

## ARTICLE

# BUSINESS COMPETITION ANALYSIS OF IRAN'S AIRLINE INDUSTRY USING FUZZY TOPSIS METHOD

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## ABSTRACT

This paper adopts a fuzzy TOPSIS multi-method approach for studying Iran's airline industry. First, the highly complex nature of competition in this sector is described. Then, the components of the methodology and its eclectic approach are examined. Application of fuzzy TOPSIS technique to Iran's airline industry will make it possible to rank its airlines in the light of key success variables of this sector. This paper also evaluates the empirical findings of fuzzy TOPSIS method from a managerial perspective. Data analysis reveals that the competitive price has the greatest weight among performance criteria of airlines. The results of this research indicate the superiority of private airlines over public ones in obtaining competitive advantages due to their stable management, paying attention to advertising, improving quality of services and reducing variable costs.

## INTRODUCTION

This paper is aimed at using fuzzy TOPSIS technique for Iran's airline sector in order to rank the air carriers based on relative closeness coefficient and the main criteria of success in this industry. This analysis provides useful information for Iranian airlines to assess their goals and strategies. For this purpose, in the first section of the paper, increasing competition in Iran's airline industry will be elaborated, which poses a serious threat to the survival of companies in the period of economic sanctions. Furthermore, in this section a brief review will be provided regarding the main features of domestic airlines of Iran. In the next section that deals with the background of the research methodology, building blocks of fuzzy TOPSIS approach, i.e. linguistic variables and fuzzy sets as well as conventional TOPSIS method will be explained, and then the proposed fuzzy TOPSIS method will be elaborated. Fuzzy TOPSIS technique can be used for various problems ranging from choosing a location for facilities, robot selection [1- 2], selecting an analytical system for a software company, selection of the optimum initial training aircraft in the Taiwan Air Force Academy [3], quality of service in the hospitality industry [19], plant layout design [3], transshipment site selection [4], evaluation of the competitive advantages of shopping websites [6], as well as machine tool selection [5]. We assume that this fuzzy TOPSIS multi-method approach with its extensive applications, compared to its sub-components, can be a unique and more useful tool, and can accommodate the rules and requirements of survival in a chaotic and uncertain environment like the airline industry, where the competitors are struggling for survival and success. The next section deals with the application of fuzzy TOPSIS approach to Iran's airline industry, which, from a comparative perspective, provides valuable information for airlines to review their judges, objectives, strategies, programs, projects and actions. The final section is an analysis of the results of the fuzzy TOPSIS approach from a managerial perspective, where a managerial assessment is given regarding the meaning of quantitative values derived from the fuzzy TOPSIS method. Our goal is to justify our analysis by demonstrating the operations of airlines in accordance with the main success factors in the industry. The final section provides conclusion.

### The nature of Iran's airline industry

"Iranian Airways" was established in 1944 and provided its first air travel services for Tehran-Mashhad route and after the Second World War. The geographical conditions of Iran, its vastness, remoteness of relatively crowded areas from each other, road and rail vehicle shortages, the need for fast and reliable connections among academic and government organizations, and above all the absence of a regular network with high functionality in order to revive mutual aviation rights with other countries, as well as the need for ensuring the welfare of the nation, led the board of ministers to ratify the proposal suggested by the road and transportation minister for establishing a national airline in 1961. Subsequently, Iran National Airlines Corporation was established by the merger of two airlines, i.e. "Iranians Airways" and "Persian Air Services", and a new airline was established named "Iran Air", using the "HOMA" bird as its symbol in the same year and began its operations in 1962. Now, after seven decades of establishment of aviation industry in Iran, more than 15 public and private airlines are active in the country, which indicates the potentials of its passenger and cargo market. United States sanctions against Iran have had many adverse impacts on the aviation and aerospace industry, and have caused its passenger and cargo fleet, which was one of the largest air fleets in Asia and the Middle East in the 1960s, become unable to rebuild and modernize itself.

Sanctions imposed by the United States against aviation and aerospace industry of Iran have impacted the

### KEY WORDS

Iran's airlines, Multi-criteria decision-making, Fuzzy TOPSIS, Multi-method approach, Competitive advantage.

Published: 10 September 2016

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aviation operations in the country from various aspects. Most importantly, Iranian airlines mainly use the older aircrafts, and are not able to refurbish their fleets due to such sanctions. The use of older aircrafts, in its turn, undermines civil aviation safety, since one of the factors affecting safety is the use of new equipment and original spare parts for aircrafts. Due to the lack of free access to the global market for upgrading the aviation fleet and the necessity of meeting such demands, speculative and rent-seeking behaviors have become dominant in this context.

Iran's aging aviation fleet has led it to lose a large share of transportation of passengers and cargo in international airways to the competitors, i.e. foreign companies. This has not only a negative impact on fair market competition among airlines, but also has caused significant economic loss for Iran. It should be noted that foreign airlines continuously increase the number of their aircrafts and flight lines, and have won at least half of the Iranian passengers on international flights. Given that Iran is a vast country and there are long distances between destinations in the country, people are forced to use flights, so probably, if airlines can develop more, there will be more potential customers that will use airplanes.

**Iran Air** - On February 23, 1961 a national commercial airline company was established in Iran for the first time. The company was named "Iran National Airlines Corporation" and is internationally known as Iran Air, abbreviated as "HOMA" in Persian, which is the name of a legendary bird too. It acquired the facilities of other private companies already working in Iran and became a full member of IATA in 1964. Its official name was changed to "The Airline of the Islamic Republic of Iran", again abbreviated as "HOMA", in 1981. The number of active airplanes of Iran Air fleet (aircrafts on the flight lines) rose to 51 aircrafts.

**Mahan Air** - Iran's first private airline was registered under the name of Mahan Air in 1992. The company started its national operations with flights of Tehran - Kerman - Tehran route. Mahan Air, then, acquired two Airbus A300B4 passenger aircrafts and added them to its fleet in 1999 in order for achieving the objective of development, security and safety. In the following years, it has also acquired and operated other types of airplanes such as Airbus A300-600, A310, A320, A340 as well as Boeing 747-300/400 as the most modern aircrafts available for long-range flights to Europe and the Far East destinations. For short-range routes within the country, 16 aircrafts of BAe-146-300 type have been added to its fleet. The increased number of aircrafts in the fleet (54 aircrafts) and flight network development to different parts of the country and the world stimulated a strong growth in the number of passengers, in such a way that according to the Iranian Civil Aviation Organization, Mahan Air has transported the largest number of passengers, both within the domestic network as well as international network, among Iranian airlines in 2012. In 2009, Mahan launched its Frequent Traveler Club, named Mahan & Miles.

**Aseman Airlines** - It was established in the year 1980 from the merger of four airlines, i.e. Air Taxi, Pars Air, Air Service and Hour Aseman. Aseman Airlines has now the largest flight network to domestic destinations and particularly to the deprived areas. It has established three flight centers in Tehran, Shiraz and Mashhad for better coverage of its flight network. Each of these three centers benefit from independent flight crew and maintenance hangars for recruiting and training local experts and performing daily flights with an adequate independence. The latest prestigious certificate issued in this regard is IOSA that have been issued by IATA for Aseman Airlines. Now, it has 33 aircrafts and performs regular flights to 40 domestic and 13 foreign destinations.

**Kish Air** - With the aim of developing the operations of Kish Island by connecting it to the centers of the provinces as well as to the countries around the Persian Gulf, Kish Air was established in 1991. After the first stage of establishment and by the end of 1992, the development stage of Kish Air began with appointment of a new management team. Currently, Kish Air is in the fifth stage of its history and the company management has successfully realized its new strategies, resulting in the increased number of owned aircrafts rather than leased ones, as well as replacement of Eastern aircraft with Western ones in its fleet. At present, the company owns seven Boeing MD as well as 3 Fokker 100 aircrafts. The company has meet all required international specifications and standards, is a member for IATA, and is the Iran's first airline with IATA Operational Safety Audit (IOSA) certificate.

**Zagros Airlines** - It was established in Arvand Free Zone and started its operations in 2005. Zagros Airlines currently has a fleet of 19 aircrafts, including 11 Airbus A320 and eight Boeing MD series airplanes. The company has managed to grow by 30% in terms of domestic and international destinations and by 70% in terms of number of passengers, and has transported more than 3 million passengers in the past year.

**Qeshm Air** - It was established in 2009, and became affiliated with Sorinet Development Holding of Qeshm; and its official name changed from Faraz Qeshm to Qeshm Air in 2012. Finally, the company was transferred to the Ministry of Petroleum of the Islamic Republic of Iran in 2014. The company is in possession of 21 aircrafts and provides services on different routes and to different destinations.

**Table 1:** Number of passengers of flights in 2015

| Row | Company name    | No. of passengers |
|-----|-----------------|-------------------|
| 1   | Iran Air        | 4,000,000         |
| 2   | Mahan Air       | 6,500,000         |
| 3   | Aseman Airlines | 2,489,682         |
| 4   | Kish Air        | 1,700,000         |
| 5   | Zagros Airlines | 3,500,000         |
| 6   | Qeshm Air       | 1,600,000         |

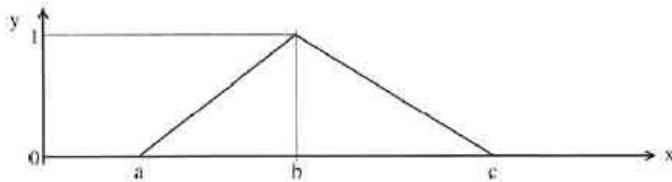
## METHODS

This section briefly outlines linguistic variables, fuzzy sets, TOPSIS technique and the proposed fuzzy TOPSIS method.

### Linguistic Variables and Fuzzy Sets

A linguistic variable is a variable whose values are words or sentences in a natural or artificial language [7]. For example, age is a linguistic variable if its values are linguistic rather than numerical, i.e., "old", "young", "very young" [20]. The concept of a linguistic variable indicates approximate characterization of phenomena which are either too complex or too ill-defined to be describable quantitatively. The main applications of the linguistic approach lies in the realm of humanistic systems - especially in the fields of artificial intelligence, linguistics, human decision processes, pattern recognition, psychology, law, medical diagnosis, information retrieval, economics and related areas [7-8].

Fuzzy sets and fuzzy logic are considered as powerful mathematical tools for modeling of uncertain systems in industry. Fuzzy set theory is the expansion of classical set theory. While classical set theory only embraces full membership or non-membership, fuzzy set theory also accepts partial membership. A fuzzy number like R [9-10-11]:



**Fig. 1:** An example of a triangular membership function.

Different fuzzy numbers can be used depending on circumstance. However, triangular fuzzy numbers are more common, since they have simple arithmetic characterization and can be used in a fuzzy environment to promote the process of providing information in an efficient manner. In this research, we have used triangular fuzzy numbers for fuzzy TOPSIS approach. Triangular fuzzy numbers can be described as a, b, c, where these parameters represent the lowest possible value, most likely value and the highest possible value respectively that will describe a fuzzy event. Triangular fuzzy number is shown in [ Fig. 1]. While triangular fuzzy numbers have various functions, we have only noted the most important of them in this research. If we define two positive triangular fuzzy numbers (a<sub>1</sub>, b<sub>1</sub>, c<sub>1</sub>) and (a<sub>2</sub>, b<sub>2</sub>, c<sub>2</sub>), then:

$$(a_1, b_1, c_1) + (a_2, b_2, c_2) = (a_1 + a_2, b_1 + b_2, c_1 + c_2) \tag{1}$$

$$(a_1, b_1, c_1) \times (a_2, b_2, c_2) = (a_1 \times a_2, b_1 \times b_2, c_1 \times c_2) \tag{2}$$

$$(a_1, b_1, c_1) \times k = (a_1 \times k, b_1 \times k, c_1 \times k) \text{ where } k > 0 \tag{3}$$

### TOPSIS Method

TOPSIS stands for the "Technique for Order of Preference by Similarity to Ideal Solution" [3]. The ideal solution (which is also known as positive solution), is a solution to maximize the benefit criteria and minimize the cost criteria, whereas the negative solution (non-ideal solution) maximizes the cost criteria and minimizes the benefit criteria [9].

The benefit criterion is to be maximized, while the cost criterion is to be minimized. The best alternative is the alternative that will be close to the ideal solution and distant from the negative solution as much as possible. We assume that our multi-criteria decision problem has *m* alternatives (A<sub>1</sub>, A<sub>2</sub>, ..., A<sub>m</sub>) and *n* criterion or characteristic of decision-making (C<sub>1</sub>, C<sub>2</sub>, ..., C<sub>n</sub>). Each alternative is evaluated with regard to *n* criteria or characteristic. All values or ranks given to alternatives with regard to each criterion will be

marked in the decision matrix as  $X = (x_{ij})_{m \times n}$ . If  $W = (w_1, w_2, \dots, w_n)$  will be the vector for relative weight of criterion,  $j^{th}$   $w_j$  will be obtained. The TOPSIS method can be summarized as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^m x_{ij}^2}} \quad i = 1, 2, \dots, m \quad j = 1, 2, \dots, n \quad (4)$$

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{j=1}^n x_{ij}^2}} \quad i = 1, 2, \dots, m \quad j = 1, 2, \dots, n \quad (5)$$

By calculating  $r_{ij}$  which represent the value/ranking of normalized criterion/characteristic, the decision matrix  $X = (x_{ij})_{m \times n}$  can be normalized, where  $w_j$  is the relative weight of  $j^{th}$  criterion or characteristic. The calculations of the Euclidean distances of each alternative from positive and negative ideal solutions are as follows:

$$v_{ij} = r_{ij} \cdot w_j \quad \text{where } i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n \quad (6)$$

$$d_i^+ = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^+)^2} \quad i = 1, 2, \dots, m \quad (9)$$

$$d_i^- = \sqrt{\sum_{j=1}^n (v_{ij} - v_j^-)^2} \quad i = 1, 2, \dots, m \quad (10)$$

The approximate closeness of each criterion to the ideal solution will be calculated. Approximate closeness of alternative  $A_i$  in relation to  $A^*$ , i.e.  $CC_i$  ranking, changes based on the approximate closeness to the ideal solution. The larger the value of  $CC_i$ , the better the alternative  $A_i$ . The most suitable alternative is the closest to the ideal solution.

$$CC_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad i = 1, 2, \dots, m \quad (11)$$

### The Proposed Fuzzy TOPSIS Method

The main steps of fuzzy TOPSIS method include:

**First step:** In the first step, a panel will be formed consisted of some decision-makers who are fully informed with regard to airline selection and the adopted assessment process. In a group that  $K$  decision-makers ( $D_1, D_2, \dots, D_k$ ) are responsible for the ranking ( $y_{jk}$ ) of each criterion ( $C_1, C_2, \dots, C_n$ ), with an increasing trend:

$$a_j = \min_k \{y_{jk}\}, \quad b_j = \frac{1}{K} \sum_{k=1}^K y_{jk}, \quad c_j = \max_k \{y_{jk}\} \quad (12)$$

$$\tilde{w}_j = (w_{j1}, w_{j2}, w_{j3})$$

$$w_{j1} = \frac{\frac{1}{a_j}}{\sum_{j=1}^n \frac{1}{a_j}}, \quad w_{j2} = \frac{\frac{1}{b_j}}{\sum_{j=1}^n \frac{1}{b_j}}, \quad w_{j3} = \frac{\frac{1}{c_j}}{\sum_{j=1}^n \frac{1}{c_j}} \quad (13)$$

**Second step:** The normalized decision matrix is obtained as follows:

$$X = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix} \quad (14)$$

**Third step:** After forming the decision matrix, normalization is performed. This calculation is done by formulas 4 and 5.

$$R = \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots \\ r_{mi1} & r_{mi2} & \dots & r_{mi n} \end{bmatrix} \quad (15)$$

**Fourth step:** Due to the different weights of each criterion, weighted normalized decision matrix is calculated by significant weight of evaluation criterion weight.

$$\bar{V} = [v_{ij}]_{\max} \text{ for } i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n \quad (16)$$

**Fifth step:** The positive and negative fuzzy solutions are determined as follows:

$$\begin{aligned} \bar{A}^+ &= (\bar{v}_1^+, \bar{v}_2^+, \dots, \bar{v}_n^+) \\ \bar{v}_j^+ &= (\max_i(v_{ij1}), \max_i(v_{ij2}), \dots, \max_i(v_{ijn})) \\ \bar{A}^- &= (\bar{v}_1^-, \bar{v}_2^-, \dots, \bar{v}_n^-) \\ \bar{v}_j^- &= (\min_i(v_{ij1}), \min_i(v_{ij2}), \dots, \min_i(v_{ijn})) \\ & \quad i = 1, 2, \dots, m \text{ and } j = 1, 2, \dots, n \end{aligned} \quad (17)$$

**Sixth step:** Then, the fuzzy distance of each alternative from positive and negative fuzzy ideal solutions is calculated as follows:

$$\begin{aligned} d_i^+ &= \sqrt{\sum_{j=1}^n (\bar{v}_j^+ - \bar{v}_{ij}^+)^2} \text{ and} \\ d_i^- &= \sqrt{\sum_{j=1}^n (\bar{v}_j^- - \bar{v}_{ij}^-)^2} \quad i = 1, 2, \dots, m \end{aligned} \quad (18)$$

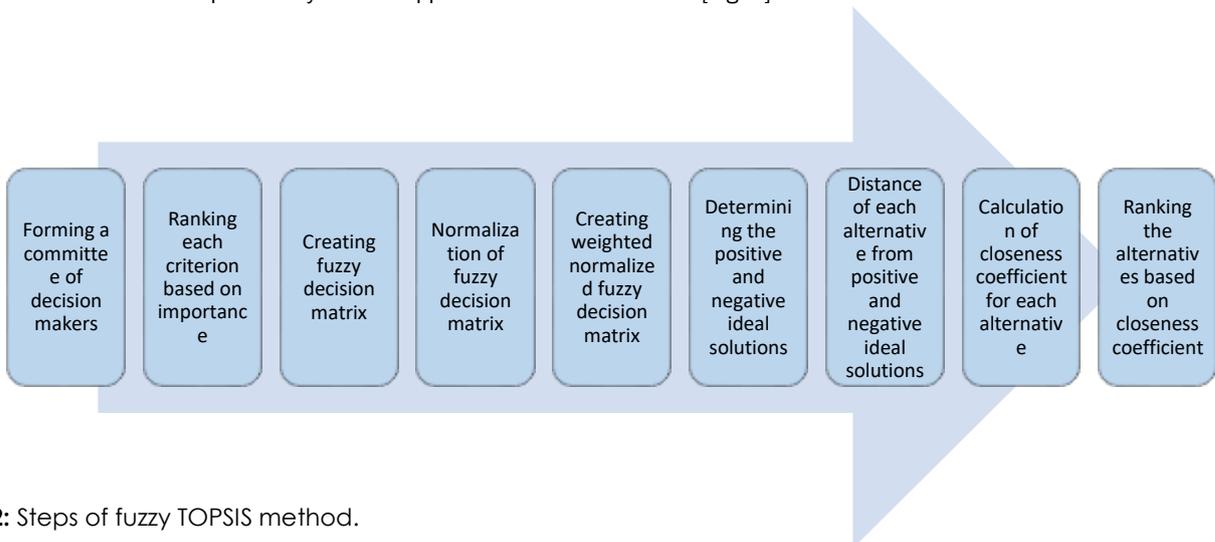
**Seventh step:** Fuzzy approximation represents the distances of positive and negative fuzzy solutions at the same time.

$$\bar{CC}_i = \frac{d_i^-}{d_i^+ + d_i^-} \quad i = 1, 2, \dots, m \quad (19)$$

**Eighth step:** Defuzzification of fuzzy closeness coefficient is performed as follows:

$$CC_i = \sqrt[3]{\bar{CC}_{i1} \cdot \bar{CC}_{i2} \cdot \bar{CC}_{i3}} \quad (20)$$

This formula can be considered as defuzzification process. Closeness coefficient (CC<sub>i</sub>) is defined for all possible alternatives. Ranking of alternatives can be determined by means of this closeness coefficient. The steps of fuzzy TOPSIS approach are summarized in [Fig. 2].



**Fig. 2:** Steps of fuzzy TOPSIS method.

## Application of Fuzzy TOPSIS technique to Iran's airline industry

The proposed algorithm for application of fuzzy TOPSIS method to Iran's airline industry can be explained in the following steps.

In the first step, a panel was formed consisted of 24 experts of selected companies from different departments such as procurement, quality, production and planning involved in devising strategy. Using semi-structured interviews with these individuals, a list of nine criteria for the process of devising strategy was prepared. These criteria concern the various aspects of the strategy, including advertising, product quality, cost competitiveness, customer loyalty, market share, customer services, e-commerce, management experience and brand. The characteristics of such criteria in the aviation sector of Iran are as follows.

### Advertising

Advertising in the airline business is a means to stimulate customers to buy and use the products and services of the airline or become assured of the continued efforts of the marketing mix. Existence of different airline companies with different ticket prices in airline industry suggests that advertising programs have become an important and necessary issue for air carriers. Overall, they guarantee the advertising programs of airlines as well as increase the sales and market share. In airline business, advertising is a way for creating an image of the company, selling products and offering services as well as motivating the crew [12].

### Product Quality

Product quality in the airline business is composed of a process that begins with purchasing a ticket and includes the behaviors and characteristics of the cabin crew and executives. The quality of services offered in airline business may include: the expected time for ticket purchase, ticket fares, waiting time for check-in and boarding the airplane, the delay before the flight, the distances between the seats inside the airplane, the number of services provided by stewardesses, quality of services, emergency materials and equipment, on-time landing, waiting time for collecting baggage and the number of damaged or lost baggage [12].

### Cost Competitiveness

Proper calculating of costs of services in aviation business plays a vital role in determining the costs of tickets. Airline companies need to minimize their costs and omit those operations that do not provide added value to their final product. Fixed and variable costs that have a direct impact on the costs in the aviation sector include: (1) fixed costs: amortization, depreciation, insurance costs, engineering costs, operating costs and infrastructure costs, and (2) variable costs: costs of fuel, maintenance and repair costs, personnel expenses and the costs of passengers and meals.

### Customer Loyalty

Airline companies are continually developing and improving their products and services to satisfy customers' needs. The companies use loyalty programs to ensure the integrity of the customers. In such programs, the client's data is stored in some databases, and thereby some promotions can be offered directly to the groups of clients. The result of such a clear strategy and planning is low costs and high profits for airlines [13].

Domestic airlines that are in a fierce competition in terms of quality and services offer similar or identical products and services. Customers cannot distinguish between the products or services of these companies. That is why customer loyalty to a particular brand cannot be felt in airline industry. Customers can easily change their brands to obtain the desired products or services [14].

### Market Share

Market share is a percentage of the total market that a company has secured for certain categories of products or a specific product. Market share is usually classified based on geographic region (state, country, etc.), gender, ethnicity and other demographic factors. Companies try to increase their market share to be able to achieve economies of scale for production, distribution, advertising and other fields of application of categories, and to increase their profit margins and earnings [15].

### Customer Services

Airlines must be aware of the needs of their customers at the time of planning for products and services. The services offered in airline business include: cabin orders, aircraft type, flight frequency, flight network, ticket booking points, punctuality and services offered at the travel time [16].

E-commerce

Although air travel is one of the fastest types of travel, however, it is too costly for many people. Thus, airline companies must invest in e-commerce infrastructure and expand their operations in this field to make the most of e-commerce applications, and to meet their customers' demands as well as to increase their profit margins. E-commerce provides a suitable environment for airlines to communicate with their customers in a reliable and timely manner [17]. Due to benefitting from advanced technology, speed, quality of services, security and convenience as well as from continuous and low-cost e-commerce applications, air travels have become one of the building blocks of civic and contemporary life. Airlines can alleviate their problem of high costs or completely resolve it by means of their e-commerce measures [17]. According to IATA, typical ticket cost is about \$10, while online ticket cost is nearly \$1. That is why e-commerce provides the airline companies with many advantages such as savings in distribution costs, growing competition, a dynamic and market-oriented pricing as well as availability and provision of direct services to customers [18].

Management experience

The airline's management is crucial for keeping the costs down. Management should inspire the employees to use effective strategies for reducing costs. Motivation of employees is one of the major keys is performing more efficient work and lowering the costs.

Brand

With regard to branding in the airline industry, some factors play vital roles such as promotional and advertising measures, logo and colors of the company, aircraft interior design, ticket sales points, waiting halls at the airports and the variety and quality of provided services during flight. Booking and purchasing tickets are the early interactions during customers' contact with the airline. Hence, the design of ticket reservation points is an important milestone for the airlines. If the first encounter will not be pleasing, there will be a direct negative impact on the brand. Employees working in these positions should be skilled, trained and qualified. Interactions for booking and purchasing tickets via telephone should be understandable, simple and clear. After a brief introduction of the criteria from a managerial viewpoint, the managers are asked to rank the criteria in accordance with their relative importance. Then, using AHP technique and Expert Choice software program, the values (weights) of those criteria will be obtained that are to be used in fuzzy TOPSIS method. The values are presented in [Table 2].

Table 2: The final weight of criteria

| Criterion             | Final weight |
|-----------------------|--------------|
| Competitive price     | 0.244        |
| Quality of services   | 0.195        |
| Customer loyalty      | 0.193        |
| Customer services     | 0.091        |
| Market share          | 0.084        |
| Brand                 | 0.064        |
| Management experience | 0.049        |
| E-commerce            | 0.045        |
| Advertising           | 0.035        |

Solving the Fuzzy TOPSIS algorithm

(Step 1) Creating a decision matrix for ranking consisted of m alternatives and n criteria.

The decision matrix is given in the following table. As you can see, the relative importance of alternatives with respect to each criterion has been represented by triangular fuzzy numbers. Given that every criterion has several sub-criteria, the mean of the sub-criteria for each dimension will be calculated.

Table 3: Data for fuzzy decision matrix

| Alternatives<br>Criteria | Weights of<br>criteria<br>(AHP) | Mahan            | Zagros           | Kish Air         | Aseman           | Qeshm Air        | Iran Air         |
|--------------------------|---------------------------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Advertising              | 0.035                           | (0.4,0.5,0.6)    | (0.4,0.5,0.6)    | (0.33,0.43,0.53) | (0,0.1,0.2)      | (0.53,0.63,0.73) | (0.37,0.47,0.57) |
| Quality of services      | 0.196                           | (0.67,0.77,0.87) | (0.43,0.53,0.63) | (0.4,0.5,0.6)    | (0.37,0.47,0.57) | (0.5,0.6,0.7)    | (0.4,0.5,0.6)    |
| Competitive price        | 0.244                           | (0.47,0.57,0.67) | (0.3,0.4,0.5)    | (0.5,0.6,0.7)    | (0.53,0.63,0.73) | (0.57,0.67,0.77) | (0.57,0.67,0.77) |
| Customer loyalty         | 0.193                           | (0.45,0.55,0.65) | (0.25,0.35,0.45) | (0.3,0.4,0.5)    | (0,0.1,0.2)      | (0.6,0.7,0.8)    | (0.4,0.5,0.6)    |

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|                       |       |                  |                  |                  |                  |               |                  |
|-----------------------|-------|------------------|------------------|------------------|------------------|---------------|------------------|
| Customer services     | 0.084 | (0.55,0.65,0.75) | (0.55,0.65,0.75) | (0.2,0.3,0.4)    | (0.3,0.4,0.5)    | (0.8,0.9,1)   | (0.5,0.6,0.7)    |
| Market share          | 0.091 | (0.7,0.8,0.9)    | (0.35,0.45,0.55) | (0.35,0.45,0.55) | (0.3,0.4,0.5)    | (0.5,0.6,0.7) | (0.35,0.45,0.55) |
| E-commerce            | 0.045 | (0.6,0.7,0.8)    | (0.57,0.67,0.77) | (0.03,0.13,0.23) | (0.27,0.37,0.47) | (0.4,0.5,0.6) | (0.43,0.53,0.63) |
| Management experience | 0.049 | (0.43,0.53,0.63) | (0.57,0.67,0.77) | (0.33,0.43,0.53) | (0.3,0.4,0.5)    | (0.6,0.7,0.8) | (0.43,0.53,0.63) |
| Brand                 | 0.064 | (0.65,0.75,0.85) | (0.45,0.55,0.65) | (0.4,0.5,0.6)    | (0.35,0.45,0.55) | (0.7,0.8,0.9) | (0.5,0.6,0.7)    |

(Step 2) Normalizing the decision matrix

Table 4: Data for normalized fuzzy decision matrix

| Alternatives Criteria | Weight criteria | Mahan            | Zagros           | Kish Air         | Aseman           | Qeshm Air        | Iran Air         |
|-----------------------|-----------------|------------------|------------------|------------------|------------------|------------------|------------------|
| Advertising           | 0.035           | (0.55,0.68,0.82) | (0.55,0.68,0.82) | (0.45,0.59,0.73) | (0,0.14,0.27)    | (0.73,0.86,1)    | (0.5,0.64,0.77)  |
| Quality of services   | 0.196           | (0.77,0.88,1)    | (0.5,0.62,0.73)  | (0.46,0.58,0.69) | (0.42,0.54,0.65) | (0.58,0.69,0.81) | (0.46,0.58,0.69) |
| Competitive price     | 0.244           | (0.45,0.53,0.64) | (0.6,0.75,1)     | (0.43,0.5,0.6)   | (0.41,0.47,0.56) | (0.39,0.45,0.53) | (0.39,0.45,0.53) |
| Customer loyalty      | 0.193           | (0.56,0.69,0.81) | (0.31,0.44,0.56) | (0.38,0.5,0.63)  | (0,0.13,0.25)    | (0.75,0.88,1)    | (0.5,0.63,0.75)  |
| Customer services     | 0.084           | (0.55,0.65,0.75) | (0.55,0.65,0.75) | (0.2,0.3,0.4)    | (0.3,0.4,0.5)    | (0.8,0.9,1)      | (0.5,0.6,0.7)    |
| Market share          | 0.091           | (0.78,0.89,1)    | (0.39,0.5,0.61)  | (0.39,0.5,0.61)  | (0.33,0.44,0.56) | (0.56,0.67,0.78) | (0.39,0.5,0.61)  |
| E-commerce            | 0.045           | (0.75,0.88,1)    | (0.71,0.83,0.96) | (0.04,0.17,0.29) | (0.33,0.46,0.58) | (0.5,0.63,0.75)  | (0.54,0.67,0.79) |
| Management experience | 0.049           | (0.54,0.67,0.79) | (0.71,0.83,0.96) | (0.42,0.54,0.67) | (0.38,0.5,0.63)  | (0.75,0.88,1)    | (0.54,0.67,0.79) |
| Brand                 | 0.064           | (0.72,0.83,0.94) | (0.5,0.61,0.72)  | (0.44,0.56,0.67) | (0.39,0.5,0.61)  | (0.78,0.89,1)    | (0.56,0.67,0.78) |

(Step 3) Creating the weighted normalized fuzzy decision matrix

Multiplying the normalized decision matrix ( $\tilde{r}_{ij}$ ) by the weights of criteria ( $w$ ) gives the weighted normalized fuzzy matrix ( $\tilde{V}$ ).

Table 5: Creating the weighted normalized fuzzy decision matrix

| Alternative Criteria | Mahan               | Zagros              | Kish Air            | Aseman              | Qeshm Air           | Iran Air            |
|----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Advertising          | (0.019,0.024,0.029) | (0.019,0.024,0.029) | (0.016,0.021,0.025) | (0,0.005,0.01)      | (0.025,0.03,0.035)  | (0.018,0.022,0.027) |
| Quality of services  | (0.151,0.173,0.196) | (0.098,0.121,0.143) | (0.09,0.113,0.136)  | (0.083,0.106,0.128) | (0.113,0.136,0.158) | (0.09,0.113,0.136)  |
| Competitive price    | (0.11,0.129,0.157)  | (0.146,0.183,0.244) | (0.105,0.122,0.146) | (0.1,0.116,0.137)   | (0.095,0.11,0.129)  | (0.095,0.11,0.129)  |
| Customer loyalty     | (0.109,0.133,0.157) | (0.06,0.084,0.109)  | (0.072,0.097,0.121) | (0,0.024,0.048)     | (0.145,0.169,0.193) | (0.097,0.121,0.145) |
| Customer services    | (0.046,0.055,0.063) | (0.046,0.055,0.063) | (0.017,0.025,0.034) | (0.025,0.034,0.042) | (0.067,0.076,0.084) | (0.042,0.05,0.059)  |
| Market share         | (0.071,0.081,0.091) | (0.035,0.046,0.056) | (0.035,0.046,0.056) | (0.03,0.04,0.051)   | (0.051,0.061,0.071) | (0.035,0.046,0.056) |

|                       |                     |                     |                     |                     |                     |                     |
|-----------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| E-commerce            | (0.034,0.039,0.045) | (0.032,0.038,0.043) | (0.002,0.008,0.013) | (0.015,0.021,0.026) | (0.023,0.028,0.034) | (0.024,0.03,0.036)  |
| Management experience | (0.027,0.033,0.039) | (0.035,0.041,0.047) | (0.02,0.027,0.033)  | (0.018,0.025,0.031) | (0.037,0.043,0.049) | (0.027,0.033,0.039) |
| Brand                 | (0.046,0.053,0.06)  | (0.032,0.039,0.046) | (0.028,0.036,0.043) | (0.025,0.032,0.039) | (0.05,0.057,0.064)  | (0.036,0.043,0.05)  |

**(Step 4)** Determining the positive ideal solution ( $\tilde{V}_j^*$ ) and the negative ideal solution ( $\tilde{V}_j^-$ )

Given that in the process of normalization all parameters become positive, at this step, the largest number of each criterion is considered as the positive ideal solution of that criterion, whereas, the smallest number is considered as the negative ideal solution of that criterion.

**Table 6:** Positive and negative ideal solutions

| Criterion             | Positive ideal solution ( $\tilde{V}_j^*$ ) | Negative ideal solution ( $\tilde{V}_j^-$ ) |
|-----------------------|---|---|
| Advertising           | (0.025,0.03,0.035)                          | (0,0.005,0.01)                              |
| Quality of services   | (0.151,0.173,0.196)                         | (0.083,0.106,0.128)                         |
| Competitive price     | (0.146,0.183,0.244)                         | (0.095,0.11,0.129)                          |
| Customer loyalty      | (0.145,0.169,0.193)                         | (0,0.024,0.048)                             |
| Customer services     | (0.067,0.076,0.084)                         | (0.017,0.025,0.034)                         |
| Market share          | (0.071,0.081,0.091)                         | (0.03,0.04,0.051)                           |
| E-commerce            | (0.034,0.039,0.045)                         | (0.002,0.008,0.013)                         |
| Management experience | (0.037,0.043,0.049)                         | (0.018,0.025,0.031)                         |
| Brand                 | (0.05,0.057,0.064)                          | (0.025,0.032,0.039)                         |

**Step 5)** Determining the distance of each alternative from positive ideal solution ( $d_i^*$ ) and negative ideal solution ( $d_i^-$ )

**Table 7:** The distance of each alternative from positive ideal solution

| Alternative | ( $d_i^*$ ) |
|-------------|-------------|
| Iran Air    | 0.2948      |
| Qeshm Air   | 0.1531      |
| Aseman      | 0.4602      |
| Kish Air    | 0.3683      |
| Zagros      | 0.2217      |
| Mahan       | 0.1401      |

**Table 8:** The distance of each alternative from negative ideal solution

| Alternative | ( $d_i^-$ ) |
|-------------|-------------|
| Iran Air    | 0.1931      |
| Qeshm Air   | 0.3349      |
| Aseman      | 0.0278      |
| Kish Air    | 0.1197      |
| Zagros      | 0.2663      |
| Mahan       | 0.3479      |

**(Step 6)** Determining the closeness coefficient ( $CC_i$ ) for each alternative

Once the positive distance ( $d_i^+$ ) and negative distance ( $d_i^-$ ) is calculated for each alternative  $A_i$ , the closeness coefficient ( $CC_i$ ) of each alternative will also be computed:

**Table 9:** Calculation of closeness coefficient for each alternative

| Alternative | $(d_i^-)$ | $(d_i^+)$ | $( )$  | Rank |
|-------------|-----------|-----------|--------|------|
| Iran Air    | 0.1931    | 0.2948    | 0.3958 | 4    |
| Qeshm Air   | 0.3349    | 0.1531    | 0.6863 | 2    |
| Aseman      | 0.0278    | 0.4602    | 0.0569 | 6    |
| Kish Air    | 0.1197    | 0.3683    | 0.2454 | 5    |
| Zagros      | 0.2663    | 0.2217    | 0.5458 | 3    |
| Mahan       | 0.3479    | 0.1401    | 0.7129 | 1    |

The closeness coefficients are calculated in the above table for each alternative. The alternatives (airlines) with a larger closeness coefficient will also have a higher priority.

**(Step 7)** Ranking the alternatives based on closeness coefficient

The graph of the rankings of the airlines is presented below. As it is clear from the [Fig. 3], Mahan with the closeness coefficient of 0.712 is ranked first, Qeshm Air has the closeness coefficient of 0.686 and is ranked second, while Zagros with the closeness coefficient of 0.545 is in the third rank. Aseman Airlines has the lowest coefficient closeness, i.e. 0.056, and is ranked last. Iran Air and Kish Air are ranked fourth and fifth, respectively.

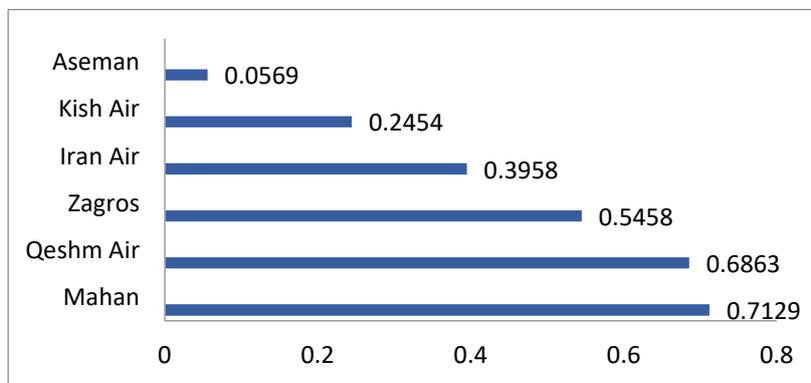


Fig. 3: Airline rankings based on the closeness coefficient

DISCUSSION AND ANALYSIS OF RESULTS

After implementing the fuzzy TOPSIS method, rankings of airlines were determined in the light of the success variables of this sector. These findings can be discussed from a managerial viewpoint and in terms of the following operations and key success factors in Iran's airline industry.

Iran's first private airline, Mahan Air was established in 1992 and its mission is "safe, efficient and high-yield transportation of passengers, cargo and mail, and providing services of superior quality in accordance with the international standards". The airline currently is operating 51 aircrafts, flying to more than 49 domestic and 51 international destinations from the Middle East to the Far East and European continent. The number of passengers of the airlines was about 6.5 million people in 2015.

Mahan Air mainly uses outdoor advertising in order to attract customers and improve its brand. Such advertising are mostly the advertisements at airports, in-flight magazines and the company's websites.

In order to provide the highest and best services in addition to compliance with international standards for flights, Mahan Air has committed itself to fulfill all the expectations of the passengers. Mahan Air's meals follow the special processing guidelines and techniques of cooking and seasoning. For in-flight meals, the local taste and dishes of the destination countries have been taken into account. In some flights, western cuisine and cooking methods as well as some dishes for people who favor certain taste have been included in the menu.

Flight crew and attendants are trained periodically and continuously to provide passengers with the best services, and to achieve customer satisfaction in order for gaining competitive advantage.

Aimed at lowering the prices of services and tickets, Mahan has collaborated with and created partnerships, and also has established some service companies in recent years, including Saman Airport Services Company for airport handling, Mahan Safir Transportation Company, Mahan Air Cargo Services, Arman Catering Company in the field of catering and also providing services to other companies, Botia training center for in-service training of its staff, and Mahan Technique to perform technical repairs. Mahan Air Maintenance Center has already issued technical certificates for other airlines.

Mahan Company has offered special facilities for the purpose of attracting and retaining customers; it

launched its Frequent Traveler Club, named Mahan & Miles in 2009. Creating a dedicated lounge in flight terminals, special free pre-flight amenities for business class travelers and the members of Frequent Traveler Club including a variety of drinks, snacks, warm breakfast, and various sweets as self-service, use of wireless internet, Persian and English-language press and the children's play and entertainment area are among other services of the company.

The company has reduced its delays to less than 8% of the total delays of domestic airlines, has established new passenger services offices in Europe (Milan, Rome, Turin etc.), and has lower ticket prices comparing foreign airlines to be able to maintain its market share and improve it.

Stable management can be considered as one of the most important factors for the success of the company. Hamid Arabnejad has been the CEO and Chairman of the Board from the beginning of its establishment and has created an integrated management team to implement a strategic plan in order to improve and expand the operations of Mahan Air.

In 2013, Mahan Air's brand was considered as one of the "100 most valuable brands of Iran" at the "10th Iranian Industries Champions Festival". Lalim Touristic and Recreational Complex in Sari, Mazandaran is under construction in collaboration with Mahan Air at a distance of 7 kilometers away from Sari International Airport including a five-star hotel and residential units on a land with an area of 15 hectares and with a building area of 60 thousand square meters.

Qeshm Air is one of the Iranian public airlines. The company started its operations in 1993 and was transferred to the Ministry of Petroleum of the Islamic Republic of Iran in 2014. The company has 13 active airplanes of Fokker 100, Airbus and BAE types. It provides nearly 3,000 seats and offers flights and cargo services to more than 22 domestic and international destinations.

Advertising is one of the strengths of the company, and its widespread advertising on television, at airports and at international destinations has distinguished the company in attracting more passengers and gaining competitive advantage over other airlines.

The main station of the airlines is Qeshm Island Airport and its other hubs include Imam Khomeini International Airport and Mehrabad International Airport.

Providing high quality flight and ticket sales services are among the strengths of Qeshm Air, which had led this company to be ranked second among domestic airlines. Qeshm Air transfers those travelers who directly purchase their tickets from the company's website from their home to the airport for free. The establishment of new sales systems as well as different in-flight services with the highest standards of quality and safety has led to the considerable growth of customer loyalty for the company. The company's data center was established in 2016, yet another growing trend of the company towards e-commerce. Qeshm Air is the only airline brand among top 10 top luxury brands of Iran.

Zagros Airlines began its operations in 2005. The company has been able to increase the number of aircrafts in its fleet, to become among the leading and growing companies of Iran, and to make significant contributions to Iran's airline industry in a short period of time. Zagros Airlines currently has a fleet of 19 aircrafts, including 11 Airbus A320 and eight Boeing MD series airplanes, provides more than 3,000 seats and offers flight services to more than 20 domestic and international destinations. The company has managed to grow by 30% in terms of domestic and international destinations and by 70% in terms of number of passengers, and has transported more than 3 million passengers in the past year (2015). The main station of this airline is Mehrabad airport in Tehran and it has established a repair and maintenance hangar in Mashhad in order to lower its costs.

Advertising of the company is mainly done as in-flight promotions and the passengers of this airline will enjoy some facilities such as a discount on hotel rates and use of leisure facilities on some routes. The major competitive advantage of the company is its reasonable and lower ticket prices comparing other airlines. The airline has managed to bring down its variable costs, to organize e-commerce and to purchase Airbus passenger aircrafts as some steps towards greater customer satisfaction and increased market share of the company for passenger transportation. The weaknesses of the company include flight delays, which are around 11% of the total delays of all airlines, and flight services of lower quality than other airlines.

Consecutive United States' sanctions against Iran's aviation industry and Iranian airlines in the last 30 years have led to complete decline of Iran Air from its golden days. The extent of these pressures increased up to the point that the International Association of Air Transport (IATA) suspended the settlement of accounts of all airlines with the Airline of the Islamic Republic of Iran. The impact of such sanctions for Iran Air is prohibition of selling tickets for Iran Air planes by air travel agencies. Refraining from selling fuel to aging, worn-out Iranian planes has turned Iran's Homa, which was known as the Caviar Airline long time ago, into one of the largest Iranian loser companies. Over the last 30 years, business sanctions prevented Iran Air from purchasing new airplanes from western companies. This has forced Iran Air to use aging airplanes and jumbo jets procured before the Islamic Revolution in 1979 for transportation of passengers. According to Airfleets.net, Iran Air's air transportation fleet consists of 46 jets with average fleet age of 27 years, and there are even 40-year-old Boeing aircrafts still flying. Increased number of incidents of Iran Air's aircrafts due to technical problems caused the Europe Union to ban the flight of most of the company's airplanes in 2010.

Currently, 60% of the shares and management of the company are controlled by the government, and 40% of the shares are transferred to the public via Edalat Shares Cooperatives. Iran Airtour Airline and Homa Hotels Group were previously the subsidiaries of Iran Air; Homa Hotels Group was sold to the Social

Security Administration and Iran Airtour Airline to the private sector.

Obviously, the company has failed to obtain a good market share due to loss of its foreign advertising outlets, lack of access to e-commerce and crippled airplanes with regard to lack of access to maintenance and repair resources and spare parts suppliers. The flight delay of 16% out of the total delays of the country's airline industry is another complicating issue. The company's strengths include old loyal customers as well as its brand as the flight carrier.

Kish Air was established in 1991 with the aim of developing the operations of Kish Island by connecting it to the centers of the provinces as well as to the countries around the Persian Gulf. After registration and receiving legal permits, Kish Air became a joint stock company as one of the subsidiaries of Kish Free Zone Organization. The main station of the company is Kish airport and Mehrabad Airport in Tehran is its second flight hub. The company owns 10 active aircrafts of Boeing MD and Fokker 100 types.

Like other Iranian public airlines, economic sanctions have adversely affected the performance and expansion of the company. However, data analysis indicates that lack of management stability is the main problem of the company for planning and business operations, to the extent that the company's rank was lower than other airlines' ranks for all the examined aspects. Replacement of CEOs for seven times in the past ten years and exerting influence over decision-making and policy-making processes of Kish Air by Kish Free Zone Organization as its parent organization have caused the company to face with some great challenges in competition with other domestic competitors. Lack of advertising and e-commerce platforms, increased variable costs and deteriorated quality of services have led to a sharp decline of Kish Air's market share, and subsequently the brand of this airline have lost its former popularity.

Aseman Airlines was established in the year 1980 from the merger of four airlines, i.e. Air Taxi, Pars Air, Air Service and Hour Aseman. Aseman Airlines has established three flight centers in Tehran, Shiraz and Mashhad for better coverage of its flight network. Each of these three centers benefit from independent flight crew and maintenance hangars for recruiting and training local experts and performing daily flights with an adequate independence. Aseman Airlines was transferred to the National Pension Fund in 2002. It has now 33 aircrafts, 20 of which are active and perform regular flights to 40 domestic and 13 foreign destinations.

In recent years, Aseman Airlines has tried to lower its costs in order to raise capital and purchase new airplanes, and for this purpose, it has jointly established Arman Catering Company in collaboration with Mahan Air, and 50% of its shares belong to Aseman Airlines; it has also developed its technical-engineering department namely "Aseman Technique" to attract customers for its services. However, Aseman Airlines was ranked last in our rankings, mainly due to weakness in advertising, underdevelopment of e-commerce and management instability. The economic sanctions have also crippled a major part of the company's fleet, and its passenger transportation market share has dropped sharply comparing with other domestic competitors. Flight delays of the company, which are around 19% of the total delays in Iran, have led Aseman Airlines to lose much of its loyal customers.

## CONCLUSION

In this study, fuzzy TOPSIS method was employed instead of conventional TOPSIS technique. In the light of the key success factors in Iran's airline sector, a comparative assessment was performed in this regard. Mahan Air and Qeshm Air showed outperformance comparing with other airlines in terms of advertising and product quality, and thus achieved competitive advantage in these fields. The performance of Zagros Airlines was relatively good, whereas other airlines had poor performance in this regard, so it is necessary for them to address this issue. In terms of cost competitiveness, Zagros Airlines and Mahan Air were at the top, while other airlines were underperforming. Mahan Air and Qeshm Air were the most competitive airlines in terms of customer loyalty and market share. Whereas Zagros Airlines had a good market share compared to other competitors, Iran Air, Kish Air, and Aseman Airlines had underperformance in this regard and must handle the issue in their strategic planning process. In terms of customer services, Qeshm Air showed a remarkable performance, Iran Air and Zagros Airlines had a modest performance, and Mahan Air's performance was relatively good, however, Kish Air and Aseman Airlines were considered as poor performers. Mahan Air also was an excellent performer in terms of e-commerce and management experience, Zagros Airlines was a modest one, and other airlines were not good at all in these fields, and thus, they should carefully consider these issues. With regard to the branding, Mahan Air and Qeshm Air were the best companies; Iran Air was modest, but other airlines underperformed, so they shall revise the relevant issues in their long-term planning. By considering all of these key success factors, we can see that Mahan Air is a fully competitive company, Air Qeshm is in the second, and Zagros Airlines in the third place; other airlines are in the following ranks.

The findings show that private airlines have been able to maintain their dominant role. It should be noted that despite the fact that Zagros Airlines is a newly established airline compared with other competitors, it has intensified competition in the sector and has become a main competitor for other airlines in recent years. Iran Air, Aseman Airlines and Kish Air must pay special attention to the key success factors of the industry if they want to survive in it, and they must consider the long-term planning into account.

## CONFLICT OF INTEREST

There is no conflict of interest.

## ACKNOWLEDGEMENTS

None

## FINANCIAL DISCLOSURE

None

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