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Digital Transformation of the Tourism Industry Driven by Artificial Intelligence and Big Data

Siyan Li

School of Glasgow University, Glasgow, UK

Abstract

Artificial intelligence (AI) and big data are increasingly influencing the digital transformation of the tourism industry. This paper explores how these technologies interact to reshape tourism services, business models, and the roles of stakeholders. Drawing on existing literature and industry cases, and applying the S-curve model and disruptive innovation theory, it analyzes changes in technological development and the competitive landscape of the industry. Although these changes create opportunities for service innovation and efficiency improvements, they also raise concerns about data privacy, algorithmic bias, employment, and inequalities in digital capabilities. The paper concludes that successful digital transformation in the tourism industry requires the coordinated integration of technological innovation and institutional governance, with greater emphasis on fairness, inclusiveness, and long-term sustainability.

Keywords

Tourism Digital Transformation; Artificial Intelligence; Big Data; S-curve Model.

1. Introduction

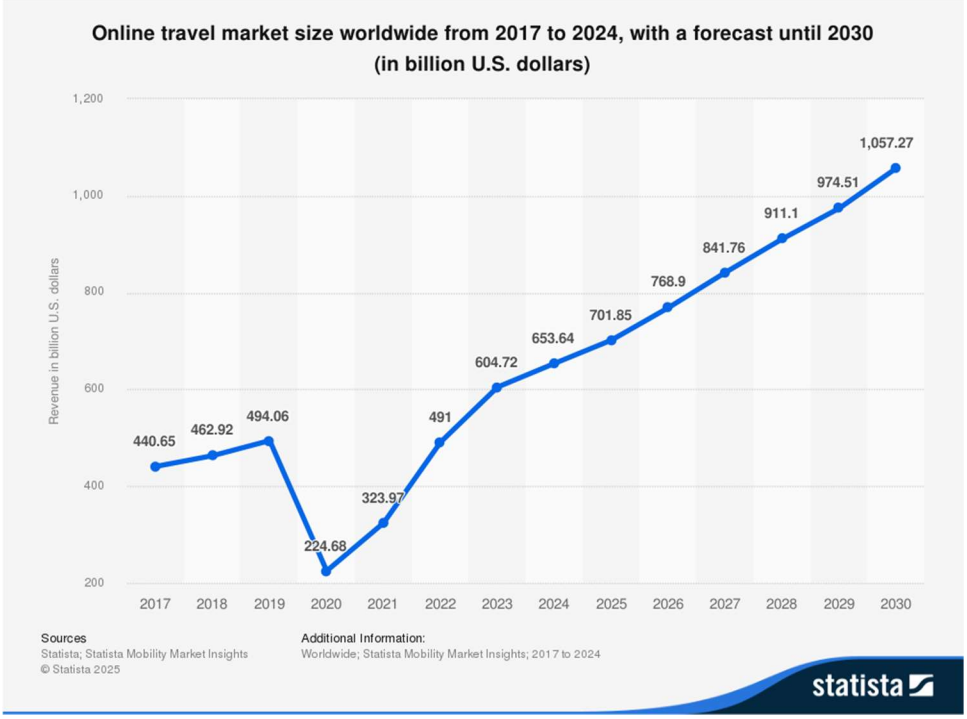


Figure 1. Online travel market size worldwide from 2017 to 2024 [3]

With the wave of digitization sweeping the world, the tourism industry is transforming from a traditional service model to intelligent operation. By using data collection, analysis and intelligent decision-making, the tourism industry is reshaping the service process, operational

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logic and value creation of the entire industry [1]. In the past five years, artificial intelligence (AI) and big data have become the dual-core driving forces for the development of tourism, comprehensively promoting changes in the supply, demand and governance of the industry [2]. This article systematically analyses the technological evolution of artificial intelligence and big data, the transformation of the roles of key stakeholders and their impact on individuals, society and organization. In addition, this article also uses the perspective of innovative management theory to make an in-depth interpretation, providing valuable policy and practical inspiration for government agencies, tourism enterprises and scientific and technological innovation institutions.

2. Technologies for Digital Transformation in the Tourism Industry

2.1. Research on Artificial Intelligence in the Tourism Industry

Artificial intelligence (AI) refers to a series of technologies that enable computer systems to simulate human intelligent activities. Its core capabilities include perceptual learning, natural language processing (NLP), computer vision (CV), reasoning and generation [4]. In the tourism industry, artificial intelligence uses Technologies such as Transformer Architecture and Retrieval Enhancement Generation (RAG), and combines with the Model as a Service (MaaS) model [5] to conduct in-depth analysis and efficient utilization of tourism data, for tourists, enterprises and Government agencies provide intelligent decision-making support, services and management tools.

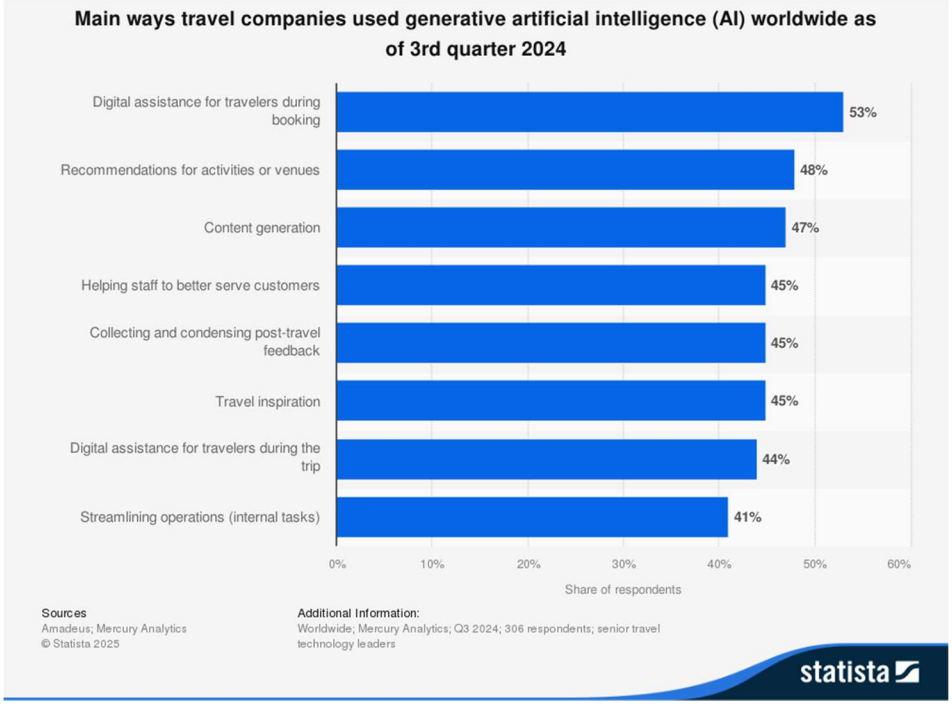


Figure 2. Main ways travel companies used generative Al worldwide as 2024 [6]

The academic community generally agrees with the value of artificial intelligence in improving the travel experience and operational efficiency, but the relevant debates still exist. One of the discussion directions mainly focuses on ethical issues, such as service injustice caused by algorithmic bias and the risk of user privacy leakage [7]. Another key point of debate is whether artificial intelligence will replace tourism practitioners: research shows that low-skilled jobs may be replaced by automation, thus pushing the workforce to high-skilled, emotion-driven service jobs [8]. In general, artificial intelligence tourism research is constantly developing,

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striving to strike a balance between technical functions, user experience quality and ethical governance.

2.2. Research on Big Data in the Tourism Industry

Tourism big data refers to a large number of multi-source data sets generated in tourism activities, covering stakeholders from tourists, enterprises to the government. It has the core characteristics of large data volume, many types and fast-changing data. It has a wide range of data sources, including online travel agency (OTA) user behaviour data, hotel transaction records, Internet of Things real-time sensing data and government public statistics [9]. Its unique industry attributes include strong space-time correlation, significant seasonal fluctuations, and rich emotional insights into tourists.

Tourism big data research is shifting from basic data collection and statistics to advanced data interpretation and value mining, and more and more attention is paid to multi-source data integration and prediction model optimization [10]. A core research challenge is how to balance data security and privacy protection with data sharing and value maximization, which is a key issue affecting the development direction of this field.

2.3. Comparison and Intersection of AI and Big Data in the Digital Transformation of the Tourism Industry

2.3.1. Comparison of Core Characteristics

There are significant differences between the core focus and value of artificial intelligence and big data in the digital transformation of the tourism industry. Artificial intelligence is centred on algorithms and priorities intelligent decision-making and interaction capabilities. Its core value is to transform raw data into executable intelligent services and strategies. In contrast, big data is centred on data centers, emphasising data collection, integration and analysis capabilities to provide data-driven decision-making support. Big data is good at mass storage, multi-source integration and trend prediction, paying special attention to back-end operation and governance intelligence [5]. In practice, artificial intelligence acts as the user of big data, and big data acts as the basic data provider of artificial intelligence, and the two form a complementary relationship.

2.3.2. Dependence Relationship and Collaborative Mechanism

Artificial intelligence and big data are interdependent in the transformation of tourism. The development of artificial intelligence relies entirely on high-quality and large-scale data to train machine learning algorithms and optimize large-scale models; the richness and quality of data directly determine the application effect of artificial intelligence, such as the accuracy of the travel recommendation system, which depends on the accumulation of user behaviour and scene data [2]. On the contrary, the value of big data can only be released through in-depth mining and intelligent interpretation of artificial intelligence empowerment, so as to transform raw data into practical and decision-making guidance insights [11]. This synergy forms a dual-drive mechanism that drives the innovation of tourism.

3. Analysis of the Evolution Trend of Digital Transformation in the Tourism Industry

3.1. Analysis Using the S-Curve Model

3.1.1. Initiation and Climbing Phase (2021–2022)

In the early S-curve stage, the application of artificial intelligence and big data in tourism was limited to basic functions such as simple passenger flow statistics and basic artificial intelligence customer service, with narrow coverage and low performance. Most scenic spot systems only support ticket reservations, and the passenger flow prediction error is large [12].

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Due to the uncertain return on investment, small and medium-sized tourism enterprises have adopted a wait-and-see attitude [8], while the transformation work focusses on leading online tourism platforms and national scenic spots.

3.1.2. Rapid Growth Phase (2023–2024)

Driven by optimized big data algorithms and mature artificial intelligence technologies, such as natural language processing and digital people, the technology has entered the rapid growth stage of the S-shaped curve. The application scenario has expanded exponentially, Ctrip's "Ask AI" assistant and other functional tools have been widely launched, and services such as intelligent scheduling and personalized itinerary customization of scenic spots have also evolved from optional value-added services to essential functions [13]. A positive feedback cycle has been formed between technical capabilities and market demand, which has promoted the digital transformation of the whole industry.

3.1.3. Gradual Maturity Phase (2025)

With the stabilization of technology, digitization has become the industry standard, and the growth rate of the S-shaped curve has slowed down. The competitive pattern has changed from owning technology to providing high-quality technology. Enterprises give priority to optimizing operations, such as optimizing the cost structure of intelligent services and improving the self-service resolution rate of AI customer service [14]. Technical standards tend to be unified throughout the industry, and functions such as multilingual interaction and AR guidance have become common norms in the industry, marking the industry's shift from isolated innovation to integrated system-level transformation.

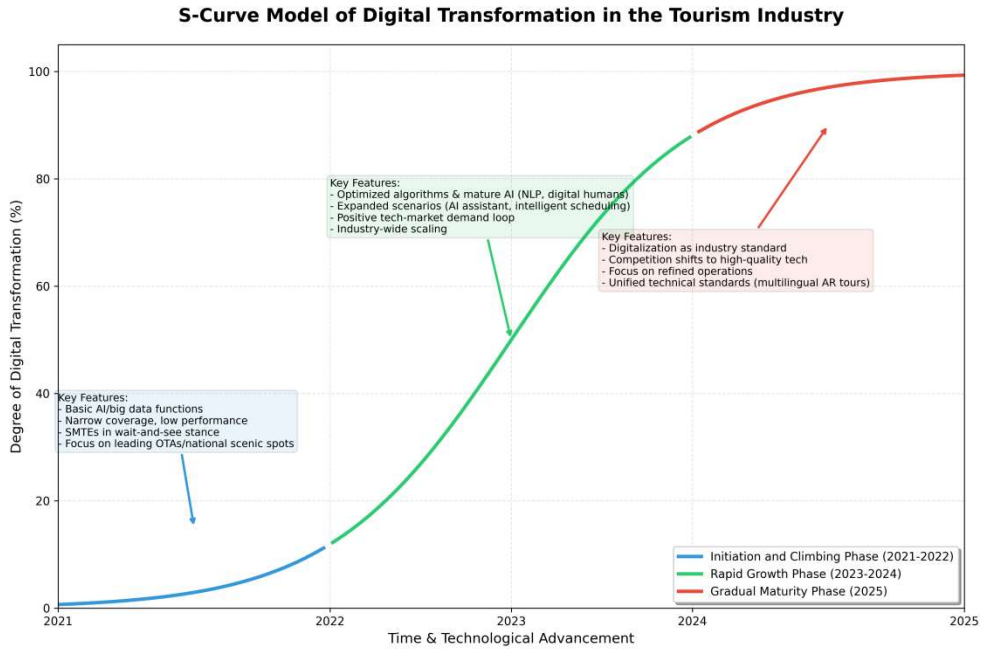


Figure 3. S-Curve Model of Digital Transformation in the Tourism industry [15]

3.2. Reshaping Industry Competition Patterns and Business Models Through Disruptive Innovation Analysis

The disruptive innovation theory points out that start-ups or new entrants can launch more convenient and low-cost products, enter from low-end or emerging markets, gradually erode the mainstream market, and ultimately replace the position of traditional enterprises [16]. This concept is particularly evident in the digital transformation of the tourism industry.

First, early digital products entered the low-end market ignored by traditional enterprises with their low cost and simple functions. For example, lightweight SaaS services do not require the

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high technical investment of large scenic spots, and meet the basic needs of small and medium-sized travel agencies with modular tools, such as online booking management and simple passenger flow statistics [17]. They quickly occupied the market of small and medium-sized tourism entities, forcing large service providers to reduce the cost of basic services and gradually changing the pricing and service pattern of the industry.

Second, changes have emerged in new markets, creating brand-new tourism consumption scenarios and converting non-consumers into consumers. For example, online virtual exhibition halls enable people who cannot travel on-site to realize "cloud tourism" through VR technology, opening up a completely new market [12]. These innovations were not valued by traditional tourism enterprises at first, but with the expansion of user scale, they have gradually diverted the customer source of the mainstream market.

In addition, great changes have taken place in business models, and the core value of traditional business formats has been disrupted. AI combined with big data can generate itinerary plans for free and quickly, directly weakening their intermediary value. This has forced traditional travel agencies to shift from standardized services to differentiated fields such as high-end customization and cultural explanation, completing the reconstruction of business models.

4. Key Stakeholders and Role Evolution

4.1. Technology Inventors and Researchers

4.1.1. Key Stakeholders and Their Contributions in the AI Field

The application and development of AI technology in the tourism industry cannot be separated from the continuous innovation of scientific research teams and technology developers worldwide. In the field of basic research, the three giants of deep learning including Geoffrey Hinton, Yann LeCun, and Yoshua Bengio, laid the theoretical foundation for deep learning. The core technologies they proposed, such as the back propagation algorithm and constitutional neural networks, provided underlying support for the application of AI in the tourism industry [18]. In particular, the Transformer architecture proposed by Hinton's team in 2017 became the core technical foundation of large language models, directly driving the transformation of tourism AI from dedicated models to general-purpose large models. In the field of technology research and development, the scientific research teams of OpenAI, DeepMind, Baidu, Google and other enterprises are the core driving forces. The GPT-3 model launched by OpenAI in 2020 has a strong natural language generation capability, which provides technical possibilities for applications such as travel AI assistant and intelligent itinerary planning.

4.1.2. Key Stakeholders and Their Contributions in the Big Data Field

The development of big data in the tourism industry cannot be separated from the promotion of scientific research teams and technical institutions. In the field of data processing technology, open-source big data frameworks such as Hadoop and Spark developed by the Apache Foundation provide low-cost and high-comput data processing solutions for tourism enterprises, promoting the popularization of big data technology among small and medium-sized tourism enterprises [19]. Cloud computing platforms such as AWS and Google Cloud developed by companies such as Google and Amazon provide powerful big data storage and computing power, providing infrastructure support for the large-scale application of tourism big data.

4.2. Enterprise Entities

4.2.1. OTA Platforms

As core intermediaries in the tourism industry, OTA platforms have transformed from information intermediaries and product sellers into technology platform providers and data

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producers, driven by AI and big data technologies. Between 2020 and 2024, OTA platforms gradually became core drivers of tourism technology innovation [20]. On one hand, through continuous technological R&D, OTA platforms launched a series of AI and big data applications, including intelligent itinerary customization, dynamic pricing, and big data marketing, directly serving platform users and partner merchants. On the other hand, OTA platforms began to open up their technological and data resources to small and medium-sized tourism enterprises, empowering the upstream and downstream of the industry. For example, in 2024, Ctrip opened its "AI Itinerary Customization Tool" and "Big Data Passenger Flow Prediction Interface" to over 5,000 small and medium-sized travel agencies, helping them gain customized service capabilities. The order volume of cooperating travel agencies increased by an average of 60% [21].

At the same time, OTA platforms have become core producers and integrates of tourism big data. By accumulating massive amounts of user booking data, browsing behavior data, and review data laying the foundation for AI algorithm training and big data analysis. For instance, Ctrip's user database contains behavioral data of over 500 million users, which can accurately depict the travel preferences of different customer groups and provide data support for personalized services [5]. In addition, OTA platforms have integrated multi-source tourism data through data sharing with related enterprises such as transportation, hotels, and scenic spots, promoting the construction of an industrial data ecosystem.

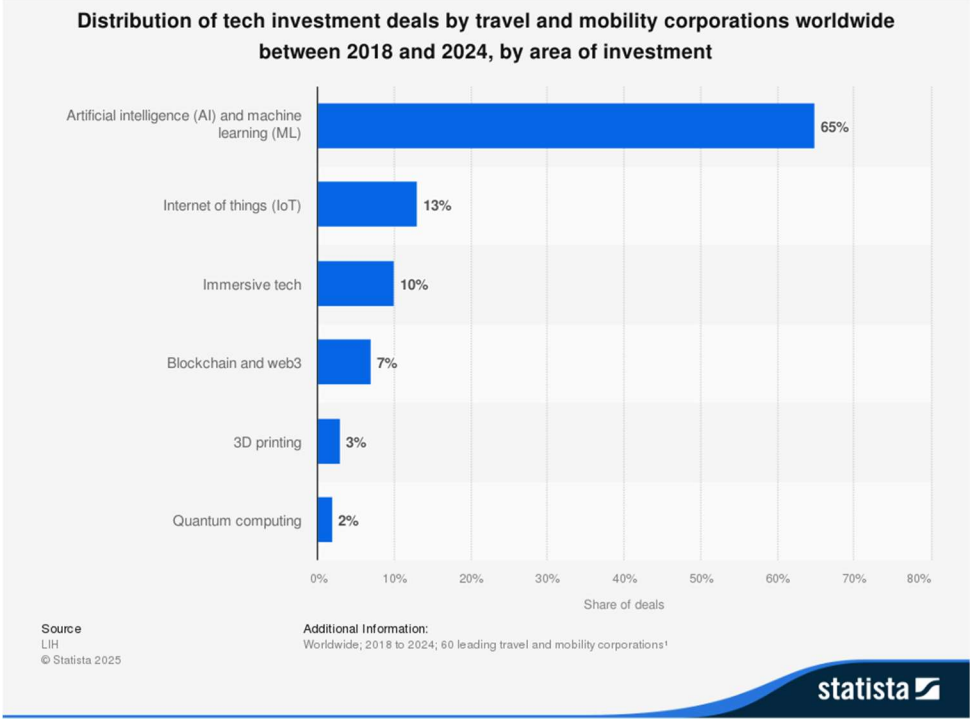


Figure 4. Distribution of tech investment deals by travel and mobility corporations worldwide, between 2018 and 2024, by area of investment [22].

4.2.2. Technology Enterprises

Technology companies such as Alibaba Cloud, Tencent Cloud, AWS, and Google Cloud have shifted their roles in tourism technology innovation from being single technology suppliers to industry solution providers. Between 2020 and 2024, technology enterprises began to deeply understand the needs of the tourism industry and develop customized solutions for specific scenarios [11]. In 2024, Alibaba Cloud launched an integrated smart scenic spot platform, which combines functions such as big data passenger flow analysis, AI security, intelligent tour guidance, and emergency response, offering full-chain services from technology deployment to

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operation and maintenance support. AWS, on the other hand, provided global big data processing and AI application solutions for international tourism enterprises, helping them realize the intelligentization of cross-border tourism services .

4.2.3. Tourism Service Providers

Tourism service providers such as hotel groups, scenic spots, and airlines have shifted their roles from passive technology users to active technology participants. Between 2020 and 2024, tourism service providers began to increase investment in technology R&D, take the initiative to participate in technological innovation, and develop differentiated smart service capabilities [12]. In terms of hotel groups, Hilton independently set up a technology team in 2024, optimized its AI check-in system based on hotel customer data, and added a personalized guest room environment preset function, which improved customer satisfaction by 40% . Marriott launched its "AI Room Butler" in 2023; through an independently developed voice interaction system, it realized the intelligentization of room services [23] . The role transformation of tourism service providers reflects the shift of technology application from external internal. By independently participating in technology R&D, tourism service providers can more accurately meet their own needs, develop technology applications that better fit service scenarios, and at the same time enhance their core competitiveness.

4.3. National and Regulatory Authorities

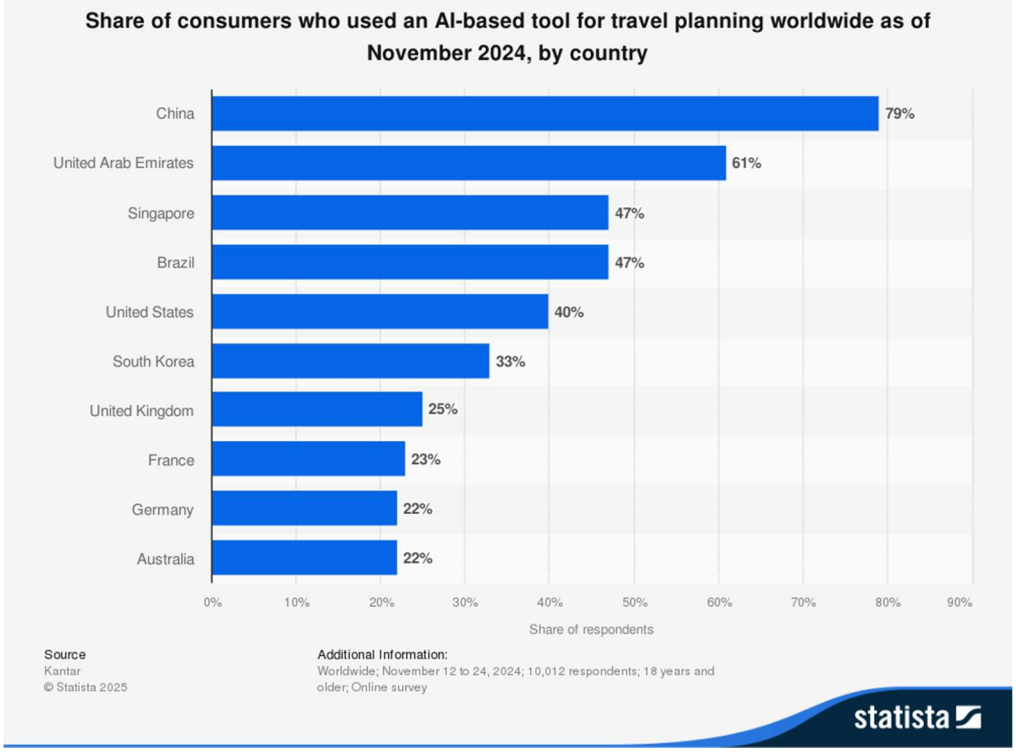


Figure 5. Share of consumers who used an AI-based tool for travel planning worldwide[26]

National and regulatory authorities have transformed from single regulators to dual-role actors of governors and promoters in the AI and big data-driven innovation of the tourism industry. Between 2020 and 2024, government departments began to actively promote the application of AI and big data in the tourism industry, becoming important promoters of technological innovation [24]. On one hand, they guided the direction of technology application by issuing policy plans, providing financial support, and building infrastructure. China's Ministry of Culture and Tourism released the Action Plan for Smart Tourism Development (2022–2025) and provided special funds to support the construction of smart tourism platforms. On the other hand, government departments strengthened supervision over technology applications

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and became governors of technological innovation. With the prominence of issues such as data privacy and algorithmic bias, government departments have issued a series of regulatory policies to standardize enterprises' technology application behaviors. China's Data Security Law and Personal Information Protection Law require tourism enterprises to standardize data collection and use to protect user privacy[25]; the EU's GDPR imposes strict requirements on the cross-border flow and storage period of tourism data [10]; the United States has strengthened supervision over tourism enterprises' algorithms through the Algorithmic Fairness Act to prevent algorithmic discrimination.

In addition, government departments have promoted the construction of cross-departmental and cross-regional data sharing mechanisms, broken down data silos, and provided a data foundation for the application of big data technology [7] . For example, the EU launched the "European Tourism Data Sharing Platform" to promote the interconnection of tourism data among member states and drive the coordinated development of regional tourism.

4.4. Summary of the Overall Trend in the Evolution of Key Actors

As the analysis above shows, the tourism ecosystem has witnessed significant changes in key actors over the past five years.

Table 1. Summary of Key Stakeholders and Role Evolution

Subject type	Character before 2024	Character after 2024	Core Changes
AI investigator	Basic theory and technology developers	Basic research and scenario adaptation research	From General Technology Research and Development to Tourism Scene Special Technology Optimization
Big data researchers	Data processing technology developer	Researcher of Multi-modal Data Fusion and Intelligent Decision Making	From Data Processing Technology Research and Development to Data Value Mining and Application
OTA terrace	Information intermediary and product seller	technology platform provider, data producer and ecosystem enabler	From optimizing internal operations to empowering industrial ecosystems
Tech companies	Basic technology suppliers	A provider of customized solutions for the tourism industry	From General Technology Output to Scenario-based Solution Integration
Travel Service Provider	Passive users of technology	Technology active participant and independent developer	From External Technology to Internal Technology Driven Innovation
government sector	market regulator	Technological Innovation Promoter, Governance and Infrastructure Construction	From Passive Supervision to Active Promotion and Standardization

It can be seen that the role changes show the characteristics of platform, digital and intelligent, and gradually form the smart tourism ecology of technology, platform, government, user collaboration.

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5. Conclusion

This study conducts a systematic analysis of the application, evolution, and impact of artificial intelligence (AI) and big data in the tourism industry. AI and big data have not only transformed the production and dissemination of tourism information, but also changed tourists' behavioral patterns, enterprises' operational mechanisms, and the concepts and practices of destination management. The study clarifies how these two technologies evolved from early auxiliary digital tools to the core driving force of industry transformation, and profoundly reshaped the operating logic, value structure and governance system of the tourism economy.

In a word, artificial intelligence and big data, as the two core forces that promote the digital transformation of the tourism industry, have brought both structural opportunities and complex governance challenges to the industry. Technology is not just a neutral tool, but also a force that deeply affects the development mode of tourism and social value orientation. Future research should further explore the relationship between these two trends and sustainable tourism development, paying special attention to cross-cutting issues such as fairness, inclusiveness and environmental impact. Only under the premise of the coordinated development of technological innovation and institutional governance can the tourism industry achieve long-term healthy and high-quality innovation upgrading.

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