
FINANCIAL PERFORMANCE EVALUATION OF TURKISH AIRLINE COMPANIES USING INTEGRATED FUZZY AHP FUZZY TOPSIS MODEL *

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Abstract

Emerging changes in global markets and financial crisis led to increase in uncertainty and instability of the financial and business environments, which lead to increase in the importance of making efficient financial decisions, along with the complexity of the financial decision making process. The aim of this study is to propose a financial performance evaluation model, based on ratio analysis of solvency, efficiency, and profitability, utilizing the integrated Fuzzy AHP Fuzzy TOPSIS. Fuzzy AHP method is used to assign weights for the evaluation criteria, and Fuzzy TOPSIS method is used to rank alternatives. Profitability and Solvency are the most important criteria, the Return On Assets and Return On Sales a company can achieve are the most important norms to reflect how well a company financially operates. The application of this model on airline companies listed in Istanbul Stock Exchange showed that Pegasus has a better financial performance than Turkish Airlines.

Keywords: Financial Performance Evaluation, Fuzzy AHP, Fuzzy TOPSIS, Aviation

JEL classification: G11, L93, R42

BÜTÜNLEŞİK BULANIK AHP BULANIK TOPSIS KULLANILARAK HAVACILIK SEKTÖRÜNDE ÇALIŞAN ŞİRKETLERİN FİNANSAL PERFORMANSININ DEĞERLENDİRİLMESİ

Öz

Finansal ve ticari çevrelerde belirsizliğe ve istikrarsızlığa, küresel piyasalarda ortaya çıkan değişiklikler ve finansal krizler neden olmuştur. Bu değişiklikler finansal karar verme sürecinin karmaşıklığı ile birlikte, etkin finansal karar verme sürecinin önemini artırmıştır. Bu çalışmanın amacı bütünleşik Bulanık AHP, Bulanık TOPSIS yöntemleriyle bir finansal analiz modeli oluşturmaktır. Ödeme gücü, faaliyet ve karlılık oran analizi, kriterlerin ve alt-kriterlerin ağırlıklarını saptamak için Bulanık AHP, alternatifleri sıralamak için Bulanık TOPSIS yöntemleri kullanılmıştır. Karlılık ve Borç Ödeme Gücü en önemli kriterler ve bir şirketin elde edebileceği Varlık Getirisi ve Satış Getirisi, bu şirketin mali açıdan ne kadar iyi çalıştığını gösteren en önemli normlardır. Bu modelin Borsa İstanbul'da işlem gören havacılık sektöründe çalışan şirketlere uygulanması, Pegasus'un Türk Hava Yolları'na göre daha iyi bir finansal performansa sahip olduğunu göstermiştir.

Anahtar kelimeler: Finansal performans değerlendirilmesi, Bulanık AHP, Bulanık TOPSIS, havacılık

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1. Introduction

Aviation is the business sector that provides air transportation services. It is one of nowadays' services that proved itself as an integrated part of human life and economic, with huge increase in demand. From (IATA annual review, 2017) aviation's vital role in the world has not always resulted in appropriate reward to airline industry, however airline efforts have resulted in a historic strengthening of the bottom line. The industry earned Return on Invested Capital of %9.9 while Cost of Capital estimated at 6.6% in 2016. It also generates wide benefits for the global economy; it is estimated that aviation support \$67.7 million supply chain jobs in 2016 and underpinned \$3.0 trillion in value-added output globally.

The Turkish air transportation provided service to 174.15 million passenger in 2016 in both internal and external flights (DHMI official site). The total assets, revenues, and net loss for Turkish airlines in 2016 are ₺65,074, ₺29,468, and ₺47 million respectively, ₺5,618, ₺3,707, and ₺136 million for Pegasus airlines (THY and Pegasus annual report, 2016). However these data might not be sufficient or be misleading when making an investment decision. Thus; the financial performance of airline companies needs to capture more extensive measures than solely total revenues and net income (Terker et al., 2016:603). Which can be achieved by implementing the financial ratio analysis in the evaluation process.

Financial statement analysis seeks to emphasize the comparative and relative importance of the data presented and to evaluate the position of the firm (Reilly & Brown, 2003:319). The analysis of financial data employs various techniques, to assess and make decision about the financial performance, that include ratio analysis, common-size analysis, study of differences of components of financial statements among industries, review of descriptive material, and comparisons of results with other types of data (Gibson, 2011:187).

During the last decades the globalization of financial markets, the intensifying competition among firms, financial institutions and organizations as well as the rapid economic, social and technological changes, have led to an increasing uncertainty and instability in the financial and business environments. Within this new context the importance of making efficient financial decisions has increased, and the complexity of the financial decision making process has also increased (Zopounidis & Doumpos, 2002:167). Though, techniques from the field of optimization, stochastic processes, simulation, forecasting, decision support systems, MCDA, fuzzy logic, etc. are now considered to be valuable tools for financial decision making.

In this study, the Integrated Fuzzy Analytic Hierarchy Process (Fuzzy AHP) and Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (Fuzzy TOPSIS) methods are used to evaluate the financial performance of airline companies listed in Istanbul Stock Exchange: Pegasus and Turkish airlines for the period of 2012-2016. Fuzzy AHP method is used to determine the weights of criteria and sub-criteria, and Fuzzy TOPSIS method is used to rank alternatives. The financial ratios of efficiency, profitability and solvency are used as the financial performance evaluation criteria.

2. Literature Review

In the literature review most of efforts related to aviation assess the financial sources of airline companies and focus on financial lease, or they address the operational performance of companies as to Feng & Wang (2000) they noticed that not much of the undertaken researches or models address the financial performance of airline companies and they mostly focus on the operational performance. Based on the conceptual frameworks created by Fielding et al. (1978), Fielding and Anderson (1984) purposed a conceptual framework to help form performance indicators involving both transportation and aspects of finance. And to overcome the problems of small sample size and unknown distribution of samples, the grey relation analysis was used to select the representative indicators, then TOPSIS method was used for the outranking of alternatives. The conducted case study was using the example of Taiwan's five major airlines. The empirical result

shows that performance evaluation for airlines can be more comprehensive, if financial ratios are considered. This result reveals that transportation indicators or financial ratios cannot alone measure all performance aspects of an airline.

Other researchers state that, for the financial performance evaluation of companies, Traditional Accounting-Based Financial Performance (AFP) measures are of general use and, believed that, the competitiveness of the company and its market stand point must be part of the evaluation process. So, value-based financial performance (VFP) measures have recently been introduced to express the company value. (Yalcin et al., 2012) proposed a new financial performance evaluation approach to rank the companies of each sector in the Turkish manufacturing industry. Fuzzy AHP used to determine the weights of criteria and sub-criteria of the proposed model of AFP and VFP as main-criteria and their sub-criteria which are for AFP: Return On Assets, Return On Equity, Earnings per Share, Price Earnings ratio. And for VFP: Economic Value Added, Market Value Added, Cash Flow Return on Investment, and Cash Value Added. TOPSIS and VIKOR were used for ranking the companies. Noting that the importance of AFP measures for the performance evaluation was near %67.6 in compare to %32.4 for VFP. Their results showed that the obtained ranks of the companies by these methods are almost same with respect to their own sectors.

Ömürbek & Kinay (2013) Used TOPSIS method, and financial performance indicators of: Current ratio, Quick ratio, and Cash ratio, Debt to Total Assets ratio, Operating Profit margin, Net Profit margin, and Return On Equity, Place Usage ratio in the plan. To evaluate and compare the financial performance of two companies: (ABC Company), listed in Istanbul Stock Exchange and (XYZ Company), listed in Frankfurt Stock Exchange. The data extracted from 2012 financial statements of both companies and related disclosures. Despite using only one year for the analysis which might be misleading especially in the current satiation of uncertainty, the weights of financial indicators ranges from %9 for Return on Equity to %16 for Place Usage ratio. And the final results of the research indicate that the performance of ABC Company is better than the performance of XYZ Company.

Reilly & Brown (2003:319) express that analysts use financial ratios because ratios are intended to provide meaningful relationships between individual values in the financial statements. Terker et al. (2016) undertake a research to see wither the general numbers and company size or indicators and ratio analysis to be used to evaluate the financial performance of airline companies. They intends to analyze the financial performance of the top 20 airlines in the Word for the period of year 2011 and 2014. To be able to measure the financial performance of these airline companies they proposed a hormone index by considering performance areas and various ratios as follow: Profitability: Return On Asset, Return On Equity, Net Profit Margin. Operating: Average Days for Account Receivables, Average Days for Inventories, and Average Days for Account Payables. Efficiency: Revenue per Employee, Revenue per Aircraft. Liquidity: Quick Ratio, Debt Ratio, and Times Interest Earned. The hormone index was used to list all airline companies examined based on their scores. This analysis supports that the measurement of financial performance based upon total revenue or profitability is somehow weak and may be extended by including other indicators. That is despite some companies are among the best companies by total assets, net income, and revenues still they were not among the best companies using the proposed model.

Using integrated Fuzzy AHP and Fuzzy TOPSIS in the financial performance evaluation, Eyüboğlu & Çelik, (2016) applied study to 13 Turkish Energy Companies traded in Istanbul stock exchange market (Borsa Istanbul) for the period of 2008-2013. They used 5 ratios as main criteria and 15 sub-criteria which are: Liquidity: Current Ratio, Quick Ratio, Cash Ratio, Profitability: Return On Equity, Return On Assets, Net Profit Margin, Financial Leverage: Debt Ratio, Debt To Equity Ratio, Activity: Accounts Receivable Turnover, Equity Turnover, Fixed Assets Turnover, Total Assets Turnover, Growth: Sales Growth, Assets Growth, Shareholders' Equity Growth. Fuzzy AHP used to determine the general weights of these ratios and Fuzzy TOPSIS for ranking the alternatives. They

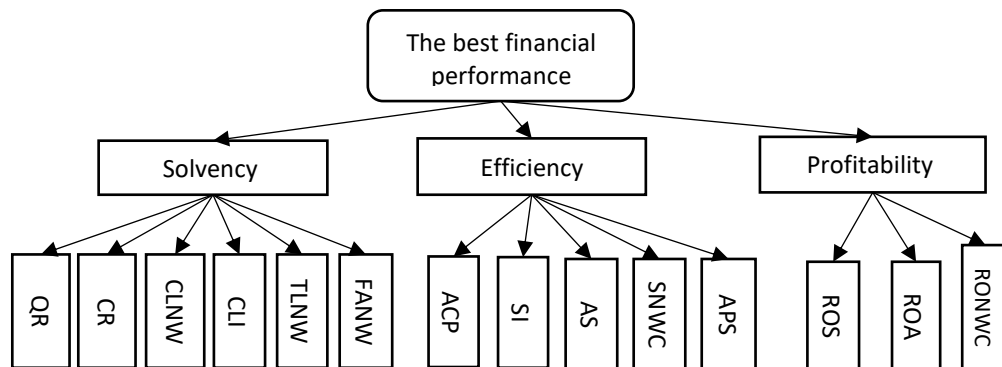
found that (as criteria) Profitability and Liquidity Ratios are the most important with an importance of 30% each and the Current Ratio and Quick Ratio are the most important as sub-criteria with final weights of 14% each. The final results show that AVTUR, TRCAS and AKSUE have the best financial performance.

Other researches relied on integrated Fuzzy AHP and Fuzzy TOPSIS where Fuzzy AHP is used to calculate relative weights of criteria and sub-criteria. Fuzzy TOPSIS is used to determine the rank of alternatives. Such works include: Integrating Fuzzy AHP and Fuzzy TOPSIS to model shopping center site selection problem for a real world application in Istanbul for (Onut et al., 2010). To propose a multi-attribute e-business website quality evaluation methodology for (Kaya, 2010). To propose a methodology for the selection of the best energy technology alternative by (Kaya & Kahraman, 2010). To provide a comprehensive criteria set for evaluation of entrepreneurial universities for (Mavi, 2014). Integrating Fuzzy AHP and Fuzzy TOPSIS for a more consistent evaluation and prioritization of trading partner to reach a supply chain coordination model for (Shukla et al., 2014). To develop a framework for water loss management in developing countries under fuzzy environment for (Zyoud et al., 2016).

3. Evaluation Criteria

The model used to evaluate the financial performance of firms driven from the industry norms and key business ratios advices by Dun & Bradstreet (Gibson, 2011) as shown in fig. 1. Financial ratios are explained in this section (Chabotar, 1989; Calomiris & Mason, 1994; Nissim & Penman, 2001; Kumbirai & Webb, 2010; Gibson, 2011; Abdul Hamid & Azmi, 2011):

Fig. 1: The Hierarchical Structure



3.1. Solvency

Refers to the ability of company to settle its debts. As to Zietlow (2010) solvency refers to the amount of assets an organization holds relative to its liabilities.

Quick Ratio (QR): observers believe that the total current assets shall not be considered when gauging the ability of the firm to meet current obligations because inventories and some other assets included in current assets might not be very liquid (Reilly & Brown, 2003). The higher the QR the higher the ability to meet CL in a quick manner.

$$QR = \frac{\text{cash} + \text{marketable securities} + \text{accounts receivable}}{\text{current liabilities}} \quad (1)$$

Current Ratio (CR): CR examines the relationship between current assets and current liabilities. In general norms a ratio of 1 is good, however it is a matter of industry in a question of needs that gives the final decision about it. The higher the CR the higher the ability to meet CL.

$$CR = \frac{\text{current assets}}{\text{current liabilities}} \quad (2)$$

Current Liabilities to Net Worth (CLNW): Shows the percent of CL to NW; that is, how much a company rely on equity comparing to reliance on CL. Net worth referred to the amount of assets remains after deducting for all liabilities. An increase in this ratio means more reliance on CL which might lead to more pressure on future cash flows.

$$CLNW = \frac{\text{current liabilities}}{\text{net worth}} \quad (3)$$

Current Liabilities to Inventory (CLI): Indicates reliance on unsold inventory for payment of debt. The increase in CL to inventory means more burden and reliance on unsold inventory.

$$CLI = \frac{\text{current liabilities}}{\text{inventory}} \quad (4)$$

Total Liabilities to Net Worth (TLNW): Or Debt to Equity Ratio, is a measure of financial leverage, indicates how much debt a company uses to acquire its assets in compare to equity. The higher this ratio means more reliance on debt and more financial expenses.

$$TLNW = \frac{\text{total liabilities}}{\text{net worth}} \quad (5)$$

Fixed Assets to Net Worth (FANW): Fixed assets to net worth indicates how many times the owners' cash is frozen in fixed assets and what remains for working capital. The increase of this ratio to 1 probably acceptable but increasing much more probably not.

$$FANW = \frac{\text{fixed assets}}{\text{net worth}} \quad (6)$$

3.2. Efficiency

Efficiency refers to the ability of company to effectively use its assets and manage its liabilities. It measures the ability of a company to utilize available assets to produce revenues.

Average Collection Period (ACP): Also referred to as the days' sales in accounts receivable, is the average amount of time between the date of credit sale and the date of collection. The higher the ACP the lower the efficiency of a company.

$$ACP = \frac{(\text{days}(365) \times \text{average account receivables})}{\text{credit sales}} \quad (7)$$

Sales to Inventory (SI): A very close measure to Inventory Turnover, it measures how many times inventory changes –bought and sold - in a time period. It is very useful when comparing companies with different size in the same industry.

$$SI = \frac{\text{net sales}}{\text{inventory}} \quad (8)$$

Assets to Sales (AS): The total assets to sales ratio is an inverse of the Asset Turnover ratio used to compare the amount of assets a company has relative to the amount of sales the company can generate using that assets, that is, how much assets is use to produce one unit (in money) of revenues. The higher this ratio the higher the amount of investment in assets needed to produce a unit of revenue.

$$AS = \frac{\text{total assets}}{\text{net sales}} \quad (9)$$

Sales to Net Working Capital (ANWC): Or Working Capital Turnover, an asset utilization measure that indicates a company's effectiveness in using its working capital; how much Net Working Capital (NWC) is needed to generate a certain level of sales. NWC is the excess of current assets over current liabilities. The higher the sales to NWC the more efficient a company in using its resources.

$$SNWC = \frac{\text{net sales}}{\text{net working capital}} \quad (10)$$

Accounts Payables to Sales (APS): Measures how much a company owes suppliers relative to sales for the period. If this ratio higher than industry average it suggest that the company is using suppliers assets (cash owed) to fund operations, and increase AP to sales may be a sign that the firm is having liquidity problems.

$$APS = \frac{\text{accounts payables}}{\text{net sales}} \quad (11)$$

3.3. Profitability

One of the very important measures for financial performance. It determines the return achieved on the money invested in the company. Profitability shall not only be calculated for one year, the object is to achieve an acceptable return and to increase or, at least, maintain it.

Return on Sales (ROS): Measures the net return earned per unit of sales. It determines the percent of Sales that remain as profit after deducting for all expenses. It is useful for determining the ability of a company to efficiently generate a profit from a given level of sales, and to compare companies with different size. The higher the ROS the more profitability a company is.

$$ROS = \frac{\text{net income}}{\text{net sales}} \quad (12)$$

Return on Assets (ROA): Measures the net return earned per unit of assets (resource). It shows how a company can convert its asset into net earnings. The higher ratio indicates higher profitability and therefore is an indicator of efficient use of resources.

$$ROA = \frac{\text{net income}}{\text{total assets}} \quad (13)$$

Return on Net Working Capital (RONWC): Measures the net return earned by unit of net working capital. It shows how a company can convert its NWC into earnings.

The higher ratio indicates higher profitability and therefore is an indicator of efficient use of resources. However, RONWC might lose meaning in case of negative NWC –excess of CL over CA– and, or net loss "inconvenience". If both are negative we got a positive result of RONWC while the company experienced loss and solvency problems.

$$RONWC = \frac{\text{net income}}{\text{net working capital}} \quad (14)$$

4. Methodology

4.1. Fuzzy Analytic Hierarchy Process (FAHP) Method

Fuzzy AHP used to help making decision in case of uncertainty and vagueness. By decision-making in the fuzzy environment is meant a decision process in which the goal and/or the constraints, but not necessarily the system under control, are fuzzy in nature. This means that the goals and/or the constraints constitute classes of alternatives whose boundaries are not sharply defined. Fuzzy goal and fuzzy constraints can be defined precisely as fuzzy sets in the space of alternatives (Bellman & Zadeh, 1970:141).

AHP measure relied on real values of assessment (priority scales) as 0 and 1. It helps making decisions when there would be different criteria to consider and that criteria has varied levels of importance among each other in relation to the decision to be made. However, in case of uncertainty and vagueness, using fuzzy numbers instead proved to be more practical and effective (Aydoğan et al., 2015). In 1930s, Lukasiewicz extended the range of truth values to all real numbers in the interval between 0 and 1. In 1937, a paper 'Vagueness: an exercise in logical analysis' was published by a philosopher Max Black. According to Black (1937) if a continuum is discrete, each element in the continuum can be allocated a number. The number will signify a degree. Black has made an important contribution in defining a fuzzy set and outlining the basic ideas of fuzzy set operations (Poplawska, 2014:114).

Zadeh (1965) first introduced the fuzzy set theory, which was oriented to the rationality of uncertainty due to imprecision or vagueness. A major contribution of fuzzy set theory is its capability of representing vague data. The theory also allows mathematical operators and programming to apply to the fuzzy domain. A fuzzy set is a class of objects with a continuum of grades of membership. Such a set is characterized by a membership (characteristic) function, which assigns to each object a grade of membership ranging between zero and one (Kahraman et al., 2004).

Steps of Fuzzy AHP based on Chang's extent analysis can be detailed as follows (Chang, 1996), (Chang & Wang, 2009), (Mohaghar et al., 2012), (Mahendran, 2014), (Eyüboğlu & Çelik, 2016):

A fuzzy number is a special fuzzy set $F = \{(x, \mu_F(x), x \in R)\}$, where x takes its values on the real line, $R: -\infty \leq x \leq \infty$ and $\mu_F(x)$ is a continuous mapping from R to the closed interval $[0,1]$.

A triangular fuzzy number (TFN), \tilde{M} is denoted simply as (l, m, u) . The parameters l ; m and u ; respectively, denote the smallest possible value, the most promising value, and the largest possible value that describe a fuzzy event.

Triangular type membership function of M fuzzy number can be described as follow:

$$\mu_{\tilde{M}}(x) = \begin{cases} \frac{x-l}{m-l} & , x \in [l, m] \\ \frac{u-x}{u-m} & , x \in [m, u] \\ 0 & , \text{otherwise} \end{cases} \quad (15)$$

For the evaluation of attributes respondents select related linguistic variable (LV), then LV converted into TFN as expressed in Table (1).

Table 1: Linguistic Variables Describing Weights of Criteria and Values of Ratings

Linguistic scale	short	TFS (l, m, u)			TFRS (l, m, u)		
Just equal	JE	1	1	1	1	1	1
Equal importance	EI	1	1	3	0.33	1	1
Weak importance of one over another	WI	1	3	5	0.2	0.33	1
Essential or strong importance	SI	3	5	7	0.14	0.2	0.33
Very strong importance	VSI	5	7	9	0.11	0.14	0.2
Extremely preferred	EP	7	9	9	0.11	0.11	0.14

Consider two triangular fuzzy numbers M_1 and M_2 , $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$. Their operational laws are as follow (16):

1. $(l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2)$
2. $(l_1, m_1, u_1) - (l_2, m_2, u_2) = (l_1 - l_2, m_1 - m_2, u_1 - u_2)$
3. $(l_1, m_1, u_1) \times (\lambda, \lambda, \lambda) = (\lambda l_1, \lambda m_1, \lambda u_1) \quad \lambda > 0, \lambda \in R$
4. $(l_1, m_1, u_1) \times (l_2, m_2, u_2) \approx (l_1 l_2, m_1 m_2, u_1 u_2)$
5. $(l_1, m_1, u_1) / (l_2, m_2, u_2) \approx (l_1 / l_2, m_1 / m_2, u_1 / u_2)$
6. $(l_1, m_1, u_1)^{-1} \approx (1 / u_1, 1 / m_1, 1 / l_1)$ (16)

Let $X = \{x_1, x_2, \dots, x_n\}$ be an object set and $U = \{u_1, u_2, \dots, u_m\}$ be a goal set. Each object is taken and extent analysis for each goal g_i is performed, respectively. Therefore, m extent analysis values for each object can be obtained, with the following signs:

$$M_{g_i}^1, M_{g_i}^2, \dots, M_{g_i}^m \quad i = 1; 2; \dots; n \quad (17)$$

Where all $M_{g_i}^j (j = 1; 2; \dots; m)$ are TFNs.

The steps of the extent analysis can be detailed as follows.

Step 1: Calculation Of The Value Of Fuzzy Synthetic Extent

The fuzzy synthetic extent value with respect to the *ith* object is defined as:

$$S_i = \sum_{j=1}^m M_{g_i}^j \times \left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1} \quad (18)$$

Here S_i is defined as the fuzzy synthetic extent.

In order to obtain the equation $\left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1}$, it is necessary to perform additional fuzzy operations with m values of the extended analysis, which is represented as follow:

$$\sum_{j=1}^m M_{g_i}^j = \left(\sum_{j=1}^m l_j, \sum_{j=1}^m m_j, \sum_{j=1}^m u_j \right) \quad (18.1)$$

$$\left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right] = \left(\sum_{i=1}^n l_i, \sum_{i=1}^n m_i, \sum_{i=1}^n u_i \right) \quad (18.2)$$

It is necessary to calculate the inverse vector using the following equation:

$$\left[\sum_{i=1}^n \sum_{j=1}^m M_{g_i}^j \right]^{-1} = \left(\frac{1}{\sum_{i=1}^n u_i}, \frac{1}{\sum_{i=1}^n m_i}, \frac{1}{\sum_{i=1}^n l_i} \right) \quad (18.3)$$

Step 2: The Degree Of Possibility: For M_2 Is Defined As:

$$v(M_2 \geq M_1) = \sup_{y \geq x} \left[\min \left(\mu_{M_1}(x), \mu_{M_2}(y) \right) \right] \quad (19)$$

And can be equivalently expressed as follows:

$$v(M_2 \geq M_1) = \text{hgt}(M_1 \cap M_2) = \mu_{M_2}(d) = \begin{cases} 1, & \text{if } m_2 \geq m_1 \\ 0, & \text{if } l \geq u_2 \\ \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)}, & \text{otherwise} \end{cases} \quad (20)$$

Where d is the ordinate of the highest intersection point D between μ_{M_1} and μ_{M_2} . To compare M_1 and M_2 , both the values of $v(M_1 \geq M_2)$ and $v(M_2 \geq M_1)$ are required.

Step 3: The Degree Possibility Of A Convex Fuzzy Number To Be Greater Than k Convex Fuzzy Numbers M_i ($i = 1; 2; \dots; k$) Can Be Defined By:

$$\begin{aligned} v(M \geq M_1, M_2, \dots, M_k) &= v[(M \geq M_1) \text{ and } v(M \geq M_2) \cdots (M \geq M_k)] \\ &= \min v(M \geq M_i), \quad i = 1; 2; 3; \dots; k \end{aligned} \quad (21)$$

Assume that:

$$d^{(A_i)} = \min v(S_i \geq S_k) \text{ for } k = 1; 2; \dots; n, k \neq i. \quad (22.1)$$

The weight vector is obtained by Equation (22.2);

$$W' = (d^{(A_1)}, d^{(A_2)}, \dots, d^{(A_n)})^T \quad (22.2)$$

Where, A_i ($i = 1; 2; \dots; n$) consists of n elements.

Step 4: Through Normalization, The Weight Vectors Are Reduced To Equation (23);

$$W = (d(A_1), d(A_2), \dots, d(A_n))^T, \text{ Where } W \text{ is a nonfuzzy number} \quad (23)$$

4.2. Fuzzy Technique For Order Preference By Similarity To Ideal Solution (FTOPSIS) Method

Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), which was first developed by Hwang and Yoon, 1981 (Aliakbari Nouri et al., 2015:374). TOPSIS, which is one of the most popular MCDM methods and worked satisfactorily in various application areas (Yavuz, 2016:1), is based on the idea, that the chosen alternative should have the shortest distance from the positive ideal solution and on the other side the farthest distance of the negative ideal solution (Jahanshahloo et al., 2006).

An Ideal Solution can be reached by maximizing the benefit criteria and minimizing the cost criteria, whereas the cost criteria are maximized and the benefit criteria are minimized in the negative solution (Kumar & Kumar Singh, 2016). It is often difficult for a decision-maker to assign a precise performance rating to an alternative for the attributes under consideration. The merit of using a fuzzy approach is to assign the relative importance of attributes using fuzzy numbers instead of precise numbers (Mohaghar et al., 2012).

Fuzzy TOPSIS calculations are given below, for detailed information about application and steps (Kuo et al., 2007; Sun, 2010; Çakır & Perçin, 2013; Wood, 2016; Özdağoğlu & Güler, 2016):

Step 1: Determine The Weighting Of Evaluation Criteria And Sub-Criteria.

In our study we used Fuzzy AHP to determine the weighting of evaluation criteria and sub-criteria.

Step 2: Construct The Fuzzy Performance/Decision Matrix And Choose The Appropriate Linguistic Variables For The Alternatives With Respect To Criteria.

In our study we used the information provided in annual financial statements of companies to evaluate their achievement.

The decision matrix is as follow:

$$D = \begin{bmatrix} \check{x}_{11} & \dots & \check{x}_{1j} & \dots & \check{x}_{1n} \\ \vdots & & \vdots & & \vdots \\ \check{x}_{i1} & \dots & \check{x}_{ij} & \dots & \check{x}_{in} \\ \vdots & & \vdots & & \vdots \\ \check{x}_{m1} & \dots & \check{x}_{mj} & \dots & \check{x}_{mn} \end{bmatrix} \text{ where } \check{x}_{ij} = (a_{ij}, b_{ij}, c_{ij}) \tag{24}$$

$$i = 1; 2; \dots; m, j = 1; 2; \dots; n$$

a_{ij} : is the lowest ratio (performance rating) from 2012 to 2016 for alternative A_i with respect to criterion (and or sub-criterion) C_i

b_{ij} : is the average ratio from 2012 to 2016 for alternative A_i with respect to criterion C_i

c_{ij} : is the highest ratio from 2012 to 2016 for alternative A_i with respect to criterion C_i

Step 3: Normalize The Fuzzy-Decision Matrix.

The normalized fuzzy-decision matrix denoted by R is shown as following formula:

$$\check{r} = [\check{r}_{ij}]_{m \times n}, i = 1; 2; \dots; m, j = 1; 2; \dots; n \tag{25}$$

Then, the normalization process can be performed by following formula:

$$\check{r}_{ij} = \left(\frac{l_{ij}}{u_j^+}, \frac{m_{ij}}{u_j^+}, \frac{u_{ij}}{u_j^+} \right), u_j^+ = \max_i \{u_{ij} | i = 1; 2; \dots; n\} \tag{25.1}$$

Or we can set the best aspired level u_j^+ and $j = 1; 2; \dots; n$ is equal 1; otherwise, the worst is 0.

The normalized \check{r}_{ij} is still triangular fuzzy numbers. For trapezoidal fuzzy numbers, the normalization process can be conducted in the same way. The weighted fuzzy normalized decision matrix is shown as following matrix \check{v} :

$$\check{v} = [\check{v}_{ij}]_{n \times n}, i = 1; 2; \dots; m, j = 1; 2; \dots; n \tag{26}$$

$$\text{Where: } \check{v}_{ij} = \check{r}_{ij} \times \check{w}_j \tag{26.1}$$

Step 4: Determine The Fuzzy Positive-Ideal Solution And Fuzzy Negative-Ideal Solution.

According to the weighted normalized fuzzy-decision matrix, we know that the elements \check{v}_{ij} are normalized positive TFN and, while A^+ contribute to the best performance scores (aspiration

levels), A^- contribute to the worst performance scores (the worst levels). Then, we can define the FPIS A^+ and FNIS A^- by the following formula (27):

$$A^+ = (\check{v}_1^*, \dots, \check{v}_j^*, \dots, \check{v}_n^*) \quad (27.1)$$

$$\check{v}_i^* = \begin{cases} \max v_{ij}, j \in N & i = 1, \dots, m, \text{ for benefit criteria} \\ \min v_{ij}, j \in N & i = 1, \dots, m, \text{ for cost criteria} \end{cases} \quad (27.2)$$

$$A^- = (\check{v}_1^-, \dots, \check{v}_j^-, \dots, \check{v}_n^-) \quad (27.3)$$

$$\check{v}_i^- = \begin{cases} \min v_{ij}, j \in N & i = 1, \dots, m, \text{ for benefit criteria} \\ \max v_{ij}, j \in N & i = 1, \dots, m, \text{ for cost criteria} \end{cases} \quad (27.4)$$

Step 5: Calculate The Distance Of Each Alternative From FPIS And FNIS.

The distances (\check{d}_i^+ and \check{d}_i^-) of each alternative from A^+ and A^- can be currently calculated by the area compensation method

$$\begin{aligned} \check{d}_i^+ &= \sum_{j=1}^n d(\check{v}_{ij}, \check{v}_j^*), \\ \check{d}_i^- &= \sum_{j=1}^n d(\check{v}_{ij}, \check{v}_j^-), \quad i = 1; 2; \dots; m, j = 1; 2; \dots; n \end{aligned} \quad (28)$$

The distance between two triangular fuzzy numbers $\check{a} = (a_1, a_2, a_3)$ and $\check{b} = (b_1, b_2, b_3)$ is calculated by the following Equation:

$$d(\check{a}, \check{b}) = \sqrt{\frac{1}{3} [(a_1 - b_1)^2 + (a_2 - b_2)^2 + (a_3 - b_3)^2]} \quad (29)$$

Step 6: Computing the Closeness Coefficients: Closeness coefficient of each alternative is computed by:

$$CC_i = \frac{\check{d}_i^-}{\check{d}_i^- + \check{d}_i^+}, \quad i = 1; 2; \dots; m \quad (30)$$

The higher the CC_i value of alternative the closer to FPIS and Farther from FNIS.

5. Application of the Proposed Method

The hierarchical structure for decision making shown in Fig. (1). the hierarchy shows all the criteria and sub-criteria related to financial performance evaluation. Our alternatives: Turkish airline companies that are listed in Istanbul Stock Exchange market, that is: Pegasus (P) and Turkish airlines (T). The priority weights of criteria and sub-criteria calculated using Fuzzy AHP, the relative importance of one criterion or sub-criterion over another assessed using questionnaire.

Table 2: Pairwise Comparisons Of Main Criteria And Their Weights

Goal	S	E	P	W
S	1.00	1.00	2.50	4.00
E	0.20	0.42	1.00	1.00
P	0.93	1.67	2.83	4.50

Four questionnaires were distributed, in June 2017, to academic personnel of finance department in Karadeniz Technical University holders of PHD degree, then calculate the average relative importance; the aggregated fuzzy pairwise comparison matrix and their weights shown in Table (2) for main criteria, and (3- 4- 5) for sub-criteria.

Table 3: Pairwise Comparisons Of Solvency Sub-Criteria And Their Weights

S	QR	CR	CLNW	CLI	TLNW	FANW	W
QR	1	1	1	2.3	3.83	5.5	1.6
CR	0.36	0.92	1.63	1	1	1	0.78
CLNW	0.61	1.79	2.8	1.43	2.17	3	1
CLI	0.2	0.42	0.63	0.22	0.47	0.83	0.41
TLNW	1.11	2.29	3.3	2.13	3.33	4	1.29
FANW	0.27	0.67	1	0.47	1.33	2	0.24

S	CLI	TLNW	FANW	W
QR	2.5	4	6	1.59
CR	1.5	3	5	0.58
CLNW	2.3	3.33	4.5	0.89
CLI	1	1	1	1.06
TLNW	3.12	4.3	4.83	1
FANW	1.33	3	4.5	0.4

Table 4: Pairwise Comparisons Of Efficiency Sub-Criteria And Their Weights

E	ACP	SI	AS	SNWC	APS	W
ACP	1.0	1.0	1.8	2.3	3.8	0.6
SI	0.9	1.8	2.3	1.0	1.0	0.6
AS	0.6	1.8	3.0	2.6	3.8	5.0
SNWC	0.2	0.3	0.8	0.9	1.5	2.5
APS	1.6	2.6	3.8	1.1	2.1	3.1

Table 5: Pairwise Comparisons Of Profitability Sub-Criteria And Their Weights

P	ROS	ROA	RONWC	W
ROS	1.00	1.00	1.00	1.06
ROA	2.12	3.30	4.33	1.00
RONWC	0.15	0.22	0.47	0.17

The final weights for sub-criteria are calculated by multiplying the local weight of each sub-criterion with the weight of its criterion as shown in Table (6).

Table 6: Final Weights Of Criteria

Criteria	C. W.	Sub-criteria	LW	FW
S	0.471	QR	0.218	0.103
		CR	0.161	0.076
		CLNW	0.197	0.093
		CLI	0.071	0.033
		TLNW	0.236	0.111
		FANW	0.117	0.055
E	0.043	ACP	0.214	0.009
		SI	0.204	0.009
		AS	0.259	0.011
P	0.486	SNWC	0.154	0.007
		AS	0.17	0.007
		ROS	0.433	0.21
		ROA	0.567	0.275
		RONWC	0	0

Decision makers agreed that Profitability and solvency are the most important measures to evaluate companies and the most important ratios are return on assets and return on sales respectively. The return the company can achieve on the invested resources is the most important

norm for financial performance evaluation, and then the net return earned per unit of sales. The return on net working capital is considered as a non-important measurement factor.

As mentioned in the second step of Fuzzy TOPSIS method, the fuzzy decision matrix is shown in Table (7). Normalized fuzzy decision matrix and weighted normalized fuzzy decision matrix are shown in Tables (8 - 9) respectively. Then the fuzzy positive-ideal solution (FPIS) and fuzzy negative-ideal solution (FNIS) calculated as explained in the 4th step of fuzzy TOPSIS calculations. Noting that (CLNW, CLI, TLNW, FANW, ACP, AS, and APS) are cost criteria.

Table 7: Fuzzy decision matrix

	QR			CR			CLNW			CLI			TLNW		
P	0.6	1.3	1.7	0.6	1.5	1.8	0.6	0.9	1.6	43	137	286	1.8	2.9	5.7
T	0.6	0.7	0.8	0.7	0.8	0.9	0.8	0.9	1.0	17	19	21	2.4	2.5	2.6
	FANW			ACP			SI			AS			SNWC		
	1.6	2.7	6	8	21	28	152	486	1020	1.2	1.3	1.5	-9.7	0.7	4.8
	2.7	2.8	3	13	17	19	39	50	57	1.3	1.6	2.2	-22.7	-13.4	-8.9
	APS			ROS			ROA			RONWC					
	0.06	0.07	0.09	-0.04	0.15	0.66	-0.02	0.13	0.57	-6.35	-1.19	0.22			
	0.06	0.07	0.08	0.00	0.06	0.10	0.00	0.04	0.06	-1.78	-0.91	0.01			

Table 8: Normalized Fuzzy Decision Matrix

	QR			CR			CLNW			CLI			TLNW		
P	0.3	0.8	1	0.3	0.8	1	0.4	0.5	1	0.1	0.5	1	0.3	0.5	1
T	0.4	0.4	0.5	0.4	0.4	0.5	0.5	0.5	0.6	0.1	0.1	0.1	0.4	0.4	0.5
	FANW			ACP			SI			AS			SNWC		
	0.3	0.5	1	0.3	0.8	1	0.1	0.5	1	0.5	0.6	0.7	-2	0.1	1
	0.5	0.5	0.5	0.5	0.6	0.7	0	0	0.1	0.6	0.7	1	-4.8	-2.8	-1.9
	APS			ROS			ROA			RONWC					
	0.7	0.8	1	-0.1	0.2	1	0	0.2	1	-28.7	-5.3	1			
	0.7	0.8	0.9	0	0.1	0.2	0	0.1	0.1	-8	-4.1	0.1			

Table 9: Weighted Normalized Fuzzy Decision Matrix

	QR			CR			CLNW			CLI			TLNW		
P	0.03	0.08	0.10	0.03	0.06	0.08	0.03	0.05	0.09	0.00	0.02	0.03	0.04	0.06	0.11
T	0.04	0.04	0.05	0.03	0.03	0.04	0.05	0.05	0.05	0.00	0.00	0.00	0.05	0.05	0.05
	FANW			ACP			SI			AS			SNWC		
	0.02	0.03	0.06	0.00	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.01	-0.01	0.00	0.01
	0.03	0.03	0.03	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01	-0.03	-0.02	-0.01
	APS			ROS			ROA			RONWC					
	0.01	0.01	0.01	-0.01	0.05	0.21	-0.01	0.06	0.28	0.00	0.00	0.00			
	0.01	0.01	0.01	0.00	0.02	0.03	0.00	0.02	0.03	0.00	0.00	0.00			

Table 10: Closeness Coefficients And Final Scores

alternative	d+	d-	cc	Rank
P	0.143	0.36	0.715	1
T	0.501	0.11	0.18	2

After calculating the distance of each alternative from FPIS and FNIS, then the Closeness Coefficients calculated and alternatives ranked. Computation of closeness coefficients of each alternative and final scores shown in Table (10). The result of application of the proposed model shows that Pegasus has a bitter financial performance than Turkish airlines.

6. Conclusion

Nowadays, Aviation services become one of the most essential parts of daily human life and economies. The operational performance of aviation industry is important, however, the financial performance of those entities is also significant for different groups of stakeholders. Therefore, this study propose an integrated Fuzzy AHP Fuzzy TOPSIS model for evaluating the financial performance of Turkish airline companies listed in Istanbul Stock Exchange.

Fuzzy AHP method is used to assign the importance weights for the evaluation criteria. The profitability and the solvency are the most significant aspects for evaluating these entities. As profitability measure; while ROA and ROS are the most important factors, RONWC is considered as an unimportant factor for the evaluation process. Fuzzy TOPSIS method is used to rank alternatives. The application of the proposed model on airline companies that are listed in Istanbul Stock Exchange from 2012 and 2016 showed that Pegasus has a better financial performance than Turkish Airlines. In which, during 2015 and 2016 Turkish Airlines Company's total assets have been estimated as 65,074 m and 47,638 m respectively, and their revenues have been estimated as 29468 m and 28752 m respectively. Whereas, Pegasus's total assets have been estimated as 5618 m and 4098 m respectively and their revenues have been estimated as 3707 m and 3488 m respectively. Interestingly, the results of applying the proposed model emphasize on the importance and the reliability of financial ratio analysis in evaluating companies' financial performance. And the usefulness of multi-criteria decision making methods.

As a huge service industry, evaluating the overall performance of airline companies is very important to understand company's position and help making efficient financial and investment decisions. Due to budget, time and information access limitation, this study contributes only to the financial performance evaluation of airline companies, farther studies may consider the nonfinancial performance aspects.

References

- Abdul Hamid, M. and Azmi, S. M. (2011). The Performance of Banking during 2000-2009: Bank Islam Malaysia Berhad and Conventional Banking in Malaysia. *International Journal of Economics and Management Sciences*, 1(1), 09-19.
- Aliakbari Nouri, F., Khalili Esbouei, S. and Antucheviciene, J. (2015). A Hybrid MCDM Approach Based on Fuzzy ANP and Fuzzy TOPSIS for Technology Selection. *INFORMATICA*, 26(3), 369-388.
- Aydogan, E. K., Demirtas, O. and Dagdeviren, M. (2015). A New Integrated Fuzzy Multi-Criteria Decision Model for Performance Evaluation. *Business and Management Studies*, 1(1), 38-55.
- Bellman, R.E. and Zadeh, L. A. (1970). Decision Making in a Fuzzy Environment. *Management Science*, 17(4), B141-164.
- Calomiris, C. W. and Mason, J. R. (1994). Contagion and Bank Failures During the Great Depression: The June 1932 Chicago Banking Panic. *NBER Working Paper #4934*.
- Chabotar, K. J. (1989). Financial Ratio Analysis Comes to Nonprofits. *The Journal of Higher Education*; 60(2), 188.
- Chang, D-Y. (1996). Applications of the Extent Analysis Method on Fuzzy AHP. *European Journal of Operational Research*, 95(3), 649-655.
- Chang, T-H. and Wang, T-C. (2009). Using the Fuzzy Multi-Criteria Decision Making Approach for Measuring the Possibility of Successful Knowledge Management. *Information Sciences*, 179(4), 355-370.

- Çakır, S. and Perçin, S. (2013). R&D Performance Measurement in EU Countries Using Combined Entropy Weight-TOPSIS Method. *Uludağ Journal of Economy and Society*, 1, 77- 95
- DHMI Official site (2017): <http://www.dhmi.gov.tr/>
- Eyüboğlu, K. and Çelik, P. (2016). Financial Performance Evaluation of Turkish Energy Companies with Fuzzy AHP and Fuzzy TOPSIS Methods. *Business and Economics Research Journal*, 7(3), 21-37.
- Feng, C. M. and Wang, R. T. (2000). Performance Evaluation for Airlines Including the Consideration of Financial Ratios. *Journal of Air Transport Management*, 6(3), 133-142.
- Gibson, C. H. (2011). *Financial Reporting and Analysis Using Financial Accounting Information*, (12th ed.). South-western.
- International Air Transport Association (IATA), IATA annual review 2017. <http://www.iata.org/publications/>
- Jahanshahloo, G.R., Hosseinzadeh Lotfi, F. and Izadikhah, M. (2006). Extension of the TOPSIS method for Decision-Making. *Applied Mathematics and Computation*, 181(2), 1544-1551.
- Kahraman, C., Cebeci, U. & Ruan, D. (2004). Multi-Attribute Comparison of Catering Service Companies Using Fuzzy AHP: The Case of Turkey. *Int. J. Production Economics*, 87(2), 171–184.
- Kaya, T. (2010). Multi-attribute Evaluation of Website Quality in E-business Using an Integrated Fuzzy AHP TOPSIS Methodology, *International Journal of Computational Intelligence Systems*, 3(3), 301-314.
- Kaya, T. and Kahraman, C. (2010). Multicriteria decision Making in Energy Planning Using a Modified Fuzzy TOPSIS Methodology. *Expert Systems with Applications*, 38(6), 6577–6585.
- Kumar, P. and Kumar Singh, R. (2016). Solving the Vendor Selection Problem Using Fuzzy TOPSIS. *International Conference in Recent Advances in Mechanical Engineering (RAME-2016)*.
- Kumbirai, M. and Webb, R. (2010). A Financial Ratio Analysis of Commercial Bank Performance in South Africa. *African Review of Economics and Finance*, 2(1).
- Kuo, M-S., Tzeng, G-H. and Huang, W-C. (2007). Group Decision-Making Based on Concepts of Ideal and Anti-Ideal Points in a Fuzzy Environment. *Mathematical and Computer Modelling*, 45(3-4), 324–339.
- Mahendran, P. (2014). A Fuzzy AHP Approach for Selection of Measuring. Instrument for Engineering College Selection. *Applied Mathematical Sciences*, 8(44), 2149 – 2161.
- Mavi, R. K. (2014). Indicators of Entrepreneurial University: Fuzzy AHP and Fuzzy TOPSIS Approach. *J Knowl Econ*, 5(2), 370–387.
- Mohaghar, A., Fathi, M. R., Faghieh, A. and Turkayesh, M. M. (2012). An Integrated Approach of Fuzzy ANP and Fuzzy TOPSIS for R&D Project Selection: A Case Study. *Australian Journal of Basic and Applied Sciences*, 6(2), 66-75.
- Nissim, D. and Penman, S. (2001). Ratio Analysis and Equity Valuation: From Research to Practice. *Review of Accounting Studies*, 6, 109–154.
- Onut, S., Efeendigil, T. and Kara, S. S. (2010). A Combined Fuzzy MCDM Approach for Selecting Shopping Center Site: An Example from Istanbul, Turkey. *Expert Systems with Applications*, 37(3), 1973–1980.

- Ömurbek, V. and Kinay, B. (2013). A TOPSIS-Based Financial Performance Assessment Study on Airline Industry. *The Journal of Faculty of Economics and Administrative Sciences*, 18(3), 343-363.
- Özdağoğlu, A. and Güler, M. E. (2016). E-Service Quality of Internet Based Banking Using Combined Fuzzy AHP and Fuzzy TOPSIS. *Tehnički vjesnik*, 23(4), 1109-1116.
- Pegasus Airlines Annual Reports, 2012-16. <http://www.pegasusinvestorrelations.com/>
- Poplawska, J. (2014). Decision Support Framework for Resources Allocation to corporate Social Responsibility (CSR) Programmes (not published PDH thesis). University of Portsmouth, England.
- Reilly, F.K. and Brown, K.C. (2003). *Investment analysis and portfolio management* (7th ed.). South-Western, MOc.
- Shukla, R. K., Garg, D. and Agarwal, A. (2014). An Integrated Approach of Fuzzy AHP and Fuzzy TOPSIS in Modeling Supply Chain Coordination. *Production & Manufacturing Research: An Open Access Journal*, 2(1), 415-437.
- Sun, C-C. (2010). A Performance Evaluation Model by Integrating Fuzzy AHP and Fuzzy TOPSIS Methods. *Expert Systems with Applications*, 37(12), 7745–7754.
- Teker, S., Teker, D. and Guner, G. (2016). Financial Performance of Top 20 Airlines. *Procedia - Social and Behavioral Sciences*, 235, 603-610.
- Turkish Airlines Annual Reports, 2012-16. <http://investor.turkishairlines.com/en>
- Wood, D. A. (2016). Supplier Selection for Development of Petroleum Industry Facilities, Applying Multi-criteria Decision Making techniques including fuzzy and intuitionistic fuzzy TOPSIS with flexible entropy weighting. *Journal of Natural Gas Science and Engineering*, 28, 594-612.
- Yalcin, N., Bayraktaroglu, A. and Kahraman, C. (2012). Application of fuzzy Multi-Criteria Decision Making Methods for Financial Performance Evaluation of Turkish Manufacturing Industries. *Expert Systems with Applications*, 39(1), 350–364.
- Yavuz, M. (2016). Equipment Selection by Using Fuzzy TOPSIS Method. *IOP Conf. Series: Earth and Environmental Science* 44, 042040.
- Zietlow, J. (2010). Nonprofit Financial Objectives and Financial Responses to a Tough Economy. *Journal of Corporate Treasury Management*, 3(3), 238–248
- Zopounidis, C. and Doumpos, M. (2002). Multi-criteria Decision Aid in Financial Decision Making: Methodologies and Literature Review. *J. Multi-Crit. Decis. Anal.* 11(4-5), 167–186.
- Zyoud, S. H., Kaufmann, L. G., Shaheen, H., Samhan, S. and Fuchs-Hanusch, D. (2016). A Framework for Water Loss Management in developing Countries Under Fuzzy Environment: Integration of Fuzzy AHP with Fuzzy TOPSIS. *Expert Systems with Applications*, 61(1), 86–105.

