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USE OF DASHBOARDS IN PREDICTING THE DEVELOPMENT OF THE COMPANY USING NEURAL NETWORKS IN HOTEL MANAGEMENT

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Abstract: Tourism development currently represents a very important part of national economics and its development and growth. To ensure growth, managers are looking for new effective tools to optimize decision making. This paper addresses the issue of dashboards based on neural networks and their utilization in managerial decision-making processes. Dashboard based reporting is oriented towards the tourism sector in Slovakia. The result of the research is the proposed balanced ranking and prediction model using financial and non-financial indicators with the application of artificial intelligence which allows to reach high level of efficiency and accuracy in evaluation of financial and non-financial health of companies operating in the hospitality sector. The proposed model also brings a new managerial and scientific point of view on the in-depth analysis of performance of these facilities. The main function of the proposed model is to classify health of a hotel. For this purpose, the MLP (Multi-Layer Perceptron) feedforward artificial neural network using backward propagation of errors was chosen as a training method.

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Key words: Predictions, financial health, neural networks, management, controlling, dashboards

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INTRODUCTION

Current development in the countries may be considered heterogeneous, even though their economic and social similarities. Each country achieves its economic and social goals with different success rate (Huttmanová, 2017). Tourism development has great importance and plays a critical role in the development of national economies. Tourism, mainly as a vital component of the so called leisure industry, has become a significant phenomenon in the last decades. Its economic, ecological, social, political, cultural and other effects form an indisputable part of the reality transformations today (Tej & Matušíková, 2014). A tourist, as a synonym of social modernity, is more flexible, more experienced in his travel habits and at the same time more challenging when choosing an offered standard. Not infrequently, he participates in creating the bidding standard, by which he consciously or unconsciously promotes his individualism, in the process of increasing globalization (Slivková & Bucher, 2017). Forecasting of tourism demand is essential for forward tourism planning. To develop appropriate public policies and to ensure sound business investment decisions, both government administration and private sector businesses use basic tourist demand forecasting to plan future operations and to assess the need for facilities and infrastructure investment. Therefore, forecasting has become essential for tourism management (Jun et al., 2018). Tourism industry is always considered as an appropriate choice to absorb economic incomes and an important source of employment (Bagherzadeh & Keshavarz, 2016).

The tourist development as well as the economic progress must take into account the characteristics of the natural and anthropic environment and the tourist development has to be done in accordance with these two variables (Gozner, 2015). If the environmental and spatial advantages of a geographical location of a city and tourism potential are considered as opportunities for the development, the bad environmental conditions are on the other hand characterized as the factor that slows the sustainable development down (Aliaskarov et al., 2017). Therefore, the efforts of many countries aim to effectively assist in the development of this industry. From the economic point of view, new techniques and procedures introduced within the field of tourism resulted in positive trends (Ružič & Demonja, 2015). In the last 20 years the development of IT-technology has led to the expansion of wireless networks covering very large territories and playing an important role in the field of tourism as well. In this context, there is an overwhelming amount of radiation from radio waves generated by wireless network devices which create the basis for several types of diseases and behaviours that affect more and more both humans and animals (Hila et al., 2017). The latest trends in this area effectively created real time dashboards. The adequate decision-making is one of the most crucial parts of a management. This statement also applies to the management of hotel facilities (Dostál et al., 2005). It is very important to deeply understand one´s own company, its performance and surrounding (Neumaierová & Neumaier, 2002).

There are numerous methods and tools suitable to fulfill this objective. All these methods provide information for the ideal decision making for the managers and a better control of these organizations (Štefko & Krajňák, 2013). From modern management models that can play an important role in the future, the most promising ones are the management decision-making methods based on a classification and prediction using

artificial neural networks (ANN) supported by high-quality reports in the form of effective real-time dashboards. The relevance of such an evolutional logical line is based on the planning and development of component elements with major emphasis on the factors referring to favorable and restrictive features in the tourist analysis (Ilies, et al., 2014). Dashboards represent modern reporting tools for controlling. The information coverage with specific indicators of the environment ensures that the company benefits from an effective and flexible information system which, at the same time, is a benchmark for comparison of the performance between the competing companies (Ivan et al., 2017). Organizations which adopt more than one management standard need to ask themselves how these different standards can be integrated with each other.

Integrated management systems (IMS) can be seen as one united management system which deals with various different requirements of other management systems (Kopia et al., 2016). When properly designed, their ability to show and describe complex data, context and knowledge in real time is invaluable and becomes an integral part of modern and effective management. Artificial neural networks are one of the modern trends in assessment of the financial and non-financial health of businesses. Because of their hidden internal structure, they are often described as a 'black box'. However, they are particularly suitable when part of the decision-making processes depends on coincidence and/or deterministic dependency. They are therefore suitable for the modeling and exploration of complex, single, often irreversible strategic management decisions. The results of data processing can be presented in the form of a dashboard.

Artificial neural networks and managerial decision-making

Human communication is a baffling, elegant, challenging, and above all complicated process. In the corporate world, communication is a dynamic process that underlines all kinds of information exchange. It is not about a mere passing of ideas, but the question is ‘can communication be better?’ Main purpose of this article is to present managerial decision-making model on an artificial neural network (Arputhamalar, Kannan, 2016). Managerial decision-making models based on ANN behave as a "black box". They usually operate in two phases:

1. First phase is typically focused on learning. Artificial neural network processes data and based on topology, algorithms and functions gains the context. There are many variations of learning methodology for different applications.
2. During the second phase, artificial neural network is perceived as an expert that produces output based on the knowledge and the learning in the first phase. At this stage, importance of presentation form and its quality is increasing. Managers need a highly precise information which is presented in a way it does not require them to spend more time than necessary to decipher it. Therefore, a dashboard is a great option.

Model design based on the artificial neural network requires multiple steps and decisions to be made by the innovation of tourist public service mechanism of wisdom tourism based on the neural network. The construction of intelligent scenic areas should not only pay attention to the input of the basic hardware facilities, but also from the tourist's point of view, understand the needs of tourists and the purposes of tourism, and therefore, constantly innovate in soft services (Wang, 2017). Hence, input and output neurons and their number are the most important elements. Based on a chosen topology, there are different types of hidden layers of neurons, their number and interconnections. Using appropriate configuration of ANN, activation functions and learning algorithm, we can create a network capable of analyzing and classifying health of companies in the accommodation sector in tourism. SEM analysis showed that the use of IT, financial performance, benchmarking, service standardization, top management support, customer satisfaction, service quality,

hotel interior and exterior design/look, location, employee training and empowerment were significant factors influencing the success and development of a hotel (Yadagaridehkordi et al., 2018). However, technology is not the only factor. An in-depth analysis of accommodation sector was a very important part of this research. Without a deep understanding of the sector, there is a high probability of incorrect results because of important attribute of ANN - GIGO (Garbage In Garbage Out). Learning system gains information only from the data that is provided. The lower the quality of the data input, the more incorrect the results will be. However, creating a high-quality model with deep knowledge of context is not sufficient enough for the managers. In real business situations, the busy managers need tools which show them information they need in a format they need it and in the moment, they need it, excluding everything that is not a top priority or can distract them. The solution proposed in this paper aimed to fulfill all three requirements. The first one with a high-quality ANN, the second one with a deep research of accommodation sector and the last one with a real-time, visually attractive and effective dashboard.

THE RESEARCH SAMPLE

For this research, a basic set of businesses operating in hotel services in Slovakia was created. Businesses were selected based on SK NACE (Classification of economic activities SK-NACE according to the Statistical Office of the Slovak Republic), specifically Section I - Accommodation and food services, Division 55 - Accommodation and Group 551 - Hotels and similar accommodation. Selected time of the research spread across the years 2009 and 2015. According to the portal "Index podnikateľa", there were 1,652 businesses under the category SK-NACE 55.1. Subjects in this group consisted of business entities that are registered in the Commercial Register of the Slovak Republic and have submitted financial statements to the commercial register. This research group was separated into two categories. The first one, labeled as **ZS1**, contained only healthy companies. The second group, labeled as **ZS2**, contained companies in liquidation or undergoing a curative process. ZS1 group consisted of 1.514 companies, ZS2 group consisted of 138 companies. Using simple random sampling, the final research samples were created (S1 from ZS1 and S2 from ZS2). To optimize and maintain objectivity of the results, companies that own more than one property were eliminated due to the unavailability of their financial statements for each individual accommodation property (Dataspot SRO, 2017). Due to the necessity to verify the functionality of the model, in addition to mechanisms that are part of the ANN, six companies were selected: two healthy companies from the group S1, 2 companies in bankruptcy/liquidation from the group S2 and two artificially created companies – one healthy and the second one problematic. Both artificially designed companies had been created to be as real as possible to represent their category. These companies were not included in the data files intended for training, validation and testing ANN. It was applied only for final verification and comparison. An overview of all companies and their designations are shown in Table 1.

Table 1. Profiles of test companies (Data source: Dataspot s.r.o., 2017)

ID	Category	Class	State
SZ1	hotel	****	healthy
SZ2	hotel	***	healthy
SK1	guest-house	**	bankruptcy
SK2	congress hotel	***	bankruptcy
SSZ	hotel	***	simulated healthy
SSK	hotel	***	simulated bankruptcy

Design of model, data sources and input variables

Hotel and tourism business can be characterized as a business in an unstable environment with a certain degree of risk and uncertainty. Changes in the market are usually very fast and rather frequent. The common problem is also the rationality of customer behaviour and changing trends. Therefore, the replacement of staff in this process is difficult, despite intensive development of advanced technologies and management practices. The proposed model is designed to be a helpful tool for managers, not their replacement. It helps managers focus on the core of the business. During the analytical phase of the research, we have conducted many experiments with popular conventional models like Tafler model, Altman Z Score, Springate model and many more. Almost none of the commonly used models is applicable for tourism and specifically for hotel management. Principal problems of conventional models were identified, such as their static nature and reliance on the principles of market behaviour which relies on a certain rational behaviour of the consumer. Moreover, many models focus only on the financial side of the business, which is ideal for manufacturing companies, but not so much for customer and service based businesses. Therefore, the presented model had to overcome these disadvantages and at the same time, become a convenient and effective tool for the managers. To mend these traditional issues and to make a practical and precise model, we had focused on both financial and non-financial data and selected the most important factors for hotel analysis and benchmarking.

The data was gathered from multiple sources that can be separated into two main groups:

1. **Financial data:** Register of Financial Statements, Commercial Bulletin, Trade Register, Statistical Office of the Slovak Republic, Financial Administration Slovak Republic, Public Procurement Office, Social Insurance Agency in Slovakia, Insurance Companies Všeobecná zdravotná poisťovna, Dôvera and Union.
2. **Non-financial data:** Association of Hotels and Restaurants of the Slovak Republic, Association of Tourism of the SR, Hotrec, Booking.com, TripAdvisor, STB, UNWTO, WTTC, Eurostat, European Travel Commision, Eurobarometer and the hotel websites.

After the analysis of all types of collected information, the input variables were selected. They were divided into three groups:

- **Financial** – standard and reliable indicators of a financial analysis and prediction models.
- **Non-financial** – important information specifying a property.
- **Organizational** – information specifying a company.

Input variables, their category, type and defined ID for clarity of research are presented in Table 2.

Model mechanics

Model mechanics defines processes that convert inputs into outputs, thus fulfilling the main function of the proposed model – to classify the health of the hotel and provide meaningful and practical information to the manager. They represent a substantial part of the model. Model mechanics can be described through these basic steps: input of variables, processing of variables, application of artificial neural networks and display of the output data in the form of a dashboard. The main function of the proposed model is to classify health of a hotel. For this purpose, we have chosen a training method MLP (Multi-Layer Perceptron) feedforward artificial neural network which uses backward propagation of errors. ANN model contains 21 input neurons. Each input neuron represents one variable. The model includes 1 hidden layer and the output layer contains one neuron. During the experimental phase, we have analyzed multiple types and configurations of artificial neural networks. The final testing configurations consisted of 9-18 hidden neurons, 10%-20% of data separated for testing and 3 different training algorithms (Levenberg-Marquardt, Bayesian Regularization a Scaled conjugate gradient).

Table 2. The input variables (Data source: proccesing by Karahuta, 2016)

Category	ID	Name	Type
Financial	VF1	Receivables turnover period	R
	VF2	Commitments turnover period	R
	VF3	Inventory turnover period	R
	VF4	Overcapitalisation degree	R
	VF5	Total debt	R
	VF6	Short-term debt	R
	VF7	Return on equity	R
	VF8	Return on sales	R
	VF9	Total liquidity	R
	VF10	Current liquidity	R
	VF11	Year	I
Organizational	PO1	Year of foundation	I
	PO2	Size of organization	C
Non-financial	VN1	Class	C
	VN2	Category	C
	VN3	Number of rooms	I
	VN4	Price	R
	VN5	Location type	C
	VN6	Seasonality	B
	VN7	Booking.com – score	R
	VN8	Tripadvisor - score	R

Variable types: I – Integer, R – Real, B – Boolean, C – Categorical

Final configuration consisted of 12 hidden neurons, 70% of data for training, 15% for validation and 15% for testing. The training algorithm was Levenberg-Marquardt.

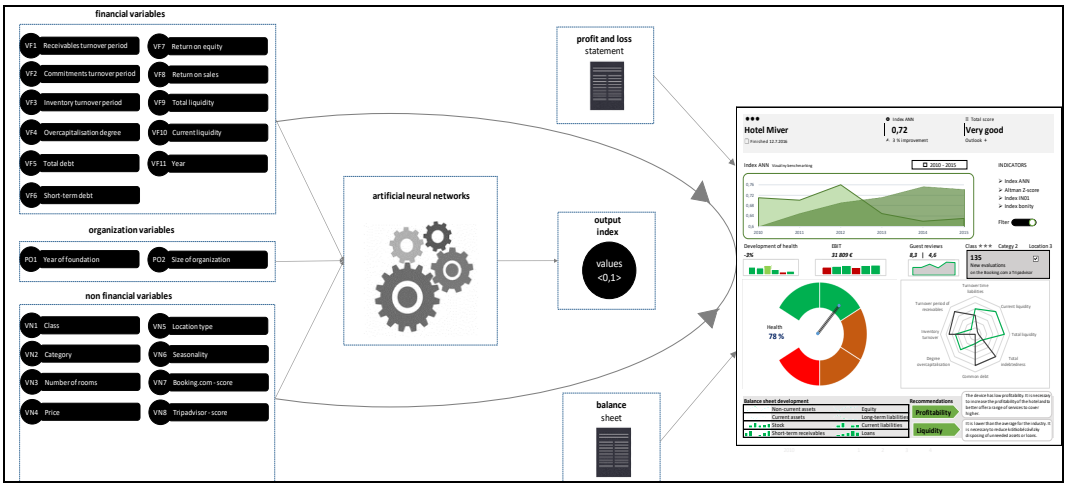

Figure 1. Business health assessment model based on neural networks

The model output

The output of the proposed ANN is a real number in the range of <0;1> for each company per year. This one number provides immediate information about the state of the business health. Number 1 represents a healthy enterprise, whereas number 0 represents a troubled company. The turning point is in the middle with a value of 0.5. The main output of the model is the dashboard which processes and shows multiple

financial and non-financial data in textual and multiple visual formats. The most important part is the result of ANN, its interpretation and multiple recommendations for the manager. The diagram of the model is shown in Figure 1.

THE DASHBOARD FOR MANAGERS

In conclusion, we would like to point out the indicators that are relevant and applicable in models for the classification and prediction of the state of an organization. There are many indicators that may be applicable in models evaluating the state of a property. Controlling in tourism offers a whole group of quality indicators, but for their assessment the non-public information is often needed. One of the requirements for this model was the use of publicly available data. We consider customer satisfaction one of the key factors. Sensitive work with the customer is crucial. Modern web portals and especially mobile applications allow everyone to immediately evaluate and share their feelings and opinions. After the customer´s submition of the evaluation, the manager loses virtually any possibility to change or to modify such feedback. This creates a significant pressure on the quality of provided services. We use three different Artificial Neural Networks techniques to predict tourist demand: multi-layer perceptron, radial basis function and the Elman neural networks. The structure of the networks is based on a multiple-input multiple-output (MIMO) approach (Claveria et al., 2017).

Despite highlighting the importance of the analysis of non-financial factors, we do not expect their direct impact on the financial health of the company. Their importance and significance is increasing in combination with financial indicators and other non-financial indicators. Each category and class of accommodation property generally has an existing target group of customers. Problems with inappropriate choice of category, class or other nonfinancial variable arise from their improper combinations (for example, a 5* hotel in an unattractive and economically less developed area). The research has shown that the model built upon the artificial neural network using a complex business analysis in context of the internal and external factors is more accurate than conventional models. To confirm this hypothesis, we have chosen randomly selected companies that were previously labeled as healthy or unhealthy. These data were not included in the data set intended for the Artificial Neural Network training. Then, we have calculated the classification of companies using conventional methods as well as the proposed model. Results were statistically compared with the actual state. For this purpose, the Pearson χ^2 test was used. Summary of the results can be seen in Table 3. Assumptions and hypothesis were confirmed. All conventional models were significantly different from the real situation. In the case of the proposed model, the statistical discrepancy was not confirmed. This does not prove that conventional models are incorrect or unusable. However, they are supposed to be used in sectors they were created for (mostly manufacturing companies). Despite this, many authors used them as universal models.

Table 3. χ^2 test results (Data source: Karahuta, 2016, p. 135)

ANN	Pearson χ^2: .382114, df=1, p=.536474
Altman	Pearson χ^2: 18.4314, df=1, p=.000018
Springate	Pearson χ^2: 46.3404, df=1, p=.000000
Taffler	Pearson χ^2: 4.91860, df=1, p=.026569
IN01	Pearson χ^2: 29.4185, df=1, p=.000000

The main and most important feature of the model is the managerial dashboard of the accommodation property. The result of the model is meaningful only if it is precise

and easily understandable. The model output index is an easily understandable exact number in the range from 0 to 1 (the value which defines the level of a company's health). Despite the presumable simplicity, it reaches its full potential for application in management processes with visual display, benchmarking and in context with other relevant information. A designed dashboard enables managers to interactively overview the state of the companies they direct. A screenshot of application is shown in Figure 2. The dashboard is fully adjustable and it enables the managers to customize it to best suit their working process. It includes several basic components:

- **Index ANN.** It is a numerical result of the proposed model and its verbal interpretation (for example, 0.72 - very good). At the same time, the manager immediately sees the percentage change from the earlier period. Based on the analysis of previous years, the application predicts the future development (positive, negative or no significant change).

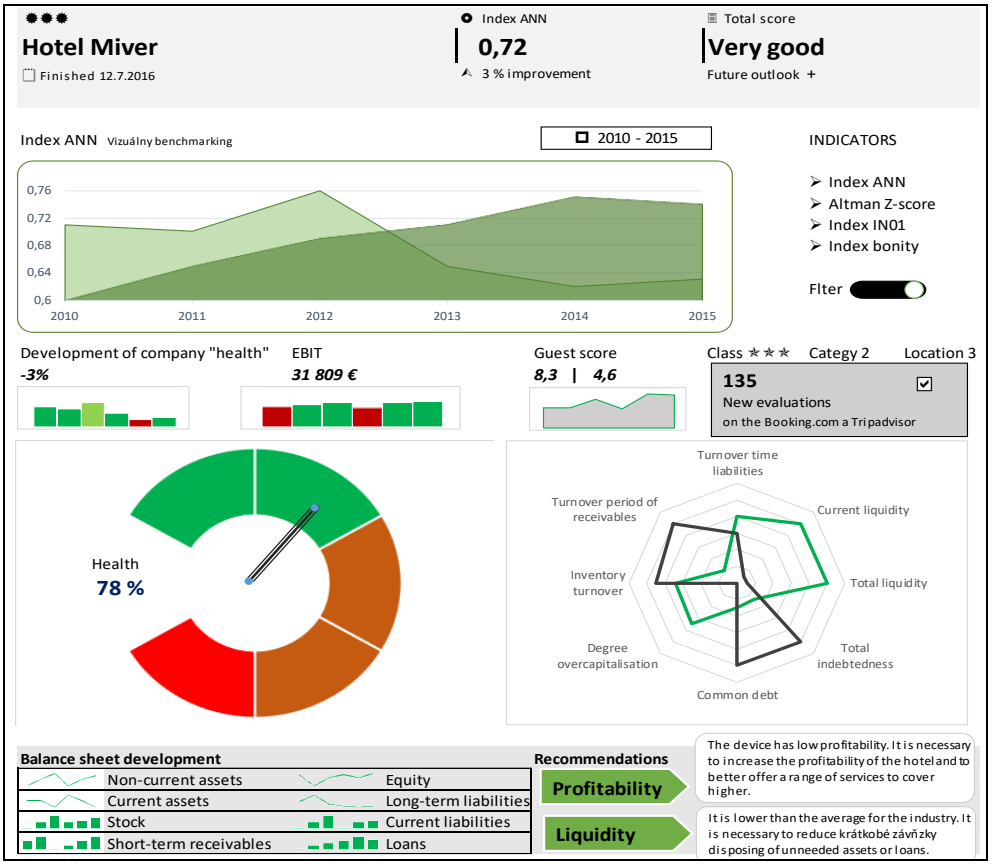

Figure 2. Dashboard (Source: own proccesing by Karahuta, 2016)

- **Visual benchmarking**. The client has the opportunity to compare the development of their own business compared to the industry in which it operates. It can follow various indices, models and indicators. It is also possible to set different filters, dates and scales.
- **Financial indicators and their comparison**. The report effectively utilizes the input data and displays them clearly using various forms of graphs and visuals. One of the options is a radar chart that very effectively visually portrays the position of the company

in the sector of selected indicators. The bar and line graphs show the evolution of key indicators over the past period.

- **The overall condition**. The general condition, or health of the company, represents the combination of our model and benchmarking with companies with similar characteristics. A key element is the index ANN converted into a percentage and adjusted by the absolute state of the sector. Colours provide immediate information on the status of the company.
- **Recommendations**. They form an important part of the dashboard. They are partly automated and warn against the limits of indicators. Recommendations also create a space for cooperation of the commercial and academic world. Index ANN and recommendations generate the majority of added value of the report.

CONCLUSION

Hotel management is a significantly practical area and its scientific development is deeply connected with practice. A solution presented in this work provides a powerful link between the two dimensions. Scientists and academics can apply their broad knowledge in real-life situations and analyze real data and ultimately help managers with the development of their business. At the same time, managers can confront scientific theories with practice and deliver results and data. This principle is also applied in our proposed model as shown on Figure 3.

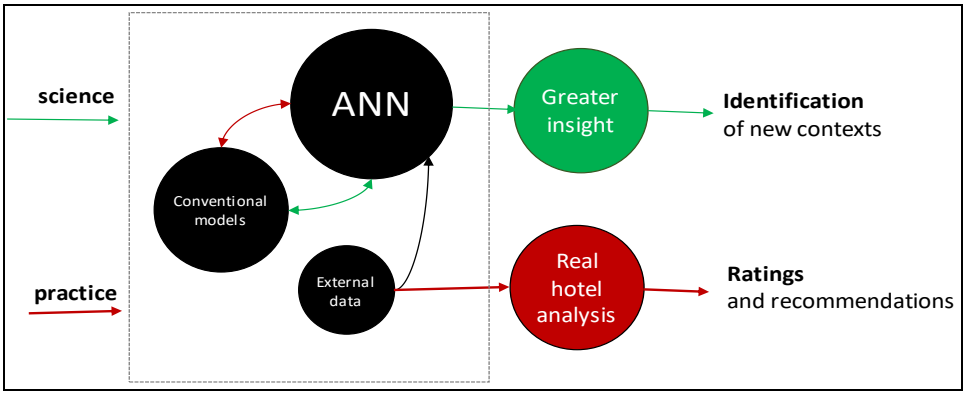

Figure 3. Interconnection of science and practice (Source: own proccesing by Karahuta, 2016)

The ability of ANN to learn, as part of the core model, is very important. Within the principle of GIGO (garbage in, garbage out), it is important to ensure that the input data are correct and reliable. The more accurate and detailed the data provided by businesses, the better the advice and analysis provided by science and the better the reports model that is generated. Thus, new connections can subsequently be discovered to improve the business. There is, therefore, the chance for symbiotic cooperation of practice and science.

While maintaining the principles and methodology applied in the design of the model, the model can be extended with new input data, thus exponentially expanding the number of combinations of elements and potential new context. At the same time, the model methodology enables its transformation for other sectors, too. The model offers benefits at many levels and dimensions. It is easily applicable in practice due to the fact that the proposed model is based on real data and analysis of the real environment. A database of accommodation facilities, proposed methodology and variable analysis create a solid foundation for further scientific knowledge and research in the future (Karahuta, 2016).

Aknowlegments

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