ISSN 2723-6471

Applied Data Science and Artificial Intelligence for Tourism and Hospitality Industry in Society 5.0: A Review

Hartatik[1, 2,*], R. Rizal Isnanto[3], Budi Warsito[4]

[1,3,4] *Doctoral Program of Information Systems, School of Postgraduate Studies, Universitas Diponegoro, Semarang, Indonesia*

[2]*Department of Informatics Engineering, Vocational School, Universitas Sebelas Maret, Surakarta, Indonesia*

(Received: August 12, 2024; Revised: September 21, 2024; Accepted: September 25, 2024; Available online: October 15, 2024)

Abstract

The primary purpose of this research is to delve into the emerging trends of artificial intelligence and data science with a specific focus on the tourism and hospitality sectors. A comprehensive methodology used to conduct this research includes collecting article data, conducting analysis and then conducting a review study on data science and artificial intelligence trends. These articles were selected based on metadata sourced from web of science and Scopus metadata. In particular, the research scrutinized and assessed the evolving trends in data science and artificial intelligence within the hotel and tourism category. This analysis drew data from two prominent databases, Web of Science and Scopus, obtained a total of 4155 articles identified using the software and generated 124 terms in the articles with at least ten co-occurrence relationships. The findings of this study explain the huge potential, namely the trend of data application of science and artificial intelligence in the tourism sector which is categorized in five distinct areas: forecasting tourist demand, implementing customized service recommender systems for the tourism industry, classifying tourist behavior patterns in automation, analyzing and understanding tourist behavior, developing tourist destinations, and planning itineraries. Additionally, the research anticipates a heavy emphasis on future studies on predicting travel demand. Looking ahead, this research extends the foundations laid by previous review studies primarily focusing on knowledge and forecasting methodologies in the tourism sector. The conclusions drawn in this research are well-supported by the evolving landscape of knowledge in this field. Furthermore, contributions of this research it offers valuable insights into the future directions of apllied data science and artificial intelligent research are represents the pioneering effort to analyze of applying machine learning to advance artificial intelligence and big data within the hotel and travel industries. The authors propose several avenues for future research in this domain based on the data unearthed.

Keywords: Forecasting Demand, Machine Learning, Data Science, Tourism, Artificial Intelligence

1. Introduction

In the era of society 5.0, the tourism industry is growing rapidly, especially in digital marketing and promotion. In the era of society 5.0, the implementation of business strategies that help achieve marketing goals and gain a competitive advantage in the market is an important component of modern business operations. Marketing strategy is very important, because the development of the business world is growing more dynamic and competitive. The intricacies of marketing strategies are essential for success and sustainable growth, especially in the digital age. Various factors that affect success in business include globalization factors, technological advancements, and changes in consumer behavior. Therefore, in an effort to optimize a competitive business, companies must change and improve their marketing strategies, which refers to digital marketing. Digital marketing is a technological advancement and trend in the field of marketing that reaches a wider market and users. In research, [1] it was shown that current digital marketing trends are based on the utilization of big data, automation and artificial intelligence called B2B digital marketing. In addition, [2] conduct research on research opportunities related to big data, especially discussing consumer behavior and preferences in the tourism and hospitality sectors, which is a determining factor in business strategies. The company leverages data and analytics to personalize marketing and promotional strategies to customers, in an effort to address the growing demand for travel experiences tailored to customer interests [3].

Every organization or business must be able to increase competitiveness due to the availability of big data and the period of globalization, which is characterized by extremely rapid and intense rivalry [4]. By embracing the advancement of information and communication technology (ICT), which can gather, process, analyze, and produce

***Corresponding author: Hartatik (hartatik@students.undip.ac.id)**
DOI: https://doi.org/10.47738/jads.v5i4.300

hidden information that reveals core values (Big Data), businesses can become more competitive in the age of globalization. If an organization or company fails to effectively utilize technology in alignment with its data journey and the current attributes of its business, it is likely to experience a decline [5].

Research that utilizes the use of technology in the big data era in marketing strategies was conducted by Lin and Xiao, digital advances have had a major influence on the travel and tourism sector. The emergence of the digital economy has fueled the growth of international tourism [6]. The process of business digitization has revolutionized how the tourist sector functions and opened up new business prospects. Tourism's digital transformation involves adapting to cutting-edge developments in big data technologies, data science, artificial intelligence, and automation [6], [7]. This transition encompasses a diverse range of digital services for tourists, such as websites facilitating travel planning and reservations, travel management apps like tipLt and Kayak, virtual tours of tourist destinations, and the implementation of virtual reality to enhance the overall tourism experience [8]. It includes online marketing, electronic payment systems, Tourist experiences, assistance mobile apps, participation in online travel tourism communities, and utilizing digital maps and styling for efficient tourism management.

In the current era of Big Data, the development of Artificial Intelligence technology is so fast and changing various sectors, including the tourism sector, adding customer service, increasing operational efficiency, increasing satisfaction with travel experiences, and supporting sustainability initiatives. The benefits of AI are supported by the development of science, so methods that support its optimization and efficiency are continuously developed in various studies. Among them, shesi (2020) regarding the use of machine learning with deep learning methods in the tourism sector in implementing AI [9].

Various studies have been carried out in recent years regarding the implementation of science data and AI using machine learning algorithms among them the application of text mining and market sentiment analysis [10], [11] as well as its apllication in the tourism industry in the era of society 5.0 [12], [13], [14]. For that, this research aims to conduct a systematic review and critically analyze the sentiment analysis literature on the application of machine learning to artificial intelligence and data science in the field of hospitality and tourism.

2. Literature Review

2.1. Big Data

Big data is a collection of data or information that is very large and complex. With the increase in internet usage, the collection of data and information will continue to increase. Big data is a collection of very large and complex data, namely any information from anyone on the internet for personal and business purposes. Big data includes five basic frameworks called 5V (Velocity, Volume, Value, Variety, and Veracity): high data entry speed, data with value, data in large volumes, complex data variations, and data that contains truth/facts. Along with the development of technology in various industrial sectors, big data has become a central factor in business development, especially digital-based [2], [5].

2.2. Applied data science dan Artificial Intelligence

The concept of Data Science in industry includes the process of collecting, processing, and analyzing data to support decision-making to increase productivity efficiency, improve product quality, and even reduce operational costs, for example by utilizing regression analysis methods, production data can predict production failures to maintain production quality [4], [6]. In addition, in the era of Society 5.0, technological transformation is the main driver in forming an innovative and adaptive industrial ecosystem. AI technology provides a strong foundation for the industrial operational revolution. The efficient application of Data Science is the key to optimizing operations and identifying new opportunities. The industry can improve efficiency, productivity, and product quality by utilizing the right technology and data analysis methods. [1], [7].

Collecting all available data from many complex sources requires extensive processing to acquire the intended value or benefits. In this study, data processing in the digital era to provide deeper value unfolds through three integrated stages. The process begins with Data Integration in big data, which involves collecting and transforming all existing data into big data. In its industrial application, business actors acquire all data from online store websites, beginning

 ISSN 2723-6471

with new account registration data and progressing to wishlists and other items. All data will be recorded in the information system and used in the next step. Following the initial collection, the next stage involves Data Processing and Management. This method is conducted once the data has been collected. In this step, storing and categorizing data employs data science concepts such as statistical approaches and informatics computers to make data more easily accessible when needed.

The journey of data processing culminates with Data Analysis and Prediction, , where AI plays a critical role. The final step in this big data processing is data analysis and prediction, which involves undertaking analysis for future needs to make wiser, more timely, and more efficient decisions. For example, AI can be used to examine a user's previous data from a tour excursion toto determine the best future promotional content for that user.

Big Data analysis software and technologies quickly evolved in application and computation throughout the Industrial Revolution 5.0 timeframe. Applied data science is an important topic of research that combines statistical methods, analysis techniques, computational logic, and algorithms to deal with the rising complexity of data in digital information systems. Thus, applied data science and AI technology are very important for information systems in the big data era, especially in developing a new paradigm in society in the digital era 5.0 and future research potential [5], [7].

3. Methodology

This section describes research techniques for an integrated machine-bibliometric-based literature review on applications of data science and artificial intelligence. This method is designed to reduce potential sources of bias stemming from the subjective judgment of authors at various stages of the review. This research focuses on AI's possible applications, which are developing now and, in the future, opening up a wide range of research opportunities in areas such as optimization methodologies and specialized research fields for discovering future research gaps. This study used the ' review overview' methodology, which proposes the development of a systematic literature review, which involves locating, assessing, and synthesizing the results of previous article reviews and is characterized by finding answers to questions posed by the researcher.

Finally, we investigate trends in applied data science and artificial intelligence with this approach and, analyze future work, outline ideas, and assess previous work to identify some of the bases specified for future work. We collected data by developing our last research question in the first step. At the first step, we collecting data by developed our last research question, RQ1, RQ2 and RQ3.

RQ1: What are the main topics, advantages, and disadvantages of using AI in the tourist sector, as per the existing literature?

RQ2: What approaches are frequently used in AI applications in the tourism sector, and what are the possible consequences?

RQ3: According to the available literature and recent advancements in the field, what are the potential areas of future study in applications of AI in the tourist industry?

Based on these questions, we develop query search equations that consider the research's interest. The keywords for the search included:

"Hospitality and tourism" and) ("Artificial Intelligence" OR "AI" OR "Big data" OR "Data science" OR "exploratory data" OR "Machine Learning" OR "neural network*" OR "Deep Learning" OR "Expert Systems" OR "Natural Language Processing" OR "NLP" OR "sentiment analysis" OR "Robotics" OR "Big Data Analytics" OR "personalized services" OR "route planning." The next steps which are the stages in the research carried out are shown in Figure 1.

 ISSN 2723-6471

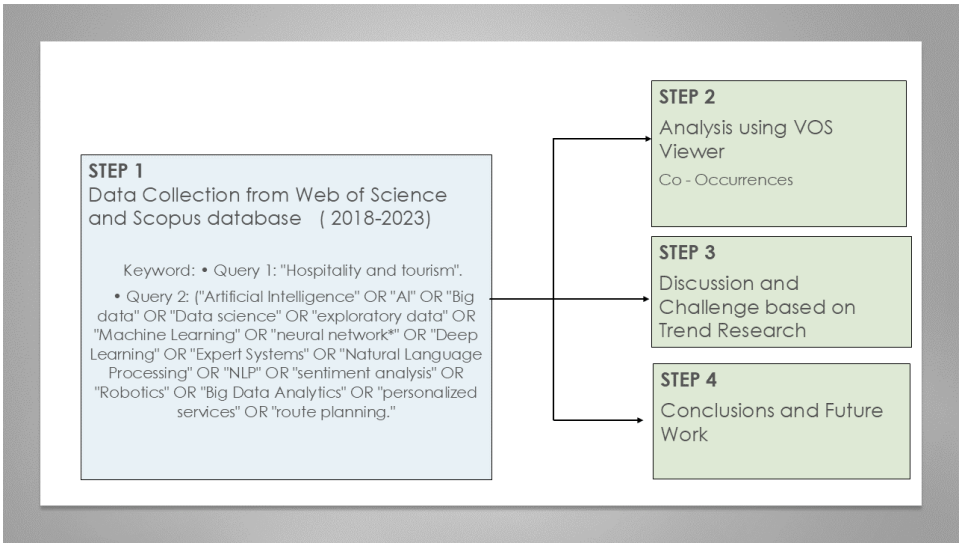

Figure 1. Schema of Research methodology

Finally, we investigate trends in applied data science and artificial intelligence with this approach and, analyze future work, outline ideas, and assess previous work to identify some of the bases specified for future work. The use of VOSviewer software for visualization and analysis is an important component of the process, allowing the identification of major themes, prominent authors, and the intellectual structure of the area. The complete steps are described in figure 1, which illustrates the stages of research methodology in the research conducted.

4. Results and Discussion

Based on the findings of a review of articles in the tourism and hospitality industry on data science and artificial intelligence, a further 4155 articles were identified using VosViewer software to generate a text-based map utilizing the title and abstract columns. This text-based approach is intended to classify articles on data science and AI applications by retrieving highly related articles, namely articles with at least ten co-occurrence relations. In the VosViewer analysis process, 124 terms have at least ten co-occurrence relations. VOSviewer analysis Explores the relationships between concepts or keywords in the literature by displaying a map with connected term dots. Each dot represents a document, and the distance between dots indicates the kinship relationship. The resulting clusters can indicate related fields or emerging topics as indicated by the thickness of the visualized dots on the term.

Based on RQ1, RQ2, and RQ3, the results of the analysis and observation of the papers that have been collected are shown in figure 2 and figure 3. In figure 2 provides an overview of the research from each country's position. Figure 2 articles with authors from China occupy the largest position for applied data science and AI research topics in the field of tourism, and then the second and third ranks, with numbers that are not far apart, are from India and the United States. Meanwhile, based on the database obtained, Indonesia is ranked 8th.

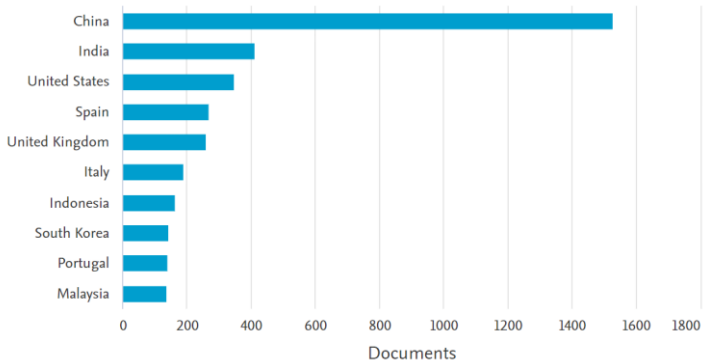

Figure 2. Country of the articles' origin

 ISSN 2723-6471

In the VosViewer analysis process, the database was analyzed by selecting the keywords with the most occurrences. In this study, 124 keywords had at least ten links with other keywords. Figure 3 illustrates the results of observational analysis of research topics based on the metadata obtained, namely the trend of using data science and AI data which is grouped into five categories.

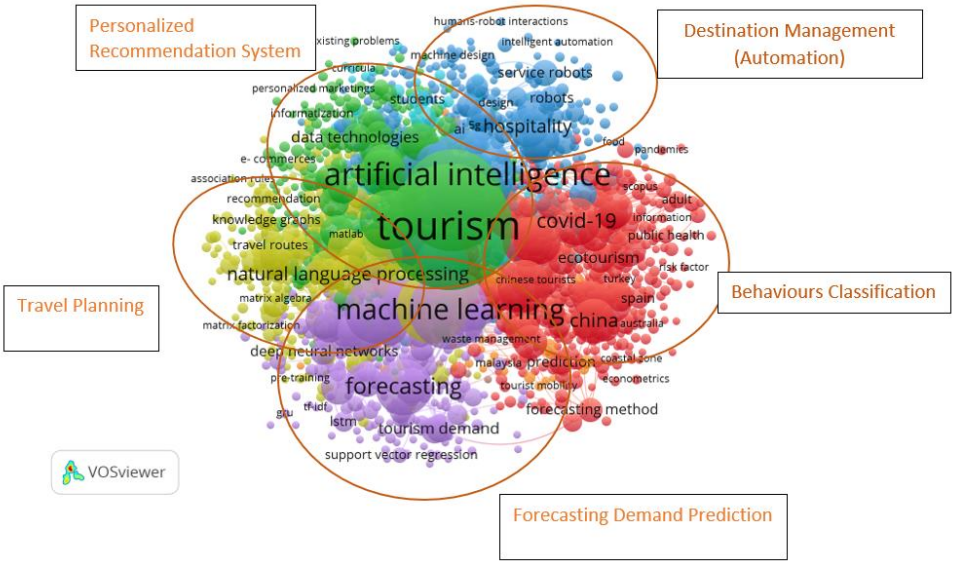

Figure 3. Research trends in data science and AI

The following are data science and AI trends in the tourism sector based on the review paper in this study. Based on figure 3, there are five opportunities to develop and apply data science and artificial intelligence. In detail, figure 3 will be discussed as follows:

4.1. Tourism Destination Management (Automation)

Research on the diverse impacts of AI within the tourism industry, especially concerning users and society, has notably surged in recent years. Specific case studies of implementation data science and artificial intelligence are data availability in various online media to describe users' behavior [15], [16]. In their 2019 study, Li et al. delved into the repercussions of robotics on the hotel sector and how these repercussions influence employees' attitudes and behaviors [17] using sentiment analysis [18], [19]. For instance, this research scrutinized the consequences of implementing automation through robots to perform tasks traditionally carried out by humans within the hotel industry. They conceptualized human traits' scope, effects, and intent in utilizing automated services. They leveraged the viewpoints of both tourists and hotels to elucidate the impact of human-robot interactions. A novel approach to evaluating the effectiveness of AI in the travel and tourism domain entails a meticulous exploration of this impact [20]. To fully exploit the advantages of AI-based automation and implement it effectively, future research must focus on appropriate methodologies to exploit its full potential. The use of state-of-the-art AI technology in this study aligns with the prerequisites for developing functional AI systems tailored to the travel and tourism sector. Prospects may include the classification of customer behavior and preferences, sentiment analysis, and semantic clustering when selecting tourist destinations through the use of chatbots [21], [22], [17]. In practical implementation as a potential research development, namely the development of information systems related to Tourism Destination Management (Automation) by implementing text reviews and ratings. This will help practitioners capture company and product profiling of tourist destinations so that they can be used to formulate tourism management.

4.2. Tourism Demand Forecasting

Forecasting in the tourism industry has been revolutionized thanks to the adoption of predictive analytics and many AI-powered models. This advancement empowers organizations to offer more precise estimations and predictions by utilizing AI algorithms and machine learning techniques. This, in turn, streamlines strategic planning and decision-making, particularly within the ever-evolving tourism sector, where anticipating tourist demand is paramount. It simplifies businesses' prediction process for future trends, demand patterns, and market fluctuations. AI can play a

pivotal role in predicting future economic conditions and income levels and identifying current trends and potential tourist demand [23]. The research [24] employs high-frequency forecasting algorithms and vast datasets from mobile devices to predict and manage visitor movements in tourist areas [25]. To ensure precision in predictions, a range of data sources are tapped into, including expert databases, government records, and operational data, as highlighted [24]. According to [26], the most effective and contemporary approaches for fostering growth trends in the hospitality sector are Business Intelligence (BI) and IT-based solutions.

In the realm of tourist forecasting, time series models and AI-based techniques such as support vector regression, neural networks, and genetic algorithms are commonly deployed in advanced research phases. Recent trends in tourism forecasting have enthusiastically embraced state-of-the-art methodologies, encompassing big data analysis, machine learning, the utilization of search engine data, and the analysis of internet search volumes. Forecasting tourist demand remains valuable in this continually evolving landscape [27], [28]. The method used and an opportunity for future research development is by using the ARIMA, SARIMA, SARIMAX forecasting methods to determine dynamic patterns.

4.3. Tourism Route Planning

The deep learning approach has been used extensively in research over the past ten years, particularly in using scientific and artificial intelligence data to develop tourism routes [29], [30]. Future research projects will be able to take use of this. Future research endeavors will undoubtedly continue to harness the potential of this approach. In the context of digital transformation, tourism route planning encompasses how travelers plan their itineraries based on their preferences and how it aids in organizing trips in alignment with their budgets. The development of route planning within the tourism sector is poised to offer significant research opportunities in the future, as highlighted by [31], [32], [33]. The methods used in research on this topic are Convolutional Neural Network (CNN), Long Short Term Memory (LSTM), Recurrent Neural Network (RNN), Natural Language Processing (NLP), deep reinforcement learning (DRL).

4.5. Tourism Behavior Classification

Classification of tourism behavior by utilizing useful images and text in tourism marketing. It plays an important role in shaping the perception and intention of tourists [34]. The COVID-19 pandemic has significantly impacted the tourism industry, so an effective destination marketing strategy is needed to revive tourism. Tourism specialists use images as data to understand how visual representations of a site form and reflect it. Destination images influence and change tourists' perceptions of places [35]. The two essential components of an image are its content and composition. While composition indicates how the performance is put together about earlier performances, content refers to the performance as a whole. Empirical studies in the field of tourism may be divided based on the research's focus [36]. To determine the type or characteristics of the target picture, the investigations in the first category use a sample of the recovered images.

Research trends on Tourism Behavior Classification, According to [37], the study employed photographs to better understand the impressions and actions of visitors to a location. Secondly, research [38] shows that Geotagged images are used as data sources in this work. In addition to embedded metadata (such as time and location), these image and text are specific to behavior classification (example tags of photo, titles, and descriptions). Using spatial statistics and ArcGIS methods to evaluate geotagged photos in different cities and regions, it is possible to determine how appealing a site is to tourists and to comprehend the patterns of their travel behavior [39]. On the other hand, geographical features just serve as a background or a metaphor for a location in a picture. In contrast, visual content with items in an image could provide additional information about an area. A fuller comprehension of the situation shown in the image may be gained by combining the photographic material (such as color, form, texture, light, and composition), which makes up the overall framed image. Because images include valuable metadata and a wealth of other data, it is essential to deploy powerful data mining tools that can interact directly with the picture content [40]. The methods used in research trends and challenge for future research on the focus of behavioral tourism are utilizing big data, machine learning, and deep learning, including ordinary least squares (OLS), spatial autocorrelation, naive Bayes classifier, user-generated content, and deep learning algorithms.

4.5. Tourism Personalized Service Recommender System

The studies on text recognition, robot automation research by [41], and research in the field of tourism for image recognition by [42] are a few examples of earlier studies that used data science and AI to explain decision-making. Previous studies have used pre-training models from many academic fields to address descriptive and prescriptive problems in the tourism industry. As a result, this framework contains flaws, and the results must be tailored to the model of choice. However, these limits may be overcome by providing the tourist sector with more targeted and precise AI solutions.

The present growth of tourism and digital transformation delivers and provides unusually open data with the presence of an online-based recommendation system in the tourist sector [35]. Artificial intelligence and business intelligence, deep learning, blockchain, and cloud computing have all altered several industries over the last decade[43], [44]. At the same time, the need for sophisticated systems and a wealth of travel-related data has given rise to the idea of "Smart Tourism," which may be seen as an extension of traditional tourism, including tourism recommendations based on big data [45], [46]. Their article identifies eleven fundamental ideas and strategies necessary for smart tourism's growth.

A recommendation model for tourism promotion is developed in this study using artificial intelligence technology and data analytics based on user preference analysis using semantic clustering techniques and machine learning algorithms, specifically a combination of artificial neural networks (ANN) [47], [48], with latent factors including using Latent Dirichlet Allocation (LDA) [49], [50]. This study will gather user preferences for information that affects the promotion of tourism, such as hotel preferences and travel destinations [51] and tourist destinations [52], on social media and YouTube [53]. Future research on deep learning methods is a challenge for future research implemented in recommendation models and recommendation models that integrate customer behavior to increase the accuracy of model evaluation.

Based on the focus area of the research above, the following is a summary of the application of applied data science and artificial intelligence in tourism and hospitality, as seen in table 1 and figure 4.

Table 1. Summary Methods of Applying Applied Data Science and AI in Tourism

No Ref	Contribution	Dataset	Method	Area
[19]	This paper highlights the contribution of computer deep learning technology to analyze tourist behavior and perceptions in tourism destinations by classifying tourist behavior for automation.	137,265 photos Beijing	ResNet-101 for image classification and Content analysis using NVivo, text blob, and ThoughtView for data statistics	Tourism Destination Management (Automation)
[20]	This paper introduces a new combination of CNN's deep learning technique and KMeans' unsupervised learning method for sentiment analysis in movie reviews, providing a better sentiment estimation than existing methods.	Movie review data containing 10,662	CNN, KNN, CNN-KNN, CNN-K Means	Tourism Destination Management (Automation)
[21], [22]	This paper proposes a sentiment classification model for educational tourism reviews based on the multichannel attention mechanism of CNN and LSTM, contributing to improving the accuracy of sentiment analysis in the tourism industry	60,000 comments on educational tourism	Word2vev, TF-IDF, CNN, KNN, LSTM	Tourism Destination Management (Automation)
[25]	tourism demand from various perspectives to predict and demand mining tourism. This is critical for the sustainable development of wetland ecotourism, as highlighted in the study.	Number of wetland ecotourism from 2015 to 2019	Single Wetland Ecotourism Demand Prediction Model (DPM) based on Fuzzy Clustering Algorithm	Tourism demand forecasting
[29]	This paper proposes a trip planning method using Ant Colony Optimization (ACO) for one-day trips, considering previous trip records and multi-destination optimization to meet user demand.	Kyoto with 150 POIs, Sapporo with 100 POIs, and Tokyo with 150 POIs	Ant colony optimization, P-VNS, and MOACOPW	Tourism Route Planning
[30]	health tourism development in China, analyzing healthcare tourism routes through neural network algorithms to optimize travel routes	20,000 sample data from the Mafengwo Tourism website	ANN	Tourism Route Planning

[38]	Contribute to the literature on Big Data and tourism activities by comparing three different data sources to get a comprehensive analysis of tourist locations.	Using 3 dataset sources, namely Panoramio for sightseeing activities, Foursquare for consumption activities, and Twitter for connectivity activities	Spatial Autocorrelation Analysis; Ordinary Least Square (OLS)	Tourism Behavior Classification
[39]	Contribute research to gain a comprehensive understanding of the prejudices reflected in online photos posted by travelers	53,000 photos collected from hotel review platform, TripAdvisor.	UGC: content analysis based on deep learning	Tourism Behavior Classification
[45]	The research aims to offer insights into Artificial Neural Networks and Matrix Factorization Neural Networks, demonstrating the architecture of ANN models to predict traveler preferences	100,000 ratings up to 9000 movies by 600 users	Deep Learning and model Collaborative Filtering	Tourism personalized service Recommender system
[47]	The study focuses on beer recommendations based on rating data and compares 10 classification models for text sentiment analysis, improving the credibility of recommended beer products and increasing user acceptance.	The total data 37,500 data	Sentiment Analysis: a.Conventional Machine Learning Models (Decision Trees, Random Forests, Extra Trees, Naive Bayesian, Logistic Regression, and Stochastic Gradient Descent). b. Deep learning models such as CNN, RNN, and LSTM	Tourism personalized service Recommender system

Based on the data collected, the discussion and table 1 results show that the deep learning method tends to be used more in research in the field of tourism and hospitality industry. Figure 4 provides an overview of the proposed framework for future research to advance the scientific development and application of artificial intelligence and data science trends. Figure 4 shows the application of artificial intelligence science and data, as well as a grouping of research topics that can be developed in the field of tourism.

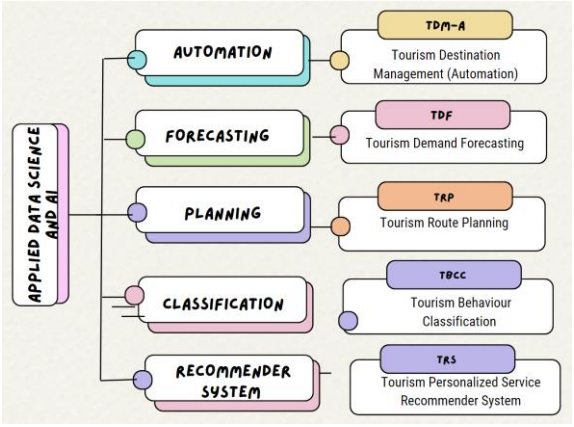

Figure 4. Proposed Framework for Future Research

The deep learning approach in the context of using cyan data and AI in the tourism sector was discovered to be viable development material based on the debate and evaluation of the paper. The analysis using vosviewer for deep learning techniques in tourism and AI is provided below at figure 5.

 ISSN 2723-6471

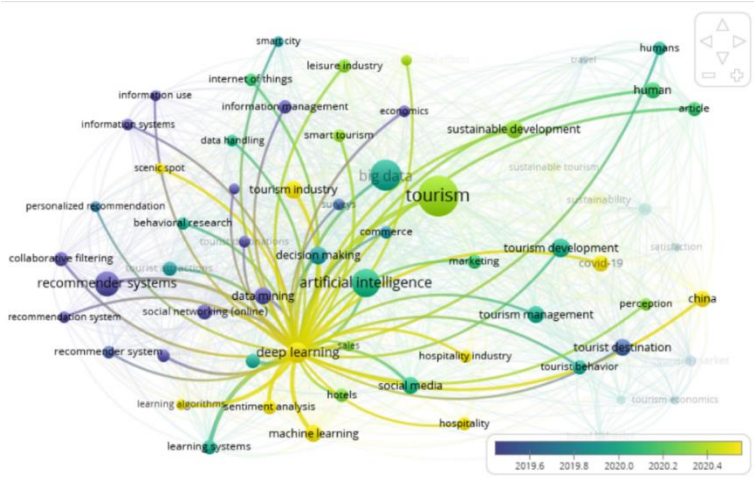

Figure 5. Deep Learning Methods

Figure 5 depicts the utilization of the deep learning approach as derived from the review of articles within this study. Over the past five years, various researchers have explored the application of deep learning in tourism and hospitality. These applications have been related to management, recommender systems, artificial intelligence, the implementation of data science in destination management, tourist behavior, smart city initiatives, and decision-making processes [54], [55].

5. Conclusions

Leveraging AI and big data capabilities allows businesses to offer customized services and sustainably improve services, especially in the tourism and hospitality sectors. Through the use of AI in tourism destination management automation, for example, chatbots and virtual assistants can quickly provide personalized responses to customer questions, thereby increasing customer satisfaction and reducing response time. Machine learning algorithms can analyze vast data, including customer preferences and behaviors, to provide individualized recommendations and suggestions for itineraries, accommodations, and activities.

Future applications include recommendations for personalizing tourism based on preferences, particularly in research on user preference analysis using clustering and machine learning methods. These include analysis methods, grouping, preference for classification data, and topic modeling analysis. Future trend of research development is the use of artificial intelligence concepts to assess user preferences to improve travel forecasts and recommendations. Future studies will mainly focus on using machine learning techniques such as the ANN and Bayesian methods and deep learning such as CNN and RNN to help develop recommendation models to promote tourism. The development of future research also still has a wide opportunity to forecast tourist arrivals based on tourist arrival data, especially with the development of unstructured data that allows estimates based on data reviews.

Numerous studies have been conducted on using deep learning in the tourist and hospitality sectors. However, this study still has limitations due to the small number of studies conducted in this sector. Further research on the selected study focus is required. Finally, the approaches that support the creation of AI-based travel recommendations are always evolving, necessitating the continuation of the suggested research path to maintain the development of a strong foundation for data science and AI-based travel recommendations. Every tourism research plan needs to include a thorough explanation of the optimization and recommendation techniques.

Data science and artificial intelligence have become a method of recognizing consumer behavior as a modern marketing effort. This research can be used to understand, analyze, and explore the potential use and benefits of applying data science and AI to company strategies. This means that managers or supervisors can understand the various benefits of big data to develop digital marketing strategies. In addition, the proposed direction of future research also helps companies to create a roadmap for company development in the digital era, especially in decision-making, implementing new promotional methods based on user data exploration, and providing periodic visualization of tourism potential so that it can increase visits and tourist attractions.

6. Declarations

6.1. Author Contributions

Conceptualization: H.T, R.R.I., and B.W.; Methodology: R.R.I.; Software: H.T; Validation: H.T. and R.R.I.; Data Analysis: H.T. and R.R.I.; Resources: R.R.I.; Data Curation: R.R.I.; Writing Original Draft Preparation: H.T. and R.R.I.; Writing Review and Editing: R.R.I. and H.T.; Visualization: H.T.; All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6.3. Funding

We thank Universitas Sebelas Maret, Surakarta, Indonesia, Applied Data Science and Artificial Intelligence Research Group, for providing the funds under Penelitian Hibah Disertasi Doktor Universitas Sebelas Maret (PDD-UNS), with the following reference No. 194.2/UN27.22/PT.01.03/2024.

6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. 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.

References

[1] J. R. Saura, D. Ribeiro-Soriano, and D. Palacios-Marqués, "Setting B2B digital marketing in artificial intelligence-based CRMs: A review and directions for future research," *Ind. Mark. Manag.*, vol. 98, no. August, pp. 161–178, 2021, doi: 10.1016/j.indmarman.2021.08.006.

[2] P. Sunagar, R. Hanumantharaju, G. M. Siddesh, A. Kanavalli, and K. G. Srinivasa, "Influence of big data in smart tourism," *in Hybrid Computational Intelligence: Challenges and Applications, Department of CSE, Ramaiah Institute of Technology, Bangalore, India: Elsevier*, vol 1. no. 978-0-12-818438-7, pp. 25–47, 2020. doi: 10.1016/B978-0-12-818699-2.00002-0.

[3] A. Morzhyna, M. Oliinichenko, and Y. Postykina, "Modern Trends in Digital Marketing," *Mod. Econ.*, vol. 14, no. 1, pp. 174–179, Apr. 2019, doi: 10.31521/modecon.V14(2019)-27.

[4] R. Egger, "Applied Data Science in Tourism: Interdisciplinary Approaches, Methodologies, and Applications," *Zeitschrift für Tour.*, vol. 13, no. 2, pp. 303–304, 2021, doi: 10.1515/tw-2021-0018.

[5] K. Venkatram and M. A. Geetha, ''Review on big data and analytics Concepts, philosophy, process and applications,'' *Cybern. Inf. Technol.*, vol. 17, no. 2, pp. 3–27, Jun. 2017, doi: 10.1515/cait-2017-0013.

[6] Y. Li, Z. Lin, and S. Xiao, "Using social media big data for tourist demand forecasting: A new machine learning analytical approach," *J. Digit. Econ.*, vol. 1, no. 1, pp. 32–43, 2022, doi: 10.1016/j.jdec.2022.08.006.

[7] E. Marine-Roig and S. Anton Clavé, "Tourism analytics with massive user-generated content: A case study of Barcelona," *J. Destin. Mark. Manag.*, vol. 4, no. 3, pp. 162–172, 2015, doi: 10.1016/j.jdmm.2015.06.004.

[8] E. Lewandowicz and J. Bac-Bronowicz, "Outdoor Tourism, Kayaking, Tourism Potential And Tourism Operations In Central-Eastern Europe: The Case Of Poland," *Geoj. Tour. Geosites*, vol. 40, no. 1, pp. 232–241, 2021, doi: 10.30892/GTG.40128-824.

[9] M. Al Shehhi and A. Karathanasopoulos, "Forecasting hotel room prices in selected GCC cities using deep learning," *J. Hosp. Tour. Manag.*, vol. 42, no . arch2020, pp. 40–50, 2020, doi: 10.1016/j.jhtm.2019.11.003.

[10] M. Bordoloi and S. K. Biswas, "Sentiment analysis: A survey on design framework, applications and future scopes," *Artificial*

Intelligence Review, vol. 56, no. March 2023, pp. 12505–12560, 2023. doi: 10.1007/s10462-023-10442-2.

[11] M. Gao, J. Wang, and O. Liu, "Is UGC sentiment helpful for recommendation? An application of sentiment-based recommendation model," *Industrial Management and Data Systems*, vol. 124, no. 4, pp. 1356-1384, 2024, doi: 10.1108/imds-05-2023-0335.

[12] A. Tanwar and D. K. Vishwakarma, "A deep neural network-based hybrid recommender system with user-user networks," *Multimed. Tools Appl.*, vol. 82, no. 10, pp. 15613–15633, 2023, doi: 10.1007/s11042-022-13936-3.

[13] W. Shafqat and Y. C. Byun, "A recommendation mechanism for under-emphasized tourist spots using topic modeling and sentiment analysis," *Sustain.*, vol. 12, no. 1, pp. 1-26, 2020, doi: 10.3390/SU12010320.

[14] Oztemel, E., and Gursev, S. "Literature review of Industry 4.0 and related technologies", *Journal of intelligent manufacturing*, vol, 31, no. 1, pp. 127-182, 2020.doi: 10.1007/s10845-018-1433-8.

[15] C. Qin, C. Zhang, and Y. Bu, "Exploring the distribution regularities of user attention and sentiment toward product aspects in online reviews," *Electron. Libr.*, vol. 39, no. 4, pp. 615–638, 2021, doi: 10.1108/EL-11-2020-0324.

[16] H. Li, W. Li, J. Zhao, P. Yu, and Y. Huang, "A sentiment analysis approach for travel-related Chinese online review content," *PeerJ Comput. Sci.*, vol. 9, no. August 23, pp.1-21, 2023, doi: 10.7717/peerj-cs.1538.

[17] E. Park, J. Kang, D. Choi, and J. Han, "Understanding customers' hotel revisiting behaviour: a sentiment analysis of online feedback reviews," *Curr. Issues Tour.*, vol. 23, no. 5, pp. 605–611, 2020, doi: 10.1080/13683500.2018.1549025.

[18] K. Zhang, Y. Chen, and C. Li, "Discovering the tourists' behaviors and perceptions in a tourism destination by analyzing photos' visual content with a computer deep learning model: The case of Beijing," *Tour. Manag.*, vol. 75, no. December 2023, pp. 595–608, 2019, doi: 10.1016/j.tourman.2019.07.002.

[19] B. S. Lakshmi, P. S. Raj, and R. R. Vikram, "Sentiment Analysis Using Deep Learning Technique CNN with KMeans," *Int. J. Pure Appl. Math.*, vol. 114, no. 11, pp. 47–57, 2017.

[20] S. Choi, Y., Choi, M., Oh, M., and Kim, "Service robots in hotels: understanding the service quality perceptions of human-robot interaction," *J. Hosp. Mark. Manag.*, vol. 29, no. 6, pp. 613-635, 2019.

[21] Y. Wang, C. Chu, and T. Lan, "Sentiment Classification of Educational Tourism Reviews Based on Parallel CNN and LSTM with Attention Mechanism," *Mob. Inf. Syst.*, vol. 2022, no. January, pp. 1-12, 2022, doi: 10.1155/2022/6177427.

[22] P. Hajek and J.-M. Sahut, "Mining behavioural and sentiment-dependent linguistic patterns from restaurant reviews for fake review detection," *Technol. Forecast. Soc. Change*, vol. 177, no. April 2022, pp. 1-10, 2022, doi: 10.1016/j.techfore.2022.121532.

[23] Z. Doborjeh, N. Hemmington, M. Doborjeh, and N. Kasabov, "Artificial intelligence: a systematic review of methods and applications in hospitality and tourism," *Int. J. Contemp. Hosp. Manag.*, vol. 34, no. 3, pp. 1154–1176, 2022, doi: 10.1108/IJCHM-06-2021-0767.

[24] A. Essien and G. Chukwukelu, "Deep learning in hospitality and tourism: a research framework agenda for future research," *Int. J. Contemp. Hosp. Manag.*, vol. 34, no. 12, pp. 4480–4515, 2022, doi: 10.1108/IJCHM-09-2021-1176.

[25] B. Shao, L. Chen, and N. Xing, "Wetland Ecotourism Development Using Deep Learning and Grey Clustering Algorithm from the Perspective of Sustainable Development," *J. Environ. Public Health*, vol. 2022, no. August 2022, pp. 1-10, 2022, doi: 10.1155/2022/1040999.

[26] L. Chen, H. Hu, X. He, and M. Lyu, "The Development Path and Data Mining Mode of Rural Tourism under the Background of Big Data," *Wirel. Commun. Mob. Comput.*, vol. 2022, pp. 1-13, 2022, doi: 10.1155/2022/3031169.

[27] X. Liang, C. Hong, W. Zhou, and M. Yang, "Air travel demand forecasting based on big data: A struggle against public anxiety," *Front. Psychol.*, vol. 13, no. December 2022, pp. 1-13, 2022, doi: 10.3389/fpsyg.2022.1017875.

[28] A. Guizzardi, F. M. E. Pons, G. Angelini, and E. Ranieri, "Big data from dynamic pricing: A smart approach to tourism demand forecasting," *Int. J. Forecast.*, vol. 37, no. 3, pp. 1049–1060, 2021, doi: 10.1016/j.ijforecast.2020.11.006.

[29] E. Saeki, S. Bao, T. Takayama, and N. Togawa, "Multi-Objective Trip Planning Based on Ant Colony Optimization Utilizing Trip Records," *IEEE Access*, vol. 10, no. December 2022, pp. 127825–127844, 2022, doi: 10.1109/ACCESS.2022.3227431.

[30] S. Wang, "Route Planning of Health Care Tourism Based on Computer Deep Learning," *Wirel. Commun. Mob. Comput.*, vol. 2022, no. August 2022, pp. 1-12, 2022, doi: 10.1155/2022/4500009.

[31] I. Cenamor, T. de la Rosa, S. Núñez, and D. Borrajo, "Planning for tourism routes using social networks," *Expert Syst. Appl.*, vol. 69, no. March 2017, pp. 1–9, 2017, doi: 10.1016/j.eswa.2016.10.030.

[32] Noorian Avval, Ali Akbar, and Ali Harounabadi. "A hybrid recommender system using topic modeling and prefixspan algorithm in social media." *Complex and Intelligent Systems*, vol. 9, no.4, pp. 4457-4482, 2023. doi: 10.1007/s40747-022-00958-5.

[33] W. Bi, G. Wang, and M. Zhang, "Personalized Recommendation of Rural Tourism Based on Traffic Classification and User Data Analysis," *Secur. Commun. Networks*, vol. 2022, no. January 2022, 2022, doi: 10.1155/2022/4434833.

[34] C. Oo, M. WankhadSahe, and B. K. Singh, "Sentiment analysis using deep learning techniques: a comprehensive review," *Int. J. Multimed. Inf. Retr.*, vol. 12, no. 2, pp. 1–23, 2023, doi: 10.1007/s13735-023-00308-2.

[35] Q. Li, S. Li, S. Zhang, J. Hu, and J. Hu, "A review of text corpus-based tourism big data mining," *Appl. Sci.*, vol. 9, no. 16, pp. 1–27, 2019, doi: 10.3390/app9163300.

[36] N. Balomenou and B. Garrod, "Photographs in tourism research: Prejudice, power, performance and participant-generated images," *Tourism Management*, vol. 70, no. 1, pp. 201-217, 2019, doi :10.1016/j.tourman.2018.08.014.

[37] M. H. Salas-Olmedo, B. Moya-Gómez, J. C. García-Palomares, and J. Gutiérrez, "Tourists' digital footprint in cities: Comparing Big Data sources," *Tour. Manag.*, vol. 66, no. june, pp. 13–25, 2018, doi: 10.1016/j.tourman.2017.11.001.

[38] N. Deng and X. (Robert) Li, "Feeling a destination through the 'right' photos: A machine learning model for DMOs' photo selection," *Tour. Manag.*, vol. 65, no. Apr., pp. 267–278, 2018, doi: 10.1016/j.tourman.2017.09.010.

[39] M. Ren, H. Q. Vu, G. Li, and R. Law, "Large-scale comparative analyses of hotel photo content posted by managers and customers to review platforms based on deep learning: implications for hospitality marketers," *J. Hosp. Mark. Manag.*, vol. 30, no. 1, pp. 96–119, 2021, doi: 10.1080/19368623.2020.1765226.

[40] A. Nikjoo and H. Bakhshi, "The presence of tourists and residents in shared travel photos," *Tour. Manag.*, vol. 70, no. August 2018, pp. 89–98, 2019, doi: 10.1016/j.tourman.2018.08.005.

[41] S. Ivanov, C. Webster, and P. Seyyedi, "Consumers' attitudes towards the introduction of robots in accommodation establishments," *Tourism*, vol. 66, no. 3, pp. 302–317, 2018, UDC: 338.488.2: 007.52(55).

[42] H. Li, L. Zhang, and C. H. C. Hsu, "Research on user-generated photos in tourism and hospitality: A systematic review and way forward," *Tour. Manag.*, vol. 96, no. June 2022, pp. 1-16, 2023, doi: 10.1016/j.tourman.2022.104714.

[43] J. Borràs, A. Moreno, and A. Valls, "Intelligent tourism recommender systems: A survey," *Expert Syst. Appl.*, vol. 41, no. 16, pp. 7370–7389, 2014, doi: 10.1016/j.eswa.2014.06.007.

[44] Singh, S., Sharma, P. K., Yoon, B., Shojafar, M., Cho, G. H., and Ra, I. H, "Convergence of blockchain and artificial intelligence in IoT network for the sustainable smart city", *Sustainable cities and society*, vol. 63 no. dec., pp. 1-16, 2020, doi : 10.1016/j.scs.2020.102364.

[45] Z. Yuan, "Big Data Recommendation Research Based on Travel Consumer Sentiment Analysis," *Frontiers in Psychology*, vol. 13, no. February 2022 , pp. 1-10, 2022. doi: 10.3389/fpsyg.2022.857292.

[46] Q. Shambour, M. M. Abualhaj, and A. A. Abu-Shareha, "A Trust-Based Recommender System for Personalized Restaurants Recommendation," *Int. J. Electr. Comput. Eng. Syst.*, vol. 13, no. 4, pp. 293–299, 2022, doi: 10.32985/IJECES.13.4.5.

[47] A. Kontogianni, E. Alepis, and C. Patsakis, "Promoting smart tourism personalised services via a combination of deep learning techniques," *Expert Syst. Appl.*, vol. 187, no. September 2021, pp. 1-16, 2022, doi: 10.1016/j.eswa.2021.115964.

[48] H. Jelodar et al., "Recommendation system based on semantic scholar mining and topic modeling on conference publications," *Soft Comput.*, vol. 25, no. 5, pp. 3675–3696, 2021, doi: 10.1007/s00500-020-05397-3.

[49] P. Ni, Y. Li, and V. Chang, "Recommendation and Sentiment Analysis Based on Consumer Review and Rating," *Int. J. Bus. Intell. Res.*, vol. 11, no. 2, pp. 11–27, 2020, doi: 10.4018/ijbir.2020070102.

[50] Huang, C., Wang, Q., Yang, D., and Xu, F, "Topic mining of tourist attractions based on a seasonal context aware LDA model", *Intelligent Data Analysis*, vol. 22, no. 2, pp. 383-405, 2018, doi : 10.3233/IDA-173364.

[51] M. L. Yadav and B. Roychoudhury, "Effect of trip mode on opinion about hotel aspects: A social media analysis approach," *Int. J. Hosp. Manag.*, vol. 80, no. September 2018, pp. 155–165, 2019, doi: 10.1016/j.ijhm.2019.02.002.

[52] Y. Huang and L. Bian, "A Bayesian network and analytic hierarchy process based personalized recommendations for tourist

attractions over the Internet," *Expert Syst. Appl.*, vol. 36, no. 1, pp. 933–943, 2009, doi: 10.1016/j.eswa.2007.10.019.

[53] E. Kauffmann, J. Peral, D. Gil, A. Ferrández, R. Sellers, and H. Mora, "Managing marketing decision-making with sentiment analysis: An evaluation of the main product features using text data mining," *Sustain.*, vol. 11, no. 15, pp. 1–19, 2019, doi: 10.3390/su11154235.

[54] I. H. Sarker, "Data Science and Analytics: An Overview from Data-Driven Smart Computing, Decision-Making and Applications Perspective," *SN Comput. Sci.*, vol. 2, no. 5, pp. 1–22, 2021, doi: 10.1007/s42979-021-00765-8.

[55] M. K. Sahu and S. Selot, "Comparative Analysis of Various Supervised Machine Learning Techniques Used for Sentiment Analysis on Tourism Reviews," *in Lecture Notes in Networks and Systems*, vol. 341, no. January 2022, pp. 19–49, 2022. doi: 10.1007/978-981-16-7118-0_3.