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Benchmarking customer satisfaction levels of airline companies: An entropy-grey relational analysis approach

Havayolu şirketlerinin müşteri memnuniyeti düzeylerinin kıyaslanması: Entropi-gri ilişkisel analiz yaklaşımı

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ABSTRACT

The transportation sector plays a critical role in facilitating tourism movements. Airline operators must adapt to the evolving market dynamics and gain a competitive edge by meeting passenger expectations. However, the persistent challenges of delivering excellent service quality and achieving high customer satisfaction levels persist. Assessing service quality and customer satisfaction is crucial for airlines to maintain a competitive advantage. Comparing the service quality levels of airline companies with competitors allows for the identification of the company's strengths and weaknesses. In this way, airlines can enhance their customer-oriented service approach, gain a competitive advantage, and take strategic steps to maintain their leadership position in the industry. Multi-criteria decision-making methods are effective in managing decision making by considering various criteria or factors. Previous research has shown a limited number of studies employing multi-criteria decision-making methods to compare the customer satisfaction levels of airline companies. This study aims to compare the customer satisfaction levels of twenty international full-service airline companies and determine the importance level of the criteria influencing customer satisfaction. In this context, entropy and grey relational analysis methods were used. The study concludes that the most critical factors influencing the customer satisfaction of airline companies include flight comfort, legroom, and food and beverage service.

ÖZET

Ulaştırma sektörü turizm hareketlerinin kolaylaştırılmasında kritik bir rol oynamaktadır. Havayolu işletmeleri, gelişen pazar dinamiklerine uyum sağlamalı ve yolcu beklentilerini karşılayarak rekabet avantajı elde etmelidir. Ancak mükemmel hizmet kalitesi sunmanın ve yüksek müşteri memnuniyeti düzeylerine ulaşmanın çeşitli zorlukları devam etmektedir. Hizmet kalitesinin ve müşteri memnuniyetinin değerlendirilmesi, havayollarının rekabet avantajını sürdürmesi açısından çok önemlidir. Havayolu şirketlerinin hizmet kalitesi seviyelerinin rakiplerle kıyaslanması, işletmenin güçlü ve zayıf yönlerinin belirlenmesine olanak tanır. Bu sayede havayolu firmaları, müşteri odaklı hizmet anlayışlarını geliştirerek rekabet avantajı elde edebilir ve sektördeki lider konumlarını koruma yolunda stratejik adımlar atabilirler. Çok kriterli karar verme yöntemleri, çeşitli kriterleri veya faktörleri dikkate alarak karar verme sürecinin yönetilmesinde etkilidir. Geçmiş çalışmalar incelendiğinde havayolu şirketlerinin müşteri memnuniyet düzeylerini karşılaştırmak için çok kriterli karar verme yöntemlerinin nadiren kullanıldığı görülmüştür. Bu çalışmanın amacı, yirmi uluslararası tam hizmet sunan havayolu şirketinin müşteri memnuniyet düzeylerini karşılaştırmak ve müşteri memnuniyetini etkileyen kriterlerin önem seviyelerini belirlemektir. Bu bağlamda entropi ve gri ilişkisel analiz yöntemleri kullanılmıştır. Araştırmada havayolu şirketlerinin müşteri memnuniyetini etkileyen en önemli kriterlerin uçuş konforu, bacak mesafesi ve yiyecek-içecek hizmeti olduğu sonucuna varılmıştır.

1. Introduction

The tourism industry encompasses various activities, including transportation, gastronomy, accommodation, cultural exchange, and recreation. The essence of tourism is rooted in mobility, thus requiring the provision of transportation services to facilitate arrivals and departures at destinations. The fundamental aspect of tourism revolves around movement, requiring transportation for travellers to arrive at and depart from their destinations. Air transportation, in particular, plays a significant role in enabling long-distance travel and diverse forms of tourism (Bieger & Wittmer, 2006). Infrastructure and services in transportation are critical determinants of tourism demand, with developments such as

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new bridges, highways, or airports often stimulating demand (Middleton & Clarke, 2009:60). Air connectivity and transport services are vital for facilitating travel between countries (Prideaux, 2000).

Airline business models can be divided into different categories, such as low-cost, full-service, and charter. Full-service airline companies offer various service classes, including economy and business class. Accordingly, they provide diverse services such as different seat sizes, luxury food and beverage options, and in-cabin entertainment (Mutlu & Sertoğlu, 2018). Full-service airlines are integral to the air transportation industry because they offer comprehensive flight networks, cater to various customer needs with multiple service classes, and provide a wide range of amenities and services that enhance passenger comfort and satisfaction. This versatility allows them to serve both business and leisure travelers effectively, contributing to global connectivity and the overall growth of the aviation sector.

The air transportation industry is dynamic, with passenger expectations continually evolving. These changes create new market opportunities and intensify competition. To gain a competitive edge, airline companies must comprehend evolving market dynamics and meet passenger expectations to ensure satisfaction (Okumuş & Asil, 2007). A customer-centric approach and adaptability to changing demands are critical for airline success. In a fiercely competitive aviation industry, the survival and long-term success of airline companies hinge on converting passengers into loyal customers (Kazançoğlu, 2011). It is known that it is more profitable for companies to retain existing customers than to acquire new customers to replace lost ones (Hussain, Al Nasser & Hussain, 2014). Satisfying passengers is not merely an option but a means to create sustainable competitive advantages that allow airlines to retain customers (Yılmaz Uz & Özer Canarslan, 2019).

Corporate image and perceived service quality are pivotal in fostering customer loyalty (Chen & Liu, 2017; Kijpanjasub & Jitkuekul, 2019). By cultivating a strong corporate image and enhancing service quality, airlines can establish enduring customer relationships and thus gain a competitive advantage. The contemporary service industry faces the challenge of maintaining high service quality and customer satisfaction amidst evolving expectations and heightened competition (Hung et al., 2003). Airlines gauge customer satisfaction levels to enhance service quality and benchmark against competitors. Customer complaints, survey research, and feedback are noteworthy in evaluating service quality and customer satisfaction. In particular, comments and reviews on various forums or websites serve as valuable secondary data sources.

The phenomenon of consumers sharing their attitudes and behaviours over the Internet is referred to as electronic word-of-mouth communication (E-WOM) (Lee & Hu, 2005). E-WOM is a communication practice where individuals who do not know each other exchange various topics and comments in a virtual environment through different channels and methods (Sarıışık & Özbay, 2012). Nowadays, data on websites such as Google, YouTube, Facebook, and web forums are essential for businesses to gauge customer satisfaction and address complaints. Individuals willing to voice their opinions about brands share and disseminate comments through chat rooms, news groups, and electronic consumer forums (Gelb & Sundaram, 2002). TripAdvisor serves as a significant source of secondary data due to its abundance of comments and evaluations of airline companies.

While past studies have predominantly relied on surveys and scales to assess customer satisfaction and service quality, multi-criteria decision-making methods offer convenient and effective alternatives for analyzing secondary data. However, studies using secondary data and multi-criteria decision-making methods to evaluate airline service quality and customer satisfaction are limited. This research aims to compare customer satisfaction levels among leading full-service airlines by utilizing the multi-criteria decision-making method. The study entails collecting secondary data from tripadvisor.com in the first phase, which is then weighted using the entropy method to determine the significance of criteria influencing customer satisfaction in airlines. Subsequently, according to the determined criteria weights, the grey relational analysis method was used to compare customer satisfaction levels to rank the airlines.

The second section of the study comprises a literature review, encompassing previous studies focused on assessing and comparing service quality and customer satisfaction levels. The third section elucidates the research methodologies, detailing the application steps of entropy and grey relational analysis methods. The fourth part entails the application steps and findings, while the fifth chapter discusses the research outcomes and limitations.

2. Literature Review

2.1. Customer Satisfaction and Service Quality in Airline Industry

As customer satisfaction has become vital in airline operations and competition has intensified, service quality has received increasing attention in the airline industry (David, 2013). With growing competition among airlines, delivering exceptional service has become essential for businesses. Today, outstanding service quality and achieving high customer satisfaction are among the top priorities and challenges in the service sector (Hung et al., 2003).

Determining the service quality levels of airlines and comparing customer satisfaction levels have been carried out using different methods in past studies. SERVQUAL (Parasuraman et al., 1988) stands out as one of the best models for evaluating customers' expectations and perceptions. Customers assess service quality in this model by discerning any gap between their expectations and perceptions. The SERVQUAL scale comprises five dimensions: Physical Characteristics, Reliability, Responsiveness, Trust, and Empathy, respectively. In past research, this method has been frequently implemented to measure airline service quality. For example, Ataman, Behram, and Sedat (2011) focused on measuring and evaluating Turkish Airlines' service quality in the business airline market. For this purpose, they evaluated passengers' perceptions and expectations regarding service quality using the SERVQUAL model. According to the research results, the dimension of service quality with the

lowest perception-expectation difference in Turkish Airlines' business airline market was physical characteristics, while the highest difference was observed in the reliability dimension. Based on these findings, it was emphasized that the company should make improvements in the reliability dimension. Another study conducted by Hatipoğlu and Işık (2015) intended to determine the domestic customer profile of AnadoluJet Airline and measure its service quality. In this regard, a survey prepared within the SERVQUAL quality measurement model framework was administered to AnadoluJet's domestic passengers. The gap analysis based on the survey results shows that AnadoluJet has high expectations but low perception in terms of customer satisfaction. These results indicate that the company has shortcomings in meeting customer expectations in specific service areas and that improvements need to be made in these areas (Hatipoğlu & Işık, 2015).

In the research conducted by Pekkaya and Akıllı (2013), the service quality evaluations of passengers from eight airline companies operating in Türkiye and their prioritized service quality dimensions were examined. In this context, five dimensions in the SERVPERF/SERVQUAL scale were measured through surveys. According to the research results, while customer dissatisfaction was notably observed in the enthusiasm dimension, customers were generally satisfied with other dimensions. In his study, İbik (2006) sought to evaluate the service quality of a private airline operating domestic routes using the SERVQUAL model. According to the research results, passengers particularly emphasized the assurance and reliability dimensions, with physical elements deemed less significant. Additionally, differences in quality expectations among passengers from different provinces were observed. DU et al. (2012) conducted research to determine service variables in the Nigerian air transport industry and evaluate the service quality of a Nigerian airline company. Data were analyzed using the SERVQUAL model to determine their satisfaction with Aerocotractors airline services. The results revealed that the airline offered good service quality in terms of empathy, responsiveness, and technical aspects of its services. However, improvements were needed in reliability and tangible dimensions, with an overall poor service level observed. In this context, airline managers are recommended to enhance service levels and conduct regular performance surveys with their customers.

Abdel Rady (2018) applied the AIRQUAL methodology inspired by SERVQUAL. In his study, he sought to evaluate the effect of service quality at Egypt Airlines on passenger satisfaction. The research examined five dimensions of airline services, determining passengers' satisfaction levels. According to the research results, the dimensions that had the most significant impact on Egypt Airlines' service quality were empathy and responsiveness. However, the need for improvement in terms of reliability and tangible elements was identified. Passengers' perception of service quality shapes the airline's image and influences repeat customer choice. In some studies, the SERVQUAL method was applied by weighting. For example, Chou et al. (2011) intended to evaluate the service quality of Taiwanese airlines using the fuzzy weighted SERVQUAL model. Comparing customer expectations and perceptions, the most significant service quality gaps identified were comfort and cleanliness of seats, food and beverage quality, handling of customer complaints, security, crew's approach to unexpected situations, aircraft size, availability of flight times, handling of delays, on-time departure and arrival, and in-flight entertainment opportunities and programs.

2.2. Multi-Criteria Decision Making Methods in Service Quality Evaluation

Multi-criteria decision-making methods are utilized to compare customer satisfaction levels with the services offered by airlines or to assess the service quality of airlines. The general process of multi-criteria decision-making encompasses six basic steps: (1) defining the problem, (2) determining requirements, (3) establishing objectives, (4) identifying alternatives, (5) developing evaluation criteria, and (6) selecting and applying the decision-making technique (Demidovskij, 2020). Multi-criteria decision-making methods have been frequently used to decision problems in various fields of tourism. Studies on the assessment of mountain tourism sustainability (Xu et al., 2023), evaluation of cultural sites (Stević et al., 2019), and prioritization of the barriers to tourism growth in rural (Jena et al., 2023) can be given as examples.

In past studies, various multi-criteria decision-making methods have been employed to evaluate airline service quality. For instance, Ardil (2021) applied the preference analysis for reference ideal solution (PARIS), and the technique for order preference by similarity to ideal solution (TOPSIS) approaches to assess airline quality. Criteria, including on-time arrivals, lost luggage, involuntary denied boardings, and consumer complaints, were evaluated in this study, with criterion weights determined using the entropy method. In another study, Ghorabaee et al. (2017) proposed a hybrid simulation-based assignment approach to evaluate airlines based on service quality criteria. The evaluation involved five airline companies and was based on the opinions of 58 experts across 28 criteria. A probability distribution was adopted to model the opinions of decision-makers, and a stochastic decision matrix was created. Multi-criteria decision-making methods were then employed to evaluate the alternatives in a simulation process.

Chang and Yeh (2001) provided an objective assessment of airline competitiveness. The evaluation problem was formulated as a multi-attribute decision-making model, and the multi-attribute value theory was solved using the simple additive weighting method, the weighted multiplication method, and the technique for order preference by similarity to the ideal solution. Five competitiveness dimensions and their associated objective performance measures were identified to measure and compare the overall competitiveness of Taiwan's five major domestic airlines in terms of effectiveness and efficiency. The simple additive weighting method was suggested for use based on empirical verification.

The Analytical Hierarchy Process (AHP) is another frequently used multi-criteria decision-making method for evaluating the service quality performance of airlines. Singh (2016) concentrated on evaluating the service quality performance of

domestic full-service airlines in India through a framework based on the Analytic Hierarchy Process (AHP). A competitive service quality gap analysis was conducted to evaluate and compare the strengths and weaknesses of the focal company determined according to the AHP results against its competitors. Assurance emerged as the most significant criterion, with security identified as the most critical sub-criterion, followed by on-time performance, services performed correctly the first time, and the recovery process for delayed or lost baggage. Bakır & Atalık (2021) conducted a study to evaluate e-service quality in the airline industry from the consumers' perspective, proposing an integrated Fuzzy Analytic Hierarchy Process (F-AHP) and Fuzzy Measurement Alternatives and Ranking by Consensus Solution (F-MARCOS) approach. The three most vital e-service criteria were determined as reliability, understandability, and security. Mimovic (2018) used the AHP method to evaluate the service quality of Middle Eastern airlines, determining that seat comfort and staff courtesy were the most critical factors. Airline companies were compared by considering the determined criteria weights, with Etihad Airways determined to have higher ratings than other airlines.

Secondary data play a crucial role due to their low cost and potential to provide broader information than primary data sources. Past studies have indicated that electronic word-of-mouth (e-WOM) has a direct effect on ticket purchasing intention (Hassan et al., 2020). TripAdvisor is a significant online platform providing travellers with helpful reviews of hotels, restaurants, and attractions. Various studies have obtained essential findings regarding the services, quality, and customer satisfaction offered by airlines using Tripadvisor data as a secondary source. For example, Bakır (2019) evaluated the customer satisfaction level of leading airlines operating in Europe using electronic consumer experiences on the Tripadvisor website as a secondary data source. SWARA and MABAC methods were employed in an integrated manner to determine criterion weights and evaluate airline companies. The most essential criterion for customer satisfaction was found to be "value for money," while the least important criterion was "food and beverage." In another study, Brochado et al. (2019) analyzed comments about six airline companies shared by passengers on Tripadvisor using mixed content analysis to identify main themes associated with higher and lower value for money.

Although past research has primarily utilized surveys and scales to measure customer satisfaction and service quality, multi-criteria decision-making methods present a convenient alternative for analyzing secondary data. Nevertheless, there is a scarcity of studies that use these methods with secondary data to assess airline service quality and customer satisfaction, indicating a gap in the literature on this subject. The integrated use of entropy and grey relational analysis methods enables an objective comparison of customer satisfaction in airlines. In addition, by determining the criterion weights, the importance levels of the criteria that affect customer satisfaction performances in airlines can be determined. To the best of our knowledge, entropy and grey relational analysis methods have not yet been employed to assess airlines' service quality and customer satisfaction. This study seeks to fill the literature gap by comparing customer satisfaction levels based on online evaluations of leading companies in the industry.

3. Methods

The research utilized the entropy and grey relational analysis methods. The entropy method was employed to weigh the criteria determined within the research scope and ascertain their importance levels. The impact of the criteria on customer satisfaction performance was assessed using the entropy method. Additionally, the grey relational analysis method was used to compare the customer satisfaction levels of airline companies. This section explains the steps for applying the entropy and grey relational analysis methods.

3.1. Entropy Method

Weighting criteria using the Entropy Method involves assigning relative importance to each criterion based on its contribution to the overall decision-making process. The concept of information entropy was first introduced by Shannon, and the entropy method was adapted from thermodynamics to information systems (Dos Santos et al., 2019). Objective fixed weight methods rely on intrinsic knowledge of the indices to assign weights, aiming to eliminate human-made artefacts and provide results that more closely align with actual information. In information theory, Shannon's entropy measures the degree of disorder and demonstrates its relevance in evaluating system information. The smaller the entropy value, the less disordered the system is. The entropy method is an objective constant weighting method that relies on the amount of information to determine the weight of a criterion. The entropy method is applied as follows (Li et al., 2011):

Step 1: Creating the Decision Matrix

First, the decision matrix (D) is created as follows:

a_{ij} ,i. alternative j. value

$$D=\begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ a_{m1} & a_{m2} & \cdots & a_{mm} \end{bmatrix}$$

i=1,2,3…….,m and j =1,2,3…….,n (1)

Step 2: Normalization of the decision matrix

Equation (2) can be used to convert the attribute value of the criteria into "the utility criteria". For "the cost criteria," equation (3) transforms the attribute value of the criterion. (Li et al., 2011).

$$r_{ij} = \frac{a_{ij}}{max_j a_{ij}}$$

i=1,2,3…….,m and j =1,2,3…….,n (2)

$$r_{ij} = \frac{min_j a_{ij}}{a_{ij}}, \quad min_j a_{ij} \neq 0$$

i=1,2,3…….,m and j =1,2,3…….,n (3)

Step 3: Calculating the Entropy Values (e_{ij}) of the Criteria:

After the normalized matrices are obtained, entropy values (e_{ij}) are determined using Equations 4 and 5.

$$p_{ij} = \frac{a_{ij}}{\sum_{i=1}^{m} a_{ij}}$$

i=1,2,3…….,m and j =1,2,3…….,n (4)

$$e_{ij} = -(\ln m)^{-1} . \sum_{j=1}^{n} p_{ij} . \ln(p_{ij})$$

i=1,2,3…….,m and j =1,2,3…….,n (5)

Step 4: Calculation of Entropy Weights of Criteria (w_j):

Entropy weights are obtained by Equation 6.

$$w_j = \frac{(1-e_j)}{n-\sum_{j=1}^{m} e_j}$$

j =1,2,3…….,n (6)

3.2. Grey Relational Analysisi Method (GRA)

Grey system theory, first developed by Deng, is widely employed to solve uncertainty problems caused by a lack of information (Wu, 2002). This systems-oriented framework facilitates the study of prediction, relationship analysis, modelling, and decision-making in systems characterized by uncertainty or limited data (Tong & Wang, 2003). Grey Relational Analysis (GRA), a sub-methodology of grey systems theory, serves as an approach to assessing relationships. The term "grey relationship" refers to the measurement of the changing relationship between two systems or two different elements within the same system (Koçak & Özer, 2022). The method offers advantages in terms of simplicity and efficiency, especially in small datasets, and offers applicability to decision problems with complex structures (Yıldırım, 2015).

Step 1: In the first step, data is prepared and the decision matrix is created. Reference series (x_0) and compared series(Xi) are created. The compared series (Xi) is represented in the form of a matrix.

$$x_0 = (x_0(1), x_0(2), \ldots., x_0(j), \ldots., x_0(n))$$

i=1,2,3…….,m (7)

$$x_i = (x_i(1), x_i(2), \ldots., x_i(j), \ldots., x_i(n))$$

i=1,2,3…….,m (8)

$$X_i = \begin{bmatrix} x_1(1) & x_1(2) & \cdots & x_1(n) \\ x_2(1) & x_2(2) & \cdots & x_2(n) \\ \vdots & \vdots & \vdots & \vdots \\ x_n(1) & x_n(2) & \cdots & x_n(n) \end{bmatrix}$$

Step 2: Normalizing the decision matrix can be achieved using one of Equations 9, 10, or 11 depending on whether the criteria are categorized as benefit (larger-is-better), cost (smaller-is-better), or Desired Amount (DA) (if the criterion should ideally be close to DA) (Malekpoor et al., 2018).

Where $\max_j x_i(j)$ is the maximum value of entity j and $\min_j x_i(j)$ is the minimum value of entity j.

For larger-is-better transformation, $x_i(j)$ can be transformed to $x_i^*(j)$, the equation is defined as:

$$x_i^*(j) = \frac{x_i(j) - \min_j x_i(j)}{\max_j x_i(j) - \min_j x_i(j)},$$

i=1,2,3…….,m and j =1,2,3…….,n (9)

For smaller-is-better, the equation to transform $x_i(j)$ to $x_i^*(j)$ is

$$x_i^*(j) = \frac{\max_j x_i(j) - x_i(j)}{\max_j x_i(j) - \min_j x_i(j)},$$

i=1,2,3…….,m and j =1,2,3…….,n (10)

For nominal-is-best, if the target value is $x_{0b}(j)$ and $\max_j x_i(j)$ 3 $x_{0b}(j)$ 3 $\min_j x_i(j)$; then the equation is:

$$x_i^*(j) = \frac{|x_i(j) - x_{0b}(j)|}{\max_j x_i(j) - x_{0b}(j)},$$

i=1,2,3…….,m and j =1,2,3…….,n (11)

After the above procedures, the normalized decision matrix is created.

$$X_i^* = \begin{bmatrix} x_1^*(1) & x_1^*(2) & \ldots & x_1^*(n) \\ x_2^*(1) & x_2^*(2) & \ldots & x_2^*(n) \\ \vdots & \vdots & \vdots & \vdots \\ x_n^*(1) & x_n^*(2) & \ldots & x_n^*(n) \end{bmatrix}$$

(12)

Step 3: j. The distance $\Delta_{0i}(j)$, which is the absolute value of the difference between x_0^* and x_i^* at the point, is calculated. The formula is as follows:

$$\Delta_{0i}(j) = |x_0^*(j) - x_i^*(j)|$$

i=1,2,3…….,m and j =1,2,3…….,n (13)

$$= \begin{bmatrix} D_{01}(1) & D_{01}(2) & \ldots & D_{01}(n) \\ D_{02}(1) & D_{02}(2) & \ldots & D_{02}(n) \\ \vdots & \vdots & \vdots & \vdots \\ D_{0m}(1) & D_{0m}(2) & \ldots & D_{0m}(n) \end{bmatrix}$$

Step 4: Grey relational coefficients (GRC) are calculated using the following equation:

$$g_{0i}(j) = \frac{D\min + zD\max}{D_{0i}(j) + zD\max},$$

i=1,2,3…….,m and j =1,2,3…….,n (14)

$\max_i \max_j D_{0i}(j)$, $D\min = \min_i \min_j D_{0i}(j)$, and $z \in$ [0,1].

Step 5: Grey coefficient degrees are calculated (GCD). If the weights of the criteria (W_i(j)) are determined, the degree of the grey coefficient is calculated as follows:

$$G_{0i} = \sum_{j=1}^{n} [W_i(j) \cdot r_{0i}(j)]$$

i=1,2,3……,m and j =1,2,3……,n (15)

$D\max = \max_i \max_j D_{0i}(j)$, $D\min = \min_i \min_j D_{0i}(j)$, and $Z \in [0,1]$.

Step 5: Grey coefficient degrees are calculated (GCD). If the weights of the criteria (W_i(j)) are determined, the degree of the grey coefficient is calculated as follows:

$$G_{0i} = \sum_{j=1}^{n} [W_i(j) \cdot r_{0i}(j)]$$

i=1,2,3……,m and j =1,2,3……,n (15)

For decision-making processes, any alternative is the most important alternative if it has the highest G_{0i} value. Therefore, the priorities of the alternatives can be ranked according to their G_{0i} values.

4. Results

The research comprises two stages. Twenty airlines, identified among the best in the world by Skytrax, were compared within the research's framework based on the determined criteria and weights. Initially, criteria were weighted using the Entropy method to determine the significance levels reflecting the impact of these criteria on customer satisfaction performance. Criteria used in the study are Legroom (C1), Seat comfort (C2), In-flight entertainment (Wi-Fi, TV, movies) (C3), Onboard Experience (C4), Customer service (C5), Cleanliness (C6), Check-in and boarding (C7), Food and beverage services (C8). Data was obtained from tripadvisor.com and represents the mean scores given by customers between January 2016 and March 2024.

Table 1. Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8
Air France	3.5	3.5	3.5	3.5	3.5	4	3.5	3.5
ANA All Nippon Airways	4	4	4	4	4.5	4.5	4	4
British Airways	3.5	3.5	3	3	3.5	4	3.5	3
China Southern Airlines	3.5	3.5	3	3.5	3.5	5	3.5	3.5
Emirates	4	4	4.5	4	4	4.5	4.5	4
Etihad Airways	3.5	3.5	3.5	3.5	3.5	4	3.5	3.5
EVA Air	4	4	4	4	4.5	4.5	4.5	4
Finnair	3.5	3.5	3	3.5	4	4	4	3.5
Hainan Airlines	4	3.5	3.5	3.5	4	4	4	3.5
Japan Airlines	4	4	4	4	4.5	4.5	4.5	4
KLM Royal Dutch Airlines	3.5	3.5	3.5	4	4	4	4	3.5
Korean Air	4	4	4	4	4.5	4.5	4.5	4
Lufthansa	3.5	3.5	3.5	3.5	3.5	4	4	3.5
Qantas Airways	3.5	3.5	3.5	3.5	4	4	4	3.5
Qatar Airways	4	4	4	4	4	4.5	4	4
Singapore Airlines	4	4	4.5	4	4.5	4.5	4.5	4
Swiss International Air Lines	3.5	3.5	3.5	3.5	4	4	4	3.5
Turkish Airlines	3.5	3.5	4	4	4	4	4	4
Virgin Atlantic	4	4	4	4	4	4	4.5	4
Vistara	4	4	3	4	4	4.5	4	4

Source: *Created by author*.

In the application of the entropy method, the decision matrix was created first. The decision matrix is shown in Table 1.

After the decision matrix was created, the data were normalized. Since all criteria were determined as benefit criteria in the normalization process, Equation 2 was used. The normalized decision matrix is presented in Table 2.

Equations 4 and 5 were utilized to determine the Entropy Values of the Criteria. After establishing the entropy values, the entropy weights of the criteria were calculated using Equation 6. The criteria are listed according to their importance in Table 3.

Table 2. Normalized Decision Matrix

	C1	C2	C3	C4	C5	C6	C7	C8
Air France	0.875	0.875	0.778	0.875	0.778	0.800	0.778	0.875
ANA All Nippon Airways	1.000	1.000	0.889	1.000	1.000	0.900	0.889	1.000
British Airways	0.875	0.875	0.667	0.750	0.778	0.800	0.778	0.750
China Southern Airlines	0.875	0.875	0.667	0.875	0.778	1.000	0.778	0.875
Emirates	1.000	1.000	1.000	1.000	0.889	0.900	1.000	1.000
Etihad Airways	0.875	0.875	0.778	0.875	0.778	0.800	0.778	0.875
EVA Air	1.000	1.000	0.889	1.000	1.000	0.900	1.000	1.000
Finnair	0.875	0.875	0.667	0.875	0.889	0.800	0.889	0.875
Hainan Airlines	1.000	0.875	0.778	0.875	0.889	0.800	0.889	0.875
Japan Airlines	1.000	1.000	0.889	1.000	1.000	0.900	1.000	1.000
KLM Royal Dutch Airlines	0.875	0.875	0.778	1.000	0.889	0.800	0.889	0.875
Korean Air	1.000	1.000	0.889	1.000	1.000	0.900	1.000	1.000
Lufthansa	0.875	0.875	0.778	0.875	0.778	0.800	0.889	0.875
Qantas Airways	0.875	0.875	0.778	0.875	0.889	0.800	0.889	0.875
Qatar Airways	1.000	1.000	0.889	1.000	0.889	0.900	0.889	1.000
Singapore Airlines	1.000	1.000	1.000	1.000	1.000	0.900	1.000	1.000
Swiss International Air Lines	0.875	0.875	0.778	0.875	0.889	0.800	0.889	0.875
Turkish Airlines	0.875	0.875	0.889	1.000	0.889	0.800	0.889	1.000
Virgin Atlantic	1.000	1.000	0.889	1.000	0.889	0.800	1.000	1.000
Vistara	1.000	1.000	0.667	1.000	0.889	0.900	0.889	1.000

Source: *Created by author*.

According to the research results, seat comfort (0.1341) and legroom (0.1331) were determined as the two most important criteria affecting the performance of airlines. These criteria are followed by food and beverage (0.1329), onboarding experience (0.1319), cleanliness (0.1319), customer service (0.1221), and check-in and boarding (0.1207). The inflight entertainment (0.0933) criterion was determined as having the least impact on the customer satisfaction performance of airlines.

After determining the entropy weights, the grey relational analysis method was applied. Considering the decision matrix created and shown in Table 1, the reference series (x_0=4,4,4.5,4,4.5,5,4.5,4) was first created with the help of Equation 7. Then, since all criteria are utility criteria (larger is better), the decision matrix was normalized using Equation 9. The normalized decision matrix is presented in Table 4.

In the next stage, the distances between the reference series and normalized values were calculated using Equation 13. Once this value was obtained, grey relational coefficients (GRC) were determined by applying it in Equation 14. In the final stage, grey relational degrees (GRD) were computed using Equation 15, and airline companies were ranked based on their service quality and customer satisfaction levels.

The results of the grey relational analysis, displaying the grey relational degrees and rankings of airline companies, are presented in Table 5.

As a result of the research, Singapore Airlines was determined to have the highest service quality level. It has been found that Singapore Airlines' service quality level is significantly higher than that of most other airlines. Following Singapore Airlines are Eva Air, Japan Airlines, Korean Air, Emirates, and ANA All Nippon Airways, respectively. Qatar Airways and Vistara are companies with high customer satisfaction. Turkish Airlines, considered one of the well-known airlines in the world, ranks in the middle in terms of service quality level compared to other companies. Turkish Airlines is followed by Hainan Airlines, KLM Royal Dutch Airlines, China Southern Airlines, and Swiss International Air Lines. Finnair, Lufthansa, Air France, Etihad Airways, and British Airways were identified as businesses with lower service quality levels.

Table 3. Criterion Weights Table

Criteria	**Weights**
Seat comfort	0.1341
Legroom	0.1331
Food and Beverage	0.1329
Onboarding Experience	0.1319
Cleanliness	0.1319
Customer service	0.1221
Check-in and boarding	0.1207
Inflight entertainment (Wi-Fi, TV, movies)	0.0933

Source: *Created by author.*

5. Conclusion and Discussion

Transportation facilities and infrastructure greatly influence tourists' choices of tourism destinations. For airline companies to gain a competitive edge, understanding this evolving market and ensuring customer satisfaction by meeting passengers' expectations is essential (Okumuş & Asil, 2007). This study aims to determine the indicators that significantly impact customer satisfaction with airline companies and to compare the satisfaction levels among leading airlines. For this purpose, scores for eight different criteria for airline companies on TripAdvisor were collected. Initially, the entropy method was applied to objectively determine the weights of the criteria influencing customer satisfaction performance of airline companies. According to the results of the entropy method, the importance rankings of the criteria were established. The research findings identified seat comfort as the most critical criterion affecting customer satisfaction with airlines. According to Punel, Hassan, and Ermagun (2019), seat comfort is essential in evaluating the overall flight experience. Legroom was recognized as an additional significant factor affecting satisfaction. Previous studies have indicated that insufficient legroom is one of the most common factors contributing to discomfort or dissatisfaction (Sezgen, Mason, & Mayer, 2019). Additionally, Ban, Joung, and Kim

Table 4. Normalized Decision Matrix

	C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**
Reference Set	1	1	1	1	1	1	1	1
Air France	0	0	0,33	0,5	0	0	0	0,5
ANA All Nippon Airways	1	1	0,67	1	1	0,5	0,5	1
British Airways	0	0	0,00	0	0	0	0	0
China Southern Airlines	0	0	0,00	0,5	0	1	0	0,5
Emirates	1	1	1,00	1	0,5	0,5	1	1
Etihad Airways	0	0	0,33	0,5	0	0	0	0,5
EVA Air	1	1	0,67	1	1	0,5	1	1
Finnair	0	0	0,00	0,5	0,5	0	0,5	0,5
Hainan Airlines	1	0	0,33	0,5	0,5	0	0,5	0,5
Japan Airlines	1	1	0,67	1	1	0,5	1	1
KLM Royal Dutch Airlines	0	0	0,33	1	0,5	0	0,5	0,5
Korean Air	1	1	0,67	1	1	0,5	1	1
Lufthansa	0	0	0,33	0,5	0	0	0,5	0,5
Qantas Airways	0	0	0,33	0,5	0,5	0	0,5	0,5
Qatar Airways	1	1	0,67	1	0,5	0,5	0,5	1
Singapore Airlines	1	1	1,00	1	1	0,5	1	1
Swiss International Air Lines	0	0	0,33	0,5	0,5	0	0,5	0,5
Turkish Airlines	0	0	0,67	1	0,5	0	0,5	1
Virgin Atlantic	1	1	0,67	1	0,5	0	1	1
Vistara	1	1	0,00	1	0,5	0,5	<0,5	1

Source: *Created by author.*

Table 5. Grey Relational Analysis Results

Airlines Company	Grey Relational Degree	Rank	Airlines Company	Grey Relational Degree	Rank
Singapore Airlines	0.934	1	Hainan Airlines	0.516	11
EVA Air	0.897	2	KLM Royal Dutch Airlines	0.493	12
Japan Airlines	0.897	3	China Southern Airlines	0.465	13
Korean Air	0.897	4	Qantas Airways	0.427	14
Emirates	0.873	5	Swiss International Air Lines	0.427	15
ANA All Nippon Airways	0.836	6	Finnair	0.418	16
Virgin Atlantic	0.814	7	Lufthansa	0.406	17
Qatar Airways	0.775	8	Air France	0.386	18
Vistara	0.750	9	Etihad Airways	0.386	19
Turkish Airlines	0.575	10	British Airways	0.333	20

Source: *Created by author*.

(2019) corroborated in their research that 'legroom' is a significant dimension in airline seat comfort.

Food and beverage services are the third most important criterion affecting customer satisfaction performance. An and Noh (2009) stated that in-flight food service is an essential determinant of in-flight service. Food and beverage services offered during airline travel are a critical element that significantly affects the customer experience. Especially on long-haul flights, passengers' food and beverage needs should be taken into account. Providing a healthy and satisfying meal onboard can increase passengers' comfort and satisfaction. In addition, airline companies that offer quality and diverse menus can leave a positive impression on customers and gain a competitive advantage. Food and beverage options offered by airline companies shape the brand image. For example, Turkish Airlines promises to transform the flight experience into a restaurant experience by partnering with Do&Co, a company that provides high-quality food and beverage services to transportation companies. Chefs called flying chefs serve quality food to passengers. Singapore Airlines offers Premium economy passengers a menu consisting of over 200 types of appetizers, main courses, desserts, cheeses and crackers (Altcheck & Rains, 2024). These efforts to improve service quality demonstrate the impact of secondary services on brand image and customer satisfaction.

Cleanliness and onboard experience were also identified as highly significant criteria. Cleanliness is fundamental to maintaining health and hygiene standards, particularly in environments like airplanes that serve thousands of passengers. Cleanliness directly impacts passenger comfort and contentment, ultimately contributing to their overall satisfaction. Prioritizing passenger satisfaction often results in favorable recommendations being shared through word of mouth. In addition, a positive onboard experience enhances passenger comfort, enjoyment, and convenience during their journey, leading to higher satisfaction levels.

According to the research results, customer service and check-in and boarding criteria emerged as less important criteria. In the airline industry, customer service, check-in and boarding are critical elements that directly impact passengers' travel experience. Providing solutions to customer problems quickly increases passenger satisfaction and increases the likelihood of choosing them again. At the same time, friendly and helpful staff positively affects the travel experience of passengers and strengthens the airline's reputation. In addition, smooth check-in and boarding processes reduce passengers' pre-travel stress and enable them to use their time more efficiently. Having regular and organized boarding procedures ensures that the plane takes off on time and the flight runs smoothly.

After determining the criteria weights, the airlines were objectively ranked using the grey relational analysis method. Within the framework of eight criteria, Singapore Airlines has the highest level of customer satisfaction. Singapore Airlines is followed by EVA Air, Japan Airlines and Korean Airlines. Turkish Airlines ranks tenth in terms of customer satisfaction. Lufthansa, Air France, Etihad Airways and British Airways have lower customer satisfaction levels than other airlines.

In conclusion, the results of the study show that the entropy and grey relational analysis method, which has not been used in previous studies for airline comparison, is an appropriate and effective method for benchmarking service quality and customer satisfaction levels. Businesses can increase customer satisfaction by keeping the quality of in-flight services such as flight comfort, food services and cleaning high. The research results suggest that for airlines, being aware of these critical criteria for achieving customer satisfaction and improving service quality can help them gain a competitive advantage and maintain their leading position in the industry. Such analysis can contribute to the development of strategies focused on service quality and customer satisfaction in the airline industry.

5.1. Practical Imlications

The research results highlight the importance of customer satisfaction in the airline industry. It shows that airline companies need to develop various strategies to increase customer satisfaction. The high customer satisfaction levels of companies such as Singapore Airlines reveal their success in providing quality service and meeting customer needs. On the other hand, the fact that the customer satisfaction level of an internationally renowned airline company such as Turkish Airlines ranks tenth shows that they have the potential for improvement in this area. These results show that companies should improve service quality by taking customer feedback into account and focusing on customer satisfaction to gain a competitive advantage. In addition, the fact that customer satisfaction levels of major airline companies such as Lufthansa, Air France, Etihad Airways and British Airways are lower than others shows that these companies need to work to increase customer satisfaction.

5.2. Theorical Implications

In previous studies, airline companies' customer satisfaction and service quality were measured on various scales. The SERVQUAL scale (Parasuraman et al., 1988) is one of the

most widely utilized tools for measuring service quality. Meanwhile, some studies have compared companies' service quality using multi-criteria decision-making (MCDM) methods. For instance, Bakır (2019) applied MCDM methods to evaluate the service quality of low-cost airlines. However, the grey relational analysis method had not previously been employed to compare customer satisfaction levels among leading airline companies. The grey relational analysis method had not been used before to compare customer satisfaction levels of leading airline companies. This research shows that entropy and grey relational analyses are suitable tools for determining criterion weights and comparing customer satisfaction levels. In this way, this study contributes to the analysis of customer satisfaction and service quality in the airline industry by bringing a new perspective to the literature.

5.3. Limitations and Suggestions to Future Research

The research has certain limitations. First of all, it was restricted to 20 leading airline companies. In future studies, the proposed methods could be used to compare different companies, such as low-cost airlines. Low-cost airlines typically offer only a single class of service, high-density seating, few or low-cost services such as free food and beverage, and no connecting services (Pels, Njegovan & Behrens, 2009). Therefore, the criteria determining customer satisfaction performance in airlines with this business model may possess different weights and levels of importance. Another limitation is the criteria utilized in the research. Eight criteria on TripAdvisor were employed to gauge customer satisfaction levels. Different indicators could be used to assess airlines' service quality and customer satisfaction. Future studies could compare results using various secondary data sources.

Ethics Statement: Ethics committee approval was not obtained for this study as it did not require ethics committee approval. In case of detection of a contrary situation, TO&RE Journal has no responsibility, and all responsibility belongs to the author(s) of the study.

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Conflict of Interest: As the study has a single author, there is no conflict of interest.

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