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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

PERECEPTION BASED SYSTEMS FOR SERVICE QUALITY EVALUATION IN AIRLINES

Speciality: 3338.01 - "System analysis, management and information processing (management and decision making)

Field of science: Technical

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GENERAL DESCRIPTION OF RESEARCH

The relevance of the topic and level of research. High quality and reliable functioning of civil air transport contributes to the compehensive development of the economy of any country and it is one of the important indicators of the quality of people life. Nowadays, the civil air transportation sector of the economy is characterized by excessively fierce competition, especially in the provision of services both directly at airports and during flights. At the same time, the quality of passenger transportation services should meet the constantly growing requirements of consumers to the maximum extent.

Information support for effective management and the development of operational technologies to improve the quality of service that fully meets the requirements of air passengers requires the use of new scientifically based (innovative) approaches to ensure the permanent growth of the airline's competitiveness based on a multi-criteria assessment of the level of customer service quality. Based on the analysis of the subject area, we came to the conclusion that one of these approaches is the expert-fuzzy analysis of relevant data, which provides the solution of weakly structured problems and describes the behavior of a similar system of a humanistic type.

An analysis of the main directions in the study of the air transportation market indicates that in the country practice there is not enough developed methodology for assessing the levels of service quality for air passengers, which would adequately correspond to the current level of competition in the air transportation market. The current level of development of fuzzy sets theory, methods and approaches of fuzzy logic makes it possible to take into account an increasing number of not only metrizable (quantitative), but also non-metrizable (qualitative or weakly structured) parameters that significantly affect the quality of service and the competitiveness of aviation services and offer a modern, more adequate and a combined method for assessing the quality of service for air passengers. Based on these prerequisites, it becomes obvious the importance and relevance of developing methods for assessing and analyzing the competitiveness of airlines, carried out within the framework of this dissertation work, which have theoretical and practical significance for the economy of country.

The main goal and objectives of the study. The purpose of the dissertation work is to develop methods and models for the operational assessment of the quality of the logistics service of civil air transport in modern conditions, which contribute to improving the efficiency of airline management and, as a result, increasing the level of its competitiveness.

Accordance with the stated goal, the following tasks were set and solved in the dissertation work:

- to study and analyze existing approaches to managing the quality of services in a highly competitive environment, to identify the features of using an expert-fuzzy approach to assessing the competitiveness of aviation services for the transportation of passengers;
- to research the factors of competitiveness of airlines and determine the degree of importance of the service quality in the multi-criteria assessment of the competitiveness of airlines;
- to analyze the logistics services of airlines operating in the air transportation market in Azerbaijan;
- analyze a set of indicators of the quality of aviation services, consider systems for assessing their qualities and identify working list of indicators for assessing the competitiveness of airlines;
- adapt fuzzy multi-criteria evaluation methods, including the Fuzzy Delphi method, fuzzy inference system and fuzzy maximin convolution method to assess the competitiveness of airlines and test the corresponding models on the example of airlines operating in the civil air transportation market in Azerbaijan;
- develop an expert system for identifying the specific weights of evaluation criteria and obtaining a weighted assessment of the competitiveness of airlines;
- adapt the Pareto rule and the Borda method for multi-criteria assessment of the competitiveness of airlines and test them on the example of airlines operating in the civil air transportation market in Azerbaijan;

- conduct a comparative analysis of the results obtained by different methods on a hypothetical example and on the example of airlines operating in the civil air transportation market in Azerbaijan.

Research object. The object of the study are British Airways, Lufthansa, Turkish Airlines and AZAL, which provide services in Azerbaijan and meet the needs of the population in passenger air transportation. The subject of the study is the issues and problems of assessing the quality of logistics services in the system of operational management of an airline in a competitive environment for the implementation of passenger air transportation.

Methodology in conducted the research. During the research process was used a systematic approach, including comparison, generalization, synthesis and analysis using fuzzy modeling, expert evaluation and other scientific research methods.

In research were widely used educational and scientific publications, current publications in the subject area, analytical and statistical materials, as well as the results of Internet expertise, which provides the initial data for remote surveys of various categories of passengers using the services of British Airways, Lufthansa, Turkish Airlines and AZAL actively operating in the air transportation market in Azerbaijan.

The main scientific results submitted for defense. The following are submitted for defense:

- results of a study on the assessment of the quality of logistics services in the civil air transportation market in Azerbaijan
- detailing and systematization of the factors influencing the logistic assessment of service quality in the airline;
- a combined expert-fuzzy method for logistical assessment of service quality in an airline using for increasing the competitiveness of an airline;
- Expert-fuzzy approach for analysing results of influence indicators of different forms on integral level of quality
- the results of calculating the integral level of service quality for various categories of air passengers in an airline based on the use of an expert fuzzy approach and scoring analysis methods;

- the results of calculating the integral level of service quality for various categories of air passengers in British Airways, Lufthansa, Turkish Airlines and AZAL operating in the air transportation market in Azerbaijan.

Scientific novelty in the study. The scientific novelty of the dissertation is as follows:

- the stages of service that affect the perception of the quality of logistics service by air passengers are identified, and the corresponding questionnaires (questionnaires) are formed for conducting an internet expertise;
- justified the list of indicators used in the calculation of complex indicators converted into an integral assessment of the level of service quality at various stages of servicing air passengers;
- an expert system has been developed for identifying the weights of evaluation criteria and a weighted assessment of service quality for air passengers and the corresponding ranking airlines in relation of their levels of competitiveness;
- a methodology for an objective integral assessment of the quality of service for air passengers has been developed, which is used to increase the competitiveness of an airline;
- the calculation of the integral assessment of the level service quality is presented for various categories of air passengers in an airline based on an expert-fuzzy approach.

Scientific and practical significance of the study. The theoretical significance of the dissertation research lies in the fact that on the basis of existing theoretical provisions and analytical assessments obtained in the work, an objective methodology for assessing the quality of logistics services in airlines in a competitive environment has been developed and substantiated using the example of British Airways, Lufthansa, Turkish Airlines and AZAL, successfully operating in the air transportation market in Azerbaijan.

The practical significance of the dissertation work lies in the possibility of applying its main provisions, conclusions and recommendations in the process of operational management of an airline using a methodology for assessing the quality of a logistics service, which allows, on the basis of a combined, expert-fuzzy approach, to develop a science-based development strategy for an airline in order to increase its competitiveness.

Approbation of work. The main results of the dissertation work were presented at the 15th International Scientific and Practical Conference ICAFS (2022 Montenegro) Web-Science and SCOPUS, at the 3rd International Scientific and Practical Conference AICT-IEEE (Baku, Azerbaijan 2009) Web-Science and SCOPUS, at the 3rd scientific and practical conference of doctoral students and young researchers (2018, Baku, Azerbaijan); Forth International Conference on Soft Computing, Computing with Words and Perceptions in System Analysis, Decision and Control. (2007, Turkey), at the International Scientific and Practical Conference "Application of information and communication technologies in science and education." (2007, Baku, Azerbaijan).

Name of the organization where the work was done: The dissertation work was done at the Computer Engineering Department of Information Technology and Management Faculty at the Azerbaijan State Oil and Industry University.

Number of published scientific articles. According to the results of the research 10 scientific papers were published, including 2 abroad, in journals with international scientific citation indices from the Web-Science and SCOPUS archives, and 3 theses of reports at international scientific conferences.

Structure and scope of the dissertation work. The work consists of a list of used designations, an introduction, 4 chapters, a conclusion and a list of references. The work contains a total of 189,024 characters, table of contents - 2681 characters, introduction - 13,106 characters, first chapter - 66,289 characters, second chapter - 51,112 characters, third chapter - 9,333 characters, fourth chapter - 36,125 characters, conclusion - 1519 characters , as well as 26 tables and 8 figures.

CONTENT

Introduction outlines the relevance of the dissertation work, provides a list of tasks and approaches necessary to achieve the goal of the dissertation, describes the structure and content of the work, as well as the desired results submitted for defense.

The first chapter, devoted to the study of the situation in the aviation services market in the conditions of fierce competition and the permanent growth of consumer preferences, as well as the existing problems of assessing and managing service quality, examines the logistical capabilities of the main airlines that are actively operating in the air passenger transportation market in Azerbaijan.

It is noted that the problem of studying the conjuncture of the aviation services market in a competitive environment is becoming particularly acute and requires scientific organizations to develop a modern methodology for forecasting air transportation based on the study and prediction of the behavior of carriers and clients in a highly competitive environment using the principles of system analysis and the development of mathematical tools. At present, various methods for forecasting the transportation of passengers in air transport have become widespread and developed. In this direction, the most popular works: of A.M. Andronova, N.N. Gromova, F.P. Ermolaeva, A.V. Gubenko, Yu.M. Paramonova, V.A. Persianova, V.A. Sabolina, A.A. Sokolova, N.S. Uskova, O.R. Frolova, A.N. Khizhnyak, S.L. Chepinogi and other authors. Nevertheless, many modern problems of air traffic forecasting are still insufficiently studied[1]. The main place in the chapter is occupied by a detailed analysis of the logistics services of four airlines operating in the passenger air transportation market in Azerbaijan, as well as related infrastructures.

The second chapter proposes an expert-fuzzy methodology for assessing the logistical level of airlines' competitiveness in terms of their compliance with the growing requirements and wishes of air passengers. This methodology is based on the application of two approaches to the multi-criteria assessment of airline logistics

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[1] С. Иманова, Обзор работ по оценки качества сервиса в бизнес-среде, Journal of Baku Engineering University, Vol-3 Number-3, (2019)- стр.65

services, based on the use of an expert method of weighted assessments of influencing factors and fuzzy methods of multi-criteria assessment of alternatives under conditions of uncertainty[2]. Regular air passengers act as experts, on the basis of whose conclusions regarding the factors reflecting the levels of services provided to them, by means of the proposed methods and models, integral assessments of the satisfaction of hypothetical airlines are formed and their comparative analysis is carried out.

The competence requirements of approaches to the formation and assessment of the level of competitiveness of an airline consist in the study of multidimensional evaluated factors and their use in the formation of airline ratings. There is no single approach to the methodology for calculating the rating of an airline, as there are different points of view regarding the composition of factors that have a significant impact on the level of competitiveness of an airline. For a visual demonstration of the proposed methods for assessing the competitiveness of airlines, a limited set of the following factors was chosen: x_1 - ticket price; x_2 – airline reliability; x_3 – line regularity; x_4 – service on board the aircraft; x_5 – aircraft type. Testing and comparative analysis of the adequacy of the proposed approaches was carried out on a hypothetical example of a group of airlines, which we will conventionally denote as: a_1, a_2, …, a_{10}. From the point of view of making decisions on the subject of assessing attractiveness, these airlines are alternatives, the level or competitiveness of which is assessed by experts from among different categories of airline passengers according to the above variables: $x_1, x_2, \dots, x_5$.

To assess the consistency of the conclusions, the Kendall concordance coefficient is used, which demonstrates the multiple rank correlation of expert assessments[3].

$$W = \frac{12 \cdot S}{m^2 (n^3 - n)}, \qquad (1)$$

[2] R. Aliev, R.Aliev, B. Fazlollahi, Soft Computing and its Application in Business and Economics, Springer, (2004), p 211

[3] A.S. A. Lin ,Note on the concordance correlation coefficient, Biometrics,(2012) vol. 56, pp. 324–325

where m is the number of experts; n is the number of airline attractiveness factors, and S is the deviation of expert opinions from the average ranking of the airline attractiveness variables, which is calculated, for example, by the formula:[4]

$$S = \sum_{i=1}^{n}\left(\sum_{j=1}^{m} r_{ij} - \frac{m(n+1)}{2}\right)^2, \tag{2}$$

where $r_{ij} \in \{1, \ldots, 5\}$ is the rank of the i-th factor according to the j-th expert.

Identification of the weights of the relative influence of airline attractiveness factors is carried out iteratively:[4]

$$\alpha_i(t+1) = \sum_{j=1}^{m} w_j(t)\alpha_{ij}, \tag{3}$$

where $w_j(t)$ is a weight coefficient characterizing the degree of competence of the j-th expert ($j = 1 \div m$) at time t. For each iteration step, the weights that determine the degrees of expert competence are established based on the following equalities:[4]

$$\begin{cases} w_j(t) = \dfrac{1}{\eta(t)}\sum_{i=1}^{n}\alpha_i(t)\cdot\alpha_{ij} \quad (j = \overline{1,\ m-1}), \\ w_m(t) = 1 - \sum_{j=1}^{m-1} w_j(t),\ \sum_{j=1}^{m} w_j(t) = 1, \end{cases} \tag{4}$$

where $\eta(t)$ is a normalizing factor that ensures the transition to the next iteration step[4]

$$\eta(t) = \sum_{i=1}^{n}\sum_{j=1}^{m}\alpha_i(t)\alpha_{ij} \tag{5}$$

The process of determining group estimates of normalized values ends after the condition is met:[5]

$$\max_i\left\{\left|\alpha_i(t+1) - \alpha_i(t)\right|\right\} \le \varepsilon, \tag{6}$$

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[4] Wu, S. Hedayat, and W. Lin A, Statistical Tools for Measuring Agreement, New York: Springer. (2013). p. 154

[5] M.Mardanov, R. Rzayev One approach to multi-criteria evaluation of alternatives in the logical basis of neural networks. ICAFS (2018) – Vol. 797. – pp. 387 -479.

where ε is the allowable accuracy of calculations, which is set in advance by the user. In the considered example, the value $\varepsilon = 0.0001$ is accepted as an acceptable accuracy, and at the initial stage $(t = 0)$ the degrees of expert competence are the same - equal to $1/m$

In accordance with (3) - (6) at the 3rd step, the generalized weights of competitiveness factors x_i $(i=1 \div 5)$: are obtained: $\alpha_1(3)=0.28995$, $\alpha_2(3)=0.23760$, $\alpha_3(3)=0.18721$, $\alpha_4(3)=0.15449$, $\alpha_5(3)=0.13075$.

The method of expert assessments also involves a discussion among consumers of aviation services about the level of attractiveness of the airline in terms of its compliance with the criteria x_i $(i=1 \div 5)$. Each of the independent experts (from the categories of passengers most frequently using airlines services) is provided with a list of evaluation criteria x_i and is invited to individually evaluate one or another airline for its satisfaction for each of them. According to the five-point scoring system, the following numerical values are assigned to the verbal assessments of experts: **5** - Perfect; **4** -Vert Satisfactory; **3** -More Than Satisfcatory; **2** -Satisfactory; **1** -Unsatisfactory. Further, the expert assessments of airlines' satisfaction are analyzed for their consistency (or inconsistency) according to the rule: the maximum allowable difference between two expert opinions on the airline's satisfaction with respect to the criterion x_i $(i = 1 \div 5)$ should not exceed 3. This rule makes it possible to filter out unacceptable deviations in expert assessments regarding the airline's satisfaction by a separate factor x_i.

The output of the integral consumer index in the range from 0 to 100 is carried out using the evaluation criterion[5]

$$R = \frac{\sum_{i=1}^{5} \alpha_i e_i}{\max_i \sum_{i=1}^{5} \alpha_i e_i} \times 100, \qquad (7)$$

where α_i is the weight that determines the relative importance of the factor x_i $(i = 1 \div 5)$; e_i is the rating of the airline's satisfaction separately for the i-th factor x_i, given by the expert according to the five-point rating system approved above.

After collecting, processing, including averaging and applying the final assessment criterion (7), integral assessments of competitiveness levels were obtained for the selected airlines.

The choice of a method for assessing the competitiveness of airlines is determined by the target setting dictated by the consumer community. The best way to describe them is their verbal reproduction or, even better, fuzzy sets, which allows the use of fuzzy methods for multi-criteria project evaluation in the presence of weakly structured data of indicators x_i (i=1÷5).[6] Representing the indicators x_i (i=1÷5) in the system of comparative evaluation of the effectiveness of airlines in the form of linguistic variables, in the chapter, fuzzy decision-making methods are adapted to solve the problem of evaluating, ranking and choosing the best airline.

Multi-criteria evaluation of alternatives involves the use of a compositional aggregation rule for each specific case. For grading the levels of competitiveness of airlines, eight evaluative concepts were chosen, such as: u_1 - "Too low"; u_2 - "Very low"; u_3 - "More than low"; u_4–"Low"; u_5 – "High", u_6 – "More than high", u_7- "Very high", u_8- "Too high".[7] $C=\{u_1, u_2, u_3, u_4, u_5, u_6, u_7, u_8\}$ is understood as a classifier in the form of a set of evaluation features by which the levels of competitiveness of airlines are classified. At the same time, the basic verbal model is formulated in the form of the following consistent judgments:[8]

d_1: "If an airline offers an affordable airfare and is reliable, then it is acceptable";

d_2: "In addition to the above, the company operates regular air transportation, then it is more than acceptable";

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[6] Zadeh L.A. The foundation of a linguistic field and its application to close reasoning, Tou K.S., Fu J.T. (eds), Studying Systems and Intellectual Technologies. (1976) pp. 1–10

[7] Новое понятие в современной математике и его использование для принятия новых решений. Новое в зарубежной математике:– М.: Мир (2010) стр. 24

[8] The provided statements, serving as informational segments, are built upon heuristic knowledge and can always be tailored by specialists to meet the demands of consumers.

d_3: "If an airline offers an affordable airfare, is reliable, operates scheduled air transportation, offers high-quality on-board service, and operates a fleet of modern aircraft, then it is flawless";

d_4: "If an airline offers an affordable airfare, is reliable, offers high in-flight service, and operates a fleet of modern aircraft, then it is very affordable";

d_5: "If an airline offers an affordable airfare, is reliable, operates a fleet of modern aircraft, but offers low on-board service, then it is still acceptable";

d_6: "If an airline offers a high airfare, operates non-scheduled flights, and operates a fleet of obsolete types of airliners, then it is unacceptable"

The above reasoning reflects internal causality, where influencers and airline acceptability are input and output characteristics, respectively. Assuming the factors of influence as linguistic variables x_i (i=1÷5), and the acceptability of the airline as the output linguistic variable y, the terms of which reflect different levels, the full set of terms of the input and output linguistic variables are summarized in Table. 1, taking into account which the corresponding fuzzy inference system[9] was built:

d_1:"If x_1=Available and x_2=Reliable, then y =Acceptable";

d_2: "If x_1= Available and x_2= Reliable and x_3=Regulate, then y=More than acceptable";

d_3: "If x_1= Available and x_2= Reliable and x_3=Regular and x4=High and x5=Modern, then y=Perfect";

d_4: "If x_1=Affordable and x_2=Reliable and x_4=High and x_5=Modern, then y=Very acceptable";

d_5: "If x_1=Affordable and x_2=Reliable and x_4=Low and x_5=Modern, then y=Acceptable";

d_6: "If x_1=Not available and x_3=Irregular and x_5=Out of date, then y=Unacceptable."

[9] И.З. Батыршин, Базовые формулирование неточной логики и их обобщения Отечество- Казань, .(2001) стр. 100

Table 1. Input and output linguistic variables

Входы	x_1	Variable name	Price tariff
		term set	{AVAILABLE, UNAVAILABLE}
		universe	[0, 1]
	x_2	Variable name	Flight safety
		term set	{RELIABLE}
		universe	[0, 1]
	x_3	Variable name	Frequency
		term set	{REGULAR, IRREGULAR}
		universe	[0, 1]
	x_4	Variable name	Service on board
		term set	{HIGH}
		universe	[0, 1]
	x_5	Variable name	Aircraft fleet
		term set	{MODERN, OUT OF DATE}
		universe	[0, 1]
Выход	y	Variable name	Airline rating
		term set	{UNACCEPTABLE, ACCEPTABLE, MORE THAN ACCEPTABLE, VERY ACCEPTABLE, EXCELLENT}
		universe	{0, 0.1, 0.2, …., 0.9, 1}

The implementation of the fuzzy inference system gave a general functional solution in the form of the following matrix

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
u_1	0.9997	0.9547	0.8547	0.7547	0.6547	0.5547	0.4547	0.3547	0.2547	0.1547	0.0547
u_2	0.9977	0.9993	0.9128	0.8128	0.7128	0.6128	0.5128	0.4128	0.3128	0.2128	0.1128
u_3	0.9870	0.9948	0.9948	0.9096	0.8096	0.7096	0.6096	0.5096	0.4096	0.3096	0.2096
$R=$ u_4	0.9453	0.9703	0.9703	0.9703	0.9514	0.8514	0.7514	0.6514	0.5514	0.4514	0.3514
u_5	0.8275	0.8808	0.8808	0.8808	0.8808	0.8808	0.8808	0.8311	0.7311	0.6311	0.5311
u_6	0.5921	0.6621	0.6621	0.6621	0.6621	0.6621	0.6621	0.6621	0.6621	0.6621	0.7241
u_7	0.2759	0.3234	0.3234	0.3234	0.3234	0.3234	0.3234	0.3234	0.3234	0.3234	0.8903
u_8	0.0352	0.0425	0.0425	0.0425	0.0425	0.0425	0.0425	0.0425	0.0425	0.0425	0.9872

where the k-th line defines the output regarding the k-th level of the airline's competitiveness in the form of a fuzzy set E_k.

As a result of defuzzification of the fuzzy conclusions of the evaluation model, a gradation of competitiveness levels on the scale of the segment [0, 100] was obtained (see Table 2)

Table 2. Gradation of airline competitiveness levels

Interval	The level of competitiveness of airlines
[0, 25.79]	TOO LOW
(25.79; 28.71]	VERY LOW
(28.71, 33.24]	MORE THAN LOW
(33.24, 39.46]	LOW
(39.46, 46.76]	HIGH
(46.76, 55.95]	MORE THAN HIGH
(55.95, 83.88]	VERY HIGH
(83.88, 100]	TOO HIGH

To build a fuzzy inference system for assessing the levels of competitiveness of airlines, a verbal model was chosen as the basis, formulated in the form of the following information fragments:

d_1: “If the airfare is acceptable and the reliability of the airline is acceptable, then it is satisfactory”;

d_2: "If, in addition to the above, the frequency of air travel is acceptable, then the airline is more than satisfactory";

d_3: "If the price of the ticket is acceptable, the reliability of the airline is acceptable, the frequency of air transportation is acceptable, the service on board is acceptable and the fleet of aircraft is acceptable, then the airline is faultless";

d_4: "If the airfare is acceptable, the airline's reliability is acceptable, the on-board service is acceptable, and the fleet is acceptable, then the airline is very satisfactory";

d_5: “If the price of the ticket is acceptable, the reliability of the airline is acceptable, the fleet of aircraft is acceptable, but the service on board is unacceptable, then the airline is still satisfactory”;

d_6: "If the airfare is unacceptable, the frequency of air travel is unacceptable, and the fleet is unacceptable, then the airline is unsatisfactory."

Here, hypothetical airlines a_k (k=1÷10), are accepted as assessed alternatives, which have passed the primary assessment examination on a five-point scale for the relative influence of factors x_i (i=1÷5) on their level of consumer attractiveness (see Table 1).

Fuzzification of the input characteristics is carried out using fuzzy subsets of the universe $U=\{a_1, a_2, \ldots, a_{10}\}$ in the form $A_i = \{\mu_{A_i}(a_1)/a_1, \mu_{A_i}(a_2)/a_2, \ldots, \mu_{A_i}(a_{10})/a_{10}\}$, where $\mu_{A_i}(a_t)$ (t=1÷10) are the values of the Gaussian membership functions

$$\mu_{A_i}(a_t) = \exp\left\{-\frac{[e_i(a_t)-5]^2}{\sigma_i^2}\right\}, \qquad (8)$$

where $e_i(a_t)$ is the consolidated assessment of experts regarding the airline a_t (t=1÷10), made on a 5-point scale for the attractiveness of the airline according to the i-th factor of influence x_i (i =1÷5) (see Table 1); σ_i^2 = 6.25 is the variance chosen empirically, which is the same for all cases of fuzzification.

Assuming influence factors x_i (i = 1 ÷ 5) as linguistic variables, one of their meanings, the term "ACCEPTABLE", as their best qualitative characteristic, is represented as a fuzzy set A_i of the universe $U = \{a_1, a_2, \ldots, a_{10}\}$:

- A_1={0.9139/a_1, 0.99/a_2, 0.7788/a_3, 0.9139/a_4, 0.9608/a_5, 0.6977/a_6, 0.2982/a_7, 0.4449/a_8, 1/a_9, 0.6126/a_{10}};
- A_2={0.9608/a_1, 0.6977/a_2, 0.8521/a_3, 0.6977/a_4, 0.3679/a_5, 0.4449/a_6, 0.1845/a_7, 0.1845/a_8, 0.99/a_9, 0.4449/a_{10}};
- A_3={0.99/a_1, 0.9139/a_2, 0.6126/a_3, 0.4449/a_4, 0.6126/a_5, 0.2982/a_6, 0.1054/a_7, 0.1054/a_8, 0.9608/a_9, 0.7788/a_{10}};
- A_4={0.99/a_1, 0.7788/a_2, 0.7788/a_3, 0.4449/a_4, 0.2982/a_5, 0.1054/a_6, 0.2044/a_7, 0.0556/a_8, 0.99/a_9, 0.9139/a_{10}};
- A_5={0.9139/a_1, 0.4449/a_2, 0.6126/a_3, 0.1845/a_4, 0.1845/a_5, 0.0556/a_6, 0.1409/a_7, 0.0271/a_8, 0.9139/a_9, 0.6126/a_{10}};

Taking into account these formalisms, the corresponding system of fuzzy inference is constructed:

d_1: "If $x_1 = A_1$ and $x_2 = A_2$, then $y = S$";

d_2: "If $x_1 = A_1$ and $x_2 = A_2$ and $x_3 = A_3$, then $y = MS$";

d_3: "If $x_1 = A_1$ and $x_2 = A_2$ and $x_3 = A_3$ and $x_4 = A_4$ and $x_5 = A_5$, then $y = P$";

d_4: "If $x_1 = A_1$ and $x_2 = A_2$ and $x_4 = A_4$ and $x_5 = A_5$, then $y = VS$";

d_5: "If $x_1 = A_1$ and $x_2 = A_2$ and $x_4 = \neg A_4$ and $x_5 = A_5$, then $y = S$";

d_6: "If $x_1 = \neg A_1$ and $x_3 = \neg A_3$ and $x_5 = \neg A_5$, then $y = YS$",

where $\forall j \in J = \{0, 0.1, \ldots, 1\}$:
S=SATISFACTORY (airline), $\mu_S(j)=j$;
MS=MORE THAN SATISFACTORY, $\mu_{MS}(j)=j^{(1/2)}$

P=PERFECT, $\mu_P(j)=\begin{cases}1, j=1,\\ 0, j<1;\end{cases}$

VS=VERY SATISFACTORY, $\mu_{VS}(j)=j^2$;
US=UNSATISFACTORY, $\mu_{US}(j)=1-j$.

As a result of the implementation of fuzzy relations, a general functional solution was obtained in the form of a matrix R, which on a discrete set J reflects the internal causal relationship between the averaged expert estimates of airlines for their compliance with factors x_i (i=1÷5), on the one hand, and the corresponding airline satisfaction levels, on the other.

$R =$

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1
a_1	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	0.9900
a_2	0.3023	0.4023	0.5023	0.5551	0.5551	0.5551	0.5551	0.5551	0.5551	0.5551	0.9900
a_3	0.2212	0.3212	0.3874	0.3874	0.3874	0.3874	0.3874	0.3874	0.3874	0.3874	0.7788
a_4	0.3023	0.4023	0.5023	0.6023	0.7023	0.8023	0.8155	0.8155	0.8155	0.8155	0.9139
a_5	0.6321	0.7321	0.8155	0.8155	0.8155	0.8155	0.8155	0.8155	0.8155	0.8155	0.9608
a_6	0.5551	0.6551	0.7551	0.8551	0.9444	0.9444	0.9444	0.9444	0.8977	0.7977	0.6977
a_7	0.8155	0.8691	0.8946	0.8946	0.8946	0.7982	0.6982	0.5982	0.4982	0.3982	0.2982
a_8	0.8155	0.9155	0.9729	0.9729	0.9729	0.9449	0.8449	0.7449	0.6449	0.5449	0.4449
a_9	0.0100	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	0.0861	1.0000
a_{10}	0.5551	0.5551	0.5551	0.5551	0.5551	0.5551	0.5551	0.5551	0.5551	0.5551	0.7788

As a result of defuzzification, the following numerical estimates of airlines' satisfaction were established:

a_1=0.9565; a_2=0.7428; a_3=0.7662; a_4=0.6402; a_5=0.5895; a_6=0.5274; a_7=0.3897; a_8=0.4253; a_9=0.9608; a_{10}=0.6436. By simply multiplying these values by 100, the ratios of the final ratings of airlines' satisfaction on the scale of the segment [0, 100] are obtained, which are presented in Table 4.

Processing of expert assessments on a five-point system, presented in Table 3 with respect to factors x_i (i=1÷5) for airlines a_k (k=1÷10),

was carried out using the fuzzy maximin convolution method: both for criteria with the same degree of importance and for criteria with relative priority weights. Taking into account the fuzzy formalisms $A_i(a)$ introduced above, the set of optimal alternatives will be:
A={min{0.9139, 0.9608, 0.9900, 0.9900, 0.9139}, min{0.9900, 0.6977, 0.9139, 0.7788, 0.4449}, min{0.7788, 0.8521, 0.6126, 0.7788, 0.6126}, min{0.9139, 0.6977, 0.4449, 0.4449, 0.1845}, min{0.9608, 0.3679, 0.6126, 0.2982, 0.1845}, min{0.6977, 0.4449, 0.2982, 0.1054, 0.0556}, min{0.2982, 0.1845, 0.1054, 0.2044, 0.1409}, min{0.4449, 0.1845, 0.1054, 0.0556, 0.0271}, min{1.0000, 0.9900, 0.9608, 0.9900, 0.9139}, min{0.6126, 0.4449, 0.7788, 0.9139, 0.6126}} = {0.9139, 0.4449, 0.6126, 0.1845, 0.1845, 0.0556, 0.1054, 0.0271, 0.9139, 0.4449}.

Table 3. Assessment of airline competitiveness levels

Airlines	Weighting coefficients of evaluation criteria					Integral assessment
	α_1	α_2	α_3	α_4	α_5	
	0.28995	0.23760	0.18721	0.15449	0.13075	
	Consolidated expert opinion					
	e_1	e_2	e_3	e_4	e_5	
a_1	4.25	4.50	4.75	4.75	4.25	89.61
a_2	4.75	3.50	4.25	3.75	2.75	78.87
a_3	3.75	4.00	3.25	3.75	3.25	73.01
a_4	4.25	3.50	2.75	2.75	1.75	64.65
a_5	4.50	2.50	3.25	2.25	1.75	61.67
a_6	3.50	2.75	2.25	1.25	0.75	47.61
a_7	2.25	1.75	1.25	1.85	1.50	35.68
a_8	2.75	1.75	1.25	0.75	0.25	31.91
a_9	5.00	4.75	4.50	4.75	4.25	94.21
a_{10}	3.25	2.75	3.75	4.25	3.25	67.59

The most competitive airline is determined from the regulatory vector of priorities relative to alternative airlines:

$$\max\{\mu_A(a_i)\}=\max\{0.9139, 0.4449, 0.6126, 0.1845, 0.1845, 0.0556, 0.1054, 0.0271, 0.9139, 0.4449\}.$$

From the point of view of the acceptability of indicators x_i (i=1÷5) two airlines are the best at once: $a_1$and a_9, which correspond to the value 0.9139. The subsequent ranking of airlines is built in descending order: $a_3 \to 0.6126$, $a_{10} \to 0.4449$, $a_2 \to 0.4449$, $a_4 \to 0.1845$, $a_5 \to 0.1845$, $a_7 \to 0.1054$, $a_6 \to 0.0556$, $a_8 \to 0.0271$.

In the case of maximin convolution of criteria with different degrees of importance (i.e., taking into account the weighted criteria $A_i(a)$), the set of optimal alternatives will be:

$A = \{\min\{0.91393^{0.28995}, 0.96079^{0.23760}, 0.99005^{0.18721}, 0.99005^{0.15449}, 0.91393^{0.13075}\}; \min\{0.99005^{0.28995}, 0.69768^{0.23760}, 0.91393^{0.18721}, 0.77880^{0.15449}, 0.44486^{0.13075}\}; \min\{0.77880^{0.28995}, 0.85214^{0.23760}, 0.61263^{0.18721}, 0.77880^{0.15449}, 0.61263^{0.13075}\}; \min\{0.91393^{0.28995}, 0.69768^{0.23760}, 0.44486^{0.18721}, 0.44486^{0.15449}, 0.18452^{0.13075}\}; \min\{0.96079^{0.28995}, 0.36788^{0.23760}, 0.61263^{0.18721}, 0.29820^{0.15449}, 0.18452^{0.13075}\}; \min\{0.69768^{0.28995}, 0.44486^{0.23760}, 0.29820^{0.18721}, 0.10540^{0.15449}, 0.05558^{0.13075}\}; \min\{0.29820^{0.28995}, 0.18452^{0.23760}, 0.10540^{0.18721}, 0.20442^{0.15449}, 0.14086^{0.13075}\}; \min\{0.44486^{0.28995}, 0.18452^{0.23760}, 0.10540^{0.18721}, 0.05558^{0.15449}, 0.02705^{0.13075}\}; \min\{1.00000^{0.28995}, 0.99005^{0.23760}, 0.96079^{0.18721}, 0.99005^{0.15449}, 0.91393^{0.13075}\}; \min\{0.61263^{0.28995}, 0.44486^{0.23760}, 0.77880^{0.18721}, 0.91393^{0.15449}, 0.61263^{0.13075}\}\} = =\{\min\{0.9742, 0.9905, 0.9981, 0.9985, 0.9883\}; \min\{0.9971, 0.9180, 0.9833, 0.9621, 0.8995\}; \min\{0.9301, 0.9627, 0.9123, 0.9621, 0.9379\}; \min\{0.9742, 0.9180, 0.8593, 0.8824, 0.8017\}; \min\{0.9885, 0.7885, 0.9123, 0.8295, 0.8017\}; \min\{0.9009, 0.8249, 0.7973, 0.7064, 0.6853\}; \min\{0.7041, 0.6693, 0.6562, 0.7825, 0.7739\}; \min\{0.7907, 0.6693, 0.6562, 0.6399, 0.6238\}; \min\{1.0000, 0.9976, 0.9925, 0.9985, 0.9883\}; \min\{0.8676, 0.8249, 0.9543, 0.9862, 0.9379\}\} = \{0.9742, 0.8995, 0.9123, 0.8017, 0.7885, 0.6853, 0.6562, 0.6238, 0.9883, 0.8249\}$.

As in the previous case, the most competitive airline is determined from the regulatory vector of priorities relative to alternative airlines:

$$\max\{\mu_A(a_k)\}=\{0.9742, 0.8995, 0.9123, 0.8017, 0.7885, 0.6853, 0.6562, 0.6238, 0.9883, 0.8249\}.$$

Among the components of this resulting vector, the largest is 0.9883, which corresponds to the alternative a_9. This means that the best airline is a_9. The subsequent ranking of airlines is built in descending order: $a_1 \to 0.9742$, $a_3 \to 0.9123$, $a_2 \to 0.8995$, $a_{10} \to 0.8249$, $a_4 \to 0.8017$, $a_5 \to 0.7885$, $a_6 \to 0.6853$, $a_7 \to 0.6562$, $a_8 \to 0.6238$.

Comparative analysis of the results obtained by three methods for assessing the levels of competitiveness of airlines a_k (k=1÷10) is presented in Table 4.

Table 4. Comparison and analysis of airline ratings.

Airlines	Weighted estimate method		Fuzzy inference system		Maximin convolution method: with the same degrees of importance of the criteria		Maximin convolution method: with different degrees of importance of criteria	
	S	O	S	O	S	O	S	O
a_1	89.61	2	0.9565	2	0.9139	2	0.9742	2
a_2	78.87	3	0.7428	4	0.4449	4	0.8995	4
a_3	73.01	4	0.7662	3	0.6126	3	0.9123	3
a_4	64.65	6	0.6402	6	0.1845	6	0.8017	6
a_5	61.67	7	0.5895	7	0.1845	7	0.7885	7
a_6	47.61	8	0.5274	8	0.0556	9	0.6853	8
a_7	35.68	9	0.3897	10	0.1054	8	0.6562	9
a_8	31.91	10	0.4253	9	0.0271	10	0.6238	10
a_9	94.21	1	0.9608	1	0.9139	1	0.9883	1
a_{10}	67.59	5	0.6436	5	0.4449	5	0.8249	5

The third chapter discusses the traditional approach to solving the problem of multi-criteria assessment of alternative airlines in the presence of information about competitiveness factors from reliable sources.[10] Within the framework of the formed set of indicators of the competitiveness of the airline, the methodology for comparative analysis and selection of the airline is discussed, which is based on the adaptation and application of the methods of comparative analysis of Pareto and Borda.[11] As a result of applying these methods, airlines were ranked in terms of their compliance with certain evaluation criteria.

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[10] S.Imanova, Audit of Satisfaction of the Consumer, Journal of Qafqaz University, Number 20, (2007) pp.187-192

[11] Применение методов Парето и Борда при выборе инвестиционных проектов. URL:https://afdanalyse.ru/publ/investicionnyj_analiz/teorija/primenenie_metodov_pareto_i_borda_pri_vybore_investicionnykh_proektov/27-1-0-330

The Pareto rule provides for mutual comparison, ranking and selection of the best airlines to rank the top airlines. At the first stage, within the framework of the system of criteria x_i (i=1÷5), the considered airlines were ranked in the form of Table 5.

Table 5. Ranking by competitiveness factors

No	Benchmarking indicators for projects				
	x_1	x_2	x_3	x_4	x_5
1	a_9	a_9	a_1	a_1	a_1
2	a_2	a_1	a_9	a_9	a_9
3	a_5	a_3	a_2	a_{10}	a_3
4	a_1	a_2	a_{10}	a_2	a_{10}
5	a_4	a_4	a_3	a_3	a_2
6	a_3	a_6	a_5	a_4	a_4
7	a_6	a_{10}	a_4	a_5	a_5
8	a_{10}	a_5	a_6	a_7	a_7
9	a_8	a_7	a_7	a_6	a_6
10	a_7	a_8	a_8	a_8	a_8

At the next step, a comparative analysis of airlines by factors x_i is carried out by determining their pairwise preferences. In Table 6, these preferences are determined according to the following rule: say, for a_1 in the field of intersection of row x_1 and column a_2, the symbol "-" is set based on the fact that the value of x_1 for airline a_1 is less than for a_2, and the sign is set for the intersection with column a_3 "+", since the value of x_1 in a_1 is greater than in a_3. In cases of equal values of factors for airlines, the sign "0" is set.

Table 6. Preference table based on pairwise comparisons

a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}
x_1	-	+	0	-	+	+	+	-	+
x_2	+	+	+	+	+	+	+	+	+
x_3	+	+	+	+	+	+	+	+	+
x_4	+	+	+	+	+	+	+	0	+
x_5	+	+	+	+	+	+	+	0	+
a_2	a_1	a_3	a_4	a_5	a_6	a_7	a_8	a_9	a_{10}

x_1	+	+	+	+	+	+	+	-	+
x_2	-	-	0	+	+	+	+	-	+
x_3	-	+	+	+	+	+	+	-	+
x_4	-	0	+	+	+	+	+	-	-
x_5	-	-	+	+	+	+	+	-	-
…									
a_{10}	a_1	a_2	a_3	a_4	a_5	a_6	a_7	a_8	a_9
x_1	-	-	-	-	-	-	+	+	-
x_2	-	-	-	-	+	0	+	+	-
x_3	-	-	+	+	+	+	+	+	-
x_4	-	+	+	+	+	+	+	+	-
x_5	-	+	0	+	+	+	+	+	-

Here, airlines with columns that do not contain the "-" character are preferred. Therefore, the most preferred airline is a_9, which contains 8 such columns at once, namely: a_2, a_3, a_4, a_6, a_7, a_8, a_9 and a_{10}. This means that a_9 is preferred over a_2, a_3, a_4, a_6, a_7, a_8, a_9 and a_{10}. It is followed by a1, which includes 6 columns a3, a4, a6, a7, a8 and a10 that do not contain "-" signs, which means that a_1 is preferred over a_3, a_4, a_6, a_7, a_8 and a_{10}. For a_2, columns a_5, a_6, a_7 и a_8; для a_3 and a_4 - columns a_6, a_7 and a_8; for a_5 - columns a_7 и a_8; for a_6 - column a_8; for a_{10}, columns a_8 and a_9 do not contain the "-" sign. As can be seen from this analysis, in relation to the a_8 airline, all the others have certain advantages. Therefore, this airline is assigned the 10th position, and for the remaining 9, this procedure is again applied.

As can be seen, the Pareto method induces more solutions than necessary. Therefore, to complete the comparative analysis, Borda's selective rule is used, according to which airlines are ranked by each factor x_i in descending order with the assignment of appropriate rank values (see Table 7) and then the total rank is calculated for each decision (see Table 8). As a result, the airline with the highest value of the total rank is considered the best.

Table 7. Airline ranking by the Borda method

Rank	Airline Benchmarks				
	x_1	x_2	x_3	x_4	x_5
10	a_9	a_9	a_1	a_1	a_1
9	a_2	a_1	a_9	a_9	a_9
8	a_5	a_3	a_2	a_{10}	a_3
7	a_1	a_2	a_{10}	a_2	a_{10}
6	a_4	a_4	a_3	a_3	a_2
5	a_3	a_6	a_5	a_4	a_4
4	a_6	a_{10}	a_4	a_5	a_5
3	a_{10}	a_5	a_6	a_7	a_7
2	a_8	a_7	a_7	a_6	a_6
1	a_7	a_8	a_8	a_8	a_8

Table 8. Airline ranking using the Borda method

Airlines	Benchmarks					Sum of points	Order
	x_1	x_2	x_3	x_4	x_5		
a_1	7	9	10	10	10	46	2
a_2	9	7	8	7	6	37	3
a_3	5	8	6	6	8	33	4
a_4	6	6	4	5	5	26	6
a_5	8	3	5	4	4	24	7
a_6	4	5	3	2	2	16	8
a_7	1	2	2	3	3	11	9
a_8	2	1	1	1	1	6	10
a_9	10	10	9	9	9	47	1
a_{10}	3	4	7	8	7	29	5

In Table 9 shows the results of solving the problem of choosing the best airline, which are based on a single database of expert assessment of the considered airlines. The presented results are somewhat different, which is explained by different ways of interpreting the initial information.

Table 9. Airline ranking by different methods

Airlines	Weighted estimate method		Fuzzy inference system		Maximin convolution method: with the same degrees of importance of the criteria		Maximin convolution method: with different degrees of importance of criteria		Pareto method	Borda method	
	S	O	S	O	S	O	S	O	S	S	O
a_1	89.61	2	0.9565	2	0.9139	2	0.9742	2	2	46	2
a_2	78.87	3	0.7428	4	0.4449	4	0.8995	4	3	37	3
a_3	73.01	4	0.7662	3	0.6126	3	0.9123	3	4	33	4
a_4	64.65	6	0.6402	6	0.1845	6	0.8017	6	5	26	6
a_5	61.67	7	0.5895	7	0.1845	7	0.7885	7	6	24	7
a_6	47.61	8	0.5274	8	0.0556	9	0.6853	8	8	16	8
a_7	35.68	9	0.3897	10	0.1054	8	0.6562	9	9	11	9
a_8	31.91	10	0.4253	9	0.0271	10	0.6238	10	10	6	10
a_9	94.21	1	0.9608	1	0.9139	1	0.9883	1	1	47	1
a_{10}	67.59	5	0.6436	5	0.4449	5	0.8249	5	7	29	5

S - score, O – order

The fourth chapter discusses a combined approach to assessing the competitiveness of British Airways (a_1), Lufthansa (a_2), Turkish Airlines (a_3), and AZAL (a_4), which are the most active in the passenger air transportation market in Azerbaijan. The basis of the approach is the data of expert preferences regarding the levels of logistics services obtained in the course of passenger surveys.

To adapt the Fuzzy Delphi[12] method to solve the problem, the following step-by-step procedure was chosen as a basis.

Step 1. Establishing qualitative evaluation criteria for the formation of the first questionnaire.

Step 2. For each airline, identification of the triangular membership function with parameters:

$$a_0 = \sqrt[m]{\prod_{i=1}^{n} Avr_i}\ , \quad a_{\min} = \min_{j=1,m}\{\min_{i=1,n}(e_{ij})\} \quad \text{и} \quad a_{\max} = \max_{j=1,m}\{\max_{i=1,n}(e_{ij})\}\ ,$$ [13]

where Avr_i – average expert assessment of the airline's satisfaction with respect to the i-th feature; e_{ij} is the assessment of the j-th expert on the satisfaction of the airline with respect to the i-th attribute; n is the number of evaluation criteria (in particular, n=5); m - number of experts.

Step 3. Correction of membership functions based on the knowledge identified in step 2 and the formation of a new questionnaire for distribution among experts on-line.

Step 4. Carrying out statistical tests for the convergence of the established membership functions for each linguistic variable that plays the role of an evaluation criterion.

According to the results of the iterative process, due to the use of the Delphi method, fuzzy sets in a triangular form are established that most adequately describe the qualitative evaluation criteria, that is, the terms of linguistic variables x_i (i=1÷5). Based on the refined fuzzy descriptions of the criteria, questionnaires were formed, which were sent to the experts for their final examination.

After the 3rd iteration of the survey, data were obtained, which, after processing using the Fuzzy Delphi method, regarding the feature x_2, were reflected in Table 10. In particular, the triangular membership functions that describe the degree of satisfaction of airlines with respect to the x_2 criterion are shown in Fig. 1.

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[12] Метод Дельфи и его применение. URL: 4brain-https://4brain.ru/blog/метод-дельфи-и-его-применение, (2015)

[13] S.Imanova, Service quality evaluation by Fuzzy Delphi Method, IEEE, DOI: 10.1109/AICT15929.2009, (2007)

Table 10. Aggregated results of the 3rd internet review

Airlines	Triangular membership function parameters		
	a_{min}	a_{max}	a_0
a_1	80	100	90
a_2	80	100	91
a_3	70	100	82
a_4	80	95	80

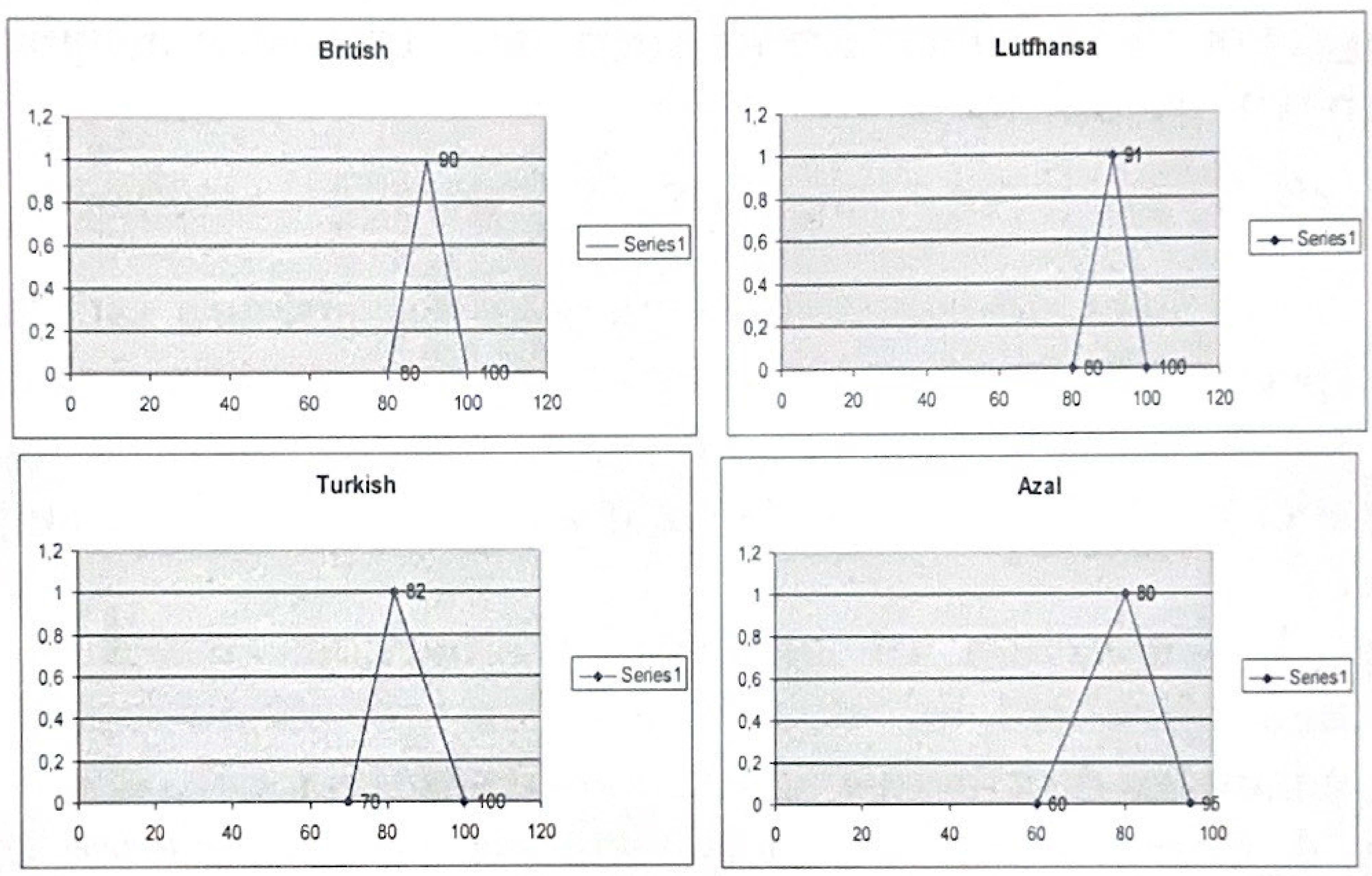

Figure. 1. Membership functions after the 3rd internet expertise

According to the results of the analysis performed by the Fuzzy Delphi method, all the considered airlines have a fairly high qualification assessment in the passenger air transportation market in Azerbaijan. The results of the Internet examination of these airlines according to the x_2 criterion showed that Lufthansa is rated as the most reliable in terms of safety. British Airways ranks second in this indicator, Turkish Airlines ranks 3rd, and AZAL ranks 4th. The integrated results of the Internet expertise allowed obtaining very important information about airlines, on the basis of which they can significantly improve the quality of services provided, as well as increase their business activity. Expert data from a survey of passengers from different categories and their processing through the application of the Fuzzy Delphi method showed that British Airways and Lufthansa have the highest rating for safety, where Turkish Airlines and Azal received average ratings. In terms of financial stability, Lufthansa is the best airline. 2nd position - British Airways, 3rd - AZAL, 4th - Turkish Airlines. Regarding guarantee packages that arrive with passengers, Turkish Airlines is the best. The analysis by the flight regularity factor showed that Lufthansa is in the 1st place, British Airways is in the 2nd position, Turkish Airlines is in the 3rd position, and AZAL is in the 4th position. A good booking service in terms of the indicator shows that Lufthansa and British Airways are in 1st position, Turkish Airlines is in 2nd, and AZAL is in 3rd place. Thus, according to the totality of integral assessments regarding the satisfaction of airlines in terms of their compliance with indicators x_i (i=1÷5), obtained using the Fuzzy Delphi method for processing Internet expertise data, Lufthansa has a competitive advantage over the other four companies. This is followed by British Airways, Turkish Airlines and AZAL.[14]

Taking into account the generalized weights α_i (i=1÷5),identified for the competitiveness factors of airlines x_i (i=1÷5) on the basis of expert opinions, and the application of the final assessment criterion (7), for the selected airlines, integral estimates of competitiveness levels were obtained (see Table 11).

Table 11. Overall airline satisfaction ratings

Airlines	Factors of competitiveness					Assessment
	Ticket price	Reliability	Frequency	Service	Aircraft type	
	x_1	x_2	x_3	x_4	x_5	
	Weighting coefficients of evaluation criteria					
	α_1	α_2	α_3	α_4	α_5	
	0.28995	0.23760	0.18721	0.15449	0.13075	
a_1	86	90	88	87	89	87.87
a_2	90	91	92	93	90	91.08
a_3	92	82	86	89	86	87.25
a_4	85	80	84	86	88	84.17

[14] S. Imanova, Application of Fuzzy Delphi Method for Evaluation Service Quality of Airlines in Azerbaijan, b-Quadrat Verlag (2007) pp. 331-337

As a result of applying the fuzzy inference system, as well as the fuzzy method of maximin convolution, both for the case of equivalence of qualitative evaluation criteria, and for the case when these criteria have different significance, according to the algorithms described in the 2nd and 3rd chapters, integral estimates of satisfaction were obtained airlines British Airways, Lufthansa, Turkish Airlines and AZAL for the entire set of criteria x_i (i=1÷5). Comparative analysis of the results obtained by three methods for assessing the levels of competitiveness of airlines is presented in Table. 12, which shows that regarding the positions of British Airways, Lufthansa, Turkish Airlines and AZAL, the results are completely the same. Moreover, as can be seen from Table. 12, this ranking is also confirmed by the results of evaluating these airlines using the rather trivial Pareto rule and the Borda method.

Table 12. Results of assessment of airlines in the passenger air transportation market in Azerbaijan

Airlines	Fuzzy Delphi Method		Fuzzy inference system		Maximin convolution method: with the same degrees of importance of the criteria		Maximin convolution method: with different degrees of importance of criteria	
	S	O	S	O	S	O	S	O
British Airways	87.87	2	0.9080	2	0.83529	2	0.94915	2
Lufthansa	91.08	1	0.9535	1	0.91226	1	0.97373	1
Turkish Airlines	87.25	3	0.8635	3	0.74266	3	0.93175	3
AZAL	84.17	4	0.8246	4	0.69260	4	0.91643	4

S - score, O – order

MAIN RESULTS

The main scientific results submitted for defense are formulated as the following statements:

- results of a study on the assessment of the quality of logistics services in the civil air transportation market in Azerbaijan;
- detailing and systematization of the factors influencing the logistic assessment of the quality of service in the airline;
- a combined expert-fuzzy method for logistical assessment of the quality of service in an airline, used to increase the competitiveness of an airline;
- expert-fuzzy approach to the analysis of the results of the influence of indicators of different nature on the integral level of quality;
- the results of calculating the integral level of service quality for various categories of air passengers in an airline based on the use of an expert fuzzy approach and scoring analysis methods;
- the results of calculating the integral level of service quality for various categories of air passengers in British Airways, Lufthansa, Turkish Airlines and AZAL operating in the air transportation market in Azerbaijan.

The main results of the dissertation work are published in the following scientific articles:

1. S. Imanova, Application of Fuzzy Delphi Method for Evaluation Service Quality of Airlines in Azerbaijan b-Quadrat Verlag, ICSCCW-2007, pp. 331-337
2. S.Imanova, Total Quality Management in Azerbaijan-the way to perfection is difficult// Caucasus and Central Asia in the Globalization Process, Qafqaz University, Baku 02-07 May 2007, pp.487-490
3. S. Imanova, Algılanan hizmet kalitesinin Fuzzy Delphi metodla ölçülmesi//Elm və təhsildə informasiya-kommunikasiya texnologiyalarının tətbiqi, Bakı 01-03 Noyabr 2007, s.87-91
4. S.N.Imanova, Service quality evaluation by Fuzzy Delphi Method// International Conference on Application of Information and Communication Technologies-IEEE, 14-16 October 2007, DOI: 10.1109/AICT15929.2009
5. S.N.Imanova, Audit of Satisfaction of the Consumer//Journal of Qafqaz University, Number 20, 2007, pp.187-192
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7. S.N.İmanova, Müasir idarəetmədə klassik keyfiyyət anlayışı// II International Scientific Conference of Young Researchers, Baku 27-28 April 2018, стр. 686-690
8. S.Imanova, S.Suleymanov, G.Jafarli, The role of data analytics in transportation// III International Scientific Conference of Young Researchers, Baku 29-30 April 2019, pp.478-480
9. С.Н.Иманова, Обзор работ по оценки качества сервиса в бизнес-среде//Journal of Baku Engineering University, Vol-3 №-2 2019, стр.63-71
10. S.Imanova, Evaluation of logistics services of airlines in the Azerbaijan passenger transportation market, Lecture notes in networks and systems, Springer Cham, Vol-610, pp 154-163

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