International Journal of Latest Research in Humanities and Social Science (IJLRHSS)
Volume 09 - Issue 03, 2026
www.ijlrhss.com || PP. 148-163

Spatial Narrative and Semiotic Interpretation: A Digital Study of the Linear Cultural Heritage Landscape of the Jiazhou Section of the Southwest Silk Road

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Abstract: This study takes the linear cultural heritage landscape of the Jiazhou section of the Southwest Silk Road as its research object, integrating spatial narrative theory and semiotic methodology to explore an innovative pathway for digital preservation, interpretation, and revitalization. The research begins by clarifying the historical context and spatial configuration of the Jiazhou section, highlighting its geographical characteristics as a land-water transportation hub and the linear distribution of landscape elements along riverine axes and mountainous terrains. It systematically analyzes the narrative sequence of "introduction, development, transition, and conclusion" formed by elements such as ancient paths, passes, post stations, wharves, and settlements, revealing a spatial rhythm characterized by measured alternation between tension and relaxation. Subsequently, the study interprets the landscape's semiotic system from both material and non-material dimensions. It analyzes the historical signification of physical remnants like cart ruts, plank roads, and architectural structures, as well as the cultural connotations of practice-based symbols such as trackers' chanties and sacrificial rituals, uncovering the layering of symbolic meanings throughout history. Based on this, the study constructs an integrated research framework of "Spatial Narrative - Semiotic Analysis - Digital Presentation." In terms of the digital pathway, the research proposes establishing a spatio-temporal narrative database integrating geographic information, attribute data, and multi-modal historical records, providing a foundational data layer for holistic conservation. It also suggests employing technologies like 3D modeling, VR/AR to achieve narrative reconstruction of multi-dimensional scenes and dynamic restoration of historical contexts. Finally, it involves designing interactive digital storytelling experiences through mechanisms like role-playing and interactive triggers, promoting a paradigm shift in cultural heritage from static preservation to living transmission. The conclusion posits that this digital pathway effectively integrates heritage elements, achieving the contemporary translation of historical memory and facilitating public engagement. It provides a practical, replicable model for the sustainable preservation and value transformation of linear cultural heritage.

Keywords: linear cultural heritage landscape; spatial narrative; semiotics; digital approaches

1. Introduction

1.1 Research Background

With the deepening implementation of China's "Belt and Road" Initiative and the continued promotion of the cultural power strategy, the preservation, transmission, and revitalization of cultural heritage have become increasingly pivotal in demonstrating cultural confidence and fostering coordinated regional development. The Southwest Silk Road, as a vital historical corridor for external exchange in ancient Southwest China, carries the legacy of over two millennia of commercial trade, ethnic migrations, and cultural amalgamation. Its linear

cultural heritage landscape is not merely a geographical connector but a narrative medium interwoven with multiple cultural symbols [1]. Within this corridor, the Jiazhou section (present-day Leshan area), located at the core of the Min River Basin, served as a critical land-water interchange node on the Southern Silk Road. It embodies a convergence of Ba-Shu culture, frontier culture, and Central Plains civilization, preserving a rich array of tangible and intangible heritage elements, including ancient trails, wharves, post stations, cliff carvings, and ancient towns. These constitute a highly representative cultural landscape corridor. However, due to the unique challenges of linear heritage—such as its extensive distribution, large scale, and complex morphology—coupled with pressures from both natural erosion and urban-rural development, the integrated conservation and in-depth value interpretation of this section face significant challenges.

In recent years, the rapid advancement of digital technologies has provided novel methodological pathways for cultural heritage research. Technological means such as 3D scanning, Geographic Information Systems (GIS), Virtual Reality (VR), and Augmented Reality (AR) have made it feasible to systematically collect, visually reconstruct, and interactively interpret the spatial structures, narrative logics, and semiotic systems of linear cultural heritage. Within this context, incorporating spatial narrative theory and semiotic analysis into a digital research framework not only aids in revealing the dynamic evolutionary mechanisms and processes of cultural meaning-making within the Jiazhou section's heritage landscape across historical periods but also, through digital media, facilitates the living presentation and public dissemination of cultural heritage. This approach provides theoretical support and practical models for the sustainable conservation and innovative transformation of linear cultural heritage in the new era [2].

1.2 Research Aims and Significance

1.2.1 Research Aims

This study aims to systematically investigate the constitutive logic, narrative structure, and cultural connotations of the linear cultural heritage landscape of the Jiazhou section of the Southwest Silk Road, employing spatial narrative theory and semiotic analysis as the theoretical foundation, integrated with digital technological methods. Through field surveys and data collection of diverse elements along the ancient road, including site ruins, settlements, transportation nodes, and natural landforms, the research seeks to construct a spatio-temporal information database for this heritage corridor. Utilizing Geographic Information Systems (GIS), 3D modeling, and visualization technologies, it aims to digitally reconstruct the spatial configuration and evolutionary processes of the landscape.

Building upon this foundation, the study will delve into analyzing the semiotic relationships embedded within the heritage landscape among material forms, spatial sequences, and cultural symbolism. It aims to reveal the multiple narrative functions—such as trade circulation, ethnic interaction, and belief dissemination—that the landscape carried within its historical context. Ultimately, the research strives to explore a digital research pathway that integrates spatial narrative interpretation and semiotic meaning excavation. This pathway aims not only to provide scientific evidence and technical support for the conservation, interpretation, and presentation of the Jiazhou section's cultural heritage but also to transcend traditional static preservation models. It seeks to promote the transformation of linear cultural heritage from "material remains" to "cultural narratives," thereby achieving the revitalized transmission of historical memory and deepening public participation.

1.2.2 Research Significance

Theoretical Significance: By systematically integrating spatial narrative theory and semiotic methodology into the research framework of the Jiazhou section's linear cultural heritage, this study moves beyond the limitations of conventional research that often focuses on singular material relics and point-based

conservation. Instead, it shifts attention towards the dynamic evolution and the accumulative generation of cultural meaning within continuous geographical space. Through analyzing the spatial sequences and logical interconnections among the ancient trail sites, settlements, transport nodes, and the natural environment along the route, the research uncovers the underlying narrative structures of historical events, human activities, and cultural exchanges, thereby enriching the theoretical understanding of linear cultural heritage as "space-as-text." Simultaneously, the in-depth interpretation of the diverse semiotic systems within the landscape—including stone inscriptions, architectural styles, place names, and folk activities—deepens the comprehension of regional cultural identity and trans-regional civilizational interaction. It contributes to the theoretical development of a culturally contextualized heritage interpretation system for China and promotes a paradigm shift in digital humanities-informed heritage research from data integration to meaning construction.

Practical Significance: On a practical level, by constructing a digital information platform for the Jiazhou section's linear cultural heritage, integrating high-precision surveying, 3D modeling, and GIS-based spatio-temporal analysis, the study provides actionable technical support for the precise documentation, dynamic monitoring, and scientific conservation of the heritage. This effectively addresses the issue of fragmented protection often resulting from the extensive distribution and management complexities of linear heritage. The resulting digital assets can be utilized not only for virtual restoration of damaged sites and simulation of historical scenes but also for immersive exhibitions, intelligent guided tours, and online education, significantly expanding the public reach and societal engagement with cultural heritage. The research findings can serve as scientific evidence and decision-making references for local governments in formulating cultural heritage conservation plans and developing cultural tourism routes, promoting the transformation of cultural resources into cultural-tourism industry value, and supporting rural revitalization and regional cultural branding. Furthermore, the explored integrated research model of "Spatial Narrative - Semiotic Interpretation - Digital Presentation" can serve as a replicable and scalable practical example for the digital preservation and revitalization of other linear cultural heritage routes in China, such as the Ancient Tea-Horse Road and the Qin-Shu Ancient Road.

1.3 Literature Review

1.3.1 Spatial Narrative Theory and Landscape Semiotic Interpretation Mechanisms

Domestic research on spatial narrative has expanded from literary theory to the fields of architecture and landscape architecture, providing core theoretical support for the semiotic interpretation of linear cultural heritage. Cheng Xilin (2007) outlined the spatial turn in narrative theory, arguing that space is not merely the setting for a story but possesses narrative functions itself [3]. Yun Yan (2015), through interpreting relevant works, explored the dialectical relationship between "narrative of space" and "space of narrative," emphasizing the active role of space in meaning generation [4]. In specific applications, Yang Shuyun and Huang Qiaosheng (2016) used Lao She's "Liu Family Courtyard" as a case study to analyze spatial layouts and symbolic narrative strategies in literary works, revealing how material space carries cultural metaphors [5]. Ye Yun and Yu Chuanfei (2011) conducted a comparative reading of narrative texts and architectural space, proposing a "new narrative" perspective on how architectural space conveys information akin to a text [6]. Li Bohua et al. (2025) further studied the mechanism of environmental education functions in traditional villages from a spatial narrative perspective, finding that narrative spaces significantly enhance the depth of cultural perception [7]. Zhou Xiang et al. (2024), taking Suzhou gardens as an example, constructed a heritage interpretation system from a landscape anthropology perspective, exploring pathways for semiotic interpretation under diverse cognitive frameworks [8]. Collectively, these studies demonstrate that spatial narrative theory can effectively

decode the symbolic meanings of landscape elements within the Jiazhou section's linear cultural heritage, providing methodological tools for understanding its historical memory and cultural logic.

1.3.2 Linear Cultural Heritage Conservation and the Application of Digital Technologies

Focusing on the conservation of linear cultural heritage and traditional villages, domestic research emphasizes intervention modes of digital technology, landscape restoration mechanisms, and the state of intangible cultural heritage transmission. Tao Jin et al. (2024) reviewed the research history of traditional rural settlements in China, highlighting the necessity of technology-enabled settlement conservation [9]. He Ming and Yuan Enpei (2023) conducted an in-depth analysis of the application of China's digital landscape technology in intangible cultural heritage safeguarding, revealing its significant efficacy in recording, displaying, and dissemination [10]. Ma Xiaona et al. (2019) comprehensively reviewed the current state of digitalization in intangible cultural heritage, identifying its core value in enhancing heritage visibility [11]. Jia Xiuqing and Wang Jue (2012) discussed the application logic of digital methods in cultural heritage transmission and innovation [12]. Liu Peilin et al. (2022) investigated the digital transmission of traditional village landscape genes, finding that this technology can significantly boost tourism value [13]. Li Jingyu and Wang Xi (2024) explored the comprehensive application pathways of digital technology in vernacular landscape research, proposing analytical methods based on multi-source data fusion [14]. These findings confirm that digital technology can achieve not only the permanent preservation and restoration of the Jiazhou section's heritage but also activate its vitality through digital dissemination.

1.3.3 Heritage Revitalization, Smart Governance, and Tourism Synergy

Regarding the value transformation and social functions of heritage, scholars have focused on revitalization mechanisms for linear cultural heritage, smart data-driven governance pathways, and synergistic models for cultural-tourism development. Xie Qian et al. (2022) constructed a knowledge graph of traditional Chinese village landscape research, quantitatively analyzing core themes like landscape genes and regional characteristics [15]. Zhong Wenjing and Liang Yingzhang (2025), through CiteSpace-based visual analysis, revealed a trend in rural studies shifting from singular conservation to living transmission [16]. Li Fei (2022), using Yunnan's Bisezhai as a case, proposed a "node-driven corridor" tourism development model for key nodes of linear cultural heritage [17]. Yang Ren et al. (2026) focused on the Ancient Southern Guangdong Post Road, discussing the crucial role of constructing cultural identifiers in traditional villages along the route for the synergistic revitalization of linear cultural heritage [18]. He Mengfan et al. (2023) studied strategies for the development of agricultural heritage empowered by digital technology [19]. Zhang Yaqiong et al. (2025) constructed a knowledge graph of digital landscape heritage, revealing a trend towards intelligent development [20]. Zhou Xiang et al. (2023) emphasized the importance of landscape-based integrated heritage conservation and practice [21]. These studies provide direct strategic references for how the Jiazhou section of the Southwest Silk Road can achieve living utilization, smart governance, and deep integration of culture and tourism through digital means.

1.4 Research Content and Methodology

This study takes the linear cultural heritage landscape of the Jiazhou section of the Southwest Silk Road as its research object, systematically conducting digital research centered on the two core dimensions of "spatial narrative" and "semiotic interpretation." Firstly, through literature review and field investigation, historical documents, local gazetteers, archaeological reports, and oral histories related to the ancient road corridor will be collected to clarify its historical context, spatial scope, and heritage components, establishing a foundational

research database. Subsequently, an integrated approach using digital technologies such as drone aerial photography, 3D laser scanning, GPS positioning, and Geographic Information Systems (GIS) will be employed for high-precision data acquisition and spatial modeling of key heritage sites, including the ancient road itself, post station ruins, ferry wharves, cliff inscriptions, and traditional settlements. This will result in a multi-dimensional spatio-temporal information platform encompassing spatial distribution, topography, and heritage attributes.

Next, spatial narrative theory will be introduced to analyze the sequential organization, path connectivity, and nodal structure of heritage elements within the geographical space. This aims to reconstruct the dynamic processes of trade circulation, military defense, ethnic migration, and cultural transmission that the linear landscape bore during different historical periods, thereby revealing the spatial logic of the linear landscape as a "historical narrative carrier." Concurrently, employing semiotic analysis methods, the study will conduct an in-depth interpretation of the cultural symbolism and meaning systems embedded in landscape elements such as architectural forms, stone inscriptions, toponymic symbols, religious imagery, and folk activities, exploring their semiotic functions in constructing local identity and facilitating cross-regional cultural exchange.

Finally, leveraging technologies like Virtual Reality (VR), Augmented Reality (AR), and interactive web platforms, the research will visually integrate and immersively present the findings on spatial narrative structures and semiotic interpretation, achieving digital activation and public dissemination of the cultural heritage.

Methodologically, an interdisciplinary approach is adopted, grounded in heritage studies and integrating spatial analysis from geography, morphological studies from architecture, textual criticism from history, and technological approaches from digital humanities. A combination of fieldwork, data analysis, theoretical interpretation, and digital reconstruction ensures the scientific rigor, systematic nature, and innovativeness of the research.

2. Core Concepts and Theoretical Foundations

2.1 The Connotation of Linear Cultural Heritage and Landscape Narrative

As a distinctive heritage category, linear cultural heritage transcends the spatio-temporal limitations of traditional point-based or areal heritage, emphasizing the dynamic connectivity and integrated characteristics formed by cultural routes throughout historical evolution. Its core value lies not only in the collection of material remains along the route but, more importantly, in the process of cultural exchange that connected different regions, ethnic groups, and civilizations—a process solidified and transmitted through specific geographical spaces. In the context of the Jiazhou section of the Southwest Silk Road, linear cultural heritage manifests as a composite cultural corridor traversing mountains, rivers, and connecting towns and villages. Its landscape forms bear the multiple historical memories of commercial trade, ethnic migration, and religious dissemination, constituting a spatial sequence characterized by high continuity and heterogeneity [22].

Landscape narrative serves as a key theoretical tool for transforming abstract historical context into perceptible spatial experience. It advocates for telling specific cultural stories through the organization and arrangement of spatial elements. In linear cultural heritage studies, landscape narrative extends beyond static descriptions of individual sites, striving to reveal the logical relationships and meaning-generating mechanisms behind spatial structures. By integrating the temporal dimension into spatial analysis, landscape narrative can reconstruct the historical scenes of heritage routes, enabling observers to perceive the accumulation and transformation of culture through movement. For the Jiazhou section, the connotation of landscape narrative lies in excavating the symbolic meanings embedded in elements like roads, passes, and wharves, interpreting them

within the grand historical backdrop of the Southwest Silk Road, thereby establishing a deep dialogue between people and place, past and present. For instance, the descriptions of the perilous and busy nature of the "Jiayang Ancient Road" in literary travelogues and local chronicles from the Tang and Song dynasties onward constitute an early layer of narrative and symbolic recording of the linear space, providing the original textual context for contemporary interpretation.

The combination of linear cultural heritage and landscape narrative provides a new epistemological foundation for understanding complex cultural routes. Both point towards a holistic, dynamic, and meaningful conception of space, implying that heritage conservation should not merely focus on the preservation of physical entities but also emphasize their function as vehicles for cultural narration. This theoretical perspective requires that in digital research, researchers must not only restore the physical spatial forms but also reconstruct the narrative logic of space through digital media, making latent cultural genes visible in scenes interwoven with the virtual and the real. This lays a solid theoretical foundation for subsequent semiotic interpretation and digital reconstruction.

2.2 Theoretical Framework for Semiotic Interpretation

Semiotics provides a rigorous logical framework for interpreting the deeper cultural connotations of linear cultural heritage landscapes. Its core lies in treating heritage elements as semiotic systems carrying specific historical information. In the research context of the Jiazhou section of the Southwest Silk Road, elements such as road patterns, architectural forms, stone inscriptions, and even natural landforms transcend their mere material properties, transforming into signifiers with referential functions, pointing to specific signified contents like commercial activities, ethnic fusion, or religious beliefs. Peirce's trichotomy of signs and Saussure's dyadic model converge here, collectively constructing an analytical framework for deciphering the semantics of the heritage landscape. By distinguishing the distribution patterns and combinatorial modes of iconic, indexical, and symbolic signs within the space, one can reveal how the Jiazhou landscape transmits historical information through visual forms, thereby understanding how ancient peoples constructed identity and cultural order using spatial elements [23]. This interpretive pathway endows originally silent material remains with a voice, turning them into readable and comprehensible texts.

The purpose of constructing a semiotic interpretation framework is to establish a translation mechanism from material form to cultural meaning, addressing the risk of information loss and contextual disconnection in digital reconstruction processes. During the digital reconstruction of linear cultural heritage, if the process remains at the level of geometric modeling and texture mapping, it often leads to the separation of the signifier and signified of heritage symbols, reducing the digital landscape to a hollow shell lacking soul. Therefore, it is essential to introduce in-depth semiotic interpretation methods to excavate the syntactic rules and pragmatic contexts behind the Jiazhou landscape symbols, clarifying the functional positioning of different semiotic units within the overall narrative structure. This theoretical framework emphasizes the dynamic generativity of symbols, positing that heritage meaning is constantly reconstructed through human-environment interaction and historical evolution. Applying this to digital research guides digital technology in accurately capturing and representing the cultural genes of heritage, ensuring that virtual scenes possess not only visual authenticity but also coherence in cultural logic, thereby achieving a leap from formal restoration to meaning regeneration, providing solid semantic support for the digital expression of spatial narrative.

2.3 The Convergence of Digital Humanities and Cultural Heritage Studies

The rise of digital humanities signifies a profound transformation in the research paradigms of the

humanities, with its core lying in utilizing computational thinking and digital technologies to re-examine and interpret traditional cultural subjects. In the field of cultural heritage studies, digital humanities is no longer merely an auxiliary recording tool but has evolved into a methodological system capable of deeply engaging with heritage cognition, conservation, and transmission. For linear cultural heritage with complex spatio-temporal attributes, such as the Jiazhou section of the Southwest Silk Road, digital humanities offers a new perspective that transcends the limitations of traditional textual research and field surveys. Through technological means like Geographic Information Systems, 3D reconstruction, and big data correlation analysis, researchers can connect dispersed heritage sites like beads on a string, reconstruct historical geographical environments in virtual space, and quantitatively analyze spatial layout characteristics, thereby revealing cultural evolutionary patterns difficult to detect with the naked eye [24]. This deep integration of technology and humanities shifts heritage research from static descriptive analysis to dynamic simulation-based inference, providing robust data support and visualization pathways for understanding the nodal functions and interactive mechanisms of the Jiazhou section within the Southwest Silk Road network.

The convergence point of digital humanities and cultural heritage studies is prominently manifested in the capability for multi-dimensional integration of heritage information and meaning reconstruction. Traditional research is often constrained by media forms, making it difficult to comprehensively present the massive heterogeneous data and the underlying complex social networks embodied in linear cultural heritage. In contrast, digital humanities platforms can break down disciplinary barriers, performing structured processing and relational mining of multi-source information, including archaeological discoveries, historical documents, and oral histories. In the digital study of the Jiazhou section, this convergence implies constructing a comprehensive information model integrating spatial location, temporal evolution, and cultural semantics. This model not only records the material forms of the heritage but also, through algorithmic simulation, recreates historical scenes of commercial flows and population migrations, concretizing abstract spatial narratives. More importantly, digital humanities emphasizes public participation and interactive experiences, promoting a shift in heritage conservation from an expert-driven, closed system towards an open, socially shared ecosystem. This allows the cultural value of the Jiazhou section to gain new vitality within the digital context, opening broad theoretical and practical avenues for the living transmission and sustainable utilization of heritage.

3. The Landscape Narrative Structure and Spatial Representation of the Jiazhou Section's Linear Cultural Heritage

3.1 Historical Context and Spatial Configuration of the Jiazhou Section

The historical context of the Jiazhou section of the Southwest Silk Road is deeply rooted in the millennia-long processes of commercial trade and ethnic migration between the ancient Central Plains, the southwestern frontier, and even South and Southeast Asia. Its formation and development bear witness to a thousand-year history of civilizational exchange. As a land-water transportation hub, Jiazhou, leveraging its unique geographical advantage at the confluence of the Min, Dadu, and Qingyi Rivers, became a key node on the Silk Road connecting the Chengdu Plain with the Yunnan-Guizhou Plateau. Throughout historical periods, this corridor facilitated not only the flow of goods like tea, silk, salt, and iron but also promoted the spread of Buddhism, the Tea-Horse trade, and deep intermingling of multi-ethnic cultures. Its pivotal position as the "confluence of three rivers, a crucial land-water junction" was established early in historical records. For example, the Gazetteer of Jiading Prefecture notes: "Jiading Prefecture, governing the confluence of three rivers, with continuous flow of boats and carts, serves as the southwestern bastion of Shu," vividly outlining its historical role as a core node for goods distribution and human mobility. This long-term historical accumulation

elevated the Jiazhou section beyond a mere transportation function, evolving into a lifeline rich with historical memory and cultural sedimentation. Its spatial configuration was not a random natural distribution but the result of careful planning by ancient peoples adapting to mountainous terrain and based on economic needs and military defense strategies. It exhibits linear characteristics extending along rivers and rising with mountainous terrain, forming a unique substrate of regional cultural landscape.

In terms of spatial representation, the linear cultural heritage of the Jiazhou section exhibits a distinct hierarchical and networked structure. With the main ancient trail as the backbone, it connects diverse heritage elements such as passes, post stations, wharves, ancient towns, and religious structures, forming a spatial sequence combining points, lines, and areas. These elements are not isolated in geographical space but are interconnected through specific visual corridors and path logic, collectively constructing a landscape system with strong directionality and narrativity. The interweaving of river waterways and mountain land routes shaped a three-dimensional, composite transportation network, enabling the Jiazhou section to flexibly adapt to environmental changes and societal demands across different historical periods. This spatial configuration not only reflects the adaptive wisdom of ancient peoples in interacting with the natural environment but also, on a macro scale, established Jiazhou's hub status within the Southwest Silk Road network. An in-depth analysis of this historical context and spatial configuration is a prerequisite for understanding the landscape narrative logic of the Jiazhou section and provides accurate spatial coordinates and historical context for subsequent excavation of its symbolic meanings and digital reconstruction.

3.2 Narrative Types and Spatial Distribution of Landscape Elements

The landscape elements of the Jiazhou section of the Southwest Silk Road can be categorized into three types based on their narrative functions: Path-Guiding, Node-Stopping, and Environmental-Background. Together, they construct a complete linear narrative chain. Path-Guiding elements primarily include ancient road remains, plank road holes, and tracking paths. Serving as narrative threads, they dictate the direction and rhythm of movement, implying a sense of historical flow and continuity. Node-Stopping elements encompass passes, wharves, post stations, and ancient settlement towns. These spaces are not only physical places for goods distribution, rest, and personnel activities but also climactic episodes where stories unfold, bearing core historical events such as trade, military defense, and ethnic integration. The establishment of official post stations, in particular, reflects the narrative rhythm and administrative logic of the linear space. According to records in the Collected Statutes of the Qing Dynasty and local gazetteers, the Jiazhou section had post stations like "Pingqiang Post" and "Suxi Post," whose functions were explicitly defined as "delivering official documents and accommodating envoys and travelers." These fixed nodes served as anchors for the official narrative in space. Environmental-Background elements include distinctive landforms, hydrological features, and vegetation communities. They provide the grand spatio-temporal stage for the entire narrative, imbuing the landscape with a unique regional atmosphere and emotional tone. These three types of elements functionally support each other, concretizing abstract historical processes into perceptible spatial experiences, making the Jiazhou section not merely a transportation route but a three-dimensional history book unfolding across the land.
Spatially, these narrative elements exhibit a notable pattern of clustering along riverine axes and differentiation along vertical mountainous gradients. Major narrative nodes are densely distributed along the banks of rivers such as the Minjiang and Dadu Rivers, forming a linear pattern characterized by the parallel alignment of water and land routes and the interdependence of ports and post stations. This configuration reflects the historical reality of ancient transportation's reliance on waterways. Meanwhile, constrained by topographical conditions, passes and defensive installations are predominantly situated on perilous ridge locations, whereas commercial

settlements tend to be located on relatively flat river terraces. Such vertical functional differentiation establishes a three-dimensional spatial system of defense and economy. The spacing between elements is not uniform but exhibits rhythmic variations in density according to travel patterns and geographical barriers. Key nodes feature a high concentration of elements, forming narrative climaxes, while transitional segments are relatively sparse, serving as connections and foils. This spatial pattern not only reveals adaptive strategies in human-environment relationships but also provides a clear logical basis for scene scheduling and view analysis in digital reconstruction, ensuring spatial authenticity and historical coherence in virtual narratives [25].

3.3 Narrative Sequence and Rhythm in Linear Space

The narrative sequence of linear cultural heritage is not a simple spatial enumeration but a temporally constructed spatial experience based on movement. In the Jiazhou section of the Southwest Silk Road, the narrative sequence follows a logical structure of "introduction, development, transition, and conclusion." The entrance to the ancient path serves as the prologue, guiding travelers into the historical context through winding mountain paths and river courses. As space unfolds, the imposing presence of a pass marks a narrative transition, hinting at the crossing of geographical boundaries and the advent of security challenges. The appearance of post stations and wharves constitutes the narrative climax, where the convergence of people and goods and the most intense cultural collisions occurred, bearing the richest historical information and emotional memories. This sequential arrangement transforms originally static material remains into a flowing plotline. As travelers move, they continuously receive new visual signals and cultural cues, psychologically constructing a coherent historical picture. Digital research must accurately capture this sequential logic, restoring the traveler's perspective through virtual path planning, allowing audiences to perceive the flow of time and the progression of the story in an immersive experience.

Narrative rhythm is the key mechanism controlling information density and emotional tension, manifested in the alternating changes of spatial openness/enclosure, landscape density/sparsity, and visual expansion/contraction. The topographical complexity of the Jiazhou section naturally shapes a rhythm of rises and falls. Narrow and perilous plank road sections create a tense, oppressive atmosphere, forcing travelers to focus on the path beneath and the danger ahead, forming a tight narrative beat. In contrast, open river valley plains or ancient town terraces provide space for respite, where suddenly open vistas accompany a rich presentation of information, constituting narrative expansion and sedimentation. This alternation between fast and slow, tension and relaxation, not only regulates the physiological load of travel but also psychologically reinforces the depth of memory. In digital reconstruction, understanding and recreating this rhythm is crucial. By adjusting the cinematography, lighting atmosphere, and interaction frequency of virtual scenes, the authentic cadence of travel can be simulated, avoiding the aesthetic fatigue caused by monotonous exposition. This achieves a deep transformation from physical space to emotional space, enhancing the appeal and artistic tension of linear spatial narrative.

4. The Semiotic System and Meaning Interpretation of the Jiazhou Section's Linear Cultural Heritage Landscape

4.1 Material Landscape Symbols and Their Cultural Signification

Material landscape symbols are the tangible carriers of historical memory for the Jiazhou section of the Southwest Silk Road. Their forms and textures directly point to specific cultural significations. Cart ruts on the ancient road, stone grooves left by trackers' hauling, and weathered holes for supporting plank roads are not merely physical remnants of transportation functions but profound metaphors for ancient commercial prosperity and the human struggle against nature. These symbols, in their silent material forms, record the frequency of

logistics and the hardship of travel over centuries, solidifying abstract historical time into touchable spatial textures. The masonry methods of pass walls, the wear patterns of wharf steps, and the beam-column structures of post station buildings similarly constitute a rich semiotic vocabulary. They respectively refer to the strict hierarchies of military defense, the bustling scenes of land-water transfer, and the administrative order of frontier governance. Through morphological analysis of these material symbols, the functional positioning of the Jiazhou section as a hub within the Southwest Silk Road network can be decoded, revealing the social operational mechanisms and power relations hidden behind bricks, stones, earth, and wood.

Furthermore, the cultural signification of material landscape symbols transcends singular functional explanations, rising to representations of regional spirit and collective memory. The distinctive color contrast between the red sandstone landform of the Jiazhou section and the artificial structures forms a unique visual semiotic system, symbolizing the tenacious implantation and harmonious coexistence of human civilization within a rugged natural environment. Landmark structures like bridges, pagodas, and cliff carvings often carry folk beliefs of praying for safety and warding off water-related evils, serving as media connecting secular life and the spiritual world. For example, the construction of the Leshan Giant Buddha, explicitly recorded in historical sources like the Record of the Great Buddha Statue at Lingyun Temple in Jiazhou as "seizing natural danger with merciful power, transforming turbulent waves into peaceful flow," possessed the symbolic meaning of "calming waters" to ensure safe navigation, a significance that transcended the religious sphere to become a collective psychological symbol imprinted on the landscape. Over the long course of historical evolution, these symbols have been continuously imbued with new meanings, gradually transforming from their initial practical functions into symbols of ethnic identity and cultural belonging. From the perspective of digital research, the precise extraction and semantic annotation of these material symbols form the foundation for constructing a virtual heritage knowledge graph. Only by deeply interpreting their underlying cultural signification can digital representation avoid becoming a mere formal geometric restoration, thereby recreating the profound historical depth and humanistic spirit of the Jiazhou section in virtual space, and achieving the value transformation of material remains into cultural assets [26].

4.2 Non-Material Practices and Ritual Symbols

Non-material practices and ritual symbols constitute the soul of the Jiazhou section's linear cultural heritage. They are attached to material space yet transcend physicality, endowing the landscape with vibrant life through dynamic behavioral performances and oral transmission. Along this ancient trade route, trackers' chanties, caravan bell sounds, and specific travel taboos collectively weave a unique auditory and behavioral semiotic system. These sound symbols are not merely tools for coordinating labor rhythms but also carriers of group emotional cohesion and cultural identity. Echoing in empty valleys and over rushing river surfaces, they elevate individual survival experiences into collective historical memory. Concurrently, ritualistic practices along the route, such as sacrifices to mountain gods, worship of water deities, and guild rules in inns, constitute a special language for dialogue between humans and the natural environment. These practices are not later recollections but are documented in contemporary local records. For instance, the Gazetteer of Leshan County - Customs records: "Boatmen, before downstream journeys, invariably pour libations into the river's heart, praying to the Water Mansion; land travelers passing dangerous defiles silently pray to the Mountain God." This clearly indicates that specific rituals were tightly bound to specific risk-laden spaces (river's heart, dangerous defiles), serving as semiotic behavioral strategies for travelers dealing with uncontrollable natural forces. These rituals are not isolated folk activities but are deeply embedded within the functional logic of spatial nodes. For example, blessing ceremonies before departure at a wharf reinforced the sacredness of the aquatic space, while

oath-swearing activities at a pass imbued the boundary space with a sense of sacred covenant, transforming physical passages into cultural fields rich with spiritual connotations.

The key to interpreting the meanings of such non-material symbols lies in revealing the underlying social networks and cosmological perceptions. Travel practices along the Jiazhou section were often accompanied by reverence for and adaptation to natural forces. Related legends, folk tales, and beliefs reflect the deep-seated need of ancient merchants and travelers for psychological comfort and safety in harsh environments. These oral literatures and ritual behaviors complement each other, transforming geographical hazards like treacherous rapids and cliffs into heroic trials in mythological narratives, thereby dissolving the fear of the real journey and constructing a unique sense of place. In the digital context, capturing and reconstructing these fleeting non-material symbols is extremely challenging yet crucial. Recreating the dynamic postures of trackers through motion capture technology, reproducing the soundscapes of caravan travel using spatial audio technology, or designing interactive narrative engines that allow users to participate in virtual rituals can effectively activate dormant historical memories. This paradigm shift from static display to dynamic experience ensures that non-material practices are no longer appendages to textual descriptions but become perceptible, interactive core elements within the digital landscape, thereby achieving a deep interpretation and living transmission of the holistic value of the Jiazhou section's cultural heritage [27].

4.3 Layering of Meaning in Landscape Symbols and Their Contemporary Translation

The landscape symbols of the Jiazhou section's linear cultural heritage are not static, singular signifiers but dynamic texts accumulating layers of meaning throughout history. From their initial practical transportation functions to later roles as military defense barriers, and now as carriers of ethnic memory and objects of touristic appreciation, the same material entity has been imbued with multiple, even contradictory, cultural significations at different historical junctures. This layering of meaning elevates the ancient road, passes, and wharves beyond mere physical existence, transforming them into complex semiotic fields that crystallize political struggles, commercial prosperity and decline, and ethnic migrations across generations. Ancient stone steps record both the arduous footprints of caravans and bear the gaze of modern tourists. Remnants of city walls symbolize past enclosure and defense, yet are now translated into historical witnesses of openness and exchange. This spatio-temporally interwoven semiotic characteristic demands that researchers adopt an archaeological stratigraphic perspective during interpretation, peeling away and sorting through the sedimentary layers of meaning from different periods. This approach restores the complexity and richness of the landscape as a historical container, avoiding its reduction to a flattened historical slice.

Facing the contemporary social context, achieving the translation of meaning for landscape symbols is a key pathway to activating the vitality of heritage. Digital technology provides a translation medium that transcends traditional static displays, capable of transforming obscure historical symbols into visual languages and interactive experiences understandable and relatable to modern people. Through Augmented Reality and Virtual Reality technologies, abstract commercial data, war scenes, or folk rituals can be projected back onto the actual landscape, making implicit cultural logic explicit. This allows contemporary audiences to reconstruct and reproduce historical meaning through immersive interaction. This translation is not a dissolution of authenticity but a creative inheritance. It breaks down temporal and spatial barriers, enabling the ancient Silk Road spirit to resonate with modern values. In this process, landscape symbols shift from passive objects of observation to active narrative subjects. Their meanings are extended through infinite replication and dissemination in digital space, ultimately achieving transformation from historical remains to contemporary cultural capital, providing solid spiritual support for the construction of regional cultural identity.

5. Digital Pathways: Preservation, Interpretation, and Experience Construction of Landscape Narrative

5.1 Constructing a Narrative Database Based on Spatial Information

Constructing a narrative database based on spatial information forms the cornerstone for the digital preservation of the Jiazhou section's linear cultural heritage. Its core lies in breaking the limitations of traditional archival management, such as the separation of text and images and the fragmentation of time and space, to establish a multi-dimensionally coupled data organization paradigm. This database is not merely a repository for geographic information but a logical architecture that deeply correlates the complex natural topography, distribution of remains, historical events, character legends, and folk activities of the Jiazhou section. A central task in building this logical architecture is the systematic compilation, geographical calibration, and semantic linking of records scattered across texts like Yu Di Ji Sheng, Shu Zhong Guang Ji, and various dynastic local gazetteers and literary collections concerning the mountains, rivers, ferries, post routes, products, and events of the Jiazhou section. This transforms traditional philological research findings into structured data units recognizable and usable by computational models. By introducing a high-precision 3D Geographic Information System, each ancient road remnant, pass site, or wharf node is assigned precise spatial coordinates and attribute tags. Simultaneously, associated multi-modal narrative data—including oral history audio, excerpts from ancient texts, archaeological survey drawings, and historical scene reconstruction images—are linked. This aggregation method, indexed by space, re-weaves discrete heritage components into a dense network of meaning within the digital domain, ensuring the isomorphism of landscape material forms and the cultural memories they bear at the data level. This provides a solid ontological foundation for subsequent in-depth interpretation.

In designing the data structure, full consideration must be given to the fluid characteristics of linear cultural heritage, constructing an ontology model that supports spatio-temporal dynamic evolution. The database should not only record the static status of heritage points but also incorporate the temporal dimension. Through version management technology, it should recreate the trajectory of spatial pattern changes and functional evolution of the Jiazhou section across different historical periods. This necessitates establishing complex semantic relationships between data entries. For instance, the repair records of a certain plank road section should be logically linked to specific periods' commercial policies, military conflicts, or natural disaster events. This reconstructs the dynamic historical process of "paths following people, events moving with places" at the data foundation level. Furthermore, the database should feature open interface standards and an extensible metadata framework, allowing for the continuous addition of new archaeological findings or folk survey results, maintaining the growth of the knowledge system. This narrative database based on spatial information essentially constructs a computable historical-geographical environment. It not only achieves the permanent preservation and efficient retrieval of heritage information but also provides the underlying data support for algorithm-driven intelligent narrative generation, dynamic rendering of virtual scenes, and personalized tour route planning. It signifies a paradigm shift in heritage conservation from passive recording to active knowledge services [28].

5.2 Narrative Reconstruction of Multi-Dimensional Digital Scenes

The narrative reconstruction of multi-dimensional digital scenes aims to transcend the limitations of traditional static displays, using virtual simulation technologies to reconstruct the spatio-temporal field of the Jiazhou section's linear cultural heritage, dynamically reviving historical narratives in digital space. This process is not a simple geometric copy of the real landscape but a dynamic resurrection of history based on the previously constructed narrative database, utilizing high-precision 3D modeling, panoramic image stitching, and physics engine rendering to restore the spatial texture and environmental atmosphere of the ancient road at

different historical junctures. Digital scenes must accurately recreate the perilous features of the topography, the material textures of architectural remains, and the ecological succession of vegetation and water systems, while incorporating dynamic changes in lighting, shadows, and weather systems to create historically immersive contexts. In such high-fidelity virtual environments, vanished post stations, damaged plank roads, and bustling wharves are completely restored. Users can navigate between past and present from a first-person perspective, intuitively perceiving the spatial scale and geographical barriers of the Jiazhou section as a Silk Road hub, thereby establishing a deep cognitive understanding of the heritage's value at both visual and psychological levels.

More crucially, the construction of multi-dimensional scenes must carry the logical function of spatial narrative, transforming abstract historical texts into visualized dynamic event flows. By embedding timeline controls and interactive trigger mechanisms within virtual scenes, researchers can demonstrate scenarios like caravan route choices, tactical layouts for pass defense, or survival challenges during floods, turning static landscape symbols into flowing historical scripts. This narrative reconstruction emphasizes the synergistic effect of multi-sensory channels. Combined with spatial audio technology to recreate soundscape elements like trackers' chanties and the clatter of horse hooves, and even simulating the tactile feel of wind or olfactory memories of specific seasons, it aims to fully activate users' embodied cognition. Every node in the scene becomes a stage for narrative events. Users are no longer passive observers but active participants; their movement trajectories and interactive behaviors will trigger the layered display of corresponding historical information in real-time, allowing them to autonomously piece together a complete cultural picture during exploration. This paradigm shift from static exhibition to dynamic interpretation not only addresses the difficulty of holistically displaying linear cultural heritage due to its large span and scattered distribution but also endows the heritage site with a new dimension of life, making it a living historical space that can be read, experienced, and engaged in dialogue.

5.3 Interactive Digital Storytelling and Public Experience Design

Interactive digital storytelling and public experience design constitute the terminal interface for the digital dissemination of the Jiazhou section's linear cultural heritage. Its core logic lies in transforming one-way information transmission into a two-way co-construction of meaning. At this level, digital technology is no longer merely a tool for historical reconstruction but becomes a mediating bridge connecting the past and present, heritage and the public. By constructing interactive narrative frameworks based on role-playing, the public transitions from passive viewers to participants in the historical process. Users can embody ancient merchants, trackers, or border garrison soldiers in virtual space, making route choices, responding to sudden dangers, or engaging in trade based on real historical and geographical data. This embodied interactive experience breaks down temporal and spatial barriers, making the abstract Silk Road spirit tangible and comprehensible through the specific fates and survival challenges of characters, thereby eliciting deep emotional resonance and achieving a leap from cognitive understanding to emotional identification.

The key to experience design lies in establishing dynamic feedback mechanisms and non-linear narrative structures that correspond to the inherent fluidity and complexity of linear cultural heritage. The system should adjust narrative pacing and information presentation in real-time based on user interaction. Different choices may lead to varied historical outcomes or unlock unique cultural perspectives, revealing the diverse and co-existing cultural ecology behind the Jiazhou landscape. For example, a user's choice of different goods at a virtual wharf might trigger different trade route stories, while dialogue choices at a pass might unveil hidden details of military defense. This open-ended narrative strategy not only enriches the experiential layers but also

encourages the public to actively explore and construct heritage value, forming personalized interpretations. Simultaneously, on-site guided tour applications combining Augmented Reality technology can overlay virtual narrative layers onto the actual landscape, allowing tourists to engage in immediate dialogue with historical relics through mobile devices while walking, achieving seamless integration of online and offline experiences. Ultimately, this interactive digital storytelling not only enhances public engagement and sense of gain but also imbues the ancient Silk Road with new vitality of the times within the construction of collective memory, promoting the shift of cultural heritage conservation from a specialized domain to societal co-sharing.

6. Conclusion

This study, through an in-depth analysis of the linear cultural heritage landscape of the Jiazhou section of the Southwest Silk Road, reveals its dual essence as both a spatial narrative carrier and a collection of symbols. The research finds that the ancient roads, passes, and wharves of the Jiazhou section are not isolated material remains but meaning-laden fields that have accumulated layers of historical memory, ethnic migration, and commercial exchange over time. Their landscape symbols exhibit significant characteristics of meaning layering and polysemy throughout spatio-temporal evolution. Addressing this complexity, the digital pathway constructed in this study demonstrates that a narrative database based on spatial information can effectively integrate dispersed heritage elements and reconstruct the logical connections between material forms and cultural memory. The reconstruction of multi-dimensional digital scenes and the design of interactive storytelling successfully transform static historical texts into dynamic, embodied experiences, overcoming the limitations of temporal and spatial fragmentation inherent in traditional conservation models. This systematic approach, from data ontology to scene reconstruction to public interaction, not only achieves the holistic preservation of the full picture of linear cultural heritage but also accomplishes the contemporary translation of heritage meaning through technological empowerment. It allows the ancient Silk Road spirit to radiate new vitality within the digital context, providing solid empirical support and an innovative paradigm for the construction of regional cultural identity.

Looking ahead, with the iterative advancement of technologies like artificial intelligence, big data, and the metaverse, digital research on linear cultural heritage will usher in even broader development space. Future work should focus on deepening the application of semantic web technologies in heritage knowledge graphs to achieve more intelligent narrative generation and personalized recommendation, enabling each participant to embark on a unique cultural exploration journey. Concurrently, greater attention must be paid to the ethical dimensions and boundaries of authenticity regarding digital heritage, seeking an optimal balance between technological innovation and historical respect to prevent the erosion of cultural seriousness by excessive entertainment. Furthermore, interdisciplinary collaboration mechanisms urgently need strengthening. The deep integration of archaeology, history, computer science, and communication studies will promote the formation of a more comprehensive theoretical system and technical standards. The ultimate goal is to construct an open, shared, and dynamically evolving digital ecosystem, transforming the Jiazhou section of the Southwest Silk Road not only into a preserved past but also into a living cultural resource that connects the future, inspires creativity, and promotes civilizational dialogue, contributing Chinese wisdom and solutions to the sustainable conservation of global linear cultural heritage.

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