



Artificial Intelligence as Catalyst for the Tourism Sector: A Literature Review


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Abstract: The analysis of Artificial Intelligence techniques and models used in the tourism sector provides insightful information for the management and innovation of this industry. In this paper, we conduct a comprehensive review of the different techniques and models, in regards to Artificial Intelligence when applied to the tourism industry. Specifically, we present a categorization of Artificial Intelligence applications used in different areas of tourism. The results allow to recognize valid studies and useful tools for the activation and growth of the tourism sector, an industry that represents a significant increase in the Gross Domestic Product of various economies and supports the development of life conditions for their inhabitants. Artificial Intelligence applications generate more personalized travel experiences, improve the efficiency of tourism services and strengthen the tourism competitiveness of the destination.

Keywords: Artificial Intelligence, Machine Learning, tourism management, tourism innovation, tourism forecast, hospitality industry

Categories: G.3, H.2, I.2, I.7, J.4

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1 Introduction

Growth in the tourism industry represents an opportunity and a challenge in the economy and development of various locations, thanks to investments and creation quality job opportunities [Calero and Turner, 2020]. This industry is characterized by fast and deep changes that in recent years have included new technologies, and a preference for tourism based on experiences and nature, which have played a critical

role in the reactivation of this industry after the pandemic generated by Covid-19 [UNWTO, 2023].

Innovation is, therefore, a fundamental key in the tourism industry, by satisfying the needs and expectations of tourists, in a process of permanent interaction. Success in tourism management lies in detecting changes in the customer's preferences and responding to them by reviewing and adapting the services, according to new requirements [Buhalis and Cooper, 2022]. According to the World Travel & Tourism Council, the travel and tourism sector contributed 10.3% to the global GDP in 2019; percentage that decreased to 5.3% in 2020, increased to 6.1% in 2021, and increased to 7.6% in 2022, this due to mobility restrictions given by the pandemic. Also, in 2019, the tourism industry generated 330 million jobs, while in 2020, 62 million jobs were lost, in 2021, 18.2 million jobs were recovered, and in 2022, 22 million jobs were recovered, changes generated during the pandemic and subsequent reactivation process [WTTC, 2022, WTTC, 2023].

In this context, the development of smart systems and Internet communications represent a significant opportunity for the tourism sector, due to travelers collecting and exchanging information and the contribution that this activity represents to the location's economy. This is where Artificial Intelligence (AI) plays a fundamental role, as a new stage in the tourism industry, with better opportunities for tourism service providers.

The objective of this paper is to contribute with a description of the different AI techniques that have paved the way for innovation and development of the tourism sector, considering that the consulted literature identifies reviews that focus on a specific AI technique and on a specific tourist activity (accommodation, transportation, food and drinks, etc.).

The remainder of this paper is structured as follows: Section 2, *Methodology* describes the criteria for selection and review of papers. In Section 3, *Review findings and discussions* pertains to a review on *Information and Communication Technologies in tourism*, based on the evolution of these tools and the support they have provided to the sector since the 1960s. In addition, different literature reviews on this topic, are presented. Furthermore, *Artificial Intelligence in tourism* is reviewed and analyzed, highlighting the impact of smart systems on innovation in the tourism industry, as well as their importance in the decision-making process. This analysis has been categorized according to the areas of tourism management. Finally, Section 4 includes the *Conclusions and Future Research* of the present work.

2 Methodology

The development of the present work considered a Systemic Literature Review (SLR) to identify and examine scientific articles related to AI in the tourism sector, summarizing the most relevant and current research. The SLR includes a valid, reliable, and repeatable protocol that helps to determine existing research and recognize information gaps to be explored. For the development of this work, three stages in the SLR are considered: planning the review, conducting it, and reviewing the results, as suggested by [Tranfield *et al.*, 2003].

2.1 Planning the Review

The work focused on the search for applications of AI techniques important for market intelligence to improve the competitiveness of the tourism sector. The keywords used in this search were: Artificial Neuronal Network (ANN), Machine Learning (ML), Gradient Booster Regression Trees (GBRT), Random Forest, Naïve Bayes, Support Vector Machine (SVM), and N-gram models, regression, clustering, tourism industry, tourism management, tourism innovation, etc., using combinations of keywords related to AI and tourism, for each search. The papers identified were analyzed to confirm that they corresponded to the subject of the review.

2.2 The review

The initial search was carried out in Google Scholar, a database that offers results from important journals such as Elsevier, IEEE, Springer, etc. The queries used combinations of the previously mentioned keywords and the following search criteria:

- Articles developed in English and published in scientific journals of impact.
- Date of publication in the period between 2016 and 2023.
- Scientific papers with the highest number of citations or reviews, representing the highest impact in their scientific area. We limited the analysis to articles with at least 8 citations, except for articles published in 2022 and 2023, in which a minimum number of citations is not considered. The minimum number of citations was established according to the average citation per item (topic "artificial intelligence" AND "tourism"; in the study period), according to Citation Report in Web of Science. <https://www.webofscience.com/wos/woscc/citation-report/115f8ad4-9ec6-4f3b-8b72-8356436977a4-8759b02c>
- Publications in indexed journals corresponding to the areas of AI and tourism.

In addition, the Bibliometrix package of R was used to analyze the results of the Web of Science search to obtain data on the scientific literature.

2.3 Review results

The information search reflects the increase in the number of researches related to AI applications in tourism during the study period. This increase indicates the researchers' interest in analyzing the influence of AI on the growth of the tourism industry whose development is based on innovation and appropriation of technology.

3 Review findings and discussions

The literature presents different definitions of Information and Communication Technologies - ICT - according to the area of study which this concept is associated. However, all these concepts consider that ICT are technologies that provide access to information through telecommunications, which include the Internet, wireless networks, and cellular phones, among others.

The tourism industry has maintained for long a close relationship with ICT, since the creation of the first computerized airline reservation system in 1960. The Global Distribution System (GDS) in the 1980s, and the creation of the Internet in the '90s, are milestones that substantially modified the operation and strategy practices of the tourism sector [Leung, 2020].

ICTs have changed the way in which travelers' access information, plan, book tourism services, and share their experiences. The platforms that provide these services also collect data related to their preferences, age, nationality, etc. Those responsible for tourism management can make use of such data, even those in small towns that did not have this information before, in order to develop effective strategies to promote the tourist destinations in an effective and smart way. Therefore, how this data is used offers an extraordinary opportunity due to its ability to provide answers to practically any question that may be asked about the behaviors, opinions, and feelings of tourists [Mariani *et al.*, 2016].

The contribution that ICT has had in the tourism sector has grown and evolved thanks to new technologies such as the Internet of Things [Nitti *et al.*, 2017], smartphones [Kang *et al.*, 2020], portable devices [Castañeda *et al.*, 2019], new connectivity [Liang *et al.*, 2017], and Big Data [Demunter, 2017] among others. These concepts have increased the interest of several researchers, who now are trying to understand how technology helps in the search for travel information and in the decision-making process in order to develop better tools in a scenario in which information will continue to be an important and exciting topic [Xiang, 2018].

The Table 1 summarizes the most interesting review articles on ICT in tourism, as a topic of interest in different investigations. The Table 1 includes authors, review period, number of articles that were analyzed, as well as the area of knowledge to which it belongs.

Author / Year	Period	Articles Reviewed	Area
[Singh, 2015]	1981 – 2012	182	ICT Application in Tourism
[Leung <i>et al.</i> , 2015]	1996 – 2013	331	Marketing in Tourism
[Pesonen, 2013]	2000 – 2011	188	ICT and Market Segment in Tourism
[Leung <i>et al.</i> , 2013]	2007 – 2011	44	Social Media in Tourism
[Zeng and Gerritsen, 2014]	2007 – 2013	279	Social Media in Tourism
[Law <i>et al.</i> , 2014]	2009 – 2013	107	ICT Application in Tourism
[Khatri, 2019]	2009 – 2018	63	ICT Application in Tourism
[Molina-Collado <i>et al.</i> , 2022]	1988-2021	2424	ICT Application in Tourism
[Law <i>et al.</i> , 2019]	2014 – 2017	288	ICT Application in Tourism
[Marasco <i>et al.</i> , 2018]	- 2017	79	Innovation in Tourism
[Han and Bai, 2022]	2010-2019	575	Marketing in Tourism
[Verma <i>et al.</i> , 2022]	2000-2021	1652	ICT Application in Tourism

Table 1: Previously Reviewed Articles - ICT in Tourism

These publications, among others, reflect an increase in scientific articles focused on ICT in Tourism, as a result of the interest created by the incorporation of new technologies such as AI, which brings us closer to programs that simulate human intelligence.

Through the years, the concept of intelligence has been researched in various investigations, identifying it as the ability or faculty to understand, reason, know, learn and solve problems. In a manner of speaking, the concept of AI has also been the subject of different definitions, highlighting American scientist John McCarthy’s research, who at the Dartmouth Conference in 1956 coined this term as “the science and ingenuity of creating intelligent machines, specifically, intelligent computer programs” [McCarthy, 2007].

As AI obtains greater applications with advanced algorithms and improved computing and storage capacity; it becomes an integrating element of digital systems and, more specifically, has a profound impact on human decision-making processes [Duan *et al.*, 2019]. Smart systems work on areas such as knowledge representation [Ahmed *et al.*, 2019], reasoning [Georgeff and Ingrand, 1989], ML [Hutter *et al.*, 2019], perception in Natural Language Processing (NLP) [Young *et al.*, 2018], as well as facial recognition [Chen and Jenkins, 2017]. Specifically, in the travel and tourism industry, smart systems provide innovations in recommendation systems [Abbasi-Moud *et al.*, 2021, Thiengburanathum *et al.*, 2016], emotional computing, group decisions, social networks and analysis, allowing them to design and experiment on business models, model-making of user decisions and use analysis, with the predominance of ICT-based platforms such as Airbnb, Uber and Online Travel Agencies (OTA) [Neidhardt and Werthner, 2018].

The tourism industry applies AI in OTA, air traffic controllers, hotel chains, tour operators, a sector that generates and uses large amounts of information with results that set a competitive advantage by being able to anticipate, predict and proactively satisfy customer’ needs [Romero Dexeus, 2019]. The search in Web of Science with the keywords AI and tourism, between 2016 and 2022, was analyzed with Bibliometrix package of the R programming language, displaying the information in Fig. 1.

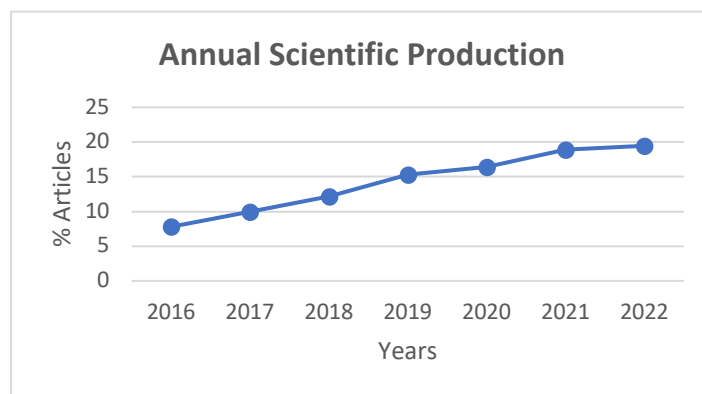


Figure 1: Annual Scientific Production
 Keywords: Artificial Intelligence and tourism
 Range of years: 2016 to 2022

Fig. 1 shows the scientific production between 2016 to 2022, related to AI in tourism, which shows the percentage of scientific production for each year, in relation to the total number of productions during the period 2016 - 2022. The scientific production in 2022 is higher than in previous years, which demonstrates the importance of the research topic.

In general, it can be seen that the number of works on AI in different applications for tourism, published between 2016 to 2022, maintains a growing trend, which coincides with the period of reactivation of the tourism industry (2020–2022), a space of analysis of the new preferences of tourists and reinvention of tourism services. The works developed have been of great importance for the generation of strategies in the tourism sector.

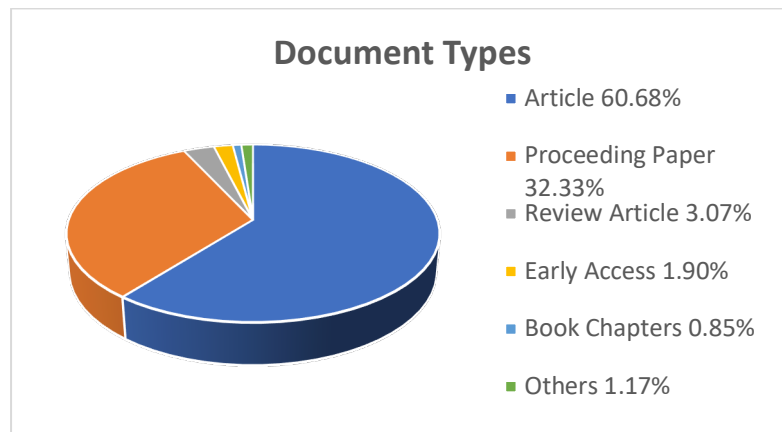


Figure 2: Document Types

Keywords: Artificial Intelligence and tourism

Range of years: 2016 to 2022

Fig. 2 shows the document types of scientific production between 2016 and 2022, related to AI in tourism. The highest percentage of scientific production corresponds to 60.68% of articles and 32.33% of proceedings papers.

Next, we will categorize the paper according to the following areas of study: 1. *Forecast in the Tourism Sector*, 2. *Travel Planning*, 3. *Tourist Destinations Marketing*, 4. *Analysis of Online Comment Log* and 5. *Touristic Chatbots*.

3.1 Forecast in the Tourism Sector

Being able to make accurate predictions about the behavior of tourism drastically reduces uncertainty, which will help us in the management of the different areas related to the tourism industry. Thus, AI-based forecasting has fomented great interest and focuses on models such as the fuzzy theory, gray theory, ANN, genetic algorithms, and expert systems [Wang, 2004], with algorithms that find user behavior from large databases generated with the online registration of users during searches, reservations, purchases and comments of tourist services on the Internet [Moro and Rita, 2016].

Tourism is perhaps one of the sectors that has benefited the most from ML, this forecasts tourist expenses, determines profiles, and predicts the number of arrivals. In

the research by [Cankurt and Subasi, 2015] the series of tourist demand in Turkey in a period between 1996 and 2013 is analyzed. It is imperative that ML-based predictive models consider the different periods of the year when demand varies significantly, in order to make predictions that are more in line with the reality of the sector at the time. This paper uses the Principal Components Analysis (PCA) to decorrelate the input data, Back-Propagation Neural Network Architecture (BPNN), and the adaptive differential evolution algorithm (ADE).

By obtaining forecasts through ML and Internet search indexes, it is possible to predict tourist arrivals to a certain destination, performance that can be compared with the results obtained by other tools such as Google and Baidu [Sun *et al.*, 2019]. In the research by [Li *et al.*, 2018a] algorithms are created to forecast tourist arrivals. The objective of the research is to forecast the number of tourists arriving in Beijing in order to control the inconvenience generated by the arrival of a number of tourists exceeding the capacity of the destination. For this purpose, algorithms are designed using data on arrivals in Beijing in the period from January 2011 to December 2016. Using PCA, dimensionality is reduced. A hybrid model is then created using the ADE algorithm and the BPNN model. Comparing the results obtained with other techniques, it is identified that this model increases the prediction accuracy.

On the other hand, Gradient Boosted Regression Trees, Ranking SVM and ML techniques produce predictive models that when applied in tourism management allow different types of prediction, such as the following location that a tourist will have according to their travel history. Specifically, the technique called Gradient Boosted Regression is used for classification problems and model generation for predictions based on decision branches, while the Ranking SVM function is a method for learning to classify in the extraction of key phrases process [Muntean *et al.*, 2015].

Also, research shows that the use of ANN is perfectly applicable to forecast tourism demand. ANN are usually applied for pattern recognition due to their association, memory, storage, and learning function [Li *et al.*, 2009]. For example, research conducted by [Folgeri *et al.*, 2017] evidences the importance of ANN in predicting tourist information. For the study, monthly data on tourist arrivals in Croatia were collected for the period from January 1, 2007, to December 31, 2012. The results indicate that ANN is a robust method in predicting tourist arrivals, a method that outperforms linear regression.

The forecast of tourist demand represents a valid source of information for decision-making related to personnel, capacity, resource management and pricing strategies. Therefore, a more accurate forecast will be a lot more useful to create strategies in tourism management [Jiao and Chen, 2019]. Tourism demand forecasting is an important element in the efficient planning and allocation of resources in the tourism industry. [Li and Jiao, 2020] conducts a literature review on tourism demand forecasting from 1960 to 2018, showing the relevance of this research topic.

The following figure shows the annual scientific production of Forecast in the Tourism Sector:

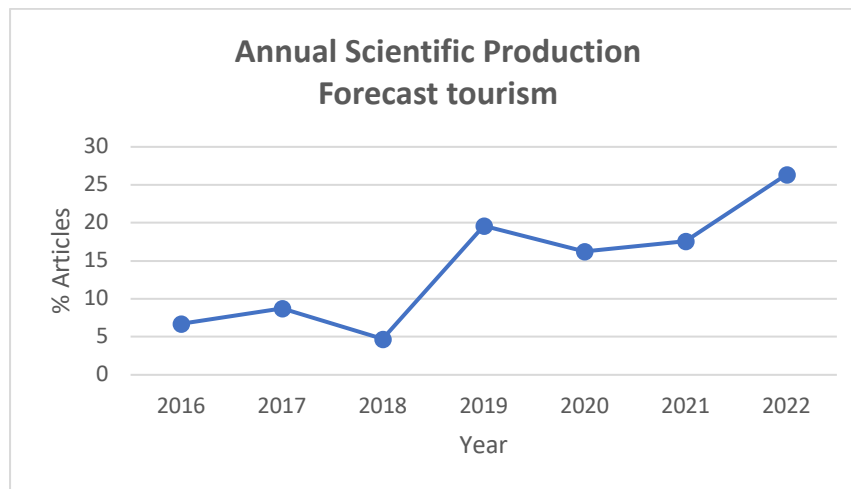


Figure 3: Annual Scientific Production
 Keywords: Forecast tourism and Artificial Intelligence
 Range of years: 2016 to 2022

Fig. 3 shows the percentage of scientific production using Artificial Intelligence in forecasts in tourism, for each year in relation to the total number of productions during the period 2016 – 2022. Fig. 3 shows that scientific production related to tourism forecasting decreased in the year 2018 and also in 2020. One possible explanation for the decrease in 2020 is that, during the pandemic, the tourism industry operation changed considerably due to mobility restrictions. In this sense, it was necessary to analyze the new scenario and determine the variables to be considered for the development of forecast models for the tourism industry.

3.2 Travel Planning

AI-based travel planning systems provide orderly and precisely categorized information to organize the trip, providing a personalized plan taking into account tourist's preferences. These systems take into account the user's demands and parameters such as the cost of the trip, traffic volume, weather and the time of the trip in the tourist destination [Dezfouli *et al.*, 2018].

AI-based travel planning allows tourists a personalized and advanced offer of services, always looking for the best options, taking into account tastes and preferences. The travel recommendation systems use the haversine algorithm and Traveling Salesman Problem (TSP), they consider the user's preferences, as well as the traffic, weather, recommendations, transportation, etc. of a particular city. In addition, a recommendation system can consider the popularity of tourist attractions and possible waiting times at these attractions as part of personalized itinerary recommendations. Information about the suggested tourist sites is collected from websites and social networks through an AI retrieval process [Asaithambi *et al.*, 2023].

Among the tools used for travel planning, clustering or grouping techniques [Saxena *et al.*, 2017] stand out as unsupervised ML algorithms that represents an important issue to analyze. In the travel industry, the 'k-means' clustering technique has

several applications such as the algorithms used for travel itineraries by finding a complete route that connects all the nodes of a network, visiting each point once and minimizing the total travel time (TSP) [Rani *et al.*, 2018].

[Ravi *et al.*, 2019] proposed a hybrid travel recommendation system based on location, with swarm intelligence algorithms, which provides points of interest depending on the preferences and the users' needs, as registered on TripAdvisor. This system efficiently extracts, filter and present heterogeneous and geographically distributed tourist information from the Internet, such as the Intelligent Travel Planning (ITP), a travel planning system, whose objective is to find different useful tourism solutions for the users of the system.

Other researches such as that conducted by [Jiang *et al.*, 2013] propose a tourist recommendation system based on the information provided by geographically tagged photographs on the Internet. It identifies tourist attractions according to their geographical location and determines popularity based on the number of user photographs. The textual tags in an attraction are grouped as a document and analyzed using the vector space model. According to the textual and visual information of said photographs, one can determine the user's personal interests.

A recommendation system allows to know the best options for travel, given the large amount of information and offer of tourist services on the Internet. It is also important that these systems consider the restrictions established during the pandemic generated by Covid-19. In this sense, the work of [Nilashi *et al.*, 2021] presents travel recommendation based on social networks, the system stores updated information about Covid-19 and the tourist's recent trips, which is analyzed with ML techniques.

Some recommender systems analyze the Vacation Planning Problem (VPP), which is related to the design of tourist trips in a large geographical area, providing daily and personalized tourist routes, intermediate destinations along the trip and places of accommodation. The study presented by [Vathis *et al.*, 2023], presents a heuristic model for the VPP. The model is based on the clustering of points of interest according to the distance of the points as well as the available transportation between them. This type of algorithm is also used in other areas such as search and rescue operations, clustering points of interest to locate or save people.

Several recommendation systems for tourism use Multi-Agent Systems (MAS) to improve the recommendation process. In the work done by [Alves *et al.*, 2022], they present the modeling of a mobile Group Recommendation System (GRS) using the personality of tourists to predict the preference for tourist attractions, as well as intelligent agents with microservices, achieving to provide better group recommendations.

The following figure shows the scientific production related to Travel Planning:

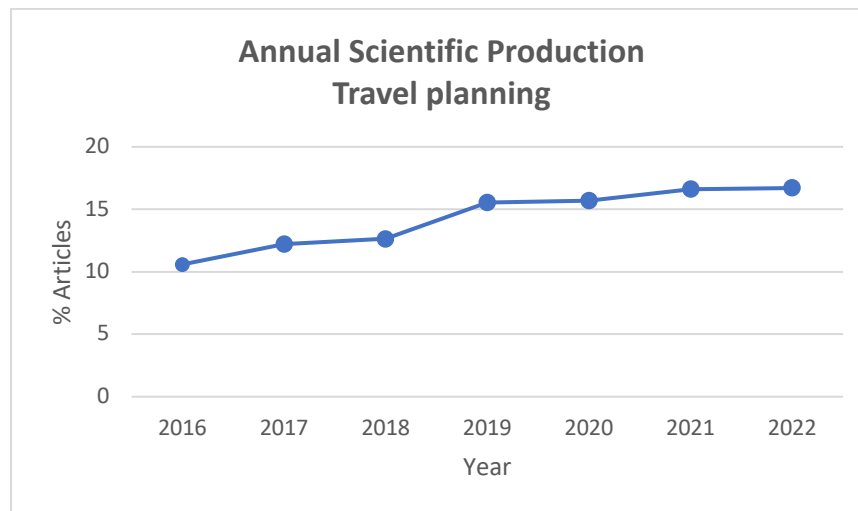


Figure 4: Annual Scientific Production
 Keywords: Travel planning and Artificial Intelligence in tourism
 Range of years: 2016 to 2022

Fig. 4 reflects a slow growth of the scientific production related to travel planning platforms, during the period from 2019 to 2022, compared to previous years. This could be related to the decrease in the use of travel recommendation platforms, and the identification of new requirements and preferences of tourists, according to the mobility and security restrictions generated by the pandemic.

3.3 Tourist Destinations Marketing

Marketing in the tourism industry was known for face-to-face interactions between service providers and tourists, which changed with the creation of platforms offering a wide range of tourism services. Currently, OTAs present various travel options and suggestions for tourists, where tourism providers contact potential travelers via the Internet, supporting to the evolution of this sector [Romero Dexeus, 2019]. Smart systems are responsible for defining prices in airlines and in the hotel industry according to the Revenue Management, they are systems that predict consumer behavior and aim at maximizing revenue growth.

Tourist Destinations Marketing is an area that has benefited from advanced data analysis, ANN and knowledge representation technologies. [Stalidis *et al.*, 2015] presented in their research a smart support system for this area, which uses as input the data collected with surveys which were done to tourists who visited Thessaloniki in Greece between May and October 2013. The smart system includes a method of data analysis that identifies multivariate nonlinear relationships, the decomposition of complex phenomena into factors, and the definition of the characteristics of population groups. A second method focused on ANN to make smart decisions in new cases based on what has been learned; and a third knowledge model method that expresses the results in an understandable way.

ANNs can evaluate the capacities to select products and services in an e-tourism environment. These models are precise in classifying products and services in perspective for consumers, taking into consideration that from the launch of the first tourism website, this area has been one of the fastest growing segments in e-commerce. It is valuable to incorporate behavioral factors in e-tourism systems, proposing a multi-agent e-tourism system architecture for product intermediation, supplier negotiation and evaluation, which is based on the supplier reputation agent and the use of ANNs [Cao and Schniederjans, 2006].

The article by [Pyo *et al.*, 2002] takes as a case study the stagnation in the growth of the number of tourists and their spending on the island of Cheju in South Korea. By analyzing the variables of a large database from the island's airport, it looks to improve tourism promotion by building a smart model that determines the visitors, that once have returned home, would recommend visiting the destination.

The AI technique ‘fuzzy theory’ [Sugeno and Kang, 1998], combined with ANN, can be used for population projections that incorporates concepts such as probability, optimization, simulation and precision, along with policy decision-making advertising and tourism marketing. The article by [Li, 2000] proposes the development of a hybrid system for the promotion of a tourist destination based on marketing strategies. The hybrid system includes the features of an expert system, fuzzy logic and a forecasting model with ANN.

It is also interesting to analyze the benefit of the metaverse in tourism marketing. The metaverse offers the opportunity to experience a tourist destination without physically traveling. A potential tourist can explore the destination, tourist facilities and services, prior to travel. The metaverse benefits tourism marketing, travel planning [Monaco and Sacchi, 2023], and the metaverse can support sustainable tourism development [Go and Kang, 2023].

Fig. 5 shows the annual scientific production in Tourism destinations marketing:

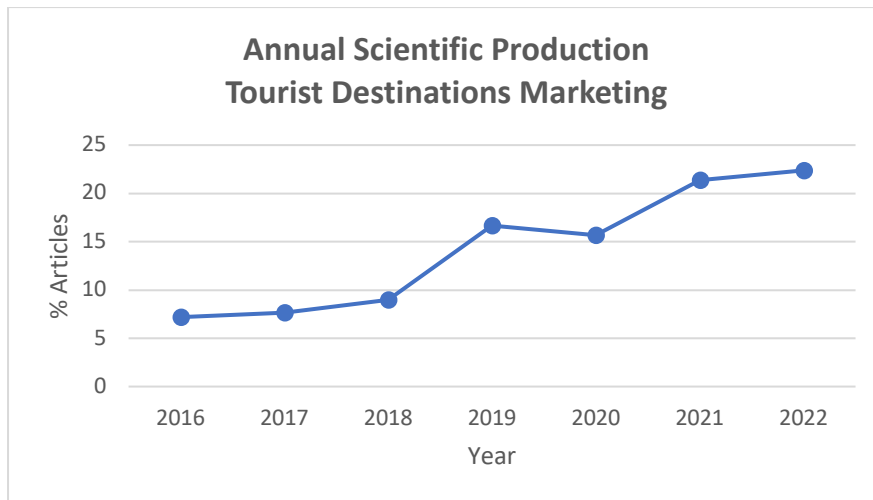


Figure 5: Annual Scientific Production
 Keywords: Tourism Marketing and Artificial Intelligence
 Range of years: 2016 to 2022

The scientific production in Tourist destinations marketing decreased in 2020, which could reflect the rethinking of tourism marketing, in agreement with new tourism services, as part of the revival of the tourism industry. The tourism sector was probably one of the most affected industries during the pandemic, with high economic losses, which limited the tourist destinations marketing.

3.4 Analysis of Online Comment Log

The analysis of comments registered in social networks and other online platforms (TripAdvisor, Booking, Kayak, Triage, Expedia, and Airbnb, among others) by means of AI techniques quantify visitor satisfaction towards the services provided in a tourist destination, making it possible to define tourists' requirements or preferences. This type of information is, in many cases, the basis for decision-making processes by potential tourists who organize their trip based on comment reviews made by other tourists.

Models such as Word2vec [Li *et al.*, 2018b] and the Random Forest algorithm [Kurnia *et al.*, 2020] can be used to classify user post-trip comments made on social networks or platforms designed for this particular purpose. Comments can be analyzed with deep learning models and NLP techniques [Ku *et al.*, 2019]. This information is a very valuable opportunity for decision-makers which want to improve services, gain knowledge about the market and innovate.

In reality, platform accelerated growth used to record trip-related personal comments has increased the amount of information now available for use by other tourists, or by those responsible for tourism management as an indicator of the topics that need improvement. The research conducted by [Ye *et al.*, 2009] analyzes sentiment classification techniques of reviews recorded in travel blogs for seven popular places in the United States and Europe, comparing Naïve Bayes, SVM and N-gram models. The experiment indicates that if the training datasets have a large number of reviews, the models achieve an accuracy of at least 80%.

The development of technology has created new channels for the generation and consultation of information in the tourism sector. Currently, tourism service platforms generate a large volume of data, which are processed with different methods to provide quality information to decision-makers. In this context, opinion mining based on sentiment orientation allows interpreting tourist perceptions [Alaei *et al.*, 2019].

AI techniques make it possible to derive insights from the analysis of multiple opinions, reviews and ratings of tourism services, recorded on social networks. This analysis helps to identify opportunities and represents a competitive advantage for decision makers, a topic that has generated the interest of different researchers [Chen *et al.*, 2017, Gan *et al.*, 2017, Geetha *et al.*, 2017, Gitto and Mancuso, 2017, Kim *et al.*, 2017, Lee *et al.*, 2017, Luo *et al.*, 2020, Ma *et al.*, 2018, Ren and Hong, 2017].

In [Gyódi, 2022, Nilashi *et al.*, 2017, Silva *et al.*, 2022, Sun *et al.*, 2022, Yang and Han., 2021] effects of the COVID-19 pandemic on the hotel sector and new travelers' demands are identified through sentiment analysis. The studies consider the comments registered by tourists in an online platform, during and before the pandemic. These studies provide important information for the reactivation of the tourism industry [Gyódi, 2022].

Fig. 6 shows the annual scientific production on the analysis of online comment:

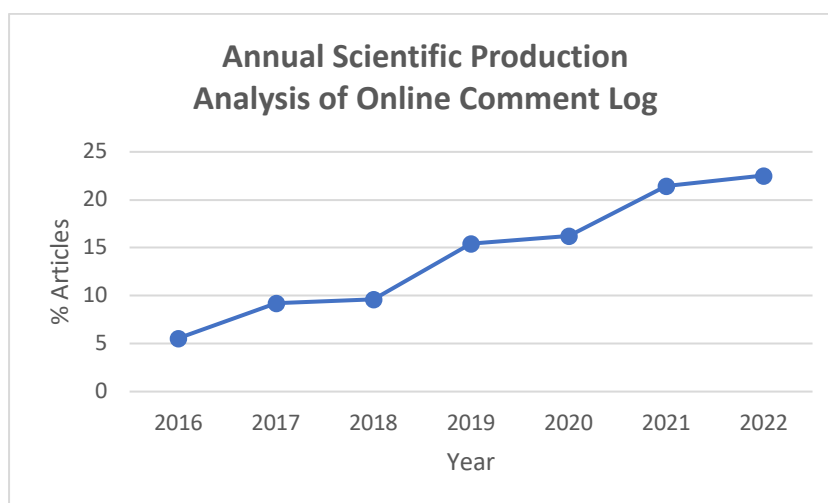


Figure 6: Annual Scientific Production – Analysis of Online Comment Log
Keywords: Text mining and sentiment analysis in tourism
Range of years: 2016 to 2022

Fig. 6 presents the increase in scientific production related to Artificial Intelligence in the analysis of online comment log, which would be related to the relevance of the analysis of comments to identify new tourism needs, mainly during the reactivation of the tourism industry.

3.5 Touristic Chatbots

Another form of application when it comes to AI that improves communication between service provider industries and their clients are AI-operated chatbots, which are intelligent solutions used by companies to provide a personalized service. In the tourism sector, hotels, airlines, tour operators, and others use chatbots to provide a better service to their customers.

A study done by [Zsarnoczky, 2017] focused on using chatbots to answer more than 300 questions related to accommodation, travel options, transportation, as well as available programs at the Matra Resort in Hungary. The results of said research indicated that tourists use chatbots for travel planning, finding them convenient to get information.

The research conducted by [Sano *et al.*, 2018], analyzes the generation of a knowledge base of tourist sites in the cities of Malang and Batu, by means of the hierarchical clustering algorithm AGNES (Agglomerative Nesting). The chatbot fed with this database provides information about the tourist sites that can be optimally visited by tourists with short stay times.

[Alotaibi *et al.*, 2020] presents a case study of the Smart Guidance chatbot that provides information about the city of Jeddah in Saudi Arabia for travel planning. The text received by the chatbot is analyzed in the NLP engine, determines keywords and answers the user's query.

Also, the paper presented by [Suanpang and Jamjuntret, 2021] presents the development of a chatbot that provides information to tourists interested in visiting the Active Beach area in Thailand. The design uses a Deep Learning model and demonstrates the usefulness of chatbots to improve the stay of tourists in different destinations.

The systemic review of literature elaborated by [Calvaresi *et al.*, 2021], presents studies of the services provided by chatbots in hotels, airlines and travel agencies, highlighting their contribution to the competitiveness of the tourism industry, due to the speed of response to customers and the wide availability. The role of chatbots in the tourism industry generates the interest of different researchers [Li *et al.*, 2021, Melián-González *et al.*, 2021, Mohamad Suhaili *et al.*, 2021].

Chatbots or virtual assistants are implemented in the tourism sector to improve communication, user experience and empathy. The tourism sector uses travel chatbots, voice-based chatbots and emotion-based chatbots [Doborjeh *et al.*, 2022]. An interesting implementation is the emotion chatbot, which can give a more personalized response. The emotion chatbot uses natural language processing algorithms to analyze the conversation and identify emotions, according to which it performs the best response [Lv *et al.*, 2021].

The following figure shows the annual scientific production on Tourist Chatbots:

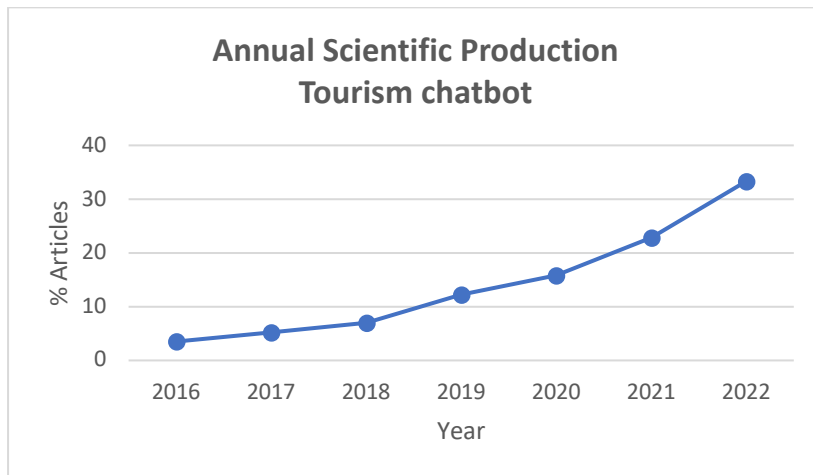


Figure 7: Annual Scientific Production
 Keywords: Artificial Intelligence and tourism Chatbots
 Range of years: 2016 to 2022

Fig. 7 shows a significant increase in the annual scientific production on tourism chatbots, which could be related to the importance of chatbots, mainly during the reactivation of the tourism industry. Chatbots allow to establish permanent communication with customers, resolving concerns and generating important data for management.

3.6 Other areas of study

As a field that is constantly advancing, its versatility to perform complex tasks makes it a valuable tool for the growth of various industries. The healthcare sector uses AI in: early disease detection, drug development, treatment personalization, epidemic outbreak prediction and so on [Schwalbe and Wahl, 2020]. Another important field of application is air quality and its influence on health, where AI makes it possible to develop forecasts to detect elevated concentrations of certain air pollutants so that measures can be taken to avoid negative effects [Méndez *et al.*, 2023].

Industry has also benefited from AI through improved productivity, reduced operating costs, quality control and industrial robotics, among many other applications [Javaid *et al.*, 2022]. In this context, the number of devices connecting to the Internet is increasing and the incorporation of AI into communication networks is beneficial. Also in communications in large cities, the AI methods can predict network traffic and improve network performance [Chen *et al.*, 2021].

In the food field, AI enables crop management, pest control, crop forecasting, etc. Companies in the food sector also benefit from AI with sales forecasting to minimize expired products and avoid economic losses [Tsoumakas, 2019].

These are just some of the areas where AI has had a relevant impact.

4 Conclusions and Future Research

This article reviews the literature related to the contribution of AI in the tourism industry, an area characterized by its contribution to the economy and development of many countries' economies. In this context, the increased coverage and use of the Internet, social networks and the creation of smart systems demonstrate high levels of innovation in this sector.

In countries whose economy is committed to innovation and the development of the tourism industry, it is necessary for the public administration and the private sector to define joint strategies supported by AI, a tool that allows detecting trends and knowing the demands of tourists based on registration on platforms and social networks.

In the scientific production related to Artificial Intelligence applications in tourism, for the period from 2016 to 2022, it was possible to identify that 60.68% of the production corresponds to articles published in a journal and 32.33% were published in Conference Proceedings, being the types with the highest percentage, as shown in Fig 2. Review Article only represents 3.07%, and other types of documents less than 2%

The literature reviewed shows that ANN models are used to predict tourist arrivals, models that outperform linear regression techniques. The relevance of fuzzy theory models, gray theory, genetic algorithms, ML and expert systems was also identified, with results that support the development of the tourist offer of the localities.

Chatbots interact with tourists and allow the automation of different services. Deep learning models are used in their design and NLP engines identify keywords to answer user queries.

Large databases created from keywords that users register for search, reservations, purchases and from comments of tourist services on the Internet represent the main input when it comes to smart systems used in different areas of management for the

tourism sector. This article reviews publications related to Forecasting in the Tourism Sector, a relevant topic due to the information it provides to those responsible for decision-making in the tourism sector, in aspects such as new investments or the forecast of logistical aspects. Smart systems for travel planning, tools used by travelers, who choose a destination and tourist services to be included in their next trip are also reviewed. Marketing of tourist destinations carried out by OTAs, platforms that hire different tourist services. Articles related to Tourism Marketing are also reviewed, smart systems that promote a tourist destination. Online records analysis provides information on the perception of tourists about the services received. Finally, chatbots, AI applications that are part of tourist services are also reviewed and considered.

Tourism is probably one of the areas most affected by the public health crisis created by the COVID-19 pandemic, having to reinvent itself while also attaining an economic reactivation. Therefore, it is the most opportune moment for science, through different research, to propose smart applications that accelerate the path towards the recovery of said industry.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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