Research Article

Construction and Design of a Smart Tourism Model Based on Big Data Technologies

QiaoRan Jia,1 YiLin Cui,2 E. N. X. U. A. N. LIU,2 Jack Young,1 Yuyue Polly,1 WeiSheng Sun2,3 and HuaWen Shen1

1Faculty of International Tourism and Management, City University of Macau, Macao Special Administrative Region 999078, China
2Faculty of Business, City University of Macau, Macao Special Administrative Region 999078, China

Correspondence should be addressed to WeiSheng Sun; 714429967@qq.com

Received 9 February 2022; Accepted 17 March 2022; Published 5 May 2022

Academic Editor: Mian Ahmad Jan

Copyright © 2022 Qiao Ran Jia et al. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

With the continuous advancement in technology, the tourism sector has developed to become one of the most important sectors globally in the modern period. These factors have given rise to the concept of ”smart tourism,” which can be described as a step forward from conventional tourism. To achieve a true smart tourism experience, the appropriate services must be supplied to the correct user at the right time and in the most efficient and feasible manner. Keeping the importance of technology and tourism in consideration, the proposal and penetration of innovation-driven development strategies and smart tourism have become the focus of attention in the tourism industry at this stage. Smart tourism is comprised of a large number of tourists, devices, and operational processes which generate an enormous volume of tourism data. Handling such large amounts of tourism data in an effective and accurate manner is indeed an important thing to consider. To handle this issue, this study focuses on the construction and design of a smart tourism model based on big data technologies. This study explains in detail the relationship between smart tourism and big data and explores the construction of smart tourism applications in the context of big data. By explaining the relationship between smart tourism and big data, it is pointed out that the development of smart tourism needs to rely on the construction of a smart tourism application model under the background of big data. To this end, the role of smart tourism, building smart tourism platforms, improving information sharing mechanisms, exploring the implementation path of smart tourism application models, and further promoting the development of smart tourism, is of a great interest for the enterprises, scholars, and tourists. The proposed model is expected to be of a great help for the tourism industry.

1. Introduction

The travel and tourism sector is one of the largest sectors in the world [1]. It is an important part of the social and economic activities of many countries, as it creates work opportunities and business prospects [2]. The tourism sector continues to rise year after year, with tourist arrivals reaching 1.22 billion in 2016, up from 540 million in 2006, and it is predicted to exceed 1.8 billion by 2030 [3]. According to statistical analysis results in 2017, the tourism sector directly contributed around 2.6 trillion US dollars to the global economy, creating millions of employment opportunities [4]. The understanding that the travel and tourism business is extremely profitable for a country has resulted in a pressing desire to make tourism locations as appealing as possible.

With the advancement of the tourism sector, we are entering into a period of rapid change in technological development that enables us to access a large amount of tourism data. The data may include information about lodging, food and beverage companies, cultural heritage areas of interest, etc., as well as reviews, ratings, and traveler recommendations [5]. However, with such an enormous volume of data, the number of available options grows exponentially, as does the potential of information overload. As a result, it becomes even more critical to understand the tourists’ requirements and behaviors, in order to improve the overall tourist experience by providing the appropriate services to the correct user at the
appropriate time. The foregoing facts lead to the development of the “smart tourism” idea, which may be regarded as a step forward from traditional tourism [6].

Technological advancement and breakthroughs in the field of Information and Communication Technology (ICT), particularly mobile application technology, has had a significant impact on the industries, businesses, education, and the private and public sectors [7]. With the development and advancement of ICT, the tourism information process and transaction using digital platform has become a significant approach [8]. Tourists and customers make online transactions linked to travel, such as looking for information and arranging trips, making reservations for restaurants and hotels, and offering feedback via online surveys.

With the steady growth of the national economy, quality of life has become the main pursuit of people, and tourism as the main way of leisure and relaxation has become a major approach for the people of different societies. Looking at the development of my country’s tourism industry at this stage, although tourism benefits and the number of tourists have grown rapidly, it is limited by the short development cycle and insufficient supporting facilities. The related tourism companies and departments have not yet perfected tourism facilities; therefore, there is a need for the development of a proper and smart tourism industry. For this reason, the design of scientific forecasting mechanisms and solutions will have a profound impact on the development of tourism and increase the benefits of tourism economy to a certain extent.

China is one of the first countries to implement smart tourism. The following are the driving causes for China’s active development of smart tourism. Firstly, China considers smart tourism to be strategically important on a national level. China’s National Tourism Administration (CNTA) announced a smart tourism program in early 2011 with the goal of achieving information-based smart tourism in China within ten years. Since then, China has seen remarkable growth in smart tourism. In November 2013, the CNTA announced officially the “Beautiful China—2014 Year of Smart Travel” as the tourism subject, reinforcing smart tourism as a key strategy for national tourism development [9]. Secondly, China’s smart tourism is a legacy of smart city initiatives [10]. Since 2011, China has made significant investments in the development of smart cities in order to support the predominantly urban population [11]. In China, 95% of cities above the subprovincial level and 76% of cities above the prefecture level advocated the creation of smart cities by September 2015. The overall investments in China’s smart cities is expected to exceed 0.5 trillion Yuan, according to the “Prospects and Investment Forecast Analysis of China’s Smart City Construction from 2016 to 2025” (Forward-Looking Industry Research Institute, 2016). Many of China’s pilot smart cities are also important tourist sites, with high priority given to travel and tourism. As a result, smart city initiatives for inhabitants and tourists are being developed in order to improve the quality of travel experiences in these areas. Thirdly, smart tourism enterprises are an essential component of China’s worldwide competitiveness. In order to achieve the competitiveness level, various different scholars have acknowledged the importance of smart technology [6, 12, 13]. Fourth, in order to meet the problems posed by globalization, Chinese businesses and government have prioritized the development of smart tourism. The tourism industries are affected by the globalization on both the supply and demand sides. Globalization necessitates a global supply chain as well as electronic information and reservation systems. Globalization, on the other hand, raises demand for new transport services including digital hotel and autoreservations, room booking services, online travel groups, video brochure, mobile payments, and payment services. Further, in the last decade, China has accelerated smart sustainable tourism in order to acquire comparative edge in globalization.

Since the number of tourists is growing at an accelerating pace, the data generated by them is also growing in size, leading to the concept of big data. Nowadays, big data technologies are used extensively for data acquisition, data characterization, data storage, data accessibility, and the analysis of large datasets [8]. Big data is considered a highly promising technique for transforming traditional tourism into “smart tourism.” In the context of smart tourism, big data can provide customer-based knowledge to help decision-making and enhance the performance of the tourism industry. However, the smart tourism big data platforms lack monitoring capabilities and are not mature enough to meet the needs of smart tourism. In order to overcome this issue, this study proposes a big data-enabled smart tourism model that addresses the issues in the earlier models. The main contributions of this study are listed as follows:

(i) In this paper, we proposed a smart tourism model based on big data technologies. The proposed system collects the big data from three major sources, i.e., tourists, devices they used, and the operational processes. Big data from these sources has helped the tourism sector become more successful and efficient by providing insight into tourist behavior and current market trends.

(ii) It is of a great significance to improve the construction of smart tourism application model based on advanced technologies. This study explains in detail the relationship between smart tourism and big data and explores the construction of smart tourism applications in the context of big data.

(iii) Smart tourism big data platforms have one major issue, i.e., they lack monitoring capabilities and are not mature enough to meet the needs of smart tourism. This study proposes a big data-enabled smart tourism model that addresses this issue.

(iv) The analytical results revealed that the proposed model is better than the earlier models and approaches in terms of the mentioned performance measures.

The remaining paper is organized in the following order: Section 2 represents the relationship between smart tourism and big data. Section 3 illustrates the construction of smart
tourism application model, and Section 4 describes the implementation path of smart tourism application model. Finally, Section 5 concludes the research work.

2. The Relationship between Smart Tourism and Big Data

The proposal and implementation of smart tourism depends on the application of digital tourism. To a certain extent, smart tourism is an advanced stage of digital tourism, and it is gradually becoming an inevitable trend in the development of Japanese and Chinese tourism. In 2014, the National Tourism Administration took the “2014 Smart Tourism Year” as the theme, from the perspective of smart tourism, and carried out smart construction of tourist attractions, tourist characteristic villages, tourist cities, and other projects based on specific conditions [14].

At this stage, the meaning of smart tourism has not yet been clearly defined. Some scholars believe that with the help of cloud computing, Internet of Things (IoT), big data, and other technologies, smart tourism can provide more comprehensive services during the travel process. Some scholars also said that smart tourism refers to the reasonable adjustments made by the tourist for the first time in their travel plans and make full use of travel information based on the collection and analysis of relevant economic, activity, environmental, and resource information in the tourist area. However, in general, smart tourism relies on a new generation of technology to serve the individual needs of different tourists and improve the travel experience, thereby improving the quality of tourism services and increasing tourism-related profits. Smart tourism is based on the collection and analysis of tourism location, historical consumption, and personalized demand information, with the help of data mining technology to provide interactive tourism information services [15–17]. Therefore, in order to develop smart tourism more effectively, we will focus on building a database, collecting and integrating massive amounts of data related to the tourism industry, and providing tourists with personalized services, so that the tourism industry can develop in a better way and improve the service quality of our country tourism industry, as shown in Figure 1.

As discussed earlier, big data is playing a significant part in the development of smart tourism. Big data helps the tourism industries to maintain the data generated by the visitors, devices, and operation processes in an effective manner. Figure 2 shows the relationship of big data with the tourism sector and the usage of big data in the tourism industry.

3. Construction of Smart Tourism Application Model

In the context of big data, only relying on the framework of the smart tourism application model can help the tourism industry to develop in a better way. To this end, through the construction of a complete and reasonable application model, the latest and most comprehensive travel route quotation, reasonable travel advice, and air ticket discount information for specific tourism activities are provided to provide tourists with the best information services. The entry point of the model construction period is to use big data technology to realize the complete construction process of travel enthusiasts [18, 19]. Through the identification of travel information and its relationship, the application model is established based on the needs of the application object. The model makes full use of the big data platform and integrates the tourism industry information, based on the collection and research of specific consumption trends and travel history records of tourists, so as to provide personalized services for tourists during the travel process.

3.1. Application Object. Related tourism departments, tourists, tourism companies, and local residents are the main application targets of smart tourism. Compared with the traditional application model, the smart tourism application model is aimed to help the local residents and builds a smart tourism application model that can promote economic development by providing related services to the government, enterprises, and the tourists. Effective coordination and integration between tourism services and management ensure that tourists are more friendly and peaceful with local community residents during tourism activities [20, 21], as shown in Figure 3.

3.2. Operation Mode. During the specified period when the application model is running, the IoT, big data, Internet, and other technologies are used to comprehensively collect and analyze the data information generated in the tourism activities and the tourism information formed in the tourist area. In this study, we have further improved the application model to realize the scientific prediction of future development trends of a regional tourism system. The forecasting and data monitoring system can scientifically predict and analyze the future development trend of local traffic flow, so that relevant government departments, companies, and other entities can provide high-quality tourism services. Further, it also provides guidance and foundation for smart tourism. Avoiding a large number of tourists in the tourism spots, a large number of accidents occur due to the unfair control of traffic, as shown in Figure 4.
Building a virtual tourism service platform based on local capital, broadening all aspects of information channels such as tourism accommodation, tourism companies, tourist attractions, travel agencies, information exchange among local tourists, and effectively building service entity information sharing platform, can help the smart tourism system. When building the platform, the tourism company should be used as a unit to collect the corporate data, government data, scenic spot data, and resident data generated during the development of related tourism activities. Further, the data needs to be presented in a standardized format to the application model in order to classify it. At the same time, with the help of the Internet and IoT technology, the relevant basic data is accurately marked on the map. The prefectures, states, and cities should be clearly marked and divided into a number of tourist destinations based on specific conditions, then serve as a reference to label tourist information scientifically and reasonably. By constructing a reasonable prediction model, real-time monitoring and early warning can be realized, and what will happen at the destination at a different time can be predicted. Constructing a predictive and early warning model, based on relevant basic data of tourism companies, governments, scenic spots, and local tourists, using cloud computing, IoT, and other technologies to hold events at different times, and locations, needs to be determined. The time period of basic data and the use of digital axis icons to automatically make particular changes in the flow of tourists at different times in the tourism area, such as the instantaneous flow of tourists at a certain destination or at a specific time, is of great interest. Based on the tourism statistics of “regions,” assuming that the statistical unit is “people-day,” the data of all regions of the whole country are directly added to obtain a national-level tourism population statistical model.

In Equation (1), $N$ is the total number of tourists nationwide, $P_j$ is the total number of tourists in the $j^{th}$ state, and $M$ is the number of administrative districts in the country. To get more accurate statistical results, some data should be deduplicated and supplemented in the practice of statistics, where $\mu$ represents the number of tourists that need to be deducted and $\theta$ represents the number of tourists that may be missed. According to the national tourist sources, the total number of national tourists can be further divided into two parts: the number of inbound tourists and the number of domestic tourists.

$$N = \sum_{j=1}^{M} P_j - \mu + \theta. \tag{1}$$

### 3.2.1. Statistical Model of Inbound Tourists.

Inbound tourists are mainly composed of tourists from foreign countries, Hong Kong, Macau, and Taiwan. This part of the tourist data is available directly from the Immigration Bureau of the Public Security Bureau. This data is generally more reliable and accurate. However, this portion of the number of inbound tourists collected by the Ministry of Public Security does not include tourist time dimension information, only the number of tourists entering our territory is known, but there is no way to know about the trip information. This part of the period includes foreign tourists, as well as some
duplicate data (such as foreigners entering our country for public affairs). Therefore, a statistical model of inbound tourist statistics at the national level can be built on the state tourist statistics as given below:

\[ N_C = \sum_{j=1}^{M} F_j \]  

(2)

In Equation (2), \( N_C \) is the total number of inbound tourists in our country during the statistical period \( T \) (unit: man-day) and \( F_j \) is the number of foreign tourist statistics received by state \( j \) during the statistical period. \( M \) is the number of local administrative districts in our country. When local tourism statistics were implemented, some of the tourists who entered for public affairs were removed, so it is no longer necessary to consider the double-counting of groups of such people.

3.2.2. Statistical Model of the Number of Domestic Tourists. The number of domestic tourists can be calculated directly by subtracting the number of inbound tourists from the total number of tourists, and the model is as follows:

\[ N_L = N - N_C. \]  

(3)

In Equation (3), \( N_L \) represents the total number of domestic tourists, \( N \) illustrates the total number of tourists, and \( N_C \) describes the total number of inbound tourists.

3.3. Platform Construction. Building a tourism big data application platform is the core of the smart tourism model. Its exact goal is to provide consumers with barrier-free and personalized digital travel services. The massive data of the tourism industry is a basic function to realize the tourism prediction and feedback. Application model building platforms need to analyze, divide, and build subplatforms for different stakeholders, such as government subplatforms, community subplatforms, and tourism subplatforms. There are certain differences between the subjects of the application model platform, but for any subject, the application of the platform must rely on the acquisition of tourism information data [22, 23]. Through the effective construction of the application model, the information interaction and communication enhancement between the subplatforms are realized, and the purpose of information sharing is achieved. The application model platform can give full play to the role of government supervision, provide guidance for the operation and management of tourist attractions and businesses, and improve tourism service satisfaction, as shown in Figure 5.

Building an application model requires a lot of money and time at the early stage, and it cannot be profitable in a short period of time [24]. Therefore, municipal departments need to pay attention to the diversification and diversification of investment and financing channels, which can be divided into construction and enterprise participation in the government. Government investment, government-enterprise joint venture construction, government guidance, planning, enterprise investment construction, government procurement of services, etc., play a leading role and gradually build a government-led development model [25].

4. Implementation Path of Smart Tourism Application Model

4.1. Pay Attention to the Status and Function of Smart Tourism. In the context of the era of big data, the development of innovation-driven strategies shows initial results. The IoT and cloud computing build smart tourism computing and communication networks to solve tourism development problems. During the exhibition, information asymmetry and unbalanced supply and demand promote the development of informatization, technology, and intelligence in our country’s tourism industry. Keeping this in mind, the government and enterprises decided to develop smart tourism systems. Therefore, we need to pay more attention to the development and building of smart tourism platforms based on big data. Due to the situation and funding of specific regions, the impact on big data platforms is increasing. The development efforts, clarifying the role and status of smart tourism, promote the government to work with tourism companies and capture the opportunity of the development of tourism in the era of big data to promote the long-term development of smart tourism.
4.2. Pay Attention to the Construction of Smart Tourism Platform. According to the regional development, create industrial management of the experience of local residents in tourism clusters, business operations, and services. The smart tourism service system vigorously develops and realizes the mining and development of tourism information data related to the tourism industry through the application layer of the smart tourism model. At the same time, government departments need to encourage relevant companies to participate in platform construction, guide tourist demand analysis and surveys during the platform construction process, and implement tourism pilot activities, including general activities and tourism activities to be realized such as smart cities, smart tourism, and smart scenic spots, or the organic combination of online and offline consumption. Like this, we will further improve the time, flow feedback platform, and monitoring and early warning platform to build and realize high-quality and efficient information exchange and sharing between local transportation and other public safety agencies in the development of tourism activities. In this way, increasing the platform construction can play an important role in the development of smart tourism strategy. Hence, it lays a good foundation, improves the development level of the tourism industry, and promotes the long-term development of smart tourism, as shown in Figure 6.

4.3. Pay Attention to the Improvement of Information Sharing Mechanism. To scientifically construct an information sharing mechanism, it is necessary to correctly identify information and information sharing mechanism. Recognizing that information sharing is more than just summarizing travel information, relevant travel companies, governments, tourists, and local residents will participate together. Based on the facts about the complete information sharing mechanism of the government, tourists, enterprises, and locals, encourage the public and social organizations to participate in further strengthening the data informatization of the tourism industry to build an information chain. All subjects are required to integrate into the smart tourism platform to have relevant data resources, and one should use this as the basis to realize the sharing and interaction of information resources. In addition, in the process of platform construction, we will increase the data in-depth efforts to provide more accurate and comprehensive information regarding the tourism sector. Feedback through the two-way sharing of information and data eliminates information barriers between political governments, enterprises, tourists, and locals by promoting barrier-free services, information resources, and effective sharing, as shown in Figure 7.

5. Conclusion

Smart tourism practice has piqued the interest of Chinese government officials, businesses, and academics since the smart tourism plan that was proposed by the CNTA in 2009. Technological advancements have changed the way tourists look for, plan, and purchase their trips as well as how they interpret and execute their experiences. The main driver of this trend is China’s growing smart city building at the city, provincial, and national levels, which improves target operation and management in a scientific and intelligent manner. Tourism has always been on the cutting edge of technical advancements; therefore, new cutting-edge technologies have also fueled the rapid growth of smart tourism. In addition, the emerging needs of new tourists for smart products give impetus to smart tourism construction in China. Taking the importance of smart tourism and advanced technologies into consideration, this study proposes the development of an application model for smart tourism based on big data technology. Based on a large amount of data and information in the tourism industry, different data types are imported into the prediction model which then provides information about the travel routes. Further, the tourism industry operators can rationalize the flow of landscape tourism. Forecast marketing and consumer tourism provide scientific and reasonable advice to promote the long-term and healthy development of smart tourism. It is anticipated that the proposed model based on big data technologies will assist the tourism industry in the development and maintenance of the tourism sector.

Data Availability

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.
Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] T. Brandt, J. Bendler, and D. Neumann, “Social media analytics and value creation in urban smart tourism ecosystems,” Information Management, vol. 54, no. 6, pp. 703–713, 2017.

[2] M. Figueredo, N. Cacho, A. Thome, A. Cacho, F. Lopes, and M. Araujo, “Using social media photos to identify tourism preferences in smart tourism destination,” in 2017 IEEE international conference on big data. Big Data, pp. 4068–4073, Boston, MA, USA, 2017.

[3] A. Kontogianni and E. Alepis, “Smart tourism: state of the art and literature review for the last six years,” Array, vol. 6, article 100020, 2020.

[4] Statista, “Travel and tourism total economic contribution worldwide,” https://www.statista.com/topics/962/global-tourism/.

[5] M. Figueredo, J. L. Ribeiro, N. Cacho et al., “From Photos to Travel Itinerary: A Tourism Recommender System for Smart Tourism Destination,” in 2018 IEEE Fourth International Conference on Big Data Computing Service and Applications (BigDataService), pp. 85–92, Bamberg, Germany, 2018.

[6] U. Gretzel, M. Sigala, Z. Xiang, and C. Koo, “Smart tourism: foundations and developments,” Electronic Markets, vol. 25, no. 3, pp. 179–188, 2015.

[7] J. Vaid and S. Kesharwani, “Role of big data analytics in social media marketing of MICE tourism,” Global Journal of Enterprise Information System, vol. 10, pp. 55–61, 2018.

[8] S. J. Miah, H. Q. Vu, J. Gammack, and M. McGrath, “A big data analytics method for tourist behaviour analysis,” Information & Management, vol. 54, no. 6, pp. 771–785, 2017.

[9] X. Wang, F. Zhen, J. Tang, L. Shen, and D. Liu, “Applications, experiences, and challenges of smart tourism development in China,” Journal of Urban Technology, vol. 22, pp. 1–26, 2021.

[10] L. Zhang, N. Li, and M. Liu, “On the basic concept of smarter tourism and its theoretical system,” Tourism Tribune, vol. 27, no. 5, pp. 66–73, 2012.

[11] P. Liu and Z. H. Peng, “China’s Smart City Pilots: A Progress Report,” Computer, vol. 47, no. 10, pp. 72–81, 2014.

[12] M. Cimbaljević, U. Stankov, D. Demirović, and V. Pavuković, “Nice and smart: creating a smarter festival: the study of exit (Novi Sad, Serbia),” Asia Pacific Journal of Tourism Research, vol. 38, pp. 415–427, 2019.

[13] P. M. da Costa Liberato, E. Alén-González, and D. F. de Azevedo Liberato, “Digital technology in a smart tourist destination: the case of Porto,” Journal of Urban Technology, vol. 25, no. 1, pp. 75–97, 2018.

[14] L. Weiqiang, S. Tingting, and X. Ping, “Research on the information prevention and control system of public security in the new era,” Digital communication WORLD, vol. 3, pp. 21–22, 2019.

[15] H. Long, “Research on the construction of university information security system under the background of educational modernization,” China Collective Economy, vol. 24, pp. 167–168, 2019.

[16] A. Chunyuan, J. Hu, and S. Haijun, “Considerations on innovating the construction of public security prevention and control system in colleges and universities,” Journal of Qingdao Agricultural University (Social Science Edition), vol. 3, pp. 49–53, 2016.

[17] L. Yong, “Inquiry into strategies for the construction of public security prevention and control system in colleges and universities under the new situation,” Journal of Kaifeng institute of Education, vol. 12, pp. 122–123, 2019.

[18] G. Lin, J. Zheng, and Z. Wenyans, “Discussion on smart tourism city model based on big data,” Computer Times, vol. 10, pp. 99–102, 2018.

[19] Y. Haitao, “Discussion on the teaching model reform of smart tourism information courses under the background of big data,” Fujian Computer, vol. 5, pp. 75–76, 2018.

[20] C. Jianmin and X. Suli, “Intelligent tourism big data analysis model based on artificial intelligence type construction,” Computer Knowledge and Technology, vol. 11, pp. 189-190, 2019.

[21] K. Yonghui and Z. Guangying, “Phase Research on the Evolution of Smart Tourism from the Perspective of Big Data,” Journal of Hainan Normal University (Social Science Edition), vol. 8, pp. 100–105, 2016.

[22] L. Yi, “Innovation in the ideological and political teaching mode of college students in the era of big data,” Friends of Humanities, vol. 21, p. 69, 2018.

[23] M. Lianghong, “Innovation of Online Ideological and Political Education for College Students in the Era of Big Data Inquiry,” Journal of Shanxi Youth Vocational College, vol. 30, no. 3, pp. 35–37, 2017.

[24] M. Xiangrui, “The big data era of projection pursuit based on RAGA study on the evaluation of students’ ideological and political and daily performance,” Economist, vol. 3, pp. 199–200, 2018.

[25] L. Wang and H. Zhang, “Smart tourism management mode under the background of big data,” Big Data Analytics for Cyber-Physical System in Smart City, vol. 71, pp. 282–288, 2020.