Optimization Strategies for Transportation and Tourism Integration along National Highway 310 (Gansu–Qinghai Section)

ZHAO Jiarong, BAO Xue

(School of Architecture and Urban Planning, Lanzhou Jiaotong University, Lanzhou, Gansu 730070, China)

Abstract A systematic analysis is performed to assess the current situation of transportation and tourism integration in 20 districts and counties located along National Highway 310 (Gansu-Qinghai section), and optimization strategies are explored based on the findings of this analysis. The findings indicate a pressing necessity for further improvement in the practice of transportation and tourism integration in both Gansu and Qinghai provinces. Based on this foundation, a development framework for transportation and tourism integration has been established. This framework simulates a "fast-forward-slow-travel" system in which tourists commence their journey from the origin, traverse through core, secondary, and subsidiary tourist destinations, and ultimately reach the core, secondary, and subsidiary attractions. Furthermore, this study presents optimization recommendations for the integrated development of regional transportation and tourism along the designated route. These suggestions encompass the establishment and optimization of facilities and service points, the planning and design of tourism routes, the promotion of regional synergistic development, the construction of intelligent tourism, and the implementation of green tourism pathways.

Keywords Transportation and tourism integration, National Highway 310 (Gansu-Qinghai section), Optimization strategy

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In contemporary society, transportation networks and emerging cultural and tourism industries have emerged as significant contributors to economic growth and social development. The integration of these two sectors has garnered considerable attention on a global scale[1]. Particularly in China, the ongoing advancement of "the Belt and Road Initiative" has positioned the Gansu-Qinghai region as a strategic hub linking Central Asia and West Asia. Its multicultural characteristics and abundant cultural tourism resources increasingly underscore its significant value. The relevant policies explicitly emphasize the necessity of enhancing synergistic cooperation among the eastern, central, and western regions[2]. Furthermore, they advocate for the efficient allocation of resources and the coordinated development of regional economy.

1 Research background and regions

This study focuses on 20 districts and counties situated along National Highway 310 (Gansu–Qinghai section), as illustrated in Fig.1. The specific areas include Maiji District, Qinzhou District, Qin'an County, Gangu County, Wushan County, Tongwei County, Longxi County, Weiyuan County, Lintao County, Linxia City, Linxia County, Kangle County, Hezheng County, Jishishan Autonomous County, Minhe Autonomous County, Xunhua Autonomous County, Hualong Autonomous County, Jianzha County, Guide County, and Gonghe County.

2 Current situation of transportation and tourism integration

2.1 Current situation of Gansu–Qinghai regional integration

In recent years, Gansu Province and Qinghai Province have made significant advancements in the construction of transportation infrastructure. As of July 2024, the primary framework of Gansu Province's comprehensive three-dimensional transportation network, consisting of "three corridors and six channels", had been successfully established. Statistics indicate that the total highway mileage within the province has reached 158,200 km, with 86% of 5A-level scenic spots being accessible via highways or first-class roads. In terms of railroad construction, the total operational mileage has attained 5,765 km, with all ten prefecture-level cities within the province being accessible by rail[3]. The main body of the third-phase expansion project at Lanzhou Zhongchuan International Airport has been successfully completed, resulting in an optimized airport layout characterized by "one main trunk and eight subsidiary branches". As the "fast-forward-slow-travel" transportation and tourism network system continues to evolve, the province's transportation network is transitioning from a basic adaptation stage to a new phase of appropriate advancement. It is important to note that Gansu Province continues to encounter challenges in the development of transportation and tourism integration, including regional development imbalances and insufficient allocation of resources. Therefore, there is a pressing need to innovate development concepts and optimize pathways to elevate the integration of transportation and tourism to a higher level.

By the end of 2023, the total length of roads in Qinghai Province had reached 89,400 km. The construction of transportation infrastructure has yielded significant outcomes, resulting in the establishment of a multi-tiered road network system that includes national highways, provincial highways, expressways, and rural roads. The construction of a comprehensive three-dimensional transportation network, consisting of "one main axis, three corridors, and four channels", not only underscores the critical significance of the Qinghai–Tibet and Gansu-Qinghai-Xinjiang axis but also facilitates effective connectivity among key economic regions, such as the Hehuang Valley, Pan–Gonghe Basin, Qaidam Basin, and the Sanjiangyuan region, through the establishment of three essential corridors[4]. In terms of tourism transportation, all 5A-level scenic spots in Qinghai Province are accessible via highways or first-class roads. Furthermore, the development of railroad infrastructure has seen a continuous increase in operational mileage, while the electrification rate of mainline railroads has remained at a high level. The construction of the air transport network has also yielded significant outcomes. The airport layout, centered around Xining Airport and supported by Golmud Airport and Yushu Airport, has effectively encompassed the entire province. Qinghai Province has proactively investigated

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the practice of transportation and tourism integration, exemplified by the development of the Qinghai Lake Ring Road, the Chaka Salt Lake Tourist Highway, and various specialized tourism routes. These efforts not only improve the accessibility of significant scenic spots but also offer tourists a diverse array of experiential options. These initiatives have successfully facilitated the comprehensive integration of transportation and tourism, thereby infusing new vitality into regional economic and social development.

2.2 Current situation of regional inte–gration along the route

The National Highway 310 (Gansu–Qinghai section) serves as a major traffic artery linking Gansu and Qinghai. This region presents an exemplary case for examining the integration of highway transportation and tourism, given the abundance of both natural and cultural tourism resources located along its route. The present transportation status of the region along the designated route, as well as the 343 cultural tourism resource points that have been compiled, is illustrated in Fig.2. From a macroscopic perspective, the transportation corridor along National Highway 310 facilitates the distribution of cultural tourism resources, resulting in the areas along the route becoming the most concentrated zones for such resources. This phenomenon not only underscores the significant role of transportation networks and infrastructure in fostering the development of cultural tourism, but also elucidates the intricate relationship between the diverse characteristics of nature and culture and the geospatial distribution[5]. Secondly, the various types of cultural and tourism resources, along with their uneven geospatial distribution, are clearly illustrated in the figure. This distribution is influenced by multiple factors, including topography, climate, hydrology, and historical development and evolution. As a result, distinctive and complementary areas rich in cultural and tourism resources have emerged, creating unique tourism zones. This uneven distribution not only offers a differentiated resource base for transportation and tourism integration but also presents both challenges and opportunities for the coordinated development of regional tourism. From the perspective of cultural diversity, the cultural and tourism resources of the regions along the route are characterized by rich cultural connotations and unique folk customs. The distribution of these cultural and tourism resources exhibits traits of diversity, imbalance, and a close dependence on transportation corridors. In the endeavor to promote the development of transportation and tourism integration, it is essential to fully leverage the advantages of resource endowment and geographical conditions. This includes strengthening regional tourism cooperation and fostering the coordinated development of transportation. Furthermore, it is imperative to achieve the sustainable utilization of cultural and tourism resources, as well as to facilitate the

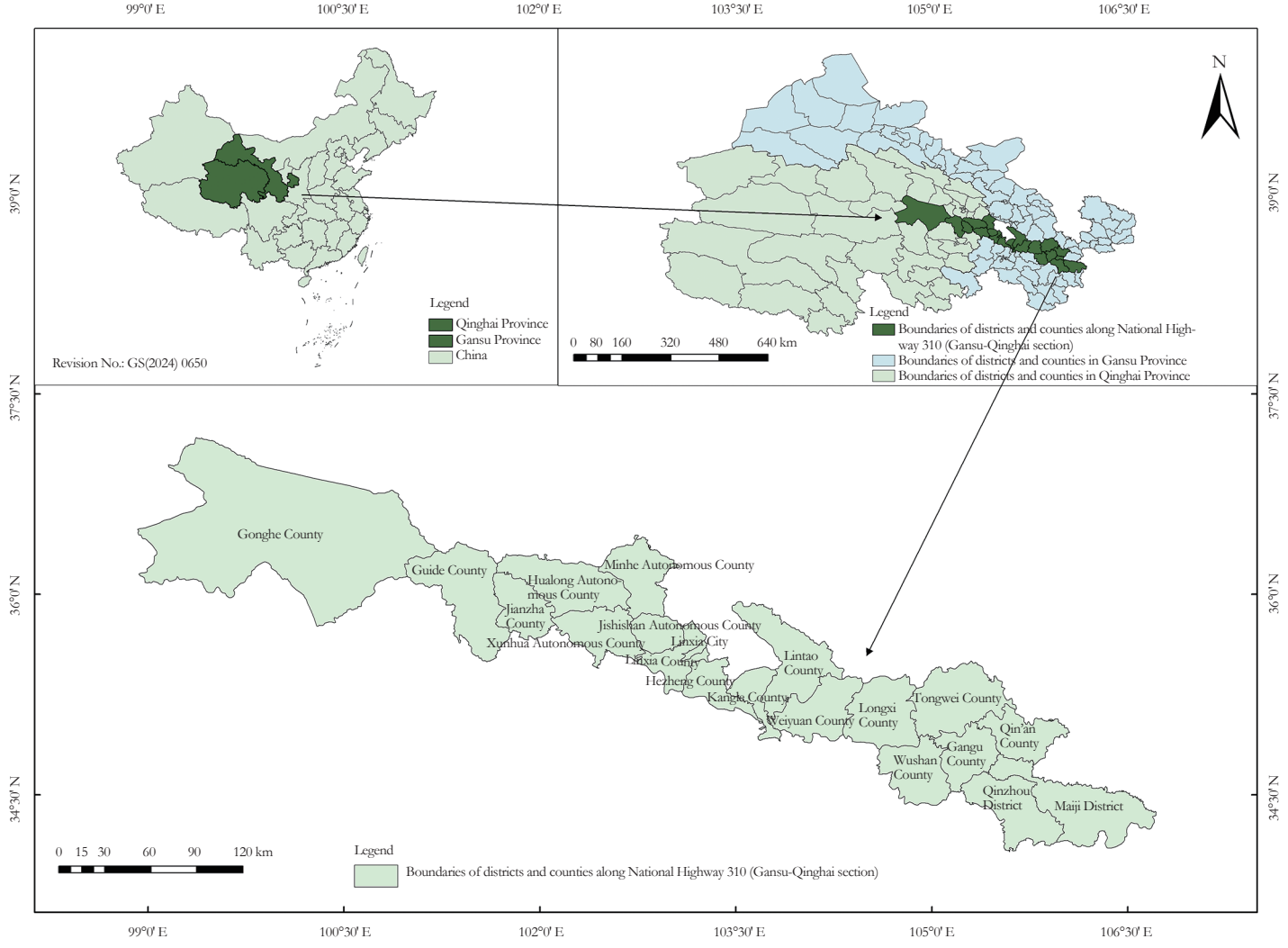

Fig.1 Location of study regions

transformation and upgrading of the tourism industry.

3 Optimization strategies

3.1 Transportation and tourism integration development system

Transportation infrastructure across the 20 districts and counties within the study area is not keeping pace with the level of tourism development, exhibiting varying degrees of lag. The development of transportation and tourism integration constitutes a complex and multifaceted system influenced by numerous factors. Consequently, addressing the current challenges solely based on the information gathered proves to be insufficient. Therefore, there is an urgent necessity to establish a systematic development planning framework that comprehensively addresses these issues. Fig.3 simulates a developmental system in which tourists initiate their journey from the origin, traverse through core, secondary, and subsidiary tourist destinations, and ultimately reach the core, secondary, and subsidiary attractions. The design aims to establish a "fast-forward-slow-travel" network and optimize the connectivity between "fast forward" and "slow travel". Simultaneously, based on this framework, various levels of service centers and specialized stations are established to create a simulated closed-loop for tourist travel. This approach offers both theoretical insights and practical pathways for the comprehensive integration of transportation and tourism within the region.

3.2 Optimization of facility service points

In alignment with the layout principle that emphasizes the characterization of small areas while promoting the synergization of larger areas, the arrangement of facilities and service points across the 20 districts and counties situated along National Highway 310 (Gansu-Qinghai section) has been optimized.

In light of the regional scale, the present condition of transportation and tourism integration, as well as the corresponding service demands, large-area synergization involves the careful delineation of coverage areas for primary, secondary, and tertiary service centers, thereby establishing a multi-level, networked service system.

The primary service nodes are primarily situated in areas with a high concentration of cultural and tourism resources, as well as in transportation hub cities that possess comprehensive service functions. These nodes extend their coverage over a radius of 50 to 70 km, thereby providing extensive reach and a full spectrum of services. This arrangement is designed to accommodate the diverse needs of tourists and to enhance their overall tourism experience.

The secondary service nodes are primarily situated in counties where cultural and tourism resources are densely concentrated or in proximity to significant scenic spots. These nodes possess complete service functions and extend coverage over a radius of 30 to 50 km, aiming at fulfilling the fundamental needs of tourists and enhance the overall convenience of the tourism experience.

The tertiary service nodes are predominantly situated in the periphery of cultural and tourism resource areas or along tourism highways, with a coverage range of 10 to 30 km. These nodes exhibit a smaller coverage area and provide more fundamental service functions[6], aimed at fulfilling tourists' needs for basic meals, rest, and supplies, thereby enhancing the overall comfort of the tourism experience.

The characterization of small areas pertains to the establishment of various types of featured stations that exhibit greater flexibility, tailored to the specific resource endowments and cultural attributes of each small region. This approach emphasizes regional distinctiveness while simultaneously addressing the diverse needs of tourists. For instance, Maiji District in Tianshui City utilizes the cultural heritage of the Maiji Mountain Grottoes to establish cultural experience stations. Similarly, Linxia City, located within the Linxia Hui Autonomous Prefecture, utilizes its historical and cultural districts, specifically the Eight Square and Thirteen Alleys, to establish cultural experience stations. Additionally, Guide County in the Hainan Tibetan Autonomous Prefecture capitalizes on the Yellow River Qing National Wetland Park to develop ecological sightseeing stations. This layout optimally utilizes regional resources, thereby enhancing the appeal of tourism[7]. By implementing this synergistic arrangement, the present study aims to achieve a balanced spatial distribution of service facilities and functional complementarity, addressing the diverse needs of various regions and distinct groups of tourists.

3.3 Tourism route design

The planning and design of tourism routes is a fundamental aspect of the integration between tourism and transportation. The quality of these designs significantly influences both the experiences of tourists and the overall appeal of regional tourism. Nevertheless, numerous deficiencies persist in the current tourism routes, particularly concerning resource integration, transportation connectivity, and the overall experience of tourists. Therefore, the study established two specific thematic lines: the culture of the Ancient Tea Horse Road and the culture of the Yellow River. The thematic line associated with the culture of the Ancient Tea Horse Road is centered on the "Longyou ancient road and trade culture", encompassing nine districts and counties: Maiji District, Qinzhou District, Qin'an County, Gangu County, Wushan County, Tongwei County, Longxi County, Weiyuan County, and Lintao County. These regions are situated within the radiation range of Gansu-Qinghai section and have historically maintained a significant connection to the tea horse trade. This relationship serves to illustrate the broader impact of ancient road trade culture. The primary node has been designated as Maiji District, whereas the secondary nodes have been identified as Qinzhou District, Longxi County, and Lintao County. The thematic focus of the Yellow River cultural special line encompasses "Hehuang Culture and the River Landscape", which includes 11 counties and districts in the upper reaches of the Yellow River: Kangle County, Hezheng County, Linxia City, Linxia County, Jishishan Autonomous County, Minhe Autonomous County, Hualong Autonomous County, Xunhua Autonomous County, Jianzha County, Guide County, and Gonghe County. This cultural line effectively captures the distinctive characteristics of the integration between ethnic culture and the natural landscape in the region. The primary nodes are established in Linxia City and Gonghe County, while the secondary nodes are identified in Minhe Autonomous County, Xunhua Autonomous County, and Guide County. This configuration effectively illustrates the typical characteristics of the composite system of nature and humanity in the upper reaches of the Yellow River.

3.4 Regional synergistic development

The establishment of a policy coordination mechanism serves as the foundation for regional synergistic development. It is imperative for regions to formulate systematic tourism development policies, delineate their respective responsibilities and obligations, and foster regional cooperation[8]. This study focuses on the Maiji District, Qinzhou District, and other districts and counties within the research area that possess abundant cultural and tourism resources. It aims to establish policy linkages with neighboring counties, such as Qin'an County and Gangu County, to collaboratively develop tourism development plans, intending to ensure the rational allocation

and efficient utilization of resources. Furthermore, through coordinated policies, the initiative seeks to address the existing deficiencies in regional synergistic mechanisms and enhance the overall competitiveness of regional tourism. In light of the establishment of a policy coordination mechanism, it is imperative for each region to advance the implementation of initiatives that emphasize the development of a regional tourism resource-sharing platform. This approach should foster a regional linkage effect through collaborative promotional efforts, thereby providing essential support for synergistic development. Such measures will facilitate the efficient sharing of cultural and tourism resources, as well as information services, significantly improving the effectiveness of resource utilization and extending the cultural and tourism industry chain.

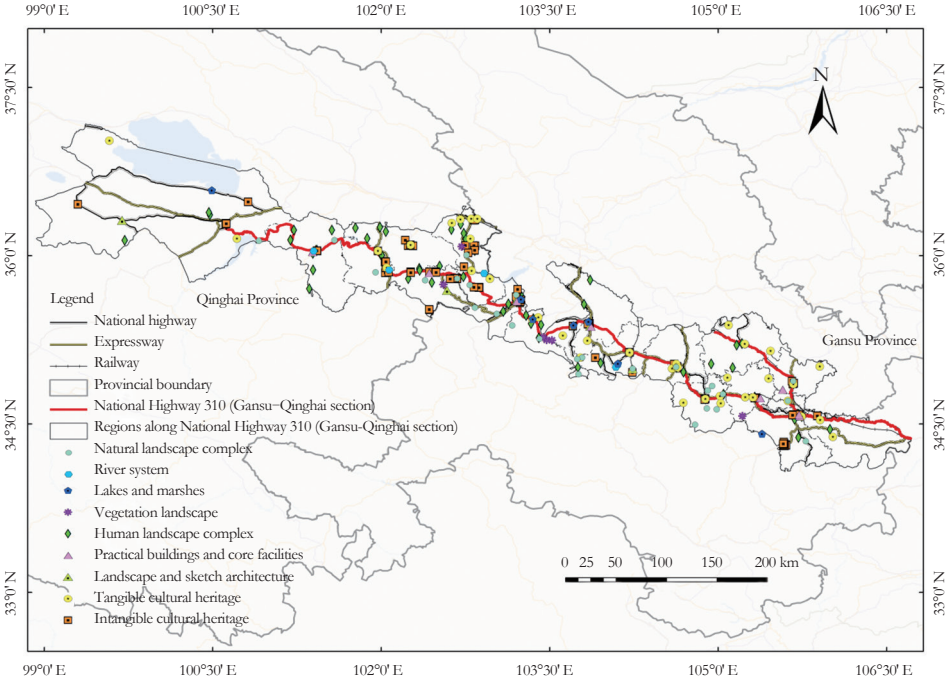

Fig.2 Current situation of transportation and tourism distribution along National Highway 310 (Gansu–Qinghai section)

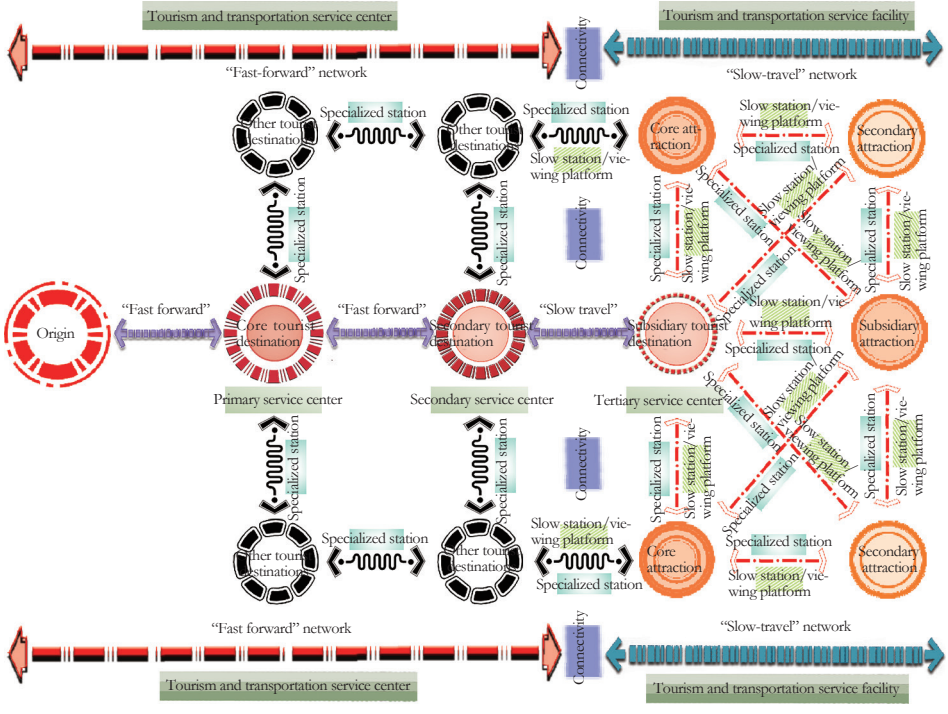

Fig.3 Transportation and tourism integration development system

3.5 Smart tourism construction

The cultural and tourism resources of the 20 districts and counties along National Highway 310 (Gansu–Qinghai section) are abundant and diverse, encompassing natural landscapes, historical culture, folk customs, and other dimensions. To achieve a comprehensive integration of highway transportation and tourism, it is essential to establish a platform for resource sharing. The information-sharing platform serves as a foundation for the synergistic development of regional tourism. By establishing a unified tourism information platform, comprehensive one-stop information services can be offered to tourists. It is proposed to take a leadership role in the promotion of intelligent transportation service systems at key tourist attractions. This initiative aims to integrate real-time data regarding road conditions, passenger flow, parking availability, and other relevant factors, thereby providing tourists with precise travel guidance. When the conditions are favorable, the initiative will progressively expand its coverage to the adjacent districts and counties, ultimately establishing a smart tourism and transportation service system that connects the entire region[9]. This will facilitate an integrated development pattern characterized by data sharing, service synergy, and emergency coordination within the area. This phased promotion strategy acknowledges the disparities in regional economic development while simultaneously enhancing the quality of services in tourism and transportation. This approach aligns with the current policy direction aimed at the integrated development of intelligent tourism and transportation.

3.6 Green tourism pathway practice

The green tourism pathway serves as a crucial entry point for achieving sustainable development of regional tourism. The fundamental objective is to promote low-carbon, ecological, and sustainable tourism development through the dissemination and practice of green concepts. By considering the unique characteristics of the vertical belt spectrum, it is possible to formulate differentiated green tourism development strategies tailored to the specific needs of the region[10]. The region along the route is abundant in ecological resources, which can be leveraged to satisfy the diverse tourism demands of visitors and to improve the overall competitiveness of regional tourism through the development of thematic tourism initiatives, such as ecological adventures and cultural studies. Nevertheless, the region concurrently confronts the dual challenges

of ecological vulnerability and the pressures associated with tourism development.

The exploration of green tourism practices serves as an effective means to enhance the appeal of regional tourism while simultaneously functioning as a critical strategy for achieving a balance between ecological preservation and tourism development. By establishing cross-sectoral coordination mechanisms, improving ecological compensation policies, and innovating community participation models, and other institutional frameworks, it is possible to foster the synergistic protection of regional natural and cultural diversity. This approach promotes the development of a sustainable pattern in which humans and nature coexist harmoniously.

4 Conclusions

A systematic analysis is performed to assess the current situation of transportation and tourism integration in 20 districts and counties located along National Highway 310 (Gansu–Qinghai section), and optimization strategies are further explored. We examine the current situation of integrated transportation and tourism development in the Gansu–Qinghai region and its surrounding areas. The findings indicate that both Gansu and Qinghai provinces face an urgent need to elevate the integration of transportation and tourism. This can be achieved through the innovation of development concepts and the optimization of operational models, thereby enhancing the comprehensive benefits of both the transportation and tourism industries. We additionally develop a framework aimed at facilitating the deep integration of road transportation and tourism. This framework simulates a "fast-forward-slow-travel" system in which tourists commence their journey from the origin, traverse through core, secondary, and subsidiary tourist destinations, and ultimately reach the core, secondary, and subsidiary attractions. Furthermore, this study presents optimization recommendations for the integrated development of regional transportation and tourism along the designated route. These suggestions encompass the establishment and optimization of facilities and service points, the planning and design of tourism routes, the promotion of regional synergistic development, the construction of intelligent tourism, and the implementation of green tourism routes. This approach offers a practice approach for the comprehensive integration of regional transportation and tourism, and enhances the experience of tourists while simultaneously extending the tourism industry chain. Furthermore, it promotes the high-quality development of regional tourism and facilitates the realization of multiple benefits across transportation, tourism, economy, and culture.

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Priority should be given to native species to fulfill essential ecological requirements while simultaneously contributing to the distinctive characteristics of the local landscape.

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