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A MATHEMATICAL ALGORITHM FOR ASSESSING THE QUALITY OF TOURISM ACTIVITY

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Abstract

The complexity and heterogeneity of a tourism product have profound implications on the efficiency of the sector in terms of expanding the coverage and assessment spectrum, as a result of a series of specific activities: tourism transport, food retail, provision of other basic and complementary services, services, sales of goods, domestic and international tourism, the results by their nature having both direct and indirect effects. The diversity of services, the seasonal nature of rural tourism, the typology of tourism forms, price and tariff categories involve the use of a system of indicators, which can be viewed as a cybernetic system. In this paper, following rigorous selection and critical analysis of the concepts, we sought to establish an alternative method of quality assessment in tourism.

The purpose of the research was to propose an indicator for assessing the quality of tourism activity. For this purpose we performed the following steps: study of the relevant literature; gathering the required information by conducting complex market research, using a survey of managers of tourist accommodation establishments as a tool for data collection; obtaining the necessary information by conducting complex market research using a survey of customers of the same tourist accommodation establishments as a tool for data collection; using software to centralise data and information (Excel, MatLAB); Delphi study (opinion of specialists in the field); statistical modelling; calculation of importance coefficients; development of an indicator to assess the quality of tourist services.

The algorithm for assessing the quality index of the tourism activity which we have proposed is an original contribution, based on the comparative analysis of survey answers of businesses and customers respectively in a defined tourist area and on the evaluation of sub-criteria by experts.

Keywords*: tourism, algorithm, quality of tourism activity, criterion, assessment of tourism activity, indicators*

1. Introduction

Reality has demonstrated that the system of tourism-specific indicators must provide information on:

- *the tourism demand* - by measuring the domestic and international tourist circulation within the national borders;
- *the tourism offer* or the economic potential in terms of infrastructure and human resources;

- *the value outcomes of the tourist activity* in terms of expenditure, income and economic efficiency;
- *the quality of tourism activity*.

As regards their form, the above indicators can be expressed in: ***natural, natural-conventional and value units (lei, euro, and dollar)*** and are determined in the form of: ***absolute (global) indicators, average indicators, intensity indicators, structure indicators and dynamics indicators***.

The system of indicators present at the macroeconomic level is also found at the microeconomic level, yet much more detailed, allowing a highly detailed analysis of the process of tourism activity and of the factors that influence it.

These indicators can be structured on [2, p. 45]:

1. indicators of tourism demand;
2. indicators of tourism offer;
3. indicators of the demand-supply relationship;
4. tourism expenditure indicators;
5. tourism income indicators;
6. indicators of the economic efficiency of tourism;
7. indicators of the quality of tourism activity.

The indicators of the quality of tourism activity, which are the object of this paper, can be viewed as a set of specific components that contribute to the complete characterisation of tourism activity. They express the qualitative side of the offer, as well as the social, cultural-educational and policy effects of the tourism industry. The difficulties encountered in measuring the qualitative aspects of tourism also have an impact on determining the specific indicators. For this reason, the effects of the qualitative side of tourism activity are assessed indirectly.

The indicators of the offer quality can be assessed based on the increasing/decreasing demand as a result of improved/deteriorated and diversified/non-diversified tourism services. *For this purpose, the following elements are taken into account: the level of quality of offer and service diversification; the level of comfort and facilities provided by tourism establishments; the competitiveness indicators; the indicators for maintaining the ecological balance of the environment* [7, p. 148].

2. Extent of research into the matter

Most studies and research activities in the area of quality assessment of tourism activity emphasise that the individual experience of the customer with a particular product or service represents the basis of assessment. Research promoting this idea can be found both in the European school of thought (more precisely, in the Nordic school), represented by Grönroos, Gummesson, Lethinen and Olsen and in the American school, represented by Parasuraman, Zeithaml and Berry. According to experts such as Bergman and Klefsjö, Cosmescu, Lickorish, Kotler, Zait, the characteristics of tourism activity include: intangibility, heterogeneity, simultaneity, diversity, variability, seasonality, the impossibility to protect the trade mark and the non-transfer of ownership title [1, p. 21].

There are a range of mathematical models and algorithms focused on assessing the quality of tourism activity which particularly highlight strengths and weaknesses. Some of these models are applicable, but it is important for tourism industry professionals to know that they are aware of them and how they can be used to achieve quality and customer satisfaction.

The mathematical algorithm, which we propose in this research, involves the assessment of the ***tourism attractiveness index*** by taking into account the following major components (criteria):

- ***natural tourism resources;***
- ***anthropic tourism resources;***
- ***equipment and facilities;***
- ***general infrastructure***.

By applying the ***relevance tree technique*** (the decision-making process is complex, i.e. it does not require a single isolated decision, but rather a range of interdependent decisions, unfolding in a series over several periods of time), these groups of tourism attractiveness factors can be divided, in turn, into component elements that constitute a lower level of the tree (subcriteria) [3, p. 239]. The following factors are included and analysed in the structure of each element part of the tourism offer:

a) ***Natural tourism resources***: landscape; relief: variety of forms and attractiveness of landscapes; climate: climatic elements favourable to the development of tourism activities; hydrographic network: watercourses and water bodies; fauna: wildlife and fishing; flora: forests, specific vegetation; protected areas; therapeutic factors; environmental quality.

b) ***Anthropic tourist resources***: historical and art monuments; archaeological remains; churches and monasteries; museums; folk architecture; crafts and artisanship; traditional customs.

c) ***Equipment and facilities***: accommodation (lodging) facilities; tourism food services: restaurants, bars, etc. classical or specific (with traditional dishes); leisure facilities; spa facilities.

d) ***General infrastructure***: access ways: road, railway, air, naval; technical-municipal networks: water supply, sewerage, natural gas supply, electricity, heating; ecological waste collection points.

3. Methods and materials applied

The aim of the present research was to propose an indicator for assessing the quality of tourism activity. For this purpose, the following steps were performed: research of relevant literature in the field; gathering the required information by conducting complex market research using a survey of managers of tourist accommodation establishments as a tool for data collection; obtaining the necessary information by conducting complex market research using a survey of customers of the same tourist accommodation establishments as a tool for data collection; using software to centralise data and information (Excel, MatLAB); Delphi study (opinion of specialists in the field); statistical modelling; calculation of importance coefficients; development of an indicator to assess the quality of tourism services.

The approach ranges from the conceptual-methodological dimensions to those based on probing the experimental field, dominated by information, statistics, analyses and interpretations supported by concrete situations.

4. Findings and discussions

Stages of the mathematical algorithm for assessing the quality of tourism activity

Tourism activity is among the key phenomena that have emerged in the contemporary era, its spectacular development being a highlight of the past century. The quality of tourism activity (tourism products and services) is a microeconomic indicator part of the system of tourism indicators. According to the current standard, indicators of the quality of the tourism activity are quantitative expressions and respectively qualitative assessments of the features of tourism products and services [6, p. 61].

The mathematical algorithm that we aim to put forward presupposes, in the first stage, for any given case, the existence of 5 criteria (1- extremely important, 2- very important, 3- important, 4- not very important, 5- not at all important).

Using the Delphi study (opinion of specialists in the field), we called on 10 specialists in the field of tourism to perform an assessment based on a ranking scale from 1 to 10. The next step involves calculating the mean rate of answers to three questions addressed to both managers and customers of the tourism establishments regarding the quality of the tourism activity in a given area.

1. Please rate the importance of the following aspects in your choice of an establishment (hotel, bed and breakfast, others) to stay in:

Extremely important	Very important	Important	Not very important	Not at all important
1	***2***	***3***	***4***	***5***

2. Please rate the importance of the following aspects with regard to the quality of tourism products and services offered to you:

Extremely important	Very important	Important	Not very important	Not at all important
1	***2***	***3***	***4***	***5***

3. Please rate the overall quality of services:

Extremely important	Very important	Important	Not very important	Not at all important
1	***2***	***3***	***4***	***5***

Thus, we begin with the qualitative assessment and then perform the quantitative assessment. The answers to such questions, usually expressed by the rate of answers for each lower level sub-criterion, are rendered graphically, both for customers and for businesses in a certain tourist area. One criterion includes several sub-levels (sub-criteria), for example, for the criterion (question 2 of the questionnaire) - *very important*, we have the following:

Table 1. Criteria and subcriteria

No	Criterion (c – customers; a – businesses/agents)	Sublevels (subcriteria)		
		1	2	3
1.	2. Please rate the importance of the following aspects with regard to the quality of tourism products and services offered to you:	Spatial quality	- access facilities;	
2.			- clarity of markings (signals)	
3.			- parking facilities	
4.			- facilities in the vicinity of the accommodation provider	
5.		Quality of choice	- diversity of proposals (specific features of different types of rooms)	
6.			- variety of products and services	
7.		Quality itself	- facilities parameter (5 types of standards are considered)	1. facility standards
8.				2. usage standards
9.			- staff helpfulness	3. maintenance standards
10.				4. sanitation standards
11.				5. safety standards
12.				
13.		Quality of relationship	- direct (staff-customer)	
14.			- indirect (customer-customer)	

Source: Data processed by the authors

After centralizing the ratings from 1 to 10 submitted by the experts in the field, we calculated the arithmetic mean for each criterion and sub-criterion (quality sub-levels) in order to establish an importance coefficient (CIi).

Table 2. Calculating the importance coefficients linked to the subcriteria

General criterion		Sublevel (subcriterion)			Rating
1.	Please rate the importance of the following aspects with	Spatial quality **CI_1 = 0.62**	- access facilities; **CI_{11} = 0,82**		8.2
2.			- clarity of markings (signals) **CI_{12} = 0.88**		8.8

3.	regard to the quality of tourism products and services offered to you: **CI = 0.33**		- stopover facilities **CI_{13} = 0.89**		8.9
4.			- facilities in the vicinity of the accommodation provider; **CI_{14}= 0.97**		9.7
5.		Quality of choice **CI_2 = 0.86**	- diversity of proposals (specific features of different types of rooms) **CI_{21} = 0,89**		8.9
6.			- variety of products and services **CI_{22} = 0,97**		9.7
7.		Quality itself **CI_3 = 0.72**	Facilities parameter (5 types of standards are considered) **CI_{31} = 0,73**	1. facility standards **CI = 0.91**	9.1
8.				2. usage standards **CI = 0,95**	9.5
9.				3. maintenance standards **CI = 0,92**	9.2
10.				4. sanitation standards **CI = 0,96**	9.6
11.				5. safety standards **CI = 0,97**	9.7
12.			Staff helpfulness **CI_{32} = 0.99**		9.9
13.		Quality of relationship **CI_4 = 0.87**	direct (staff-customer) **CI_{41}=1,0**		10
14.			- indirect (customer-customer) **CI_{42} = 0,87**		8.7

Source: Data processed by the authors

Calculation summary

The importance coefficient for the immediately higher sub-criterion is obtained by multiplying the lower sub-level importance coefficients. The criteria and sub-criteria are interlinked, therefore a given importance coefficient is the result of the lower level sub-criteria multiplication.

The experts' ratings provide an assessment geared towards perfection and also express the relationship between criteria and sub-criteria, respectively. Moreover, such ratings serve as strong reference when assessing the relative quality index of the activity (tourism products and services).

$CI = CI_1 \times CI_2 \times CI_3 \times CI_4 = 0.62 \times 0.86 \times 0.73 \times 0.87 = 0.33$
$CI_1 = CI_{11} \times CI_{12} \times CI_{13} \times C_{14} = 0.82 \times 0.88 \times 0.89 \times 0.97 = 0,62$
$CI_2 = CI_{21} \times CI_{22} = 0,89 \times 0,97 = 0,86$
$CI_3 = CI_{31} \times CI_{32} = 0,73 \times 0,99 = 0,72$
$CI_4 = CI_{41} \times CI_{42} = 1 \times 0,87 = 0,97$

By processing the resulting values in EXCEL, we obtained a graphical modelling of the mean frequency of answers to the questions in the survey (referring to the qualitative assessment of tourism services and products by managers and customers).

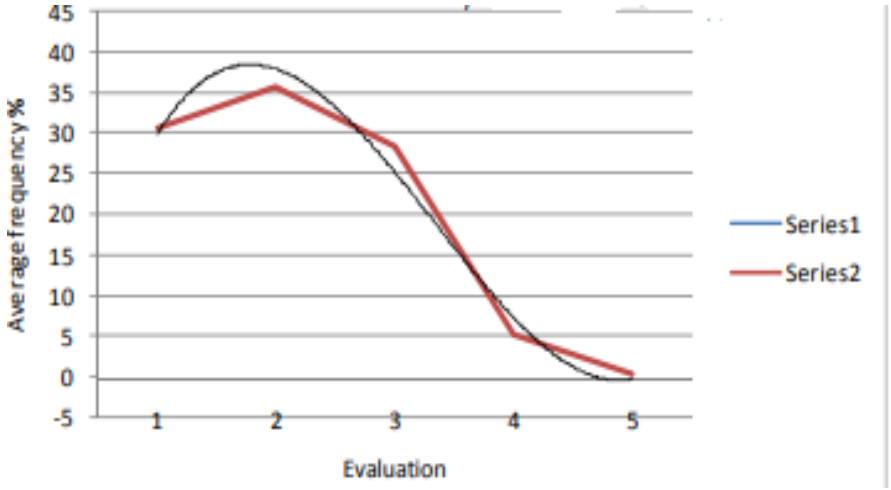

Figure 1. Modelling of results for the general criterion

As a next step, the distribution of points according to an n-degree polynomial function was modelled. The regression equation has the following general form: $\mathbf{Y_{ic(a-c)\ area} = bx^3+cx^2+dx+e}$. The regression equation is the result of modelling the results for the general criterion "Please rate the importance for you of the following aspects of the quality of tourism activity (products and services) offered".

Table 3 contains the polynomial equations obtained by modelling using the MatLAB 7 software with the **PS.m** function.

Based on the results (the bounded areas under the polynomial curves), the relative quality index of the activity (tourism products and services) is obtained, which we propose to calculate using the formula below:

$$IRCPST_{zona} = \sum_{i=1}^{m} \left[CI_{i} \cdot \frac{\int_{1}^{n} Y_{iczona}(x) \cdot dx}{\int_{1}^{n} Y_{iazona}(x) \cdot dx} \right] \quad (1)$$

where:

- $IRCPST_{zona}$ – relative quality index of the activity in the given area/zone;
- CI – importance coefficient of common criteria for customers (c) and businesses/agents (a);
- Y_{iczona} – polynomial equation for customers in the given area/zone;

- Y_{iazona} – polynomial equation for businesses in the given area/zone;
- 1 … n – integration interval according to rating levels (1 … 5) for the n degree polynomial equation:
- 1 … m – the criteria considered.

Table 3. Criterion and equation characteristic for customers and businesses

No	Criterion c – customers; a – businesses / agents;	Equation for the given area/zone is: $Y_{ic(a-c)\ zone} = bx^3+cx^2+dx+e$, i = criterion.	
		Customers	**Businesses**
1	2.c/a Please rate the importance of the following aspects with regard to the quality of tourism products and services offered to you. **CI_2 = 0.33**	y_{2cVD} =(2.414*x.^3 - 24.725*x.^2+ 67.213*x - 18.288); y_{2cNT} =(3.59*x.^3 - 36.508*x.^2+ 101.69*x - 45.027); y_{2cBE} =(3.8021*x.^3 - 35.787*x.^2+ 89.458*x - 25.813); ***Area:*** ***A_{2cVD} = 83.9010*** ***A_{2cNT} = 84.3529*** ***A_{2cBE} = 84.7916***	y_{2aVD} =(3.1136*x.^3 -29.498*x.^2+ 71.831*x -11.131); y_{2aNT} =(0.9567*x.^3 -14.306*x.^2+ 51.474*x -20.609); y_{2aBE} =(-9.2448*x.^3+ 88.449*x.^2 - 258.56*x+ 238.75); ***Area:*** ***A_{2aVD} = 89.7885*** ***A_{2aNT} = 84.3735*** ***A_{2aBE} = 45.1230***

Source: Data processed by the authors using MatLAB 7 with PS.m function [4, pp. 11-21]

$$\frac{\int_1^n Y_{iczona}(x)\cdot dx}{\int_1^n Y_{iazona}(x)\cdot dx}$$ (2), is the ratio of the areas for each distinct criterion.

The ratio of areas is equivalent to the ratio of demand (customers) according to questions and supply (businesses). Ideally, under equilibrium conditions, customer demand should be equal to the available offer of businesses and, as a result, the quality index should be characterised by the sum (Ci) value. A lower minus would mean that businesses offer more than customers' demand.

The proposed calculation methodology considers the assessment of the criteria in relation to:

- Customers' evaluation;
- Managers' evaluation;
- Ratings by specialists.

5. Conclusions

Indicators of the *quality of the tourism activity* serve to inform decision-makers on the state of the system at a given moment or on its evolution in time. Based on such indicators, decisions

can be made to mitigate seasonality by: making the best use of equipment and facilities; rational use of labour; changing tourist flows in favour of international ones; obtaining a higher volume of income; superior benefits and profitability based on the same material and human resources; diversifying the range of services; optimising the offer structure; cost reduction; increasing labour productivity [5, p. 192].

The results derived from the research allow us to draw some conclusions. Thus, we noticed that the models developed by most specialists rely on assessing the quality of services based on individual experience of the customer with regard to a particular service.

According to this perspective, the quality of tourism activities can be assessed by consumers only after consuming the service or product and according to their perception. As regards quality measurement, most models do not offer an explanation of how it could be performed/quantified. Through the proposed indicator, we took into account customers' opinions about the quality of tourism activities in addition to the opinion on the quality offered by specialists and providers in the field.

In our case, the quality of tourism activity is derived from the ratio between the quality demanded by the customer and the quality offered by the supplier. Both the quality demanded and the quality offered are based on the same quality aspects. One can observe significant differences between the two categories of subjects (managers and customers), following the analysis of polynomial equations obtained from modelling the mean frequency. It is obvious that the quality of tourism activity perceived by customers is lower than that offered by managers.

From a strategic and operational point of view, managers of tourist accommodation establishments should act to improve the quality of tourism activity in order to raise the relative quality indicator, compared to the maximum ideal value. Consequently, there will be a harmonisation of customers' quality requirements with the offer of tourist accommodation establishments.

The proposed algorithm represents an original contribution and leaves room to adding other criteria and to completing the model, taking into account the complexity of the tourism system. We believe that this indicator could be included in the quality of life indicators. The obtained results, namely the calculation relation of this indicator, reflect a particular situation of quality tourism activity, requested by clients and offered by the tourist accommodation establishments.

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Rezumat

Complexitatea şi eterogenitatea produsului turistic, are implicaţii profunde asupra eficienţei acestui sector în ceea ce priveşte lărgirea spectrului de acoperire şi evaluare, exprimând rezultatul unei serii de activităţi specifice: transportul turistic, alimentaţia publică, furnizarea altor servicii de bază şi complementare servicii, vânzări de bunuri, turism intern şi internaţional, rezultatele, prin natura lor, având atât efecte directe, cât şi indirecte. Diversitatea serviciilor, caracterul sezonier al turismului rural, tipologia formelor de turism, categoria preţurilor şi tarifelor implică utilizarea unui sistem de indicatori, care pot fi trataţi ca un sistem cibernetic. În această lucrare, după o selecţie riguroasă şi o analiză critică a conceptelor, ne-am propus să stabilim o metodă alternativă de evaluare a calităţii în turism.

Scopul cercetării a constituit propunerea unui indicator de evaluare a calităţii activităţii turistice. Printre obiective am realizat: studiul bibliografiei aferente; obţinerea informaţiilor necesare prin realizarea unor cercetări complexe de piaţă folosind chestionarul aplicat managerilor structurilor de cazare turistică ca instrument pentru colectarea datelor; obţinerea informaţiilor necesare prin realizarea de cercetări complexe de piaţă cu ajutorul chestionarului aplicat clienţilor aceloraşi structuri de cazare turistică ca instrument pentru colectarea datelor; aplicarea programelor pentru centralizarea datelor şi a informaţiilor (Excel, MatLAB), studiului Delphi (opinia specialiştilor în domeniu), modelării statistice; calculul coeficienţilor de importanţă; dezvoltarea unui indicator de evaluare a calităţii serviciilor turistice.

Algoritmul pentru evaluarea indicelui de calitate al activităţii turistice pe care l-am propus, reprezintă contribuţie originală şi se bazează pe analiza comparativă a răspunsurilor agenţilor economici respective a clienţilor dintr-o anumită zonă turistică şi pe evaluarea subcriteriilor de către experţi.

***Cuvinte-cheie**: turism, algoritm, calitatea activităţii turistice, criteriu, evaluarea activităţii turistice, indicatori*

Аннотация

Сложность и неоднородность туристического продукта оказывают значительное влияние на эффективность сектора с точки зрения расширения спектра охвата и оценки комбинации специфических видов деятельности: туристический транспорт, общественное питание, предоставление других основных и дополнительных услуг, продажа товаров, внутренний и международный туризм, с результатами прямого и косвенного влияния. Разнообразие услуг, сезонный характер сельского туризма, типология форм туризма, ценовые и тарифные категории предполагают

использование системы показателей, которую можно рассматривать как кибернетическую. В этой статье, после тщательного отбора и критического анализа концепций, авторы попытались создать альтернативный метод оценки качества туристической деятельности.

Целью исследования состояло в предложении авторами показателя оценки качества туристической деятельности. В этом контексте были выполнены следующие задачи: изучение соответствующей литературы; сбор необходимой информации путем проведения комплексного исследования рынка с использованием опроса руководителей учреждений размещения туристов в качестве инструмента сбора данных; получение необходимой информации путем проведения комплексного исследования рынка с использованием опроса клиентов тех же туристических объектов размещения в качестве инструмента для сбора данных; использование программного обеспечения для централизации данных и информации (Excel, MatLAB), исследования Delphi (мнения специалистов в данной области), статистического моделирования; расчет коэффициентов значимости; разработка показателя оценки качества туристических услуг.

Предложенный алгоритм оценки показателя качества туристической деятельности считаем оригинальным вкладом, основанным на сравнительном анализе ответов на опросы предприятий и клиентов в определенной туристической зоне и на оценке подкритериев экспертами.

***Ключевые слова**: туризм, алгоритм, качество туристической деятельности, критерий, оценка туристической деятельности, показатели*

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