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THE EMBEDDING CONVERGENCE OF SMART CITIES AND TOURISM INTERNET OF THINGS IN CHINA: AN ADVANCE PERSPECTIVE

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ABSTRACT

The smart city strategy is an inevitable trend in the future development of Chinese cities. The smart tourism city is an important part and a practical attempt of the smart city strategy. The China National Tourism Administration has officially announced "Beautiful China: 2014 Year of Smart Travel" as tourism theme. Thus, huge development opportunities are in store for the future of smart tourism. This strategy attempts to combine the Internet of Things (IoT) technology with the development of the smart tourism industry and smart tourism cities. Many Chinese scholars stated their ideas on the technological structure of IoT and the extension of smart tourism industries. At the same time, many Chinese cities have attempted to combine IoT and smart tourism. There is a trend of embedding Application of Tourism IoT in China's Scenic Spots. Smart tourism should build an IoT information technology public platform, covering service management to marketing management. The emerging smart tourism industry fits China's economic growth and industrial transformation. Based on these developments, this research determines the current status and development potential of smart tourism in China, and offers recommendations for their applications in China.

Keywords: Embedding Convergence, Smart Tourism, Internet of Things

INTRODUCTION

The constant and steady growth of China's economy since the implementation of the reform and open policy has drawn worldwide attention. Researchers have begun to take an interest in the study of the Chinese model and China's urban development (Ma and Wu, 2005). China has already entered a period of rapid urbanization. From 17.92% in 1978,

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the rate of urbanization increased to 53.73% in 2013. China's urbanization rate is predicted to reach 68% in 2030, when the rapid development period ends; and to exceed 80% by 2050, when China enters a stabilizing and intensifying stage of urbanization （Li, 2014）. Therefore, improving the quality of urbanization in China has become an important issue. In this relation, the concept of smart city, which refers to a new urban development space that contains the physical world, the virtual world of the Internet, and the intelligent world of the Internet of Things, has become important (Yang, 2011). The Internet of Things (IoT) is a phrase of the system, which is connected to the Internet; it also refers to the convergence of intelligent devices and smart appliances (Ashton, 2009).The concepts of smart city and IoT, which are based on the urban information system, have brought significant innovative opportunities for the future strategy of China's urban development.

The smart city strategy is an inevitable trend in the future development of Chinese cities (CESI, 2009). The strategy is a process of integrating information technology and intellectual economy, with the aim to comprehensively improve the urban planning management and service level in China. The strategy involves the relevant convergence of industrialization, informatization, and urbanization. In essence, this strategy engenders a change from industrial informatization to social intellectualization and media foundations (Wang, Xing and Li, 2010). Media foundations pertain to the Internet, IoT, telecommunication networks, broadcast and television networks, wireless networks, cloud computing, and big data (Sundmaeker, Guillemin, Friess and Woelffle, 2010; Dikaiakos, Katsaros, Mehra, Pallis and Vakali, 2009).

Smart city is a new management and development model of urban social systems that features technology integration, industry convergence, and intelligent services. China plans to build a "National Experience Center of Smart City" to provide a model for the construction of smart cities and to satisfy the needs of existing smart cities. The smart city concept covers multiple industries, including tourism. The smart tourism city is an important part and a practical attempt of the smart city strategy (McCartney, Butler and Bennett, 2008). China carried out the selection of the first batch of "National Smart Tourism Cities" and a total of 18 cities were selected as pilot sites. By the end of 2012, the National Tourism Administration in China determined the second batch of smart tourism pilot cities, bringing the number of China's smart tourism cities to 33. This strategy attempts to combine the IoT technology with the development of the smart tourism industry and smart tourism cities.

Based on cloud computing and the IoT technology, smart tourism

aims to apply intelligent perception of all kinds of tourism information, like tourist resources, tourism economy, tourism activities, and tourism participants, among others, to realize the acquisition and adjustment of real-time tourism information through mobile Internet or Internet terminal equipment (MacKay and Vogt, 2012; Cho and Jang, 2008). Thus, smart tourism will become an important component of China's smart city strategy, whereas the IoT technology will be the core carrier of the smart tourism information system. At present, the National Tourism Administration has officially announced "Beautiful China—2014 Year of Smart Travel" as tourism theme. Thus, huge development opportunities are in store for the future of smart tourism. Based on these developments, this research determines the current status and development potential of smart tourism in China, defines the concepts of smart tourism and IoT, and offers recommendations for their applications in China.

SMART APPLICATIONS OF IoT INFORMATION TECHNOLOGY IN CHINA

Since Kevin Ashton first put forward the concept of IoT, the idea has received substantial attention from governments, scientific technology enterprises, and scientific research institutions (Weber, 2010; Sarma, Brock and Ashton, 2000). The International Telecommunications Union (ITU) expanded the concept of IoT, from the original radio-frequency identification (RFID) technology to a broader spectrum (Lu, Zhang, Yang and Ning, 2008; I. Lee and B. Lee, 2010; Ustundag, Kilin and Cevikcan, 2010). The emergence of the concept of smart planet and the promotion of smart cities enhanced the involvement of the IoT technology in the economic revitalization strategy, which is based on the investment and urban development of the government. China's Ministry of Industry and Information Technology issued the first "IoT Development Plan (2011–2015)" in 2011. According to the Report of Application Field Market Demand and Investment Forecast on China, the market of the IoT industry (2013–2017) in China has reached 365 billion China Yuan in 2012 and projected to attain the 750 billion China Yuan by 2015. The IoT technology will play an extremely important role in the development of China's smart cities and smart tourism industry (Stabb et al., 2002).

Many Chinese scholars stated their ideas on the technological structure of IoT and the extension of smart industries (Lin, 2013). The concepts, architecture, and key technological problems of IoT have been reviewed (Sun, Liu, Li, Fan and Sun, 2010). Essentially, researchers have assisted in the understanding of the concept of IoT from the perspective of

sensor network of things and have provided an introduction on the global development and international strategic plans of this technology. Furthermore, China's progress has been discussed in terms of IoT applications in identification technology, architecture technology, communication and network, search and discovery service, data processing, security and privacy, standardization, and governance (Ning and Xu, 2010; Ning, Zhang, F. Liu, W. Liu and Qu, 2006). The applications of RFID technology, sensor network, relationship between IoT and other networks, and supporting technologies of IoT in socio-economic life have been analyzed (Wu, 2010). Consequently, the architecture of IoT was divided into two categories, the back-end centralized and front distributed architectures, from a functional perspective, and comparatively analyzed in terms of horizontality, scalability, context-awareness, interactivity, and adaptability (Chen, Cui and Xie, 2013). Linked data of organizational structure, consisting of data conversion, data processing, data association, data storage and index, and data application services were presented based on the demands, planning, implementation, and operation of Wuhan Smart City (Yuan, 2012).

Tourism informatization and intellectualization is the future trend of the integration of the IoT technology into the tourism industrial upgrading (Xiang, Gretzel and Fesenmaier, 2009). Chen (2013) attempted to design a real-time positioning system based on "received signal strength indication" (RSSI) ranging and the IoT technology. Test results showed that this design could identify real-time positioning of visitors and automatically mark them on the resort map, which could facilitate an exchange of information (e.g., alarm messages). Wen, Xu and Li (2013) established a model of tourism commodity informatization through actual investigation and survey on the key processes of tourism commodities. As a result, a web-based traceability system was designed using two-dimensional code, RFID, active server page (ASP), net module development, and so on. Zhao (2008) introduced and analyzed the development of tracing data with RFID technology and the application of RFID in tourism industry. Guo (2010) applied the geo-browser/spatial data server model to digital tourism engineering and established a preliminary hierarchical theoretical system and technical architecture, which could provide the theoretical basis and application models for the public spatial information service platform in the new geographic information age. Chen and Zhou (2010) proved that the IoT technology enhances the convenience of tourism. Tourist destination selection, tourist routes planning, hotel bookings, and integration management of tourist attractions could be included in the IoT information system. The IoT technology could integrate all kinds of

tourism resources, particularly information resources. Sharing resort information, hotel information, and transportation information could provide support and suggestions for customers. The future application of the IoT technology in smart tourism development mainly includes intelligent hotel management system, scenic spot intelligent ticketing system, intelligent remote video monitoring system, intelligent tour guide system, and intelligent travel agency system (Formica and Kothari, 2008; Gretzel, 2011).

THE CONCEPT AND DEVELOPMENT TREND OF CHINA'S SMART TOURISM

Since the concept of smart planet was put forward, the idea of "smart" was immediately associated with urban development and industrial upgrading. Subsequently, smart tourism, based on the IoT technology, came into being. The technologies of smart tourism include the Advanced Traveler Information Systems (ATIS), Advanced Vehicle Control Systems (AVCS), Advanced Commercial Vehicle Operation (ACVO), and Electronic Toll Collection System (ETC), among others. Singapore implements a "Digital Concierge Programme," one of the key programs of Singapore's "iN2015" plan, which allows visitors to access mobile tourism services anytime and anywhere. Korea has developed a mobile tourist information service system called "I TOUR SEOUL." A steamboat ski resort in Colorado has designed a guest tracking system using RFID technology in 2005. The mountain resort area of Pennsylvania has introduced the RFID wristband system. London once launched an intelligent guide system. Belgium is implementing a "TagTagCity" program (Owaied, Farhan, Al-Hawamdeh and Al-Okialy, 2011; Braun and Hollick, 2006; Kenteris, Gavalas and Economou, 2009; CEC, 2009). In 2011, China established the Smart Tourist Service Center in Zhenjiang, Jiangsu Province, with approval from the National Tourism Administration (PGZC, 2011). The center aims at enhancing the development of China's smart tourism, supporting the research, development, and promotion of smart tourism software and other related sections, and providing industrial support and technical services for the construction of smart tourism cities. The Overall Proposal for China's Smart Tourist Service Center indicates that the IoT technologies, such as sensing, wireless, and ad hoc networks, will completely change the production-consumption pattern of traditional information, as shown in Figure 1. And the involvement of the tourism IoT will construct a smart tourist information service network within which, people and society can perceive each other (Ding, 2012).

Figure 1. *Smart tourism mobile information devices*

As shown in Table 1, thus far, research on smart tourism by Chinese scholars mainly revolves around its definition, connotation, framework, value, application, and development trend, as well as its relation with tourism informationization (Xu, Li, Qian and Liu, 2013). Smart tourism is a "systematic and intensified transformation, which is based on the new generation of information and communication technology (ICT) integration, for the purpose of satisfying the individualized needs of tourists, improving tourist experience and satisfaction, as well as realizing the sharing and effective utilization of tourism resources and social resources" (Zhang, 2012). The supporting technologies of smart tourism include cloud computing, IoT, high-speed mobile communication technology, geographic information system (GIS), and virtual reality technology (Liu and Fan, 2011). Zhang, Li and Liu (2012) proposed the component application architecture (CAA) framework of smart tourism comprising three levels, namely, capabilities, attributes, and applications. Smart tourism is generally dependent on the following four core information technologies: IoT, mobile communication, cloud computing, and artificial intelligent technology. These technologies connect the physical infrastructure, information infrastructure, social infrastructure, and commercial infrastructure of tourism, and supplies smart tourism value to multiple stakeholders.

The future direction of smart tourism is mainly reflected in intelligent service, intelligent business, intelligent management, and intelligent governance (Yao, 2012). The framework of smart tourism development should be composed of eight systems: including institution, infrastructure, information resources, application support, application, service, regulations, and standardized norms, as well as the operation and maintenance of information security. Dang, Zhang and Chen (2011) discussed the essential concepts of Smart Scenic Site and up-to-date information technology according to the characteristics of tourism resources conservation, business management, tourism development,

public service, and decision support. Furthermore, a general framework was proposed for the Smart Scenic Site, which includes three platforms (information infrastructure, data infrastructure, and service sharing infrastructure) and five systems (network, data, service, application, and decision). J. Li, Zhang and H. Li (2012) developed a set of smart city indicators and an evaluation method according to the characteristics and requirements of different types of cities, including those of tourist cities. An introduction to the smart information industries in major Chinese cities, such as Beijing, Shanghai, Shenzhen, and Guangzhou, was also provided.

Table 1. *Research subjects of smart tourism (ST) in China*

System Info	**Relevant Participant**	**Practical Analysis**	**Exploitation Strategy**
Concept Connotation	ST Subject: Tourism Destination Tourism Enterprise Tourism Administration	City Smart Tourism Development Scheme	Facing Problems Choke Spot
Characteristic Function	ST Media: Platform System	Scenic Region Plan	Development Prospect
Development Path	ST Object: Tourist Community Resident	Technology Application	Service Framework

THE EMBEDDING APPLICATION OF TOURISM IoT IN CHINA'S SCENIC SPOTS

The tourism industry is an important entry point for the application of the IoT technology (Atzori, Iera and Morobito, 2010). Many Chinese cities and famous scenic spots have attempted to combine IoT and smart tourism. Among the provinces, Hainan is one of the first to engage in this undertaking. The province integrated IoT with the construction of Hainan International Tourism Island and with the establishment of a tourist demand-oriented tourism integration platform across the island.

Intelligent informatization and IoT networking of scenic spots are important characteristics of smart tourism (Guinard, Trifa, Karnouskos, Spiess and Savio, 2010). Smart scenic spots contain: (1) intelligent IoT, which could sense geographical things, natural disasters, tourist behaviors, community residents, staff, and infrastructure of the scenic spots through the Internet; (2) data warehouse, which could provide decision information and intelligent tourism service through the building of a data center and data extracting; (3) cloud computing, which could store huge amounts of

tourism information for query and calculation through the building of a tourism information platform (Li, Gao and Zhao, 2011). As shown in Figure 2, based on the analysis of business and operation management of scenic spots, a mature scenic spot information system should consist of several IoT information systems including an entrance guard and ticketing system that utilizes the RFID technology, vehicle scheduling system, multimedia display system, light-emitting diode (LED) information publishing system, intelligent monitoring system, supervisory information system using sensor technology, wireless local area networks (WLAN), peer to peer (P2P), three-dimensional (3D), portable application description (PAD) and other network technologies throughout the entire system (Guo, 2011). Zhou, Yang and Shen (2012) employed the embedded IoT technology applications in the virtual tourism landscape design and provided a technical feasibility for realizing the space and time, and interaction between tourists and tourism landscapes. Against the background of the IoT technology, authenticity in the tourism experience is the basic principle of virtual tourism landscape design; an attractive image is the basic objective of virtual tourism landscape design, whereas theme design, set design, script design, and symbol design are the main contents of virtual tourism landscape design.

To highlight the specific practices and applications of IoT in smart scenic spots, Shao, Zhang, Ma and Deng (2010) conducted a case study on the intelligent management mode of China's Jiuzhaigou National Park, through which the design of a "Wisdom Scenic" framework was created based on IoT and according to the requirements of scenic spot management. Furthermore, the functions of the scenic spot IoT, which consists of RFID, internet protocol cameras, intelligent executing terminals, and data centers, in the management of tourists, were discussed. Chang, Li and Huang (2011) pointed out that, as one of the frontier information technologies, IoT provides the foundation for realizing smart scenic spots. Based on the analysis of the present situation and development demands of the Summer Palace, the conception of information infrastructure for smart Summer Palace was proposed. Following the smart Nanjing urban development strategy, Deng and Zhang (2012) built a smart tourism central management platform through the integration of the electronic ticketing system, tourist flow monitoring, analysis system of scenic spots, vehicle monitoring system, tour guide management system of travel agents, digital room service and operation management system of hotels, and destination marketing system. This central platform is expected to satisfy the individualized needs of tourists, and improve tourist satisfaction and the urban tourism function to enhance the competiveness of Nanjing as a

tourist destination. Focusing on the construction of the Changzhou smart tourism public service platform, Liu (2012) developed a smart tourism information service center and data exchange system based on the multi-channel tourism industry data center through the full sharing of the tourism video, geographic information system (GIS), and other information resources. Han, Wang and Bo (2012) identified the functions of Qinhuangdao smart tourism management system by analyzing the IoT technology from several aspects: ticketing management, resource management, and tourist management, among others. Zhang, Wang, Ye and Zhao (2012) formulated a smart tourism information system framework for Leshan tourism spot based on the IoT technology, in which business data are sent via wireless network equipment and connected to the look 'n' stop (LNS) in the center through virtual private network (VPN) channel router. Through this framework, video and voice could be coded and the data could be delivered through a wireless network; thus, realizing remote wireless monitoring and remote scheduling. X. Ma, B. Ma, Liu and Yang (2012) investigated and analyzed the coal industry, information industry, and the natural eco-tourism bases of the western part of China in terms of the applications of the IoT technology by using Ningxia, Chongqing, and Yunnan as samples. Xiao and Zhao (2010) conducted a case study on the application of RS (Remote Sensing), GIS (Geographic Information System) and GPS (Global Positioning System) technology in a natural disaster warning system in a scenic spot in Shennongjia National Nature Reserve.

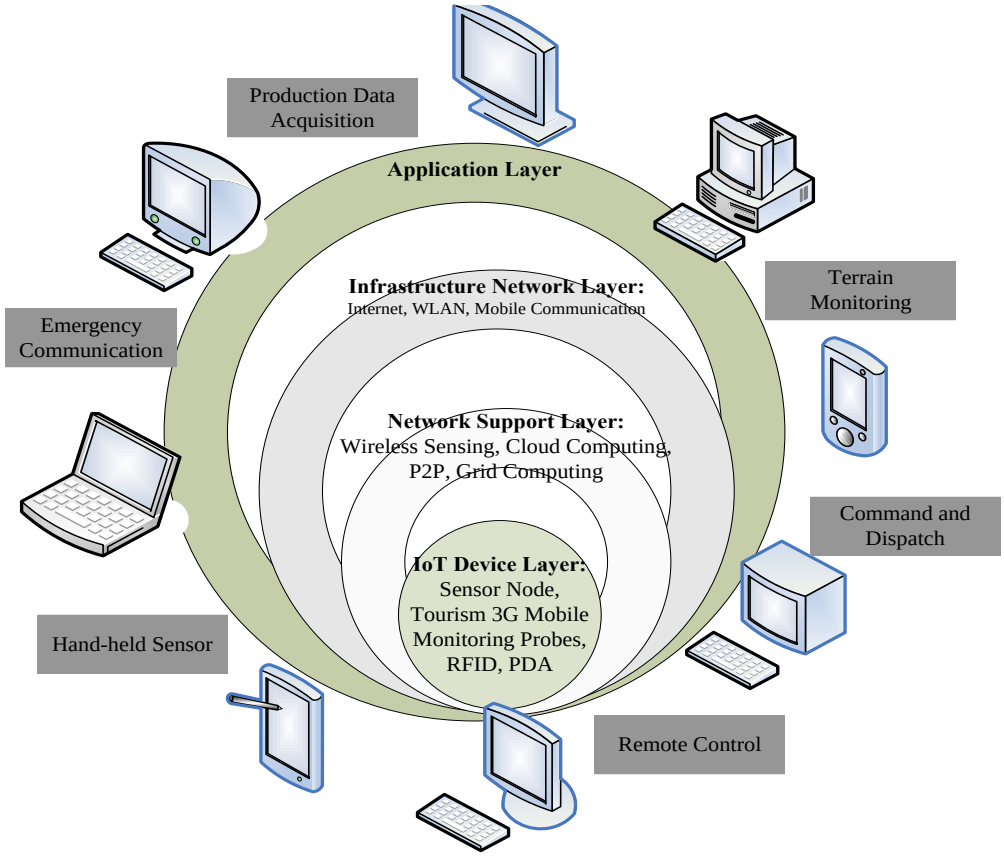

Figure 2. *Intelligent architecture diagram of smart scenic spot*

THE SERVICE FRAMEWORK AND CONVERGENCE PATH OF SMART TOURISM IoT

As shown in Figure 3, against the background of the IoT technology in the new era, innovation in the tourism industry should grasp the adaptive characteristics of tourism. Smart tourism should build an IoT information technology public platform, covering service management to marketing management (Salasin and Madni, 2007; Shen, Fan, Zong, Mao and Huang, 2009). There are three different patterns of tourism innovation evolution under IoT: market driven, policy driven and comprehensive (Liu, 2012). Smart tourism development experiences in Nanjing include those that were produced by the smart tourism public data service center, the mobile client terminal "tourist assistant," and the rural tourism marketing platform, among others (Jin, 2012).

To improve tourist satisfaction, stimulate tourist consumption, increase industry service level, and enhance the development of tourism consumers and tourism economy, the smart tourism public service

platform should be characterized by mobile communication and IoT, a self-driving travel service, an urban scenic spot tour guide service, a tourist service quality evaluation system, and a tourist flow monitoring system (Du, 2012). Wang (2013) designed a tourism security platform based on IoT and cloud computing. This platform connects the security equipment with service facilities in the scenic area via IoT, and realizes intelligent warning, monitoring management, and emergency response through a wireless sensor network. Zhu and Zhang (2011) provided a constructive outlook and several suggestions for the smart marketing of tourist destinations in several aspects including the scenic spot preview system, intelligent remote planning, resource booking system, experience sharing system, tourism transaction system, and so on.

Huang and Li (2011) discussed the implementation paths of smart tourism from perspective of the tourists, tourism enterprises, tourist destination, tourism management organizations, tourism-related government departments, and tourism industry. Focusing on the security monitoring and management problems in high-altitude scenic spots, Hu et al. (2013) constructed a framework for tourist security monitoring information service station based on IoT. This station stores geological disaster information, tourist position information, and video images and sends them to the information security center through the 3rd generation telecommunication (3G) network. The information can facilitate the formulation of emergency warnings and rescue action when needed.

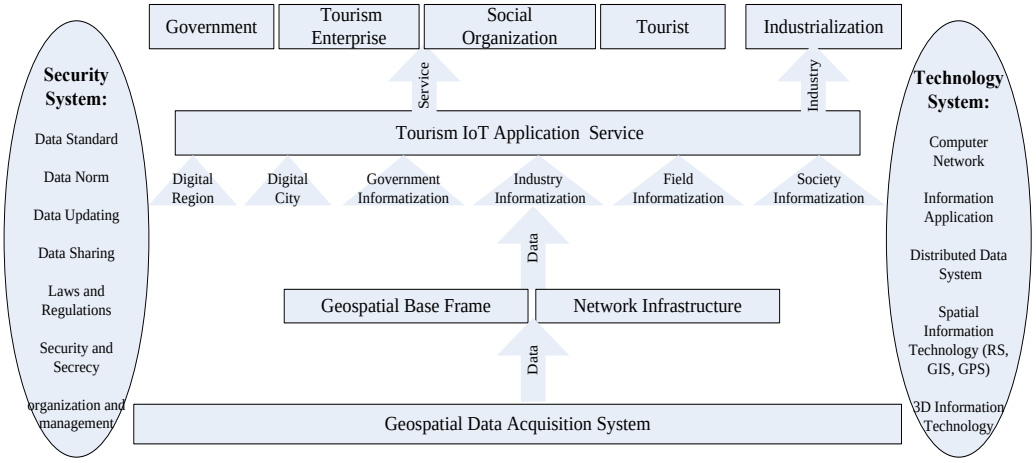

Figure 3. *Tourism IoT platform of smart digital service system*

CONCLUSION

Primarily, a smart city is a networked city and as such, IoT is a significant symbol (Wang, X. Li and Y. Li, 2013). Smart infrastructure, smart management and operation, smart information service, and smart tourism are important components and symbols of the maturity of the development of a smart city, as well as of the interaction process of physical space and cyberspace (Koshizuka and Sakamura, 2010; Gomez and Paradells, 2010; Mayer-Schonberger and Culier, 2013). Smart tourism is a fundamental part of the construction of the smart city's application system; it depends on the infrastructure of the smart city, utilization of information resources, and development of the intelligence industry. Building a tourism IoT information platform, speeding up the smart transformation of tourist cities' infrastructure, and utilizing smart technologies comprehensively in the tourism industry are critical points that should be addressed to ensure the smart tourism development in China.

In applying IoT in smart tourism, the asymmetry of the information island needs to be eliminated. Resource consumption could be substituted by exploiting information resources (Shelby, 2010). The contradictions in an imbalanced supply and demand could be solved through technical approaches. The process of applying IoT to tourism has to undergo several stages, namely, tourism infrastructure construction, tourism information data construction, and tourism service platform construction. Ultimately, the unified information platform, which will support tourism operation monitoring and automated management, is created.

The emerging smart tourism industry fits China's economic growth and industrial transformation. The development of tourism IoT that features mobile search, mobile positioning, mobile payment, mobile tour guides, virtual offices, social media, interactive communications, and other information services, will considerably improve the social utilization of energy, promote the development of China's mode of production toward a smart, ecological, and technological direction, and contribute to the strategic transformation of China's tourism industry from online travel to smart travel.

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