DECISION-MAKING MODEL FOR ASSESSING THE QUALITY OF SERVICES IN HOTELS

Abstract: The aspiration to achieve comparative advantages in the tourism of the Republic of Serbia has increased the competitiveness of this branch. Various measures in order to achieve the expected results are being undertaken. One of the measures is the decision of the Belgrade Chamber of Commerce on the development of criteria for evaluating the quality of services. Application of multi-criteria decision-making (Analytic hierarchy process (AHP) and Technique for Order Preference by Similarity to Ideal Solution method (TOPSIS)) method and their computer support in making decisions for the given problem greatly simplifies and speeds up the process. The application program, created for the purpose of solving this problem simply provides solutions after entering the data. The aim of this work is to, by solving this problem, point to the necessity, assistance and importance of the scientific discipline of decision-making theory and decision-making support systems in everyday decision-making that are applied by individuals or groups, solving this problem.

Keywords: tourism, multi-criteria decision-making, AHP, TOPSIS, IKOR.
1. Introduction

Tourism, although not an economic activity such as industry, transport, trade, can be considered one of the industries in the world whose further growth can be expected. It represents an important export product, which is, among other things, employment generator and in a number of analysis one of the most dynamic phenomena that affect other economic sectors. Tourism Development Strategy of the Republic of Serbia points to the fact that tourism is a little used source of economic growth in the Republic of Serbia, it was never a serious issue of development policy and its potentials have not been valorized.

In order to improve competitiveness and achieve the expected results, various decisions are used in an attempt to overcome the existing problems. One of these decisions is the development of criteria for evaluating the quality of services provided by hotels in Belgrade. This is of great importance when it comes to standardization of services and specifying minimum conditions, which among other things provide better information and realistic expectations of consumers. Application of multi-criteria decision-making with its different methods and their IT support significantly facilitates and accelerates this process in making decisions for the given problem.

2. Measures for improvement of tourism in the city of Belgrade

Today, the Republic of Serbia has only comparative advantages in tourism, because it can offer different types of tourist destinations. Competitive advantages in tourism of the Republic of Serbia are conditioned by the political attitude towards tourism as an important creator of national prosperity. In order to overcome a number of shortcomings that prevent transforming comparative into competitive advantages, related to services of hotels and restaurants, the

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1 Ognjanović Jasmina (2020): “Brend poslodavca i performanse radne snage u hotelskim preduzećima”, Menadžment u hotelijerstvu i turizmu, 8(2), str. 65-78.
2 Tasić Jelena (2018): “Budući trendovi i pravci razvoja ruralnog turizma u Srbiji i u svetu”, Oditor, 4(3), str. 7-19
3 Milosavljević Stefan, Pantelejić, Đorđe & Mededović Damir (2019): “Primena i mogućnost unapređenja ekonomskih činilaca u realizaciji održivog razvoja”, Održivi razvoj, 1(1), str. 7-16
6 Milićević Snažana & Trišić Igor (2019): “Ekonomski i socio-kulturni efekti razvoja turizma u turističkim destinacijama”, Megatrend revija, 16(2), str. 21-38
7 Vukolić Dragan (2020): “Gastronomski proizvodi u funkciji razvoja različitih oblika turizma u Sremskom okrugu”, Održivi razvoj, 2(2), str. 41-54
Belgrade Chamber of Commerce has developed criteria for assessing the quality of hotel services. This internal standard was adopted by the decision of the Board of Directors of the Belgrade Chamber of Commerce, No. 01-8/41 of 26 September 2003. The aim of the adoption of this internal standard is to define criteria for assessing the quality of services provided by hotels in Belgrade. These criteria would be used by the assessors of the Belgrade Chamber of Commerce in the assessment of the quality of services provided by hotels in Belgrade. The hotel being evaluated must meet the conditions of internal standards listed below.

Based on the Report submitted by the hotel in accordance with the Rules, the fulfillment of conditions is assessed by:

a) The Chamber related association, which the hotel by its activities belongs to, by checking compliance with the following conditions:
   − positive business;
   − average capacity utilization in the past and/or current year of more than 60%;
   − normal inspection findings;
   − no negative reviews received from the Consumers Association and other organizations;
   − environment and health protection.

b) The Centre for Business Education and Quality Improvement – the Chamber Sector for Business Education by checking the training of hotel staff in the field of:
   − business communication;
   − personal style and image;
   − hygiene and conditions for the production of safe food;
   − marketing and
   − other areas.

3. Research instruments and methods

The definition of one of the pioneers of management Henry Fayol is a wider used definition and a guide mark for its further definition and explanation management: Management is the process of forecasting, organization, command, coordination and control. It is a process or function most important for each company, including enterprise management business. Basic management functions can be seen in the schematic view, which is the most understandable assessment of their settings.

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Decision-making is seen as an integral part of any management function and a factor of cohesion between these functions, whose work is a result of management decision.

### 3.1. Decision-making

Any decision as a choice of one, from a set of possible alternatives (actions), whereby in the set there must be at least two alternatives implies the existence of a decision-maker (everyone who works in the business environment, bearing the full responsibility for a certain section). It is the entity authorized and responsible for solving the decision-making problem (problem situation) and making a decision. The decision-making problem can be seen as an event that has consequences that create the problem or problem situation, which adversely affect the achievement of the goals set. Within the resulting problem situation, there may be one or more decision problems to be solved. The decision is made for each decision-making problem. The attention is focused on three aspects, as follows: 1) decision-making process, 2) decision-maker, and 3) decision itself. The decision maker has several alternatives, so his choice involves comparing these alternatives and an analysis of their consequences. The decision may involve a moment in one ongoing process of analysis of alternatives that is implemented in order to achieve a certain goal, where a decision-maker needs to choose an action that probably leads to achieving the set goal.

Decision-making analysis as “a formalized process of increasing human understanding and management in terms of a given environment” is a relatively new field in the theory of decision-making. It is a philosophy that allows a systematic and formal approach to the issue of decision-making, and at the same time provides a practical approach to the problem by using the necessary concepts. However, decision-making theory cannot fully replace the intuitive thinking of each individual. Decision-making theory should help the decision-maker’s judgment is as successful as possible. The basis of the decision-making process consists of several stages that need to be defined. Firstly, you need to define a system or problem and its parameters. The second step is to determine decision-making criteria or objectives to be achieved (the most significant step). The third step is to formulate a relationship between the parameters and the criteria i.e. model.

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The fourth step is to generate the alternatives or actions that are available to the decision-maker as a choice when making a decision, by changing the parameter values. As a final stage, there is a choice of action that best meets the set criteria. Although the authors variously define the number and scope of the stages, common key words link the process. The main problem is the failure to recognize the real problem, as a result of the subjective factor, i.e. the man himself.

3.2. Multiple-criteria Decision-making

Real needs to solve problems with more criteria functions open a new chapter of mathematical programming called multiple-criteria programming. “All classical optimization methods use only one criterion in decision-making or solving a problem, which drastically reduces the reality of the problems that can be solved”\(^\text{13}\). On the other hand, the presence of a number of criteria in decision-making models also has negative characteristics. The models become considerably more complex in the mathematical sense, and there is a danger that the solution to the problem includes only some of the set criteria\(^\text{14}\). Therefore, the real problems were resolved on a case-by-case basis, and only later, the developed methods were formalized and launched as methods of solving problems for individual categories of problems. The range of problems for multiple-criteria decision-making is wide, but all these problems have some common elements:

− numerous criteria (objective function, criteria function), or decision-making attributes, created by the decision-maker;
− conflict between the criteria, as the most common case in real problems;
− incomparable units of measurement for different criteria;
− a number of alternatives (solutions) for selection and
− the process of selecting a final solution, it could be designing the best action (alternative) or a selection of the best action from a set of pre-defined final actions.

3.3. AHP – Analytic Hierarchy Process

There are numerous methods for solving multi-criteria decision-making models that can be classified based on several criteria. The most acceptable nowadays are as follows:

− method ELECTRE;
− method PROMETHEE;

\(^{13}\) Stankova Michaela & Hampel David (2018): “Bankruptcy prediction of engineering companies in the EU using classification methods”, Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis, 66(5), pp. 1347-1356

– method AHP (analytic hierarchy process);
– method TOPSIS;
– method SAW and others.

AHP method\textsuperscript{15} is one of the most popular and commonly used decision-making methods when the decision is based on several attributes used as criteria. That is, this method can find solutions of multiple attribute decision-making, i.e. the solution to the problem of choice of the best alternative from a set of available alternatives. It is based on the principle of decision-making, human knowledge and information that decision-makers have in the decision-making process\textsuperscript{16}. It is used for finding a solution to a wide range of management issues, ranging from very simple to very complex. The problems the decision-makers are faced with and requirements of the environment (situation) for rapid reaction are elements that cannot be reconciled without IT support to the decision-making process. In this paper, the decision is related to the choice of some of the available alternatives (offers) or their ranking.

In solving the problem, three components can be identified. These are: 1) the decomposition of the system, 2) comparative evaluation and 3) synthesis of priorities. The decomposition of the system means to make a hierarchical structure, with the basic elements of the system, namely: objective (goal), criteria (sub-criteria) and alternatives. The second component is a mathematical model, used to calculate the priorities in the weight of elements that are at the same level of hierarchical structure. The mathematical model is the basis for the generation of a rating scale. The third component of the model means that the obtained local priorities of criteria, sub-criteria and alternatives are synthesized in the overall priorities of the alternatives. At the beginning of this method, it is necessary to define the hierarchical model and its elements, with the objective (goal) at the top, the criteria and sub-criteria at the next levels, and finally, the alternatives at the last level.

3.4. TOPSIS method

(\textit{Technique for Order Preference by Similarity to Ideal Solution})

TOPSIS method is based on the concept that the selected alternative should have the shortest distance from the positive ideal solution and the longest distance from the negative ideal solution, whose values have to be pre-determined. The optimum alternative is the one that has the shortest geometric distance from the positive ideal solution and the longest geometric distance from the negative ideal solution.


A method of calculating TOPSIS method consists of 6 steps, as follows:
Step 1. Normalizing decision-making matrix;
Step 2. Multiplying normalized matrix by weight coefficients;
Step 3. Determining ideal solutions;
Step 4. Determining distance of alternatives from ideal solutions;
Step 5. Determining relative proximity of alternatives from ideal solution;
Step 6. Ranking alternatives.

The ideal solution is defined by top rating values of alternatives for each criterion; conversely, the negative ideal solution has the worst rating values of alternatives.

The benefits of using TOPSIS method are:
- The user can express their preferences through assigning weight coefficients to criteria (through determining relative weight of criteria);
- Easy to use;
- Clearly defined alternative rankings.

Disadvantages of using TOPSIS method are:
- The solution depends directly on the input values (evaluating alternatives by criteria);
- The criteria are linear.

3.5. IKOR method (Iterative Compromise Ranking)

The basic idea of IKOR method¹ is that after the normalization relative to the minimum and maximum element of the criteria is performed, a compromise between the minimax strategy and the strategy of expected value is set. The method is iterative in the sense that the decision-maker iteratively takes part in the search for a solution that is the result of a compromise. The decision-maker defines the extent of attaching importance to one or the other strategy. In IKOR method, the compromise is established between 1. Strategy of maximum group benefit (it is the expected value) and 2. MINIMAX strategy (the alternative that has the least bad feature is selected). Ranking alternatives is done through the total order of the alternatives, which is obtained as a result of a compromise.

The characteristics of these methods are shown only to the extent necessary for understanding of their application in decision-making concerning the choice of some of the available alternatives (offers) or their ranking.

3.6. Decision-making support systems

In decision-making process, people have always needed some support. Today, it cannot be imagined without information technologies and systems. Decision-making support is necessary for at least three reasons: in almost all decision-making situations there is a large amount of data that needs to be processed and to do this a proportional amount of time is required; the time for decision-making is always limited, i.e. there is a time period in which it is necessary to make a decision. As a rule, this period is always less than the period needed to process all the data available; there is a need of a decision-maker to make the right decision; in addition to the fact that successful decisions raise the decision-maker’s reputation, they also affect the quality of functioning of the whole organization. At the present time, the decision-making support is commonly referred to as business intelligence, and can be defined as a set of information technologies, organizational rules as well as the knowledge and skills of employees in the organization, united in generating, recording, integration and analysis of data with the aim to reach the necessary knowledge for decision-making. Decision Support Systems (DSS) are information systems, which are similar and complementary to standard information systems and aim to support mainly decision-making business processes.

The problems to be solved from the standpoint of decision-making can be structured, semi-structured and unstructured. When the problem is structured, it can be relatively easy to define, while it is significantly harder for the remaining two cases. Transferring decision-making problems from unstructured into the structured ones is one of the most important tasks of decision support and led to the emergence of Decision Support Systems (DSS) as the first tool that can tackle unstructured problems.

4. Results and Discussion

The quality assessment of hotel services in Belgrade based on the criteria established by internal standard and developing the appropriate decision support system is a problem that will be solved in the paper using the combination of AHP and TOPSIS methods. Problem solving is based on the principle

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21 Suknović Milija & Delibašić Boris (2010): Business intelligence and decision support systems, Belgrade, R. Serbia: Faculty of Organizational Sciences
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of decision-making, human knowledge and information that decision-makers have in the decision-making process. It can be used for finding a solution to a wide range of management issues, ranging from very simple to very complex. The problems the decision-makers are faced with and requirements of the environment (situation) for rapid reaction are elements that cannot be reconciled without IT support to the decision-making process (www.odlucivanje.fon.rs). The advantage of all multiple-criteria decision-making methods is software support. Problem solving will be carried out using a combination of AHP and TOPSIS methods, whose implementation will lead to the optimal solution, facilitate decision-making and ensure the scientific basis of the overall decision-making process. Checking the results obtained shall be done using IKOR method.

The criteria for the evaluation of alternatives in this case are:

\begin{enumerate}
\item[$K_1$] Positive business. It is determined on the basis of balance sheet and income statement. The balance sheet shows assets, liabilities and equity at a specific time (usually at the end of the year or half a year) and is a picture of the financial situation of the company at a specific time. The income statement shows the revenues and expenses of a company for a specified period, usually for one year or half a year and describes the profitability of the company over time.
\item[$K_2$] Average capacity utilization in the past and/or current year of more than 60%. In tourism, capacity relating to catering facilities is the ability of a catering business unit to achieve a certain effect per unit of time, expressed in the appropriate trade (supply and delivery) of catering products and services. Accommodation capacities are expressed in the number of beds and rooms. Capacity utilization of a catering business unit is defined as the relationship between the achieved and possible effects in a given time period and is expressed as a percentage. Let us say that a hotel has 200 beds, works throughout the year, and that for the year had 55,000 overnight stays. Its maximum capacity or maximum capacity utilization would be 200 beds x 365 days = 73,000 overnight stays (100%). However, capacity utilization level of this hotel for the year is 75% (55,000 overnight stays), and is obtained by the formula:

\[ \text{Capacity utilization level} = \frac{\text{the achieved number of overnight stays}}{\text{possible number of overnight stays}} \times 100. \]

\item[$K_3$] Normal inspection findings (including environment and health protection). Hotels are subject to the following republic inspections:

\begin{itemize}
\item Market Inspection.
\item Republic Market Inspection is responsible for:
\begin{itemize}
\item Supervision of trade in goods and services;
\end{itemize}
\end{itemize}
\end{enumerate}

Quality control of industrial non-food products;
Consumer protection supervision;
Control of criteria and units of measurement;
Control of the use of trademarks and service marks, quality signs and origin labels;
Market supply and price controls;
Prevention of unfair competition;
Defining the conditions for carrying out economic activities.

Tourist Inspection:
Republic Tourist Inspection is responsible for:
− Supervision of catering activities;
− Control and categorization of catering facilities;
− Supervision of travel agencies;
− Service delivery supervision in tourism.

Sanitary Inspection:
Republic Sanitary Inspection is responsible for:
− Health and sanitary control in the field of protection of population from infectious diseases, food and consumer product safety, trade and import, the public supply of drinking water;
− Control of sanitary and hygienic condition of the buildings, plants, machinery, equipment, furniture and accessories used for carrying out activities under sanitary supervision;
− Sanitary supervision of persons who are legally placed under health and sanitary control, as well as control of persons and their belongings in international traffic;
− Determining sanitary-hygienic and health conditions of facilities under sanitary supervision in the construction and reconstruction procedures.

Labor Inspection:
Republic Labor Inspection is responsible for:
− Control of implementation of regulations in the field of the Labor Law;
− Control of implementation of the Law and other legislative acts in the field of health and safety at work (occupational safety and health).

Inspection for Environmental Protection:
Republic Inspection for Environmental Protection is responsible for:
− Protection of air, water, land and protection from noise and vibration of the facilities whose business licence is issued by the competent ministry;
− Control and categorization of catering facilities;
− Protection from ionizing and non-ionizing radiation, the handling of hazardous materials and ozone-depleting substances;
− Protection and use of natural resources (fish, basic geological research, and for groundwater detailed investigations, as well), protected natural resources, trade and use of protected wild fauna and flora;
Control of transboundary movement (import, export and transit) of poisons, hazardous wastes and their disposal, ozone-depleting substances, sources of ionizing radiation and protected plant and animal species, radiation control.

Veterinary Inspection:
- Veterinary control and supervision of animal source foods is carried by the Department of food safety and quality control of products, raw materials and animal wastes.

Tax Administration Inspection:
- Control and supervision of collecting public revenues is carried out by the tax police.

No negative reviews received from the Consumers Association and other organizations. Consumer protection is a constitutional category, which clearly shows the commitment of the state to conduct an active policy of consumer protection and the construction of the legal system in this area, which corresponds to a modern democratic society. The basic principles of the association are to protect the interests of consumers, the protection of legal goods and services, and therefore quality.

The first sub-system of the decision support system is a database, which in our case includes the data collected and shown in Table 1.

### Table 1: Decision matrix (data base)

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Alternatives</th>
<th>K₁</th>
<th>K₂</th>
<th>K₃</th>
<th>K₄</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hotel 1</td>
<td>800 000</td>
<td>60%</td>
<td>FO</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Hotel 2</td>
<td>1 000 000</td>
<td>80%</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Hotel 3</td>
<td>1 100 000</td>
<td>55%</td>
<td>FO</td>
<td>C (1 user)</td>
</tr>
<tr>
<td></td>
<td>Hotel 4</td>
<td>900 000</td>
<td>70%</td>
<td>LI</td>
<td>-</td>
</tr>
</tbody>
</table>

Source: Author’s research.

FO-financial offense; LI-violation within the jurisdiction of the labor inspection; C-complaints

### Table 2: Quantified input data

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Alternatives</th>
<th>K₁</th>
<th>K₂</th>
<th>K₃</th>
<th>K₄</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hotel 1</td>
<td>800 000</td>
<td>60%</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Hotel 2</td>
<td>1 000 000</td>
<td>80%</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Hotel 3</td>
<td>1 100 000</td>
<td>55%</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Hotel 4</td>
<td>900 000</td>
<td>70%</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

Source: Author’s research.

To determine the relative weights of the criteria, or their relevance, AHP method will be used. To assess the relative weights of the criteria, the Saaty rating scale will be used.
### Table 3: Assessment of the relative weights of criteria

<table>
<thead>
<tr>
<th></th>
<th>K₁</th>
<th>K₂</th>
<th>K₃</th>
<th>K₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>K₁</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>7</td>
</tr>
<tr>
<td>K₂</td>
<td>0.5</td>
<td>1</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>K₃</td>
<td>0.2</td>
<td>0.3333</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>K₄</td>
<td>0.1428</td>
<td>0.2</td>
<td>0.3333</td>
<td>1</td>
</tr>
<tr>
<td>Σ</td>
<td>1.8428</td>
<td>3.5333</td>
<td>9.3333</td>
<td>16.0000</td>
</tr>
</tbody>
</table>

**Source:** Author’s research.

### Table 4: Calculating eigenvector of the corresponding eigenvalues

<table>
<thead>
<tr>
<th></th>
<th>K₁</th>
<th>K₂</th>
<th>K₃</th>
<th>K₄</th>
<th>Σ</th>
<th>W(Σ/4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>K₁</td>
<td>0.5427</td>
<td>0.5660</td>
<td>0.5357</td>
<td>0.4375</td>
<td>2.0819</td>
<td>0.5205</td>
</tr>
<tr>
<td>K₂</td>
<td>0.2713</td>
<td>0.2830</td>
<td>0.3214</td>
<td>0.3125</td>
<td>1.1883</td>
<td>0.2971</td>
</tr>
<tr>
<td>K₃</td>
<td>0.1085</td>
<td>0.0943</td>
<td>0.1071</td>
<td>0.1875</td>
<td>0.4975</td>
<td>0.1244</td>
</tr>
<tr>
<td>K₄</td>
<td>0.0775</td>
<td>0.0566</td>
<td>0.0357</td>
<td>0.0625</td>
<td>0.2323</td>
<td>0.0581</td>
</tr>
</tbody>
</table>

**Source:** Author’s research.

TOPSIS method will be applied in the second part of the model to find the optimal solution to the observed problem.

### Table 5: Decision matrix that should be normalized

<table>
<thead>
<tr>
<th>Criteria</th>
<th>K₁</th>
<th>K₂</th>
<th>K₃</th>
<th>K₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternatives</td>
<td>w₁=0.5</td>
<td>w₂=0.3</td>
<td>w₃=0.1</td>
<td>w₄=0.1</td>
</tr>
<tr>
<td>Hotel 1</td>
<td>8,000</td>
<td>60,000</td>
<td>3,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>10,000</td>
<td>80,000</td>
<td>9,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>11,000</td>
<td>55,000</td>
<td>3,000</td>
<td>7,000</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>9,000</td>
<td>70,000</td>
<td>7,000</td>
<td>9,000</td>
</tr>
</tbody>
</table>

**Source:** Author’s research.

### Table 6: Normalized decision matrix

<table>
<thead>
<tr>
<th>Criteria</th>
<th>K₁</th>
<th>K₂</th>
<th>K₃</th>
<th>K₄</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternatives</td>
<td>w₁=0.5</td>
<td>w₂=0.3</td>
<td>w₃=0.1</td>
<td>w₄=0.1</td>
</tr>
<tr>
<td>Hotel 1</td>
<td>0.4181667</td>
<td>0.4481482</td>
<td>0.246598</td>
<td>0.526685</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>0.52270837</td>
<td>0.5975309</td>
<td>0.739795</td>
<td>0.526685</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>0.57497921</td>
<td>0.4108025</td>
<td>0.246598</td>
<td>0.409644</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>0.47043754</td>
<td>0.5228396</td>
<td>0.575396</td>
<td>0.526685</td>
</tr>
</tbody>
</table>

**Source:** Author’s research.
Table 7: Multiplication of the normalized matrix values with the criteria weighting coefficients

<table>
<thead>
<tr>
<th>Criteria</th>
<th>$K_1$</th>
<th>$K_2$</th>
<th>$K_3$</th>
<th>$K_4$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternatives</td>
<td>0,5</td>
<td>0,3</td>
<td>0,1</td>
<td>0,1</td>
</tr>
<tr>
<td>Hotel 1</td>
<td>0,209</td>
<td>0,134</td>
<td>0,025</td>
<td>0,053</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>0,261</td>
<td>0,179</td>
<td>0,074</td>
<td>0,053</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>0,287</td>
<td>0,123</td>
<td>0,025</td>
<td>0,041</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>0,235</td>
<td>0,157</td>
<td>0,058</td>
<td>0,053</td>
</tr>
</tbody>
</table>

Source: Author’s research.

It follows that:

Ideal solution is: $A^* = \{0.287, 0.179, 0.074, 0.053\}$

Negative ideal solution is: $A^- = \{0.209, 0.123, 0.025, 0.041\}$

If $S_i^*$ and $S_i^-$ denote the distance from the ideal solutions we get the results shown in Table 8.

Table 8: Determining distance of alternatives from ideal solutions

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>$S_i^*$</th>
<th>$S_i^-$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel 1</td>
<td>0,102899668</td>
<td>0,01620214</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>0,026135419</td>
<td>0,09186803</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>0,075547959</td>
<td>0,07840626</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>0,059199685</td>
<td>0,05505302</td>
</tr>
</tbody>
</table>

Source: Author’s research.

The next phase is to determine the relative proximity of alternatives to the ideal solution by using the following formula:

$$Q_i^* = S_i^- / S_i^* + S_i^- , \ i = 1, \ldots, n$$

Based on the solutions obtained, alternative ranking can be performed:

Table 9: Alternative ranking

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Relative proximity</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel 1</td>
<td>0,136036048</td>
<td>4</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>0,778519869</td>
<td>1</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>0,509282946</td>
<td>2</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>0,481853081</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Author’s research.
Based on the conducted TOPSIS method, a solution obtained is that the best quality of service in terms of the criteria established by the internal standard is in the hotel number 2, which achieved the highest ranking of all the alternatives.

By applying IKOR method, we will check the results obtained:

**Table 10: Decision table that should be normalized**

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Criteria 1 ( w_1 = 0.5 )</th>
<th>Criteria 2 ( w_2 = 0.3 )</th>
<th>Criteria 3 ( w_3 = 0.1 )</th>
<th>Criteria 4 ( w_4 = 0.1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel 1</td>
<td>8,000</td>
<td>60,000</td>
<td>3,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>10,000</td>
<td>80,000</td>
<td>9,000</td>
<td>9,000</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>11,000</td>
<td>55,000</td>
<td>3,000</td>
<td>7,000</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>9,000</td>
<td>70,000</td>
<td>7,000</td>
<td>9,000</td>
</tr>
</tbody>
</table>

**Source:** Author’s research.

**Table 11: Normalized decision table**

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Criteria 1 ( w_1 = 0.5 )</th>
<th>Criteria 2 ( w_2 = 0.3 )</th>
<th>Criteria 3 ( w_3 = 0.1 )</th>
<th>Criteria 4 ( w_4 = 0.1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel 1</td>
<td>1</td>
<td>0.8</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>0.333</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>0.67</td>
<td>0.4</td>
<td>0.333</td>
<td>0</td>
</tr>
</tbody>
</table>

**Source:** Author’s research.

**Table 12: Multiplication of decision table weights**

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Criteria 1 ( w_1 = 0.5 )</th>
<th>Criteria 2 ( w_2 = 0.3 )</th>
<th>Criteria 3 ( w_3 = 0.1 )</th>
<th>Criteria 4 ( w_4 = 0.1 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel 1</td>
<td>0.5</td>
<td>0.24</td>
<td>0.1</td>
<td>0</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>0.1665</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>0</td>
<td>0.3</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>0.335</td>
<td>0.12</td>
<td>0.0333</td>
<td>0</td>
</tr>
</tbody>
</table>

**Source:** Author’s research.

**Table 13: Calculating utility and minmax strategy**

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>utility ( w_1 = 0.5 )</th>
<th>minmax ( w_2 = 0.5 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel 1</td>
<td>0.84</td>
<td>0.5</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>0.1665</td>
<td>0.1665</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>0.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>0.4883</td>
<td>0.335</td>
</tr>
</tbody>
</table>

**Source:** Author’s research.
Table 14: Calculating compromise and, on the basis of the obtained solutions, alternative ranking can be performed

<table>
<thead>
<tr>
<th>Alternatives</th>
<th>Compromise</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hotel 1</td>
<td>0.67</td>
<td>4</td>
</tr>
<tr>
<td>Hotel 2</td>
<td>0.166</td>
<td>1</td>
</tr>
<tr>
<td>Hotel 3</td>
<td>0.4</td>
<td>2</td>
</tr>
<tr>
<td>Hotel 4</td>
<td>0.41</td>
<td>3</td>
</tr>
</tbody>
</table>

Source: Author’s research.

Based on the conducted IKOR method, a solution obtained is that the best quality of service in terms of the criteria established by the internal standard is in the hotel number 2, which achieved the highest ranking of all the alternatives.

5. Conclusion

For a quality decision that is the result of the best possible solution at the given time, it is necessary to take into account all the available real data, process them through acceptance of the principles of science and profession, and to perform evaluation. Today’s conditions include making decisions in situations where there is a large variety of often mutually conflicting criteria. Methods for multiple decision-making are imposed as a perfect decision-making tool. The necessity of making decisions faster than the others has made the concept of business intelligence an essential tool for managers in making business decisions.

This paper presents a model of multiple-criteria decision-making using AHP and TOPSIS methods and decision support system applied to the case of evaluation of the quality of services provided by hotels in Belgrade, based on the criteria established by the internal standard. The aim was to show the practical application of some of the methods for multiple-criteria decision-making and decision support systems in making important decisions. We have chosen a combination of AHP and TOPSIS methods for multiple-criteria decision-making and the program created in Excel, by which we formed a multiple-criteria decision analysis model for the assessment of the quality of services provided by hotels in Belgrade. Four hotels were selected as alternatives. Multiple-criteria decision analysis in this case undoubtedly offered a solution to the problem based on the real data. The model provides a number of options, and alternatives can be compared by one criterion or several criteria, depending on the preferences of a decision-maker. In addition, the hotels can use the model for comparison with the competition, as well as in order to identify their own weaknesses that need to be eliminated to attract users.


MODEL ODLUČIVANJA
PRI OCENI KVALITETA USLUGA U HOTELIJERSTVU

Sažetak: Težnja za ostvarivanjem komparativnih prednosti u turizmu Republike Srbije povećala je konkurentnost ove grane. Preduzimaju se različite mere u cilju dostizanja očekivanih rezultata. Jedna od meri je i odluka Privedne komore Beograda o izradi kriterijuma za ocenu kvaliteta usluge. Primena višekriterijumskog odlučivanja (analitičko hijerarhijski proces (AHP) i TOPSIS metoda) i njihova informatička podržanost u donošenju odluka za posmatrani problem, znatno olakšava i ubrzava ovaj proces. Primena programa, izrađenog za potrebe rešavanja ovog problema jednostavno daje rešenja nakon unošenja podataka.
Cilj ovog rada je da se rešavanjem ovog problema, ukaže na nužnost, pomoć i značaj naučne discipline teorije odlučivanja i sistema za podršku odlučivanju, u svakodnevnom donošenju odluka koje primenjuju pojedinci ili grupe, rešavanjem ovog problema.

Ključne reči: turizam, višekriterijumsko odlučivanje, AHP, TOPSIS, IKOR.