness of citizen of Eskişehir. Cluster in Opportunities are (O1) High and sustainable demand to airlines, (O2) Support of Anadolu University to airlines, (O3) Anadolu University as an owner of the Airport and Airport operator, (O4) Suitability and compatibility of city with own airport:

City & Airport Harmony, (O5) Demographic qualifications, population and culture of Eskişehir. Cluster in Costs are (C1) Additional operational costs of airline from new routes, (C2) Public Relations commercial advertising and promotion expenses. Clusters in Risks are (R1) Demand volatility based economic reasons/conditions, (R2) Inconsistency of fleet planning with connected flight network: selection of wrong fleet type planning by airlines. Alternative clusters are Eskişehir-İstanbul-Frankfurt, Eskişehir-İstanbul-Cologne, Eskişehir-İstanbul-Munich, Eskişehir-İstanbul-Hamburg, Eskişehir-İstanbul-Brussel, Eskişehir-İstanbul-Athens, Eskişehir-İstanbul-Prag, Eskişehir-İzmir-Berlin, Eskişehir- İzmir-Cologne, Eskişehir- İzmir-Frankfurt, Eskişehir-İzmir-Brussel- Eskişehir-İzmir-Athens, Eskişehir-Athens-Cologne.

Literature Review

One of multi-criteria decision-making methods, the Analytical Network Process method has been utilized in myriad studies. Some of example studies are shown alphabetically. With ANP method, accounting software selection (Bastı & Boyar, 2012), automobile selection (Yavaş, et al., 2014), choosing optimum ready-mixed concrete manufacturer (Ömürbek & Tunca, 2013), customer credit evaluation (Kök & Aksu, 2013), decision support system (Setiawan, et al., 2016), determination logistics cost drivers (Karaa & Geyikçi, 2015), development of medicinal plants cultivation (Rassam, et al., 2014), estimating market share (Alptekin, 2010; Yuluğkural, et al., 2005), evaluation of the wordload of academic staff (Bulut & Soylu, 2009), facility location selection (Ustasüleyman & Perçin, 2007; Önüt, et al., 2008), improvement of university dynamic integrated strategy model (Çelik & Murat, 2010), in youth substance abuse and early warning system (Atan, et al., 2015), industrial institution (Meydan, 2010), kombi selection (Ertuğrul & Aytaç, 2012), nurse scheduling problem (Bağ, et al., 2012), personnel selection (Aksakal & Dağdeviren, 2010; Soba, et al., 2014), postgraduate department selection (Ömürbek, et al., 2013), project selection (Kim et all, 2009), risk management framework (Flouris & Küçük Yılmaz, 2010), selection of online shopping site (Ömürbek & Şimşek, 2014), selection of warehouse logistics service provider (Görener, 2014; Cheng & Li, 2004; Özbek & Eren, 2013), student affairs information system software selection (Ayık & Kılavuz, 2013), supplier selection (Görener, 2009; Yüzügüllü & Baynal, 2013; Çetin & Önder, 2015; Çakın & Özdemir, 2013), university selection (Yıldız, 2014), urban development proposals (Navarro, et al., 2008).

It is observed that the ANP has a fairly wide variety of application areas. The ANP method is being used with utmost success and effectiveness in the evaluation of project achievements, supplier selection, online shopping site selection, and scientific field, university, staff and manager selection. When considering the research on the aerospace industry, the Coulter and Sarkis (2006) Airline's budget allocation decision for advertising was evaluated by utilizing the ANP method, and it was decided that the most important criterion was Internet advertisement. Özdemir, Başlıgil and Karaca (2011) adopted the ANP method for aircraft selection and used Turkish Airlines as a sample. Yazgan and Üstün (2011) carried out the selection process of civilian pilots with the ANP method. On the other hand, Yong (2011) evaluated the research on strategic risk in the Chinese aviation market using the ANP method.

The scope of this study encompasses the modeling development for the realization of connected commercial flights, and the grid network model analyses of aviation lifestyle by considering the benefits, costs, opportunities and risks. It is considered that optimum networking models and application strategies will become available to airline companies by combining risk analysis with feasibility studies. A multi-criteria decision-making packaged Super decision software was used in the analysis of the study. When the ANP is applied in selecting the optimal interconnected grid network, first the objective is determined and then the BOCR criteria are tabulated. The analytic network process diagram is shown in Figure 2.
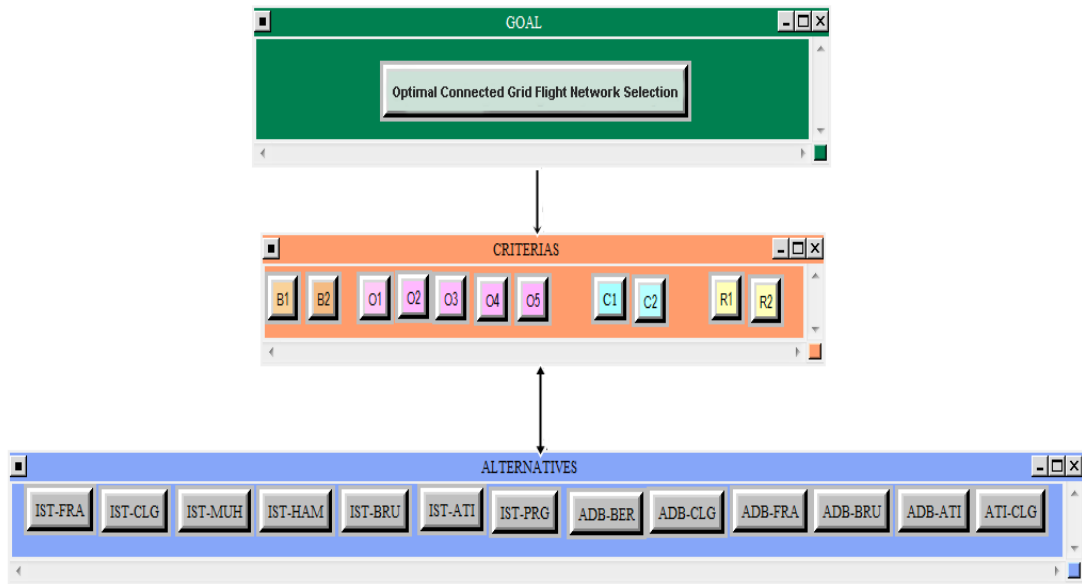
Figure 2: Analytical Network Process
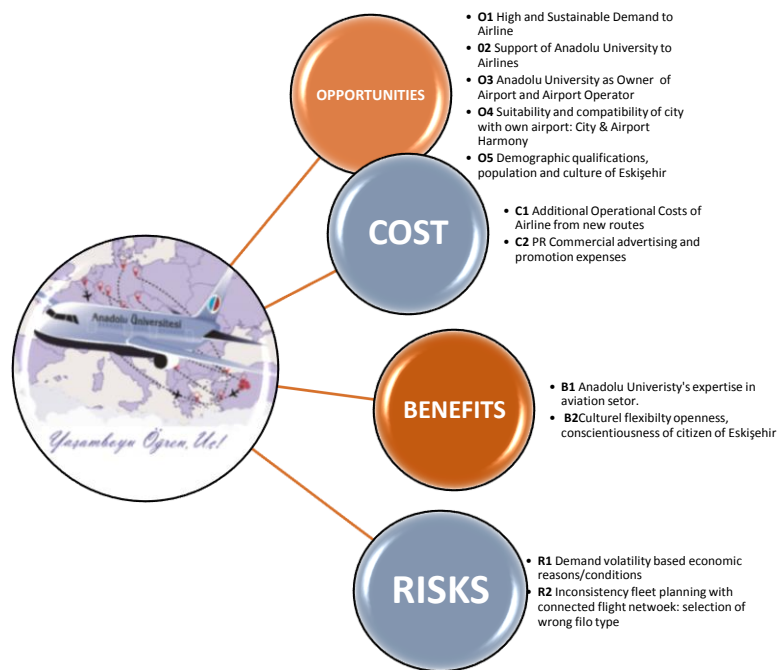

Figure 3: Diagram for BOCR Criteria of Grid Flight Network with Slogan "Lifelong, Learn, Fly"

As a result of setting objectives and entering criteria and alternatives into the program, paired comparisons have been made. The analysis has been conducted, based on expert opinions and referred to for these paired comparisons. The paired comparisons are made by taking the experts

opinion working in the aviation sector and then clusters' priority weights were calculated by using expert's opinions. The final step is the calculation of the limiting priorities of the weighted supermatrix. According to the results, the alternative for Eskişehir-İstanbul-Cologne is the highest priority from the other alternatives. The consistency of expert judgements is less than 0.1 for these models and is said to be consistent. It is anticipated that the inconsistency index will not be greater than 0.1. It is recommended that the comparisons should be consulted again and reviewed if it is larger (Ishizaka & Nemery, 2013: 72). The ratios of the criteria based on priorities are given in Figure 4.
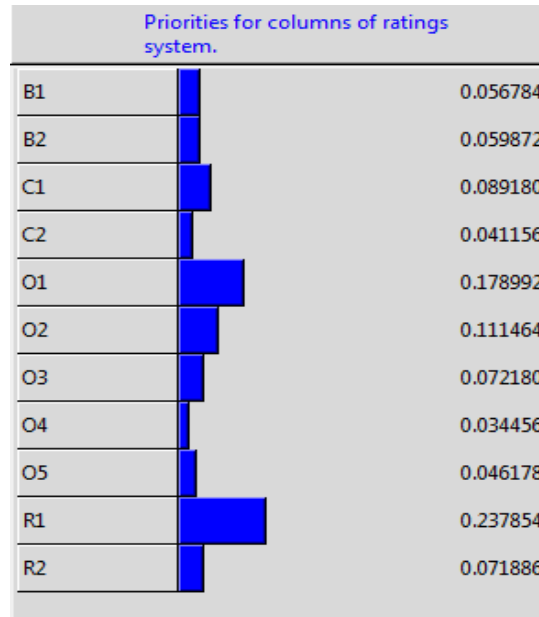
Priorities for columns of ratings system.	
B1	0.056784
B2	0.059872
C1	0.089180
C2	0.041156
O1	0.178992
O2	0.111464
O3	0.072180
O4	0.034456
O5	0.046178
R1	0.237854
R2	0.071886

Figure 4: Priorities for Columns of Ratings System

Eskişehir is becoming an important location in creating interconnected grid flight network scenarios. Priorities present at below. First priority in the figure is Risk (R1); the reasons are the fact that people are willing for and demanding aviation, and the fact that the city hosts the first airport connected to a university. Having many opportunities is a great advantage, but launching a new line has always carried risks for airlines. Drawn upon expert opinions, as a result of this study, despite the opportunities that may arise as a result of the performance of the flights, there might also be various risks emerged related to demand fluctuations and economic irregularities. As these factors may influence the sustainable success of flights, the latter is considered as a risk factor. Second one is (O1); according to the study (Küçük Yılmaz & all, 2016), demand for air transportation has been occurred, which is an advantage both for Eskişehir and University. (O2); Anadolu University supports to airlines both as an administrative and an infrastructure. (C1); new routes require additional operational costs of airlines, which is third one for priorities. The cost criterion is one of the most important and managers may change their planning according to the costs that are incurred. (O3); Anadolu University as an owner of the Airport and Airport operator. Flights at Hasan Polatkan Airport is currently operated by the Anadolu University. In order to encourage airlines to schedule flights, costs for the offered services will be reduced and there will be discount in certain costs such as landing - take-off and landing - parking (R2); inconsistency of fleet planning with connected flight network: selection of wrong fleet type planning by airlines affect to supply and demand the air transportation which is the another risk criteria. (B2); Eskişehir has cultural flexibility openness,

conscientiousness of citizen and that is the most safety city in Turkey (B1); Anadolu university has expertise in aviation sector, and educates students for the sector via first aviation faculty (O5); demographic qualifications, population and culture of Eskisehir are suitable for air transportation demand (C2); public relations commercial advertising and promotion expenses are important for airlines (O4); suitability and compatibility of city with own airport: City & Airport Harmony.
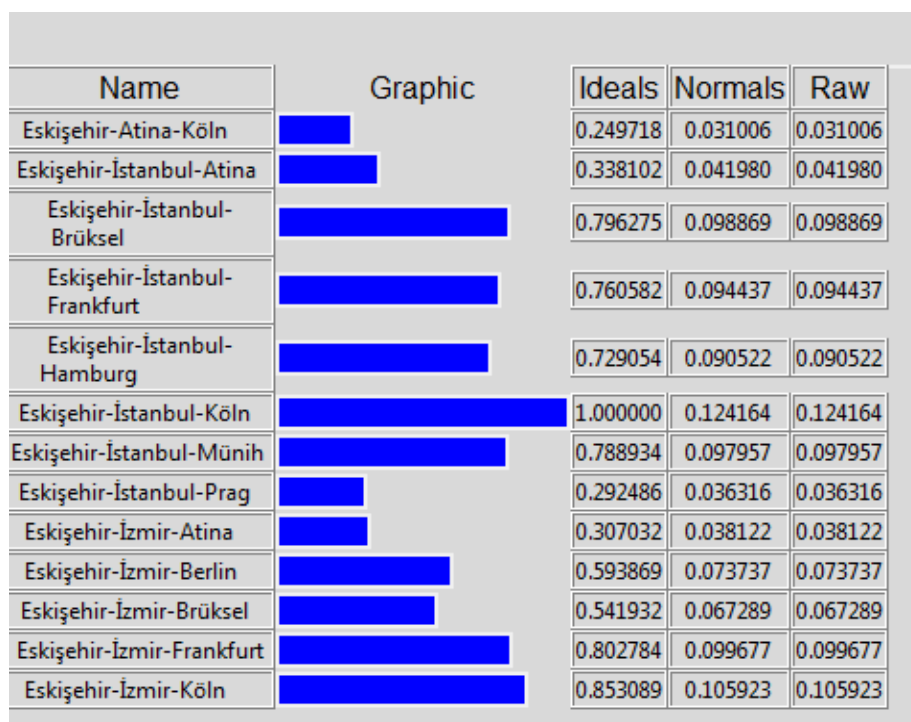
Name	Graphic	Ideals	Normals	Raw
Eskişehir-Atina-Köln		0.249718	0.031006	0.031006
Eskişehir-İstanbul-Atina		0.338102	0.041980	0.041980
Eskişehir-İstanbul-Brüksel		0.796275	0.098869	0.098869
Eskişehir-İstanbul-Frankfurt		0.760582	0.094437	0.094437
Eskişehir-İstanbul-Hamburg		0.729054	0.090522	0.090522
Eskişehir-İstanbul-Köln		1.000000	0.124164	0.124164
Eskişehir-İstanbul-Münih		0.788934	0.097957	0.097957
Eskişehir-İstanbul-Prag		0.292486	0.036316	0.036316
Eskişehir-İzmir-Atina		0.307032	0.038122	0.038122
Eskişehir-İzmir-Berlin		0.593869	0.073737	0.073737
Eskişehir-İzmir-Brüksel		0.541932	0.067289	0.067289
Eskişehir-İzmir-Frankfurt		0.802784	0.099677	0.099677
Eskişehir-İzmir-Köln		0.853089	0.105923	0.105923

Figure 5: Evaluation of Flight Scenarios According to Criteria

Figure 5 demonstrates the sequence of flight scenarios as a result of the analyses performed during the selection of the best alternative for optimal interconnected grid network selection among 13 alternatives. According to (Küçük Yılmaz & all, 2016) study's results, it figured out that there is an air transportation demand to İstanbul, İzmir. To determine flight scenarios for Europe destinations, Eskisehir Chamber of Commerce and Industry's data have been obtained. As a result of this examination, flight scenarios are composed of. As can be seen in Figure 5, it is demonstrated that the Eskişehir-İstanbul-Cologne line is the best alternative. The second best line is the Eskişehir-İzmir-Cologne line and the third best line is the Eskişehir-İzmir-Frankfurt line. These are followed by the Eskişehir-İstanbul-Brussels line. It is seen that there is a demand for the Eskişehir-Brussels line, which offers direct flights. However, the high intensity of demand for the Eskişehir-Brussels line is only for around six-eight months of the season and it does not peak throughout the year. But there are still partly regular flights that can be described as scheduled charters. One of the results of our project is that Eskişehir-İstanbul-Cologne is the best alternative for the optimum interconnected grid flight network. Another notable result is that Germany has a high potential for sustainability for all of its cities included in the project. In the 13 scenarios submitted, the Brussels line has the qualities that can be characterized as a regular charter, while Prague is less advantageous compared to the other options. Similarly, the results of the evaluations and analyses show that flights to Cologne through Athens with a connection at Eskişehir are not as effective as the other scenarios.

Analyses were conducted not only in İstanbul but also in İzmir, with the aim of creating the best alternatives in our scenario. Other reasons for İzmir the best alternative can be listed as follows:

- the increasing air traffic of İstanbul,
- the existing slot problem at İstanbul Atatürk Airport,
- the future opening of the third airport in İstanbul and
- the fact that when the third airport is opened Atatürk Airport will be closed,
- the vision for İzmir Adnan Menderes Airport to become one of the hubs in the near future.

Conclusion, Recommendations and Discussion

Considering current global economic conditions, as well as the current situation of the Turkish economy and the aviation sector, especially airlines, it is of utmost importance to use resources more efficiently and appropriately. This project, which has the potential to provide infrastructure for future work, has been designed to continue with new projects including other regions of the world.

In order to solve this problem in this study, it is suggested to select the optimum flight alternatives by following the suggested pre-selection process steps and then using the developed Analytical Network Process model. In this study, the Analytical Network Process was chosen as the most suitable choice among the alternatives of optimum flight routes, so that the Analytical Network Processor should be able to handle all the dependencies and feedback between the criteria and the qualitative, quantitative, abstract or concrete. It is the first and most comprehensive mathematical theory that makes it possible to use all kinds of data in the decision-making process and to make decisions as a group. On the other hand, today, airlines take care about the concept of sustainability in order to ensure the continuity of their development. The concept of sustainability has been built on three main dimensions: economic, environmental and social. If the concept of sustainability is taken up for business, it turns out that in order for a corporate's development to be sustainable, it must have not only economic but also environmental and social superior performance. After determining the relationships among all the elements included in the proposed ANP model and making related connections, pairwise comparisons were made by using expert opinions and the model was synthesized and the results were obtained. According to the results obtained from the proposed ANP model, the most suitable alternative is Eskişehir-İstanbul-Cologne. As a result of talks with the Eskişehir Chamber of Commerce and Eskişehir Chamber of Industry, the concentration of demand in Turkey for international flights to Germany is tied to the fact that many activities and events (fairs, etc.) take place in Germany. As a result, the most significant contribution of this study to the aviation sector is the creation of a comprehensive and extensible ANP model in the selection of optimum flight models in terms of benefit, opportunity, cost and risk criteria for sustainable development. Another notable result is that Germany has a high potential for sustainability for all of its cities included in the project. For further research, airlines can easily use this proposed ANP model by adapting to them by changing alternatives and adding specific criteria according to their needs.

REFERENCES

Aksakal, E. and Dağdeviren, M. (2010). ANP ve Dematel Yöntemleri İle Personel Seçimi Problemine Bütünleşik Bir Yaklaşım, *Gazi Üniversitesi Mühendislik ve Mimarlık Fakülte Dergisi,* 25(4), pp. 905-913.

Alptekin, N. (2010). Analitik Ağ Süreci Yaklaşımı İle Türkiye'de Beyaz Eşya Sektörünün Pazar Payı Tahmini, *Doğuş Üniversitesi Dergisi,* 11(1), pp. 18-27.

Atan, M., Türe, H. and Koçak, D. (2015). Analitik Ağ Süreci Yöntemi İle Gençlerde Madde Bağımlılığı ve Erken Uyarı Sistemine İlişkin Bir Uygulama, *Pamukkale Üniversitesi Sosyal Bilimler Ensitüsü Dergisi,* 24, pp. 103-112.

Ayık, Z. and Kılavuz, Y. (2013). Analitik Ağ Süreci Yaklaşımı ve Topsis Yöntemi İle Öğrenci İşleri Bilgi Sistemi Yazılımı Seçimi, *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi,* 27(4), pp. 1-18.

Bağ, N., Özdemir, M. and Eren, T. (2012). 0-1 Hedef Programlama ve ANP Yöntemi İle Hemşire Çizelgeleme Problemi Çözümü, *International Journal of Engineering Reseach and Development,* 4(1) , pp. 1-6.

Bastı, M. and Boyar, E. (2012). Muhasebe Paket Programı Seçiminde Analitik Ağ Sürecinin Kullanımı, *Dumlupınar Üniversitesi Sosyal Bilimler Dergisi,* 34, pp. 261-280.

Bulut, K. and Soylu, B. (2009). Öğretim Üyelerinin İş Yükü Seviyelerinin Bir Analitik Ağ Modeli İle Değerlendirilmesi: Mühendislik Fakültesinde Bir Uygulama, *Erciyes Üniversitesi Fen Bilimleri Ensitüsü Dergisi,* 25(1-2), pp. 150-167.

Burghouwt, G. (2007). *Airline Network Development in Europe and its Implications for Airport Planning,* Ashgate Publishing, Hampshire.

Cheng, E. W. and Li, H. (2004). Contractor Selection Using the Analytic Network Process, *Construction Management and Economics,* 22, pp. 1021-1032.

Coulter, K. and Sarkis, J. (2006). An Application Of The Analytic Network Process To The Advertising Media Budget Allocation Decision, *The International Journal on Media Management,* 8(4), pp. 164-172.

Çakın, E. and Özdemir, A.(2013). Tedarikçi Seçim Kararında Analitik Ağ Süreci ve Electre Yöntemlerinin Kullanılması ve Bir Uygulama, *Afyon Kocatepe Üniversitesi İİBF Dergisi,* 15(2), pp. 339-365.

Çelik, N. and Murat, G.(2010). Analitik Ağ Süreci Yöntemi İle Üniversite Dinamik Entegre Strateji Modeli Geliştirilmesi, *Yönetim,* 21(67), pp. 32-51.

Çetin, O. and Önder, E. (2015). Tedarikçi Seçiminde Analitik Ağ Süreci Yönteminin Kullanılması, *Kafkas Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 6(10), pp. 335-354.

Dinçer, Ö. (2004). *Stratejik Yönetim ve İşletme Politikası,* Beta yayınları, İstanbul.

Ertuğrul, İ. and Aytaç, E. (2012). Analitik Ağ Süreci Yöntemi ve Kombi Seçim Probleminde Uygulanabilirliği, *Dokuz Eylül Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 27(2), pp. 79-92.

Flouris, T. and Küçük Yılmaz, A. (2010). The Risk Management Framework to Strategic Human Resource Management, *International Research Journal of Finance and Economics,* 36, pp. 25-45.

Goedeking, P. (2010). *Networks in Aviation Strategies and Structures,* Springer, Berlin.

Görener, A. (2009). Kesici Takım Tedarikçisi Seçiminde Analitik Ağ Sürecinin Kullanımı, *Havacılık ve Uzay Teknolojileri Dergisi,* 4(1), pp. 99-110.

Görener, A. (2014). Depolama Faaliyetleri İçin Lojistik Servis Sağlayıcı Seçiminde Önemli Değerlendirme Kriterlerinin Belirlenmesi, *Uluslararası Yönetim İktisat ve İşletme Dergisi,* 10 (22), pp. 173-191.

Ishizaka, A. and Nemery, P. (2013). *Multi-Criteria Decision Analysis,* Wiley&Sons Inc., West Sussex.

Karaa, İ. E. and Geyikçi, U. B. (2015). Analitik Ağ Süreci İle Lojistik Sektöründe Lojistik Maliyet Unsurları ve Ağırlıklarının Belirlenmesi, *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 20(1), pp. 101-113.

Kim, I., Shin, S., Choi, Y. Thang, N. M., Ramos, E. R. and Hwang, W. J. (2009). Development of a Project Selection Method on Information System Using ANP and Fuzzy Logic, *International Journal of Computer, Electrical, Automation, Control and Information Engineering,* 3(5), pp. 1286-1291.

Koçel, T. (2014). *İşletme Yöneticiliği,* Beta Basım A. Ş., İstanbul.

Kök, D. and Aksu, G. (2013). Müşteri Kredi Değerliliğinin Belirlenmesinde Analitik Ağ Süreci Kullanımı: Bir Model Önerisi, *Muhasebe ve Finansman Dergisi,* Temmuz, pp. 167-186.

Kucuk Yılmaz, A. (2017), *Project No: 1608F604 Eskisehir Hasan Polatkan Airport Grid Coeected Fligt Network Modelling within Scope of Demand Optimization in Both Global and National Scale: Eskisehir Resource-Need Equation II",* Anadolu University, Eskişehir.

Küçük Yılmaz, A., Kiracı K., Durak, M.Ş., Özdemir, E. and Tanrıverdi, G. (2016). *Havayolu Yolcu Talebinin Belirlenmesi: Eskişehir Kaynak İhtiyaç Denklemi,* Anadolu Üniversitesi, Eskişehir.

Meydan, C. (2010). Bağımsız Derecelendirme Şirketlerinin Kurumsal (Şirket) Derecelendirme Yaklaşımları Çerçevesinde Bir Derecelendirme Uygulaması, *Maliye Finans Yazıları*, 24(86).

Navarro, G., Melon, G., Martin, D. and Dutra, A. (2008). Evaluation of Urban Development Proposals: An ANP approach, *World Academy of Science, Engineering and Technology,* 44, pp. 498-508.

Ömürbek, N., Demirci, N. and Akalin, P. (2013). Analitik Ağ Süreci ve Topsis Yöntemleriyle Bilimdalı Seçimi, *Akademik Araştırmalar ve Çalışmalar Dergisi,* 5(9), pp. 118-140.

Ömürbek, N. and Şimşek, A. (2014). Analitik Hiyerarşi Süreci ve Analitik Ağ Süreci Yöntemleri İle Online Alışveriş Site Seçimi, *Yönetim ve Ekonomi Araştırmaları Dergisi,* 22, pp. 306-327.

Ömürbek, N. and Tunca, Z. (2013). Analitik Hiyerarşi Süreci ve Analitik Ağ Süreci Yöntemlerinde Grup Kararı Verilmesi Aşamasına İlişkin Bir Örnek Uygulama, *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakülte Dergisi,* 18(3), pp. 47-70.

Önder, E. (2015). Analitik Ağ Süreci, *Çok Kriterli Karar Verme Yöntemleri,* Yıldırım, B.F. and Önder, E. (Ed.), Dora Yayıncılık, Bursa, pp. 75-116.

Önder, E. and Önder, G. (2015). Analitik Hiyerarşi Süreci, *Çok Kriterli Karar Verme Yöntemleri* Yıldırım, B.F. and Önder, E. (Ed.), Dora Yayıncılık, Bursa, pp. 21-64.

Önüt, S., Tuzkaya, U. and Kemer, B. (2008). Hastane Yeri Seçimine Bir Analitik Ağ Süreci Yaklaşımı, *Mühendislik ve Fen Bilimleri Dergisi,* 25(4), pp. 367-379.

Özbek, A. and Eren, T. (2013). Analitik Ağ Süreci Yaklaşımıyla Üçüncü Parti Lojistik Firma Seçimi, *Atatürk Üniversitesi İktisadi ve İdari Bilimler Dergisi,* 27(1), pp. 95-113.

Özdemir, Y., Başlıgil, H. and Karaca, M. (2011). *Aircraft Selection Using Analytic Netwotk Process:A Case for Turkish Airlines,* in *Proceedings of the World Congress on Engineering Vol II in London, UK, 2011*

Özgen, H. and Yalçın, A. (2011). *Temel İşletmecilik Bilgisi,* Nobel Kitabevi, Adana.

Özkalp, E. and Kırel, Ç. (2016). *Örgütsel Davranış,* Ekin Basım Yayın Dağıtım, Eskişehir.

Rassam, G., Gholami, M. R., Mellati, F., Gol, A.E. and Mashayekhan, A. (2014). Prioritizing of Effective Factors on Development of Medicinal Plants Cultivation Using the Analytic Network Process, *Journal of The Faculty Forestry Istanbul University*, 64(2), pp. 69-77.

Robbins, S. P. and Judge, T. A. (2007). What is Organizational Behavior, *Organizational Behavior* Robbins, S.P. and Judge, T.A. (Ed.), Pearson Prentice Hall, New Jersey.

Saaty, T. L. and Özdemir, M. S. (2005). The Analytic Network Process, *A Dictionary Of Decisions Wth Dependence And Feedback Based On The Analytic Network Process,* Saaty, T.L. and Özdemir, M.S. (Ed.), RWS Publications, Pittsburg.

Setiawan, A., Handojo, A. and Gozali, O. (2016). The Development of Officer Selectio System Using the Method of Analytic Network Process at Pharmacy Company, *International Journal of Engineering and Manufacturing,* 2, pp. 1-9.

Soba, M., Aydemir, İ. and Şimşek, A. (2014). Meslek Yüksekokullarında Yönetici Seçimi Üzerine Bir Uygulama: Analitik Ağ Süreci Yöntemi, *Uluslararası Alanya İşletme Fakültesi Dergisi,* 6(3), pp. 179-192.

Turan, G. (2015). Çok Kriterli Karar Verme, *Çok Kriterli Karar Verme Yöntemleri,* Yıldırım, B.F. and Önder, E. (Ed.), Bursa: Dora yayınları, pp-15-19.

Ustasüleyman, T. and Perçin, S. (2007). Analitik Ağ Süreci Yaklaşımıyla Kuruluş Yeri Seçimi, *Gazi Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi,* 9(3), pp. 37-55.

Ülgen, H. and Mirze, K. (2013). *İşletmelerde Stratejik Yönetim,* Beta yayınları, İstanbul.

Yavaş, M., Ersöz, T., Kabak, M. and Ersöz , F. (2014). Otomobil Seçimine Çok Kriterli Yaklaşım Önerisi, *İşletme ve İktisat Çalışmaları Dergisi,* 2(4), pp. 110-118.

Yazgan, E. and Üstün, K. (2011). Application of Analytic Network Process: Weighting of Selection Criteria for Civil Pilots, *Journal of Aeronautics and Space Technologies,*5(2), pp. 1-12.

Yeşil, S. (2013). *Küreselleşme ve Değişen Çevre Dinamikleri Işığında Yeni Yönetim Yaklaşımlarından Seçme Konular,* Seçkin Yayıncılık, Ankara.

Yıldız, K. (2013). *Örgütsel Bağlılık İle Örgütsel Sinizm ve Örgütsel Muhalefet Arasındaki İlişki*, Turkish Studies - International Periodical for the Languages, Literature and History of Turkish or Turkic Volume 8/6 Spring 2013, p. 853-879, ISSN: 1308-2140, www.turkishstudies.net, ANKARA-TURKEY.

Yıldız, A. (2014). En İyi Üniversite Seçiminde Analitik Ağ Prosesinin Kullanımı, *İleri Teknoloji Bilimleri Dergisi,* 3(2), pp. 108-119.

Yong, W. (2011). Strategy Risk Research on Chinese Aviation Market: Based on Analytic Network Process and the Fuzzy Assessment Method, *African Journal of Marketing Management,* 3(3), pp. 56-64.

Yuluğkural, Y., Felek, S. and Aladağ, Z. (2005). *Mobil İletişim Sektöründe Pazar Paylaşımının ANP Yöntemi İle Tahminlenmesi/Pazar Payı Arttırma Amaçlı Strateji Öneri Süreci,* İstanbul Ticaret Üniversitesi, pp. 89-93.

Yüzügüllü, E. and Baynal, K. (2013). Tedarik Zinciri Yönetiminde Analitik Ağ Süreci İle Tedarikçi Seçimi ve Bir Uygulama", *İstanbul Üniversitesi İşletme Fakültesi Dergisi,* 42(1), pp. 77-92.