DISCUSSING THE CLASSIFICATION OF TOURISM INFRASTRUCTURE FROM THE PERSPECTIVE OF SUSTAINABLE DEVELOPMENT

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Abstract. Tourism infrastructure is the core support for the development of tourism destinations, and its classification system directly affects the efficiency of resource allocation and the realization of sustainable development goals. This study systematically sorts out the classification framework of tourism infrastructure from the three-dimensional perspective of sustainable development (economic, social, and environmental), and proposes a dual classification system based on functional attributes and sustainable performance. The study found that traditional function-oriented classifications (transportation, accommodation, catering, entertainment, etc.) failed to fully reflect the sustainable attributes of infrastructure. After introducing the sustainability dimension, tourism infrastructure can be divided into three categories: traditional, improved and eco-innovative. The study suggests that the planning and management of tourism infrastructure should go beyond a single functional perspective and establish a comprehensive evaluation system covering economic efficiency, social inclusion and environmental harmony.

Keywords: *tourism infrastructure; sustainable development; triple bottom line; infrastructure assessment.*

Introduction

Tourism has become one of the largest economic sectors in the world. According to statistics from the United Nations World Tourism Organization (UNWTO), tourism contributes approximately 10% of global GDP and 1 in 10 jobs [1]. However, the rapid development of tourism has posed unprecedented challenges to destination infrastructure. As the core support for the development of tourist destinations, tourism infrastructure not only determines the quality of tourist experience, but also profoundly affects the economic development, social welfare and ecological environment of the destination [2].

Since the Brundtland Report was proposed in 1987, the concept of sustainable development has become the core framework of the global development agenda. The 2030 Agenda for Sustainable Development adopted by the United Nations in 2015 established 17 Sustainable Development Goals (SDGs), of which Goal 8 (decent work and economic growth), Goal 9 (industry, innovation and infrastructure), Goal 11 (sustainable cities and communities) and Goal 12 (responsible consumption and production) are all directly related to tourism infrastructure[1].

Although the importance of tourism infrastructure has been widely recognized, the academic community has not yet reached a unified consensus on its classification system. Existing classifications are mostly based on functional attributes (such as transportation, accommodation, catering, etc.) and lack systematic consideration of the sustainability dimension. This limitation of classification leads to infrastructure planning often focusing on economic efficiency and ignoring social equity and environmental carrying capacity, which in turn leads to problems such as over-tourism, environmental depletion, and community conflicts.

In view of this, this study aims to systematically sort out the existing tourism infrastructure classification system and its limitations; reconstruct the tourism infrastructure classification framework from the perspective of sustainable development; and explore the practical significance of this classification system for tourism planning and policy formulation. The research adopts literature review and theoretical analysis methods, integrating

multidisciplinary perspectives, in order to provide theoretical support for the sustainable management of tourism infrastructure.

Literature review

Munir et al. pointed out that tourism infrastructure is "basic facilities built for the economic and social integration of tourists, taking into account community needs." The core elements of tourism infrastructure include transportation, accommodation, communication networks, tourist information, and leisure or sports facilities[2]. Mandić et al. define tourism infrastructure as a system of interrelated legal, physical and environmental elements to support tourism activities [3]. Apriyati and others believe that tourism infrastructure is the foundation of tourism development and a key factor in improving the attractiveness of a destination[4]. Sunandar et al. also showed through empirical research that high-quality infrastructure can improve tourist satisfaction and promote their return, thereby enhancing tourism competitiveness [5]. Kutlu & Ayyıldız pointed out that tourists' evaluation of attractions, cultural heritage, transportation, accommodation, shopping, entertainment, health and safety, etc., jointly affect their overall evaluation of the destination image [6]. These findings explain the continued academic focus on infrastructure issues in tourism research. Infrastructure affects people's perception of a destination's image. Jovanović and Ilić define tourism infrastructure as a multi-dimensional composite system that not only covers transportation (air, railway, highway), accommodation facilities, and catering services, but also includes communication networks, tourism information distribution systems, municipal health facilities, and dedicated sports and leisure entertainment spaces[7]. Within this broad framework, tourism infrastructure is further subdivided into two categories: "Hard Infrastructure" and "Soft Infrastructure". Hard infrastructure refers to tangible physical entities, such as airport runways, railway tracks, hotel buildings, scenic trails, municipal drainage pipe networks, etc.; soft infrastructure refers to the non-material elements that support the operation of tourism services, including human resources (foreign language tour guides, hotel managers), institutional arrangements (tourism regulations, quality certification systems), information systems (online booking platforms, destination marketing networks) and financial services (international credit card acceptance, currency exchange convenience)

Research methods

This study adopts systematic literature review and theoretical analysis methods. Deconstruct and compare the existing classification systems to identify the coverage blind spots of various systems in the sustainable development dimension. Finally, based on the TBL framework and SDGs goals, build a new classification system that integrates functional attributes and sustainable performance.

Elkington proposed the "Triple Bottom Line" (TBL) of sustainable development in 1994, emphasizing that development should simultaneously meet the requirements of the three dimensions of economic prosperity, social well-being and environmental sustainability[8]. In the tourism field, the TBL framework has been widely used in destination sustainability assessment. The United Nations Sustainable Development Goals (SDGs) provide a more specific frame of reference for the sustainable classification of tourism infrastructure. Goal 9 explicitly calls for "building resilient infrastructure, promoting inclusive and sustainable industrialization and promoting innovation." Goal 11 emphasizes "building inclusive, safe, resilient and sustainable cities and human settlements", in which the improvement of tourism infrastructure is regarded as an important way to enhance urban sustainability[1].

Badar and Bahadure proposed an evaluation tool containing seven dimensions when assessing tourism sustainability in the Indian hill town of Shimla: tourism resources, tourism activities, tourism relevance, tourism leakage, environmental and social sustainability,

infrastructure and attractions[9]. This study shows that the infrastructure dimension must be evaluated in conjunction with other sustainability dimensions to fully reflect the quality of tourism development.

Results and Discussion

The existing classification system of tourism infrastructure revolves around functional orientation, supply entities, and spatial distribution.

Function-oriented classification: Tourism infrastructure can be divided into six categories, transportation infrastructure, environmental infrastructure, information service infrastructure, cultural and leisure infrastructure, commercial service infrastructure and public safety infrastructure. The advantage of this classification is that it is highly operable and easy to manage, but its main limitation is that it treats infrastructure as an isolated functional module and ignores the interdependence and external effects between systems.

Classification of supply entities: According to the different investment and operating entities, tourism infrastructure can be divided into three categories: public sector supply, private sector supply and public-private partnership (PPP) model supply. In developing countries such as Uzbekistan, the PPP model has become an important mechanism for the development of tourism infrastructure. As of January 1, 2025, the total number of public-private partnership projects signed in Uzbekistan is approximately US$28 billion, of which approximately 90% is concentrated in the energy sector, and tourism-related projects are still relatively limited. The classification of supply entities is helpful in analyzing efficiency and equity issues under different governance models, but it lacks consideration from the perspective of sustainable development.

Spatial distribution classification: According to the coverage of infrastructure, it can be divided into international, national, regional, urban and rural, internal scenic area infrastructure and regional connectivity infrastructure. This classification highlights the impact of spatial heterogeneity on infrastructure needs but again lacks systematic consideration of sustainable performance.

Through literature research, it was found that the existing tourism infrastructure classification system has the following shortcomings:

Missing environmental dimension: Traditional functional classification treats environmental infrastructure (such as garbage disposal, sewage treatment) as functional modules parallel to other facilities, rather than as sustainable attributes across all infrastructure types. In fact, carbon emissions from transportation infrastructure, water and electricity consumption from accommodation facilities, and waste from catering facilities all have a significant impact on the environment. According to the UNWTO/ITF (2019) report, CO_2 emissions from the tourism transportation sector account for 22% of total transportation emissions, and total emissions are expected to increase from 1,597 million tons in 2016 to 1,998 million tons (an increase of 25%) by 2030 [10].

Inadequate social dimension: Existing classifications pay less attention to the social inclusion of infrastructure, such as barrier-free design for people with disabilities, accessibility to low-income groups, respect for the cultural traditions of local communities, etc. The International Labor Organization (ILO) lists 'social and economic inclusion of stakeholders' as one of the core elements in Burkina Faso's sustainable tourism strategy, emphasizing stimulating the local economy and creating jobs through the development of infrastructure and public services, and the promotion of local procurement[11].

Single economic dimension: The economic logic implicit in functional classification focuses on the service supply capacity of infrastructure, while ignoring deep economic indicators such as resource utilization efficiency, life cycle costs, and economic resilience. For

example, high tourism intensity (i.e., the ratio of overnight visitors to resident population) may indicate the risk of overtourism, leading to environmental degradation and reduced quality of life.

Insufficient system resilience: Existing classifications are mostly static frameworks that fail to reflect the infrastructure's ability to adapt to external shocks such as climate change and public health crises. For example, the COVID-19 pandemic has fully demonstrated the importance of the resilience of tourism infrastructure - tourist destinations that are overly dependent on international tourists show extremely high vulnerability to external shocks.

Based on the above analysis, this study proposes a "Dual-Dimension Classification Framework (DDCF)" for tourism infrastructure. The framework contains two orthogonal dimensions: the functional attributes dimension (horizontal) and the sustainable performance dimension (vertical).

The functional attribute dimension retains the reasonable core of traditional classification and divides tourism infrastructure into six categories:

- Transport infrastructure (roads, airports, ports, public transport)
- Accommodation infrastructure (hotels, hostels, B&Bs, campsites)
- Catering infrastructure (restaurants, cafes, fast food restaurants, street food)
- Information infrastructure (visitor centres, signage systems, digital platforms)
- Leisure infrastructure (scenic facilities, cultural venues, entertainment venues)
- Public infrastructure (water and electricity supply, sanitation system, safety facilities)

The sustainable performance dimension divides each type of infrastructure into three levels based on the triple bottom line principle:

(1) Traditional: The main goal is to meet basic functional needs, with limited consideration of sustainability. Typical characteristics include high energy consumption, high emissions, low social inclusion and low economic resilience. Examples include transportation systems that rely on fossil fuels and accommodation facilities that lack water conservation measures.

(2) Improved: On the basis of functional satisfaction, some sustainable development measures are introduced. For example, hotels that use energy-saving equipment, scenic spots with barrier-free facilities, tourist destinations that implement garbage classification, etc. Improved infrastructure represents the current mainstream practice level in the industry.

(3) Eco-innovative: Embed sustainability into the entire process of infrastructure design, construction and operation. Typical characteristics include: using renewable energy, adopting a circular economy model, realizing community co-construction and sharing, and having climate adaptability, etc. For example, eco-lodges such as Mashpi Lodge in Ecuador have achieved significant improvements in environmental performance by maximizing the use of natural light, reducing water consumption and improving air conditioning systems [12].

Based on the above discussion, this article constructs a "dual-dimensional classification matrix" of tourism infrastructure (see Table 1). The matrix cross-combines six functional types with three sustainable performance levels to form 18 analysis units, providing a structured tool for the systematic evaluation of tourism infrastructure.

Table 1

Dual-dimensional classification matrix of tourism infrastructure

Functional / Sustainability	Traditional	Improved	Eco-innovative
Transport	Fossil Fuel-dependent Transport System	Hybrid / Partially Electrified Transport	Zero-carbon Smart Transport System
Accommodation	High-energy-consumption Hotel	New Energy-supplemented Hotel Accommodation	New Energy + Waste Heat Recovery Integrated Hotel Accommodation
Catering	Single-use Product-dependent Catering	Local Sourcing / Food Waste Reduction Catering	Zero-waste Circular Catering / Direct Farm-to-table

Functional / Sustainability	Traditional	Improved	Eco-innovative
Information	Paper-based / One-way Information Dissemination	Digital / Multilingual Information Platform	Intelligent / Personalized / Accessible Information System
Recreation	High-impact Scenic Area Development	Carrying Capacity Management	Nature-based Solutions / Immersive Ecological Experience
Public Utilities	Linear Emission Water-Electricity-Sanitation System	Water & Energy Conservation / Waste Sorting System	Closed-loop Circular / Renewable Energy Infrastructure

This dual-dimensional framework provides a systematic assessment tool for tourism infrastructure planning in tourist destinations. Planners can determine target performance levels for various types of infrastructure based on the destination's resource endowment and stage of development. For example, for ecologically fragile areas, priority should be given to the development of ecologically innovative infrastructure; while for economically underdeveloped areas, basic functions can be guaranteed while gradually transitioning to improved infrastructure.

This study integrates functional attributes and sustainable performance into a dual-dimensional framework, enriching the perspective of sustainable development in tourism infrastructure classification. Traditional classifications are mostly static descriptions. This framework introduces the evolution path of "traditional-improved-eco-innovative", reveals the dynamic process of sustainable transformation of tourism infrastructure, and provides a standardized reference for the sustainability monitoring of tourism infrastructure. Specific indicators (such as energy consumption intensity, carbon emission intensity, community participation, economic leakage rate, etc.) can be combined to establish a hierarchical assessment system and carry out green certification or sustainable development rating accordingly.

Despite the theoretical superiority of the dual-dimensional framework, its implementation faces the following challenges:

Data acquisition is difficult. Quantitative assessment of sustainable performance requires a large amount of micro-data support, and many developing countries lack a systematic tourism infrastructure statistical system. Response strategies include: establishing internationally unified data collection standards; using big data and remote sensing technology to supplement traditional statistics; and encouraging companies to voluntarily disclose sustainability information.

Cost-benefit trade-offs. The upfront investment in eco-innovative infrastructure is usually higher than that of traditional infrastructure, which may inhibit the willingness of the private sector to participate. Response strategies include: designing reasonable subsidy and tax incentive mechanisms; promoting the PPP model to spread risks; developing green financial instruments (such as green bonds, sustainable development-linked loans).

Stakeholder coordination. Infrastructure upgrades often involve the interests of governments, enterprises, communities, tourists and other parties, making coordination difficult. Response strategies include: establishing an inclusive governance mechanism; conducting community participatory planning; and introducing third-party evaluation and supervision.

Technology transfer barriers. There is a capability gap in developing countries in eco-innovation technologies. Response strategies include: strengthening international technical cooperation; establishing a regional knowledge sharing platform; and cultivating local professional talents.

Conclusion

From the perspective of sustainable development, this paper systematically examines the limitations of the existing tourism infrastructure classification system and constructs a dual-

dimensional classification framework that integrates functional attributes and sustainable performance. The main conclusions are as follows:

The existing function-oriented tourism infrastructure classification system has significant blind spots in sustainable development. The environmental dimension, social dimension and system resilience dimension are insufficient, resulting in infrastructure planning focusing on short-term economic benefits and ignoring long-term sustainability. Based on the triple bottom line principle and SDGs goals, tourism infrastructure is divided into three levels: traditional, improved and eco-innovative, which intersect with six major functional types to form 18 analysis units, providing a structured tool for system evaluation. The dual-dimensional classification framework has multiple application values, including policy formulation, investment guidance, monitoring and evaluation, and international comparison. However, its implementation faces challenges such as data acquisition, cost-effectiveness, interest coordination, and technology transfer, and requires further exploration and improvement.

The sustainable transformation of tourism infrastructure is a gradual process, and different regions should develop differentiated transformation paths based on their own development stages and resource endowments. Developed countries can take the lead in realizing the popularization of eco-innovative infrastructure, while developing countries should gradually promote improved upgrades while ensuring basic functions.

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