

Spatial Research and Digital Analysis of the Ancient Post Station and City Tower in Linqiong along the Southwest Silk Road

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Abstract

This study focuses on two core analytical units of Linqiong—a pivotal node along the Southwest Silk Road: its ancient post station and city gate tower. Employing digital methodologies, it reconstructs their historical spatial structures to explore innovative approaches for preserving and revitalizing linear cultural heritage. From a historical geographical perspective, the research examines Linqiong's central role in the Silk Road network, integrating textual evidence with field investigations to investigate how natural environments, topography, and transportation routes influenced its site selection and planning. It also analyzes how architectural conventions and regional cultural characteristics from the Song to Yuan dynasties shaped the spatial configurations of these architectural complexes. Building upon this foundation, a three-dimensional virtual reconstruction model incorporating multi-source data was developed, with spatial syntax analysis employed to validate its reliability. The study demonstrates that this approach effectively addresses display limitations caused by insufficient physical remains, provides visual support for interpreting and transforming cultural heritage values, facilitates a shift from static preservation to dynamic presentation, and holds significant practical reference value and potential for broader application.

Keywords: The Southwest Silk Road, The Ancient Post Station of Linqiong, The Ancient City Tower, Spatial Research, Digital Studies, Cultural Heritage Conservation

Introduction

Research Background

Due to its special location and function in cross-cultural communication, as an important channel for cultural exchange, the intersection of Eastern and Western cultures is the Southwest Silk Road in China. It brings together material remains as well as profound spiritual connotations, while also reflecting the history of interactions between many ethnic groups (Duan Yu, 2009). With the concept of cultural heritage protection evolving from simple preservation to dynamic inheritance, systematically organizing and scientifically protecting

important nodes along the route has become very necessary. Linqiong is the central point of Chengdu's external transportation and is also a typical representative of regional culture (Fang Tie, 2015).

The title of 'the first prefecture of southern Tianfu' reflects its strategic significance in local economic development (Lin Feng, 2013). The preserved Qiong bamboo staffs, Qiong kiln porcelains, ancient city wall remains, old post roads, and various other physical and spatial forms together form a vast cultural treasure. In recent years, the acceleration of urbanization has caused some historical buildings to be damaged or disappear, resulting in a serious loss of related cultural information and adversely affecting the original landscape and appearance. In this situation, using modern information technology for emergency documentation becomes particularly important. Obtaining high-precision data through 3D laser scanning technology, conducting spatial analysis and visualization with the support of GIS, and using virtual reality technology to restore scene experiences can overcome the time and space limitations of traditional field surveys and provide strong support for academic research. Using online platforms to increase the speed of dissemination allows the public to participate in specific protection practices. Based on the above context, this article primarily studies how to use digital tools to deepen the research on representative relics in the Linqiong area, attempting to create a sustainable model, thereby providing a reference for the expansion of similar topics and theoretical innovation.

Research Objective

This paper takes the Linqiong Ancient Post Station and City Gate Tower of the Southwest Silk Road as typical cases, using the theory of spatial archaeology and digital technology methods to systematically analyze their historical evolution process and functional attributes. It mainly explores their cultural value and spatial organization as important nodes in linear cultural heritage. By integrating various literature sources and field survey data, and employing modern information technologies such as 3D modeling, the spatial structure and construction components of the ancient building complex are accurately restored, providing technical support for the scientific protection of immovable cultural relics, and compensating for the technical shortcomings of traditional cultural relic preservation. The research aims to explore the practical models formed by digital achievements in aspects such as cultural heritage exhibition, public dissemination, and cross-disciplinary integration, creating a historical and cultural experience platform that blends virtual and real elements, and promoting the planning and implementation of sustainable utilization and modernization transmission of historical and cultural resources along the Southwest Silk Road.

Research Significance

This article focuses on the cultural route of the Southwest Silk Road as the research subject, selecting the Linqiong Ancient Post Station and the Ancient City Tower as two typical heritage resources for study. It employs multidisciplinary research methods, including historical geography, architectural archaeology, and digital technology, to establish a series of research frameworks for spatial analysis and three-dimensional virtual restoration.

Theoretically, it studies the spatial distribution characteristics and functional change patterns of linear cultural heritage nodes and proposes new methods and systems for the digital preservation of traditional architectural heritage (Dan Jixiang, 2012), providing theoretical

support for the restoration of other types of cultural relics. Practically, by utilizing three-dimensional laser scanning and space syntax analysis technology, it accurately reconstructs the forms of certain historical buildings, improving the scientific level of cultural heritage display in the Linqiong Ancient City, and providing a technical basis for both its preservation plans and the cultural conservation aspect of urban renewal processes. Furthermore, it actively seeks opportunities for applying digital achievements in public education, immersive experiences, and cultural dissemination, transforming cultural heritage from a unidirectional static display into an interactive multidimensional experience, enhancing the public's understanding and recognition of the historical and cultural connotations of the Southwest Silk Road, and demonstrating significant academic value and social service significance.

Research Content and Research Methods

Research Content

This paper begins with the protection of the linear cultural heritage of the Southwest Silk Road and selects the ancient Línqióng post station and ancient city tower as research objects, conducting a systematic study using the theoretical framework of spatial archaeology and digital technology. From the perspective of macro historical geography, it provides a comprehensive review of the evolution of the Lingguan Dao (Duan Yu, 2009). Relying on the geopolitical advantage of being "the first prefecture south of Tianfu," it analyzes the reasons for the site selection of the ancient post stations and city tower in the Linqiong area from two aspects: the support of natural conditions behind the site and their role in strategic defense, dissecting their functions as hubs in the Silk Road trade network and the importance of their military defense system. On a micro level, based on detailed literature and field survey data, the paper reconstructs the functional layout of the Linqiong ancient post station and the local cultural characteristics, and restores the spatial structure and defense facilities of the ancient city tower, further exploring the spatial relationship and operational coordination between the two.

The research results enrich the understanding of the material cultural heritage along the Southwest Silk Road and provide practical references and technical support for the scientific protection of such heritage. Due to the severe lack of ground relics, this paper mainly uses digital technology to establish 3D virtual models of the Linqiong ancient post station and city tower. During the research process, it follows the principle of scientific restoration, integrating archaeological data, historical records, and modern topographical survey results to accurately reproduce the spatial layout of the ancient post station and its defense system. Using professional 3D modeling software, the geometric structure and surface materials of the ancient building complex and defense facilities are meticulously reconstructed. Space syntax analysis is used to evaluate the visual perception and route accessibility of the design proposals (Liu et al., 2025), exploring the impact mechanisms of different planning schemes on military defense capabilities and traffic network operations to identify the best restoration plan. This paper also explores the potential future development of digital outcomes based on their applications in cultural heritage display, immersive experience creation, and public participation and interaction, providing systematic theoretical support and technical innovation paths for the effective protection and innovative development of the Linqiong ancient city cultural heritage.

Research Methods

This study is based on a multidisciplinary integrated methodological framework and uses a comprehensive research paradigm to ensure the rigor and theoretical value of the academic outcomes. Through systematic field investigations, the study examines the Linqiong Ancient City site and its surrounding environment, primarily conducting three-dimensional scanning and spatial coordinate collection of the Qilongshan Ancient Road remains, the Wenjing River system, and the foundations of the city walls. Professional photographic equipment is used to record the spatial forms, material characteristics, and ecological environment of existing structures, creating a complete visual dataset. Extensive historical documents are collected, including local chronicles, ancient map collections, archaeological excavation reports, and relevant academic journals, establishing a comprehensive historical information database on the Linqiong Ancient Town relay station and city tower constructions. Based on data obtained from field measurements and literature, scientific reasoning methods are used to analyze the spatial distribution patterns, functional zoning principles, and construction techniques of the ancient relay station and city tower. To enhance the objectivity of the research and social participation, semi-structured interviews were incorporated during the investigation, inviting local history experts and community residents to participate in discussions, thereby filling in critical detail gaps in oral transmission and achieving the integration of multiple lines of evidence. This lays a solid foundation for subsequent digital restoration and cultural heritage protection work.

Key and Difficult Points of Research*Research Focus*

This article mainly combines historical remains and documentary materials to accurately restore the structure and location of the Linqiong Ancient Post Station and Ancient City Tower. The study begins by sorting out the route of the Lingguan Path of the Southwestern Silk Road and its relationship with the mountainous and river systems of Linqiong Ancient City, and then analyzes the spatial positions and functional attributes of the ancient road, post station, and city tower within the regional geographic pattern, investigating the reasons for Linqiong's location as an important node on the Silk Road and the design concept of its defense system. Based on the current shortcomings in cultural heritage protection, and combined with professional understanding of the ancient post station's plan layout, functional zoning, and city tower architectural style, a spatial simulation model is established based on archaeological evidence. The ultimate aim is to transform cultural heritage from static preservation into dynamic inheritance, using methods such as 3D modeling, spatial semantic analysis, and multi-scenario virtual simulation to turn research results into interactive digital resources, and designing application programs compatible with site exhibitions, public participation, and cultural dissemination, so that academic achievements and cultural value can truly be connected.

Research Challenges

The main difficulty of this study lies in the fact that there are very few historical relics and scant documentary records in the Linqiong area, making it challenging to reconstruct the spatial layout and construction logic of the ancient Linqiong post station and city tower through scientific methods. This area is an important node on the Southwest Silk Road, and the post stations along the route have been severely damaged over time due to natural weathering and human destruction. Most of the existing physical remains are also scattered,

which poses significant difficulties in establishing a complete site framework by combining local historical and geographical records with partial surface remains such as those along the Qilong Mountain ancient road. Particularly in digital reconstruction, it is crucial to address the technical challenge of integrating multi-source heterogeneous data, that is, how to organically combine findings from field archaeology and traditional studies of historical geography with modern 3D modeling technologies.

Due to the lack of detailed architectural standards, and without understanding the local cultural background and military defense needs, it is also necessary to reasonably infer the specific structural features of the ancient city tower and its relationship with the surrounding environment based on the specific conditions of the area (Cao Huaiwen & Wang Sa, 2022; Wu Shulan, 2022). This places high demands on the researchers' interdisciplinary knowledge and comprehensive practical abilities. In terms of the application prospects for digital display, it is necessary to further explore how to improve the public's interactive experience while ensuring academic rigor, thereby enhancing the effectiveness of cultural heritage transmission. The pursuit of such a research objective, which combines both theoretical study and practical operation, is the main goal of this project.

Research Innovations

This study breaks through the traditional heritage research model that relies solely on textual verification and physical surveying, and for the first time reshapes the spatial form of the Linqiong section of the Southwest Silk Road into a new model of digital revitalization, achieving systematic integration and exploration. The research overcomes the conventional narrative constraints on ancient post stations and city defense structures, using advanced digital technologies such as space syntax to conduct quantitative analysis from multiple aspects including spatial distribution, visual transparency, traffic flow routes, and defensive functions. Furthermore, by comparing multiple models, it develops effective decision-making methods to accurately identify the spatial layout characteristics of historical remains. The study broadens the perspective which typically focuses on individual buildings, establishing a GIS-based three-dimensional historical environment reconstruction system by examining the interactions among the Qilongshan ancient road, other natural landform elements (Wenjing River), and cultural facilities (Jin Yibing & Li Simin, 2020). In practice, a scientifically reasonable and practically feasible cultural heritage revitalization model is proposed, transforming research results into public-oriented cultural heritage education products and service platforms through virtual reality technology, interactive design methods, and narrative display (Tang Tian, 2025), providing a theoretical foundation and practical reference for the sustainable protection and rational utilization of linear cultural heritage node buildings.

Literature Review

Research Status of the Southwest Silk Road and Architectural Heritage

As an important link between ancient China and the outside world, it played a significant role in the long course of history. Its route planning, process of change, and role in foreign cultural exchange have been widely recognized in academic circles. From an interdisciplinary perspective, the role of the Southwest Silk Road from the pre-Qin to the Han dynasties is studied, considering it a major route for East-West trade and a key driving force for the development of civilization and opening up in the Bashu region (Duan Yu, 2009). In the review of the historical development of this route, particular emphasis is placed on its special role as

a tool for cultural exchange (Fang Tie, 2015); From the perspective of visual cultural studies, this ancient road is explained to illustrate the artistic style influence this ancient road brought to early Chinese civilization (Elias, 2024). The Southwest Silk Road is a typical linear cultural heritage, and its conservation efforts have gradually expanded from traditional material relics to integrating regional resources and practicing sustainable development. The concept of "living" cultural heritage management emphasizes the protection of the entire ecological environment (Shan Jixiang, 2012), rather than relying solely on physical buildings or sites for repair. The Silk Road, as a cultural symbol, has attracted some attention in its current dissemination and changes (Du Yunhong, 2015).

On this issue, scholars have turned their attention to the investigation of the main infrastructure supporting the operation of the Silk Road, namely the relay stations. Through comparative analysis of relay station relics along the Northwest Silk Road and Grand Canal, it is concluded that these stations not only served transportation but also played roles in national defense construction, material allocation, and regional social integration (Cao Wei & Yao Jie, 2014); By including the Jiangnan post stations from the Yuan, Ming, and Qing dynasties, it was concluded and proven that the post station system was the key support for the operation of the bureaucratic system, playing an irreplaceable role in information transmission and maintaining public order (Yin Minzhi, 2026). A detailed analysis of the social effects of the Qing dynasty post station system was conducted, clarifying how it influenced grassroots governance (Chen Zhiping & Wu Xiaofei, 2024).

According to documentary research, the Ming dynasty Guizhou courier network changed local economic development and ethnic interaction structures (Cao Yanqiong, 2023). When facing difficulties in protecting post station sites under modern conditions, digital methods are used to collect complete heritage data and create 3D visual models to compensate for data loss caused by physical decay (Xu Xin et al., 2025); Through investigations of Liuke Villages on Hainan Island, it was found that during the preservation of post stations, some traditional stations have disappeared, but the spiritual imprint of the stations left behind has been preserved through community memories, reshaping modern social identity (Gao Yingjie et al., 2025). Existing research shows that post stations should not be regarded as isolated functional architectural groups, but rather as a spatial network composed of complex socio-political structures and integrated with multiple functions. Its deeper meaning requires in-depth analysis in relation to certain regional historical and cultural contexts.

Research Status of Ancient City Towers and Defensive Systems

The spatial layout and military functions of ancient city towers have always been a focus of academic research. In **A History of Chinese Architecture**, the historical development of ancient towers is clearly outlined, suggesting that ancient towers were not only city defense fortresses but also cultural symbols with rich cultural connotations and historical value (Liang Sicheng, 2025). Within the framework of space and power, a deeper analysis of the spatial structure of Qin and Han imperial cities is carried out, and from the perspective of political culture, it is explained that the meanings contained in urban architecture are complex and not simply within the scope of architectural functionality; it serves as a comprehensive system for ritual regulations, security needs, and other aspects, thereby strengthening the legitimacy of the regime and political authority (Lu Xiqi & Ma Jian, 2009).

The operational mechanisms of military defense systems have been recorded extensively in historical documents. Through discussions on city battle strategies during the Tang Dynasty, it is believed that city towers served as important command centers, intelligence hubs, and troop deployment nodes, playing an organizational and command role during wartime (Liang Kemin, 2023). Starting from the northern region of the Ming Great Wall, defense engineering spatial distribution is analyzed using ravine and valley units, proposing that city towers, along with city walls and passes, together form a multi-layered defense system (He Ding et al., 2023). Field investigations of Ming-era Haixi Jurchen settlements further proved that city towers played an important node role within networked defense systems (Cao Huaiwen & Wang Sa, 2022; Wu Shulan, 2022).

Research on the Ming postal system discusses the functional connections between city towers and courier stations. Regional studies, based on the spatial layout of ancient settlements along the Qinghai Silk Road southern route, show that site selection is related to the natural geographic environment and transportation networks (Jin Yibing & Li Simin, 2020). Furthermore, investigations of ancient city sites in the Hexi Corridor analyze the spatial organization patterns of ancient architectural complexes and consider their coordination with the ecological environment (Chang Yuanli et al., 2026). Studies of Han-era Silk Road village sites in Ningxia explore the spatial interactions between ancient frontier outposts and trade networks (Li Jining & Liu Wanying, 2022). Attention should be paid to the historical evolution of areas surrounding bell and drum towers within historical and cultural cities, illustrating how these landmark buildings shaped the city's visual image and influenced residents' cognitive perception (Zhu Jin, 2011). Existing research indicates that, both in macro strategic planning and micro functional construction, city towers are an essential component of the traditional military defense system.

The study of the relationship between city towers and urban spaces has become a focal topic in academic circles. Using the research paradigm of 'image-based historical documentation,' a systematic explanation was provided for the construction ideas of the ancient city of Yu Zhong in Chongqing, which follow the terrain, and it is suggested that the location of city towers was mostly chosen based on topographical features to enhance defensive functions. Through an analysis of changes in the functions and positions of city towers during the urbanization process in Chengdu in the Tang and Song periods, certain patterns were identified. Using Quanzhou Port from the Song to Yuan dynasties as an example, the mutual influence between city towers and the maritime network under the development of the port economy was explored (Lin Yuhong, 2026).

When studying the spatial structure of ancient towns along the Yellow River in Shandong Province, a deeper understanding was gained of the collaborative effects between city towers and the Yellow River flood control system (Wang Huiying et al., 2024). Literature on the modern preservation and adaptive reuse of city towers shows discussions on comprehensive renovation plans for the Xi'an City Wall from the perspective of World Cultural Heritage protection, balancing the preservation of traditional style with modern functional use. In urban planning and design, the space syntax research method was used to evaluate the impact of the Zhengding City Wall area on regional economic development. Some scholars

have studied the value, impact, and cultural significance of cultural heritage based on two different cultural backgrounds. Current research indicates that city towers are complex cultural relics: they are an important part of the military defense system and also a symbolic marker of local culture (Wei Yifei, 2024). In the future, theoretical research on the multicultural connotations and historical development processes of city towers should be deepened, taking into account the context of cross-national Silk Road heritage declarations, changes in the natural environment, and trends in socio-economic transformation under globalization.

Research Status of Digital Protection and Revitalization of Cultural Heritage

Against the backdrop of the information age, digital technology has gradually developed into a powerful support for the protection and revitalization of cultural heritage. Currently, digitally driven cultural heritage is undergoing transformation, with technological innovation becoming an important factor in promoting cultural transmission (Wang Bo, 2025), reshaping the space for interpreting the value of cultural heritage. The digitization of cultural heritage is undergoing transformation, and technological innovation has become an important factor in promoting cultural transmission. Research on the two intangible cultural heritages of Xuzhou paper-cutting and sachets, and the analysis of their mechanisms for digital survival, proposes a technical framework for the digital protection of intangible cultural heritage from the perspective of the Ancient Silk Road post station sites (Liu Yahui, 2026), and has created an interactive virtual reality technology system to examine the transmission and innovation of intangible cultural heritage (Xu Xin et al., 2025). These achievements, on one hand, deepen scholars' understanding of the digitization of cultural heritage and, on the other hand, provide theoretical support and practical reference for this study to digitally restore the structures of Linqiong Ancient Post Station and city walls.

At present, the academic community has achieved a series of results regarding ancient city tower architecture, the spatial layout of cities, and military defense systems, with research gradually moving toward quantitative analysis. Through the method of image-based historiography, a certain degree of study has been conducted on the mountain and water environment construction concepts of the ancient city site in Yuzhong District of Chongqing, bringing new perspectives to the study of ancient urban geographical features (Wang Zheng & He Xi, 2022). Research has been conducted on gully landform units, systematically discussing the planning principles of defensive facilities along the northern section of the Great Wall during the Ming Dynasty and the factors influencing them (He Ding et al., 2023). A Study on the Changes in Security Protection Methods During the Establishment of Early Jurchen Settlements (Cao Huaiwen & Wang Sa, 2022). A detailed organization of the expansion of the ancient city of Chengdu from the Tang to the Song dynasties was conducted (Wu Lei, 2024), the development direction of the city-building movement in Sichuan and Chongqing during the Tang and Song periods and the changes in city wall structures were studied (Ma Jian, 2010), and the spatial organization model of the capital during the Tang dynasty was summarized (Liu et al., 2025). Using spatial syntax theory, the mechanism of city wall shape on the expansion routes of small-scale historic and cultural cities (Li Rui, 2006); It studied which socio-cultural factors drive the spatial formation of traditional towns (Rusic & Ma Jian, 2009); It evaluates the transformation of urban forms under the flourishing trade of Quanzhou seaports during the Song and Yuan dynasties (Lin Yuhong, 2026);

A study was conducted on the historical evolution of the distribution patterns along the banks of multiple ancient cities in the Yellow River tidal flat region of Shandong Province (Wang Huiying, Deng Qingzhe & Yang Jiming, 2024). This not only deepened the understanding of the urban development model of a particular region but also provided valuable academic support for understanding the functional zoning and defensive layout of the Linqiong ancient city tower.

Scholars have discussed the linear nature of Silk Road cultural heritage from multiple perspectives and summarized its main significance. It systematically analyzes the early transportation network and route changes of the Southwest Silk Road (Duan Yu, 2009), and for the first time clarifies Linqiong's functional positioning as an important node (Fang Tie, 2015); Research was conducted on the postal station architectural complexes along the ancient Silk Road in Northwest China and the settlement forms along the Grand Canal (Cao Wei, 2013), and through literature analysis, relevant historical and cultural materials were found in these areas (Yao Jie, 2014);

A typical settlement model formed in Qionghai Liuke Village due to the influence of post roads is discussed in detail (Gao Yingjie et al., 2025); Regarding the research results of specific sites, the spatial layout of ancient city villages along the Henan Road of the Silk Road in Qinghai was analyzed (Jin Yibing & Li Simin, 2020), and the main research was on the spatial distribution patterns of village sites along the Han Silk Road within Ningxia (Li Jining & Liu Wanying, 2022). From a macro perspective, it analyzes the historical value and development process of the Southwest Silk Road (Shan Jixiang, 2012), and proposes scientific protection measures to expand the scope of research (Du Yunhong, 2015). The research results provide a deeper understanding of the traditional relay system, especially in the reconstruction of the spatial structure and functional area of the ancient Linqiong post station, providing important theoretical guidance and strong reference value in real life.

Node Value and Heritage Composition of the Qionglai Section of the Southwest Silk Road

The route and cultural characteristics of the Southwest Silk Road

The main routes and branches of the Southwest Silk Road

The Southwest Silk Road is not a linear transportation system; it is an important corridor connecting East Asia and South Asia. During the pre-Qin and Han periods, it was the main route for trade between the East and the West and promoted the development of civilization in the Bashu region (Cao Wei, 2013). This system was influenced by complex terrain, resulting in a network structure with multiple parallel routes in its path planning. Overall, it mainly includes branches such as the Shushen-Du Road and the Ancient Tea Horse Road, with three core trunk routes forming its basic framework. The first is the Shushen-Du Road, starting from Chengdu, passing through Linqiong, Ya'an, Xichang, reaching Dali and extending to India, serving as an important passage connecting East Asia and South Asia.

The second is the "Five-Foot Road," starting from the Bashu region to Guizhou, primarily transporting goods between Sichuan and Guizhou. The third is the "Lingguan Road" or "Yak Road," mainly used for trade between regions in the southwest. These three routes intersect and influence each other spatially, forming the main framework of overland trade in ancient Southwest China. Each route differs in function and service scope, but key nodal cities connect resources and facilitate cultural exchange. The junction of the Shushen-Du Road and

the Lingguan Road is located in present-day Qionglai City in the southwest of Chengdu, Sichuan Province (historically known as Linqiong), which serves as a major transportation route from the Chengdu Plain to the frontier and a regional logistics and cultural exchange center. Its special geographical location gives Qionglai a unique strategic position within the Southwest Silk Road network. Conducting in-depth research on the main trunks of the Southwest Silk Road and their branch routes not only allows for analysis of the spatial layout patterns but also provides important geographical evidence for the study of the spatial distribution of Linqiong Ancient Town and other cultural heritage sites.

The Cultural Attributes of the Southwest Silk Road as a Cultural Heritage

As the main bearer of cultural heritage, the Southwest Silk Road has a primary value that goes beyond the scope limited by traditional linear transportation networks, demonstrating a cultural route that crosses regions and time, and integrates multiple perspectives. According to academic findings, this type of cultural route not only has a connecting function in geographical space but also plays an important role in human migration, commercial exchanges, and the dissemination of ideas (Jing Xie, 2025). The Southwest Silk Road is a typical cultural heritage landscape, and the cumulative historical traces formed by its tangible heritage and intangible cultural phenomena organically combine scattered historical events and related factors, forming a three-dimensional cultural complex (Cao Wei & Yao Jie, 2014). This process reflects the dynamic development trend of cultural transmission and shapes the cultural connections between ancient Shu culture and the cultures of the Eurasian continent. From the perspective of preservation practice, consideration should be given to the overall integrity of the route and the cultural heritage work of node cities, researching the trajectories of regional ethnic migrations and the historical and cultural relics left by economic and trade activities. This system reveals the deep underlying patterns behind cross-regional cultural exchanges and interactions, while also reflecting its impact on historical development.

The cultural connotation of the Southwest Silk Road reflects its multiple functions and diverse values. As a carrier of commercial circulation, it not only facilitates the spread of religious ideas but also serves migration functions for ethnic groups and military defense purposes, thus demonstrating obvious integrative characteristics. The functional characteristics of cross-border integration give many important nodes along the route, such as cities like Linqiong, a rich and unique historical accumulation and cultural symbolism. By examining tangible remains (ancient road sites, city wall ruins, etc.) and intangible cultural heritage (local customs, traditional crafts, etc.) (Lai Xiangyan et al., 2025), a profound understanding of the entire structure of this heritage and its embedded meanings can be achieved. Due to its overall value for academic study, scholars should use a systems theory approach to study the interaction and co-evolution mechanisms between natural geographical elements and human civilization activities from a holistic perspective (Du Yunhong, 2015).

The Historical and Geographical Location of Linqiong

Qionglai, formerly known as Linqiong, has a history of over 2,200 years and is praised as "the first prefecture of Tianfu coming south" (Lin Feng, 2013). To study its historical and geographical significance, it is necessary to comprehensively examine it within the entire network system of the Southwest Silk Road and the regional development layout of the

Chengdu Plain. As a hub connecting the inland hinterland and frontier regions, the strategic position of the "First Prefecture of Tianfu Coming from the South" is influenced both by natural geographical factors and by acquired factors shaped by cultural accumulation and material heritage formed during urbanization. Qionglai lies on the transition zone from the western edge of the Chengdu Plain to the western Sichuan Plateau. Its terrain and landforms are a mix of mountains, hills, and plains, with the lowest point reaching an elevation of 453.5 meters; it borders the Tiantai Mountains to the north and the Baimo River system to the south. Relying on a well-developed water transportation network, it played an important role as a transfer hub on the ancient Silk Road (Gu Yuanzhong, 2007). The geographical layout of the area allows it to meet the trade and circulation needs of eastern economic centers like Chengdu, while also providing essential living supplies and services for travelers venturing further afield. Bridging the East and Connecting the West and North, Qionglai became its prominent functional and distinctive feature in the ancient Silk Road trade network.

Linqiong Ancient City was built in the 14th year of King Huiwen of Qin's Gengyuan era (311 BC), and has a history of over two thousand years, always situated in the same location. Its development can be roughly divided into several important stages. When it was first built in the Han dynasty, the city wall had a perimeter of six li, laying the initial framework for the structure. After being upgraded to the seat of Qiongzhou in the Tang dynasty, the city's functions were enhanced. In the Ming and Qing dynasties, the classic layout of one ring, two streets, six courtyards, and twenty-seven alleys was formally established (Lin Feng, 2013). Although each dynasty has made additions, removals, or repairs to the building's layout, none have departed from the original core area. This diachronic change also reflects the geographical factors underlying site selection from the Qin and Han dynasties. Through concrete forms such as street and alley planning and water system layout, the socio-economic demands and cultural accumulation of different eras have been fixed.

This special situation provides a rare physical archive for exploring the development process of cities at the crossroads of the Silk Road in Southwest China. Due to its special geographical location and resource advantages, the Linqiong area plays a very important role on the Silk Road. Relying on the convenient navigation of the Wenjing River system and the diverse and abundant natural resources (Dan Jixiang, 2012), the region developed certain characteristic products represented by Qiongyo kiln porcelain, Qiong bamboo walking sticks, tea, and silk. The Qiongyo celadon, renowned in the Tang and Song dynasties, promoted the development of the local economy with its exquisite glaze craftsmanship and various decorative techniques, and was spread to western Yunnan, Tibet, and Southeast Asia through the Silk Road, serving as valuable physical evidence for the study of ancient cultural exchanges between the East and the West. Qiong bamboo walking sticks, exported via the Silk Road to the Daxia Kingdom (present-day Afghanistan) since the Han dynasty, demonstrate that Linqiong played a very important role in early external exchanges of Chinese civilization. These are all cultural products originating from a specific geographical environment and were carried across cultures through the Silk Road, a major international trade route, thereby enhancing Linqiong's historical status as a strategic hub on the Silk Road.

The relationship between the Southwest Silk Road and Linqiong

The route distribution of the Southwest Silk Road had a profound impact on the spatial structure and functional development of Linqiong city, transforming it from a core node of a

general administrative region into a regional transportation hub and commercial center connecting the inland hinterland and border areas (Li Jining & Liu Wanying, 2022). Linqiong, due to its central position from the Chengdu Plain to the western Sichuan Plateau, developed two important branch lines on the main route of the Silk Road: one passing along the western side of the Qionglai Mountains into the Qinghai-Tibet Plateau, and the other running through Ya'an and Xichang to the Southeast Asian subcontinent. This typical binary branching traffic pattern gave Linqiong special geographical significance, serving both as a hub for east-west material circulation and as a major venue for east-west cultural exchange (Chang Yuanli et al., 2026). On this basis, Linqiong formed a spatial organization to meet the needs of large-scale cargo transportation and exhibited an inclusive cultural characteristic. With the expansion of the Silk Road commercial network, Linqiong, leveraging its convenient logistics and developed handicraft base, became a distribution center for silk products, Shu brocade, Qiong bamboo staffs, and Qiong kiln porcelain. The water-land combined transportation system allowed these goods to reach broader markets, thereby improving the regional industrial structure, promoting the development of commercial streets and warehousing facilities, and causing the urban boundaries to exhibit phased expansion and contraction influenced by the rise and fall of the Silk Road.

The Composition and Current Protection Status of Linqiong's Heritage

LinQiong was an important hub on the ancient Silk Road in the southwest, and the spatial distribution of its heritage exhibits a strong composite nature. Cultural heritage includes both macro-level traces of transportation routes and micro-level remains of certain types of buildings. When systematically cataloging local cultural relics, the primary consideration should be the ancient road sites, which are the main carriers of culture. Although over two thousand years of natural weathering and urbanization have caused varying degrees of damage to these sites, detailed surveys of the low hilly areas around LinQiong (particularly the Qilong Mountain area) still reveal some relatively well-preserved original roadbeds and overlapped pavement traces (Dan Jixiang, 2012). These technological relics of stone slab paving and rammed earth construction not only accurately demonstrate the specific route of Lingguan Road as it passed through LinQiong, but also clearly reflect the scale, layout, and construction methods of ancient roads, providing critical linking clues for cultural sites across the region (Huang Yuehao et al., 2026).

The LinQiong city defense system and material remains constitute the main part of the cultural relics in the LinQiong area. Although traditional wooden post stations have disappeared over time, archaeological discoveries combined with historical documents allow for a rough estimation of their distribution, main structural forms, locations of auxiliary facilities (stables, warehouses, etc.), and the interactive functions with contemporaneous defensive structures. The currently preserved portions of city walls and gates, although altered and repaired in later periods, still maintain the original site planning and layout, exhibiting clear strategic significance and cultural value. These physical remnants are both essential components of the ancient military defense system and primary factors shaping the urban spatial structure and history of urban development, resulting in a typical mountain-plain composite urban landscape influenced by natural water systems such as the Wenjing River. At the same time, there are some handicraft remains closely connected to the Silk Road trade network. LinQiong was one of the origins of Qiong kilns, with numerous ceramic production sites distributed within its territory, producing many exquisite Qiong kiln ceramics

that fully reflect LinQiong's significant economic role in the region. Various cultural remains along the ancient post roads, such as cliff carvings, ancient bridges, traditional wells, and inscription steles, complement many omissions in official historical records and vividly depict commerce, religious transmission, and local governance during that period. These various cultural heritages are interconnected, collectively creating a complete portrayal of the glorious history of LinQiong ancient city along the southwestern Silk Road in a linear spatial context (Tang Xianglong et al., 2026).

The Site Selection Logic of the Ancient Post Stations and Ancient City Towers in the Qionglai Section of the Southwest Silk Road

The Impact of the Southwest Silk Road Lingguan Path on the Linqiong Node

Lingguan Road was one of the transit stations on the Southwest Silk Road leading to India (anciently called Shendu) and played a decisive role in the development pattern of Linqiong, this important node city. The starting point of the ancient road was on the east bank of the Dadu River, stretching southward through places like Maoni and Lan County. It was an important transportation hub connecting the Bashu region with the South Asian subcontinent. Linqiong, located at the gateway of Sichuan along Lingguan Road, was not only a crucial hub from the Chengdu Plain to the southwestern mountains but also a major station for the gathering of goods and the movement of people (Du Yunhong, 2015). Its unique geographical location gradually led it to form a relatively complete network of post stations and a tight urban defense system to cope with frequent commercial exchanges and military confrontations. When Lingguan Road was in operation, the title "the first prefecture south of the Heavenly Province" became Linqiong's city emblem, and the numerous traditional post station remains along the route and well-preserved city defense structures effectively reflect its rich historical and cultural heritage. These physical elements together supported the operational needs of the Silk Road within China, highlighting Linqiong's strategic position in the ancient transportation network.

The Impact of Mountain and Water Terrain Patterns on Site Selection for Ecology and Defense
The site selection of the ancient city of Linqiong reflects the traditional construction concept of 'adapting measures to the times and conditions,' forming a spatial layout that is both practical and aesthetically pleasing by relying on the mountains and terrain. The Wenjing River flows through the city from south to north, which not only facilitates the development of silk trade logistics but also provides natural barriers on the south, west, and north sides of the city, greatly reducing the possibility of external forces entering from the south and establishing a strong defense line for the city's security (Chu Jin, 2011). Located at the junction of plains and low mountains, the terrain of Linqiong is higher in the north and lower in the south. The advantage of this terrain lies in its excellent vantage points, allowing comprehensive control over important surrounding transportation nodes.

The strategic layout of 'high above and low below' not only enhances defensive functions but also improves the overall reliability of military defense, ultimately achieving the goal of easy defense but difficult attack. The design concept of situating the city by the mountains and rivers follows natural ecological rules, which not only ensures the safety of the settlement but also integrates the cultural landscape and ecological environment through terrain organization, reflecting the ideal of harmonious coexistence between humans and nature (Yin Zekai et al., 2022).

Analysis of Physical Evidence of the Ruins on Qilong Mountain Ancient Road

As the central physical relic of the Qionglai section of the Southwest Silk Road, the Qilongshan Ancient Road site provides important archaeological support for the study of the courier station system in the transportation network of western Sichuan during the Qin and Han periods. The site is located at Chenghuanggang, Qilongshan, Pingle Town, Qionglai City, Chengdu. It is about 2 kilometers long, and the road surface forms a raised cross-section: the main road in the middle is paved with cobblestones, and the sides are also neatly arranged with cobblestones, with a 1.4-meter-high side ditch and protective wall. This design reflects the careful consideration of drainage functions and road safety by the ancients and demonstrates the technical level of craftsmen at that time. Through systematic analysis of the stratigraphic relationship of the relics and scientific identification of unearthed artifacts (Han dynasty wuzhu coins), it has been proven that this route formed a complete traffic system during the Han dynasty.

In terms of geographical location, this ancient road, together with the Lingqiong Ancient City and many surrounding important courier stations, formed an organic spatial contact network. Its entrance and exit positions were arranged very precisely, fitting well with the requirements of urban structure and transportation hub functional layout (Duan Yu, 2006). These archaeological discoveries not only confirm the records in ancient texts regarding the route of Lingguan Road but also show the integrated road planning concept in western Sichuan during the Qin and Han periods, which relied on both military defense and economic exchange. As a representative tangible witness, the Qilongshan Ancient Road site played a key role in enriching the regional historical and cultural chain and has become another important support point for studying the development trajectory of ancient Shu civilization (Jin Pan et al., 2025).

The Spatial Relationship Deduction Between Ancient Post Stations and Ancient City Towers

The spatial layout of ancient post stations and city towers does not exist in isolation; it relies on the complex systemic framework formed by the Silk Road transportation network and military defense system. In terms of site planning, there is a clear phenomenon of 'coordinated distribution' between the two: city towers mostly appear at important transportation hubs or strategic terrain points (Cao Yanqiong, 2023), serving as the main defensive facilities in the overall strategic deployment; post stations are established around the city towers or near city gates, forming a logistics supply network supported by the city's defense infrastructure (Liang Sicheng, 2025). Regarding spatial organization, traditional post roads act as the link connecting the two, enhancing tactical deployment capabilities while improving the efficiency of goods, people, and information flow. Post stations primarily function to transfer materials and provide rest for personnel, while city towers serve both protective and command functions.

The two rely on the internal road system to achieve seamless connection and coordinated operation (He Lejun, 2024). This concept not only significantly enhances commercial exchanges along the Silk Road but also greatly strengthens the overall defense capabilities of the region, vividly demonstrating the ancient urban planning's special talent in emphasizing functional zoning and scientific resource allocation.

A Study on the Spatial Form of the Ancient Lingqiong Post Station and Ancient City Tower
Spatial Composition Deduction of Ancient Post Stations

The ancient Linqiong courier station is a key node on the Southwest Silk Road. Under the traditional courier station system, it also developed characteristics due to the geographical environment of western Sichuan. Its layout is primarily courtyard-based, with a central axis neatly organizing the various functional areas, presenting a fairly typical courtyard arrangement (Cao Yanqiong, 2023). It meets the basic requirements of combining official duties with daily life. This design concept not only caters to the needs of ancient document transmission, personnel reception, and material storage, but also makes the coordination between various facilities more harmonious by connecting the buildings into an integrated whole. Specifically, the front section consists of the gate tower and main hall, serving as a place for officials to receive guests and handle official business; the middle section is an open courtyard in the form of a skylight, serving both lighting and social purposes; the rear section is a combination of auxiliary buildings such as guest rooms, stables, and warehouses, collectively forming a comprehensive service system. In terms of materials and techniques, the architecture effectively incorporates the traditional craftsmanship of western Sichuan, extensively using local bamboo and wood, red sandstone, glazed tiles, and other regional materials alongside a large use of frame-and-beam wooden structures to meet the needs of the humid and cold climate as well as local cultural requirements (Gao Yingjie et al., 2025).

Spatial Form Evolution of the Ancient City Tower

The Lingqiong Ancient City Tower is one of the components of the city's defense system and also a landmark architectural carrier (Ma Jian, 2010). In its spatial layout design, it was influenced by the tower construction techniques of the Southwest region during the Song and Yuan dynasties, and it has been systematically optimized and reconstructed based on existing historical remains. In terms of plan layout, it is mostly a regular rectangle or square, using a raised-beam wooden structure to establish a stable foundation support system, achieving the functional division of two vertical spaces and enhancing visual layers (Gao Yingjie et al., 2025). Vertically, roofs generally feature double-eaved or single-eaved hipped roofs with strong aesthetic characteristics and rich craft details. Especially, the deep eaves treatment greatly improves the roof's resistance to rainwater erosion. The base is formed by high city walls made of rammed earth or stone to create the first physical barrier, while the arched gate controls the main entrance area. Around the exterior walls, arrow slits, watchtowers, parapets, and crenellations are installed, forming a complete and efficient comprehensive defense system. The use of building materials well reflects the typical construction concepts of traditional residential buildings in western Sichuan: the main framework is made with durable wooden beams and columns, primarily cedar; the roof uses refined blue tiles to improve insulation; and the ground-level foundation mainly uses local red sandstone or bluestone blocks, meticulously assembled and joined (Cao Huaiwen & Wang Sa, 2022).

The Functional Complexity of Courier Stations and City Towers

The ancient Lingqiong post station and the ancient city tower are not two isolated buildings, but functional building complexes, including military defense, commercial management, transportation, and information transmission. From a military perspective, their unique spatial distribution and advantageous geographical location make them a key part of the regional defense system. The city tower is a strategic high point, responsible for reconnaissance and early warning tasks, and together with the surrounding post station system, it established a multi-layered three-dimensional defense system, thereby ensuring

the security situation along the Silk Road (Cao Huaiwen & Wang Sa, 2022). The building complex is one of the important organizations for tax supervision, strictly monitoring the goods entering and leaving, and collecting tariffs from them, playing a significant role in maintaining the stability of our country's economic order. From a cultural perspective, the post station has dedicated service facilities and resting places, providing convenience to travelers and reflecting the focus on human-centered values in ancient civilization. Supported by a mature postal network, the complex also has special functions such as emergency information transmission and official receptions (Cao Yanqiong, 2023), giving it high political value in local governance. The integrated design model excellently reflects the wisdom and efficient collaborative ability demonstrated by residents of the Southwest Silk Road in response to a complex natural environment (Lu Xiqi & Ma Jian, 2009).

Digital Research Focused on Preservation and Revitalization

The Logical Framework of Digital Restoration and the Principles of Heritage Conservation

Due to severe damage to surface buildings and the dispersed nature of underground remains, digital restoration has become an application that integrates three-dimensional modeling technology with an interdisciplinary theoretical framework. It is both a technical method for spatial reconstruction and an academic approach to interpreting cultural heritage. The digital restoration plan proposed in this chapter aims to bridge the gap between traditional documentary records and modern information technology, addressing how to achieve reasonable inference and scientific verification of the site's spatial structure through multi-source data integration in the absence of physical evidence (Meng Zhirong et al., 2025). The research is conducted strictly according to the principles of authenticity and completeness. When reproducing historical buildings and their layouts in a virtual environment, it relies on extensive historical documentation, systematic archaeological survey results, relevant case studies, accurate data statistics, and rigorous model testing, ensuring that the research outcomes have solid academic support rather than being merely artistic creations or subjective conjectures. It reflects the process of integrating technological innovation with cultural heritage preservation. This study mainly explores the intrinsic connection between empirical data and reasonable inference, establishing a complete system for information selection and evaluation (Liu Yahui, 2026). High-precision digital modeling techniques are used for elements with clear archaeological evidence, such as city wall foundations and ancient road routes, accurately reproducing their spatial distribution and elevation characteristics. For parts lacking direct artifact support, such as the shapes of post station roofs and the styles of city gate decorations, scientific hypotheses are proposed based on the functional layouts and craftsmanship characteristics of similar buildings in nearby areas of the same period. During the virtual simulation process, model data are labeled to distinguish between "concrete evidence" and "reasonable inference," expressing the credibility range of the restoration results quantitatively, ensuring the academic rigor and practical feasibility of the research outcomes, and providing reliable scientific and technical support, as well as a theoretical basis, for subsequent field investigations.

The main content of this paper is the creation of a research paradigm for multi-source data integration. By transforming textual descriptions from historical documents into spatial coordinates, and on this basis utilizing Historical Geographic Information Systems (HGIS) to combine ancient maps and field survey data, a complete set of restoration analysis methods is obtained. This step converts analysis on a two-dimensional plane into reconstruction in

three-dimensional space, distinguishing between coarse summaries of macro regions and fine details of micro features. The resulting restoration model both meets architectural theoretical norms and technical standards and effectively demonstrates the historical and cultural landscape formed by Linqiong Ancient City's reliance on natural terrain. Therefore, by establishing such a systematic and scientific digital restoration system, after eliminating subjective influences, a reliable digital support platform is provided for spatial simulation in complex scenarios and analysis from various perspectives. This also accelerates the transformation of cultural heritage value from conceptual understanding to concrete physical space (Ouyang Jiaying & Liu Xiudi, 2026).

Construction of 3D Digital Models of Ancient Post Stations and Ancient City Towers

After completing the design of the logical framework for digital restoration and the planning of preservation concepts, the process moved on to the detailed creation of the three-dimensional digital model. This period broke through the technical barriers of traditional geometric shape splicing and, using archaeological survey data, historical and geographical information, architectural structure deduction, and defense system analysis, transformed abstract spatial relationships into concrete spatial entities, expressed quantitatively with accurate geometric parameters (Li Guolong, 2026). The modeling process used a bottom-up layered analysis method, starting with the macro topography and landforms, then the main buildings and their ancillary facilities, and finally performing detailed reconstruction work to fully recreate the spatial layout of the Linqiong ancient station on the Southwest Silk Road during a specific period, as well as its city towers (Ouyang Jiaying & Liu Xiudi, 2026).

Using data resources from historical geographic information systems (HGIS) and terrain survey data around Linqiong Ancient City, the key landscape elements such as the Wenjing River system and the Qilong Mountain shallow hill terrain were accurately restored on a digital virtual reality platform. A digital elevation model (DEM) was used to analyze and reconstruct the spatial structure of the ancient city, which was situated along water and built defenses along mountains, and to refine the main route of the Lingguan Road, studying the relationship between ancient transportation routes and natural terrain. Three-dimensional visualization technology was employed to organically map architectural space and the geographical environment together, scientifically presenting the ecological coexistence relationships in the digital space, thereby achieving the integration of cultural heritage protection with modern information technology.

From the above analysis, it can be seen that this paper adopts a parametric modeling method to establish the spatial structure system of the post station building complex. Based on the floor plan and functional zoning scheme determined in Chapter Five, a detailed study is conducted on the overall design concept of "shop in front, post station in back" or "government office in front, post station in back," and the spatial characteristics and mutual influences of important functional areas such as guest rooms, stables, and storage are comprehensively explained.

According to the technical specifications in the literature and the construction standards of traditional timber buildings in the Sichuan area, during the specific production process, the main components such as the traditional mortise-and-tenon timber frame system and Xieshan-style roof are carefully replicated to ensure that the model not only has historical

and cultural connotations but also maintains structural rationality and authenticity. The key to the digital reconstruction of the ancient city tower defense system is to demonstrate its importance as a military defensive facility. By comprehensively utilizing ancient texts and documents, the defensive facilities such as city walls, barbicans, arrow towers, and main towers are accurately restored, and details such as watch openings, shooting holes, and battlements are finely displayed using 3D software. Optical algorithms are used to simulate and evaluate its field of view and combat performance.

The resulting virtual model can fully reflect the overall appearance of the building complex and provide important data support and technical assurance for site protection and digital archaeology research. The application of regionally characteristic materials and the creation of a cultural atmosphere allow the artistic value of the model to be better realized (Shen Ting, 2025). Based on the local building materials used in traditional buildings in the Linqiong area, such as blue bricks, gray tiles, timber, and rammed earth, virtual scenes are created with detailed textures, and the rules of material and color changes under various light sources are studied. Special attention is paid to the weathering of ancient buildings in the humid and rainy environment of western Sichuan and the adhesion of plants, and scientific methods are used for reasonable simulation. This precise modeling not only enhances the authenticity of the restoration effect but also provides high academic value and immersive foundational data resources for subsequent analysis and digital reproduction.

Multi-scheme Simulation and Spatial Verification

This article preliminarily explores the internal logical mechanisms of cultural development along the Southwest Silk Road, but it still needs to be verified and supplemented through multi-level spatial expansion and comprehensive long-term sequence investigations. It is recommended to expand the research scope from Qionglai City to the entire Southwest Silk Road Economic Belt, and to use multi-scale spatial comparative analysis to examine the historical positioning and strategic value of each region during specific periods. Methodologically, it is necessary to break through traditional disciplinary barriers, establish a multidisciplinary cooperative network, and integrate knowledge systems from history, archaeology, sociology, and digital humanities to create a systematic cultural heritage protection evaluation model and operational framework. Moreover, there is an urgent need to establish a dynamic monitoring and early-warning system that can continuously track changes in both heritage entities and the ecological environment, thereby ensuring the long-term continuation and development of intangible cultural heritage. These improvements are conducive to deepening the understanding of the entire Southwest Silk Road and provide theoretical and technical support for the study of transnational historical cultures.

Heritage Conservation and Activated Application Pathways of Digital Achievements

Research on digital restoration primarily focuses on studying how the practical application of high-precision digital models plays a role in improving and innovating cultural resource protection efforts. This chapter mainly summarizes previous research findings. It introduces three aspects of using this method during the creation of three-dimensional digital models of Linqiong Ancient Post Station and the Ancient City Tower (i.e., interpretation of heritage connotations, application in site exhibition, and dissemination of mass culture), which are the results achieved by using this method. Through advanced digital techniques, the traditional static method of preserving culture is transformed into a vibrant and dynamic mode for

cultural heritage transmission, creating channels for communication and in-depth exchange between historical cultural heritage and contemporary culture, thereby achieving a deep integration of historical heritage and modern culture (Tang Tian, 2025).

Digital outcomes play a significant role in spatially displaying the evaluation of cultural value. For relics such as the Linqiong Ancient Post Station and the Ancient City Tower grounds, traditional two-dimensional maps cannot fully reflect the logic behind the historical site selection and the spatial distribution of the defensive system hidden within them. By using high-precision three-dimensional modeling technology, all elements described in documentation, such as natural geographical features, arrangement of the Lingguan routes, and the interaction between the city tower and the post station, can be fully presented. Intuitive spatial display methods allow scholars to gain a deeper understanding of the structural characteristics of heritage spaces and their historical and cultural reasons. This also lays the foundation for managers to develop reasonable protection policies and designate key protected areas, serving as a method for preserving the authenticity and integrity of cultural heritage.

The virtual restoration scheme proposed in this article offers new ideas for coordinating the preservation and display of heritage sites. Using traditional physical reconstruction methods for tangible remains such as ancient courier stations and city towers may lead to errors and distortions. Therefore, augmented reality (AR) technology should be used for digital simulation to analyze and reconstruct the three-dimensional data of tangible remains, thereby obtaining realistic digital restoration models and accurately mapping them to the actual heritage site (Wang Bo, 2025). Visitors can experience the timely representation of virtual buildings within the damaged ruins using mobile devices or wearable terminals, allowing them to gain a clearer understanding of the overall appearance and historical culture of ancient architectural complexes. Displaying in a combination of virtual and real forms can preserve the original historical and cultural information of the site while enhancing the interactivity and visual appeal for tourists, thereby improving the actual tourism effect. The greatest impact of digital technology on the revitalization of cultural heritage lies in the process formed by interactive experience design and narrative structure. High-precision three-dimensional reconstruction technology can be used to build immersive virtual reality systems or interactive digital exhibition spaces, allowing audiences to perceive the cultural connotations of the Ancient Southwest Silk Road from multiple angles. Historical scenes such as customs inspections, resting stations, and commercial exchanges can be restored, presenting the results of archaeological research through gamified designs and multi-level simulation devices. This not only strengthens public understanding and recognition of the Linqiong Silk Road culture but also, by utilizing cloud computing platforms to break geographical limitations, significantly enhances the ways cultural heritage is disseminated. It brings new forms of expression to the linear heritage of the Southwest Silk Road, providing new forms of representation for the Linqiong Silk Road in the context of the digital age.

Conclusion

Research Summary

This study takes Linqiong, an important node on the Southwest Silk Road, as a case study and conducts a detailed analysis of the core heritage characteristics of the ancient post stations and city towers in Linqiong. Using historical geography methods, combined with spatial

analysis techniques, it analyzes the site selection patterns and functional positioning of cultural heritage along the Silk Road network. The study shows that Linqiong relied on the Lingguan transportation route for its planning and layout, while also taking advantage of the natural terrain of the area; the ancient post stations and city towers formed an organically connected spatial distribution pattern, constituting a system that combined military defense and logistical services.

On this basis, this paper creates a theoretical framework for multi-source data integrated spatial reconstruction and carries out three-dimensional digital recreations of the relevant sites, using space syntax analysis to verify the accuracy of the reconstructions. The study demonstrates that using digital methods to overcome the limitations caused by the scarcity of physical heritage can both faithfully present the real cultural and historical context and facilitate the dissemination and recreation of cultural heritage values. This promotes the modernization and comprehensive development of traditional preservation concepts and provides new perspectives and technological support for innovative exploration in the field of cultural heritage.

Research Limitations

This article attempts to reshape the historical space of the Linqiong Ancient Post Station and the Ancient City Tower through the use of digital technology. However, due to the lack of complete information and insufficient data, the research results are highly limited. On one hand, because the remains of ground buildings have been damaged or disappeared, relevant restoration work mainly relies on reasoning and assumptions. Although the study references the typical construction regulations of buildings in the Southwest region during the Song and Yuan periods and, based on this, conducts comparative analysis combined with the characteristics of surrounding sites, it lacks systematic archaeological data support for any particular area. Therefore, aspects such as architectural details and scale positioning rely more on subjective judgment.

Additionally, the creation of digital twin scenarios faces technical and capability limitations in realistically reflecting the micro-environment, especially with regard to detailed restoration of terrain, landscape, and vegetation distribution, which mostly adopts abstract artistic representation and cannot truly present the historical natural landscape or the effects of light and shadow changes. Some proposed cultural and tourism integration implementation plans are still at the theoretical stage and have not been effectively applied in specific site conservation, utilization, or museum display projects. Important issues such as user experience feedback, operational feasibility, and functional evaluation still need to be tested and improved through specific cases.

Under the broader context of continuously deepening concepts of cultural heritage preservation and the rapid development of digital technology, the research and display of the Linqiong Silk Road site still have considerable room for development. New archaeological discoveries should be used to continue reconstructing the spatial structures of ancient post stations and city towers, enhancing their scientific validity and research significance. Efforts should also be made to continually explore the applications of cutting-edge technologies such as artificial intelligence and big data analytics, achieving substantial breakthroughs in areas such as artifact disease diagnosis, natural disaster early warning, and the formulation of

restoration plans, thereby establishing a new intelligent and dynamic heritage monitoring and management system. From the perspective of cultural dissemination, immersive interactive experience platforms should be created using digital technologies such as virtual reality (VR) and augmented reality (AR) to transform cultural communication from a one-way mode to a two-way exchange, thus increasing public engagement. Additionally, interdisciplinary cooperation should be strengthened by bringing together experts and scholars from museology, history, architecture, and other fields, as well as IT specialist teams, to pool diverse knowledge to improve the overall level and sustainability of cultural heritage preservation along the Southwest Silk Road, reflecting its unique significance and immense role in contemporary society.

Research Theory and Background Contribution

My research is based on the historical context of the Southwest Silk Road, focusing specifically on the ancient post stations and city towers of Linqiong. The research perspective leans toward the preservation and revitalization of cultural heritage, rather than the restoration of its spatial layout and form. The goal is to allow it to continue existing as cultural heritage in modern cities, integrated with digital technology, so that people can interact with the ancient sites while understanding their historical and cultural significance. Through interdisciplinary research, this study not only fills the academic gap where the Silk Road was previously only described in terms of routes, as well as the gap in understanding the formation of settlements at various urban nodes along the Southwest Silk Road and the study of cultural heritage within these cities, but also provides insights into why different urban structures were established in these locations. Moreover, at the level of technical application, it offers new perspectives and practical methods for the preservation and revitalization of linear cultural heritage. In terms of theoretical contribution, this paper no longer focuses solely on individual buildings, but interprets all traditional cultural architecture collectively to explain the special value of Linqiong as a key node of the 'Southwest Silk Road.' By deeply analyzing the route of the Lingguan Road and its interaction with the topography of the Qionglai region, it reconstructs the trinity spatial organization logic of 'road—city—post.' This finding enriches existing understanding of ancient transportation networks and regional urban development in southwest China, especially demonstrating the functional complementarity and spatial synergy between post stations and city towers, showing that they are not isolated defensive or service facilities, but complex spatial nodes integrating military defense, commercial regulation, information transmission, and traveler reception. This not only deepens our understanding of Linqiong Ancient City as a heritage but also explains why people insist on regular city maintenance, demonstrating the importance of Linqiong as a cultural heritage to Qionglai and providing strong evidence for how ancient border towns maintained cross-regional cultural exchange through spatial planning. At the methodological level, addressing the research difficulties of the scarcity of surface relics and scattered documentary records in the Linqiong ancient post station and ancient city tower, a digital restoration and verification framework was established, constituting the core innovation and important contribution of this study. The research does not stop at simple virtual reconstructions of historical spaces, but instead proposes reasonable restoration and principles of public participation and interaction. By integrating archaeological survey data, historical document verification, and regional architectural typological comparisons, This study establishes a hierarchical digital restoration logic, using spatial syntax to quantitatively verify horizon reachability and defense effectiveness, thereby ensuring the academic rigor of the recovery model. The establishment

of this methodological system provides a replicable technical path for historical architectural heritage research that is "insufficient documentary" and "no physical artifacts" in the field, promoting a paradigm shift in architectural history research from qualitative description to quantitative analysis and visual verification. In terms of practical application and knowledge expansion, the results of this study respond to the practical needs of contemporary cultural heritage protection and revitalization. Through high-precision 3D digital modeling and virtual reality technology, this study overcomes the display challenges caused by the absence of physical remains, transforming static, incomplete sites into dynamic, interactive immersive experiences. This not only provides the public with an intuitive tool to understand Linqiong's historical status in the "Southwest Silk Road," but also explores an effective path to shift from "static protection" to "dynamic inheritance." The digital achievement application strategies proposed in the study, including augmented reality (AR) overlay display at site sites, digital narrative design for cultural heritage, and the construction of interactive experience platforms, provide practical solutions for activating the contemporary value of linear cultural heritage. In summary, this study organically combines theoretical interpretation, methodological innovation, and practical application, not only reshaping the historical spatial landscape of Linqiong Ancient Post Station and Ancient City Tower, but also demonstrating how to scientifically protect, interpret, and revitalize precious historical and cultural heritage in the process of modern urbanization, contributing academic wisdom and practical examples of universal reference value.

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