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Passenger Service Quality Perceptions to Star Alliance Airlines

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Abstract

Through performance measurement, airline operators can conduct situation assessments and evaluate the contributions of decisions to performance beforehand. Evaluating performance based on the perceived service quality by airline passengers has become crucial for airlines to understand and improve their services in order to achieve success in competition by meeting passengers' desires and expectations. This study aims to examine the perception of customer service quality among airline operators in the Star Alliance, the largest alliance worldwide based on 2023 data, using multi-criteria decision-making (MCDM) methods known as Entropy and MARCOS, with Tripadvisor data as a basis. Firstly, criteria weights were obtained using the Entropy method, and then airline operators were evaluated and ranked based on service quality using the MARCOS method. The study revealed that the most significant evaluation criterion was the in-flight entertainment systems (Wi-Fi, TV, movies), and Singapore Airlines exhibited the best service quality performance.

1. Introduction

The success of service quality is measured by the ability of the business and its personnel to consistently meet customer expectations. Particularly for service businesses, the importance of service quality is explained by its status as a key factor in the consumer's purchasing decision process (Wahyuni & Praninta, 2021). In order to better understand customers' experiences with services, businesses need to identify certain tangible factors (Ghotbabadi, Feiz, & Baharun, 2015). Airline service quality refers to passengers' subjective perceptions regarding the efficiency and benefit of the services provided by the service provider airline operator (Li, Wu, Han, & Li, 2022).

According to Namukasa (2013), airline service quality influencing customer satisfaction and loyalty is measured in pre-flight, in-flight, and post-flight phases. Factors affecting pre-flight service quality include the reliability of the airline website, discount offers, flight cancellations, baggage allowance, and responsiveness to emergencies. In-flight services entail quality factors such as safety perceptions, seat comfort, meal quality, in-flight entertainment services, language skills, and the courtesy of the flight crew. Post-flight service perception revolves around quality factors such as the speed of baggage delivery and retrieval (Namukasa, 2013). In contrast, Chen and Chang (2005) categorize airline services that influence customers' quality perceptions into ground services and in-flight services. Ground services encompass information gathering, reservations and ticket purchasing, airport check-in, and post-flight services, while in-flight services encompass all services provided during the flight (Chen & Chang, 2005).

However, defining and measuring the quality of airline service is challenging due to the heterogeneous, intangible, and inseparable nature of services (Chang & Yeh, 2002). Nevertheless, various conceptual and empirical studies have been conducted to explain this phenomenon. In the literature, studies on airline service quality have been conducted across different carriers (low-cost, full-service, regional) (Baker, 2013; Truitt & Ray Haynes, 1994), in different contexts (customer loyalty, satisfaction, value co-creation, corporate image, etc.) (Ostrowski, O'Brien, & Gordon, 1993; Namukasa, 2013; Chung & Tan, 2022; Yanginlar & Tuna, 2020), with different service providers (airlines, airports, cargo, etc.) (Youngo, Cunningham, & Lee, 1994; Özden & Celik, 2021; Özdağoğlu, Işıldak, & Keleş, 2022), and using various methods (quantitative, qualitative, multi-criteria decision-making) (Bakır & Atalık, 2021; Tali & Karaduman, 2021).

When the aforementioned studies were examined, no study was found in which Entropy and Marcos method were used together in measuring airline service quality in recent years. In the Entropy method, more reliable results are provided since objective weighting is made in accordance with the purpose of the study. In the Marcos method, which is a newer and flexible method, it is possible to evaluate many alternatives together without turning into complexity. The fact that there are 26 alternatives in the study shows the purpose of using this method.

In this context, this study aims to examine the perception of customer service quality among airline operators in the Star Alliance, which has the highest membership worldwide, based on 2023 data, using multi-criteria decision-making (MCDM) methods known as Entropy and MARCOS, with Tripadvisor data as a basis. In the study, 26 airline operators were evaluated as alternatives, and the criteria considered in the evaluation were determined based on Tripadvisor website criteria. Accordingly, the following sections will first address the phenomenon of service quality, followed by a literature review. Subsequently, the method used in the study will be described, and the results obtained using this method will be shared. Finally, the discussion section will present the conclusions reached in the study.

2. Literature Review

The SERVQUAL model, developed by Parasuraman et al. (1985), is widely used in the literature to measure customer perceptions of the quality of services provided by businesses. The SERVQUAL model consists of five general dimensions. (1) Tangibles; the appearance of physical facilities, equipment, and personnel. (2) Reliability; the ability to deliver the promised service reliably and accurately. (3) Responsiveness; the willingness to help customers and provide prompt service. (4) Assurance; the ability of employees to instill confidence and trust through their knowledge and courtesy. (5) Empathy; the provision of attentive and personalized attention to customers by the firm (Parasuraman, Zeithaml, & Berry, 1985).

In addition, the Airline Service Quality (AIRQUAL) model developed for airline operators is considered a significant factor for all service providers in the airline industry. Derived from the SERVQUAL service quality model, it was developed by Bari et al. (2001) as a tool to assess customer satisfaction with the services provided to them during service encounters (Badrillah, Shuib, & Nasir, 2023).

A comprehensive model based on five different dimensions has been proposed for evaluating airline service quality using AIRQUAL dimensions (Bari et al., 2001):

(1) Tangible services of airlines - Physical environment elements demonstrating in-flight features such as design, catering, and cleanliness.

(2) Tangible services at the terminal - Facilities provided for customers at the airport, including restrooms, luggage carts, and shops.

(3) Personnel - Encompasses all staff members dealing with customer service at the terminal, whether exhibiting good or uncooperative behavior towards customers.

(4) Empathy - A business policy applied to make customers feel safe and protected while using the services of the airline operator.

(5) Image - This factor involves offering tickets at low prices and maintaining the reputation of the operation to attract customers to use the services. Consequently, customers believe that the services provided by the operation will always be consistent.

The satisfaction of passengers is achieved through the quality and consistency provided by airline operators in each service component. Consequently, the relationship between airlines and passengers becomes more harmonious, influencing repeat purchase intentions, increasing passenger loyalty, generating word-of-mouth recommendations, establishing corporate reputation, and ultimately boosting the airline's profit. It can be observed that the continuous improvement of quality is not an extra cost but rather an investment made to increase profits (Rady, 2018).

One of the studies that extensively considers airline service quality, focusing on a wide range of criteria, is the work of Eboli, Bellizzi, and Mazzulla (2022). In their study, the authors compiled airline services affecting quality from all studies measuring airline service quality in the literature. Accordingly, they identified 24 factors: flight booking, seat selection, airline website, check-in process, flight frequency and scheduling, waiting lounges, boarding operations, punctuality, airline staff/cabin crew, cabin announcements, seat comfort/space availability, acoustic comfort inside the cabin, thermal comfort inside the cabin, air quality inside the cabin, cabin cleanliness, restroom facilities, safety and security measures, food and beverage services, entertainment options, in-flight internet/phone services, baggage handling and delivery, frequent flyer programs, and pricing (Eboli, Bellizzi, & Mazzulla , 2022).

When examining recent studies measuring service quality in airline operations, it is observed that various MCDM methods have been employed (Table 1).

Table 1. Studies on Service Quality in Airline Companies with MCDM Methods

Author(s)	Methods
(Gupta, 2018)	Best Worst Method (BWM) and VIKOR
(Bakır & Atalık, 2018)	Entropi and ARAS
(Perçin, 2018)	Fuzzy DEMATEL, Fuzzy ANP and Fuzzy VIKOR
(Pineda, Liou, Hsu, & Chuang, 2018)	DANP and VIKOR
(Badi & Abdulshahed, 2019)	FUCOM and AHP
(Fu, 2019)	AHP, ARAS, Multi-Choice Goal Programming
(Öztürk & Onurlubaş, 2019)	AHP and TOPSIS
(Büyüközkan, Havle, & Feyzioğlu, 2020)	Interval-Valued Intuitionistic Fuzzy AHP (IVIF-AHP)
(Altınkurt & Merdivenci, 2020)	EDAS
(Bakır & Atalık, 2021)	Fuzzy AHP and Fuzzy Marcos
(Gedik & Bayram, 2022)	Entropi and Aras
(Kavus, Tas, Ayyildiz, & Taskin, 2022)	BWM and IVN-AHP
(Awadh, 2023)	AHP

In studies conducted using multi-criteria decision-making techniques (Table 1), the scarcity of research on airline service quality is notable. Among these studies, no research focusing on passenger evaluations covering all airline operators belonging to the Star Alliance has been encountered. In this context, the aim of the study is to determine the importance levels of service quality factors based on passenger evaluations for the 26 airline operators belonging to the Star Alliance.

3. Materials and Methods

In the study, the Entropy method, known as an objective weighting method, was employed for the process of weighting criteria to determine their importance levels. Additionally, the MARCOS method was utilized to obtain rankings of decision alternatives.

3.1. The entropy method

Entropy was first introduced to the literature through its adaptation to information theory by Shannon (1948). In decision-making problems with multiple criteria, various subjective and objective decision-making techniques exist for calculating the weights of criteria. Among these, although

Analytic Hierarchy Process (AHP) is one of the most preferred methods, it has been subject to some criticisms due to its reliance on subjective criteria, which can lead to biased results. On the other hand, the Entropy method provides more reliable results as it performs objective weighting (Arslan, Durak, & Özdemir, 2021). As seen in some studies in the literature, the Entropy method is applied by following the five steps outlined below. (Kehribar, Karademir, & Evci, 2021; Özgüner & Özgüner, 2020; Bağcı & Caba, 2018; Akçakanat, Eren, Aksoy, & Ömürbek, 2017).

Step 1: *Formation of the Decision Matrix*

In the first step of the Entropy method, there is a decision matrix formed using equality (1).

$$A_{ij} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mn} \end{bmatrix} \quad (1)$$

Step 2: *Performing the Normalization Process*

In this step of the Entropy method, the decision matrix is normalized to a common unit. In this process, criteria are normalized using equality (2) without distinguishing between benefit and cost functions.

$$r_{ij} = \frac{a_{ij}}{\sum_{i=1}^{j} a_{ij}} \quad (2)$$

Here;

i= alternatives
j= criteria
$r_{ij=}$ *normalized values*
x_{ij}= *the benefit values of alternative i for criterion j*

After the normalization process, the matrix $R = [r_{ij}]_{mxn}$ is obtained.

Step 3: *Calculation of Entropy Values* (e_j) *for Criteria*

In this step, the entropy values for criteria are calculated using equality (3).

$$e_j = -k \sum_{j=1}^{n} r_{ij}.\ln(r_j) \qquad (i = 1,2,3,\ldots,m \text{ ve } j = 1,2,3,\ldots,n) \quad (3)$$

k= entropy coefficient $\{(\ln(n))^{-1}\}$
r_{ij}= *normalized values*
$e_{j=}$ *entropy value*

In this notation, e_j represents the entropy value of criterion j. and it lies between $0 \leq e_j \leq 1$.

Step 4: *Calculation of Differentiation Degree of Information* (d_j)

$$d_j = 1 - e_j \qquad (i = 1,2,3,\ldots m \text{ ve } j = 1,2,3,\ldots,n) \quad (4)$$

In this step, the calculated d_j values being high indicate that there is a high degree of contrast, or in other words, significant differentiation, among the alternative values for the criteria.

Step 5: *Calculation of Criterion Weights* (w_j)

In this final step of the method, entropy weights are obtained for each criterion.

$$w_j = {}^{1-e_j}\Big/_{\sum_{i=1}^{n}(1-e_j)} \quad (5)$$

In this case, $w_1 + w_2 + w_3 + \cdots + w_n = 1$ equality for holds.

3.2. The Measurement of Alternatives and Ranking According to Compromise Solution (MARCOS) method

After determining the weight values of criteria, the MARCOS method is employed to obtain the rankings of alternatives. MARCOS method is one of the preferred methods for ranking decision alternatives, as indicated by Stević et al. (2020). The method is based on establishing the relationship between alternatives and reference values (ideal and anti-ideal alternatives) to rank the performances of alternatives. For the defined relationships, firstly, the benefit functions of alternatives are determined, and a ranking is made according to the ideal (AI)-anti-ideal (AAI) solutions. Decision preferences are defined based on benefit functions. Benefit functions express the position of an alternative relative to the ideal and anti-ideal solutions. At this point, the best alternative is the one closest to the ideal and farthest from the anti-ideal reference point (Stević, Pamučar, Puška, & Chatterjee, 2020).

The implementation of the MARCOS method occurs in six stages (Stević, Pamučar, Puška, & Chatterjee, 2020):

Step 1: Establish an initial decision matrix

The values taken by *m* alternatives according to *n* criteria in the decision problem are represented in the decision matrix shown in Equality (7).

$$X = \begin{matrix} & C_1 & C_2 & \ldots & C_n \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{bmatrix} x_{11} & x_{12} & \ldots & x_{1n} \\ x_{21} & x_{22} & \ldots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \ldots & x_{mn} \end{bmatrix}$$

Step 2: The ideal *(AI)* and anti-ideal *(AAI)* solutions of the alternatives are calculated, and an extended matrix is constructed using the values of these solutions. In this step, each of the alternatives is evaluated for each of the criteria, and the optimal and anti-optimal solutions of this alternative are calculated for these criteria. This step is performed according to the following equations.

$$AAI = \min_j x_{ij} \;\; if \;\; j \in B \; and \;\; AAI = \max_j x_{ij} \;\; if \;\; j \in C \quad (7)$$

$$AI = \max_j x_{ij} \;\; if \;\; j \in B \; and \;\; AAI = \min_j x_{ij} \;\; if \;\; j \in C \quad (8)$$

Where B stands for the criteria to be maximized, and C stands for the criteria to be minimized.

Step 3. The normalization of the extended initial matrix *(X)*. Normalization is performed by using the following equations

$$n_{ij} = \frac{x_{ai}}{x_{ij}} \; if \; j \in C \tag{9}$$

$$n_{ij} = \frac{x_{ij}}{x_{ai}} \; if \; j \in B \tag{10}$$

Where the elements x_{ij} and x_{ai} represent the elements of the initial decision matrix.

Step 4. The determination of a weighted matrix. Aggravation is performed by multiplying normalized matrix values by corresponding weights

$$v_{ij} = n_{ij} \times w_j \tag{11}$$

Step 5. The calculation of the utility degree of the alternatives *Ki*. The utility degree is determined by applying the following equations:

$$K_i^- = \frac{S_i}{S_{aai}} \tag{12}$$

$$K_i^+ = \frac{S_i}{S_{ai}} \tag{13}$$

Where S_i ($i=1,2,..,m$) represents the sum of the elements of a weighted matrix *V*, equation:

$$S_i = \sum_{i=1}^{n} v_{ij} \tag{14}$$

Step 6. The formation of the utility function of the alternatives $f(K_i)$. The utility function is calculated by using the following equation:

$$f(K_i) = \frac{K_i^+ + K_i^-}{1 + \frac{1-f(K_i^+)}{f(K_i^+)} + \frac{1-f(K_i^-)}{f(K_i^-)}} \tag{15}$$

Where $f(K_i^-)$ is the utility function versus the anti-ideal solution, while $f(K_i^+)$ is the utility function versus the ideal solution. The utility functions are calculated using the following equations:

$$f(K_i^-) = \frac{K_i^+}{K_i^+ + K_i^-} \tag{16}$$

$$f(K_i^+) = \frac{K_i^-}{K_i^+ + K_i^-} \tag{17}$$

As a result, alternatives are ranked. A rank is formed based on the final value of the utility function. The alternative should have the most significant value of the utility function.

4. Result and Discussion

4.1. Data collection and definition of variables

Tripadvisor is the world's largest and most widely used online travel guidance company. Travelers seeking to go from one place to another turn to Tripadvisor to discover what mode of transportation to use, where to stay, what activities to engage in, and even what food to enjoy based on the reviews provided by individuals on the platform. Airlines providing travel services are also featured within the platform. Travelers share their experiences, rating them based on the criteria provided by Tripadvisor, and they can also leave comments for other travelers (potential/actual). The rating system ranges from 1 to 5. Travelers can evaluate their experience as follows: 1=very poor, 2=poor, 3=neither good nor bad, 4=good, and 5=excellent.

In order for these evaluations to be conducted, Tripadvisor has determined the criteria that define the quality of airline services as legroom, seat comfort, in-flight entertainment (Wi-Fi, TV, movies), onboard experience, customer service, value for money, cleanliness, check-in and boarding, food and beverage. Table 2 displays the criteria and codes used in this study.

Table 2. Criteria and Criteria Codes Used in the Study

Criteria Codes	Criteria
LR	Legroom
SC	Seat Comfort
IFE	In-flight entertainment
OBE	Onboard experience
CS	Customer service
VM	Value for money
CL	Cleanliness
CHB	Check-in and boarding
FB	Food and beverage

In the study, the calculation of alternative scores related to the criteria was approached using the Entropy method, and importance coefficients were calculated. Subsequently, the MARCOS method was employed to obtain rankings of the alternatives.

4.2. Obtaining importance coefficients with the entropy method

Step 1: Obtaining the Decision Matrix

In the study, the importance coefficients of the criteria were obtained using the Entropy method. The decision matrix is presented in Table 3.

Table 3. Decision Matrix for Airlines

AIRLINES	LR	SC	IFE	OBE	CS	VM	CL	CHB	FB
THY	3.500	3.500	4.000	4.000	4.000	4.000	4.000	4.000	4.000
UNITED	3.500	3.000	3.000	3.000	3.500	3.000	3.500	3.500	3.000
AEGEAN	3.500	4.000	2.500	4.000	4.000	4.000	4.500	4.000	4.000
AIR CANADA	3.500	3.500	3.500	3.000	3.500	3.000	3.500	3.500	3.000
AIR CHINA	3.000	3.000	2.500	3.000	3.000	3.500	3.500	3.500	3.000
AIR INDIA	3.500	3.500	2.500	3.000	3.000	3.500	3.000	3.500	3.000
AIR NEW ZEALAND	4.000	4.000	4.000	4.000	4.500	4.000	4.500	4.500	4.000
ALL NIPPON AIRWAYS	4.000	4.000	4.000	4.000	4.500	4.000	4.500	4.000	4.000
ASIANA AIRLINES	4.000	4.000	3.500	4.000	4.000	4.000	4.000	4.000	4.000
AUSTRIAN	3.500	3.500	3.000	3.500	4.000	3.500	4.000	4.000	3.500
AVIANCA	3.500	3.500	4.000	3.500	4.000	3.500	4.000	4.000	3.500
BRUSSELS AIRLINES	3.500	3.500	2.500	3.000	3.500	3.500	4.000	3.500	3.000
COPA AIRLINES	3.500	3.500	3.500	3.500	4.000	3.500	4.000	4.000	3.500
CROATIA AIRLINES	3.500	3.500	2.000	3.500	3.500	3.500	4.000	3.500	3.000
EGYPTAIR	3.500	3.500	2.500	3.000	3.500	3.500	3.500	3.500	3.000
ETHIOPIAN	3.500	3.500	3.000	3.000	3.500	3.500	3.500	3.500	3.500
EVA AIR	4.000	4.000	4.000	4.000	4.500	4.000	4.500	4.500	4.000
LOT POLISH AIRLINES	3.500	3.500	2.500	3.000	3.500	3.500	4.000	3.500	3.000
LUFTHANSA	3.500	3.500	3.500	3.500	4.000	3.500	4.000	4.000	3.500
SAS	3.500	3.500	2.500	3.500	3.500	3.500	4.000	4.000	3.000
SHENZHEN AIRLINES	3.500	3.500	2.500	3.000	3.500	3.500	3.500	3.500	3.000
SINGAPORE AIRLINES	4.000	4.000	4.500	4.000	4.500	4.000	4.500	4.500	4.000
SOUTH AFRICAN	3.500	3.500	3.000	3.000	3.500	3.500	4.000	3.500	3.500
SWISS	3.500	3.500	3.500	3.500	4.000	3.500	4.000	4.000	3.500
AIR PORTUGAL	3.000	3.000	2.500	3.000	3.500	3.000	3.500	3.500	3.000
THAI	4.000	4.000	3.500	4.000	4.000	4.000	4.000	4.000	4.000

Step 2: The normalized decision matrix was obtained

In this step, the values for each criterion were normalized using Equation (2). By dividing the criteria by the sum of the respective columns, normalized values were obtained. These values are presented in Table 4.

Table 4. Normalized Decision Matrix

AIRLINES	LR	SC	IFE	OBE	CS	VM	CL	CHB	FB
THY	0.038	0.038	0.049	0.045	0.041	0.043	0.039	0.040	0.045
UNITED	0.038	0.032	0.037	0.034	0.036	0.032	0.034	0.035	0.034
AEGEAN	0.038	0.043	0.030	0.045	0.041	0.043	0.044	0.040	0.045
AIR CANADA	0.038	0.038	0.043	0.034	0.036	0.032	0.034	0.035	0.034
AIR CHINA	0.032	0.032	0.030	0.034	0.030	0.037	0.034	0.035	0.034
AIR INDIA	0.038	0.038	0.030	0.034	0.030	0.037	0.029	0.035	0.034
AIR NEW ZEALAND	0.043	0.043	0.049	0.045	0.046	0.043	0.044	0.045	0.045
ALL NIPPON AIRWAYS	0.043	0.043	0.049	0.045	0.046	0.043	0.044	0.040	0.045
ASIANA AIRLINES	0.043	0.043	0.043	0.045	0.041	0.043	0.039	0.040	0.045
AUSTRIAN	0.038	0.038	0.037	0.039	0.041	0.037	0.039	0.040	0.039
AVIANCA	0.038	0.038	0.049	0.039	0.041	0.037	0.039	0.040	0.039
BRUSSELS AIRLINES	0.038	0.038	0.030	0.034	0.036	0.037	0.039	0.035	0.034
COPA AIRLINES	0.038	0.038	0.043	0.039	0.041	0.037	0.039	0.040	0.039
CROATIA AIRLINES	0.038	0.038	0.024	0.039	0.036	0.037	0.039	0.035	0.034
EGYPTAIR	0.038	0.038	0.030	0.034	0.036	0.037	0.034	0.035	0.034
ETHIOPIAN	0.038	0.038	0.037	0.034	0.036	0.037	0.034	0.035	0.039
EVA AIR	0.043	0.043	0.049	0.045	0.046	0.043	0.044	0.045	0.045
LOT POLISH AIRLINES	0.038	0.038	0.030	0.034	0.036	0.037	0.039	0.035	0.034
LUFTHANSA	0.038	0.038	0.043	0.039	0.041	0.037	0.039	0.040	0.039
SAS	0.038	0.038	0.030	0.039	0.036	0.037	0.039	0.040	0.034
SHENZHEN AIRLINES	0.038	0.038	0.030	0.034	0.036	0.037	0.034	0.035	0.034
SINGAPORE AIRLINES	0.043	0.043	0.055	0.045	0.046	0.043	0.044	0.045	0.045
SOUTH AFRICAN	0.038	0.038	0.037	0.034	0.036	0.037	0.039	0.035	0.039
SWISS	0.038	0.038	0.043	0.039	0.041	0.037	0.039	0.040	0.039
AIR PORTUGAL	0.032	0.032	0.030	0.034	0.036	0.032	0.034	0.035	0.034
THAI	0.043	0.043	0.043	0.045	0.041	0.043	0.039	0.040	0.045

Step 3: Calculation of Entropy Values for Criteria

For this step, first, the normalized values (r_{ij}) shown in Table 4 were multiplied by their natural logarithms (ln (r_{ij})). Then, the sum of the obtained r_{ij} and ln (r_{ij}) values was calculated to obtain the entropy values e_j using equation (3).

The value "k" in Equation (3) represents the entropy coefficient, which is the logarithmic form of the number of alternatives in the decision matrix. For example, considering that this study involves 26 decision alternatives, the value of "n" is assumed to be 26. Hence, using the formula $k=(ln\ (n))^{-1}$, we calculate $k=\frac{1}{\ln(26)}=0{,}3069$. All obtained e_j values in this step are presented in Table 5.

Table 5. The Values of e_j for Each Criterion

LR	SC	IFE	OBE	CS	VM	CL	CHB	FB
0.999	0.999	0.993	0.998	0.998	0.999	0.999	0.999	0.998

Step 4: The Calculation of the Differentiation Degree of Information

The entropy values e_j for the criteria shown in Table 5 have been subtracted from 1 using Equation (4), and the d_j values have been calculated (Table 6).

Table 6. The d_j values related to the criteria

LR	SC	IFE	OBE	CS	VM	CL	CHB	FB
0.001	0.001	0.007	0.002	0.002	0.001	0.001	0.001	0.002

Step 5: Calculation of Entropy Criterion Weights

In the final step, the entropy weights for the criteria were obtained using equation (5), and the results are presented in Table 7. The sum of the weight values for the 9 criteria was found to be 1. Accordingly, it was observed that the most important evaluation criterion is the in-flight entertainment systems (Wi-Fi, TV, movies) with a weight of 0.355.

Table 7. Entropy Criterion Weight Values

LR	SC	IFE	OBE	CS	VM	CL	CHB	FB
0.045	0.057	0.355	0.121	0.099	0.061	0.079	0.062	0.121

The criterion weights obtained in Table 7 will be considered as criterion weights in the subsequent step using the MARCOS method.

4.3. Application of the MARCOS (Measurement Alternatives and Ranking according to Compromise Solution) method

The creation of a multi-criteria model consists of nine criteria and twenty-six alternatives. This represents a group decision-making process, akin to the initial matrix in the MARCOS method (as in determining the importance of criteria). The estimations of decision-makers are aggregated using geometric mean to obtain an initial decision-making matrix. Using Equations (7) and (8), an expanded initial decision-making matrix is obtained, as shown in Table 8. The anti-ideal solution (AAI) represents the worst features, i.e., the highest values of their criteria, while minimum values for all other criteria of the benefit type are part of the AAI solution. The ideal solution (AI) is the opposite of the anti-ideal.

Table 8. An Extended Decision-Making Matrix

AIRLINES	LR	SC	IFE	OBE	CS	VM	CL	CHB	FB
AAI	3.000	3.000	2.000	3.000	3.000	3.000	3.000	3.500	3.000
THY	3.500	3.500	4.000	4.000	4.000	4.000	4.000	4.000	4.000
UNITED	3.500	3.000	3.000	3.000	3.500	3.000	3.500	3.500	3.000
AEGEAN	3.500	4.000	2.500	4.000	4.000	4.000	4.500	4.000	4.000
AIR CANADA	3.500	3.500	3.500	3.000	3.500	3.000	3.500	3.500	3.000
AIR CHINA	3.000	3.000	2.500	3.000	3.000	3.500	3.500	3.500	3.000
AIR INDIA	3.500	3.500	2.500	3.000	3.000	3.500	3.000	3.500	3.000
AIR NEW ZEALAND	4.000	4.000	4.000	4.000	4.500	4.000	4.500	4.500	4.000
ALL NIPPON AIRWAYS	4.000	4.000	4.000	4.000	4.500	4.000	4.500	4.000	4.000
ASIANA AIRLINES	4.000	4.000	3.500	4.000	4.000	4.000	4.000	4.000	4.000
AUSTRIAN	3.500	3.500	3.000	3.500	4.000	3.500	4.000	4.000	3.500
AVIANCA	3.500	3.500	4.000	3.500	4.000	3.500	4.000	4.000	3.500
BRUSSELS AIRLINES	3.500	3.500	2.500	3.000	3.500	3.500	4.000	3.500	3.000
COPA AIRLINES	3.500	3.500	3.500	3.500	4.000	3.500	4.000	4.000	3.500
CROATIA AIRLINES	3.500	3.500	2.000	3.500	3.500	3.500	4.000	3.500	3.000
EGYPTAIR	3.500	3.500	2.500	3.000	3.500	3.500	3.500	3.500	3.000
ETHIOPIAN	3.500	3.500	3.000	3.000	3.500	3.500	3.500	3.500	3.500
EVA AIR	4.000	4.000	4.000	4.000	4.500	4.000	4.500	4.500	4.000
LOT POLISH AIRLINES	3.500	3.500	2.500	3.000	3.500	3.500	4.000	3.500	3.000
LUFTHANSA	3.500	3.500	3.500	3.500	4.000	3.500	4.000	4.000	3.500
SAS	3.500	3.500	2.500	3.500	3.500	3.500	4.000	4.000	3.000
SHENZHEN AIRLINES	3.500	3.500	2.500	3.000	3.500	3.500	3.500	3.500	3.000
SINGAPORE AIRLINES	4.000	4.000	4.500	4.000	4.500	4.000	4.500	4.500	4.000
SOUTH AFRICAN	3.500	3.500	3.000	3.000	3.500	3.500	4.000	3.500	3.500
SWISS	3.500	3.500	3.500	3.500	4.000	3.500	4.000	4.000	3.500
AIR PORTUGAL	3.000	3.000	2.500	3.000	3.500	3.000	3.500	3.500	3.000
THAI	4.000	4.000	3.500	4.000	4.000	4.000	4.000	4.000	4.000
AI	4.000	4.000	4.500	4.000	4.500	4.000	4.500	4.500	4.000

The normalized decision matrix created using Equations (9) and (10) for airline companies is presented in Table 9.

Table 9. Normalized Matrix

AIRLINES	LR	SC	IFE	OBE	CS	VM	CL	CHB	FB
AAI	0.750	0.750	0.444	0.750	0.667	0.750	0.667	0.778	0.750
THY	0.875	0.875	0.889	1.000	0.889	1.000	0.889	0.889	1.000
UNITED	0.875	0.750	0.667	0.750	0.778	0.750	0.778	0.778	0.750
AEGEAN	0.875	1.000	0.556	1.000	0.889	1.000	1.000	0.889	1.000
AIR CANADA	0.875	0.875	0.778	0.750	0.778	0.750	0.778	0.778	0.750
AIR CHINA	0.750	0.750	0.556	0.750	0.667	0.875	0.778	0.778	0.750
AIR INDIA	0.875	0.875	0.556	0.750	0.667	0.875	0.667	0.778	0.750
AIR NEW ZEALAND	1.000	1.000	0.889	1.000	1.000	1.000	1.000	1.000	1.000
ALL NIPPON AIRWAYS	1.000	1.000	0.889	1.000	1.000	1.000	1.000	0.889	1.000
ASIANA AIRLINES	1.000	1.000	0.778	1.000	0.889	1.000	0.889	0.889	1.000
AUSTRIAN	0.875	0.875	0.667	0.875	0.889	0.875	0.889	0.889	0.875
AVIANCA	0.875	0.875	0.889	0.875	0.889	0.875	0.889	0.889	0.875
BRUSSELS AIRLINES	0.875	0.875	0.556	0.750	0.778	0.875	0.889	0.778	0.750
COPA AIRLINES	0.875	0.875	0.778	0.875	0.889	0.875	0.889	0.889	0.875
CROATIA AIRLINES	0.875	0.875	0.444	0.875	0.778	0.875	0.889	0.778	0.750
EGYPTAIR	0.875	0.875	0.556	0.750	0.778	0.875	0.778	0.778	0.750
ETHIOPIAN	0.875	0.875	0.667	0.750	0.778	0.875	0.778	0.778	0.875
EVA AIR	1.000	1.000	0.889	1.000	1.000	1.000	1.000	1.000	1.000
LOT POLISH AIRLINES	0.875	0.875	0.556	0.750	0.778	0.875	0.889	0.778	0.750
LUFTHANSA	0.875	0.875	0.778	0.875	0.889	0.875	0.889	0.889	0.875
SAS	0.875	0.875	0.556	0.875	0.778	0.875	0.889	0.889	0.750
SHENZHEN AIRLINES	0.875	0.875	0.556	0.750	0.778	0.875	0.778	0.778	0.750
SINGAPORE AIRLINES	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
SOUTH AFRICAN	0.875	0.875	0.667	0.750	0.778	0.875	0.889	0.778	0.875
SWISS	0.875	0.875	0.778	0.875	0.889	0.875	0.889	0.889	0.875
AIR PORTUGAL	0.750	0.750	0.556	0.750	0.778	0.750	0.778	0.778	0.750
THAI	1.000	1.000	0.778	1.000	0.889	1.000	0.889	0.889	1.000
AI	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

The next step is to weight the normalized matrix by multiplying all its values with the values of the criteria using Equation (11). The weighted normalized matrix is shown in Table 10.

Table 10. The Weighted Normalized Matrix

AIRLINES	LR	SC	IFE	OBE	CS	VM	CL	CHB	FB
AAI	0.034	0.043	0.158	0.091	0.066	0.046	0.052	0.048	0.091
THY	0.039	0.050	0.315	0.121	0.088	0.061	0.070	0.055	0.121
UNITED	0.039	0.043	0.236	0.091	0.077	0.046	0.061	0.048	0.091
AEGEAN	0.039	0.057	0.197	0.121	0.088	0.061	0.079	0.055	0.121
AIR CANADA	0.039	0.050	0.276	0.091	0.077	0.046	0.061	0.048	0.091
AIR CHINA	0.034	0.043	0.197	0.091	0.066	0.053	0.061	0.048	0.091
AIR INDIA	0.039	0.050	0.197	0.091	0.066	0.053	0.052	0.048	0.091
AIR NEW ZEALAND	0.045	0.057	0.315	0.121	0.099	0.061	0.079	0.062	0.121
ALL NIPPON AIRWAYS	0.045	0.057	0.315	0.121	0.099	0.061	0.079	0.055	0.121
ASIANA AIRLINES	0.045	0.057	0.276	0.121	0.088	0.061	0.070	0.055	0.121
AUSTRIAN	0.039	0.050	0.236	0.106	0.088	0.053	0.070	0.055	0.106
AVIANCA	0.039	0.050	0.315	0.106	0.088	0.053	0.070	0.055	0.106
BRUSSELS AIRLINES	0.039	0.050	0.197	0.091	0.077	0.053	0.070	0.048	0.091
COPA AIRLINES	0.039	0.050	0.276	0.106	0.088	0.053	0.070	0.055	0.106
CROATIA AIRLINES	0.039	0.050	0.158	0.106	0.077	0.053	0.070	0.048	0.091
EGYPTAIR	0.039	0.050	0.197	0.091	0.077	0.053	0.061	0.048	0.091
ETHIOPIAN	0.039	0.050	0.236	0.091	0.077	0.053	0.061	0.048	0.106
EVA AIR	0.045	0.057	0.315	0.121	0.099	0.061	0.079	0.062	0.121
LOT POLISH AIRLINES	0.039	0.050	0.197	0.091	0.077	0.053	0.070	0.048	0.091
LUFTHANSA	0.039	0.050	0.276	0.106	0.088	0.053	0.070	0.055	0.106
SAS	0.039	0.050	0.197	0.106	0.077	0.053	0.070	0.055	0.091
SHENZHEN AIRLINES	0.039	0.050	0.197	0.091	0.077	0.053	0.061	0.048	0.091
SINGAPORE AIRLINES	0.045	0.057	0.355	0.121	0.099	0.061	0.079	0.062	0.121
SOUTH AFRICAN	0.039	0.050	0.236	0.091	0.077	0.053	0.070	0.048	0.106
SWISS	0.039	0.050	0.276	0.106	0.088	0.053	0.070	0.055	0.106
AIR PORTUGAL	0.034	0.043	0.197	0.091	0.077	0.046	0.061	0.048	0.091
THAI	0.045	0.057	0.276	0.121	0.088	0.061	0.070	0.055	0.121
AI	0.045	0.057	0.355	0.121	0.099	0.061	0.079	0.062	0.121

Equations (12), (13), and (14) are utilized to perform the necessary calculations for the final step. The last step involves determining the utility function using Equations (15), (16), and (17), and creating a ranking accordingly. The best alternative is selected based on the most significant utility function value. When considering all relevant criteria, Table 11 reveals the best airline company. Accordingly, Singapore Airlines emerges as the best airline, while Air China has the lowest value in the ranking according to the utility function.

Table 11. Ranking of Alternatives According to the Utility Function

AIRLINES	Si	Ki-	Ki+	f(K-)	f(K+)	f(Ki)	Rank
AAI	0.629						
THY	0.921	1.466	0.921	0.386	0.614	0.741	5
UNITED	0.733	1.166	0.733	0.386	0.614	0.590	18
AEGEAN	0.819	1.303	0.819	0.386	0.614	0.659	12
AIR CANADA	0.779	1.240	0.779	0.386	0.614	0.627	14
AIR CHINA	0.684	1.089	0.684	0.386	0.614	0.551	26
AIR INDIA	0.688	1.095	0.688	0.386	0.614	0.554	24
AIR NEW ZEALAND	0.961	1.528	0.961	0.386	0.614	0.773	2
ALL NIPPON AIRWAYS	0.954	1.517	0.954	0.386	0.614	0.767	4
ASIANA AIRLINES	0.895	1.423	0.895	0.386	0.614	0.720	6
AUSTRIAN	0.804	1.280	0.804	0.386	0.614	0.647	13
AVIANCA	0.883	1.405	0.883	0.386	0.614	0.711	8
BRUSSELS AIRLINES	0.717	1.140	0.717	0.386	0.614	0.577	19
COPA AIRLINES	0.844	1.342	0.844	0.386	0.614	0.679	9
CROATIA AIRLINES	0.693	1.102	0.693	0.386	0.614	0.557	23
EGYPTAIR	0.708	1.126	0.708	0.386	0.614	0.570	21
ETHIOPIAN	0.763	1.213	0.763	0.386	0.614	0.614	16
EVA AIR	0.961	1.528	0.961	0.386	0.614	0.773	3
LOT POLISH AIRLINES	0.717	1.140	0.717	0.386	0.614	0.577	19
LUFTHANSA	0.844	1.342	0.844	0.386	0.614	0.679	9
SAS	0.739	1.175	0.739	0.386	0.614	0.595	17
SHENZHEN AIRLINES	0.708	1.126	0.708	0.386	0.614	0.570	21
SINGAPORE AIRLINES	1.000	1.591	1.000	0.386	0.614	0.805	1
SOUTH AFRICAN	0.771	1.227	0.771	0.386	0.614	0.621	15
SWISS	0.844	1.342	0.844	0.386	0.614	0.679	9
AIR PORTUGAL	0.688	1.094	0.688	0.386	0.614	0.553	25
THAI	0.895	1.423	0.895	0.386	0.614	0.720	6
AI	1.000						

5. Discussion

The airline transportation system, considering the diversity of services and facilities offered, is quite complex. High service quality positively influences customer satisfaction and consequently their loyalty. Loyal customers tend to have stronger intentions for repeat purchases. Therefore, in today's competitive market, businesses need to measure customers' perception of service quality to deliver better service (Ghotbabadi, Feiz, & Baharun, 2015). According to Bari et al. (2001), the key factor for success is to maintain high levels of service quality and sustain this level. Failures result in service dissatisfaction. Accordingly, based on data from 2023, this study aims to examine the perception of service quality among airlines operating under the Star Alliance, the world's largest airline alliance, using multi-criteria decision-making (MCDM) methods known as Entropy and MARCOS. For this purpose, data on quality from TripAdvisor were collected for 26 airline companies under the Star Alliance umbrella. Subsequently, these airlines were ranked based on quality data using the Entropy and MARCOS methods. The criteria analyzed include legroom, seat comfort, in-flight entertainment, onboard experience, customer service, value for money, cleanliness, check-in and boarding, and food and beverage.

Upon initial analysis, it was determined that according to the weighting process conducted with the Entropy method, the most important evaluation criterion is the in-flight entertainment systems (Wi-Fi, TV, movies) (0.355), followed by the in-flight experience (0.121) and the quality of food and beverages (0.121), which are equally important. In-flight communication systems are particularly important for full cost carrier airlines offering different segments such as first and business class, especially in the application of smart cabins (Jin & Kim, 2022). Similar studies conducted from past to present have also highlighted the role of in-flight entertainment in influencing passengers' perceptions of service quality (Alamdari, 1999; Francis, Dennis, Ison, & Humphreys, 2007; Liu , 2007; Atalık, Bakır, & Akan, 2019; John, 2022; Li, Jing, & Zhu , 2024).It is believed that the presence of series, movies, etc., in the in-flight entertainment systems with subtitles in the languages of the countries flown to, and the presence of programs specific to the country's own culture, will result in positive experiences for customers during the flight. Additionally, including alternatives from the cuisines of the countries in the catering services is expected to increase the perception of service quality among customers from those countries. Furthermore, customer service (0.099), cleanliness (0.079), check-in and boarding (0.062), value for money (0.061), seat comfort (0.057), and legroom (0.045) criteria follow in descending order. It can be said that legroom and seat comfort emerged as the least important criteria for passengers participating in the scoring process. Curtis, Rhoades & Waguespack (2012) examined satisfaction with service quality in airlines and found that seat comfort and legroom were related to the frequency of flying. Frequent flyers are more affected by these features, whereas occasional flyers may be less influenced by them. Considering that this study is based on TripAdvisor data from passengers who have flown at least once, a similar situation is likely. That is, since most of the passengers rating the service are not frequent flyers, they may place less importance on in-flight seat comfort and legroom.

Subsequently, based on the results of the MARCOS method, the airlines with the best performance were determined using the relevant criteria. Among the 26 airlines examined, Singapore Airlines was found to exhibit the best performance. This finding aligns closely with Skytrax[1] user evaluations in 2023, where Singapore Airlines was selected as the world's best airline, reflecting the similarity of the study's results. Following Singapore Airlines, Air New Zealand ranked second and Eva Air ranked third. It is noteworthy that Turkish Airlines ranked fifth, representing Turkey. Turkish Airlines' position can be attributed to its reputation as one of the airlines with the best catering services globally, which has contributed to its high standing in terms of quality perception. Additionally, in the APEX[2] passenger assessment in 2023, Turkish Airlines was awarded for the best in-flight entertainment and the best food and beverage services.

In conclusion, since one of the member airline companies of Star Alliance is Turkish Airlines operating in Turkey, it is thought that the results of the study will contribute to national theory and practice as well as being an international indicator. However, there are some limitations with this contribution. The primary constraint was that the study evaluated 26 airline companies that are members of Star Alliance, the world's largest alliance. Airlines belonging to other alliances such as Oneworld and SkyTeam were not included in the study. Furthermore, the data analyzed only reflected the evaluations of airline users on Tripadvisor, and only 9 evaluation criteria were considered in the study, which constituted additional limitations. Despite these constraints, the study is expected to contribute to the literature by analyzing the service quality of relevant airline companies using integrated methods and serve as a guiding reference for future research. It is anticipated that future studies with broader samples, the inclusion or utilization of different MCDM methods, will lead to significant progress in the literature.

Ethical approval

Not applicable.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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[1] Skytrax established in 1989, the international air transport rating organisation, based in London, UK.

[2] The Airline Passenger Experience Association

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