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FINANCIAL PERFORMANCE IN AIRLINES: APPLICATION OF TOPSIS IN FOUR EUROPE-BASED TRADITIONAL AIRLINES

Ünal BATTAL*

ABSTRACT

The purpose of this study was to measure the financial performance of four large traditional airlines based in Europe using TOPSIS method. Airlines need to measure their financial performance in order to accurately manage their future and the steps to be taken as a result of these measurements should be determined. In this study, the financial performance of Turkish Airlines, Air France-KLM, British Airways and Lufthansa was measured for the first time using TOPSIS and based on the financial data between 2013 and 2018.

A six-year review was conducted to make the assessment sufficient and accurate. The financial statements between 2013 and 2018 of the concerned airlines were utilized. The data obtained from the balance sheets and income statements were converted into financial performance indicators by performing necessary operations. TOPSIS was then applied to the financial performance indicators. To achieve the stated objective, financial ratios were calculated and then the TOPSIS was used to translate the values to a single score showing overall company performance. The calculated performance scores were then used to classify the enterprises.

The study observed that the performance scores of airlines generally fluctuated during the analysis period. However, looking at the overall six-year period, the Air France-KLM partnership showed a distinct divergence by ranking first in performance in four different years. Lufthansa also displayed a divergence by ranking second place in four different years. British Airways, on the other hand, ranked in different positions over the six-year period while Turkish Airlines ranked third and fourth in the first five years of the six-year period and rose to first place in the last year, 2018.

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STRUCTURED ABSTRACT

Airlines are one of the main components of the air transport system. The desire for continued survival and growth by airlines, which makes their main objectives, has gained prominence in the increasingly competitive environment. The technological advancements that we experience and the resultant rapid dissemination of information, as well as the integration of national economies, have made it compulsory for businesses to compete not only with local enterprises but also on a global scale. Today, most airlines compete globally and only those companies that can operate efficiently while displaying high performance are able to survive in this competitive environment. The determination of the competitiveness of the enterprise calls for the measurement and correct analysis of its financial performance. The performance of the enterprise affects its investors as well as the national economy in addition to the enterprise.

The purpose of this study was to measure the financial performance of four large traditional airlines based in Europe using TOPSIS. Airlines need to measure their financial performance in order to accurately manage their future and the steps to be taken as a result of these measurements should be determined. In this study, the financial performance of Turkish Airlines, Air France-KLM, British Airways and Lufthansa was measured for the first time using TOPSIS and based on the financial data between 2013 and 2018.

Within the framework of the general purpose of the research, answers to the following questions were sought:

- Which ratio analysis is important for the measurement of financial performance in airlines?
- How is financial performance measurement done using TOPSIS?
- How are the financial performances of the four major traditional airline carriers between 2013 and 2018 ranked according to TOPSIS?
- What are the reasons for the change in the financial performance rankings of the four major traditional airline carriers in 2013-2018?

Profit is not an adequate indicator of the performance evaluation of airlines. It is not proper to decide on the future of the business by looking only at the profit. The business should determine its performance by looking at its financial statements and financial performance measurement ratios. Financial analysis should be performed at regular intervals to help in effective decision-making, planning and audit functions. Ratios such as liquidity, net working capital, and receivables turnover are of great importance for businesses in the aviation sector. The business should be able to calculate such rates in order to obtain detailed information about its operations (Özdemir and Seçme, 2009: 80).

Multi-criteria decision-making methods have a wide range of applications when it comes to listing alternatives using more than one criterion. A study of multi-criteria decision-making methods was presented in 1981 by Hwang and Yoon. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), which is one of these techniques and often the most extensively used, was first developed by Hwang and Yoon (1981). All of the airlines subject to the study show

superiority in terms of different performance indicators. However, TOPSIS, which is one of the multi-criteria decision-making techniques, was used to make a holistic evaluation. TOPSIS was preferred because it allows for all the criteria for evaluation to be considered together. For this reason, TOPSIS was used to evaluate the performance of airlines following the performance indicators identified in the study. In addition, TOPSIS combines different evaluation options under a common denominator, thus giving the decision makers an objective evaluation. It provides a single indicator by combining all desired indicators without being dependent to a single indicator.

To ensure the accuracy of the evaluation, care was taken to ensure that all four airlines were European-based and traditional. The similarity of the selected companies and the similarity of their general characteristics was to ensure a more accurate evaluation. For this reason, only Turkish Airlines, Lufthansa, British Airways and Air France-KLM were selected, leaving out low-cost or regional airlines.

A six-year review was conducted to make the assessment sufficient and accurate. The financial statements between 2013 and 2018 of the concerned airlines were utilized. Balance sheets and income statements published by the companies online were used. The data obtained from the balance sheets and income statements were converted into financial performance indicators by performing necessary operations. TOPSIS was then applied to the financial performance indicators.

The study observed that the performance scores of airlines generally fluctuated during the analysis period. However, looking at the overall six-year period, the Air France-KLM partnership showed a distinct divergence by ranking first in performance in four different years. Lufthansa also displayed a divergence by ranking second place in four different years. British Airways, on the other hand, ranked in different positions over the six-year period while Turkish Airlines ranked third and fourth in the first five years of the six-year period and rose to first place in the last year, 2018.

This study used the TOPSIS method to evaluate the financial performance of four traditional Europe-based airlines. Future studies could;

- Investigate the reasons for the financial performance rankings for the mentioned periods,
- evaluate traditional carriers based in America and the Far East in a similar way and compare them to European-based airlines,
- conduct a similar study with European-based low-cost carriers and compare the results with traditional European-based carriers.

In this way, the differences in the financial performance of airlines operating in different geographies and with different business models could be better evaluated. The results of these evaluations could be useful to the managers and investors of the airlines in making the most appropriate decisions about the future and investments in the firms taking into consideration the proposed changes.

Keywords: Financial Performance, Ratio Analysis, TOPSIS, Air Transport.

HAVA YOLU İŞLETMELERİNDE FİNANSAL PERFORMANS: AVRUPA MERKEZLİ DÖRT GELENEKSEL HAVA YOLU İŞLETMESİNDE TOPSIS UYGULAMASI

Öz

Bu çalışmanın amacı, TOPSIS yöntemini kullanarak Avrupa'da bulunan dört büyük geleneksel havayolunun finansal performansını ölçmektir. Havayollarının geleceklerini doğru bir şekilde yönetebilmek için finansal performanslarını ölçmeleri gerekmektedir ve bu ölçümler sonucunda atılacak adımlar belirlenmelidir. Bu çalışmada, Türk Hava Yolları, Air France-KLM, British Airways ve Lufthansa'nın finansal performansı ilk kez TOPSIS kullanılarak ve 2013 ve 2018 yılları arasındaki finansal verilere göre ölçülmüştür.

Değerlendirmeyi yeterli ve doğru hale getirmek için altı yıllık bir inceleme yapılmıştır. İlgili havayollarının 2013 ve 2018 yılları arasındaki mali tabloları kullanılmıştır. Bilanço ve gelir tablolarından elde edilen veriler gerekli işlemler yapılarak finansal performans göstergelerine dönüştürülmüştür. TOPSIS daha sonra finansal performans göstergelerine uygulanmıştır. Çalışmada finansal oranlar hesaplanmış, daha sonra hesaplanan oranlar; TOPSIS yöntemi kullanılarak genel şirket performansını gösteren tek bir puana çevrilmiştir. Hesaplanan performans puanları işletmelerin sıralanmasında kullanılmıştır.

Çalışma, havayollarının performans puanlarının genel olarak analiz dönemi boyunca değiştiğini gözlemlemiştir. Bununla birlikte, toplam altı yıllık süreye bakıldığında, Air France-KLM ortaklığı, dört farklı yılda ilk sırada yer alarak belirgin bir farklılık gösterdi. Lufthansa ayrıca dört farklı yılda ikinci sırada yer alarak bir sapma gösterdi. British Airways, altı yıl boyunca farklı sıralarda yer alırken, Türk Hava Yolları altı yıllık sürenin ilk beş yılında üçüncü ve dördüncü sırada yer aldı ve son yılda 2018'de ilk sırayı aldı.

Anahtar Kelimeler: Finansal Performans, Oranlar Analizi, TOPSIS Yöntemi, Hava Taşımacılığı

Introduction

Airlines are one of the main components of the air transport system. The desire for continued survival and growth by airlines, which makes their main objectives, has gained prominence in the increasingly competitive environment. The technological advancements that we experience and the resultant rapid dissemination of information, as well as the integration of national economies, have made it compulsory for businesses to compete not only with local enterprises but also on a global scale (Wells, 1999). Today, most airlines compete globally and only those companies that can operate efficiently while displaying high performance are able to survive in this competitive environment. The determination of the competitiveness of the enterprise calls for the measurement and correct analysis of its financial performance. The performance of the enterprise affects its investors as well as the national economy in addition to the enterprise.

In order to determine and manage the performance of the enterprise, it is necessary to first measure it. You cannot manage what you cannot measure. The data used in the measurement must also

be accurate and reliable. Incorrect performed measurements may give false information about the enterprise and may have an impact including leading to bankruptcy.

Profit is not an adequate indicator of the performance evaluation of airlines. It is not proper to decide on the future of the business by looking only at the profit. The business should determine its performance by looking at its financial statements and financial performance measurement ratios. Financial analysis should be performed at regular intervals to help in effective decision-making, planning and audit functions. Ratios such as liquidity, net working capital, and receivables turnover are of great importance for businesses in the aviation sector. The business should be able to calculate such rates in order to obtain detailed information about its operations (Özdemir and Seçme, 2009: 80).

Multi-criteria decision-making methods have a wide range of applications when it comes to listing alternatives using more than one criterion. A study of multi-criteria decision-making methods was presented in 1981 by Hwang and Yoon. TOPSIS (Technique for Order Preference by Similarity to Ideal Solution), which is one of these techniques and often the most extensively used, was first developed by Hwang and Yoon (1981). The basis of this technique is to select the alternatives closest to the positive – ideal solution thereby maximizing the benefit criteria while minimizing the cost criteria (Özdemir & Seçme, 2009).

1. Financial Performance Indicators Used for Airlines

The financial ratios, which are used as financial performance indicators, are also used by the airlines to measure their financial performance. Each sector has its own unique characteristics and based on these characteristics, some ratios may be important for one sector and not important for another. Liquidity is an important concept for airlines. This is also the case with net working capital. However, stock turnover may not be of great importance for airlines (O'connor, 2001).

Liquidity Ratios: Liquidity ratios are used to measure the ability of an entity to meet its short-term debt. They show the ability of the enterprise to sustain its operations in the unexpected market and economic conditions (Aydn vd., 2014:88). The ratios measure how easily the business can generate cash its ability to carry out daily business and they can be said to be the most important ratios for airlines. This may be due to the fact that most of the debts of airlines are short-term debt. The current ratio and cash ratio were used in this study. Inventory doesn't make a large portion of airlines' current assets given that the airline industry is a service sector and due to the sectoral characteristics of the airlines. Inventories thus constitute a small part of the current assets of airlines leading the study to leave out inventory-related ratios and liquidity ratio.

Financial Leverage Ratios: Financial leverage ratios show the airline's capital structure and the resources which make up the entity's assets and to what extent. The ratios give the entity a clear idea of its financial structure like the ability to meet its long-term debt. The financial leverage ratios are also used to measure the debt-equity distribution in the funding of the assets; the soundness of firms' financial structures, the effectiveness of the resource utilization and their success in value addition (Çabuk vd., 2013:66). When airlines obtain an aircraft through financial leasing, this is considered an acquisition through long-term debt. Airlines that utilize this kind of acquisition tend to have larger balances on long-term liability accounts. Airlines, being capital intensive businesses, need to keep track of the entity's debt-equity distribution using financial leverage ratios. In addition, if the airline wants to buy a new aircraft through financial leasing, they should maintain their financial ratios at a good level, because the institutions that will give credit look at the leverage ratio of the airline. Financial leverage ratios are used to measure how appropriately airlines use their resources. In this study, the financial leverage ratio, the ratio of fixed assets to equity, debt service ratio and debt structure ratio were used.

Efficiency Ratios: Also known as activity or turnover ratios, efficiency ratios indicate how effectively companies use the assets to generate income as well as help in the interpretation of liquidity

ratios (Aydın vd., 2014:92). The majority of the assets of airlines are made of fixed assets. Aircraft make most of these are the fixed assets. It is very important for the airline to use its assets efficiently. In this study, the accounts receivable turnover ratio, equity turnover ratio and fixed assets turnover ratio were used.

Profitability Ratios: Profitability ratios measure whether the company operates profitably in all its activities as a whole or the efficiency of each of its core activities. Profitability ratios are one of the most important indicators in evaluating the effectiveness and performance of management as they show the profitability obtained through sales and investments (Aydın vd., 2014:98). As with every enterprise, the main purpose for the establishment of airlines is to make profit. Profitability ratios should be used to measure whether the profit earned is at the desired level. In this study, the gross profit margin ratio, net profit margin ratio, and assets turnover ratio were used.

2. Financial Performance of Airlines

The demand for air transportation in the world is increasing with each passing day. Technology is developing rapidly, and people's needs and wants are equally rapidly changing. The decisions made by airlines in the face of these changes are of great importance. In this respect, the most rational solution for airline managers is to try to make efficient use of the available resources. Achieving the most appropriate efficiency for any business requires effective and reliable financial performance measurements. Furthermore, the increasing competition and globalization of the in the air transport market have made performance measurements and continuous evaluation of performance a necessity.

In this part of the study, the aim, importance, and method of the research used are explained and literature review is done. Then, the TOPSIS used in the research was examined and the financial performance of the four airlines subject of the study was measured using TOPSIS and the results evaluated.

2.1. Aim, Importance and Method of Research of the Study

The purpose of this study was to measure the financial performance of four large traditional airlines based in Europe using TOPSIS. Airlines need to measure their financial performance in order to accurately manage their future and the steps to be taken as a result of these measurements should be determined. In this study, the financial performance of Turkish Airlines, Air France-KLM, British Airways and Lufthansa was measured for the first time using TOPSIS and based on the financial data between 2013 and 2018.

Within the framework of the general purpose of the research, answers to the following questions were sought:

- Which ratio analysis is important for the measurement of financial performance in airlines?
- How is financial performance measurement done using TOPSIS?
- How are the financial performances of the four major traditional airline carriers between 2013 and 2018 ranked according to TOPSIS?
- What are the reasons for the change in the financial performance rankings of the four major traditional airline carriers in 2013-2018?

All of the airlines subject to the study show superiority in terms of different performance indicators. However, TOPSIS, which is one of the multi-criteria decision-making techniques, was used to make a holistic evaluation. TOPSIS was preferred because it allows for all the criteria for evaluation to be considered together. For this reason, TOPSIS was used to evaluate the performance of airlines following the performance indicators identified in the study. In addition, TOPSIS combines different evaluation options under a common denominator, thus giving the decision makers an objective

evaluation. It provides a single indicator by combining all desired indicators without being dependent to a single indicator.

The following steps were followed in this research which measured the financial performance of four major Europe-based airlines:

1. Literature Review: The study was first started by a review of the relevant literature. Literature concerning ratio analysis, TOPSIS and air transport sector was considered in the review.
2. Data Collection: Document analysis method was used during data collection stage. The financial statements of the airlines in their annual reports published between 2013 and 2018 were examined. The data required for the calculation of financial performance indicators were calculated from these financial statements.
3. Methodology: At the end of the literature review, TOPSIS was applied to year-to-year financial data of the four traditional airlines to measure their performance.

2.2. Limitations of Research

In this part of the study, the financial performance of the four companies subject of this study was done using is made by using the ratios calculated from their financial statements and TOPSIS. The financial statements were obtained from the annual reports published by the companies. The financial performance indicators were calculated using the data obtained from the financial statements.

To ensure the accuracy of the evaluation, care was taken to ensure that all four airlines were European-based and traditional. The similarity of the selected companies and the similarity of their general characteristics was to ensure a more accurate evaluation. For this reason, only Turkish Airlines, Lufthansa, British Airways and Air France-KLM were selected, leaving out low-cost or regional airlines.

A six-year review was conducted to make the assessment sufficient and accurate. The financial statements between 2013 and 2018 of the concerned airlines were utilized. Balance sheets and income statements published by the companies online were used. The data obtained from the balance sheets and income statements were converted into financial performance indicators by performing necessary operations. TOPSIS was then applied to the financial performance indicators.

2.3. Literature review

Most of the previous research with regard to airlines performance evaluation generally focused on operational performance. Research on financial performance evaluations, which could directly affect the survival of an airline, only became started taking root after the 2000s. This included the evaluation of the effects of non-financial performance variables on the financial performance of airlines. Behn and Riley (1999) found out that even two months of non-financial data was useful in estimating quarterly income, expenses and operating income. Riley, Pearson et al. (2003) found traditional accounting variables and non-financial performance variables to be significantly associated with stock returns. They observed that changes in the non-financial performance had an increasing value relationship on earnings compared to traditional accounting measures. Davila and Venkatachalam (2004) examined the relationship between executive compensation and non-financial performance indicators such as passenger occupancy rate in airlines. They found evidence that the weight of non-financial performance indicators in executive contracts has increased.

Wang (2008) examined the financial performance of the three domestic airline companies in Taiwan from 2001 to 2005 using the fuzzy TOPSIS and gray relation analysis and found that the financial competitive strength and weaknesses of airlines could be determined comparative to each other. This led to the determination that the comparison of the performance will be useful in improving

the competitive advantage and establishing a competitive position of airlines in the market, which will, in turn, lead to the strengthening of the financial ability.

Feng and Wang (2000) evaluated the performance of five airlines in Taiwan using the financial ratios and found out that financial ratios alone cannot measure all the performance property of an airline. They stated that transportation indicators are better for production efficiency while financial ratios are better for operational efficiency.

Pestana and Wanke (2015) investigated the efficiency of African Airlines using two-stage TOPSIS and neural networks. Using the most commonly used operational indicators in the literature and performing a relative efficiency evaluation, they showed that the variables related to the size of the flight networks and the economies of scale were the most important variables for efficiency in the African airline sector when the fleet structure and public ownership were taken into consideration.

Ömürbek and Kınay (2013) evaluated the financial performance of an airline (ABC) operating on the Borsa İstanbul (BIST) and an airline (XYZ) operating on the Frankfurt Stock Exchange. They used data for 2012 for both companies. They used operational profit, net profit, current ratio, liquidity ratio, financial leverage, cash ratio, return on equity and occupancy rates as indicators of financial performance. Using TOPSIS, they concluded that ABC's performance was higher than that of XYZ. In this research, the performance of two traditional carriers which are equivalent to each other was compared only in terms of 2012 data.

Akgün and Temür (2016) evaluated the 6-year (2010-2015) financial performance of 2 airlines registered in the Borsa İstanbul transport index. They used TOPSIS, which is one of the multi-criteria decision-making methods. First, they calculated the financial ratios of Turkish Airlines and Pegasus, which were the subject of the study. In this study, they used current ratio, liquidity ratio, cash ratio, financial leverage ratio, ratio of equity to total assets, ratio of equity to total liabilities, ratio of short-term liabilities to total liabilities, ratio of fixed assets to equity, ratio of net sales to total assets, ratio to resources, ratio of return on equity and ratio of return on assets. Later, they used TOPSIS to convert the calculated ratios to a single score showing the overall operating performance. The performance of the companies was then ranked by year and it was concluded that the best performance was for Turkish Airlines in the year 2012. The research considered the performance in different years; however, a comparative financial performance evaluation was limited by the fact that Turkish Airlines is a traditional carrier and Pegasus is a low-cost carrier.

Akkaya (2004) tried to measure the performances of airlines using financial ratios. The study used Gray Relationship Analysis and TOPSIS. Within the scope of the study, 63 ratios were determined under the three main headings of production, marketing and operation. Using gray relationship analysis and TOPSIS, the ratios were then reduced to thirteen to represent each group. The study contended that the model developed in the study and the method of analysis followed would give more striking results especially in comparison of more than one airline companies.

Torlak, Peppy, Virtual and Zaim (2011) evaluated the financial performance four of airlines operating in the Turkish domestic air transport. TOPSIS was used to conduct the performance evaluation. Data such as efficiency, advertising and customer service were used in the evaluation.

Öncü, Çömlekçi and Coşkun (2013) measured the efficiency of the passenger transportation operations of airlines operating in a highly competitive environment using the data envelopment analysis program. The data obtained from the financial statements of the enterprises were analyzed using DEAP (Data Envelopment Analysis Program). The results found three of the seven enterprises examined to be effective. In addition, they identified potential improvement ratios for inefficient firms to become effective.

2.4. TOPSIS

TOPSIS is one of the multi-criteria decision-making methods. The basis of this technique, as developed by Hwang and Yoon (1981), is to select the alternative that is at shortest distance to the positive ideal solution and the farthest distance from the negative ideal solution. The TOPSIS method involves a six-step solution process. These steps are as follows (Hwang and Yoon 1981, Dumanoglu, and Ergul, 2010);

Step 1: Creating the Decision Matrix (A_{ij}): the rows in the decision matrix contain the decision points while the columns contain the evaluation factors to be used in decision making. The decision matrix is the initial matrix created by the decision-maker. In matrix A_{ij} 'm' gives the number of decision points and 'n' the number of evaluation factors.

Step 2: Creating the Standard Decision Matrix (R_{ij}): The Standard Decision Matrix is calculated from the elements of the matrix using formula 1 below.

$$r_{ij} = \frac{a_{ij}}{\sqrt{\sum_{k=1}^m a_{kj}^2}} \quad (1)$$

Step 3: Creating the Weighted Standard Decision Matrix (V_{ij}): First the weight values (w_i) of the assessment factors are determined ($\sum_{i=1}^n w_i = 1$). Then the w_i values of the elements in each column of the matrix R are multiplied by the corresponding value to form matrix V_{ij}

Step 4: Creating Ideal (A^*) and Negative Ideal (A^-) Solutions: The TOPSIS method assumes that each evaluation factor has a monotonous increasing or decreasing trend. In order to create the ideal solution set, the largest of the weighted evaluation factors in matrix V_{ij} , i.e. the column values (or the smallest if the corresponding evaluation factor is minimized) is selected. The formula for finding the ideal solution set is shown below.

$$A^* = \left\{ \left(\max_i v_{ij} \mid j \in J \right), \left(\min_i v_{ij} \mid j \in J' \right) \right\} \quad (2)$$

The set to be calculated from formula 2 can be shown as $A^* = \{v_1^*, v_2^*, \dots, v_n^*\}$. The set of negative ideal solutions is formed by selecting the smallest of the weighted evaluation factors in matrix V_{ij} , i.e. the column values (or the largest if the corresponding evaluation factor is maximized). The formula for finding the ideal solution set is shown below.

$$A^- = \left\{ \left(\min_i v_{ij} \mid j \in J \right), \left(\max_i v_{ij} \mid j \in J' \right) \right\} \quad (3)$$

The set to be calculated from formula 3 can be shown as $A^- = \{v_1^-, v_2^-, \dots, v_n^-\}$.

In both formulas, J shows the benefit (maximization) and J' shows the loss (minimization). The ideal and negative ideal solution set consists of as many elements as the number of evaluation factors.

Step 5: Calculation of Separation from the alternatives: In TOPSIS, the Euclidian Distance Approach is used to determine the deviations of the evaluation factor value for each decision point from the ideal and negative ideal solution set. The deviation values of the decision points obtained here are called Ideal Discrimination (S_i^*) and Negative Ideal Discrimination (S_i^-) Measures and are calculated using the following formulas.

$$S_i^* = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^*)^2} \quad (4)$$

$$S_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad (5)$$

The number of S_i^* and S_i^- to be calculated here will naturally be the number of decision points.

Step 6: Calculating the Relative Closeness to the Ideal Solution: The ideal and negative ideal distinction measures are used to calculate the proximity to the ideal solution for each decision point (C_i^*). The measure used here is the proportion of the negative ideal discrimination measure within the total discrimination measure. The calculation of the proximity to the ideal solution is shown in the following formula.

$$C_i^* = \frac{S_i^-}{S_i^- + S_i^*} \quad (6)$$

Where, the value C_i^* is taken in the range $0 \leq C_i^* \leq 1$ and $C_i^* = 1$ indicates the absolute proximity of the respective decision points to the ideal solution and $C_i^* = 0$ indicates the absolute proximity of the respective decision point to the negative ideal solution.

2.5. Application of TOPSIS

In this study, attention was taken to use ratios that could provide information about the liquidity status, effective assets, financial structure and profitability of the companies. The financial ratios and codes used in the analysis are shown in Table 1. In selecting financial ratios, the unique characteristics of the air transport sector and the asset resource structure of airlines were also taken into consideration.

Since the air transportation sector is a service sector, inventories take only a small of the airlines' fixed assets. For this reason, liquidity ratio, inventory turnover ratios and other inventory related ratios were not used. Liquidity is important for airlines. Therefore, current ratio and cash ratio were used as performance indicators to measure liquidity. In order to determine the effective use of the assets of the companies, the turnover ratios, receivables turnover ratios, asset turnover ratios and equity turnover ratios were used as financial performance indicators. In order to examine the financial structure of the companies, financial leverage ratio, debt structure ratio, debt service ratio, ratio of fixed assets to equity and ratio of short-term debts to total assets were used as financial performance indicators. Finally, in determining the profitability of the enterprise, net profit margin, gross profit margin and return on equity were used as financial performance indicators.

Table 1: Ratios Used in the Scope of the Study

Ratios	Code
Current Ratio	L1
Cash Ratio	L2
Financial Leverage Ratio	M1
Fixed Assets to Equity Ratio	M2
Debt Service Ratio	M3
Debt Structure Ratio	M4
Receivable Turnover Ratio	F1
Equity Turnover Ratio	F2
Fixed Assets Turnover Ratio	F3
Gross Profit Margin Ratio	K1
Net Profit Margin Ratio	K2
Return on Equity	K3

Table 2 shows the airline operators and IATA (International Air Transportation Association) codes. These codes will be used in the TOPSIS method.

Table 2: Airline Operations and Airline IATA Codes

Airline Operators	Airline IATA Codes
Air France-KLM	AF
Turkish Airlines	TK
British Airways	BA
Lufthansa	LH

The financial ratios between 2013 and 2018 of the four airlines were used to determine their financial performance. The calculated financial ratios were converted by TOPSIS to a single score which shows the overall business performance. Then, the performance rating of the airlines was done by ranking them.

2.5.1. Applying TOPSIS on the 2013 Data

Step 1: Formation of the Decision Matrix: The rows in the decision matrix contain the decision points while the columns contain the evaluation factors to be used in decision making. There are 4 decision points (airlines) and 12 evaluation factors (financial ratios) in the study. Firstly, a (4x12) Standard Decision Matrix was developed for TOPSIS. The Decision Matrix for 2013 of the airlines shown in Table 3.

Table 3: 2013 Decision Matrix (A_{ij})

2013	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,73	0,44	0,90	500	1031	46,96	14,37	11,38	2,27	7,99	-5,81	-66,23
TK	0,68	0,20	0,72	246	264	36,08	16,3	2,69	1,09	18,49	3,63	9,79
BA	0,62	0,39	0,79	332	419	48,88	21,42	5,06	1,52	5,70	2,46	12,46
LH	0,88	0,42	0,78	235	376	47,64	8,39	4,91	2,08	17,21	1,04	5,12

Step 2: Creating the Standardized Decision Matrix: The standardized decision matrix R_{ij} in Table 4 below was calculated using the elements of the A_{ij} matrix in Table 3 and using formula 1.

Table 4: Standardized Matrix Table (R_{ij})

2013	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,497	0,587	0,562	0,725	0,856	0,520	0,454	0,833	0,630	0,295	-0,790	-0,970
TK	0,463	0,267	0,450	0,357	0,219	0,399	0,516	0,197	0,303	0,682	0,494	0,143
BA	0,422	0,520	0,494	0,481	0,348	0,541	0,676	0,371	0,422	0,210	0,335	0,182
LH	0,600	0,560	0,487	0,341	0,312	0,527	0,265	0,360	0,577	0,635	0,141	0,075
Total	1,983	1,934	1,993	1,903	1,736	1,987	1,911	1,761	1,932	1,823	0,180	-0,569

Step 3: Forming a Weighted Standardized Decision Matrix: In this step, the weighted standardized values (V_{ij}) are determined by multiplying the standardized values calculated in the previous step by the weight attributes (W_i) of the evaluation factors.

When calculating the weight attributes of the evaluation factors, firstly the column values of each of the four firms in the criterion (L1, L2, M1, M2, etc.) is added. Then, the total criterion value was calculated by adding these values for 12 criteria. Finally, weights were calculated by dividing the column total of each criterion by the total value of the criteria.

Table 5: Weighted Normalized Decision Matrix (V_{ij})

2013	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
Weight	0,097	0,098	0,099	0,098	0,096	0,098	0,094	0,097	0,096	0,083	0,029	0,009
AF	0,048	0,058	0,056	0,071	0,082	0,051	0,043	0,081	0,060	0,024	-0,023	-0,009
TK	0,045	0,026	0,045	0,035	0,021	0,039	0,049	0,019	0,029	0,057	0,014	0,001
BA	0,041	0,051	0,049	0,047	0,033	0,053	0,064	0,036	0,041	0,017	0,010	0,002
LH	0,058	0,055	0,048	0,033	0,030	0,052	0,025	0,035	0,055	0,053	0,004	0,001

Step 4: Determine the Ideal (A^+) and Negative Ideal (A^-) Solution: In this step, a set of ideal and negative ideal solutions is created. For Set A^+ , the largest value in each column of the V_{ij} matrix and for the A^- set the smallest value in each column of the V_{ij} matrix were selected and the clusters were formed as follows.

$$A^+ = \{0,058; 0,058; 0,056; 0,071; 0,082; 0,053; 0,064; 0,081; 0,060; 0,057; 0,014; 0,002\}$$

$$A^- = \{0,041; 0,026; 0,045; 0,033; 0,021; 0,039; 0,025; 0,019; 0,029; 0,017; -0,023; -0,009\}$$

Step 5: Calculation of Separation from the alternates: The distance (S_i^+) for each alternative from the positive ideal solution and the distance to the negative ideal solution (S_i^-) are calculated using formulas 4 and 5 as in tables 6 and 7 below.

Table 6: Calculations for S_i^*

2013	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,000	0,003
TK	0,000	0,001	0,000	0,001	0,004	0,000	0,000	0,004	0,001	0,000	0,000	0,000	0,012
BA	0,000	0,000	0,000	0,001	0,002	0,000	0,000	0,002	0,000	0,002	0,000	0,000	0,007
LH	0,000	0,000	0,000	0,001	0,003	0,000	0,001	0,002	0,000	0,000	0,000	0,000	0,008

$$S_i^* = \{0,055; 0,107; 0,085; 0,089\}$$

Table 7: Calculations for S_i^-

2013	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,001	0,000	0,001	0,004	0,000	0,000	0,004	0,001	0,000	0,000	0,000	0,012
TK	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,002	0,001	0,000	0,004
BA	0,000	0,001	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,001	0,000	0,004
LH	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,001	0,000	0,004

$$S_i^- = \{0,108; 0,060; 0,065; 0,066\}$$

Step 6: Calculating the Relative Closeness to the Ideal Solution: The relative closeness (C_i^*) of each decision point to the ideal solution is calculated using Equation 4. In the ranking, the alternative with the highest C_i^* value takes precedence. Therefore, C_i^* values are arranged in order of magnitude and the performance order of alternatives is determined.

Table 8: The C_i^* Values of the Airlines and their Ranking

Airlines	2013 C_i^* Value	Rank
AF	0,945	1
BA	0,915	2
LH	0,911	3
TK	0,893	4

2.5.2 Applying TOPSIS on the 2014 Data

Step 1: Formation of the Decision Matrix:

Table 9: Decision Matrix (A_{ij})

2014	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,60	0,33	1,02	-1561	-3556	49,56	14,41	-37,12	2,37	7,24	-0,58	-0,28
TK	0,77	0,19	0,71	233	248	37,43	22,85	2,63	1,13	17,98	7,52	19,87
BA	0,65	0,45	0,84	420	596	48,57	22,06	6,16	1,46	8,31	5,99	36,94
LH	0,75	0,24	0,86	389	655	41,50	7,51	7,44	1,91	17,97	0,18	1,36

Step 2: Creating the Standardized Decision Matrix:

Table 10: Standardized Decision Matrix (R_{ij})

2014	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,431	0,518	0,590	-0,930	-0,968	0,556	0,404	-0,966	0,666	0,261	-0,060	-0,007
TK	0,553	0,299	0,411	0,139	0,068	0,420	0,640	0,068	0,317	0,649	0,781	0,473
BA	0,467	0,707	0,486	0,250	0,162	0,545	0,618	0,160	0,410	0,300	0,622	0,880
LH	0,539	0,377	0,497	0,232	0,178	0,466	0,211	0,194	0,537	0,649	0,019	0,032
Total	1,990	1,901	1,984	-0,309	-0,560	1,987	1,873	-0,543	1,930	1,859	1,361	1,379

Step 3: Forming a Weighted Standardized Decision Matrix:

Table 11: Weighted Standardized Decision Matrix (V_{ij})

2014	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
Weight	0,097	0,098	0,099	0,098	0,096	0,098	0,094	0,097	0,096	0,083	0,029	0,009
AF	0,042	0,051	0,058	-0,091	-0,093	0,055	0,038	-0,094	0,064	0,022	-0,002	0,000
TK	0,054	0,029	0,041	0,014	0,006	0,041	0,060	0,007	0,030	0,054	0,023	0,004
BA	0,045	0,069	0,048	0,025	0,016	0,053	0,058	0,016	0,039	0,025	0,018	0,008
LH	0,052	0,037	0,049	0,023	0,017	0,046	0,020	0,019	0,052	0,054	0,001	0,000

Step 4: Determining the Ideal (A^+) and Negative Ideal (A^-) Solution:

$$A^+ = \{0,054; 0,069; 0,058; 0,025; 0,017; 0,055; 0,060; 0,019; 0,064; 0,054; 0,023; 0,008\}$$

$$A^- = \{0,042; 0,029; 0,041; -0,091; -0,093; 0,041; 0,020; -0,094; 0,030; 0,022; -0,002; 0,000\}$$

Sep 5: Calculation of Separation from the alternatives:

Table 12: Calculations for S_i^*

2014	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,013	0,012	0,000	0,000	0,013	0,000	0,001	0,001	0,000	0,041
TK	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,004
BA	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,000	0,000	0,002
LH	0,000	0,001	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,004

$$S_i^* = \{0,202; 0,060; 0,041; 0,060\}$$

Table 13: Calculations for S_i^-

2014	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,002
TK	0,000	0,000	0,000	0,011	0,010	0,000	0,002	0,010	0,000	0,001	0,001	0,000	0,034
BA	0,000	0,002	0,000	0,013	0,012	0,000	0,001	0,012	0,000	0,000	0,000	0,000	0,041
LH	0,000	0,000	0,000	0,013	0,012	0,000	0,000	0,013	0,000	0,001	0,000	0,000	0,039

$$S_i^- = \{0,049; 0,185; 0,202; 0,199\}$$

Step 6: Calculating the Relative Closeness to the Ideal Solution:

Table 14: The C_i^* Values of the Airlines and their Ranking

Airlines	2014 C_i^* Values	RANK
BA	0,959	1
LH	0,940	2
TK	0,940	2
AF	0,798	3

2.5.3. Applying TOPSIS on the 2015 Data

Step 1: Formation of the Decision Matrix:

Table 15: Decision Matrix (A_{ij})

2015	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,62	0,33	0,98	4628	10249	52,02	14,47	115,83	2,50	9,69	0,60	69,77
TK	0,81	0,24	0,70	235	238	33,52	27,33	2,04	0,86	20,14	10,40	21,24
BA	0,59	0,35	0,70	184	245	52,88	20,94	2,57	1,39	11,15	22,13	57,02
LH	0,71	0,24	0,81	286	455	46,72	7,30	5,48	1,91	19,78	5,29	29,05

Step 2: Creating the Standardized Decision Matrix:

Table 16: Standardized Decision Matrix for 2015 (R_{ij})

2015	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,451	0,561	0,608	0,996	0,998	0,554	0,380	0,998	0,705	0,304	0,024	0,719
TK	0,589	0,408	0,434	0,051	0,023	0,357	0,718	0,018	0,243	0,632	0,416	0,219
BA	0,429	0,595	0,434	0,040	0,024	0,563	0,550	0,022	0,392	0,350	0,884	0,588
LH	0,516	0,408	0,503	0,062	0,044	0,498	0,192	0,047	0,539	0,621	0,211	0,299
Total	1,984	1,970	1,980	1,148	1,090	1,973	1,841	1,085	1,878	1,907	1,535	1,825

Step 3: Forming a Weighted Standardized Decision Matrix:

Table 17: Weighted Standardized Decision Matrix (V_{ij})

2015	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
Weight	0,097	0,098	0,099	0,098	0,096	0,098	0,094	0,097	0,096	0,083	0,029	0,009
AF	0,044	0,055	0,060	0,098	0,096	0,054	0,036	0,097	0,068	0,025	0,001	0,006
TK	0,057	0,040	0,043	0,005	0,002	0,035	0,068	0,002	0,023	0,052	0,012	0,002
BA	0,042	0,058	0,043	0,004	0,002	0,055	0,052	0,002	0,038	0,029	0,026	0,005
LH	0,050	0,040	0,050	0,006	0,004	0,049	0,018	0,005	0,052	0,052	0,006	0,003

Step 4: Determining the Ideal (A^*) and Negative Ideal (A^-) Solution

$$A^* = \{0,057; 0,058; 0,060; 0,098; 0,096; 0,055; 0,068; 0,097; 0,068; 0,052; 0,026; 0,006\}$$

$$A^- = \{0,042; 0,040; 0,043; 0,004; 0,002; 0,035; 0,018; 0,002; 0,023; 0,025; 0,001; 0,002\}$$

Sep 5: Calculation of Separation from the alternatives:

Table 18: Calculations for S_i^*

2015	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,001	0,001	0,000	0,003
TK	0,000	0,000	0,000	0,009	0,009	0,000	0,000	0,009	0,002	0,000	0,000	0,000	0,030
BA	0,000	0,000	0,000	0,009	0,009	0,000	0,000	0,009	0,001	0,001	0,000	0,000	0,029
LH	0,000	0,000	0,000	0,008	0,008	0,000	0,002	0,009	0,000	0,000	0,000	0,000	0,029

$$S_i^* = \{0,051; 0,172; 0,170; 0,170\}$$

Table 19: Calculations for S_i^-

2015	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,009	0,009	0,000	0,000	0,009	0,002	0,000	0,000	0,000	0,030
TK	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,001	0,000	0,000	0,004
BA	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,001	0,000	0,003
LH	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,000	0,000	0,002

$$S_i^- = \{0,173; 0,060; 0,052; 0,043\}$$

Step 6: Calculating the Relative Closeness to the Ideal Solution:

Table 20: The C_i^* Values of the Airlines and their Ranking

Airlines	2015 C_i^* Values	Ranking
AF	0,949	1
BA	0,830	2
LH	0,830	2
TK	0,828	3

2.5.4. Applying TOPSIS on the 2016 Data

Step 1: Formation of the Decision Matrix:

Table 21: Decision Matrix (A_{ij})

2016	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,75	0,40	0,94	825	1685	46,87	13,29	19,34	2,34	12,50	2,12	41,19
TK	0,80	0,40	0,72	264	263	33,56	22,08	1,64	0,62	11,59	-0,15	-0,26
BA	0,76	0,46	0,74	201	302	43,61	16,11	2,83	1,40	12,87	11,75	33,28
LH	0,92	0,35	0,79	237	385	39,96	6,92	4,42	1,86	22,73	5,60	24,84

Step 2: Creating the Standardized Decision Matrix:

Table 22: Standardized Decision Matrix (R_{ij})

2016	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,463	0,495	0,586	0,896	0,950	0,567	0,426	0,962	0,697	0,401	0,161	0,704
TK	0,494	0,495	0,449	0,287	0,148	0,406	0,708	0,082	0,185	0,372	-0,011	-0,004
BA	0,469	0,569	0,461	0,218	0,170	0,528	0,517	0,141	0,417	0,413	0,891	0,569
LH	0,568	0,433	0,492	0,258	0,217	0,484	0,222	0,220	0,554	0,729	0,425	0,425
Total	1,993	1,991	1,988	1,659	1,485	1,986	1,874	1,404	1,852	1,914	1,465	1,693

Step 3: Forming a Weighted Standardized Decision Matrix:

Table 23: Weighted Standardized Decision Matrix (V_{ij})

2016	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
Weight	0,097	0,098	0,099	0,098	0,096	0,098	0,094	0,097	0,096	0,083	0,029	0,009
AF	0,045	0,048	0,058	0,088	0,091	0,056	0,040	0,093	0,067	0,033	0,005	0,006
TK	0,048	0,048	0,044	0,028	0,014	0,040	0,067	0,008	0,018	0,031	0,000	0,000
BA	0,045	0,056	0,046	0,021	0,016	0,052	0,049	0,014	0,040	0,034	0,026	0,005
LH	0,055	0,042	0,049	0,025	0,021	0,047	0,021	0,021	0,053	0,060	0,012	0,004

Step 4: Determining the Ideal (A^*) and Negative Ideal (A^-) Solution

$$A^* = \{0,055; 0,056; 0,058; 0,088; 0,091; 0,056; 0,067; 0,093; 0,067; 0,060; 0,026; 0,006\}$$

$$A^- = \{0,045; 0,042; 0,044; 0,021; 0,014; 0,040; 0,021; 0,008; 0,018; 0,031; 0,000; 0,000\}$$

Step 5: Calculation of Separation from the alternatives

Table 24: Calculations for S_i^*

2016	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,000	0,002
TK	0,000	0,000	0,000	0,004	0,006	0,000	0,000	0,007	0,002	0,001	0,001	0,000	0,021
BA	0,000	0,000	0,000	0,004	0,006	0,000	0,000	0,006	0,001	0,001	0,000	0,000	0,018
LH	0,000	0,000	0,000	0,004	0,005	0,000	0,002	0,005	0,000	0,000	0,000	0,000	0,017

$$S_i^* = \{0,045; 0,146; 0,135; 0,130\}$$

Table 25: Calculations for S_i^-

2016	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,004	0,006	0,000	0,000	0,007	0,002	0,000	0,000	0,000	0,021
TK	0,000	0,000	0,000	0,000	0,000	0,000	0,002	0,000	0,000	0,000	0,000	0,000	0,002
BA	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,001	0,000	0,002
LH	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,001	0,000	0,000	0,003

$$S_i^- = \{0,145; 0,047; 0,048; 0,052\}$$

Step 6: Calculating the Relative Closeness to the Ideal Solution:

Table 26: The C_i^* Values of the Airlines and their Ranking

Airlines	2016 C_i^* Values	RANK
AF	0,955	1
LH	0,870	2
BA	0,865	3
TK	0,854	4

2.5.5. Applying TOPSIS on the 2017 Data

Step 1: Formation of the Decision Matrix:

Table 27: Decision Matrix (A_{ij})

2017	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,81	0,46	0,87	378	709	51,62	12,07	8,55	2,25	15,02	2,87	24,61
TK	0,84	0,48	0,70	243	240	33,43	17,81	1,97	0,81	19,69	5,71	11,26
BA	0,82	0,51	0,64	132	179	51,08	15,96	2,04	1,54	14,51	18,07	36,99
LH	0,87	0,31	0,73	189	277	47,39	6,69	3,70	1,96	8,86	7,46	27,67

Step 2: Creating the Standardized Decision Matrix:

Table 28: Standardized Decision Matrix (R_{ij})

2017	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,485	0,515	0,588	0,748	0,867	0,555	0,437	0,878	0,651	0,500	0,140	0,460
TK	0,503	0,537	0,473	0,481	0,293	0,360	0,645	0,202	0,234	0,655	0,278	0,210
BA	0,491	0,571	0,433	0,261	0,219	0,550	0,578	0,209	0,446	0,483	0,879	0,691
LH	0,521	0,347	0,493	0,374	0,339	0,510	0,242	0,380	0,567	0,295	0,363	0,517
Total	1,999	1,970	1,987	1,865	1,718	1,975	1,903	1,670	1,899	1,933	1,658	1,878

Step 3: Forming a Weighted Standardized Decision Matrix:

Table 29: Weighted Standardized Decision Matrix (V_{ij})

2017	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
Weight	0,097	0,098	0,099	0,098	0,096	0,098	0,094	0,097	0,096	0,083	0,029	0,009
AF	0,047	0,050	0,058	0,073	0,083	0,054	0,041	0,085	0,063	0,042	0,004	0,004
TK	0,049	0,053	0,047	0,047	0,028	0,035	0,061	0,020	0,023	0,054	0,008	0,002
BA	0,048	0,056	0,043	0,026	0,021	0,054	0,054	0,020	0,043	0,040	0,025	0,006
LH	0,051	0,034	0,049	0,037	0,033	0,050	0,023	0,037	0,054	0,024	0,011	0,005

Step 4: Determining the Ideal (A^+) and Negative Ideal (A^-) Solution:

$$A^+ = \{0,051; 0,056; 0,058; 0,073; 0,083; 0,054; 0,061; 0,085; 0,063; 0,054; 0,025; 0,006\}$$

$$A^- = \{0,047; 0,034; 0,043; 0,026; 0,021; 0,035; 0,023; 0,020; 0,023; 0,024; 0,004; 0,002\}$$

Step 5: Calculation of Separation from the alternatives

Table 30: Calculations for S_i^+

2017	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001
TK	0,000	0,000	0,000	0,001	0,003	0,000	0,000	0,004	0,002	0,000	0,000	0,000	0,010
BA	0,000	0,000	0,000	0,002	0,004	0,000	0,000	0,004	0,000	0,000	0,000	0,000	0,011
LH	0,000	0,000	0,000	0,001	0,003	0,000	0,001	0,002	0,000	0,001	0,000	0,000	0,009

$$S_i^+ = \{0,032; 0,102; 0,106; 0,097\}$$

Table 31: Calculations for S_i^-

2017	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,002	0,004	0,000	0,000	0,004	0,002	0,000	0,000	0,000	0,014
TK	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,001	0,000	0,000	0,003
BA	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,003
LH	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,002

$$S_i^- = \{0,116; 0,057; 0,054; 0,043\}$$

Step 6: Calculating the Relative Closeness to the Ideal Solution:

Table 32: The C_i^* Values of the Airlines and their Ranking

Airlines	2017 C_i^* Value	RANK
AF	0,968	1
LH	0,903	2
TK	0,898	3
BA	0,894	4

2.5.6. Applying TOPSIS on the 2018 Data

Step 1: Formation of the Decision Matrix:

Table 33: Decision Matrix (A_{ij})

2018	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0.77	0.44	0.81	243	456	43.68	13.78	5.20	2.13	6.01	(4.37)	(22.76)
TK	0.86	0.42	0.71	234	247	33.89	19.18	2.75	1.17	20.22	7.59	20.96
BA	0.59	0.36	0.76	271	354	48.44	22.18	4.23	1.55	2.53	(0.97)	(3.90)
LH	1.00	0.50	0.70	168	244	48.50	8.42	3.65	2.16	17.13	3.28	12.01

Step 2: Creating the Standardized Decision Matrix:

Table 34: Standardized Decision Matrix for 2018 (R_{ij})

2018	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
AF	0,470	0,508	0,543	0,523	0,677	0,496	0,412	0,641	0,591	0,220	-0,465	-0,681
TK	0,525	0,485	0,476	0,504	0,367	0,385	0,573	0,339	0,325	0,741	0,807	0,627
BA	0,360	0,416	0,509	0,584	0,525	0,550	0,663	0,521	0,430	0,093	-0,103	-0,117
LH	0,611	0,578	0,469	0,362	0,362	0,551	0,252	0,450	0,600	0,628	0,349	0,359
Total	1,967	1,987	1,997	1,973	1,931	1,982	1,899	1,951	1,946	1,681	0,588	0,189

Step 3: Forming a Weighted Standardized Decision Matrix:

Table 35: Weighted Standardized Decision Matrix (V_{ij})

2018	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3
Weight	0,097	0,098	0,099	0,098	0,096	0,098	0,094	0,097	0,096	0,083	0,029	0,009
AF	0,046	0,050	0,054	0,051	0,065	0,049	0,039	0,062	0,057	0,018	-0,013	-0,006
TK	0,051	0,048	0,047	0,049	0,035	0,038	0,054	0,033	0,031	0,061	0,023	0,006
BA	0,035	0,041	0,050	0,057	0,050	0,054	0,062	0,051	0,041	0,008	-0,003	-0,001
LH	0,059	0,057	0,046	0,035	0,035	0,054	0,024	0,044	0,058	0,052	0,010	0,003

Step 4: Determining the Ideal (A^+) and Negative Ideal (A^-) Solution

$$A^+ = \{0,059; 0,057; 0,054; 0,057; 0,065; 0,054; 0,062; 0,062; 0,058; 0,061; 0,023; 0,006\}$$

$$A^- = \{0,035; 0,041; 0,046; 0,035; 0,035; 0,038; 0,024; 0,033; 0,031; 0,008; -0,013; -0,006\}$$

Step 5: Calculation of Separation from the alternatives

Table 36: Calculations for S_i^*

2018	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,002	0,001	0,000	0,004
TK	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,001	0,001	0,000	0,000	0,000	0,003
BA	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,003	0,001	0,000	0,005
LH	0,000	0,000	0,000	0,000	0,001	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,004

$$S_i^* = \{0,065; 0,055; 0,071; 0,060\}$$

Table 37: Calculations for S_i^-

2018	L1	L2	M1	M2	M3	M4	F1	F2	F3	K1	K2	K3	Total
AF	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,001	0,001	0,000	0,000	0,000	0,003
TK	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,003	0,001	0,000	0,006
BA	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,000	0,000	0,000	0,000	0,000	0,003
LH	0,001	0,000	0,000	0,000	0,000	0,000	0,000	0,000	0,001	0,002	0,001	0,000	0,005

$$S_i^- = \{0,058; 0,076; 0,055; 0,067\}$$

Step 6: Calculating the Relative Closeness to the Ideal Solution:

Table 38: The C_i^* Values of the Airlines and their Ranking

Airlines	2012 C_i^* Value	RANK
TK	0,945	1
LH	0,940	2
AF	0,935	3
BA	0,929	4

Findings and Conclusion

In this study, we sought to use the TOPSIS method to analyze the financial performance of the of four traditional Europe-based airlines - Turkish Airlines, Air France-KLM, British Airways and Lufthansa - based on data obtained from their financial statements for the years 2013-2018. In the first part of the analysis, financial ratios suitable for the sector in which the firms operated were determined and using the ratio analysis method, the financial ratios were separately calculated for each firm. In the second part, the calculated financial ratios were used as input to the TOPSIS method and financial performance ranking of the firms done accordingly. In essence, similar firms were compared based on the same criteria and their performances ranked. Table 39 shows the scores period and performance rankings of the airlines for the 2013-2018 period.

Table 39: Values and Ranking of Entities Included in the Study

	2013	RANK	2014	RANK	2015	RANK	2016	RANK	2017	RANK	2018	RANK
AF	0,945	1	0,798	4	0,949	1	0,955	1	0,968	1	0,935	3
LH	0,911	3	0,940	2	0,830	3	0,870	2	0,903	2	0,940	2
BA	0,915	2	0,959	1	0,830	2	0,865	3	0,894	4	0,929	4
TK	0,893	4	0,940	3	0,828	4	0,854	4	0,898	3	0,945	1

The results reveal that the Air France-KLM partnership ranks first based on the 2013 data as obtained from the comparison from the ideal solution table. Air France-KLM is followed by British Airways, Lufthansa and Turkish Airlines respectively. As for the 2014 data, British Airways ranks first. Lufthansa, Turkish Airlines and Air France-KLM follow respectively. Air France- KLM takes the first position once more in 2015. British Airways, Lufthansa and Turkish Airlines follow respectively. According to 2016 data, Air France- KLM ranks first followed by Lufthansa, British Airways and Turkish Airlines respectively. Air France-KLM takes the lead again in 2017 to be followed by Lufthansa, Turkish Airlines and British Airways respectively. Finally, in 2018, Turkish Airlines ranked first. Lufthansa, Air France-KLM and British Airways follow respectively.

The study observed that the performance scores of airlines generally fluctuated during the analysis period. However, looking at the overall six-year period, the Air France-KLM partnership showed a distinct divergence by ranking first in performance in four different years. Lufthansa also displayed a divergence by ranking second place in four different years. British Airways, on the other

hand, ranked in different positions over the six-year period while Turkish Airlines ranked third and fourth in the first five years of the six-year period and rose to first place in the last year, 2018.

This study used the TOPSIS method to evaluate the financial performance of four traditional Europe-based airlines. Future studies could;

- Investigate the reasons for the financial performance rankings for the mentioned periods,
- evaluate traditional carriers based in America and the Far East in a similar way and compare them to European-based airlines,
- conduct a similar study with European-based low-cost carriers and compare the results with traditional European-based carriers.

In this way, the differences in the financial performance of airlines operating in different geographies and with different business models could be better evaluated. The results of these evaluations could be useful to the managers and investors of the airlines in making the most appropriate decisions about the future and investments in the firms taking into consideration the proposed changes.

REFERENCES

- Akgün, M., & Temür, A. S. (2016). Bıst Ulaştırma Endeksine Kayıtlı Şirketlerin Finansal Performanslarının Topsis Yöntemi İle Değerlendirilmesi. *Uluslararası Yönetim İktisat ve İşletme Dergisi, ICAFR 16 Özel Sayısı*.
- Akkaya, G. C. (2004). Finansal Rasyolar Yardımıyla Havayolları İşletmelerinin Performansının Değerlendirilmesi. *D.E.Ü.İ.İ.B.F.Dergisi*.
- Aydın, N., Şen, M., & Berk, N. (2014). *Finansal Yönetim-I*. Eskişehir: Anadolu Üniversitesi.
- Behn, B. K., Riley, R. A. (1999). Using Non-financial Information to Predict Financial Performance: The Case of the U.S. Airline Industry, *Journal of Accounting Auditing and Finance* 14: 29-56
- Çabuk, P. A., Başar, D. A., Sevim, P. Ş., Karagül, Y. A., Sayılır, Y. Ö., & Erol, P. C. (2013). *Mali Analiz*. Eskişehir: Anadolu Üniversitesi.
- Davilla, A., Venkatachalam, M., (2004). The Relevance of Nonfinancial Performance Measures for CEO Compensation: Evidence from the Airline Industry, *Review of Accounting Studies*, 9:443-464
- Dumanoglu, S., Ergül, N. (2010). İmkb'de İşlem Gören Teknoloji Şirketlerinin Mali Performans Ölçümü. *Muhasebe ve Finansman Dergisi*, 101-111.
- Feng, C. M., Wang, R.T. (2000). Performance evaluation for airlines including the consideration of financial ratios, *Journal of Air Transport Management*, Vol. 6, 133-142.
- Hwang, C.L., Yoon, K. (1981). *Multiple Attribute Decision Making: Methods and Applications*. New York: Springer-Verlag
- O'connor, W. E. (2001). *An Introduction To Airline Economics*. Praeger Publishers, Sixt Edition.
- Ömürbek, V., & Kınay, B. (2013). Havayolu Taşımacılığı Sektöründe Topsis Yöntemiyle Finansal Performans Değerlendirmesi. *Süleyman Demirel Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi*.
- Öncü, M. A., Çömlekçi, İ., & Coşkun, E. (2013). Havayolu Yolcu Taşıma İşletmelerinin Finansal Etkinliklerinin Ölçümüne İlişkin Bir Araştırma. *Uluslararası Alanya İşletme Fakültesi Dergisi*.

- Özdemir, A. İ., & Seçme, N. Y. (2009). İki Aşamalı Stratejik Tedarikçi Seçiminin Bulanık Topsıs Yöntemi İle Analizi. *Afyon Kocatepe Üniversitesi, İ.İ.B.F. Dergisi*, 80.
- Pestana, B. C., Wanke, P. (2015). An analysis of African airlines efficiency with two-stage TOPSIS and neural networks. *Journal of Air Transport Management*, Elsevier, vol. 44, pages 90-102.
- Riley, A. R., Pearson, T., Trompeter, G. (2003). The value relevance of non-financial performance variables and accounting information: The case of the airline industry. *Journal of Accounting and Public Policy*, 22(3):231-254
- Torlak, G., Sevkli, M., Sanal, M., & Zaim, S. (2011). Analyzing business competition by using fuzzy TOPSIS method: An example of Turkish domestic airline industry. *Expert Systems with Applications*.
- Wang, Y.J., (2008), "Applying FMCDM to Evaluate Financial Performance of Domestic Airlines in Taiwan", *Expert Systems with Applications*, 34(3), 1837-1845
- Wells, A. (1999). *Air Transportation a Management Perspective*. California: Wadsworth Publishing Company.
- <http://investor.turkishairlines.com/tr>. (2017, Aralık). <http://investor.turkishairlines.com/tr:mali-veriler/yillik-raporlar/1/tum-yillar> adresinden alındı
- <http://www.airfranceklm.com>. (2017, Aralık). <http://www.airfranceklm.com/en/finance/publications> adresinden alındı
- <http://www.iairgroup.com>. (2017, Aralık). <http://www.iairgroup.com/phoenix.zhtml?c=240949&p=irol-reportsannual> adresinden alındı
- <https://investor-relations.lufthansagroup.com>. (2017, Aralık). <https://investor-relations.lufthansagroup.com/en/finanzberichte/annual-report/> adresinden alındı

Appendix 1: FINANCIAL PERFORMANCE INDICATOR VALUES OF THE FIRMS

Table 1: Financial Performance Indicator Values-Turkish Airlines

Oranlar	2013	2014	2015	2016	2017	2018
Current Ratio	0,68	0,77	0,81	0,80	0,84	0,86
Cash Ratio	0,20	0,19	0,24	0,40	0,48	0,42
Financial Leverage Ratio	0,72	0,71	0,70	0,72	0,70	0,71
Fixed Assets to Equity Ratio	246	233	235	264	243	234
Debt Service Ratio	264	248	238	263	240	247
Debt Structure Ratio	36,08	37,43	33,52	33,56	33,43	33,89
Receivable Turnover Ratio	16,35	22,85	27,33	22,08	17,81	19,18
Equity Turnover Ratio	2,69	2,63	2,04	1,64	1,97	2,75
Fixed Assets Turnover Ratio	1,09	1,13	0,86	0,62	0,81	1,17
Gross Profit Margin Ratio	18,49	17,98	20,14	11,59	19,69	20,22
Net Profit Margin Ratio	3,63	7,52	10,40	-0,15	5,71	7,59
Return on Equity	9,79	19,87	21,24	-0,26	11,26	20,96

Table 2: Financial Performance Indicator Values-Air France-KLM

Oranlar	2013	2014	2015	2016	2017	2018
Current Ratio	0,73	0,60	0,62	0,75	0,81	0,77
Cash Ratio	0,43	0,33	0,33	0,40	0,46	0,44
Financial Leverage Ratio	0,90	1,02	0,98	0,94	0,87	0,81
Fixed Assets to Equity Ratio	500	-1561	4628	825	378	243
Debt Service Ratio	1031	-3556	10249	1685	709	456
Debt Structure Ratio	46,96	49,56	52,02	46,87	51,62	43,68
Receivable Turnover Ratio	14,37	14,41	14,47	13,29	12,07	13,78
Equity Turnover Ratio	11,38	-37,12	115,83	19,34	8,55	5,20
Fixed Assets Turnover Ratio	2,27	2,37	2,50	2,34	2,25	2,13
Gross Profit Margin Ratio	7,79	7,24	9,9	12,50	15,02	6,01
Net Profit Margin Ratio	-5,81	-0,58	0,60	2,12	2,87	-4,37
Return on Equity	-66,23	-0,28	69,77	41,19	24,61	-22,76

Table 3: Financial Performance Indicator Values-British Airways

Oranlar	2013	2014	2015	2016	2017	2018
Current Ratio	0,62	0,65	0,59	0,76	0,82	0,59
Cash Ratio	0,39	0,45	0,35	0,46	0,51	0,36
Financial Leverage Ratio	0,79	0,84	0,70	0,74	0,64	0,76
Fixed Assets to Equity Ratio	332	420	184	201	132	271
Debt Service Ratio	419	596	245	302	179	354
Debt Structure Ratio	48,88	48,57	52,88	43,61	51,08	48,44
Receivable Turnover Ratio	21,42	22,06	20,94	16,11	15,96	22,18
Equity Turnover Ratio	5,06	6,16	2,57	2,83	2,04	4,23
Fixed Assets Turnover Ratio	1,52	1,46	1,39	1,40	1,54	1,55
Gross Profit Margin Ratio	5,70	8,31	11,15	12,87	14,51	2,53
Net Profit Margin Ratio	2,46	5,99	22,13	11,75	18,07	-0,97
Return on Equity	12,46	36,94	57,02	33,28	36,99	-3,90

Table 4: Financial Performance Indicator Values-Lufthansa

Oranlar	2013	2014	2015	2016	2017	2018
Current Ratio	0,88	0,75	0,71	0,92	0,87	1,00
Cash Ratio	0,42	0,24	0,24	0,35	0,31	0,50
Financial Leverage Ratio	0,78	0,86	0,81	0,79	0,73	0,70
Fixed Assets to Equity Ratio	235	389	286	237	189	168
Debt Service Ratio	376	655	455	385	277	244
Debt Structure Ratio	47,64	41,50	46,72	39,96	47,39	48,50
Receivable Turnover Ratio	8,39	7,51	7,30	6,92	6,69	8,42
Equity Turnover Ratio	4,91	7,44	5,48	4,42	3,70	3,65
Fixed Assets Turnover Ratio	2,08	1,91	1,91	1,86	1,96	2,16
Gross Profit Margin Ratio	17,21	17,97	19,78	22,73	8,86	17,13
Net Profit Margin Ratio	1,04	0,18	5,29	5,60	7,46	3,28
Return on Equity	5,12	1,36	29,05	24,84	27,67	12,01