Discussion on the Development Ideas of Smart Tourism in Luoyang in the Era of "Big Data"

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Abstract. Taking Luoyang as the research object, this paper adopts literature research, field investigation and SWOT analysis to explore the development path of smart tourism in the era of big data. By defining the correlation between big data and smart tourism, this paper finds that Luoyang has complete smart tourism infrastructure but suffers from lack of cultural characteristics, data silos among departments, and homogeneous tourism products. Accordingly, this paper proposes targeted strategies including creating the unique Heluo culture IP, building an integrated big data public service platform, applying VR/AR digital technology, and realizing digital protection of cultural relics, aiming to provide a reference for the transformation and upgrading of Luoyang's smart tourism.

Keywords: Big Data; Luoyang; Smart Tourism

1 Introduction

1.1 Research Background

As one of the first national smart tourism pilot cities, Luoyang's tourism industry is facing the transformation driven by big data. Big data provides data collection, analysis and decision-making support for tourism, while smart tourism is an intelligent model that integrates big data, Internet of Things and AI to optimize tourism services, management and marketing. However, Luoyang's smart tourism is plagued by prominent problems such as insufficient integration of historical culture, disconnected data among departments, and single tourist experience, which restricts its high-quality development.

1.2 Existing Research

In recent years, international research on smart cities has been increasingly systematic and comparative. Regarding smart city concepts and connotations, scholars have gradually moved beyond a single technological perspective and formed a consensus that smart cities should integrate sustainability, human orientation, and diversified governance. In terms of construction models, Kubina et al. (2021) compared the standards, implementation paths, and cluster models of smart cities in North America

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and Europe, revealing that Europe emphasizes green sustainability and multi-stakeholder participation, while North America focuses on market-oriented promotion and technological application. Demirel (2023) further expanded the comparison to Europe, America, and Asia, pointing out that urban positioning, cultural diversity, and governance models significantly affect strategic choices of smart cities. Hu & Zheng (2021) focused on the differences between China and the United States, summarizing the characteristics of government-led and market-led models respectively. For the evaluation system of smart sustainable cities, Agboola, O. P., & Findikgil, M. M. (2023) proposed a comparative analytical framework to systematically examine the strategies, challenges and opportunities for building sustainable smart cities, with a focus on urban intelligence, social inclusion, resilience, technological innovation and quality of life; they also compared smart city governance models between developed economies and sub-Saharan African cities, providing practical implications for promoting sustainable smart city transformation in developing nations like Nigeria. Chen et al. (2026) systematically evaluated the smart city development levels of 62 cities in the League of Arab States based on a three-dimensional infrastructure framework covering traditional, digital and institutional aspects, and clearly revealed the significant spatial imbalance of smart city construction in the region.

1.3 Literature Review

Existing literature has laid a solid foundation for smart city research through multi-regional, multi-dimensional, and multi-perspective comparative studies. Scholars have clarified the differences in concepts, models, and evaluation systems among major global regions, and initially formed a relatively complete theoretical system. However, there are still limitations: most studies focus on horizontal comparison of developed economies, with insufficient attention to the heterogeneity of developing countries. In addition, existing research pays more attention to technological application and institutional comparison, but less to the dynamic impact of digital technology iteration and policy practice on smart city construction. Furthermore, current studies lack an in-depth analysis of the coupling mechanism between smart city construction and urban industrial resilience. Therefore, this paper integrates the perspectives of energy structure and urban industrial chain resilience, further expands the research boundary of smart cities, and makes up for the shortcomings of existing research.

2 Current Situation of Smart Tourism Development in Luoyang

2.1 The Development of Smart Tourism Has a Long History, and the Corresponding Infrastructure Is Complete (Strengths)

Luoyang boasts solid and comprehensive internal strengths in smart tourism development, which have been accumulated through years of systematic construction and policy support. As one of the first 18 national smart tourism pilot cities officially se-

lected in 2012, the city has taken the lead in laying a digital foundation for the tourism industry, making it a pioneer in smart tourism exploration across China. Up to now, Luoyang has completed the construction of a full-chain smart tourism system that covers all core links of tourism services, management and marketing, including a dedicated municipal tourism big data cloud platform, intelligent ticketing systems, real-time tourist flow monitoring equipment, mobile tour guide applications and GPS-based management tools for tourist transport vehicles. This complete system has achieved full coverage of 73 A-level scenic spots in the city, enabling real-time collection, statistics and analysis of tourist numbers, stay duration, travel routes and consumption preferences, which greatly improves the efficiency of scenic spot operation and tourist service guarantee. In addition, Luoyang has taken the lead in building multilingual tourism official websites and integrated online marketing channels covering mainstream new media platforms, which can meet the information acquisition needs of more than 80% of domestic and overseas tourists, breaking the information barrier between scenic spots and tourists. The perfect infrastructure and early-mover advantage of pilot construction make Luoyang's smart tourism have a solid starting point and development potential, which can quickly respond to the changes of tourism market demand and continuously upgrade service capacity in the era of big data.

2.2 Homogenization of Smart Tourism, Lacking Regional Characteristics and Demand Analysis (Weaknesses)

Despite the complete infrastructure of smart tourism, Luoyang still has prominent internal weaknesses that restrict the high-quality development of the industry, and these problems are all rooted in the internal construction and resource integration of the city's tourism industry. First of all, the homogenization of smart tourism products is extremely serious, with the homogeneity rate of core tourism products exceeding 62%, and nearly 70% of cultural and creative derivatives lack unique Heluo cultural genes and regional characteristics. As a famous ancient capital with thousands of years of historical accumulation, Luoyang has not transformed its profound cultural heritage into differentiated smart tourism products, and its smart tourism development positioning is vague, failing to form a unique cultural IP that is different from other ancient capital cities. Most of its smart tourism services stay at the basic level of ticket booking, traffic guidance and scenic spot introduction, without deeply integrating Heluo culture, historical relics and intangible cultural heritage into digital experience projects, resulting in low recognition and memory points of tourists. Secondly, there are obvious data silos among tourism, transportation, public security, scenic spots and other departments, which leads to the low efficiency of data interconnection and sharing, and the actual utilization rate of various smart tourism systems is less than 48%. A large number of tourist data, consumption data and operation data are scattered in different systems and cannot be integrated and analyzed centrally, which makes it impossible to carry out accurate tourist demand analysis, personalized service push and refined operation management. In addition, the application depth of big data technology in smart tourism is seriously insufficient. Most scenarios only stay in the primary application of data statistics and simple monitoring, and lack in-depth

mining of data value such as tourist portrait depiction, consumption trend prediction and market demand feedback. The lack of professional talents who are proficient in both big data analysis and tourism management also aggravates this problem. These internal weaknesses make Luoyang's smart tourism stay in the superficial level of digitalization, fail to realize the deep integration of culture, technology and tourism, and restrict the improvement of core competitiveness.

2.3 Seize the Opportunities of the Times, Keep Pace with the Development of the Times, and Create a Tourism City that Keeps Pace with the Times (Opportunities)

Luoyang's smart tourism development is facing rare external opportunities in the new era, covering policy support, market expansion, technological iteration and consumption upgrading, which provide a broad space for the transformation and upgrading of the industry. At the policy level, Henan Province has issued a number of targeted support policies to help Luoyang build a sub-central city of the Central Plains Urban Agglomeration, which clearly takes the upgrading of smart tourism and the integrated development of cultural tourism as key construction contents, bringing stable policy dividends and resource support for the industry. At the market level, China's digital cultural tourism industry has developed rapidly in recent years, with the scale of smart tourism economy reaching 1.0382 trillion yuan in 2023, and the penetration rate of smart tourism services in the national tourism market has reached 67%. The continuous expansion of the digital tourism market and the increasing acceptance of smart tourism services by tourists have created a good market environment for Luoyang. With the upgrading of residents' consumption structure, tourists' demand for personalized, experiential and intelligent tourism services is growing rapidly, which is highly consistent with the development direction of Luoyang's smart tourism. In terms of technological empowerment, emerging technologies such as big data, artificial intelligence, VR/AR and the Internet of Things are becoming more mature and popular, reducing the cost of digital transformation of scenic spots and making it easier to create immersive cultural experience projects. The digital upgrading practice of Longmen Grottoes has achieved remarkable results, realizing the integrated application of "Internet + ticketing, Internet + tour, Internet + management and Internet + cultural creation", which has set a replicable and promotable model for Luoyang's smart tourism construction. In addition, the national strategy of cultural power and digital China has continuously released policy dividends for the integration of culture and tourism, and the cross-border integration of tourism with culture, science and technology, creativity and other industries has become a new trend, providing more possibilities for Luoyang to expand the smart tourism industry chain and innovate development models. These superposed external opportunities enable Luoyang to give full play to its cultural and resource advantages, accelerate the upgrading of smart tourism and seize the initiative in the market competition.

2.4 The Development of Smart Tourism in Luoyang is Confronted with Fierce Market Competition, an Incomplete Tourism Resource and Product System, as well as a Large Number of Potential Competitors (Threats).

Luoyang's smart tourism development also faces severe external threats, mainly from market competition, market saturation and industrial chain constraints, which bring huge challenges to the city's efforts to stand out in the national smart tourism layout. First of all, the regional market competition is extremely fierce. Within 300 kilometers of Luoyang, there are more than 10 famous ancient-capital cultural tourism cities such as Xi'an, Kaifeng and Zhengzhou. These cities have their own mature cultural tourism brands and smart tourism systems, which have formed strong market attraction and diverted nearly 35% of potential cultural tourists for Luoyang. These competing cities have taken the lead in completing the differentiation of cultural IP and the upgrading of smart services, and have a higher market awareness and tourist loyalty, making Luoyang face enormous pressure to compete for tourist sources. Secondly, the national smart tourism construction has gradually tended to be saturated, and most tourist cities have completed the basic construction of intelligent platforms and digital services. Luoyang lacks a unique urban cultural label and distinctive smart tourism projects that are different from other cities, making it difficult to form a competitive advantage in the homogeneous market. In addition, the overall development of the national cultural tourism industry chain is becoming more and more perfect, and the requirements for the integration of tourism, culture, science and technology and creativity are getting higher and higher. However, Luoyang's smart tourism supporting industries are not perfect enough, and the cross-departmental and cross-industry cooperation mechanism is not mature, which restricts the integrated development of the tourism industry chain and reduces the overall operational efficiency of the industry. Furthermore, the rapid change of tourism market demand and the continuous upgrading of tourist experience requirements also put forward higher standards for the iteration speed of smart tourism products and services. Once the construction speed of Luoyang's smart tourism cannot keep up with the market changes, it will be further marginalized in the market competition. These external threats are objective and long-term, and require Luoyang to quickly make strategic adjustments and innovation breakthroughs in smart tourism development to resolve competitive pressure and achieve sustainable development.

3 Suggestions for the Development of Smart Tourism in Luoyang

3.1 Create a Unique IP of the River-Luo Culture

Give full play to the unique advantages of Luoyang as a historical and cultural capital and a leisure and vacation capital, and form a unique "River-Luo Culture" IP. Luoyang has a civilization history of over five thousand years. Hundreds of emperors have ascended the throne in the nine provinces here. It is the main birthplace of Chinese civilization and the cradle of Chinese culture. Luoyang has a profound cultural

heritage and is a well-known city both in China and around the world. At the same time, Luoyang's complex and diverse terrain and unique climate have given birth to a wide variety of scenic spots and historical sites such as famous mountains and rivers, caves, hot springs, forests and waterfalls. Its tourism resources are highly advantageous in both quantity and quality, making it one of the cities with the greatest tourism development value in Henan Province. Such a region with beautiful natural scenery and numerous historical sites has attracted scholars and poets of all ages and left behind many literary treasures, giving birth to the unique "River-Luo Culture". Seizing the unique advantages that set Luoyang apart from many other famous tourist cities and making full use of smart tourism to form a complete cultural IP of Luoyang is a better way to expand the influence of Luoyang tourism in today's information-rich era.

Expand the tourism and cultural industry chain to create a comprehensive tourism atmosphere. Today, with the rapid development of cultural diversity and the Internet, the tourism and cultural industries have given rise to many creative and highly potential new related industrial chains. The current main form of the tourism industry chain in Luoyang is local characteristic products or souvenirs. The common problems are that there are not many categories, traditional craftsmanship, serious homogeneity, lack of interactivity, and no profound cultural output has been achieved. The creation of cultural and creative products and the new creation of traditional culture should not be about simply copying and pasting traditional elements, but rather about releasing the charm of the elements from the perspectives of interpretation and dissemination, bringing consumers a sense of comfort. Luoyang boasts a considerable amount of cultural and tourism resources. Therefore, it is necessary to intensify efforts in the development of cultural industry content, establish more diverse forms of cultural and creative products, grasp the six key points of cultural, interesting, unique, practical, economic and communicative aspects in the research and development of cultural and creative products, extract Luoyang elements with development and creation value, and do a good job in the integration of Luoyang elements with related industries. Create more attractive and culturally distinctive new types of cultural and creative products to expand the influence of Luoyang's tourism industry from more perspectives.

3.2 Introduce New Internet Technologies and Comprehensively Improve the Construction of Public Service Platforms

In terms of tourism management, digital management is implemented from the perspectives of tourists, merchants and scenic spots. Specific measures in this regard include establishing a comprehensive information system for scenic spots. Tourists can conduct a series of operations such as consultation, reservation, payment and experience of scenic spots through the Internet platform. Through the integrated application of "Internet of Things + Internet + Artificial Intelligence" in the tourism process, tourists can have a deep contact with scenic spots through various forms of explanations and introductions. When problems arise, they can provide feedback to the scenic spots as soon as possible through various channels. The scenic spots can also accurately capture information such as tourists' travel routes, foot traffic and

density through the integrated system, and guide tourists accordingly. Building an all-round smart policing platform not only meets the travel experience of tourists but also ensures their safety to the greatest extent during the travel process.

Strengthen the connection with various platforms and improve the integrated tourism model. The service targets of smart tourism are "the government, tourists and enterprises". Therefore, to achieve information sharing among the three, during the process of a tourist's travel, multiple third-party platforms such as hotel accommodation and food consumption are involved, and there is also an intersection with the local government. Thus, the construction of a smart tourism platform should comprehensively consider the multi-faceted needs of tourists and build a system that covers everything from scenic spots to travel agencies, hotels, and transportation. A smart management, service and marketing system from before the trip to during the trip and then to after the trip. Achieve multi-party information sharing and business collaboration, simplify the operation process for tourists to the greatest extent, and improve efficiency and tourist satisfaction. The Luoyang Municipal Government should also actively promote the development of the city's tourism industry, introduce more humanized tourism-related policies, give full play to the leading role of the government in the construction of smart tourism infrastructure and public management platforms, and promote the transformation and upgrading of Luoyang's tourism to achieve leapfrog development.

3.3 Make Full Use of Informatization to Innovate the Smart Tourism Model

In terms of publicity and marketing in scenic spots, a big data detection platform is utilized to optimize the marketing mix and conduct precise marketing to users, thereby enhancing the efficiency of publicity work. In terms of marketing models, try more novel publicity and marketing models. Some successful examples of domestic tourism promotion models include the "Mobile Museum" of the Palace Museum, which has created a new online visiting model, and the combination of reality shows such as "Where Are We Going, Dad?" and "Two Days and One Night" with scenic spots, leveraging the influence of celebrities and variety shows to bring new popularity to the scenic spots. At the same time, it is necessary to deeply explore the cultural connotation of Luoyang's tourism industry and endow the scenic spots with story-telling elements. Enable tourists to have a chain reaction of association with the relevant elements of the scenic area. The popularity of the 2021 Henan Spring Festival Gala is a relatively good opportunity. Through it, more people can see the unique charm of Luoyang culture. Luoyang can expand cooperation with other industries and find new forms of publicity for Luoyang culture.

In terms of tourist experience and scenic area systems, we constantly introduce new ideas to enable tourists to fully appreciate the charm of Luoyang's scenic spots. For instance, the Yueyang Tower Scenic Area once launched an activity where visitors could climb the tower for free by reciting "The Record of Yueyang Tower". This not only effectively carried forward traditional culture but also added to the fun of tourism. For instance, advanced projection and camera technologies and equipment such as VR/AR are utilized to create virtual scenes that are almost indistlifelike, and

3D/4D technologies are employed to offer tourists a fantastical visual experience. In particular, Luoyang's plan to build itself into the "Capital of Museums in the East" requires the support of digitalization and new technologies. Luoyang Museums already have certain new technologies, but in an era where technology is rapidly being phased out, more efforts should still be devoted to form innovation. For cultural relic sites, accurately restoring historical scenes through digitalization, providing immersive experiences for visitors, and developing new forms of museum appreciation are the inevitable paths for museums to be reborn in the future.

Utilize smart tourism to monitor the current status of cultural relics and achieve the protection of cultural relics and historic sites during development. The ancient buildings and cultural sites in Luoyang are highly representative of the city's characteristics and culture, and they are a precious cultural treasure of Luoyang. However, while developing these cultural sites, the protection work for them cannot be ignored. The protection of cultural relics and historic sites is a highly specialized discipline that requires the support of many advanced scientific and technological means. Smart tourism should not neglect the construction in the protection of cultural relics and historic sites. Big data monitoring systems can be utilized to monitor the number of people, reasonably control the average daily flow of visitors, and try to avoid the damage caused by overloading of tourism to cultural relics and historic sites. The precision of digital technology is unmatched by human efforts. By using digitalization to conduct comprehensive data collection and recording of cultural relics and historic sites, a complete and orderly information database of cultural relics and historic sites can be established. Through these information archives, references can be provided for the protection work of cultural relics and historic sites, and the current status of cultural relics and historic sites can be detected and updated in a timely manner. Problems of cultural relics and historic sites can be discovered and timely restoration work can be carried out. Real-time monitoring of the environmental temperature, humidity and other relevant data around cultural relics and historic sites also avoids secondary damage to them.

4 Conclusion

This article centers on the theme of the intelligentization of tourism in Luoyang City. By consulting literature and conducting on-site visits to tourist attractions in Luoyang, and in combination with the core essence of smart tourism, it analyzes the current situation of the transformation and upgrading of the tourism industry in Luoyang City and puts forward reference suggestions. There are the following limitations in the research process: Firstly, the individual cultural attainments of the team are limited, and there are blind spots when looking at problems, which makes the analysis in this article not perfect. Secondly, the current research on smart tourism is not yet mature, and there are few available literature materials for reference. The analytical methods employed cannot meet the needs of practical research. Finally, the fields involved in smart tourism are numerous and the structural elements are complex. It is inevitable that there will be insufficient consideration. The existence of these limitations has

restricted the depth and breadth of research on smart tourism in Luoyang City. Finally, it is hoped that while this article offers reference suggestions, it can also provide references for the research of later scholars.

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