SOME CONSIDERATIONS ABOUT ARTIFICIAL NEURAL NETWORKS IN HOTEL INDUSTRY: STATE OF THE ART AND FUTURE DEVELOPMENTS

Maja Mamula
Raffaella Folgieri
Kristina Duvnjak

Abstract
Purpose – Technological developments, emerging business trends, globalization and changes in tourist behaviour require new ways of measuring and forecasting business performance. The purpose of this paper is to provide a comprehensive insight into the importance of AI, primarily artificial neural networks (ANN), their usage and implementation in hotel industry. The crucial benefits of an implementation of ANN in hotel industry are reflected in their ability to collect, analyse and interpret enormous data quantities. On top of that, ANN is capable of an automated generation of advanced business models and forecasts. These capabilities enable a redirection of human effort to more meaningful activities. An improved in-depth quantitative analysis and digitalization provided by ANN significantly contributes to an improved business performance in hotel industry.
Methodology – An extensive desk-research of the existing literature was carried out. Secondary data was used to establish a conclusions concerning artificial neural networks usage potentials in hotel industry.
Findings – The application possibilities of ANN as a data analysis and forecasting tool that enhances business performance are practically endless. The growing importance of innovative technologies for a successful business practice makes scientific approaches and the necessary theoretical background inevitable. So far, ANN have provided better data analysis and forecasting results than any other quantitative forecasting method. This fact underscores the need for a collaboration between theoretical research and industrial practice.
Contribution – An extensive theoretical rationale is provided for the adoption of ANN as an innovative tool for data analysis and forecasting for hotel industry. ANN as a data analysis and forecasting tool redefines the issues of hotel industry performances. The combination of tourism and AI provides a new level of sophistication in hotel industry.
Keywords hotel industry, artificial neural networks, forecasting, analysis tool

INTRODUCTION

According to Dwyer (Dwyer, et.al., 2008, 1) a key element of a successful tourism industry is the ability to recognise and deal with change across a wide range of behavioural, environmental and technological factors and the way they interact. … The challenge for tourism stakeholders in both the private and public sectors is to account for these changes proactively to achieve and maintain competitive advantage for their organisations.

As one of the most propulsive sectors in the world's economy, tourism and hotel industry exceed themselves. According to the World Tourism Organization data, international tourist arrivals reached 1.23 billion in 2016, up strongly from 674 million in 2000. At the same time, earnings reached a record US$ 1.22 trillion, increasing impressively from US$ 495 billion in 2000. With that, even more issues seem to appear regarding tourism primary, its results and performances also. As their importance grows, followed by their impact shows a positive trend in world economy, government policymakers as well as business managers, should pay close attention to the necessary modelling and forecasting of the basic determinants in tourism (Mamula and Duvnjak 2018, 58; Claveria et al. 2017, 710). In the report *Megatrends underpinning tourism to 2020: analysis of key drivers for change* (Dwyer, et. al., 2008, 35) the authors emphasize eleven areas that affect tourism, and among others, the role of technology trends in tourism development. As the impact of tourism and hotel industry is increasing, even more researches are directed in founding a solution between proper analysis and forecasting methods for tourism. Even though numerous papers were published on the issue, no consensus has been reached in term of which types of forecasting models are the most accurate and best answer to the issue (Peng, Song, and Crouch 2014, 181; Law and Au 1999, 89). Traditional methods of tourism analysis and forecasting are still largely in use, but with the development of information technologies, new and innovative methods have emerged. The research problem of this paper arises from the assumption that new and innovative methods, such as artificial intelligence, show better potential in producing relevant results than traditional methods of analysis and forecasting. The choice of forecasting method depends on various considerations, including: the level of accuracy required, the ease of use of forecasting method, the cost of producing the forecasts compared with potential gains from their use, the time frame of the forecast, on the quality and availability of data on which forecast is to be made, and the complexity of the relationships to be forecast (Dwyer, 2018, 175). Choosing a forecasting model that produces more accurate estimations (such as artificial neural networks) can contribute, consequentially, to the overall tourism and hotel industry performances. With this aim, this paper investigates the relationship between traditional and new, innovative forecasting methods. Consequently, the basic conceptual determinants of artificial neural networks are analysed and recommendations for possible future research areas has been given.

The paper consists of three sections. In the first section research methodology has been described, the second section gives a historical overview of usage of two different approach in tourism analysis; traditional one and artificial neural network approach, while the third sections gives remarks and discussion concerning the usage of artificial neural network approach in hotel industry. At the end, a short conclusion based on mentioned three sections has been given.

1. RESEARCH METHODOLOGY

To elaborate the papers issue, an extensive desk- research of the existing literature was carried out and effects of implementation of artificial intelligence in tourism and hotel industry were highlighted. The magnitude of the research results lies largely in the fact that advanced techniques, such as an artificial neural networks, are still not used in

tourism and hotel industry researches enough. Obtained paper results can be used as a starting point further for research, not just scientific one but also an applicative one.

In this paper, publications released on tourism and hotel industry, primary on analysis and forecasting methods, were examined. More precisely, in the publications which were examined, new and innovative ways of analysis and forecasting versus the traditional methods were used. The authors investigated approximately 40 papers from the last two decades, mostly publications that has been published from 2013 to 2018. The earlier papers were investigated in order to analyse the usage of traditional methods in comparison to innovative ones. In the recent years, new and innovative methods for analysis and forecasting were used. This research doesn't understate previous research, but emphasizes the importance of usage of artificial intelligence in future decision-making processes in tourism and hotel industry. The authors conducted an extensive desk-research in scientific important databases (WOSS Core Collection, Scopus, Google Scholar). Mentioned papers are references to obtain the main objectives of this paper. The time period of the search was from the earliest (1999) to the newest (2019). More than 100 papers were found from which, papers in which traditional and artificial neural network models was combined were included in further analysis. There isn't a sufficient scientific proof that new and innovative ways, such as artificial neural networks, should be used in analysis and forecasting tourism and hotel industry. The dominance of the traditional quantitative methods compared to the artificial ones is observed.

2. ARTIFICIAL NEURAL NETWORK VS. TRADITIONAL APPROACH – A HISTORICAL OVERVIEW

The development of tourism includes numerous activities that continuously contribute to the economy. To continue with the positive trend, a long- term planning is necessary. Even more, long- term considers forecasting the demand of international tourists to avoid inadequate decisions (Lin and Lee 2013, 2). Usually traditional quantitative forecasting methods – causal econometric approach and non-causal time series methods – are used when investigating tourism and hotel industry forecasting methods. As some researchers already emphasized, time-series and regression techniques have largely dominated forecasting models for international tourism demand (Peng, Song and Crouch 2014, 181). Since the information technologies have developed, the domination of traditional regression forecasting methods decreased. However, as far as the forecasting accuracy is concerned, researches show that there is no single model that consistently outperforms other models in all situations (Song and Li 2008, 203). While the pursuit of the most accurate method of forecasting is ongoing, an option of various computational and no probabilistic forecasting methods have been proposed in the literature (Egrioiglu, et al. 2015). In the new era, a theoretical background was necessary to develop a conceptual framework for the applicative purposes. The theoretical background is crucial for many reason, any information concerning the future evaluation of tourism flows, is of great concern to hoteliers and tourism in general (Petropoulos, Nikolopoulos, and Assimakopoulos 2005, 327). In the last decades, a numerous papers have investigated the issue of tourism forecasting methods primary, which forecasting methods could produce more accurate results, traditional or new and innovative methods such as artificial neural networks. As number of researchers emphasize, the prediction of tourism

demand is one of the most interesting and important areas of research in tourism studies, what can explain the numerous studies (Silva et. al. 2019, 134; Cuhadar, Cogurcu and Kukrer 2014, 12). Published papers that focus on tourism demand forecasting issue have significantly contributed to the scientific understanding of the determinants of international tourism demand. Such paper, as one written by Song and Wong (2003), serve as an useful insight of tourism decision- making process and private sector in tourism and hotel industry. The most recent paper by Wu, Song and Shen (2017) is a comprehensive review of new developments in tourism demand modelling and forecasting that consider various data measurement of tourism demand and their determinants. Before this research, a more comprehensive literature background was elaborated by Goh and Law (2011) when the adoption of the AI- based models in tourism demand studies were just recent and limited. The aforementioned study identified 15 AI-based tourism demand forecast papers, which were divided into two major categories, namely AI- based causal methods and AI- based time series models. Still, researchers are pointing out that time series models, econometric approach and artificial intelligence models are the three main categories of quantitative forecasting models (Peng, Song and Crouch 2014, 182). With the development of technology, researchers found new and innovative ways of analysis and forecasting. Artificial intelligence appears even more in scientific and applicative use fields, primary tourism and hotel industry. Unfortunately, despite the huge advancements in social robotics, in competitiveness, service quality, hospitality facilities layout, the research on robots in tourism has been extremely limited, a gap which is partially filled in the paper by Ivanov and Webster (2017). One of the most used type of artificial intelligence as an analysis and forecasting method are primary artificial neural networks. As Basheer and Haimeer (2003) highlighted, artificial neural networks are computational modelling tools that have recently emerged and found extensive acceptance in many disciplines for modelling complex real- world problems. Tourism is one of the most dynamic industry's today and can be a perfect example of testing real- world problems and reveal a true potential of implementing artificial neural networks in tourism and hotel industry.

Because of its possibilities, artificial neural networks are used in many fields. One of the benefits of artificial neural networks can be visible after successful training that can result in artificial neural networks that perform tasks such as predicting an output value, classifying an object, approximating a function, recognizing a pattern in multifactorial data and completing a known pattern (Dayhoff and DeLeo 2001, 1615). With even more researchers investigating the issue of which method produces more accurate forecasting results, this methodology has been considered interesting in economics and business areas since it is viewed as a valid alternative to the classical forecast approaches event in complex situations (Fernandes et.al. 2011, 1017). As artificial neural networks can be a tool to assess the complex dynamics of tourism system, they can produce results necessary for decision making process in tourism and hotel industry performances. In order to identify which method produces better and more accurate results of forecasting tourism demand, some researchers use the most commonly adopted methods like in building the forecasting model of visitors to Taiwan using ARIMA, ANN and MAR (Lin, Chen, and Lee 2011, 14). The study shows that ARIMA outperformed ANN and MARS by comparing RMSE, MAD and MAPE. In other cases, comparing ANN and traditional methods that include Winters exponential smoothing, Box- Jenkins ARIMA model and multivariate regressions, ANN outperforms traditional methods especially capturing the

dynamic nonlinear trend and seasonal pattern (Alon, Qi and Sadowski 2001, 147). Even when using one method, forecasting accuracy results should be compared. One of the reasons can be, as research showed, when comparing the forecasting accuracy of four processing methods for the input vector of the neural networks when investigating inbound international tourism demand to Catalonia, Spain (Claveria et al. 2017, 709). Some of the most investigated determines of tourism demand analysis in published papers are such as tourists' incomes, destination prices, prices in competing destinations, exchange rates as Baggio and Sainaghi (2016) highlighted.

It must be emphasized that econometric models have primarily contributed to developing this field of research which is shown by Song and Li (2008) who find that 71 of 121 reviewed papers employed econometric models. The main issue regarding econometric models is that they have some standard assumptions that need to be confirmed. But, because artificial neural networks do not require any standard assumptions, commonly linearity and normal distribution in forecasting time series, this approach has shown successful for forecasting a variety of implementation (Aladag, Egrioglu and Yolcu 2014, 945). Mentioned above was also stated in Yu, Wang, Gao and Tang (2017) research. Those authors tested the most advance forecasting model of seasonal trend autoregressive integrated moving average model (SARIMA) and innovative neural network model to make a short- term prediction. The SA-D model achieved good predictive performances proved by MSE, MAPE and correlation coefficient. One more study that shows that ANN is the best method for forecasting visitor arrivals with series without obvious patterns, is study by Cho (2003). The paper investigates the application of three time- series forecasting techniques: exponential smoothing, ARIMA and ANN and the results are proven with RMSE and MAPE measures of accuracy. Other benefit using ANN manifests itself. In order to handle massively parallel processing, one basic concept of digital neurohardware designs needs to be fulfilled- to connect many simple processors together to allow for fast parallel processing, to map a specific neural network on a parallel computer to achieve maximum performances (Schornauer et. al., 1998, 101). Research conducted by Noersasongko, Julfia, Syukur et. al (2016) compared performances of back propagation neural network (BPNN), K- Nearest Neighbor (KNN) and Multiple Linier Regression (MLR) for predicting tourist arrivals in a country. BPNN produces the smallest forecasting error - RMSE, compared to KNN and MLR. Presented with advantages and disadvantages of ANN- based approaches, there is a strong opinion that this method of forecasting and analysis is a valid alternative method to the traditional regression- based approaches (Krešić, Mikulić and Kožić 2013). Moreover, artificial neural networks are also able to manage incomplete data and infer knowledge where data are missed. Unlike multiple regression method, the strength of ANN lies in the fact that they use prediction and recognition of discriminating patterns rather than decomposition (Uysal and el Roubi 1999, 113). Some studies even go further in investigating the accuracy of certain methods. Burger et. al. (2001) conducted a study to forecast the US demand for travel to Durban, South Africa by comparing a variety of techniques. The study compares eight methods in total from which two of them are non- traditional ones. As many studies before, this one also showed that ANN outperforms other traditional and non- traditional methods in forecasting. The advantages of combining artificial intelligence and economics can also be combined and presented as a creative application of algorithms to tourism sectors forecasting and analysis (Folgieri, Baldigara and Mamula 2017). When forecasting tourism and hotel industry, researchers need to have

in mind the complexity and diversity of the sector. Forecasting numbers aren't the only thing that need attention. Not all data that are investigated are homogeneous. Majority of them are heterogeneous and don't have the possibilities to be transformed to numerical data. Folgieri and Bait (2014) analysed moods generated by tourist communication on the social media. Another example of heterogeneous data analysis is the sentimental analysis which helps in collecting this sort of data which is rarely used in tourist demand forecasting (Bait, Folgieri and Scarpello 2015; Folgieri, Bait and Carrion 2016). Artificial neural networks method based on artificial intelligence, can be used to make clusters or groups based on combination of characteristics from the data such as demographics, psychological characteristics and so on (Dragičević 2006, 82). Since artificial neural networks can process complex tasks, they should be used more in investing the issue of heterogeneous data in analysis and forecasting tourism and hotel industry data. The biggest advantage of accurate forecasting results is manifested in its importance for the future economic growth of tourism industry activity performances but also for the hotels to adequate its level of capacity to the tourism demand (Constantino, Fernandes and Teixeira 2016, 113).

In the search of the most accurate analysis and forecasting method, one must have in mind that artificial intelligence such as artificial neural networks, should be considered because of their capability to provide useful insights and outcomes in complex and uncertain situations (Baggio 2019, 255). With those results, a simulation of real- world problems can be conducted in any field, and in tourism and hotel industry as well. The main premise of this paper is, as some authors agree, that with the development of technology, its advantages have fundamentally changed how information is produced and consumed by all actors involved in tourism and hotel industry (Alaei, Becken and Stantic 2019, 175). Furthermore, a new source of data has emerged that can be used in tourism demand analysis and forecasting, engines such as Google or Baidu, that can significantly improve the precision of tourist volume forecasting (Sun et.al., 2019, 1) or (Li et.al., 2018). The increasing interest for tourism economy lead us to innovative forecasting methods (Yu et.al., 2017). Because of its complexity, tourism and hotel industry data are investigated with heterogeneous data which traditional methods cannot handle because they usually suffer from the prediction accuracy problem due to the high volatility, irregular movements and non-stationarity of the tourist time series (Chen et.al. 2017, 190).

3. EMPIRICAL FINDINGS AND DISCUSSION

Analysed researches imply that a significant progress has been made in the field of tourism modelling and forecasting – enough to interest a great amount of scientific public and to fund further research, especially in the field of new, innovative approaches. Based on the publications previewed above, main empirical findings concerning the artificial neural networks can be given.

Firstly, artificial neural networks are new emerging tool in tourism analysis which, in comparison to traditional methods, mostly show forecasting performance superiority. That arises from the theoretical and practical definition of artificial neural network. An artificial neural networks is an information or signal processing system composed of a

large number of simple processing elements which are interconnected by direct links and which cooperate to perform parallel distributed processing in order to solve a desired computational task (Macukow, 2016, 2).

Conducted research shows that there is wide range of possible implementations of artificial neural applications in social sciences, and in tourism as well. Apart from modelling and forecasting, artificial neural networks have a wider application in the hotel industry. Namely, the research review has shown that it can be used to address the challenges in computer vision, speech and pattern recognition. Regards to this, the authors of this research notice artificial neural networks usefulness in all areas of the hotel industry, from business facilities to customer satisfaction management, risk and security management. Application possibilities are based on the complexity of tourism and hotel industry as phenomenon. The main advantages of artificial neural networks are:

- Its specific characteristics – adaptability and nonlinearity make them adequate and useful for modelling and forecasting purposes
- In the most (but not in all of them) research they show better forecasting performance than traditional methods

The hotel industry has unique features built on the business model which has to sell its goods and services and, at the same time, to react to seasonal oscillations in the national and the international demand. Because of that, artificial neural networks can be considered as an adequate method to process the complexity of the subject issue.

Also, analysing the literature, some problematic issues regarding the use of neural networks have been identified. Most of them stem from the fact that artificial neural networks "search for" dependency between available data, which are not always in a linear relationship, through learning. Therefore, some issues concerning artificial neural networks are:

- How to model autocorrelated time series data, and at the same time, to gain better results than those produced with traditional linear or nonlinear methods?
- How to build the network which fits the subject problem the best?
- Among all available, what is the best training method/algorithm which fits the subject problem the best?

CONCLUSION

Considering conducted research, the authors conclude that real potentials of artificial neural networks in tourism analysis and forecasting hasn't yet been investigated, and implemented. In that sense, applicative use is underestimated.

The authors analysed a greater number of papers, and noticed the applicative potentials of artificial intelligence in hotel industry, but some open issues related to artificial neural networks are stated also. Methods which are traditionally used in hotel industry analysis are mostly susceptible to some issues (e.g. their static nature, reliance on the principles of market behaviour…), so there is a need for the usage of a models and methods that

can overcome common characteristic of traditional methods. In that sense, conducted research showed that implementation of new innovative methods, such as artificial neural networks are able to manage some crucial issues, which traditional methods are not. Artificial neural networks show their great potential in the numerous heterogeneous data processing, and are able to manage incomplete data and infer knowledge where data are missed also. Primary, due to its complexity data, tourism and hotel industry cannot be investigated as a homogenous sector. That is the reason why artificial neural networks, as a part of artificial intelligence, can contribute to the future decision-making processes to more accurate tourism and hotel industry determinants analysis.

The contribution of this research, in the theoretical and applicative sense, derives from the highlighting of the essential useful features of the artificial neural networks usage, but also from the opening of certain issues that bind to them, opening up new areas of their study. Thus, the authors formed the starting point for future research in the field of neural networks application potentials in the hotel industry.

ACKNOWLEDGEMENTS ¶

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Maja Mamula, PhD, Assistant Professor
University of Rijeka, Faculty of Tourism and Hospitality Management
Department of Quantitative Economics
Primorska 42, Opatija, Croatia
Phone: + 385 294 684
E-mail: majam@fthm.hr

Raffaella Folgieri, PhD, Assistant Professor
Università degli Studi di Milano,
Department of Philosophy
Via Festa del Perdono 7, Milan, Italy
Phone: +39 02 50312739
E-mail: Raffaella.Folgieri@unimi.it

Kristina Duvnjak, PhD Student
University or Rijeka, Faculty of Tourism and Hospitality Management
Primorska 42, 51410 Opatija, Croatia
E-mail: kri.duvnjak@gmail.com