

Quality assessment of airports-based on passengers' satisfaction

Patrik Hegyi and Bálint Csonka

Abstract— Along with handling ground services for airlines, airports have to improve customer services for passengers. Customer feedbacks give a good basis for identifying intervention areas; however, the importance of components affecting passenger satisfaction is often neglected. A survey was conducted to assess the extent to which the components influence satisfaction. Based on the answers, a weighting method was elaborated to support multicriteria analysis. According to the result, the proper passenger information and cleanliness were the most important on departure, and the cleanliness on the arrival side. The method was applied to determine the aggregated score of airports based on customer feedback. A sensitivity analysis was carried out with a focus on weighting functions. It was found that different function relationships have different effects on the final quality score and order of the airports.

Index Terms—airport, quality, evaluation method, passenger satisfaction

I. INTRODUCTION

SINCE the competition is increasing among airports and high-speed trains may provide an alternative for short flights, airports must keep their attractiveness to passengers. The impulses coming from the airport have a high impact on the whole transport quality. Therefore, airlines may choose other airports for their destinations if the airport quality does not meet their passengers' expectations. Moreover, low airport quality can lead to total disavowal from air transport because other alternatives are becoming more and more available. For example, high service quality night trains have become more popular in recent years.

During our paper, we give dedicated attention to passenger satisfaction at airports because it is the first part of their journey, and any good or bad impression can get a general effect on rating the whole journey.

The structure of the paper is the following: a brief overview of the relevant literature is given in Section II. In Section III. the survey is presented, and the answers are discussed. Based on the literature review and the survey results, the weighting

method is elaborated in Section IV. A case study including six airports was conducted to present the applicability of the method in Section V. Finally, the conclusion has been drawn.

II. LITERATURE REVIEW

There are several articles in the literature using multicriteria analysis to determine service quality of different services (e.g., [1], [2]), as well as to identify passengers' expectations towards them [3].

Some of them examines multicriteria assessment methods and components influencing the overall perception of airports (e.g., [4]–[9]) because the airport service quality influences the overall and business assessment of the airport [8] and the revealed relationships can help airports meet the needs of traveler's. It was found that the level of service affects the overall perception of the airport in both direct and indirect ways. It has been recognized that in many cases airport services are less important than airline services.

Papers in this field usually focus on a specific service in detail or evaluate the airport from a wider perspective. For example, smart, innovative, and integrated passenger information systems were examined at airports [10], [11]. A new benchmarking index was developed to evaluate the smartness of airports [12].

Other papers evaluated service quality using a wider perspective from a traveler's point of view. A questionnaire-based passenger satisfaction measurement has been carried out at Debrecen Airport in Hungary [13]–[16]. The survey shows that service providers have failed to meet the passenger service standard several times. It was stated that in the case of Debrecen Airport, the high standard is a key in attracting passengers from Budapest Airport. Furthermore, according to the results, the airport quality affects the tourist's opinion of the city.

According to a research paper, passengers' satisfaction was the highest at North and Southeast Asian airports, while North American airports had the lowest values [17]. People traveling alone gave higher scores than people traveling in pairs.

In another study, the most important for passengers were safety and security followed by waiting time, passenger information, cleanliness, accessibility, arrival services, and airport facilities [18].

Airports were also examined from the airlines' point of view [19]. The main results of the analysis showed that airlines' assessments of airports differ significantly depending on quality components and airports. This was interpreted as an

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important statistical finding because if each assessment were grouped, there was a minimal difference between airports, and they would not have been able to draw much from the data. It was noted that when assessing the quality of airports, airlines clearly see a trade-off between features.

Non-aeronautical components (e.g., parking areas, public transport) can also influence passengers' satisfactions [20], [21].

Service quality assessing and automation methods have been developed for airport ground handling companies [22]–[24]. The developed methods help decision-makers determine the appropriate development area, optimize ground handling operations, considering the needs of the airport. Ensuring the highest possible service level is important for ground handling companies. The quality of service also affects the judgment of the airline and the airport.

During the examination of the literature, we found that there is little research within Europe, and in many cases, the study of practical applicability and development opportunities lack. Furthermore, the comparison of various weight functions is missing and their effect on the aggregated quality is not revealed yet.

III. PASSENGER SATISFACTION SURVEY

We conducted a passenger satisfaction survey in a self-administered, closed questionnaire.

We set up a passenger-centric model (Fig. 1.) focusing on the contact with airport components (e.g., passenger information). The model was used to help us identify the components that influence the passengers' satisfaction.

A. Structure

The questions were divided into the following categories:

- General questions
- Departure questions
- Arrival questions
- Other comments

In the first group, respondents could answer general demographic questions (e.g., age group, gender, travel motivation) in a multiple-choice way.

In the second (departure) and third (arrival) question groups, they had to decide on components (i.e., shown in Figure 1.) to what extent they affect their satisfaction. Each component could be rated on a Likert-type scale. The answer

options and the assigned values are given in Table I.

TABLE I
VALUES OF ANSWER OPTIONS

Answer option	Value
Can't judge	-
Not important at all	1
Not important	2
Neutral	3
Important	4
Specifically important	5

The charging points component has been omitted as it is not yet fully developed at most airports, making it difficult for passengers who have not used or encountered it to judge its importance, leading to inconsistencies in the questionnaire replies. Thus, currently, we do not consider airports to be comparable in this respect. It was investigated only to give a basis for further investigation regarding innovative, smart airport functions.

B. Evaluation

The survey was open between 12.10.2021 and 22.10.2021. A total of 136 respondents participated in the survey and 121 of them were considered during data analysis. In the remaining 15 cases, inconsistencies and deficiencies were found, hence the answers were not considered. It is important to note that the results and findings presented below apply to the respondents and not to the general population.

Based on the responses, we found that the share of tourist/family trips is significant (89%), the number of people choosing a low-cost airline is high in all age groups ($\Sigma=73\%$), and that half of them (51%) use air travel between 1000 and 2000 km.

We found that most of the 5-point ratings at departure were for proper passenger information, low queuing time (speed of baggage drop-off and check-in, passenger security check, boarding), and cleanliness (restrooms and terminal).

There was no difference between waiting time, passenger information, and cleanliness upon arrival.

The least important component was the number of commercial and catering units on both sides. The low impact of commercial units may be because most respondents travel with a low-cost company and thus do not spend at the airport to minimize their costs.

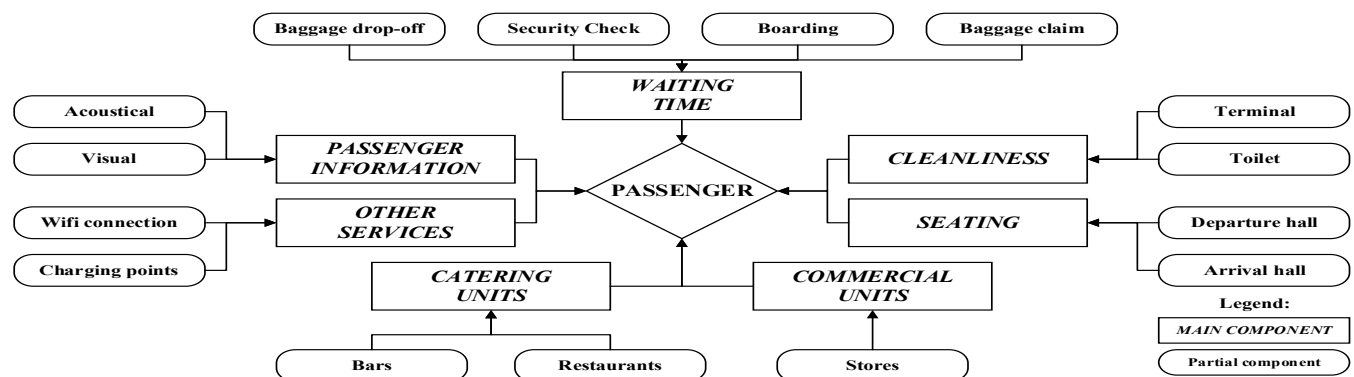


Fig.1. Passenger's connections with airport components

IV. METHODOLOGY

We have elaborated a weighting method to reflect the importance of components.

A. Weights of different groups

In the first step, the responses were grouped according to the model, and in the second step, components were assigned to the appropriate groups (Table II.).

TABLE II
COMPONENTS OF GROUPS

Group	Side	
	Departure	Arrival
Waiting time (WT)	Baggage drop; Security control; Boarding	Baggage claim
Cleanliness (CL)	Restroom; Terminal cleanliness	Restroom; Terminal cleanliness
Seating (ST)	Seating	Seating
Information (PI)	Information	Information
Catering (CT)	Catering units	Catering units
Commerce (CM)	Commercial units	Commercial units
Wi-Fi connection (WF)	Wi-Fi connection	Wi-Fi connection

In the third step, we determined the average of the preference values (Table III.).

TABLE III
AVERAGE SCORES OF GROUPS

		Departure	Arrival	Overall (g)
1.	WT	4.337	4.408	4.355
2.	CL	4.372	4.267	4.320
3.	ST	3.942	2.791	3.381
4.	PI	4.525	4.248	4.386
5.	CT	3.165	2.597	2.883
6.	CM	3.066	2.513	2.792
7.	WF	3.831	3.356	3.593

We found that the waiting time and cleanliness are equally important during departure and arrival. The biggest difference is shown by the number of seats, which is much more important during departure than during arrival. This may be because, in general passengers wait seated until the boarding. In contrast, this is not typical upon arrival.

The relationship between the average score and the weight

is described by a weight function. A key consideration in defining the functions was that the domain and codomain be divided proportionally by these functions.

The following weight functions were considered:

1. Linear
2. Power
3. Exponential
4. Logarithmic
5. Logistic

In each case, the 0-1 scale was used. The notations in each weight formula are the following:

- w_{ij} : weight, where i is the group index and j is the weighting technique index;
- g : average of each group.

1) Linear (1):

According to a linear distribution, weights from 0 to 1 were assigned to the scale from 1 to 5.

$$w_l = \frac{g - 1}{4} \quad (1)$$

2) Power (2):

In this case, we used a power function of x^4 .

$$w_p = \frac{g^4 - 1}{5^4 - 1} \quad (2)$$

3) Exponential (3):

In the exponential case, we used a 2^x function.

$$w_e = \frac{2^g - 2}{2^5 - 2} \quad (3)$$

4) Logarithmic (4):

A $\log_5$ distribution was used, as no correction is required in this case.

$$w_{lg} = \log_5 g \quad (4)$$

5) Logistic (5):

After replacing the various parameters with the corresponding values, the formula for this function relationship was obtained

$$w_{ls} = \frac{1}{1 + \exp(5 - 2g)} \quad (5)$$

The figures of the weighting functions are shown in Fig. 2. The curve of the linear function is situated below all other functions' curves. In opposite, the curve of the logarithmic functions passes over all of them in a part of the domain. The curve of the power and the linear function encloses the curve of the exponential function. The logistic function has a shape of an 'S' curve.

Power and exponential weight functions may be used to compare services based on the most important aspects. Namely, these functions focus on the evaluation of the base service. The logarithmic function reduces the difference between the weights and provides a more general evaluation of the service. It was also an aim to cover the area between the

extremums, logarithmic, and power functions, so the linear function was also considered.

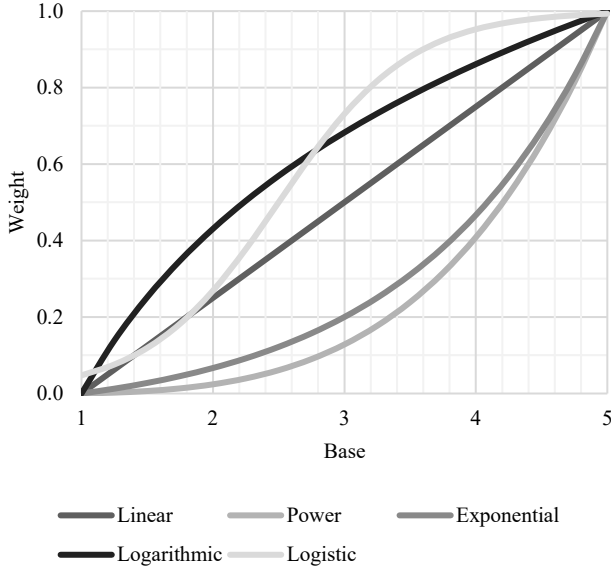


Fig. 2. Weight functions

Based on (1)-(5), we determined the weights for each group and converted them (6) so that their sum equal to one (Table IV.).

$$w'_{i,j} = \frac{w_{i,j}}{\sum_i w_{i,j}} \quad (6)$$

Based on the overall average, the most important component for passengers was the appropriate passenger information and the least important was the number of commercial units. Therefore, the passenger information (PI) component has the highest weight values, and the number of commercial units (CM) has the lowest ones.

TABLE IV
MODIFIED WEIGHT VALUES OF EACH GROUP

	g	w _i '	w _p '	w _e '	w _{lg} '	w _{ls} '
1. WT	4.355	0.179	0.239	0.219	0.164	0.163
2. CL	4.320	0.177	0.232	0.214	0.163	0.162
3. ST	3.381	0.127	0.087	0.100	0.135	0.142
4. PI	4.386	0.181	0.246	0.225	0.164	0.163
5. CT	2.883	0.101	0.045	0.064	0.118	0.114
6. CM	2.792	0.096	0.040	0.059	0.114	0.107
7. WF	3.593	0.139	0.111	0.120	0.142	0.150

V. CASE-STUDY

The applicability of the method is demonstrated through evaluations of airports.

The criteria for selecting airports were as follows

- be in Europe;
- the annual passenger traffic is between 10 and 20 million;

- one from each main European region (north, south, east, west, central);
- one from Hungary.

Based on these criteria, the following airports were selected:

1. Bucharest/Otopeni
2. Budapest/Ferenc Liszt
3. Catania/Fontanarossa
4. Cologne/Bonn
5. Helsinki/Vantaa
6. London/Luton

The locations of the selected airports are shown in Fig. 3.



Fig. 3. Location of studied airports

We used the passenger ratings at <https://www.airlinequality.com/> to evaluate the airports. Users can rate the staff, but this was not considered in the evaluation because there is staff from several companies, so it is difficult to determine which one the user is evaluating.

All components can be rated on a scale of 1-5. 1-point is the worst, and 5-point is the best score. The score means the goodness of the component.

For all six selected airports, we determined the average scores of the components (c_i) and then the aggregated airport score (Q_k) based on the weights ($w_{i,j}$ and $w'_{i,j}$) (6).

$$Q_k = \frac{\sum_i (w_{i,j} \cdot c_i)}{\sum_i w_{i,j}} = \sum_i (w'_{i,j} \cdot c_i) \quad (6)$$

These steps resulted in a final score for each airport, that are shown in Fig. 4.

The order of the airports in the weightless, logarithmic, and logistic cases is the same. In contrast, in the linear, power, and exponential cases, the relative order of the London and Bucharest airports changes. The reason for this change is that both airports have almost the same value, but the passenger information at Bucharest Airport received a 0.7 higher rating, and these weight functions magnified this discrepancy.

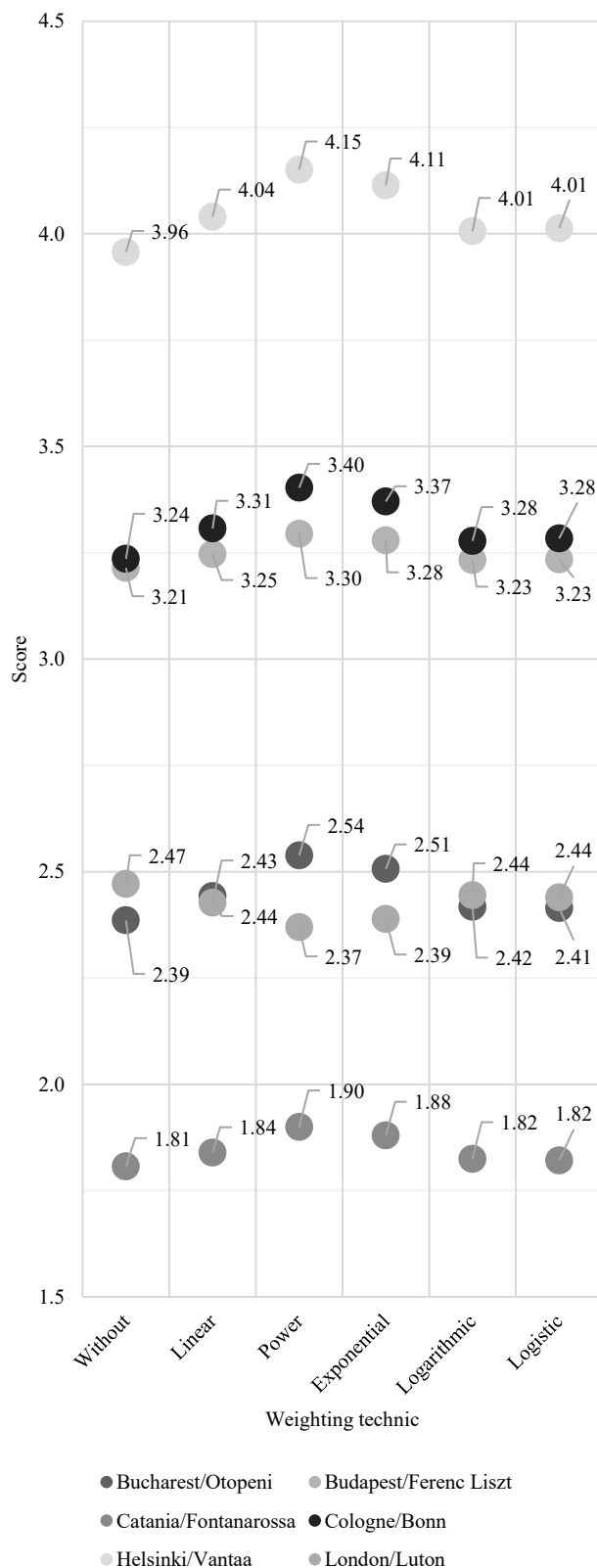


Fig. 4. Scores of studied airports

VI. CONCLUSION

Different airport components and services affect passengers' satisfaction in different ways. Most importantly, proper passenger information and short waiting times were important

for respondents.

The most important lesson learned from the survey is that the 'can't judge' answer option can lead to inconsistencies in processing, so it would be omitted in the future.

Due to different preferences, we developed and analyzed an airport evaluation method with several weighting techniques that can be applied universally to all airports.

The results give support to decision-makers: improvements can be ranked according to their impact on passenger satisfaction at airports, and their cost efficiency may be evaluated. Furthermore, airlines may compare airports based on their service quality.

The research was done in 2021 during the COVID-19 pandemic situation, which may have influenced travelers' behavior. Hence, we continue our research with a representative survey after the pandemic to get a clear picture of travelers' preferences. We also want to make a comparison of airports based on travelers' preferences and satisfactions. The set of evaluation aspects may be extended as well.

Other than that, in the future, we further break down individual components and elaborate an in-depth analysis of the departing, arriving, and transferring passenger preferences, the independent examination of the individual airport components and services to be expedient during further examinations.

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