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[Jianzhong Shi](#)^{*}, Yujie Zhang, Yuying Xu

Posted Date: 27 December 2023

doi: 10.20944/preprints202312.1979.v1

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Article

Research on the Influence Mechanism of Digital Infrastructure Construction on the Digital Transformation of Tourism Enterprises Based on the "Broadband China" Policy

Jianzhong Shi *, Yujie Zhang and Yuying Xu

School of Management, Ocean University of China, Qingdao 266100, China; zhangyujie0128@163.com (Y.Z.); 21231211082@stu.ouc.edu.cn (Y.X.)

* Correspondence: shijianzhong@ouc.edu.cn; Tel.: +86-15253232509

Abstract: Digital infrastructure is the basic guarantee for digital transformation, it is of practical significance to discuss how to effectively use digital infrastructure construction to promote the digital transformation of tourism enterprises. This paper examines the impact of digital infrastructure construction on tourism enterprises based on the "Broadband China" policy as a quasi-natural experiment. A-share tourism listed enterprises from 2010 to 2021 are studied using the double difference method. Findings indicate that digital infrastructure construction positively and significantly influences the digital transformation of tourism enterprises, driven by digital leadership and innovation capabilities. State-owned, small-scale, and high-growth tourism enterprises benefit more from this transformation. The results suggested that the state should develop differentiated digital infrastructure plans based on the specific conditions of different tourism enterprises. Additionally, tourism enterprises should enhance digital leadership and innovation capabilities through strategic changes and digital applications to amplify the impact of digital infrastructure on their transformation.

Keywords: digital infrastructure construction; digital transformation; tourism enterprises; "Broadband China" policy; double difference method

1. Introduction

The establishment of digital infrastructure serves as the fundamental basis for the advancement of the digital economy. Launched in 2013, "Broadband China" is one of China's earliest policy documents on digital infrastructure construction, and its core purpose is to improve the level of China's digital infrastructure construction, which is an important part of digital infrastructure construction. Subsequent to the implementation of this policy, pilot cities have expedited the development of digital infrastructure, resulting in a notable enhancement of China's overall digital infrastructure construction. In 2020, the Chinese government released a significant document "Opinions on Deepening the 'Internet + Tourism' to Promote the High-quality Development of Tourism Enterprises", which underscored the imperative of enhancing the construction of tourism information infrastructure and advancing the utilization of digital technology and data components in tourism enterprises.

In recent years, affected by public health events, the development of tourism enterprises has slowed down or even stagnated, and their vulnerability has become prominent [1]. In the era of COVID-19 global outbreak and digital transformation, the application of digitalization in tourism and other fields has accelerated [2]. It is imperative that tourism enterprises undergo digital transformation in order to enhance resilience and improve the quality of products and services. As a result of collaboration between China Unicom and Tencent, a document indicating that tourism enterprises have requirements for digital infrastructure has been released. However, due to the high

cost and difficulty of 5G infrastructure, tourism enterprises face practical difficulties, such as not daring to transfer or not being able to transfer because of financial and technological constraints. A digital infrastructure is a prerequisite and an important guarantee for a successful digital transformation in the tourism sector. Therefore, an in-depth discussion of the impact mechanism of digital infrastructure construction on the digital transformation of tourism enterprises has practical significance for promoting the digital transformation of tourism enterprises and supporting their high-quality development.

According to the resource orchestration theory, enterprises can create new value and gain competitive advantages by dynamically managing their resources. And in order to achieve new value goals, it is necessary to combine capabilities and resources that are appropriate for the external environment [3,4]. In other words, sustainable competitive advantage comes from the combination of the enterprise's resources, innovation ability and managerial ability [4,5]. Using the upper-echelons theory, it is argued that managers are the main decision-makers in corporate behavior, and their leadership is essential for determining the direction of corporate development [6]. Moreover, the innovation theory suggests that technological change will enhance resource utilization efficiency through organizational innovation [7]. Digital transformation of tourism enterprises is a comprehensive and whole-process digital transformation. Thus, the continuous development of digital infrastructure construction can provide tourism enterprises with rich digital resources, and the application of digital infrastructure in tourism enterprises cannot be separated from its digital leadership and innovation capabilities. Therefore, to explore the extent to which digital leadership and innovation ability have a mediating effect on tourism enterprises' digital transformation, this paper selects digital leadership and innovation ability as intermediary variables. Considering the significant individual differences among tourism enterprises, it is difficult for the construction of digital infrastructure to have an inclusive impact. As a consequence, it is also worthwhile to explore the heterogeneity of tourism enterprises in terms of their property rights, scale, and growth.

Accordingly, this paper examines 418 samples collected from 38 A-share tourism enterprises listed in China between 2010 and 2021. Through the use of the "Broadband China" policy issued in 2013, the paper investigates the impact mechanism of digital infrastructure construction on the digital transformation of tourism enterprises by utilizing the double difference method. The research objectives include: (1)Take tourism enterprises as the research object, develop a theoretical framework for analyzing the effect of digital infrastructure construction on the digital transformation of tourism enterprises. (2)Select digital leadership and innovation ability as intermediary variables to explore the mechanism of the impact of digital infrastructure construction on the digital transformation of tourism enterprises, reveal the internal logic of digital infrastructure construction affecting the digital transformation of tourism enterprises. (3)Examine how the construction of digital infrastructure affects the digital transformation of a variety of property rights, scales, and growth tourism enterprises. (4)Propose relevant policy suggestions based on the empirical results regarding the impact of promoting digital infrastructure construction on the digital transformation of tourism enterprises at the government and enterprise levels.

2. Policy Background and Literature Review

2.1. Policy Background

China proposed the "Broadband China" policy in 2011 to address problems such as slow network speeds and unbalanced regional network development, and to speed up broadband construction. During 2013, the Chinese government formulated the "Broadband China" policy and implementation plan, with the goal of building a national digital infrastructure and narrowing the gap between Chinese and developed nations' digital infrastructure development. Throughout 2014, 2015, and 2016, it has set up 117 pilot cities under the "Broadband China" policy. As a pilot city, the city must have a solid foundation for broadband development, and upon selection, they must vigorously develop digital infrastructure, such as broadband, and achieve national leadership within three years of selection. At a meeting in 2022, the Chinese government emphasized that the next work center will

focus on advancing the breakthrough of key core technologies, especially the deployment of digital infrastructure construction in a moderately advanced manner. At present, the "Broadband China" policy has become an important reference for digital infrastructure construction [8], but it is likely that the "Broadband China" policy will result in differences in the level of digital infrastructure construction between pilot cities and non-pilot cities. This provides an excellent opportunity for a quasi-natural experiment to evaluate the construction of digital infrastructure in this paper.

2.2. Literature Review

2.2.1. Digital Infrastructure Construction

As a result of the new generation of technological revolution and industrial innovation, digital infrastructure includes 5G base stations, integrated circuits, and other hardware infrastructure, as well as a data center, operating systems and other software, developed by integrating, evolving, overlapping 5G, the Internet of Things, Big Data, cloud computing and other new generation digital technologies based on data and the Internet as the basis for production. Presently, most literature focuses on cities and industrial or manufacturing enterprises, exploring the causal relationship between digital infrastructure construction and economic effects, innovation effects, and industrial effects. For example, the use of digital infrastructure technology has been explored by some scholars to contribute to industrial innovation and economic benefits [9], whereas digital infrastructure has also been used to assess the development of the digital economy [10].

Currently, Chinese scholars are primarily concerned with the impacts of the digital infrastructure construction. Since empirical research is subject to endogenous problems, taking relevant national policies as quasi-natural experiments has become a common method for assessing the level of digital infrastructure construction, among which the "Broadband China" policy is the most prevalent discussion. For example, some scholars have discussed the impact of digital infrastructure construction on economic growth [11] and industrial upgrading [12] from the macro level. Furthermore, some scholars have examined the impact of digital infrastructure construction on enterprise total factor productivity [13], innovation [14], and transaction costs [15] from the micro level. It has been found that most literature focuses mainly on cities and industrial or manufacturing enterprises, examining the causal relationship between the construction of digital infrastructure and economic, innovation, industrial, and other effects of the "Broadband China" policy. However, there is a lack of research on the impact mechanism of digital infrastructure construction on tourism enterprises' digital transformation with tourism enterprises as the research object.

2.2.2. Digital Transformation of Tourism Enterprises

Several existing research studies examine the application scenarios and empowering effects of digital technology in tourism enterprises. It has been argued by Liu et al. that the digital transformation of tourism enterprises can be achieved by applying digital technology to the landscape genes of traditional villages and disseminating them [16]. Traditional villages can be exposed and recognized through digital application scenarios, which will result in increased tourism revenues and enhanced tourism value. Zhang et al. believe that the level of digitalization of tourism enterprises can be improved by improving the application of digital technology, including product digital innovation, digital process tracking, smart marketing layout, data chain value empowerment, etc. [17]. Additionally, some research results discuss the factors affecting tourism enterprises' digital transformation. A study conducted by Li et al. found that dynamic changes in tourism demand have a significant impact on digital transformations of tourism enterprises, and regional innovation environments and big data levels play a positive moderating role in this process [18]. Although existing literature has focused on the impact of digital technology and supply and demand changes on tourism enterprises' Digital transformation, few studies have examined how digital leadership and innovation ability impact tourism enterprises' digital transformation.

The review of literature reveals that, despite the fruitful results of current research on digital infrastructure construction and digital transformation of tourism enterprises, they are relatively

isolated, and few studies analyze the internal relationship between them. As a result, the possible theoretical contributions of this paper include: (1) Linking digital infrastructure construction to tourism enterprises' digital transformation, utilizing the "Broadband China" policy as a quasi-Natural experiment, and developing a theoretical framework for assessing the impact of digital infrastructure construction on tourism enterprises' digital transformation. (2) According to the upper-echelons theory and innovation theory, digital leadership and innovation ability are introduced as intermediary variables, and the indirect impact of digital infrastructure construction on the digital transformation of tourism enterprises through digital leadership and innovation ability is examined, revealing that digital infrastructure construction plays an integral role in the internal logic of the influence of digital transformation on tourism enterprises. (3) Identify the heterogeneous impact of digital infrastructure construction on the digital transformation of tourism enterprises from various perspectives, including property rights, scale, and growth, as well as enrich and develop theoretical research on digital transformation.

3. Theoretical Analysis and Research Hypothesis

In this paper, the impact mechanism of digital infrastructure construction on the digital transformation of tourism enterprises is examined from three perspectives: direct impact, indirect impact, and heterogeneous impact.

3.1. Direct Impact

In accordance with the resource orchestration theory, the digital transformation of tourism enterprises is not possible without the ability to integrate tourism resources into digital infrastructure. Digital infrastructure has established a bridge for the free circulation of data resources utilizing digital technology and with data as the primary factor of production. By improving the allocation efficiency of resource resources by tourism enterprises [19], the digital transformation of tourism enterprises can be positively impacted.

On the one hand, a digital infrastructure can facilitate the acquisition and flow of data resources, serve as a bridge to ensure free data circulation, and assist enterprises in obtaining, processing, and transmitting information [15]. First, as a comprehensive enterprise, tourism enterprises have a natural advantage when it comes to obtaining data related to the needs of tourists. By using big data technology, it is possible to extract multifaceted and high-quality data left by tourists on the Internet and then link it with offline data of hotels, scenic spots, travel agencies, etc., effectively integrating data sources. Second, by building digital infrastructure, traditional resources no longer have to be constrained by time and space. Data resources can be disseminated through digital technology, and tourism enterprises can access rich digital resources for their digital transformation. On the other hand, through digital technology applications, enterprise production efficiency can be improved, information asymmetry can be alleviated, and enterprise costs can be reduced, thereby improving the efficiency of resource allocation [20]. First, the smooth flow of data within tourism enterprises can enhance the operational efficiency of a variety of departments within the organization. Meanwhile, through the data platform, tourism enterprises can interact with other enterprises to improve the situation of data islands and improve data sharing. Thus, this facilitates the development of tourism enterprises in a coordinated manner, helps to create a digital ecosystem, and improves the efficiency of resource allocation within and among tourism enterprises. Second, the needs of tourists are increasingly individualized and differentiated at present, and group tours are declining, while self-driving tours and customized tours are increasing. In order to achieve the balance between supply and demand in tourism enterprises, it is necessary to utilize digital technology and digital platforms to understand tourists' needs and form consumer portraits. In this way, tourism enterprises can effectively link supply and demand, which will enable them to provide personalized services to tourists and respond to changes in tourism demand. In addition, improving the efficiency of transactions between tourism supply and demand and resource allocation [21], as well as improving the ability of tourism enterprises to integrate resources can be achieved. Therefore, this paper assumes that:

Hypothesis 1 (H₁): *The construction of digital infrastructure is conducive to the digital transformation of tourism enterprises.*

3.2. Indirect Impact

3.2.1. Digital Leadership

The concept of digital leadership refers to the ability of managers to adapt and change the attitude, thinking, behaviour and performance of individuals, teams and organizations in a new environment created by the advancement of digital technology [22]. Roman et al. believes that digital leadership mainly includes digital communication, social, change, team, technology and trust capabilities [23]. Larjovuori et al. found that digital leadership primarily involves strategic vision and actions, cultural change leadership, empowerment, and the development of leadership networks [24]. This article believes that there are three main aspects to digital leadership: one is the ability to recognize the digital environment, the other is the ability to deploy digital strategies, and the third is the ability to implement digital strategies.

The indirect impact of digital infrastructure construction on the digital transformation of tourism enterprises through digital leadership is mainly reflected in the following three aspects: First, the development of digital infrastructure construction has changed the operating environment of tourism enterprises [25]. By perceiving digital technology changes and utilizing digital infrastructure to obtain massive data and discover the correlation of things in a timely manner, improve the internal control process of enterprises and improve decision-making efficiency are the basic digital leadership that managers should possess. Second, according to the upper-echelons theory, tourism enterprises cannot promote digital transformation unless their managers have digital leadership [26]. It is imperative for managers to create layouts from a strategic perspective when developing digital infrastructure for the digital transformation of tourism businesses, and adapt to the digital environment by transforming values, business processes, communication methods, working methods, and employee relations [23]. Third, digital strategy deployment requires the implementation of business plans to achieve the desired performance. In short, the digital transformation of tourism enterprises can be truly promoted only if the managers realize the importance of the application of digital infrastructure and initiate top-down changes, including strategic planning and implementation. Therefore, this paper assumes that:

Hypothesis 2 (H₂): *Digital infrastructure construction promotes the digital transformation of tourism enterprises through digital leadership.*

3.2.2. Innovation Ability

On one hand, in accordance with the theory of information resources [27,28] and the theory of enterprise innovation [29,30], the construction of digital infrastructure facilitates the identification and provision of innovation resources by tourism enterprises, as well as the promotion of knowledge spillover and corporate innovation. First, the development of digital infrastructure provides tourism enterprises with innovative resources, such as data and digital technology. By utilizing digital platforms, data centers, artificial intelligence, and other technologies, tourism enterprises have softened the market boundaries between traditional tourism enterprises and have overcome the barriers imposed by long-distance transportation. As a consequence, the flow, matching, transfer, and overflow of data throughout the entire industry chain is expedited, close communications and win-win collaboration between upstream and downstream tourism enterprises is promoted, and innovation costs are reduced [14]. Second, with the development of digital infrastructure, tourism supply and demand are now intertwined through digital platforms, which has prompted tourism enterprises to continuously innovate products and formats to meet the needs of the tourism market. Third, as a result of the digital infrastructure construction, tourism enterprises will be forced to compete for innovation. It is expected that tourism enterprises will use digital infrastructure to reduce the margin cost of innovation in order to improve production efficiency, reduce costs, and increase

profits. On the other hand, the innovation theory suggests that improving innovation ability will facilitate the digital transformation of an enterprise. As an enterprise's innovation ability improves, technical resources are accumulated and the element reserve of enterprise digital transformation is enhanced. At the same time, improving innovation ability reduces communication barriers between enterprises, facilitates mutual learning, and promotes deeper digitalization [19]. First, in terms of products, improving innovation ability is conducive to tourism enterprises utilizing big data, artificial intelligence, and other technologies in order to analyze changes in tourist demand and continuously innovate tourism products. As a result of continuous improvement, tourism products with traditional Chinese characteristics are more attractive to tourists, such as traveling to Xishuangbanna, Yunnan to experience the customs of the Dai People, and traveling to Tibet to experience the pure Tibetan culture, all of which have become popular tourism options. Second, from a marketing perspective, the improvement of innovation capabilities has resulted in the expansion of digital marketing methods for tourism enterprises, including precision marketing and content marketing, thus reducing marketing costs and strengthening publicity effects to promote their digital transformation. Therefore, this paper assumes that:

Hypothesis 3 (H₃): *The construction of digital infrastructure promotes the digital transformation of tourism enterprises by improving innovation capabilities.*

3.3. Heterogeneity Impact Analysis

Tourism enterprises have different characteristics in terms of property rights, scale, and growth. There may be an asymmetrical impact of digital infrastructure construction on the digital transformation of different tourism enterprises.

In term of the nature of property rights, tourism enterprises are divided into state-owned enterprises and non-state-owned enterprises in China. The unique economic system of China requires state-owned enterprises to formulate more social goals and be more resource-inclined, thus forming a unique management system. According to Wang et al., digital finance promotes the digital transformation of state-owned enterprises in a more significant way [31]. The possible explanation is that state-owned enterprises are more likely to have advantages in terms of scale, scientific research, and policies. The government has issued a number of policies pertaining to digital infrastructure construction to support industry development and digital transformation, including the "Broadband China" policy. However, state-owned tourism enterprises are more aware of the country's determination and strength in building digital infrastructure compared to non-state-owned enterprises. As a result, they will be better able to fully understand and implement the government's policies regarding the construction of digital infrastructure, and increase the speed and investment of digital transformation by utilizing policy preferences and resource preferences.

In term of the size, tourism enterprises can be divided into large-scale enterprises and small-scale enterprises. Generally, large-scale enterprises are characterized by large organizations and abundant resources, whereas small-scale enterprises tend to be more flexible and adaptable. Sun et al. found that the creation of digital infrastructure can significantly alleviate the financing constraints of small-scale enterprises, since large-scale enterprises have the advantage of utilizing their own advantages in making changes, while small-scale enterprises must rely more on improving the external environment to facilitate their changes [32]. The construction of digital infrastructure can alleviate the asymmetry of information and create a productive digital environment. The empirical study of Qiu indicates that digital infrastructure construction has a significant impact on the digital transformation of small-scale enterprises, primarily due to the fact that small-scale enterprises have low replacement costs and have a stronger sense of innovation vitality and transformation motivation [33]. Existing Research indicates that in the digital age, small-scale enterprises cannot compete with large-scale enterprises in terms of talent, systems, and resources. The small-scale tourism enterprises, however, are more flexible, are able to adapt to market changes more quickly, and are able to utilize digital technology to promote digital transformation by conducting product research and

development, implementing technological innovations, reforming management, and implementing smart marketing.

In term of growth levels, tourism enterprises can be divided into high-growth enterprises and low-growth enterprises. Investing in the digital transformation of tourism enterprises is a high-risk decision that requires substantial resources both in terms of human resources and capital. Tourism enterprises will tend to increase their investments in digital transformation when they are able to obtain more financial support. In the digital age, high-growth tourism enterprises generally possess greater development potential and investment opportunities as well as good viability and development prospects. High-growth tourism enterprises tend to invest more in digital transformation when faced with the layout and improvement of digital infrastructure, as the application of a new generation of digital technology can enhance enterprise value. Based on the above analysis, this paper assumes that:

Hypothesis 4a (H_{4a}): For tourism enterprises with different property rights, the construction of digital infrastructure has a more significant effect on the digital transformation of state-owned tourism enterprises.

Hypothesis 4b (H_{4b}): For tourism enterprises of different scales, digital infrastructure construction has a more significant effect on the digital transformation of small-scale tourism enterprises.

Hypothesis 4c (H_{4c}): For tourism enterprises with different growth levels, digital infrastructure construction has a more significant effect on the digital transformation of high-growth tourism enterprises.

On the basis of the above theoretical analysis, the research hypothesis diagram for this paper, shown in Figure 1, is derived.

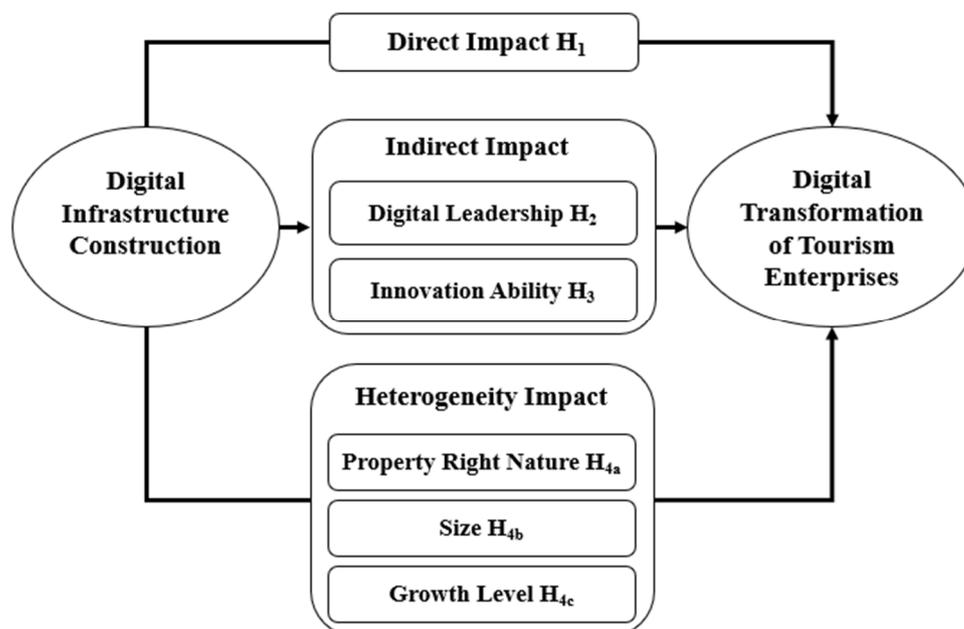


Figure 1. Research Hypothesis Diagram.

4. Research Design

4.1. Model Setting

For the purpose of avoiding endogenous problems in the impact of digital infrastructure construction on the digital transformation of tourism enterprises, this paper utilizes the "Broadband China" policy as the exogenous factor. Depending on whether the tourism enterprise is located in a "Broadband China" pilot city, the tourism enterprise is classified. An enterprise's location is

considered an experimental group if it is a "Broadband China" pilot city, otherwise it is considered a control group. At the same time, the "Broadband China" policy is used in this paper as a quasi-natural experiment since the pilot cities are divided into three batches based on the year differences. Using the multi period double difference method, a panel fixed effect model is constructed to evaluate the impact of digital infrastructure construction on the digital transformation of tourism enterprises. The specific benchmark model is as follows:

$$Dig_{it} = \beta_0 + \beta_1 DID_{it} + \sum Controls_{it} + \vartheta_i + \mu_t + \varepsilon_{it} \quad (1)$$

In order to verify whether the construction of digital infrastructure can provide power and support for Digital transformation by strengthening digital leadership and innovation capabilities, the following model is constructed using the three-step mediating effect method proposed by Wen et al. (2004).

$$(EL\backslash IA)_{it} = c_0 + c_1 DID_{it} + \sum Controls_{it} + \vartheta_i + \mu_t + \varepsilon_{it} \quad (2)$$

$$Dig_{it} = \gamma_0 + \gamma_1 DID_{it} + \gamma_2 (EL\backslash IA)_{it} + \sum Controls_{it} + \vartheta_i + \mu_t + \varepsilon_{it} \quad (3)$$

Among them, i represents the tourism enterprise and t represents the year; the explanatory variable is Dig_{it} the level of digital transformation of the DID_{it} tourism enterprise i in the period, in order to prevent the pseudo regression caused by too scattered data, the natural logarithm is taken; the core explanatory variable t is the level of digital infrastructure construction, through the "broadband China" policy is a quasi-natural experimental representation. When the city where t the tourism enterprise is registered i has been identified as the "Broadband China" pilot city during the period, it is the experimental group, with a DID_{it} value of 1, otherwise it takes a value of 0; $Controls_{it}$ is a control variable; ϑ_i and μ_t are the individual fixed effect and time fixed effect, respectively; β_0 is a constant term; ε_{it} is a random error term.

4.2. Variable Description and Data Source

4.2.1. The Explained Variable

The level of digital transformation of tourism enterprises. Based on the text analysis method, the frequency of words related to digital transformation in annual reports of tourism listed enterprises is used as the quantitative basis. First, build a dictionary of characteristic words for the digital transformation of tourism enterprises, and divide the digitalization of tourism enterprises into two parts. One part represents digital technology, including underlying technology, rapidly developing artificial intelligence technology, cloud computing technology, Internet of Things technology, blockchain Technology, big data technology and 5G technology, and the other part represents the application level of digital technology, including changes in business models, management and business in the process of digital transformation of tourism enterprises. Second, use Python software to download all annual reports of tourism listed enterprises from 2010 to 2021 in batches, then use Java PDFbox tool to convert PDF format into txt format to extract text content, and use Jieba function to segment the txt text. Finally, use Python for word frequency statistics, then search for the word frequency of keywords in the established feature word dictionary in the annual report, and take the logarithm of the sum of the word frequencies of all keywords as an indicator to measure the level of digital transformation of tourism enterprises.

4.2.2. Core Explanatory Variable

The level of digital infrastructure construction. Based on the quasi-natural experiment of the "Broadband China" policy, the construction of digital infrastructure is measured by setting dummy variables. From 2014 to 2016, China has successively announced three batches of "Broadband China" pilot cities. Assign a value based on whether the registered location of the tourism enterprise is a pilot city for "Broadband China". Set it to 1 if the location of the tourism enterprise is a pilot city for "Broadband China" in the current year and after. Otherwise, set it to 0.

4.2.3. Intermediary Variables

(1) Digital leadership (*EL*): its core requirement is that management must be open to change and have a forward-looking perspective. Generally, management philosophy of listed enterprise managers will be reflected in the "Outlook for the future development of the enterprise" section of the annual report, which includes a detailed analysis of the enterprise's development trends, the formulation of strategic core development ideas, and a detailed outline of future business strategies. Managers' ability to understand the digital environment and implement digital transformation can be clearly demonstrated by this analysis. Therefore, this paper divides the measurement of digital leadership into three aspects: digital environmental cognition, digital strategic layout, and digital plan implementation. Based on all the annual reports of listed tourism enterprises from 2010 to 2021, manually screen the "Prospect of the Enterprises' Future Development" section and find the above three aspects. If any aspect of the environment, strategy, and business plan in the year's report involves digitization-related content, the value *EL* is 1. If there is any digitalization-related content in any two aspects, the value *EL* is 2. If all three aspects reflect digitalization, the value *EL* is 3. And taking into account that the future development prospects of tourism enterprises are a requirement for digital transformation in the next year, the level of digital leadership will be lagged behind for a period to examine its intermediary role.

(2) Innovation ability (*IA*): the development of economy is driven by intangible assets, which can be combined with other assets to create high profits and competitive advantages. Here, intangible assets refer to the technological innovation of enterprises. Taking the logarithm of the intangible assets as the measurement result, this paper uses intangible assets to represent.

4.2.4. Control Variables

The control variables in this paper include enterprise size (*size*), asset-liability ratio (*lev*), profitability (*roa*), cash flow level (*cash*), enterprise age (*age*), board size (*board*), fixed asset ratio (*fixasset*), internal source financing (*innerfinance*), proportion of independent directors (*mshare*), and management compensation (*compen*). The main variables are defined in Table 1.

Table 1. Main variable definition.

Variable Class	Variable Name	Variable Symbol	Variable Calculation
Explained variable	The degree of digital transformation of tourism enterprises	<i>Digit</i>	The total word frequency of the digital transformation of listed tourism companies, taking the logarithm
Core explanatory variable	Digital infrastructure construction	<i>DID_{it}</i>	1 for the "Broadband China" pilot city in that year and later, otherwise 0
Control variable	Enterprise size	<i>size</i>	Total assets, logarithm
	Assets and liabilities	<i>lev</i>	Total liabilities/total assets
	Profitability	<i>roa</i>	Net profit/total assets
	Cash flow level	<i>cash</i>	Net cash flow/total assets
	Business age	<i>age</i>	Enterprise age + 1, take the logarithm
	Board size	<i>board</i>	Number of board members, logarithm
	Fixed Assets Ratio	<i>fixasset</i>	Net fixed assets/total assets
	Internal source financing	<i>innerfinance</i>	Net profit/net fixed assets
	Proportion of independent directors	<i>mshare</i>	Number of Independent Directors/Number of Directors

	Management compensation	<i>compen</i>	Total remuneration of directors, supervisors and executives/main business income
Mediator variable	Digital Leadership for Tourism Business Managers	<i>EL</i>	In the annual report, if the manager's environmental cognition, strategic layout, and business plan are involved in any aspect of digitalization, it is 1, if two aspects are involved in digitalization, it is 2, and if it is involved in three aspects, it is 3
	Innovation ability of tourism enterprises	<i>IA</i>	Intangible assets, logarithm

Note: The annual report data of listed tourism enterprises comes from Juchao Information Network, the list of "Broadband China" pilot cities comes from the official website of the Ministry of Industry and Information Technology, and other enterprise-level data comes from the Guotaian database (CSMAR database).

Since the "Broadband China" pilot policy is used as a quasi-natural experiment to measure the level of digital infrastructure construction, considering that the "Broadband China" pilot policy began in 2014, combined with the listing time of listed tourism enterprises, and eliminating the outliers of ST and *ST, this paper selects 418 samples of 38 A-share tourism listed enterprises from 2010 to 2021 as research samples.

4.3. Parallel Trend Test

Using the double difference model requires that both the experimental and control groups meet the parallel trend assumption. To put it another way, before the government issues its "Broadband China" policy, the digital level of tourism enterprises in the experimental group and the control group should show no significant difference, so that the two trends should be parallel. Since the pilot cities of "Broadband China" were promoted in three batches over three years, and based on Jacobson's research [34], this paper chooses the event analysis method for parallel trend testing. As indicated by the parallel trend results, there is no significant difference between the experimental group and the control group in the digital transformation of tourism enterprises when the "Broadband China" policy is not implemented in the place where the tourism enterprise is registered, which satisfies the parallel trend test.

5. Empirical Results and Analysis

5.1. Direct Impact

5.1.1. Benchmark Regression

In order to verify the impact of digital infrastructure construction on the digital transformation of tourism enterprises, the multi period double difference model is used to test equation (1), and the results are shown in Table 2. Column (1) is the result of not adding control variables and no fixed effects. Only by regression between the level of digital infrastructure construction and the level of Digital transformation of tourism enterprises, it is found that the regression coefficient is positive and significant at the level of 1%. Accordingly, the construction of digital infrastructure can significantly contribute to the Digital Transformation of tourism businesses. Column (2) is the result of adding other control variables that affect the Digital transformation of tourism enterprises on the basis of column (1). The estimated coefficient is still positively correlated at the significance level of 1%. Due to the booming development of the digital economy in recent years and the fact that various tourism enterprises are now participating in the digital wave, the digital level of tourism enterprises will continue to improve as time goes on. Therefore, this paper eliminates the estimation coefficient bias caused by time changes by controlling time. Column (3) adds a fixed time effect on the basis of

column (2) to control time. The results show that the construction of digital infrastructure promotes the Digital transformation of tourism enterprises at a significant level of 10%. Simultaneously, considering that each tourism enterprise has differences, this paper obtained the results in column (4) by controlling for the fixed effects of enterprises in the above model, with a regression coefficient of 0.281 and significant at the 5% level. It is evident from this that the construction of digital infrastructure has contributed to the digital transformation of tourism enterprises in the experimental group by 28.1% on average when other conditions are constant. Therefore, the digital infrastructure construction association may be able to promote the digital transformation of tourism enterprises, which confirms hypothesis H₁.

Table 2. Benchmark regression results.

Variables	(1) <i>Dig_{it}</i>	(2) <i>Dig_{it}</i>	(3) <i>Dig_{it}</i>	(4) <i>Dig_{it}</i>
<i>DID_{it}</i>	1.225*** (0.0840)	0.532*** (0.0987)	0.244* (0.130)	0.281** (0.139)
<i>size</i>		0.326*** (0.0588)	0.244*** (0.0599)	0.335*** (0.0898)
<i>lev</i>		-0.774*** (0.228)	-0.640*** (0.222)	-0.659*** (0.236)
<i>roa</i>		-0.0590 (0.646)	1.228* (0.658)	1.323** (0.672)
<i>cash</i>		0.0331 (0.525)	0.330 (0.500)	0.211 (0.507)
<i>age</i>		0.726*** (0.123)	0.106 (0.149)	0.140 (0.195)
<i>board</i>		0.568** (0.263)	0.649** (0.252)	0.705*** (0.265)
<i>fixasset</i>		-1.176*** (0.263)	-0.803*** (0.260)	-0.622** (0.296)
<i>innerfinance</i>		0.000103 (0.000796)	-0.000499 (0.000769)	-0.000577 (0.000779)
<i>mshare</i>		0.00555 (0.00728)	0.00324 (0.00696)	0.00439 (0.00728)
<i>compen</i>		12.35*** (3.120)	11.24*** (3.017)	12.34*** (3.231)
Constant	1.913*** (0.116)	-7.817*** (1.348)	-5.424*** (1.384)	-7.711*** (1.956)
<i>Enterprisefixed</i>	NO	NO	NO	YES
<i>Yearfixed</i>	NO	NO	YES	YES
Observations	444	444	444	444
R ²	0.352	0.547	0.591	0.592

Note: *, **, *** respectively represent significant levels of 10%, 5%, and 1%; Standard error in parentheses.

5.1.2. Robustness Check

Even though control variables are added to the benchmark regression, and time trends and differences between enterprises are controlled, the regression coefficient may still be influenced by unobservable factors. For the purpose of excluding other factors that may influence the placebo effect, a new experimental group was formed by randomly selecting pilot cities. First, randomly set the pilot cities. Due to the fact that 29 tourism enterprises are registered in the pilot cities of Broadband China, 29 cities are randomly selected to participate in the experiment. The implementation time of the policy is then randomly set, and so a "perjury" policy dummy variable is constructed, and the double difference model regression is re-run with the dummy data. Through 500 times of random sampling, the results are shown in Figure 2. The solid-line curve is the Kernel density estimation of coefficient, and the scatter points are the distribution of P value coefficient. It can be seen from Figure 2 that the mean values of the estimated kernel density values after the "false evidence strategy" test are close to 0 and obey the normal distribution, and most of the P values are greater than 0.1. By using placebo testing, unobservable factors were excluded from the regression results, resulting in more reliable benchmark regression results in this paper.

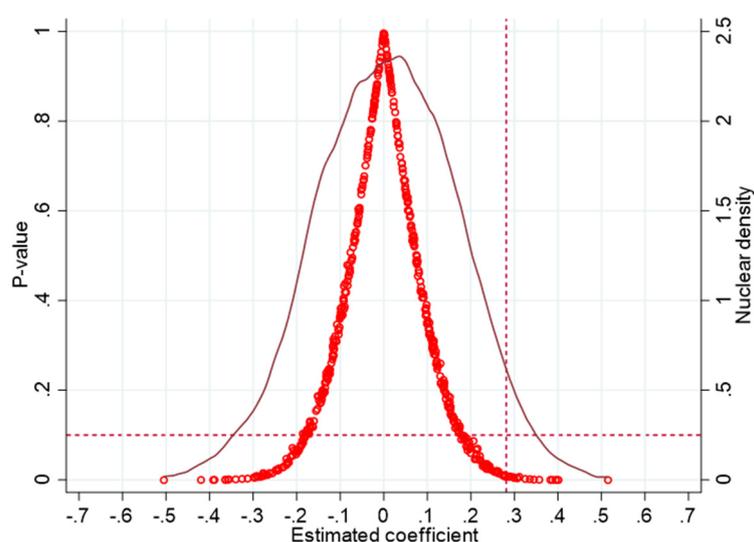


Figure 2. Placebo Test with Control Variable.

5.2. Direct Impact

5.2.1. Examination of the Indirect Influence Mechanism of Digital Leadership

The test results of the impact mechanism of digital leadership are shown in Table 3. Column (1) of Table 3 is the baseline regression result, indicating that digital infrastructure construction will promote the digital transformation of tourism enterprises. And column (2) is the impact of digital infrastructure construction on digital leadership. At a 1% level, the results indicate that the construction of digital infrastructure significantly increases the level of digital leadership among tourism enterprise managers. Column (3) is the test of the indirect impact of digital leadership. In conclusion, the results indicate that digital leadership of tourism enterprise managers dramatically facilitates digital transformation at the level of 1%, indicating the mediating role of digital leadership. Thus, hypothesis H₂ is supported. Moreover, this confirms that the digital transformation of tourism enterprises cannot be accomplished overnight, but must be undertaken as a top-down process, which cannot be dissociated from the top-level management design. It is essential for managers to recognize the need for digital transformation and to propose corresponding development strategies and business plans. For example, The OCT strategically positioned itself as a leader and practice benchmark in the digital transformation of the tourism industry in 2021. Its business planning

strategy includes improving operational capabilities and product innovation, as well as adhering to a platform thinking approach to link ecological resources. Also, this has served as a model for other tourism enterprises wishing to transform their businesses digitally.

Table 3. Test results of the impact mechanism of *EL*.

Variables	(1) <i>Dig_{it}</i>	(2) <i>EL</i>	(3) <i>Dig_{it}</i>
<i>DID_{it}</i>	0.281** (0.139)	0.624*** (0.156)	0.159 (0.138)
<i>EL</i>			0.196*** (0.0442)
<i>Controls</i>	YES	YES	YES
<i>Constant</i>	-7.711*** (1.956)	-8.250*** (2.205)	-6.090*** (1.945)
<i>Enterprisefixed</i>	YES	YES	YES
<i>Yearfixed</i>	YES	YES	YES
<i>Observations</i>	444	444	444
<i>R²</i>	0.592	0.389	0.612
<i>Number of ID</i>	38	38	38

Note: *, **, *** respectively represent significant levels of 10%, 5%, and 1%; Standard error in parentheses.

5.2.2. Inspection of the Indirect Influence Mechanism of Innovation Ability

The test results of the impact mechanism of innovation ability are shown in Table 4. Column (1) of Table 4 is the benchmark regression result, and column (2) tests the impact of digital infrastructure construction on innovation ability. In the study, the coefficient of digital infrastructure construction was found to be positive at the 1% significance level, which indicates that the construction of digital infrastructure has had a significant impact on tourism enterprises' capacity to innovate. Column (3) verifies the indirect impact of innovation ability. It can be seen that the innovation ability of tourism enterprises promotes the digital transformation of enterprises at a significance level of 5%. When the intermediary variable of innovation capability of tourism enterprises is added, the construction of digital infrastructure still has a significant impact on the Digital Transformation of tourism enterprises, demonstrating the presence of a mediating effect on the Digital Transformation of tourism enterprises, thereby verifying hypothesis H₃. In part, this is due to the construction of digital infrastructure that has led to a rapid diffusion and application of digital technology in tourism enterprises, thereby facilitating the mobility of data, information, and resources. Due to this, it has changed the original mode of operation and management, innovated business processes, encouraged product innovation, service innovation, and marketing innovation among tourism enterprises, and ultimately promoted the digital transformation of tourism enterprises.

Table 4. Test results of the impact mechanism of *IA*.

Variables	(1) <i>Dig_{it}</i>	(2) <i>IA</i>	(3) <i>Dig_{it}</i>
<i>DID_{it}</i>	0.281** (0.139)	0.502*** (0.184)	0.251* (0.139)
<i>IA</i>			0.0864** (0.0374)
<i>Controls</i>	YES	YES	YES
<i>Constant</i>	-7.711***	-13.14***	-6.148***

	(1.956)	(2.368)	(2.060)
<i>Enterprisefixed</i>	YES	YES	YES
<i>Yearfixed</i>	YES	YES	YES
<i>Observations</i>	444	455	444
<i>R²</i>	0.592	0.589	0.598
<i>Number of ID</i>	38	38	38

Note: *, **, *** respectively represent significant levels of 10%, 5%, and 1%; Standard error in parentheses.

5.3. Heterogeneity Test

5.3.1. Heterogeneity Test of the Nature of Property Rights

Columns (1) and (2) of Table 5 examine the impact of digital infrastructure construction by grouping tourism enterprises according to different property rights. Results indicate that the promotion effect of digital infrastructure construction on state-owned tourism enterprises is significant at the 1% level, but not on non-state-owned tourism enterprises. Accordingly, digital infrastructure construction has heterogeneity in terms of tourism enterprises' property rights, proving Hypothesis H_{4a}. Possibly, this is due to the fact that state-owned tourism enterprises are closely related to responding to the national call and following the national strategic plan to promote digital transformation.

5.3.2. Heterogeneity Test of Size

This paper divides the sample into large-scale and small-scale enterprises based on the median size of the enterprise. The results of Column (3) and Column (4) in Table 5 show that construction of digital infrastructure promotes digital transformation of small-scale tourism enterprises at a significance level of 1%, but does not significantly enhance large-scale tourism enterprises. It reflects the heterogeneity of digital infrastructure construction on tourism enterprises' digital transformation in terms of enterprise scale, and verifies the hypothesis H_{4b}. This may be due to the fact that large-scale tourism enterprises are already at the peak of their competitiveness, and their businesses, brands, personnel, and other aspects are already in a stable state. However, small-scale tourism enterprises are more likely to leverage the advantages of "It's easier for a small boat to change its course" and adapt to the trend of digital development. Due to their flexibility, they are able to restructure their organizational structure, adjust personnel, and reengineer business processes in order to enhance their competitiveness.

5.3.3. Heterogeneity Test of Growth Levels

The growth of enterprises mainly reflects their ability to continuously increase value. This paper chooses Tobin's Q value to measure the growth of tourism enterprises. According to the median of Tobin's Q value, tourism enterprises can be divided into high-growth enterprises and low-growth enterprises. Columns (5) and (6) of Table 5 show the impact of digital infrastructure construction on Digital transformation of tourism enterprises with different growth levels. According to the results, digital infrastructure construction promotes digital transformation at a significant level of 5% for high-growth tourism enterprises, but does not significantly promote digital transformation for low-growth tourism enterprises. Consequently, it confirms the hypothesis H_{4c} by showing that the construction of digital infrastructure affects tourism enterprises with different levels of growth differently. This is mainly because high-growth tourism enterprises have the opportunity to become more recognized and more invested within the market, and may be able to utilize sufficient funds in order to actively implement digital transformation in the face of the emergence of a digital infrastructure.

Table 5. Heterogeneity Test Results.

	(1)	(2)	(3)	(4)	(5)	(6)
	SOE	non SOE	Small-scale	Large-scale	High-growth	Low-growth
Variables	<i>Dig_{it}</i>	<i>Dig_{it}</i>	<i>Dig_{it}</i>	<i>Dig_{it}</i>	<i>Dig_{it}</i>	<i>Dig_{it}</i>
<i>DID_{it}</i>	0.460*** (0.154)	-0.234 (0.302)	0.659*** (0.193)	0.379 (0.370)	0.442** (0.198)	0.233 (0.266)
Controls	YES	YES	YES	YES	YES	YES
Constant	-5.769* (2.959)	3.338 (4.048)	-17.18*** (3.985)	-0.0684 (3.636)	-6.842** (2.996)	-9.988*** (3.414)
<i>Enterprisefixed</i>	YES	YES	YES	YES	yes	YES
<i>Yearfixed</i>	YES	YES	YES	YES	YES	YES
Observations	326	118	216	228	218	226
R ²	0.596	0.741	0.623	0.514	0.582	0.564

Note: *, **, *** respectively represent significant levels of 10%, 5%, and 1%; Standard error in parentheses.

6. Research Conclusions and Policy Recommendations

6.1. Research Conclusion

Based on the resource orchestration theory, upper-echelons theory and the innovation theory, this paper establishes a theoretical framework for the impact mechanism of digital infrastructure construction on the digital transformation of tourism enterprises. And this paper evaluates A-share tourism enterprises listed between 2010 and 2021 based on a literature review and theoretical analysis, uses the "Broadband China" policy as a quasi-natural experiment, and employs the multiperiod double difference method to demonstrate the impact of digital infrastructure construction on the digital transformation of tourism enterprises. The main conclusions are as follows:

First, the construction of digital infrastructure has a significant positive impact on the digital transformation of tourism enterprises. Even after the placebo test, the benchmark regression results continue to be valid, demonstrating that the promotion of digital infrastructure construction contributes significantly to the digital transformation of tourism enterprises. Second, the digital infrastructure construction indirectly affects the digital transformation of tourism enterprises by improving digital leadership and innovation abilities. On the one hand, the support of tourism enterprise managers is essential to the successful implementation of digital transformation. Managers of tourism enterprises have gained a deeper understanding of the external digital environment through the digital infrastructure construction, have actively engaged in digital strategic planning, and have finally implemented a digital strategy that promotes and realizes the digital transformation of tourism enterprises. On the other hand, the digital infrastructure construction will also enhance the innovation ability of tourism enterprises, and they will be able to innovate in a variety of areas such as technology application, product research and development, market updates, marketing innovation and management innovation, thus providing the driving force for digital transformation of tourism enterprises. Third, the study on heterogeneity has found that digital infrastructure construction has different impacts on the digital transformation of tourism enterprises with different characteristics, and has contributed significantly to the digital transformation of state-owned, small-scale, and high-growth tourism enterprises.

6.2. Policy Recommendations

Based on the conclusions of this paper, the following suggestions are proposed:

First and foremost, at the national level, the digital infrastructure construction needs to be further improved. Digital infrastructure must be vigorously built and improved, new generation digital technologies such as 5G, cloud computing, blockchain, big data need to be laid out and implemented, a wide variety of digital application scenarios should be promoted for tourism enterprises, and the driving force behind their digital transformation must be enhanced. Second, differentiated digital infrastructure plans must be introduced. Digital infrastructure layouts should be precisely matched to solve the problems of various enterprises, and digital infrastructure construction should be dynamically planned in order to enhance the effectiveness and influence of digital infrastructure construction and application. For example, implement policy guidance based on the actual situation of non-state-owned tourism enterprises, strengthen the concept of digitalization of non-state-owned tourism enterprises, and stimulate non-state-owned tourism enterprises to make full use of digital infrastructure for multi-faceted digital transformation.

At the enterprise level, the first step is to enhance the digital leadership of tourism enterprise managers. To obtain a competitive advantage in the era of digital economy, tourism enterprises must transform their businesses digitally, and strengthening digital leadership is the prerequisite for promoting the digital transfer of tourism. On the one hand, to ensure effective implementation of relevant digital business plans, tourism enterprises can hire positions such as Chief Data Officers and Chief Technology Officers who can provide professional technical knowledge. On the other hand, comprehensive digital leadership can also be strengthened from various aspects such as digital communication, digital socialization, digital transformation, digital teams, and digital trust. Secondly, improve the innovation capabilities of tourism enterprises. The full investment in digital infrastructure of the country has resulted in a digital dividend for tourism enterprises, which should be achieved by utilizing technology application, changing business models, optimizing business processes, etc., to increase innovation and achieve digital transformation.

The research object of this article is listed tourism enterprises, which are limited by the sample size, making it difficult to reflect the actual situation of tourism enterprises with weak economic strength and not listed on the market. In view of this deficiency, in-depth research can be conducted through questionnaires or case studies in the future. In addition, the internal and external environment will also have an impact on the digital transformation of tourism enterprises. Due to the lack of data, this paper mainly considers the influencing factors at the enterprise level, and does not introduce the influencing factors at the city level, such as the degree of openness, urbanization rate, foreign investment, into the benchmark model. However, the follow-up research on how factors at the city level affect the digital transformation of tourism enterprises is also worthy of in-depth discussion.

Author Contributions: Conceptualization, J.S., Y.Z. and Y.X.; methodology, J.S., Y.Z. and Y.X.; investigation, J.S., Y.Z. and Y.X.; resources J.S., Y.Z. and Y.X.; writing—original draft preparation, J.S. and Y.Z.; writing—review and editing, J.S. and Y.X.; supervision, J.S.; project administration, J.S.; funding acquisition, J.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by National Social Science Fund of China (Grant No. 22BJY253).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data available in a publicly accessible repository.

Conflicts of Interest: The authors declare no conflict of interest.

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