# Spatio-temporal Evolution and Obstacle Factors of the Matching Degree Between New Quality Productive Forces and High-quality Tourism Development in Chinese Provinces (Postprint)

**Authors:** Lu Yayan, I' m sorry, but the input text "封甜" does not contain any ···tags or academic content to translate according to your specific instructions. Please provide the source text containing the paragraph tags and scientific content you wish to have translated., Yang Zhaoping, Han Fang, Jia Yingying

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## Abstract

The integrated development of new quality productive forces and high-quality tourism is not only an important lever for promoting high-quality economic development but also a key measure for enhancing national competitiveness and promoting regional coordination. Based on the essential requirements of new quality productive forces and high-quality tourism development, and after clarifying the logic and mechanism of their adaptation, this study constructs respective comprehensive evaluation index systems. Utilizing the entropy-weighted TOPSIS method, a comprehensive adaptation evaluation model, and an obstacle degree model, the study conducts an in-depth analysis of the development levels, spatio-temporal evolution, and obstacle factors of new quality productive forces and high-quality tourism across 31 provinces (autonomous regions and municipalities) in China from 2006 to 2022. The results indicate that: (1) From 2006 to 2022, except for the short-term impact of the pandemic on the tourism industry, the overall development levels of both systems showed a synergistic upward trend. (2) Spatially, the development levels of both systems exhibit significant characteristics of the eastern region leading, the central region rising, and the western and northeastern regions relatively lagging. (3) The adaptation level between the two shows a fluctuating upward trend, with the adaptation type gradually transitioning from extreme maladaptation to moderate adaptation; its spatial distribution follows a "high in the east and south, low in the west and north" pattern. (4) For most provinces, the primary obstacle factors in the new quality productive forces system are the number of artificial intelligence enterprises, high-tech industry revenue, and the number of new

product development projects, while the high-quality tourism development system is constrained by the growth rate of domestic tourists, the turnover of the technology market, and the number of inbound overnight tourist arrivals. The research findings provide a scientific basis for various regions to formulate differentiated policies for empowering high-quality tourism development through new quality productive forces.

## Full Text

## Preamble

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GEOGRAPHY

# Research on the Spatiotemporal Evolution and Obstacle Factors of the Adaptation Between New Quality Productive Forces and High-Quality Tourism Development in Chinese Provinces

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### Abstract

The coordinated development of new quality productive forces and high-quality tourism is a critical path for achieving sustainable economic growth and industrial upgrading in China. This study explores the adaptation degree between these two systems across various Chinese provinces, analyzing their spatiotemporal evolution patterns and identifying key obstacle factors. By employing a comprehensive evaluation index system and spatial analysis techniques, the research provides insights into how technological innovation, green development, and digital transformation can be integrated into the tourism sector to foster high-quality growth.

## 1 Introduction

In the context of the new era, the concept of "new quality productive forces" has emerged as a core driver for high-quality economic development. Characterized by innovation, high efficiency, and high quality, new quality productive forces represent a departure from traditional growth models. Simultaneously, the tourism industry is undergoing a transition from high-quality growth to high-quality development, necessitating a fundamental shift in its operational logic and value creation processes.

The adaptation between new quality productive forces and high-quality tourism development is not merely a theoretical alignment but a practical necessity for regional economic resilience. While previous studies have focused on the digital economy or technological innovation in tourism, research specifically addressing the systemic adaptation and spatiotemporal dynamics of new quality productive forces within the tourism framework remains limited. This paper aims to bridge this gap by quantifying the coupling and adaptation levels across Chinese provinces and diagnosing the primary constraints hindering their synergistic development.

## 2 Research Methodology and Data Sources

### 2.1 Evaluation Index System

To measure the adaptation degree, this study constructs a dual-system evaluation framework. The "New Quality Productive Forces" system is evaluated through dimensions such as technological innovation, green productivity, and digital infrastructure. The "High-Quality Tourism Development" system is assessed based on economic benefits, social contributions, ecological protection, and service quality.

### 2.2 Research Methods

1. **Entropy Weight Method:** Used to determine the weights of each indicator to ensure objectivity in the evaluation process.
2. **Coupling Coordination Degree Model:** Employed to measure the level of interaction and harmony between new quality productive forces and high-quality tourism development.
3. **Spatial Autocorrelation (Moran' s I):** Used to analyze the spatial

## Introduction

In recent years, the rapid advancement of machine learning and deep learning has revolutionized various scientific disciplines. These computational methodologies offer robust frameworks for processing complex datasets, identifying intricate patterns, and generating predictive models with high precision. Within the context of geographical and environmental sciences, the integration of these technologies has become increasingly vital for addressing multifaceted spatial problems and enhancing the accuracy of regional assessments.

### Research Context and Objectives

The primary objective of this study is to explore the application of advanced algorithmic approaches to specific regional challenges. By leveraging large-scale datasets and sophisticated modeling techniques, we aim to provide a more nuanced understanding of the underlying dynamics at play. This research builds

upon established theoretical foundations while introducing innovative computational strategies to improve the reliability of our findings.

[Figure 1: see original paper]

### Methodology Overview

Our methodological framework incorporates several key stages, beginning with comprehensive data collection and preprocessing. We utilize a variety of data sources to ensure a holistic representation of the study area. Following the data acquisition phase, we implement a series of machine learning models, including neural networks and ensemble learning techniques, to analyze the spatial and temporal variations within the dataset.

The mathematical formulation of our primary model is defined as follows:

$$\mathcal{L}(\theta) = \sum_{i=1}^{n} (y_i - f(x_i; \theta))^2 + \lambda \|\theta\|^2$$

where $\theta$ represents the model parameters, $y_i$ denotes the observed values, and $f(x_i; \theta)$ is the predicted output. The regularization term $\lambda \|\theta\|^2$ is included to prevent overfitting and ensure the generalizability of the model across different subsets of the data.

### Preliminary Analysis

Initial results indicate a significant correlation between the variables under investigation. By applying the transformation $\tilde{x} = \phi(x)$, we are able to map the input features into a higher-dimensional space, facilitating the identification of non-linear relationships that were previously obscured. The use of $\bar{b}$ as a baseline metric further allows for a comparative analysis of model performance across various scenarios.

As we proceed with the detailed analysis, we maintain a rigorous focus on technical accuracy and academic precision, ensuring that each step of the process is documented and verifiable. The subsequent sections will delve deeper into the specific results and their implications for the field.

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## 摘要

# New Quality Productive Forces and the High-Quality Integrated Development of Tourism

The integration of new quality productive forces with high-quality tourism development serves not only as a critical lever for promoting high-quality economic growth but also as an essential pathway for enhancing national competitiveness and cultural soft power. As the global economy shifts toward innovation-driven models, the traditional tourism industry is undergoing a profound transformation. By leveraging advanced technologies such as artificial intelligence, big data, and green energy, the sector can transition from resource-dependent growth to a model defined by high efficiency, sustainability, and high value-added services.

This integration represents a strategic alignment between technological progress and experiential consumption. New quality productive forces provide the technical foundation for "smart tourism" and "green tourism," enabling more precise resource allocation and personalized visitor experiences. Furthermore, this synergy fosters the emergence of new business formats, such as immersive digital exhibitions and low-carbon travel solutions, which are vital for meeting the evolving demands of modern consumers while ensuring the long-term preservation of natural and cultural heritage.

Enhancing competitiveness and promoting regional coordination are key initiatives for development. Based on the essential requirements of new quality productive forces and the high-quality development of tourism, this study clarifies the logical mechanism of their adaptation. On this basis, a comprehensive evaluation index system is constructed for both variables. The research utilizes the entropy-weighted TOPSIS method and a comprehensive adaptation evaluation model to conduct its analysis.

and obstacle degree models, this study provides an in-depth analysis of the level, spatio-temporal evolution, and hindering factors of new quality productive forces and high-quality tourism development across 31 provinces (autonomous regions and municipalities) in China from 2006 to 2022. The results indicate that: (1) From 2006 to 2022, with the exception of the short-term impact of the pandemic on the tourism industry, both systems overall···

The development level of both systems exhibits a synergistic upward trend. (2) Spatially, the development levels of both systems demonstrate a significant pattern characterized by leadership in the eastern region, the rise of the central region, and relative lag in the western and northeastern regions. (3) The adaptation level between the two systems shows a fluctuating upward trend; the adaptation type has gradually transitioned from extreme maladaptation to moderate adaptation. Its spatial distribution follows a "high in the east, low

in the west" and "high in the south, low in the north" pattern. (4) For most provinces, the primary obstacle factors for the new quality productive forces system are the number of artificial intelligence enterprises, high-tech industry revenue, and the number of new product development projects. Conversely, the obstacles for the high-quality tourism development system are concentrated in the growth rate of domestic tourists, the turnover of the technology market, and the number of inbound overnight tourist arrivals. The results of this study provide a scientific basis for various regions to formulate differentiated policies for empowering high-quality tourism development through new quality productive forces.

**Keywords:** New quality productive forces; High-quality tourism development; Degree of adaptation; Spatio-temporal evolution; Obstacle factors

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## 1 Introduction

The concept of "new quality productive forces" represents a significant theoretical innovation in Marxist productive force theory, serving as a critical engine for promoting high-quality economic and social development in the new era. As a strategic pillar industry of the national economy, the tourism sector is undergoing a profound transformation from high-speed growth to high-quality development. Exploring the adaptation and synergistic relationship between new quality productive forces and high-quality tourism development is of great theoretical and practical significance for optimizing the allocation of tourism production factors and enhancing the core competitiveness of the tourism industry.

## 2 Research Methodology and Data Sources

### 2.1 Index System Construction

To scientifically measure the level of new quality productive forces and high-quality tourism development, this study constructs a comprehensive evaluation index system based on the principles of scientific rigor, systematicity, and data availability. The new quality productive forces are evaluated across three dimensions: technological innovation, industrial transformation, and green development. High-quality tourism development is measured through four dimensions: economic benefit, service quality, environmental protection, and innovation drive.

### 2.2 Measurement of Adaptation Degree

This study utilizes an adaptation model to analyze the degree of coordination between new quality productive forces and high-quality tourism development.

The adaptation degree $C$ is calculated as follows:

$$C = \left\{ \frac{f(x) \cdot g(y)}{\left[\frac{f(x)+g(y)}{2}\right]^2} \right\}^{1/2}$$

In this formula, $f(x)$ represents the evaluation index of new quality productive forces, and $g(y)$ represents the evaluation index of high-quality tourism development. To further reflect the overall synergistic effect, the coupling coordination degree model is introduced:

$$D = \sqrt{C \cdot T}$$

$$T = \alpha f(x) + \beta g(y)$$

Where $D$ is the coupling coordination degree, $T$ is the comprehensive coordination index, and $\alpha$ and $\beta$ are undetermined coefficients. In this study, both are set to

As China's economy transitions from a phase of high-speed growth to one of high-quality development, the structural optimization and efficiency enhancement of the industrial sector have become central priorities. This shift necessitates a profound transformation in traditional manufacturing paradigms, moving away from labor-intensive and resource-heavy models toward innovation-driven strategies. In this context, the integration of advanced technologies—particularly machine learning and deep learning—serves as a critical catalyst for industrial upgrading. By leveraging data-driven insights, enterprises can optimize production processes, reduce operational costs, and enhance global competitiveness, thereby aligning with the national strategic objective of achieving sustainable and high-quality economic progress.

## Major Opportunities

The high-quality development of tourism emphasizes a strategic shift from the pursuit of scale and speed toward a focus on quality and efficiency. This transition presents significant opportunities for the industry to redefine its growth trajectory. By prioritizing sustainable practices and enhanced service standards, the sector can better align with contemporary economic demands and consumer expectations. This evolution necessitates a comprehensive reevaluation of traditional development models, fostering an environment where innovation and value creation become the primary drivers of progress.

In the context of the current era, the continuous advancement of science and technology serves as a primary driver for innovation-led development.

···shifting toward quality and efficiency, transitioning from resource dependency to innovation-driven development, and moving from···

The deep advancement of national strategies has catalyzed the emergence of new quality productive forces. In September 2023, the concept of "new quality productive forces" was formally proposed, marking a significant evolution in economic development theory. These forces represent a paradigm shift from traditional growth models, characterized by high technology, high efficiency, and high quality, aligning with the requirements of high-quality development. Unlike traditional productive forces that rely on extensive resource input, new quality productive forces are driven by scientific and technological innovation, particularly breakthroughs in frontier technologies and the integration of advanced digital systems.

The core of new quality productive forces lies in the fundamental transformation of labor, instruments of labor, and subjects of labor. In this context, machine learning and deep learning serve as critical engines for optimizing industrial structures and enhancing total factor productivity. By leveraging massive datasets and sophisticated algorithms, these technologies enable the transition from labor-intensive processes to intelligence-led production. This transition is not merely an incremental improvement but a revolutionary leap that fosters emerging industries and future-oriented sectors, providing a robust foundation for sustainable economic growth and global competitiveness.

The transition from extensive development to intensive development is a critical evolution in economic growth, and the application of new quality productive forces plays a pivotal role in this process. Unlike traditional growth models that rely heavily on the massive input of labor, land, and natural resources, intensive development emphasizes the enhancement of total factor productivity through technological innovation and structural optimization. New quality productive forces, characterized by high technology, high efficiency, and high quality, serve as the core engine for this transformation. By integrating advanced digital technologies, green innovations, and intelligent manufacturing, these forces enable industries to achieve higher output with lower resource consumption, thereby facilitating a sustainable and high-quality economic trajectory.

During the symposium on promoting the comprehensive revitalization of Northeast China in the new era, held in September 2023, General Secretary Xi Jinping emphasized the need to prioritize scientific and technological innovation as a means of driving industrial innovation. This approach aims to actively cultivate strategic emerging industries and future-oriented industries, thereby accelerating the formation of new quality productive forces.

The concept of "new quality productive forces" represents a significant evolution in economic theory, emphasizing a shift from traditional growth models toward high-quality development driven by cutting-edge technological breakthroughs, innovative allocation of production factors, and deep industrial transformation. In the context of regional revitalization, this involves leveraging existing indus-

trial foundations while integrating advanced digital technologies, green energy solutions, and intelligent manufacturing processes to create a more resilient and competitive economic landscape.

To address the challenges of resource mismatch, low efficiency, and poor user experience in traditional tourism development, modern strategies must leverage advanced technological frameworks. By integrating machine learning and deep learning methodologies, the industry can transition toward a more data-driven and personalized model. These technologies enable precise demand forecasting and resource allocation, ensuring that infrastructure and services align more effectively with actual traveler needs. Furthermore, the application of intelligent systems enhances the overall visitor experience by providing seamless, real-time recommendations and optimizing service workflows, thereby overcoming the structural bottlenecks inherent in conventional tourism management.

## Introduction

General Secretary Xi Jinping first elucidated the core concept of "New Quality Productive Forces," emphasizing that "technological innovation acts as the primary driver for developing new quality productive forces."This directive highlights the urgent need to accelerate the realization of high-level self-reliance and strength in science and technology. In the current era, the rapid evolution of information technology—characterized by networking, digitalization, and intelligence—has positioned artificial intelligence (AI) as a pivotal force in the global technological revolution and industrial transformation.

### The Role of Artificial Intelligence in Modern Development

As a transformative technology, AI is reshaping the foundations of economic productivity. By integrating machine learning, deep learning, and large-scale data processing, AI enables the transition from traditional labor-intensive models to knowledge-driven and automated systems. This shift is fundamental to the cultivation of new quality productive forces, as it fosters the emergence of strategic emerging industries and future-oriented sectors.

[Figure 1: see original paper]

### Technological Innovation and Self-Reliance

The pursuit of high-level self-reliance in science and technology is not merely a strategic goal but a necessity for national security and economic resilience. The development of independent AI frameworks and hardware—such as domestic high-performance computing chips and open-source deep learning libraries —is critical. By reducing dependence on external technologies, the nation can ensure that the development of new quality productive forces remains secure and sustainable.

### Future Directions

Looking forward, the integration of AI with traditional manufacturing, healthcare, and energy sectors will be the primary battlefield for innovation. The objective is to create a synergistic ecosystem where technological breakthroughs lead directly to industrial upgrades. This process requires a robust theoretical framework and practical applications that can translate complex algorithms into tangible economic value, thereby fulfilling the requirements of the new era' s productive forces.

addressing issues such as deficiencies, thereby supporting the tourism industry' s transition toward higher quality and greater efficiency.

Accelerating the cultivation of this engine of development is essential. The core characteristics of new quality productive forces are···

towards a more equitable and sustainable direction [**?**]. Consequently, against this background,

The characteristics of "new quality productive forces"are defined by the concepts of "newness" and "quality." Here, "newness" refers to the integration of new technologies and the emergence of the new economy.

## Research on the Alignment Between New Quality Productive Forces and High-Quality Tourism Development

### 1. Introduction

The concept of "New Quality Productive Forces" represents a significant theoretical innovation in contemporary economic discourse, emphasizing the role of technological breakthroughs, innovative allocation of production factors, and deep industrial transformation. As the tourism industry transitions from a phase of rapid expansion to one of high-quality development, understanding the alignment between these new productive forces and tourism becomes essential. High-quality tourism development is no longer solely dependent on traditional resource consumption; instead, it requires a shift toward efficiency, sustainability, and enhanced value creation. This study explores the theoretical framework and practical mechanisms through which new quality productive forces drive the transformation of the tourism sector.

### 2. Theoretical Framework

The alignment between new quality productive forces and high-quality tourism development is rooted in the synergy between advanced technological applications and the evolving demands of the global travel market. New quality productive forces are characterized by high technology, high efficiency, and high quality, aligning perfectly with the objectives of modern tourism.

**2.1 Defining New Quality Productive Forces in Tourism** In the context of tourism, new quality productive forces manifest as the integration of digital technologies—such as artificial intelligence, big data, and the Internet of Things (IoT)—into the tourism value chain. These forces redefine the traditional "labor-land-capital" triad by introducing data as a critical factor of production. The core of this transformation lies in increasing Total Factor Productivity (TFP) within the tourism industry.

**2.2 Dimensions of High-Quality Tourism Development** High-quality tourism development is characterized by several key dimensions: - **Innovation-driven growth:** Moving away from traditional resource-dependent models. - **Green and sustainable practices:** Ensuring environmental conservation is integrated into the tourism experience. - **Enhanced visitor experience:** Utilizing personalization and smart services to meet diverse consumer needs. - **Structural optimization:** Improving the supply-side structure to match the sophisticated demands of modern travelers.

### 3. Mechanism of Alignment

The alignment mechanism operates through the optimization of production factors and the restructuring of industrial processes.

[Figure 1: see original paper]

**3.1 Technological Innovation and Digital Transformation** The application of $MATH_1$ represents the technological frontier where digital twins and augmented reality (AR) enhance site management and visitor engagement. By utilizing $MATH_2$, tourism enterprises can predict market trends and optimize resource allocation

"Quality" emphasizes the leading role of science and technology as well as the importance of innovation-driven development.

The relationship between these factors reveals the characteristics of their spatio-temporal evolution and identifying the underlying obstacle factors is essential for promoting the coordinated development of the two systems.

[Figure 1: see original paper]

## 1. Introduction

In the context of global environmental change and rapid urbanization, the interaction between socio-economic development and ecological preservation has become a focal point of academic research. Understanding the coupling coordination degree (CCD) between these systems is crucial for sustainable regional planning. Previous studies have often focused on static assessments; however, a dynamic analysis of spatio-temporal evolution provides a more nuanced understanding of how regional disparities emerge and persist over time.

By employing advanced spatial analysis techniques and the obstacle degree model, this study aims to quantify the level of synergy between the systems and diagnose the primary constraints hindering balanced growth. Such insights are vital for policymakers to formulate targeted strategies that address specific regional weaknesses while leveraging existing strengths.

## 2. Methodology

### 2.1 Evaluation Indicator System

To ensure a comprehensive assessment, we constructed a multi-dimensional indicator system covering both the socio-economic and ecological dimensions. The selection of indicators follows the principles of scientific rigor, data availability, and representativeness.

### 2.2 Coupling Coordination Degree Model

The coupling degree $C$ is utilized to reflect the strength of the interaction between systems, while the coordination degree $D$ measures the quality of this interaction. The formulas are defined as follows:

$$C = 2 \times \left[ \frac{U_1 \times U_2}{(U_1 + U_2)^2} \right]^{1/2}$$

$$T = \alpha U_1 + \beta U_2$$

$$D = \sqrt{C \times T}$$

In these equations, $U_1$ and $U_2$ represent the evaluation values of the two subsystems, respectively. The coefficients $\alpha$ and $\beta$ represent the relative importance of each system, typically satisfying $\alpha + \beta = 1$.

### 2.3 Obstacle Degree Model

To further explore the factors restricting the improvement of the coupling coordination degree, the obstacle degree model is introduced. This model identifies key constraints by calculating the factor contribution, indicator deviation, and the resulting obstacle value $I_i$:

$$I_i = \frac{w_i R_i}{\sum_{i=1}^{n} w_i R_i}$$

the essential nature of tourism [2]. As a strategic pillar industry of the national economy, the tourism industry plays a vital role in driving economic growth and fostering cultural exchange.

In light of the collaborative efforts of various stakeholders, promoting high-quality economic development and achieving the sustainable growth of the tourism industry have become critical objectives. These goals require a synergistic approach that integrates policy support, market mechanisms, and environmental stewardship to ensure long-term viability and resilience within the sector.

Industry serves as a vital driving force and a key mechanism for promoting high-quality development. In the context of···

Transformation is of significant importance.

Against the backdrop of the continuous advancement of a new round of "tourism revolution," the development of new quality productive forces has become a core driver for the high-quality transformation of the tourism industry. This evolution represents a fundamental shift from traditional resource-dependent growth models toward an innovation-led paradigm characterized by high technology, high efficiency, and high quality. By integrating cutting-edge technological achievements—such as artificial intelligence, big data, and the Internet of Things—with the tourism sector, new quality productive forces are reshaping the entire industrial chain, from resource allocation to consumer experience.

The promotion of these productive forces is not merely a technical upgrade but a systemic restructuring of the tourism economy. It emphasizes the deep integration of digital intelligence and green development, fostering new business formats such as immersive digital tourism, smart destination management, and personalized travel services. As the "tourism revolution" deepens, the focus shifts toward enhancing total factor productivity, ensuring that the industry can meet the increasingly sophisticated and diverse demands of modern travelers while maintaining ecological sustainability and cultural integrity. This transition marks a critical juncture in achieving a more resilient and competitive global tourism landscape.

## Introduction

The introduction of the new concept "new quality productive forces" has sparked significant academic discussion. This term represents a theoretical innovation in the field of Marxist political economy, reflecting a profound shift in the understanding of how modern technology and innovation drive economic development. Unlike traditional productive forces, which primarily rely on labor-intensive and resource-heavy growth models, new quality productive forces are characterized by high technology, high efficiency, and high quality.

Central to this concept is the role of disruptive technological innovation. In the contemporary era, the rapid advancement of machine learning, deep learning, and other cutting-edge technologies has fundamentally altered the production landscape. These advancements do not merely improve existing processes but redefine the relationship between labor, instruments of labor, and the subjects

of labor. By integrating advanced digital tools and intelligent systems into the manufacturing and service sectors, new quality productive forces foster a more sustainable and resilient economic structure.

Furthermore, the transition toward new quality productive forces necessitates a corresponding evolution in the relations of production. Academic discourse emphasizes that to fully unleash the potential of these forces, institutional reforms are required to reduce barriers to innovation and ensure a more equitable distribution of the gains from technological progress. This involves optimizing the allocation of production factors—such as data, talent, and capital—to support emerging industries and future-oriented economic activities. As research in this area continues to expand, it provides a crucial theoretical framework for understanding the future trajectory of global economic competition and high-quality development.

Injecting new momentum into the high-quality development of tourism and providing a path for transformation and upgrading.

widely discussed. Domestic scholars have primarily focused on its conceptual analysis [**?**] and quantitative measurement.

Research has been conducted in areas such as evaluation [**?**] and implementation pathways [**?**]. As a pillar of the national economy, the tourism industry···

## Introduction

The establishment of a robust theoretical framework is the prerequisite for developing a modern industrial system. From the perspective of the "three elements" of productivity—labor, instruments of labor, and subjects of labor—this paper identifies and analyzes the core drivers of industrial transformation. By examining the evolving relationship between these elements in the context of technological advancement, we can better understand the structural shifts required for high-quality economic development.

As one of the most promising "happiness industries," the high-quality development of this sector has sparked widespread academic and practical interest. High-quality development in this context refers to a transition from scale-driven expansion to value-driven optimization, emphasizing efficiency, sustainability, and the enhancement of human well-being. To achieve this, it is essential to integrate advanced technological frameworks with human-centric service models, ensuring that the industry not only contributes to economic growth but also substantively improves the quality of life for its participants.

The realization of high-quality development requires a multi-dimensional approach. First, the integration of digital technologies, such as machine learning and big data analytics, allows for more personalized and efficient service delivery. Second, institutional reforms are necessary to standardize service quality and protect consumer rights. Finally, the industry must align with broader socio-economic goals, such as environmental sustainability and social equity, to

maintain its long-term viability. By addressing these core pillars, the happiness industry can evolve into a robust engine for both economic prosperity and social harmony.

## Analysis of the Connections and Distinctions Between Traditional and New Quality Productive Forces

The evolution of productive forces represents the fundamental driving power behind human social development. Understanding the relationship between traditional productive forces and "new quality productive forces" is essential for grasping the current trajectory of economic transformation and technological progress.

### 1. The Conceptual Framework of Productive Forces

Traditional productive forces are primarily characterized by labor-intensive and resource-intensive growth models. They rely heavily on the accumulation of physical capital, large-scale labor input, and the incremental improvement of mechanical technologies. In this framework, growth is often linear and constrained by the diminishing marginal returns of traditional factors of production such as land and unskilled labor.

In contrast, new quality productive forces represent a paradigm shift driven by revolutionary technological breakthroughs, innovative allocation of production factors, and deep industrial transformation and upgrading. With data, high-end technology, and specialized knowledge as core drivers, these forces are characterized by high technology, high efficiency, and high quality. They align with the requirements of high-quality development and mark a departure from traditional extensive growth paths.

### 2. Distinctions Between Traditional and New Quality Productive Forces

The distinctions between these two forms of productive forces can be analyzed across several dimensions:

- **Core Drivers:** Traditional productive forces rely on conventional factors such as labor, land, and capital. New quality productive forces are driven by innovation, particularly "disruptive" and "frontier" technologies that redefine production possibilities.
- **Labor Characteristics:** In traditional models, the workforce is largely composed of manual or semi-skilled laborers. New quality productive forces demand a "new type of laborer" who possesses high levels of scientific literacy, digital skills, and the ability to operate complex, intelligent systems.
- **Means of Production:** Traditional means of production consist of physical machinery and hardware. New quality productive forces incorporate

"new means of production," including high-performance computing, artificial intelligence, and advanced materials, where data has emerged as a critical factor of production.

- **Environmental Impact:** Traditional production often follows a "pollute first, treat later" trajectory, characterized by high energy consumption. New quality productive forces are inherently "green," prioritizing sustainability and ecological civilization as core components of productivity itself.

### 3. Connections and Continuity

Despite their differences, new quality productive forces do not exist in isolation from traditional ones; rather, they represent an evolutionary advancement.

First, traditional industries provide the material foundation for the emergence of new

The current surge in academic research primarily stems from the evolution of development philosophies, the refinement of evaluation systems, and the continuous advancement of methodological frameworks. Researchers are increasingly focusing on how these core pillars intersect to drive innovation across various scientific disciplines.

In terms of development philosophies, there has been a significant shift toward interdisciplinary integration and sustainable growth models. This transition reflects a broader recognition that complex modern challenges cannot be solved within the silos of traditional academic boundaries. Consequently, new conceptual frameworks are being established to guide research toward more holistic and socially impactful outcomes.

Simultaneously, the transformation of evaluation systems plays a critical role in shaping the academic landscape. Moving beyond simple quantitative metrics, contemporary evaluation standards are increasingly emphasizing the quality, originality, and practical utility of research contributions. This shift encourages scholars to pursue high-risk, high-reward inquiries that offer long-term value rather than focusing solely on short-term publication counts. These evolving standards are essential for fostering a healthy academic ecosystem that rewards genuine scientific progress.

The core essence of new quality productive forces lies in their departure from traditional models. While traditional productivity relies primarily on the accumulation of basic factors of production—such as labor, land, and capital—new quality productive forces are driven by innovation and high-tech integration. This shift represents a fundamental transformation in how value is created, moving away from extensive growth patterns toward a more intensive, efficient, and sustainable developmental framework.

By prioritizing technological breakthroughs and the optimization of industrial structures, new quality productive forces foster an environment where knowl-

edge and data become the primary drivers of economic progress. This evolution necessitates a reevaluation of traditional production relations to better accommodate the rapid advancements in machine learning, deep learning, and other transformative technologies that define the modern era.

## Influencing Factors and Spatiotemporal Evolution

The analysis of influencing factors and the study of spatiotemporal evolution constitute a critical framework for understanding complex geographical, social, and environmental phenomena. By examining how specific variables interact over time and across different geographic scales, researchers can uncover the underlying mechanisms driving change and stability within a system.

### Spatiotemporal Evolution Analysis

Spatiotemporal evolution refers to the dynamic process by which a phenomenon changes its spatial distribution and intensity over a specific temporal sequence. This analysis typically employs Geographic Information Systems (GIS) and spatial econometric models to visualize and quantify shifts in patterns. Key metrics often include the center of gravity movement, spatial autocorrelation (such as Moran' s $I$), and hot-spot analysis (Getis-Ord $G_i^*$). These methods allow for the identification of spatial clusters and the determination of whether observed patterns are the result of random chance or systematic environmental and socioeconomic drivers.

### Identification of Influencing Factors

To understand the drivers behind spatiotemporal shifts, it is necessary to isolate and quantify various influencing factors. These factors are generally categorized into natural environmental constraints (e.g., topography, climate, and resource endowment) and human-induced socioeconomic drivers (e.g., urbanization, policy interventions, and economic development).

Advanced statistical and machine learning approaches are frequently utilized to measure the contribution of each factor. For instance, the Geographical Detector (GeoDetector) model is often employed to assess the power of spatial stratification heterogeneity and the interactions between different variables. The relationship can be expressed through the $q$-statistic:

$$q = 1 - \frac{\sum_{h=1}^{L} N_h \sigma_h^2}{N \sigma^2}$$

where $h = 1, \ldots, L$ represents the strata of the variable; $N_h$ and $N$ are the number of units in stratum $h$ and the entire region, respectively; and $\sigma_h^2$ and $\sigma^2$ are the variances of the target variable within the stratum and the entire region.

**Interaction Mechanisms**

The evolution of a system is rarely the result of a single factor in isolation. Instead, it arises from the complex interplay between multiple drivers. Interaction analysis determines whether two factors, when acting together, enhance or weaken each other' s influence on the dependent variable. Understanding these synergistic effects is crucial for developing targeted policy recommendations. For example, while economic growth may be a primary driver of

The analysis is conducted across multiple dimensions.

driven, relying on the large-scale investment of capital and resources [**?**], and characterized by physical labor-intensive···

As new quality productive forces become a core engine for enhancing efficiency and innovating business models within the tourism industry, the integration of advanced technologies—particularly machine learning and deep learning—has emerged as a critical frontier for both academic research and industrial application. This evolution represents a fundamental shift in how tourism services are delivered, managed, and optimized in the digital era.

Traditional productive forces primarily consist of laborers, mechanized means of production, and natural resources. In contrast, new quality productive forces represent a fundamental shift toward advanced technological integration and innovation-driven growth.

The role of innovation has become increasingly prominent, particularly in its capacity to empower the high-quality development of the tourism industry.

Productivity represents a transformation and sublimation of traditional paradigms, characterized by fundamental shifts in its core elements.

Value has become a significant subject of focus within the academic community. Currently, researchers both domestically and internationally are increasingly exploring this domain.

The qualitative transformation of the workforce is characterized by the transition of laborers into knowledge-based and skill-oriented personnel.

Relevant academic research has primarily focused on the following dimensions: First,

Talent, labor instruments have iterated into a series of digital and intelligent tools, and the objects of labor have expanded accordingly.

## Introduction to New Quality Productive Forces in Tourism

The fundamental concept of "new quality productive forces" in tourism has been proposed as a transformative framework for the industry. Scholars suggest that new quality productive forces in tourism represent a contemporary evolution of productive forces, driven primarily by technological innovation and the deep

integration of digital intelligence. Unlike traditional growth models that rely on the extensive consumption of resources and labor, these new forces emphasize high efficiency, high quality, and sustainability as their core characteristics.

### The Conceptual Framework of New Quality Productive Forces

At its core, the development of new quality productive forces in tourism involves the systemic upgrading of the three traditional elements of production: the laborer, the means of labor, and the objects of labor. In this context, the "laborer" evolves into a high-tech, knowledge-based workforce capable of navigating complex digital ecosystems. The "means of labor" shift from physical infrastructure to advanced digital platforms, artificial intelligence, and big data analytics. Finally, the "objects of labor" expand beyond traditional physical scenic spots to include virtual experiences, data assets, and multi-dimensional cultural narratives.

### Drivers of Innovation and Transformation

The transition toward new quality productive forces is catalyzed by several key drivers. First, the application of cutting-edge technologies—such as the Internet of Things (IoT), blockchain, and virtual reality (VR)—enables the creation of immersive and personalized tourism products. Second, the structural optimization of the tourism industry promotes the "tourism+" model, fostering cross-sectoral synergy between tourism, technology, and ecology. This shift not only enhances the value proposition for consumers but also aligns the industry with global green development goals.

### Strategic Implications for Industry Development

Scholars argue that fostering new quality productive forces is essential for the high-quality development of the tourism economy. By leveraging data as a new factor of production, tourism destinations can achieve precise marketing, optimized resource allocation, and enhanced crisis management capabilities. Furthermore, this paradigm shift encourages the institutional innovation necessary to break down traditional barriers, allowing for a more resilient and competitive tourism market in the digital age. Through this lens, new quality productive forces are not merely a theoretical construct but a practical roadmap for the future of global tourism.

expanding into data-driven and strategic emerging fields. Furthermore, new quality productive forces are more

## Introduction to New Quality Productive Forces in Culture and Tourism

The concepts of "New Quality Productive Forces" and "New Quality Productive Forces in Culture and Tourism" primarily refer to a contemporary evolutionary

stage of economic development driven by innovation. At its core, this framework represents a departure from traditional growth models that rely on extensive factor inputs. Instead, it emphasizes a shift toward high-tech, high-efficiency, and high-quality productive forces that align with the requirements of high-quality development.

In the context of the culture and tourism industry, new quality productive forces are characterized by the deep integration of advanced technologies—such as artificial intelligence, big data, and the Internet of Things—with cultural resources and tourism services. This integration facilitates the digital transformation of the industry, enabling the creation of immersive experiences, personalized services, and more efficient management systems. By leveraging these innovations, the sector can move beyond conventional resource-dependent growth toward a model defined by intellectual capital and technological empowerment.

emphasizing the application of green technologies and sustainable development [**?**, **?**]. Based on this,

Innovation plays a leading role in breaking through traditional limitations and aligning with high-quality development. In the context of modern scientific research, the integration of machine learning and deep learning has become a cornerstone for advancing complex system modeling. By leveraging these computational paradigms, researchers can move beyond the constraints of classical methodologies, enabling more precise predictions and robust data analysis across various disciplines. This shift toward innovation-driven research not only enhances technical efficiency but also ensures that scientific progress meets the rigorous standards required for sustainable and high-impact outcomes.

This paper argues that the essence of new quality productive forces lies in the upgrading and transformation of traditional productive forces. Unlike conventional growth models that rely on extensive factor accumulation, new quality productive forces are driven by scientific and technological innovation as the core engine. This transition represents a fundamental shift toward high-tech, high-efficiency, and high-quality development patterns, aligning with the requirements of the new development philosophy. By integrating advanced digital technologies, green development practices, and modernized industrial chains, new quality productive forces foster a more sophisticated relationship between labor, instruments of labor, and the subjects of labor, ultimately leading to a significant leap in total factor productivity.

New quality productive forces represent advanced productivity that meets the requirements of high-quality development. In the context of the digital era, these forces are characterized by a higher degree of integration.

High-quality workers, driven by scientific and technological innovation, utilize advanced production tools and digital technologies to transform traditional industries. This process represents a fundamental upgrade in productivity, where the integration of machine learning and deep learning algorithms facilitates the transition toward intelligent manufacturing. By leveraging these cutting-edge

tools, the workforce can optimize complex industrial processes, leading to significant improvements in efficiency and the creation of new value within the modern economic landscape.

and productivity characterized by new connotations [**?**]; second, it clarifies the nature of new quality productivity.

New types of labor tools act deeply upon new types of labor objects, and through the optimization and upgrading of labor processes, they catalyze the birth of new industries, new models, and new drivers of growth. This transformative interaction represents a fundamental shift in the productive forces, where advanced technological instruments are no longer merely peripheral aids but are integrated into the very core of the production cycle. By leveraging these sophisticated tools, enterprises can extract greater value from complex data sets and intangible assets, which increasingly serve as the primary objects of modern labor.

The synergy between these advanced components facilitates a more efficient allocation of resources and a more precise execution of industrial tasks. As these new labor materials penetrate various sectors, they dismantle traditional production bottlenecks and foster an environment conducive to continuous innovation. Consequently, this evolution leads to the emergence of high-value-added economic activities, redefining the competitive landscape and providing the essential momentum for sustainable, high-quality economic development.

## The Logical Mechanism of New Quality Productive Forces Empowering High-Quality Tourism Development

### Introduction

As the global economy shifts toward a paradigm driven by innovation and sustainability, the concept of "New Quality Productive Forces" has emerged as a critical driver for industrial transformation. In the context of the tourism industry, high-quality development is no longer merely about increasing visitor numbers, but about enhancing value creation, optimizing resource allocation, and ensuring ecological and social harmony. This paper explores the logical mechanism through which new quality productive forces empower the high-quality development of tourism, providing a theoretical framework for understanding this systemic evolution.

### The Core Essence of New Quality Productive Forces in Tourism

New quality productive forces represent a departure from traditional, labor-intensive, and resource-depleting growth models. In the tourism sector, these forces are characterized by the integration of cutting-edge technologies—such as Big Data, Artificial Intelligence (AI), and the Internet of Things (IoT)—with innovative management practices and high-level human capital. Unlike traditional productive forces, new quality productive forces prioritize "quality"

over "quantity," focusing on total factor productivity (TFP) as the primary indicator of success.

### The Logical Mechanism of Empowerment

The empowerment of high-quality tourism development by new quality productive forces operates through three primary dimensions: technological innovation, structural optimization, and green transformation.

**1. Technological Innovation as the Primary Engine** Technological advancement serves as the foundational layer of new quality productive forces. In the tourism industry, digital technologies enable the creation of immersive experiences through Augmented Reality (AR) and Virtual Reality (VR), effectively expanding the boundaries of traditional tourism products. Furthermore, the application of machine learning algorithms allows for precise market segmentation and personalized service delivery, significantly enhancing the tourist experience and operational efficiency. As shown in (eq:productivity_{growth}), the contribution of technological progress to output growth is maximized when integrated with specialized human capital.

**2. Structural Optimization and Industrial Synergy** New quality productive forces facilitate the deep integration of tourism with other sectors, such as agriculture, culture, and manufacturing. This "Tourism+" approach leads to the emergence of new business formats, such as smart scenic spots, digital nomads' hubs, and industrial heritage tourism. By breaking down traditional sectoral barriers, these forces optimize the industrial structure, allowing for a more resilient and diversified tourism economy. The transition from a linear value chain to a networked value ecosystem is a hallmark of this structural shift.

[Figure 1: see original paper]

···advanced productivity formed by the optimal combination of production factors. This productivity···

Through the effects of technological innovation, industrial convergence, and resource allocation, the digital economy has become a pivotal driver of modern economic transformation. Technological innovation serves as the core engine, fostering the development of cutting-edge applications and enhancing productivity across various sectors. Simultaneously, the industrial convergence effect facilitates the deep integration of digital technologies with traditional industries, breaking down conventional boundaries and creating new value chains. Finally, the resource allocation effect optimizes the distribution of production factors, reducing information asymmetry and improving overall economic efficiency. Together, these three mechanisms enable the digital economy to restructure traditional industrial frameworks and promote sustainable high-quality growth.

Characterized by "high technology, high efficiency, and green sustainability," the development of new quality productive forces aims to achieve high-quality growth. This paradigm shift represents a fundamental transformation in the mode of production, driven by revolutionary technological breakthroughs, innovative allocation of production factors, and profound industrial transformation and upgrading. By prioritizing ecological integrity and resource efficiency, these forces align economic progress with environmental stewardship, ensuring that technological advancement serves as the primary engine for sustainable and intelligent industrial evolution.

and the mechanisms of green, low-carbon effects empower the high-quality development of the culture and tourism industry.

The ultimate goal is to achieve high-quality development.

quality development [**?**]. Third, researchers have summarized practical pathways for new quality productive forces to empower high-quality tourism development, encompassing multidimensional strategies such as technological innovation, industrial integration, industrial upgrading, talent cultivation, and green development [**?**]. In summary, exploring how new quality productive forces empower the high-quality development of tourism has become a critical research agenda.

However, existing research still faces several limitations. First, there is a relative lack of theoretical exploration regarding the internal and external mechanisms through which new quality productive forces drive high-quality tourism development, making it difficult to systematically elucidate the inherent connection between the two. Second, quantitative research remains insufficient; scholars have primarily focused on the degree of coupling and coordination, while neglecting the matching relationship between the two systems and the deeper comprehensive adaptation underlying them. This limitation hinders a comprehensive reflection of the current state of integrated development and the factors influencing both new quality productive forces and high-quality tourism. To better understand and grasp the relational characteristics of these two systems, it is urgent to conduct an in-depth exploration of other potential relationships, thereby deepening the theoretical and practical understanding of how new quality productive forces empower high-quality tourism development.

Based on this foundation, and through a dialectical analysis of the adaptation mechanism between new quality productive forces and the high-quality development of tourism, this paper first constructs an evaluation index system for both constructs. Subsequently, it analyzes the spatio-temporal distribution characteristics of their respective development levels from a provincial perspective. Furthermore, an integrated adaptation evaluation model is employed to explore the adaptive relationship between these two systems in depth. Finally, the study identifies the primary obstructive factors affecting their coordinated development. This research aims to provide theoretical insights and practical guidance for leveraging new quality productive forces to promote the high-quality development of tourism.

The connotation of high-quality tourism development possesses a dual attribute of both conventional economics and political economy. The former focuses primarily on the tourism industry and the tourism economy [**?**], emphasizing the improvement of economic growth quality through scientific and technological innovation alongside business model transformation. The latter highlights the "happiness industry" attribute of tourism, emphasizing the fundamental goal of satisfying the people' s needs for a better life. Under this perspective, the focus of development shifts from the singular pursuit of economic benefits toward the pursuit of diverse economic, social, and ecological values [**?**]. Therefore, based on existing research, this paper contends that high-quality tourism development is a development paradigm rooted in the fundamental premise of sustainability. It is committed not only to the intensive growth of the tourism industry but also emphasizes responsiveness to the demands of diverse stakeholders, ultimately achieving the organic integration of economic, social, and ecological benefits.

### 1.2 理论分析

New quality productive forces and high-quality tourism development constitute a dialectical unity of the whole and its parts within a system. There exists a unity of interdependence and mutual causality between the two, with an internal logic characterized by a bidirectional interaction of "empowerment" and "feedback" [Figure 1: see original paper]. This circular mechanism drives both systems to effectively release synergistic effects through the dynamic adaptation of internal elements, jointly promoting the evolution of both systems toward higher levels of development.

On one hand, new quality productive forces empower the high-quality development of tourism. (1) New-quality laborers provide intellectual support. By mastering and applying new technologies, these workers can not only improve operational efficiency but also enrich the tourism experience.

Furthermore, they provide theoretical guidance for high-quality development.

The mastery and application of these technologies not only improve work efficiency but also enrich the tourism industry.

## 1 新质生产力与旅游高质量发展适

## Theoretical Analysis of Compatibility

The content and form of products provide a new model for the high-quality development of tourism.

### 1.1 概念内涵

By conducting precise analyses of consumer preferences and behaviors, it is possible to effectively predict market trends.

Accurately defining the theoretical connotations of "new quality productive forces" is essential for constructing a logical framework.

(2) New quality means of labor provide technical support. Through the application of technologies such as big data and cloud computing, tourism data and tourism processes can be analyzed to optimize decision-making outcomes and improve operational efficiency. Simultaneously, within the tourism sector,

Lu Yayan et al.: Spatiotemporal Evolution and Obstacle Factors of the Matching Degree Between New Quality Productive Forces and High-Quality Tourism Development in Chinese Provinces.

1 Adaptation mechanism between new quality productive forces and high-quality tourism development

The application of technologies such as artificial intelligence, virtual reality, and augmented reality within the industry···

This provides an excellent platform for the upgrading and transformation of the means of labor, relying on···

To further develop new forms and business models within the tourism industry, and to achieve the intelligent transformation of tourism···

Real-world application feedback within tourism scenarios serves as a powerful catalyst for the development of new quality productive forces. By integrating advanced technologies such as machine learning and deep learning into the tourism industry, researchers and practitioners can transform vast amounts of consumer data and operational feedback into actionable insights. This iterative process not only optimizes service delivery but also fosters innovation in resource allocation and management strategies.

## The Role of Real-World Feedback in Tourism

In the context of modern tourism, feedback is no longer limited to simple surveys; it encompasses a complex array of multi-modal data, including social media sentiment, real-time geolocation patterns, and transaction histories. Leveraging these data streams allows for the identification of emerging trends and consumer pain points. When processed through sophisticated analytical frameworks, this feedback informs the continuous refinement of tourism products, leading to more personalized and efficient experiences.

### Driving New Quality Productive Forces

The concept of "new quality productive forces" emphasizes the transition toward high-tech, high-efficiency, and high-quality economic growth. In the tourism sector, this is manifested through:

- **Technological Innovation:** The deployment of intelligent recommendation systems and automated management tools that adapt based on user interactions.
- **Structural Optimization:** Using feedback loops to reconfigure tourism supply chains, ensuring that resources are directed toward high-value and sustainable activities.
- **Enhanced Human Capital:** Empowering industry professionals with data-driven decision-making capabilities, thereby increasing overall labor productivity.

[Figure 1: see original paper]

### Methodological Integration

To effectively harness this feedback, researchers utilize various quantitative models. For instance, the relationship between user satisfaction and service quality can be modeled using $\mathcal{F}(x)$, where $x$ represents the vector of input features derived from feedback data. By minimizing the loss function $\mathcal{L}(\theta)$, where:

$$\mathcal{L}(\theta) = \sum_{i=1}^{n} (y_i - f(x_i; \theta))^2 + \lambda \|\theta\|^2$$

machine learning models can predict future demand and optimize resource distribution. These mathematical approaches ensure that the evolution of tourism services is grounded in empirical evidence rather than intuition alone.

## Conclusion

The synergy between real-world application feedback and technological advancement is fundamental to the modernization of the tourism industry. By prioritizing the collection and analysis of high-quality data, the sector can successfully transition toward a model defined by new quality productive forces, ensuring long-term sustainability

(3) New-quality objects of labor provide resource support. As the information age progresses, the scope of labor objects has expanded from traditional physical materials to include intangible resources such as data, information, and knowledge. These new-quality objects of labor serve as the fundamental "raw materials" for modern production, providing the necessary resource support for the deep integration of technology and industry. By leveraging advanced data processing and analysis techniques, these resources can be transformed into valuable insights and drivers for innovation, further fueling the development of new-quality productive forces.

continuously iterating and optimizing means of production, thereby driving production tools toward higher levels of efficiency and sophistication.

With the advent of the digital era, tourists can now acquire a vast array of travel information through various online platforms. This shift has fundamentally transformed the way individuals plan and experience their journeys, as the accessibility of digital resources allows for more informed decision-making and personalized itineraries. These online platforms serve as critical intermediaries, bridging the gap between service providers and consumers by offering real-time updates, peer reviews, and comprehensive destination guides. Consequently, the integration of information technology into the tourism sector has not only enhanced the efficiency of travel planning but has also fostered a more dynamic and interactive global tourism market.

## 1. Introduction

The study of morphological evolution represents a critical frontier in understanding the complex dynamics of structural transformation across various scientific disciplines. From biological systems to material science and large-scale cosmic structures, the transition between different states of organization follows fundamental principles that govern how form emerges and stabilizes over time. This paper explores the multi-stage processes involved in these transitions, focusing on the mechanisms that drive morphological shifts and the mathematical frameworks required to describe them.

## 2. Theoretical Framework

To analyze morphological evolution, we must first establish a robust theoretical foundation that accounts for both deterministic and stochastic influences. The evolution of a system's form can often be characterized by a set of state variables that transition through a defined configuration space.

### 2.1 Governing Equations

The primary dynamics of the system are governed by the relationship between internal forces and external constraints. We represent the general evolution of a morphological state $\mathcal{S}$ as a function of time $t$ and spatial coordinates $x$:

$$\frac{\partial \mathcal{S}}{\partial t} = \nabla \cdot (\mathcal{D} \nabla \mathcal{S}) + \mathcal{F}(\mathcal{S}, \mu)$$

where $\mathcal{D}$ represents the diffusion tensor and $\mathcal{F}$ denotes the reaction or growth term dependent on the parameter set $\mu$. This formulation allows for the modeling of phase transitions and pattern formation within the system.

[Figure 1: see original paper]

As shown in [Figure 1: see original paper], the initial stages of evolution are characterized by rapid fluctuations, followed by a stabilization phase where the primary structural features begin to emerge. This process is consistent with the

observations detailed in [**?**], which suggest that morphological complexity often peaks during the intermediate stages of development.

## 3. Multi-Stage Evolution Analysis

The evolution of morphology is rarely a linear process; instead, it typically unfolds through distinct stages, each characterized by different dominant physical or biological mechanisms.

### 3.1 Nucleation and Early Growth

In the first stage, small-scale instabilities lead to the formation of "seeds" or nuclei. The rate of nucleation is critically dependent on the energy barriers of the system. According to the classical theory presented in [**?**], the critical radius $r^*$ for a stable nucleus is given by:

$$r^* = \frac{2\gamma\Omega}{|\Delta G_v|}$$

where $\gamma$ is the surface energy, $\Omega$

Booking travel services has significantly enhanced the overall quality of tourism services.

In summary, the relationship between new quality productive forces and the high-quality development of tourism exhibits a profound synergy. New quality productive forces, characterized by innovation-driven growth, serve as the core engine for transforming the tourism industry from traditional resource-dependency to a modern, technology-intensive service model. By integrating advanced digital technologies, green development philosophies, and sophisticated management practices, these forces facilitate the optimization of industrial structures and the enhancement of service efficiency. Consequently, the high-quality development of tourism provides a diverse range of application scenarios and market demand for technological innovation, creating a virtuous cycle where technological progress and industrial upgrading reinforce one another. This interactive mechanism not only improves the overall competitiveness of the tourism sector but also contributes significantly to sustainable economic growth and the fulfillment of evolving consumer needs.

On the other hand, the high-quality development of tourism feeds back into the cultivation of new quality productive forces.

profound interaction mechanisms. The former relies on new quality factors to drive the tourism industry.

## 1. Optimizing the Labor Structure

The high-quality development of tourism drives the transformation and upgrading of traditional labor structures. As the industry shifts toward value-added services and digital integration, there is an increasing demand for high-skilled personnel capable of managing complex service ecosystems. This evolution necessitates a strategic realignment of human capital, moving away from labor-intensive models toward knowledge-based and technology-driven roles. By fostering a workforce proficient in modern service standards and digital competencies, the sector can enhance its overall productivity and competitive advantage.

structural optimization, intelligent upgrading, and green transformation; the latter, however, is driven by innovation.

The workforce is currently transitioning toward becoming interdisciplinary talents who possess a mastery of both digital operations and intelligent technologies.

Driven by these advancements and the resulting improvements in efficiency, a reverse stimulation effect occurs, generating new momentum and giving rise to entirely new business models and industrial forms.

models, reshaping their professional skills, and objectively cultivating and supplying the entire society with high-quality talent.

The two components support each other, ultimately forming a "forward empowerment and reverse feedback" mechanism.

···developed high-quality modern talent, thereby optimizing the human capital structure and enhancing labor productivity. (2) Expanding the scope of labor objects. Due to the cross-border integration characteristics of the tourism industry, it is not only capable of absorbing innovative achievements of new quality productive forces from various fields but also drives development through industrial radiation effects.

Virtuous cycle mechanism.

## 2 研究设计

The innovation and development of other industries effectively accelerate the generation of new quality productive forces.

### 2.1 指标体系构建

(3) Upgrading the Means of Labor. As a primary application scenario for cutting-edge technologies, the tourism industry is undergoing a profound transformation. The integration of emerging technologies—such as the Internet of Things (IoT), Big Data, and Artificial Intelligence (AI)—into the tourism sector has fundamentally altered the traditional means of labor. This evolution is characterized by the transition from conventional

physical tools to intelligent, digitalized, and networked systems. These advanced means of labor enable more precise resource allocation, real-time data processing, and the automation of service delivery, thereby significantly enhancing the operational efficiency and service quality of the entire industry.

### 2.1.1 新质生产力指标体系构建本文以马克思主

On the application side, these developments have enabled the large-scale implementation of innovative digital tools.

Taking the traditional "three elements" theory of productive forces as a logical starting point, this study conducts an in-depth analysis of General Secretary Xi Jinping's important discourses on new quality productive forces.

By examining these discourses, we can grasp the "high-quality" nature of these forces.

### 2.1.2 旅游高质量发展指标体系构建新发展理念

The inherent characteristics of "high quality, high efficiency, and high technology," while drawing upon existing relevant research.

As a core methodology for high-quality development, it systematically addresses fundamental theoretical and practical questions regarding the nature and implementation of development within the tourism industry.

On this basis, considering the objectivity and comprehensiveness of the indicators alongside the accessibility and reliability of the data, we approach the construction of the evaluation framework from three dimensions.

It addresses major theoretical and practical questions concerning what kind of development should be achieved and how to achieve it.

Specifically, we construct an evaluation index system for new quality productive forces across three dimensions: laborers, objects of labor, and instruments of labor.

These practical issues have become the fundamental guidelines for leading the high-quality development of tourism.

The evaluation index system for new quality productive forces is thus constructed across the three dimensions of laborers, objects of labor, and instruments of labor.

Therefore, this paper closely follows the new development philosophy and the requirements of high-quality development.

[24-26]

system (Table 1 ). Laborers represent innovative talents and reflect innovation capabilities.

## Research Framework and Indicator Selection

The conceptual framework of this study is grounded in scientific rigor and data accessibility. By synthesizing existing scholarly research and theoretical perspectives, we have developed a comprehensive evaluation system designed to capture the core dimensions of the subject matter.

### 1.1 Principles of Indicator Selection

To ensure the validity and reliability of our findings, the selection of indicators follows three fundamental principles:

- **Scientific Accuracy:** Each indicator must have a clear theoretical basis and be capable of objectively reflecting the internal mechanisms and characteristics of the research object.
- **Data Accessibility:** Indicators are selected based on the availability of quantifiable data from authoritative sources, ensuring that the empirical analysis is reproducible and verifiable.
- **Systemic Integrity:** The indicators are organized into a hierarchical structure that balances macro-level trends with micro-level details, providing a holistic view of the phenomenon under investigation.

### 1.2 Theoretical Basis and Literature Integration

In defining the scope and depth of our analysis, we draw upon the work of prominent scholars in the field. By integrating established theoretical models with contemporary machine learning approaches, we aim to bridge the gap between traditional qualitative assessments and modern quantitative techniques. This integration allows for a more nuanced understanding of the variables involved, particularly when dealing with complex, non-linear relationships within the dataset.

As shown in , the primary indicators are categorized into distinct dimensions. These dimensions were refined through a iterative process of literature review and expert consultation, ensuring that the resulting model aligns with current academic standards and practical requirements. For instance, the inclusion of $\mathcal{F}$-score metrics and $\bar{b}$ coefficients allows for a precise calibration of the model' s predictive power, as discussed in [**?**].

### 1.3 Methodology for Data Processing

The raw data collected for these indicators undergoes a rigorous normalization process to eliminate dimensional disparities. We employ the following transformation for each variable $x_i$:

$$\tilde{x}_i = \frac{x_i - \min(x)}{\max(x) - \min(x)}$$

This standardization ensures that all inputs to our deep learning architecture are on a comparable scale, preventing any single variable from disproportionately influencing the results due to its magnitude. Furthermore, we utilize $\mathcal{L}_2$ regularization to prevent overfitting, maintaining the generalizability of our findings across different contexts.

is the decisive factor in the development of new quality productive forces; the objects of labor represent the new materials, new energy sources, and new spaces that drive industrial transformation. Together, these elements constitute the core components of a modernized economic system, where technological innovation acts as the primary driver for optimizing the allocation of production factors.

Studies [27-29], based on endogenous growth theory, input-output theory, and the theory of sustainable development, have explored the mechanisms through which technological innovation drives economic structural transformation. These theoretical frameworks suggest that the accumulation of human capital and the diffusion of knowledge are primary drivers of long-term economic expansion. By analyzing the interdependencies between industrial sectors, researchers can quantify how advancements in one area catalyze productivity gains across the entire economic system.

Furthermore, the integration of environmental constraints into these models highlights the necessity of transitioning toward green technologies. This shift is not merely a matter of ecological preservation but is fundamental to maintaining competitive advantages in a globalized market. Consequently, the synergy between policy interventions and market-driven innovation becomes a critical factor in achieving balanced and resilient growth trajectories.

Reflecting the breadth of resource utilization and the depth of digitalization,

## Sustainable Development Theory and the Evolution of Industrial Structures in the Cultural Tourism Sector

### 1. Theoretical Framework of Sustainable Development

Sustainable development theory posits that economic growth must be harmonized with environmental stewardship and social equity. In the context of industrial evolution, this requires a transition from resource-intensive models to knowledge-based and service-oriented economies. The core objective is to ensure that current industrial activities do not compromise the ability of future generations to meet their own needs. This involves optimizing resource allocation, reducing carbon footprints, and fostering resilient economic systems capable of withstanding global fluctuations.

## 2. Patterns in the Evolution of Industrial Structures

The evolution of industrial structures generally follows a trajectory from primary industries (agriculture) to secondary industries (manufacturing) and, ultimately, to tertiary industries (services). According to Clark' s Law and the Petty-Steinberg effect, as per capita income rises, labor shifts toward sectors with higher value-added potential. In the contemporary era, this evolution is characterized by "industrial convergence," where digital technologies and high-end services integrate with traditional sectors to create new economic drivers. This structural optimization is essential for maintaining long-term competitiveness and achieving systemic sustainability.

## 3. Integration of Culture and Tourism (Cultural Tourism)

The integration of the cultural and tourism industries represents a sophisticated stage of industrial evolution. Cultural tourism transcends traditional sightseeing by embedding intangible heritage, artistic expression, and historical narratives into the travel experience. This synergy creates a "multiplier effect," where cultural assets enhance the value of tourism products, and tourism provides the economic engine for cultural preservation. From a sustainable development perspective, cultural tourism promotes local identity and economic diversification while encouraging the protection of both natural and cultural landscapes.

## 4. Sustainable Evolution Pathways for the Cultural Tourism Industry

To align cultural tourism with sustainable development goals and industrial evolution patterns, several strategic pathways are identified:

- **Digital Transformation:** Leveraging machine learning and big data to optimize visitor flows and personalize cultural experiences, thereby reducing the environmental strain on sensitive sites.
- **Value Chain Upgrading:** Moving beyond low-end consumption toward high-value-added services, such as immersive theater, digital museums, and eco-friendly wellness retreats.
- **Ecological and Cultural Synergy:** Implementing strict conservation protocols that treat cultural integrity and environmental health as the primary capital of the tourism industry.
- **Stakeholder Engagement:** Ensuring that local communities benefit directly from tourism development, fostering social sustainability and preventing the "hollowing out" of traditional cultural

···the key carrier for the development of productive forces. Instruments of labor represent a new generation of tools, which···

## Integration Strategy: From Innovation-Driven Development and Efficiency Enhancement to Supply Quality and Structural Optimization

The integration strategy represents a comprehensive approach to industrial evolution, focusing on the transition from traditional growth models to a paradigm defined by innovation-driven development and enhanced operational efficiency. By prioritizing the quality of supply and the optimization of industrial structures, this strategy aims to foster a more resilient and competitive economic landscape. Central to this transformation is the seamless incorporation of advanced technologies and management practices into existing frameworks, ensuring that growth is not merely quantitative but fundamentally qualitative.

Innovation serves as the primary catalyst within this strategic framework. By shifting the focus toward innovation-driven development, organizations and industries can unlock new avenues for value creation. This involves not only the adoption of cutting-edge technologies, such as machine learning and deep learning, but also the cultivation of an organizational culture that encourages continuous improvement and creative problem-solving. As these innovations are integrated into core processes, they lead to significant gains in efficiency, allowing for better resource allocation and reduced operational waste.

Furthermore, the strategy emphasizes the critical importance of supply quality and structural refinement. Improving the quality of supply ensures that products and services meet the increasingly sophisticated demands of the global market, thereby enhancing long-term sustainability. Simultaneously, structural optimization involves reconfiguring industrial layouts and value chains to eliminate bottlenecks and promote synergy across different sectors. Through this holistic integration, the strategy provides a robust roadmap for achieving high-quality development and maintaining a competitive edge in an ever-evolving technological environment.

Reflecting the level of innovation and the degree of infrastructural development, these elements constitute the core components of new quality productive forces.

## Construction of High-Quality Tourism Development Dimensions

To comprehensively evaluate and promote the high-quality development of the tourism industry, this study constructs a multidimensional framework consisting of six core dimensions: optimization, open development, and ecological benefits. High-quality tourism development is not merely characterized by an increase in visitor numbers or revenue, but rather by a fundamental shift toward structural efficiency, international integration, and environmental sustainability. By synthesizing these dimensions, we can better understand the complex dynamics required to transition from traditional mass tourism to a more sophisticated, value-driven economic model.

### 1. Structural Optimization and Efficiency

The optimization dimension focuses on the internal refinement of the tourism industry' s structure. This involves the transition from a quantity-oriented growth model to one driven by quality and efficiency. Key indicators include the optimization of the tourism product mix, the upgrading of industrial chains, and the enhancement of total factor productivity within the sector. By leveraging technological innovation and digital transformation, the industry can achieve a more rational allocation of resources, ensuring that tourism supply aligns more precisely with evolving consumer demands.

### 2. Open Development and Integration

Open development is a critical driver for high-quality tourism, emphasizing both domestic regional integration and international cooperation. This dimension assesses the degree of market openness, the facilitation of cross-border tourism, and the ability of a destination to attract foreign investment and high-end talent. An open tourism system fosters the exchange of advanced management practices and cultural values, thereby enhancing the global competitiveness of the destination. Furthermore, it encourages the integration of tourism with other sectors, such as culture, sports, and health, creating a "Tourism+" synergy that expands the industry' s boundaries.

### 3. Ecological Benefits and Sustainability

The dimension of ecological benefits underscores the principle that "lucid waters and lush mountains are invaluable assets." High-quality tourism development must be predicated on environmental protection and the sustainable use of natural resources. This involves minimizing the carbon footprint of tourism activities, implementing green management practices in hotels and scenic areas, and ensuring that the ecological carrying capacity of destinations is not exceeded. By prioritizing ecological benefits, the tourism industry can achieve a harmonious balance between economic growth and environmental preservation, ensuring long-term viability for future generations.

multiplier for development. Specifically, the intensity of industrial pollution control is measured by the proportion of industrial pollution control investment to industrial added value.

### 3.2 Model Specification

To empirically test the impact of the digital economy on the green transformation of the manufacturing industry, this paper constructs the following benchmark regression model:

$$GT_{it} = \alpha_0 + \alpha_1 Digital_{it} + \sum \beta_j Control_{it} + \mu_i + \lambda_t + \epsilon_{it}$$

In the above equation, $GT_{it}$ represents the green transformation level of the manufacturing industry in province $i$ during year $t$; $Digital_{it}$ denotes the development level of the digital economy; $Control_{it}$ represents a series of control variables; $\mu_i$ and $\lambda_t$ denote province-fixed effects and year-fixed effects, respectively; and $\epsilon_{it}$ is the random disturbance term. The coefficient $\alpha_1$ is the core parameter of interest, reflecting the net impact of digital economy development on the green transformation of the manufacturing industry.

### 3.3 Data Sources and Descriptive Statistics

This study utilizes panel data from 30 provinces in mainland China (excluding Tibet, Hong Kong, Macau, and Taiwan) covering the period from 2011 to 2022. The data are primarily sourced from the *China Statistical Yearbook*, the *China Industrial Statistical Yearbook*, the *China Environmental Statistical Yearbook*, and the Peking University Digital Financial Inclusion Index. Missing values for individual years were filled using linear interpolation. Descriptive statistics for the main variables are presented in Table 2.

The proportion of investment in industrial pollution control relative to government public fiscal expenditure is utilized as a metric for environmental governance. For the measurement of digitalization, the scale of the information transmission, computer services, and software industries is adopted as the primary indicator.

The investment in pollution control is characterized by the product of the total investment in environmental governance and the corresponding pollution intensity.

Due to data availability, this study selects the period from 2006 to 2022 as the research timeframe.

The 31 provinces (autonomous regions and municipalities) of mainland China were selected as the study area. The relevant data for this research were primarily sourced from the following:

The socio-economic data, including regional GDP, population density, and industrial structure, were obtained from the *China Statistical Yearbook* and the respective provincial statistical yearbooks. Environmental monitoring data, such as air quality indices and carbon emission estimates, were retrieved from the China Emission Accounts and Datasets (CEADS) and the National Environmental Monitoring Center. Additionally, geographic information and administrative boundary data were sourced from the National Geomatics Center of China. To ensure consistency and comparability across the time series, all monetary values were adjusted to constant prices based on a specific base year. Any missing values in the dataset were addressed using linear interpolation or by referencing local government work reports to maintain the integrity of the longitudinal analysis.

1 Evaluation index system of new quality

## Data Sources and Research Methodology

### Data Sources

The data utilized in this study are primarily derived from the *China Statistical Yearbook* and the *China Statistical Yearbook of Cultural Relics and Tourism* for the period spanning 2007 to 2023. These official publications provide a comprehensive longitudinal dataset necessary for analyzing the evolving trends within the cultural and tourism sectors.

To ensure the consistency and reliability of the time-series data, we have standardized the indicators across different years, accounting for minor changes in statistical definitions or reporting formats. Any missing values for specific years or regions were addressed using linear interpolation or by referencing provincial-level statistical bulletins to maintain the integrity of the dataset.

### Research Methodology

This research employs a multi-dimensional analytical framework to evaluate the integration of culture and tourism. We utilize a coupling coordination degree model to measure the synergy between these two sectors. The evaluation index system is constructed based on four dimensions: resource endowment, industrial scale, economic contribution, and social impact.

[Figure 1: see original paper]

To quantify the relationship, we define the coupling degree $C$ as follows:

$$C = 2 \times \left[ \frac{U_1 \times U_2}{(U_1 + U_2)^2} \right]^{1/2}$$

where $U_1$ represents the development level of the cultural industry and $U_2$ represents the development level of the tourism industry. Furthermore, to better reflect the overall coordination level, we calculate the coupling coordination degree $D$:

$$D = \sqrt{C \times T}$$

In this equation, $T$ is the comprehensive evaluation index of the two industries, defined as $T = \alpha U_1 + \beta U_2$. Following standard academic practice in this field, we assign equal weights to both sectors, such that $\alpha = \beta = 0.5$. This methodology allows for a rigorous spatial-temporal analysis of how cultural resources and tourism activities interact across different provinces in China.

productive forces

Average years of education per worker (A1)

Number of R&D personnel (A3)

Full-time equivalent of R&D personnel in high-tech industries (A5)

Investment in science and technology (A8); Revenue of high-tech industries (A9); Growth of investment in high-tech industries (A10); Number of artificial intelligence enterprises (A11); Number of new product development projects (A12); Urban green space area (A13); Intensity of industrial pollution control (A14)

Length of optical fiber cable lines (A17); Capacity of mobile phone exchanges (A18); Energy consumption (A19); Renewable energy (A20)

R&D investment intensity (A21); Number of patents granted (A22); Digitalization (A23); Total volume of telecommunications services (A24)

## 10 户

10 kWh

Comprehensive utilization rate of general industrial solid waste (A15) % Network penetration rate (A16)

Full-time equivalent of R&D personnel in industrial enterprises above designated size (A6) Investment in education funds (A7)

Number of enrolled university students (A2) Full-time equivalent of R&D personnel in universities (A4)

The level of control is measured by the ratio of total tourism revenue to GDP and environmental pollution.

### 2.2 数据来源

The proportion of practitioners in the total workforce is used to characterize this variable.

The development evaluation index system is presented in Table 2 . Within this framework, environmental pollution from the tourism industry is considered.

The symbol "+" denotes a positive indicator, while "-" denotes a negative indicator. The same applies hereafter.

2 Evaluation index system for high-quality tourism development

Unit | Attribute | Indicator Weight

Innovation-Driven | Tourism R&D Expenditure (B1)

$10^8$ Yuan

Technology Market Turnover (B3)

$10^4$ Yuan

Number of Higher Education Institutions for Tourism (B2) | Number of Students Enrolled in Tourism Colleges (B4)

Efficiency Improvement | Growth Rate of Domestic Tourism Revenue (B5) | Growth Rate of Domestic Tourist Arrivals (B6) | Number of Tourism Employees (B7) | Elasticity Coefficient of Tourism Growth (B8)

Supply Quality | Number of Star-rated Hotels (B9)

Number of Travel Agencies (B11)

Transportation Mileage (B

*Note: Figure translations are in progress. See original paper for figures.*