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*Original Paper*

# Application of Big Data in Tourism Destination Management: A Case Study of Changsha City

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***Abstract***

*In the era of information technology, the utilization of big data technology is rapidly growing, leading to significant changes in the tourism industry. Big data not only creates more business opportunities for the industry but also drives the transformation and enhancement of tourist destinations and the implementation of efficient management. This study employs two research methods: literature review and case analysis. Firstly, by reviewing relevant literature, the latest research findings and trends in big data technology for tourism destination management are summarized. Secondly, through case analysis, a comprehensive understanding of the current situation and challenges in the application of big data technology in tourism destination management in Changsha is obtained. Leveraging the Changsha cultural and tourism data platform, this study retrieves information such as tourist reception data of tourism destinations in Changsha and assesses the impact of Changsha's big data technology on tourism destination management. The research reveals limitations and challenges in the application of big data technology in Changsha's tourism destination management, including data privacy protection and technical security, which require further exploration in future practices. The goal of this study is to offer insights for the application of big data in tourism destination management in Changsha and provide guidance for destination managers in similar cities.*

***Keywords***

*big data, tourism destination management, Changsha city, problems and applications*

## 1. Introduction

In the information age, the rise of big data technology has brought profound changes to all walks of life. As an important part of the service sector, the tourism industry has also benefited from this wave of big data (Guo et al., 2023). As the core link of the tourism industry, the improvement of the efficiency and intelligent level of tourism destination management is very important for improving the city image and

optimizing the tourist experience. As a city with both historical and cultural heritage and modern development vitality, Changsha's tourism destination management is facing increasingly heavy tasks and huge opportunities.

This study selects Changsha as a case to analyze the application of big data in tourism destination management and its impact on scenic spot operation, tourist service and marketing. First, this study will focus on the application of big data in the analysis of tourist behavior. Through in-depth mining of tourists' behavior tracks and preferences in various scenic spots in Changsha, tourism destination managers can more comprehensively understand the needs and expectations of tourists, and provide more personalized and differentiated services for scenic spots. For example, Changsha can provide more personalized services for tourists by analyzing the behavior data of tourists to understand their preferences in local tourism routes, catering, accommodation and other aspects. Secondly, this paper will focus on the role of big data technology in resource management. Through the real-time monitoring and analysis of tourist flow, scenic spot heat and other data, we can more scientifically and rationally allocate resources, improve the utilization rate of scenic spot resources, and reduce the problem of tourist congestion. For example, Changsha can improve the tourism experience of tourists by analyzing the data of passenger flow and tourist behavior, reasonably arranging tourist routes and means of transport. Finally, this paper discusses the role of big data technology in market promotion. Through accurate insight into tourists' preferences, more targeted marketing strategies can be formulated to improve the popularity and attractiveness of Changsha's tourism industry. For example, Changsha can predict the number and preference of future tourists by analyzing historical data and market data, so as to provide strong support for the development of the tourism industry.

## 2. Big Data and Tourism Destination Management

The term "big data" was proposed as early as 1980, but it was not until 2011 that the industry and academia believed that the "era of big data" was really coming (Ma et al., 2023). The academic community generally believes that big data refers to a huge amount of data that cannot be extracted, stored, searched, shared, analyzed and processed by traditional software tools within a certain period of time (Manyika et al., 2011). Big data consists of countless small data. The basic rule to measure the "big" of big data is: bigger than bigger (Chen et al., 2021; Wang et al., 2013).

The combination of big data and tourism has brought great changes to the tourism industry (Huang et al., 2024). Because the whole supply chain of the tourism industry is accompanied by the interaction of service flow, information flow and value flow, there are many types of data and a large amount of data, which has a significant "4V" feature of big data (large volume, many types, high flow rate and low density). Therefore, the big data contained in the supply chain can also be called tourism big data (Ma et al., 2023; Kitchens et al., 2018). Tourism big data can be roughly divided into ten sub categories, including scenic spots, hotels, travel agencies, tour guides, tourists and tourism enterprises, and two secondary categories (as shown in Table 1) (Duan et al., 2024).

**Table 1. Composition of Tourism Big Data**

| Main category, | Secondary category | Subcategory |
|---|---|---|
| Ttourism big data (data source) | Tourism information resources and database | Visitor data |
| | | Management Data |
| | | Tourism industry business resource library |
| | | Tourism knowledge base |
| | | Tourist city information resource database |
| | | Tourism geographic information (GIS) database |
| | | Tourism industry basic resource information database |
| | Tourism digital transaction and behavior database | Financial transaction data |
| | | Internet Data |
| | | IOT data |

With the help of big data technology, it can systematically collect and deeply analyze the behavior and personalized tendency of tourists, so as to provide more personalized service solutions for tourists; At the same time, through the in-depth mining and analysis of the trend and change trend of the tourism market, it can provide more accurate and efficient marketing strategy guidance for tourism enterprises. In addition, by using the big data analysis method, we can accurately grasp the distribution and dynamic evolution of tourist flow in tourism destinations, and then help the scenic spots to achieve refined management and service optimization (Ye et al., 2022; Lu et al., 2012). Therefore, the effective integration of big data technology and tourism will effectively promote the transformation of tourism and its related destinations to the path of efficient operation, intelligent management and sustainable development.

## 3. Overview of the Case Site

With the continuous evolution and Deepening Application of big data technology, its value in the field of tourism destination management is increasingly significant. Taking Changsha, the capital city of Hunan Province, as an example, this study systematically explores the practice of big data technology in tourism destination management and its impact on tourism development. Changsha is rich in tourism resources, such as Yuelu Mountain, juzizhoutou, Huangxing square and many other well-known scenic spots, all showing its unique charm as a tourist destination. Selecting Changsha as the case study object is based on two core considerations: the first factor is that the tourism industry in Changsha has shown a

strong growth trend in recent years, and the annual total number of tourists is rising, which has become one of the popular travel destinations favored by domestic and international tourists. The tourism destination management mode and practical experience behind it have important exploration significance and reference value; Secondly, Changsha has successfully built a set of visual cultural tourism comprehensive management and control platform, which provides an intuitive and detailed data basis for the study of the practical application scenarios of big data in Changsha's tourism destination management.

## 4. Application of Big Data in Tourism Destination Management

Based on the macro perspective, big data technology can reveal the overall situation and trend characteristics of tourism development in a specific region, and provide solid data support and scientific decision-making basis for policy makers (Yang, 2023). At the same time, at the micro level, big data can also deeply analyze individual tourists' personalized preferences and consumption behavior patterns, so as to effectively support the fine division of the tourism market, the construction of precision marketing strategies, and the development and optimization of personalized service products. This ability of in-depth mining and multi-dimensional analysis gives big data broad application prospects, which not only plays a key role in traditional fields such as market demand analysis and tourism resource planning, but also can be further extended to micro application scenarios that focus on the individual characteristics of consumers (Chen & Li, 2022; Li et al., 2018), so as to realize the all-round intelligent upgrading of the tourism industry.

### *4.1 Analysis and Prediction of Tourism Demand*

Through big data technology, we can analyze tourists' consumption behavior, tourism preference, tourism demand and other information, and then predict the future tourism trend and market demand. Specifically, the detailed analysis of tourists' search history and travel itinerary data can reveal their inherent tourism tendencies and consumption habits. These insights provide a practical reference for tourism destination management and marketing strategies (Liu & Chen, 2022). Based on the observation from the perspective of tourism service providers and intermediaries, if the destination has insufficient resources and service preparation, it may lead to the lack of protection of tourists' rights and interests, which will lead to the increase of costs and the unnecessary loss of service resources (Liu & Li, 2023). For example, Liu et al. Used crowdsourcing big data to build an innovative governance framework for tourism destinations in Shenzhen and Jiangmen (Liu et al., 2023), covering eight differentiated analysis modules, and systematically reviewed the three key challenges faced by China's urban tourism governance. In addition, Andrea et al. Proposed to use the big data resources of the online travel agency (OTA) platform to build a tourism price index model (Andrea et al., 2021), which not only helps to accurately predict the fluctuation of tourism demand, but also provides scientific guidance for tourism product suppliers to formulate pricing strategies.

*4.2 Tourist Market Segmentation and Precision Marketing*

Big data technology plays a key role in the market segmentation of tourism destinations. Classifying tourist groups according to their characteristics and diversity of needs helps to formulate more accurate marketing strategies. For example, cluster analysis of tourists' age, gender, occupation, income and other information can reveal the internal tourism demand characteristics and consumption behavior patterns of different groups, and then provide customized tourism services and products for various market segments. Based on the perspective of tourists, after market segmentation, tourists can obtain a more personalized tourism experience(Chen, 2019); From the perspective of the tourism destination management agency, we can accurately predict the short-term passenger and vehicle flows in the future by integrating the big data resources inside the scenic spot (such as scenic spot ticketing system data, hotel reservation data, etc.) and third-party big data sources such as the Internet and operators, and optimize the resource allocation and service plan in advance according to the tourist attributes (Liu, 2016). For example, a study by wookhyun and silverio, based on the opinions of 1002 Spanish rural tourism tourists collected in three online communities, successfully divided the tourists in this market into three categories by using multiple correspondence analysis and cluster analysis: tourists who pay attention to comfort experience, consumers who prefer rural customs and tourists who actively seek leisure and entertainment (Wookhyun & Silverio, 2021).

*4.3 Tourism Planning and Macro Control*

Big data technology helps tourism destinations formulate development plans and macro-control. Through the in-depth mining and comprehensive analysis of the multiple data of tourist destination passenger flow, traffic conditions, scenic spot operation and so on, it can provide the basis for formulating more scientific and reasonable tourism planning and control measures. For example, based on the analysis of passenger flow and traffic situation, the actual carrying capacity and potential bottleneck problems of tourist destinations can be accurately identified, so as to provide practical guidance for the layout optimization and resource allocation of tourist destinations. Both governments and enterprises should actively promote the construction of big data monitoring platform for tourism operation, which is used to strengthen internal decision support on the one hand, and realize the innovative development of value-added services on the other (Jiang et al., 2023). Taking the empirical research of Maria and others as an example, through two stages of research (network analysis, online survey) (Maria et al., 2021), this paper deeply discusses how big data and tourist experience design work together, aiming to improve the value of tourist experience and provide more efficient decision-making tools and methods for managers.

*4.4 Tourism Management Information Sharing and Collaboration*

Big data technology can help tourism destinations realize information sharing and collaborative work (Nathaniel et al., 2020). Through the integration and sharing of information from all aspects of the tourist destination, the communication and cooperation between departments can be smoother, and the work efficiency and quality can be improved; By sharing tourist information and scenic spot information, scenic spot management departments and tourist service departments can work together better; Support

tourists to evaluate the service quality through microblogs, reviews, etc. before purchasing tourism services, so as to provide better tourist services (Joachim & Mike, 2022); Supply chains can also share real-time data such as demand status, production requirements and product supply through big data, so as to effectively improve the efficiency of the supply chain (Li, 2016; Zhang, 2017).

## 5. Application Experience of Big Data in Tourism Destination Management in Changsha

### *5.1 Establishment of Data Platform*

The Changsha municipal government cooperates with many enterprises and institutions to build the Changsha tourism big data platform (as shown in Figure 2). This platform systematically gathers information from multi-dimensional data sources, including but not limited to real-time data streams generated by various tourism online service platforms, social media, online travel agents (OTAs), scenic spot facilities and accommodation service agencies. Based on the in-depth analysis and mining technology application of these multivariate heterogeneous data, the platform provides a scientific and rigorous data support basis for Changsha tourism destination management decision-making, and effectively promotes the improvement of management efficiency and the formulation of accurate strategies.

### *5.2 Tourism Demand Forecast*

The application of big data technology is profoundly changing the way of tourism demand forecasting (Figure 1). Traditionally, tourism demand forecasting mainly relies on historical data records and industry experience models. However, the limitations of this method in accuracy and timeliness are gradually highlighted. By integrating and using big data resources, tourism destination management agencies can more accurately capture market demand dynamics and development trends, and provide reliable basis for the scientific formulation of tourism planning strategies. With the help of big data technology, Changsha has deeply explored the regular characteristics of tourist flow distribution in various regions, years and different periods. Through the mining of multi-dimensional data such as tourist search behavior, browsing mode, booking trend and evaluation feedback, it has successfully realized the effective prediction of future tourism market trend and demand. Through continuous monitoring and in-depth analysis of these real-time big data, Changsha tourism managers can accurately grasp the context of market fluctuations, and then timely adjust and optimize the supply structure and service strategy of tourism products, aiming to meet the changing needs of tourists to the greatest extent and maximize the efficiency of the tourism industry.

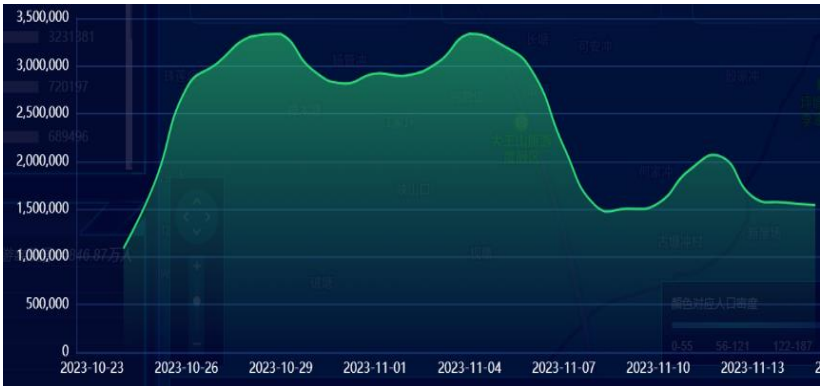


**Figure 1. Real Time Passenger Flow of Tourist Destinations in Changsha**

*5.3 Optimize the Allocation of Tourism Resources*

Big data technology not only shows significant advantages in tourism demand forecasting, but also provides strong support for in-depth insight into tourism destinations and optimizing resource allocation. Through in-depth mining and quantitative analysis of tourists' behavior patterns, consumption preferences and satisfaction driving factors, Changsha tourism destination managers can accurately locate the market gap, and on this basis, innovate and design novel tourism products and service systems that meet the market demand, so as to improve the overall experience satisfaction of tourists. The analysis of big data reveals that the pedestrian street area of Huangxing South Road in Changsha is the core area with the most intensive tourist activities, followed by the juzizhoutou fireworks viewing area and the May 1st business district (Figure 2); Search "Changsha tourism" in the microblog engine, crawl the online comment data using Octopus software (Table 2).This conclusion can help Changsha tourism destination managers carry out marketing and tourism resource allocation more accurately. In addition, with the help of big data technology, we can also obtain the distribution of the number of tourists who travel at night and their preferences for specific regions in detail, which provides a scientific basis for the precise allocation and adjustment of various resources in tourism destinations, aiming to improve the utilization efficiency of tourism resources and ensure the maximization of the matching degree of supply and demand. Through in-depth analysis of the characteristics of tourists' behavior and the changes in their internal needs, tourism destinations can achieve the precise allocation and efficient management of multi-dimensional resources such as human, material and financial resources, which not only meets the diversified personalized needs of tourists, but also avoids the waste of resources caused by information asymmetry, so as to promote the comprehensive management level and economic benefits of tourism destinations.

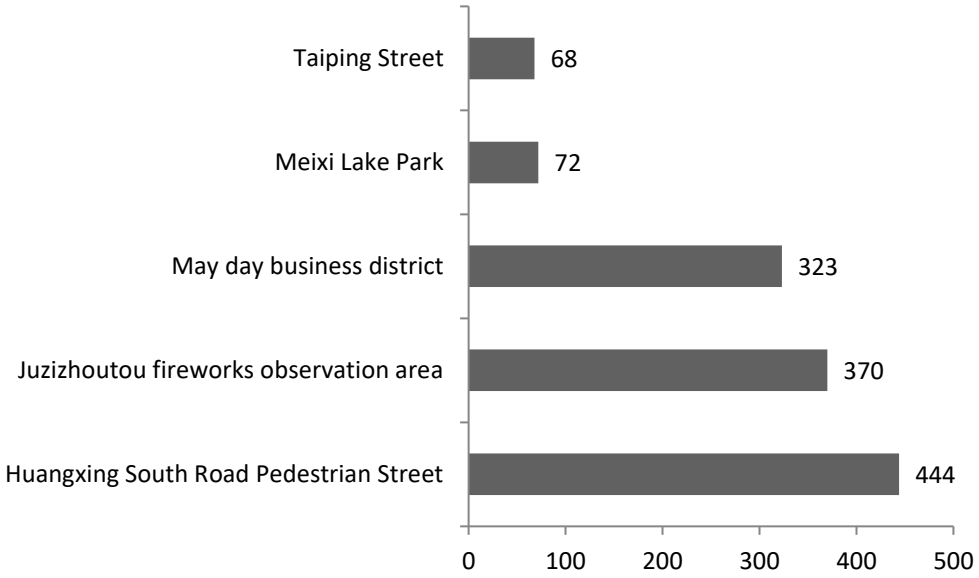


**Figure 2. Passenger Flow Ranking of Key Tourist Attractions in Changsha (person/10000 times)**

**Table 2. Microblog Changsha Travel Hot Words (excerpt)**

| Changsha tourism high frequency words | Frequency ranking |
|---|---|
| Tea color | 1 |
| Orange island | 2 |
| Yuan Longping | 3 |
| Wuyi square | 4 |
| Guard Jiefang West | 5 |
| Yuelu Mountain | 6 |
| Pozi Street police station | 7 |
| Fireworks | 8 |
| Pink zebra crossing | 9 |
| Cardioid traffic light | 10 |

*5.4 Tourism Safety Management*

Big data also plays an important role in tourism safety management. By collecting and analyzing social media, weather, traffic and other data, potential security risks can be found and dealt with in time to ensure the safety of tourists. When a traffic jam occurs in a certain area of Changsha, big data analysis can quickly remind the tourism destination management department to take corresponding safety measures to ensure the safe travel of tourists. As Tianxin District of Changsha City launched the smart Tianxin meteorological service platform with the help of big data, Internet, cloud computing and other technologies, and carried out waterlogging level prediction and early warning of multiple disasters

according to the real-time rainfall, sewer network, catchment area and waterlogging prediction model, so as to ensure the travel safety of domestic and foreign tourists.

Based on the case study of Changsha's big data enabled tourism destination management, this paper constructs the mechanism model of Changsha's big data enabled tourism destination management as shown in Figure 3. It can be seen that the application of big data in the management of tourism destinations in Changsha is not limited to a single link, but runs through the entire tourism industry chain. From the macro level to the micro operation, it has comprehensively improved the management efficiency and service quality of tourism destinations, and promoted the intelligent transformation and sustainable and healthy development of tourism industry.

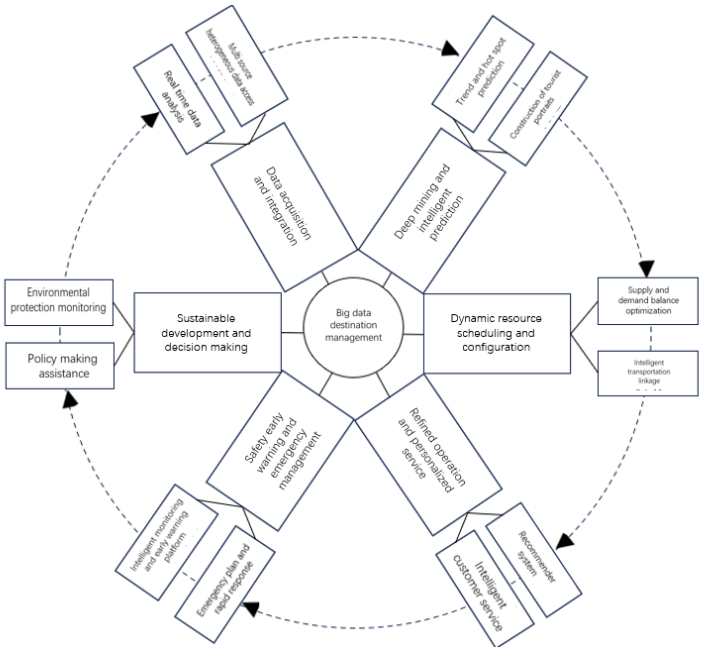


**Figure 3. Mechanism Model of Big Data Enabling Changsha Tourism Destination Management**

## 6. Problems and Countermeasures of Big Data Management in Changsha Tourist Destination

With the continuous development of information technology, big data has become one of the important driving forces for the development of modern society. At the same time, tourism destination management is also facing new challenges to adapt to the era of big data. At present, in the practice of tourism destination management in Changsha, the application of big data still has a series of problems that need to be optimized.

### *6.1 Inadequate Data Integration*

Changsha is rich in tourism resources, such as Yuelu Mountain, juzizhoutou, Wangchengpo and many other scenic spots. However, due to the fact that each scenic spot belongs to different administrative agencies and follows an independent data statistics system, the overall data integration is insufficient.

This situation not only hinders the government from unified management and effective use of the city's tourism data, but also fails to fully meet the diversified information needs of tourists.

Countermeasures: build a standardized data acquisition system. The government can formulate unified data collection standards and specifications, guide each scenic spot to carry out data statistics in a standard way, and realize the effective integration and in-depth analysis of the city's tourism data. At the same time, we should strengthen the supervision mechanism of data collection to ensure the authenticity and accuracy of the data, so as to improve the government's comprehensive management level of tourism data and serve the needs of tourists more effectively.

*6.2 Poor Data Analysis Ability*

Although the tourism destination management department of Changsha has accumulated a large number of tourism data, the in-depth mining and comprehensive use of data are still relatively limited, and the phenomenon of multiple factors intertwined in reality has not been fully considered (Yang & Wu, 2022).

Countermeasures: strengthen the construction of data analysis talent team. The government should increase investment in the training of professional data analysis talents, and improve the data analysis ability and technical level of tourism destination management departments. In addition, we can actively seek cooperation with universities and scientific research institutions, introduce advanced data analysis technology and management theory, so as to enhance the scientificity and effectiveness of tourism destination management decision-making in Changsha, and extract valuable insights from massive tourism data.

*6.3 Data Sharing Mechanism Is not Perfect*

At present, the data sharing mechanism among the scenic spots in Changsha is not perfect. A large number of tourism data are limited to the internal use of a single scenic spot, and there is a lack of effective cross scenic spot data exchange and sharing, resulting in a waste of resources. At the same time, it may also lead to repeated labor and unnecessary resource allocation.

Countermeasure: establish a data sharing platform. Build a tourism data sharing platform. The government can lead the establishment of a tourism destination data sharing platform to encourage and promote data openness and sharing among scenic spots. Through this platform, each scenic spot can obtain the tourist flow, turnover and other information of other scenic spots in real time, so as to accurately formulate the tourism destination management and service strategy. At the same time, scenic spots can share their management experience and successful cases on the platform to jointly promote the overall improvement of tourism management level.

*6.4 Data Security Needs to Be Strengthened*

With the wider application of big data, the problem of data security has become increasingly prominent. In the process of tourism destination management, Changsha shows some deficiencies in data security, and potential security risks can not be ignored. Especially when big data is widely used in the tourism industry, failure to properly handle the relationship between personal privacy protection and data utilization may lead to crisis events (Adm, 2021).

Countermeasures: the government should strengthen the construction of data security system, establish and improve the data confidentiality system and management system. Adopt cutting-edge data encryption technology and network security protection means to ensure the confidentiality and integrity of data. In addition, strengthen the security education and training for data users, improve their data security awareness and prevention skills, and form a data security mechanism with full participation.

## 7. Conclusion and Discussion

Integrating the concept of big data into tourism service supply chain management is the key path to promote the improvement of tourism management level and realize smart tourism. This study selects Changsha as a case study to explore the application and impact of big data technology in tourism destination management. The research shows that big data technology has significant practical value for tourism destination management, and brings both challenges and opportunities.

First, with the help of big data technology, we can have in-depth insight into the demand characteristics and behavior patterns of tourists. By analyzing multiple data sources such as social media and tourism websites, tourism destination managers can more accurately grasp the personalized needs and preferences of tourists, so as to provide accurate tourism services. Taking Changsha as an example, by mining the behavior data of tourists, Changsha tourism managers can optimize tourism route design, catering and accommodation recommendation and other links to meet the personalized experience needs of tourists.

Secondly, big data technology strongly supports the optimal allocation of tourism resources and the improvement of operation efficiency. Through the in-depth analysis of tourist flow, tourist behavior, tourism resources and other information, we can accurately grasp the current situation of resource utilization and reasonable allocation, and improve the overall operation and management efficiency. For example, Changsha uses big data technology to analyze passenger flow and tourist behavior data, and scientifically plan the layout of tourist routes and vehicle scheduling, aiming to enhance the tourist experience and improve the operation efficiency of the tourism service system.

Thirdly, big data technology can help tourist destinations predict future market trends and changes. Through the analysis of historical data and market data, tourist destinations can predict the future passenger flow, changes in tourist consumption preferences and market demand dynamics in a forward-looking manner, so as to formulate coping strategies in advance. For example, Changsha can predict the number and preference of future tourists by analyzing historical data and market data, so as to provide strong support for the development of the tourism industry.

Finally, in the tourism destination management of Changsha, although the application of big data technology has made some achievements, there are still some shortcomings. For example, there are some difficulties in data integration and sharing, data processing and analysis capabilities still need to be improved, and data security and privacy protection issues need to be paid attention to.

Looking forward to the future, Changsha tourism destination management should further explore the deep integration of big data and AI and other advanced technologies (such as virtual reality, metauniverse,

etc.) (Feng & Su, 2021) and build a cross industry interactive innovation mechanism. For example, combining big data and intelligent technology to form synergy in tourism destination management and urban planning, traffic management, environmental protection and other fields, so as to achieve a higher precision and intelligent level of tourism service and management, and provide a comprehensive and sustainable support system for urban comprehensive development.

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