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Research on Micro-Renewal Design of Arcade Space in Boat-Shaped Street of Luocheng Ancient Town, Qianwei County, Sichuan

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Abstract: The Boat-Shaped Street in Luocheng Ancient Town, located in Qianwei County of Sichuan Province, represents a typical traditional commercial settlement. Its distinctive boat-shaped spatial layout and continuous arcade corridor system constitute not only a significant material heritage of regional architectural culture but also an important spatial carrier for residents' daily public activities. However, under the dual influences of tourism development and the evolving demands of contemporary life, the arcade spaces are increasingly confronted with several challenges, including functional decline, insufficient public vitality, and the growing tension between the preservation of traditional architectural character and the accommodation of modern usage requirements.

From the perspective of environmental design, this study conducts a systematic investigation of the arcade spaces along Boat-Shaped Street. A combination of research methods—including literature review, on-site spatial surveying and mapping, and behavioral observation—is employed to analyze the current spatial conditions and usage patterns. The research aims to explore strategies for the micro-renewal of arcade spaces within historic streets, with the goal of improving spatial functionality and public vitality while maintaining the historical character and cultural value of the street environment.

Keywords: Boat-Shaped Street, Arcade Space, Micro-renewal, Historic and Cultural District Conservation.

1. Introduction

1.1 Research Background

1.1.1 Development Trends in the Conservation and Renewal of Historic Cultural Districts

With the acceleration of urbanization, many historic cultural districts are facing challenges such as functional decline and the gradual loss of traditional character. As important carriers of urban cultural heritage, these districts preserve historical memory and regional culture while shaping the unique identity of cities. Therefore, achieving effective conservation and rational utilization of historic districts within the process of urban renewal has become an important issue in environmental design and urban planning International heritage conservation concepts have gradually evolved from the protection of individual buildings to the preservation of the overall historic environment. The *Venice Charter* (1964) established principles of scientific conservation and appropriate use, while the *Washington Charter* (1987) emphasized the holistic protection of historic towns. Consequently, conservation approaches have shifted from "static preservation" to "dynamic conservation," aiming to maintain historical authenticity while promoting sustainable spatial development.

In China, historic district protection has increasingly shifted from large-scale demolition and reconstruction toward conservation-oriented renewal and adaptive reuse. Current research and practice emphasize preserving spatial morphology, enhancing spatial quality through refined design, and sustaining community vitality while maintaining historical fabric.

1.1.2 Application of the Micro-Renewal Concept in the Transformation of Historic Districts

Traditional large-scale urban redevelopment often leads to the destruction of historic spatial structures and the disruption of cultural continuity. In response, the concept of micro-renewal has emerged as a more sustainable approach to urban regeneration. Micro-renewal emphasizes small-scale, incremental, and low-impact interventions that respect existing spatial patterns and historical contexts. By focusing on street spaces and public nodes, it aims to improve infrastructure, enhance spatial functions, and stimulate social vitality while preserving the authenticity of historic environments. In addition, micro-renewal highlights public participation and collaborative community governance, seeking to balance heritage conservation with contemporary urban needs.

Luocheng Ancient Town in Qianwei County, Sichuan Province, is a well-preserved traditional market town. Its core area, Boat-Shaped Street, features a distinctive spatial layout and continuous corridor spaces formed by traditional wooden buildings. These corridors historically functioned as sheltered walkways and important venues for commerce and social interaction. However, with socio-economic change and tourism development, problems such as building deterioration, unauthorized alterations, and excessive commercial occupation have emerged, weakening both the visual integrity and public character of the corridor spaces.

1.2 Problem Statement

As the practice of historic district conservation and renewal continues to deepen in China, the key challenges facing traditional street spaces have gradually shifted from simple physical restoration toward issues related to spatial vitality and functional regeneration. Boat-Shaped Street in Luocheng Ancient Town represents a typical example of traditional street morphology. Its continuous corridor spaces not only facilitate pedestrian circulation but also serve as important venues for daily social interaction, commercial activities, and community life.

However, due to long-term social transformation and spatial evolution, the corridor spaces along Boat-Shaped Street have gradually experienced several issues, including weakened functions, insufficient public accessibility, and increasing conflicts between heritage preservation and modern usage demands. These problems have limited the continued expression of spatial vitality and cultural value within the historic district.

1.3 Research Objectives and Research Questions

1.3.1 Research Objectives

With the transformation of historic district renewal from large-scale redevelopment to incremental regeneration, corridor spaces have become key spatial elements connecting buildings and streets. These spaces integrate functions such as climate protection, pedestrian circulation, and public interaction, making them important entry points for improving the environmental quality of historic districts through micro-renewal interventions.

This study focuses on the corridor spaces of Boat-Shaped Street in Luocheng Ancient Town and aims to explore appropriate renewal strategies for traditional street environments. Through a systematic analysis of spatial morphology, usage patterns, and environmental conditions, the research summarizes the structural characteristics and functional logic of corridor spaces. Based on the principles of micro-renewal, a targeted design strategy framework is proposed to guide the improvement of small-scale public spaces.

Furthermore, the study examines issues related to spatial vitality, including usage efficiency, activity capacity, and environmental quality. Corresponding design strategies are suggested to reactivate the public function of corridor spaces and encourage interaction between residents and visitors, thereby enhancing the overall vitality of the historic district. By respecting the traditional spatial structure of Luocheng Ancient Town and integrating regional cultural characteristics with contemporary needs, the research aims to develop sustainable micro-renewal approaches that balance heritage conservation with functional enhancement.

1.3.2 Research Questions

This study addresses three main research questions. First, what are the existing spatial characteristics and key issues of the corridor spaces along Boat-Shaped Street? Through field investigation, spatial mapping, and behavioral observation, the study systematically analyzes spatial form, dimensional characteristics, patterns of use, and environmental conditions. Based on this analysis, the research identifies the main problems related to spatial continuity, functional organization, facility allocation, and environmental quality, as well as issues concerning space utilization efficiency, the capacity to support public activities, and environmental comfort.

Second, how can the concept of micro-renewal be applied to the transformation of corridor spaces? Micro-renewal emphasizes small-scale, low-impact, and incremental spatial interventions. Considering the structural characteristics and conservation requirements of corridor spaces, this study explores practical approaches to implementing micro-renewal strategies through spatial integration, facility improvement, interface enhancement, and environmental upgrading.

Third, how can spatial vitality be improved while preserving traditional architectural character? In the renewal of historic districts, tensions often arise between the protection of historic character and the demands of contemporary use. This research therefore explores strategies for maintaining traditional spatial patterns, material characteristics, and street scales while simultaneously improving functional organization, optimizing spatial layout, and enhancing public facilities to stimulate the potential for public activities within corridor spaces.

1.4 Research Significance

1.4.1 Theoretical Significance

(a) Providing a New Perspective for Micro-Renewal Design in Historic Districts

In the context of urban regeneration that emphasizes both heritage conservation and the renewal of existing urban fabric, historic districts have increasingly shifted from large-scale reconstruction to incremental micro-renewal approaches. Micro-renewal focuses on improving spatial quality through small-scale and low-impact interventions while respecting the original spatial patterns, historical fabric, and social structures.

However, existing studies mainly focus on overall district-level renewal strategies or tourism development models, while systematic research on micro-renewal design methods at the level of specific spatial units remains limited.

The Boat-Shaped Street of Luocheng Ancient Town represents a traditional street with distinctive spatial morphology and historical value. Its corridor spaces serve not only as important venues for public activities but also as key transitional interfaces connecting buildings and streets. By examining corridor spaces from the perspective of micro-renewal, this study contributes to a deeper understanding of the composite spatial structure of "street–corridor–shop." Through the analysis of existing conditions and the development of targeted design strategies, this research enriches the theoretical framework of micro-renewal design for historic districts and provides new perspectives for the renewal of small-scale public spaces.

(b) Providing a New Case Study for Corridor Space Research in Design Practice

Corridor spaces are important components of traditional Chinese streets and have historically served multiple functions, including circulation, commerce, climate adaptation, and social interaction. Although previous research has explored corridor spaces from architectural history or spatial morphology perspectives, systematic studies focusing on environmental design and spatial renewal remain relatively limited, particularly in terms of practical design case studies.

The spatial scale, structural form, and patterns of use along Boat-Shaped Street reflect the regional characteristics of traditional commercial streets in southern Sichuan. With the development of tourism and changes in local lifestyles, corridor spaces now face new challenges related to functional adaptability, spatial quality, and public accessibility. By conducting micro-renewal design research on the corridor spaces of Boat-Shaped Street and proposing corresponding spatial optimization strategies, this study provides a valuable practical case that contributes to the contemporary reuse and revitalization of corridor spaces.

1.4.2 Practical Significance

(a) Providing Design References for the Spatial Renewal of Luocheng Ancient Town

The Boat-Shaped Street pattern of Luocheng Ancient Town possesses significant historical and cultural value. However, under the dual influences of tourism development and everyday community life, the corridor spaces along the street have gradually revealed several issues related to functional organization, facility conditions, environmental quality, and the capacity to accommodate public activities. Problems such as limited spatial diversity, aging infrastructure, disordered interfaces, and insufficient public resting areas have affected the overall spatial quality and visitor experience.

By conducting systematic field investigations and pro blem analysis, this study proposes targeted spatial optimization strategies based on the concept of micro-renewal. While preserving the original historic character and spatial fabric, the research aims to improve corridor space s through functional integration, facility enhancement, and environmental improvement. The results of this stud y can provide practical design references for future con servation and renewal efforts in Luocheng Ancient Tow n, thereby promoting the sustainable development of the historic district.

(b) Providing a Reference Model for the Renewal of Similar Historic Districts

In many traditional towns and historic districts across China, corridor-style streets similar to Boat-Shaped Street are common. Examples include arcade streets in the Sichuan–Chongqing region and covered corridor streets in the Jiangnan area. These spatial forms typically integrate commercial, circulation, and social functions and play important roles within the spatial systems of historic neighborhoods.

However, under the pressures of modern urban development and tourism expansion, such traditional spaces often face problems such as functional decline, deteriorating spatial quality, and the weakening of historic identity.

Through a systematic study of micro-renewal design strategies for the corridor spaces of Boat-Shaped Street, this research develops a relatively comprehensive design framework that includes renewal principles, spatial optimization strategies, and practical design methods. While addressing the specific context of Luocheng Ancient Town, the findings of this study may also provide useful references for the renewal and revitalization of

other historic districts with similar spatial characteristics, thereby contributing to more sustainable development pathways for traditional street environments.

2. Literature Review

2.1 Research on the Conservation and Renewal of Historic and Cultural Districts

2.1.1 Development of Historic District Conservation in International Research

Research on the conservation of historic and cultural districts abroad has developed for more than half a century and gradually formed a relatively comprehensive academic system integrating theoretical paradigms with technical approaches, becoming a key topic in urban regeneration and cultural heritage conservation.

From the 1960s to the 1980s, the theoretical foundation of historic district conservation was established, marked by a shift from protecting individual monuments to preserving entire historic areas. In 1962, France promulgated the Historic District Conservation Act, which legally defined conservation boundaries and regulatory mechanisms for historic urban areas. The Washington Charter issued by ICOMOS in 1987 further emphasized that conservation should include spatial patterns, street textures, social functions, and cultural contexts.

Since the twenty-first century, research has entered a stage of theoretical deepening and methodological diversification. Pendlebury (2002) analyzed the relationship between heritage conservation and urban regeneration, while Roders and VanOers (2009) proposed the Historic Ur ban Landscape (HUL) approach integrating conservation with sustainable urban development. Methodologically, studies such as By kowa and Dyachkova (2021) and Lak et al. (2019) introduced quantitative evaluation and strategic analysis tools for heritage conservation and regeneration. Overall, international research provides important theoretical and methodological references for historic district conservation in China.

2.1.2 Current Research on Historic District Renewal in China

Since China established the conservation system for historic districts in 1985, research has evolved over four decades, forming a framework from conceptual construction to dynamic heritage inheritance. Fundamental theories, pioneered by scholars like Ruan Yisan, emphasize authenticity and sustainable development, viewing district s as "living heritage." Wu Lian and Wang Xin (2007) critiqued common renewal misconceptions and proposed t he dual objectives of cultural continuation and environmental improvement based on organic renewal theory. Renewal models have shifted from large-scale redevelopment to incremental, small-scale strategies, with Wang Chenghua et al. (2017) developing a micro-renewal framework integrating context restoration and vitality activation.

Value evaluation has moved from physical assessments to perception analysis, with Xie Dixiang et al. (2014) highlighting socio-cultural environments and Xiang Qian feng and Qin Wei (2024) quantifying authenticity perception. While a mature theoretical system exists, future research must deepen regionally distinctive design strategies and establish long-term dynamic preservation mechanisms, integrating theory with local practice to coordinate heritage conservation with sustainable development.

2.2 Research on Micro-Renewal Theory and Practice

2.2.1 The Concept and Development of Urban Acupuncture in International Research

Urban acupuncture is a key theoretical approach in contemporary Western urban regeneration studies, offering a sustainable alternative to large-scale redevelopment through small-scale, targeted, and catalytic interventions. The concept was first formally proposed by Manuel deSolà-Morales in 1998, who, inspired by traditional acu puncture, viewed the city as a living organism and advocated for precise, reversible interventions at “sensitive urban points” to restore urban vitality. Jaime Lerner late r expanded its practical implications by emphasizing lo w-cost, rapid community-based interventions and the importance of bottom-up public participation. In the theoretical refinement stage, Casprini et al. (2026) reinterpreted urban acupuncture as a social innovation practice integrating spatial regeneration with community collaboration, shifting evaluation criteria toward social cohesion and quality of life. Nassar (2021) further contributed by proposing a five-level screening framework and ten implementation strategies, making the concept operationally applicable. Empirically, Casprini et al. (2026) developed a quantitative assessment model based on multi-attribute value theory, applying it to Milan’s “Piazze Aperte” project to demonstrate its role in activating community vital ity, while noting its limitations in long-term environment al resilience. Elshinawy et al. (2023) extended its application to rapid public space transformation during the C OVID-19 pandemic. Overall, international research on urban acupuncture has evolved from a spatial to a social paradigm, forming a comprehensive framework encompassing theory, methodology, practice, and evaluation. However, further exploration is needed to adapt it to diverse regional contexts and assess its long-term social impacts.

2.2.2 The Concept and Development of Micro-Renewal in China

Research on urban micro-renewal in China has evolve d alongside the transition from urban expansion to the optimization of existing spaces, becoming a key topic in planning, design, and landscape architecture. A relatively comprehensive framework has been established, covering theoretical foundations, methodology, practice, and governance.

At the theoretical level, Cai Yunnan et al. (2017) provided an early systematic definition, distinguishing micro -renewal from large-scale redevelopment and superficial beautification. They characterized it as a small-scale, incremental, low-impact approach that revitalizes spaces through localized interventions, proposing a three-dimension al framework of "building restoration, public environment optimization, and community atmosphere reconstruction."

In design methodology, Hou Xiaolei (2018, 2019) expanded the application of micro-renewal from residential areas to historic public spaces through case studies. Based on community-building principles, she proposed intervention approaches including cultural identity cultivation, multi-stakeholder collaboration, and integration of every day needs, emphasizing strategies such as fragmented sp ace integration and urban catalyst activation.

Regarding governance innovation, Liu Yuelai et al. (2 019) studied participatory practices in Shanghai's community gardens, identifying five implementation models and highlighting the synergy between micro-renewal and community micro-governance. They emphasized that cultivating resident self-organization and establishing collaborative platforms are essential for overcoming the problem of "construction without management." Li Heping et al. (2022) integrated scene theory into micro-renewal, proposing a quantitative analytical framework for historic to wns.

In summary, domestic research has expanded from technical approaches to social governance perspectives. However, specialized studies on distinctive micro-spaces i n historic towns remain limited, and localized long-term mechanisms require further exploration.

2.3 Research on Veranda Spaces

2.3.1 Theoretical Development of Veranda Spaces in International Research

The veranda, a semi-open transitional space mediating interior private and exterior public realms, has been extensively studied in international architectural research along three primary dimensions: theoretical construction, physical performance analysis, and socio-cultural value.

Theoretically, foundational studies have established its liminal characteristics. Boettger (2014) defined it as a threshold space enabling gradual public-private transition. Subsequent research has enriched this framework by incorporating regional perspectives, such as Dahniar and Chiyoakiichiro's (2023) integration of climate adaptation and social function in non-Western contexts, and Tzortzi and Saxena’s (2024) multi-scale analysis linking verandas to cultural expression and social organization.

In physical performance, research has concentrated on its climatic buffering effect. Albatici et al. (2020) refined thermal calculation models to verify its energy-saving potential, while Sun et al. (2022) used CFD simulations to quantify design parameters for passive thermal comfort in humid climates.

Regarding socio-cultural value, Brown et al. (2009) provided empirical evidence of the veranda's role in fostering neighborhood and family interaction, moving beyond nostalgic interpretations.

Overall, international scholarship has developed a mature, integrated system of qualitative and quantitative methods. However, research specifically on continuous street-level veranda systems remains limited, indicating a significant gap for regionally specific exploration.

2.3.2 Theoretical Research on Veranda Spaces in China

In traditional Chinese vernacular architecture, verandas serve as critical transitional zones between interior and exterior, embodying climatic adaptation, social-cultural values, and spatial logic. Domestic research on veranda s has evolved from morphological descriptions to multidimensional, quantitative approaches. Theoretically, scholars have established the ontological understanding of verandas as fundamental spatial components. Wang Dong (2 009) identified the corridor as a key element within the “gate–hall–corridor” system, providing spatial continuity through solid-void interplay. He Feng et al. (2011) characterized verandas as typical “grey spaces” facilitating circulation and communication. Wang Zhigang et al. (2021) further revealed their dual role as climatic devices and carriers of clan rituals. In ecological adaptability research, quantitative analyses have increasingly focused on climatic regulation mechanisms. Wang Song et al. (2014) demonstrated verandas’ effectiveness in improving building energy performance. Yan Shuting et al. (2026) employed CFD simulations to assess thermal risks in veranda-style streets under extreme heat. In conservation practice, micro-renewal has emerged as the dominant approach, emphasizing low-intervention, incremental strategies.

However, scholars note common problems such as excessive focus on formal reconstruction over functional logic. Future renewal should integrate heritage preservation with performance improvement through context-sensitive strategies.

3. Research Methods

3.1 Research Approach and Technical Framework

This study focuses on the eaves corridor spaces of Boat-Shaped Street in Luocheng Ancient Town, Sichuan Province, following the analytical logic of "spatial problem identification – value element extraction – micro-renewal strategy formulation – design practice verification" t o explore feasible conservation and renewal paths for historic cultural districts. It adopts a progressive framework of site investigation, problem diagnosis, theoretical analysis, strategy development and design verification, using literature review, field survey, behavioral observation and spatial analysis to systematically examine the morphological characteristics, user behaviors and existing problems of the corridor spaces.

In the site investigation, the historical evolution and spatial structure of the ancient town are clarified, with emphasis on the corridors' scale, structure, spatial interfaces and usage status. Problems are summarized from spatial form, functional use, environmental quality and cultural expression, laying a foundation for further research. In the problem diagnosis stage, behavioral and spatial analysis identify residents' and tourists' activity patterns and spatial demands. Combined with the theories of spirit of place and historic district micro-renewal, the corridor spaces' historical, cultural and social values are evaluated to extract key value elements and renewal priorities.

Following the principles of small-scale intervention, incremental improvement and minimal disturbance, micro -renewal strategies are proposed regarding spatial interface optimization, functional diversification, pedestrian experience enhancement and regional cultural expression, aiming to improve spatial vitality while preserving traditional features. In the design practice stage, the strategies are applied to specific corridor sections, and the feasibility is verified through scheme design and evaluation.

Including six core steps (literature review, field investigation, spatial-behavioral analysis, problem identification, strategy development and design verification), this stud y integrates theory and practice, providing a methodological reference for the micro-renewal of corridor spaces i n historic cultural districts.

3.2 Research Methods

3.2.1 Literature Review Method

The literature review method provides the theoretical foundation for this study. Relevant studies related to historic district conservation, renewal of street public space s, corridor spatial morphology, and urban micro-renewal theory are systematically examined. Academic database s including CNKI, Web of Science, and Google Scholar are used to retrieve relevant research publications.

Through a comprehensive review and synthesis of previous studies, research findings on historic district renewal models, street interface spatial forms, and strategies for enhancing public space vitality are summarized. On this basis, the spatial characteristics, social functions, and renewal principles of corridor spaces in traditional streets are analyzed. These findings contribute to the establishment of the theoretical framework of this study an d provide essential support for the subsequent analysis and design strategies for the corridor spaces along Boat - Shaped Street in Luocheng Ancient Town.

3.2.2 Field Investigation Method

Field investigation serves as an important method for obtaining first-hand spatial and environmental data. The study takes Boat-Shaped Street in Luocheng Ancient Town as the main research site. Through on-site surveys, spatial measurements, photographic documentation, and route mapping, the spatial morphology, structural scale, interface composition, and environmental elements of the corridor spaces are systematically investigated.

Particular attention is given to recording elements such as column grid structures, eave dimensions, paving materials, openness of spatial interfaces, and street-side commercial activities. Basic spatial analysis maps are also produced based on the collected data. By conducting a comprehensive investigation of the physical environment of the corridor spaces, reliable empirical data are obtained to support the subsequent spatial problem analysis and micro-renewal design process.

3.2.3 Behavioral Observation Method

The behavioral observation method is applied to analyze user behavior patterns and activity characteristics within the corridor spaces of Boat-Shaped Street. Observations are conducted during different time periods, including weekdays and holidays as well as morning and evening hours.

The study focuses on various user groups, including local residents, tourists, and shop owners, and records their activities such as staying, social interaction, resting, and passing through the corridor spaces. By mapping activity distributions and identifying areas of concentrated use, the research analyzes the frequency of use, types of activities, and spatial vitality patterns within the corridor spaces.

Through behavioral analysis, existing issues related to spatial efficiency, public accessibility, and environmental comfort are identified, providing a behavioral basis for the formulation of micro-renewal design strategies.

3.2.4 Questionnaire Survey and Interview Method

In order to better understand the user experience and renewal needs of different groups, this study adopts a combination of questionnaire surveys and semi-structured interviews.

The questionnaire survey targets local residents, shop owners, and tourists, and investigates aspects such as frequency of use, environmental comfort, adequacy of facilities, and demand for public activities within the corridor spaces. The collected quantitative data are statistically analyzed to identify common perceptions and spatial needs.

At the same time, semi-structured interviews are conducted with selected residents, shop operators, and local administrators to gain deeper insights into the roles and challenges of the corridor spaces in daily life, commercial activities, and cultural continuity. By combining quantitative survey data with qualitative interview information, the study develops a comprehensive understanding of user needs for corridor space renewal.

3.2.5 Case Study Method

The case study method is used to draw lessons from successful examples of historic district public space renewal and street interface improvement both domestically and internationally.

Representative cases of historic street micro-renewal, arcade street revitalization, and historic district public sp ace activation are selected for analysis. The study examines their renewal concepts, spatial organization strategies, design approaches, and implementation outcomes.

By summarizing experiences related to spatial interface renovation, public facility provision, cultural expression, and street vitality enhancement, the research extracts adaptable strategies that can be applied to the corridor spaces of Boat-Shaped Street. These insights provide valuable references for proposing targeted and feasible micro-renewal design strategies.

3.3 Research Object and Survey Scope

3.3.1 Overview of Luocheng Ancient Town

Luocheng Ancient Town is located in Qianwei County of Leshan City, Sichuan Province. Established during the late Ming and early Qing dynasties, it is one of the relatively well-preserved traditional commercial towns in southern Sichuan.

The town was constructed along the terrain and developed into a distinctive boat-shaped spatial layout, forming a street network centered on Boat-Shaped Street. Over time, Luocheng Ancient Town evolved into a traditional settlement integrating residential, commercial, and public activities, reflecting the typical street-market culture of traditional towns in southern Sichuan.

The historical development of the town is closely associated with regional commercial activities. Most buildings along the streets are traditional timber or brick-and timber structures, with shops on the ground floor and residential spaces above, forming spatial patterns such as “shop in front and dwelling behind” or “shop below and residence above.”

To adapt to the humid and rainy local climate, continuous eaves corridors are commonly constructed along t he streets. These semi-outdoor spaces not only provide s helter from rain and sun for pedestrians but also serve as important spatial interfaces and social activity areas within the town.

As transitional spaces between buildings and streets, corridor spaces play significant roles in shaping street scale, maintaining spatial continuity, and facilitating social interaction among residents. However, with the development of tourism and changes in residents’ lifestyles, some street spaces in Luocheng Ancient Town have gradually revealed the need for environmental improvement and functional renewal.

Therefore, under the premise of preserving historical character, the application of micro-renewal approaches to optimize public street spaces has become an important direction for improving the spatial environment of the ancient town. Selecting Luocheng Ancient Town as the research site provides a representative case for studying the conservation and renewal of corridor spaces in historic cultural districts.

3.3.2 Spatial Structure of Boat-Shaped Street

Boat-Shaped Street features a distinctive spindle-shape d or boat-like plan, characterized by a wider central section and narrower ends, forming a unique spatial outline. The street extends several hundred meters, with traditional shop buildings continuously arranged along both sides. The middle section forms a relatively open public activity space, while the two ends gradually transition into narrower alleyways.

From the perspective of spatial organization, Boat-Shaped Street can be divided into three primary layers: street space, corridor space, and architectural interface.

The street space mainly accommodates circulation and public activities, serving as an important area for social interaction between residents and visitors. The corridor space, formed by the extension of building eaves, is located between buildings and the street. It functions not only as a pedestrian passage but also as a place for res ting, social interaction, and temporary commercial activities. The architectural interface, composed of traditional wooden buildings and their façades, contributes to the distinctive visual character of the street.

This composite spatial structure of "street – corridor – building" creates a continuous and layered streetscape, meeting commercial needs while reflecting the openness and shared nature of traditional public spaces in historic towns.

However, during long-term use, some corridor spaces have developed problems such as single functional use, insufficient facilities, and low spatial efficiency, which affect the overall environmental quality of the street. Therefore, analyzing the spatial structure of Boat-Shaped Street helps clarify the role of corridor spaces within the broader street system and provides a foundation for subsequent micro-renewal design.

3.3.3 Scope of Corridor Space Research

This study focuses on the continuous corridor spaces distributed along Boat-Shaped Street as the core research object. Corridor spaces refer to the semi-open transitional areas formed by the outward extension of building eaves. Their spatial boundaries are typically defined by the building façade, eave columns, and the street edge. Along Boat-Shaped Street in Luocheng Ancient Town, these corridor spaces form a continuous linear system, connecting commercial and residential activities and serving as important public circulation spaces.

In defining the research scope, representative corridor segments along both sides of Boat-Shaped Street are s elected as key study areas. These include sections with concentrated commercial activities in the middle part of the street as well as typical corridor spaces associated with traditional buildings.

The study mainly examines aspects such as spatial sc ale, spatial interfaces, functional uses, and patterns of public activities within these corridor spaces. Through fie ld measurement, behavioral observation, and spatial analysis, the spatial morphology and usage conditions are systematically documented.

At the spatial hierarchy level, particular attention is given to the interaction between corridor spaces and street spaces, as well as the internal functional organization and environmental quality of the corridor areas. Corridor spaces are regarded as an integral component of the public space system within historic districts, and their roles in circulation, commercial activities, and community interaction are analyzed from the perspective of the overall street environment.

By clearly defining the research scope, targeted micro -renewal design strategies can be proposed to address existing problems while preserving the traditional spatial pattern and historical character of the street. This approach provides references for improving the public space quality and promoting sustainable development in Luocheng Ancient Town.

3.4 Data Collection and Analysis Methods

3.4.1 Spatial Survey and Documentation

Spatial surveying and documentation form the basis f or understanding the physical characteristics of the corridor spaces along Boat-Shaped Street.

Through on-site investigation and measurement, the study systematically records spatial dimensions, structural forms, interface relationships, and supporting facilities of the corridor spaces. Measurement tools such as measuring tapes, laser distance meters, and photographic documentation are used to record key spatial elements, including corridor width, height, column spacing, eave projection length, and street cross-sections. Based on these measurements, basic plan drawings and sectional diagrams are produced to illustrate the structural characteristics of t he corridor spaces.

Additionally, photographic records, video documentation, and hand-drawn node sketches are used to capture de tails of architectural structures, paving materials, façade interfaces, shopfront arrangements, and spatial nodes. These records provide a comprehensive representation of th e morphological characteristics and historical features of the corridor spaces.

Finally, the corridor spaces are segmented and numbered into spatial units, establishing a structured database t hat supports subsequent behavioral analysis and problem identification.

3.4.2 User Behavior Investigation

To better understand the actual use of the corridor sp aces, this study combines behavioral observation with questionnaire surveys and interviews to analyze user group s and activity characteristics.

Behavioral observation is conducted to record activities such as walking, staying, resting, commercial operations, and social interactions within the corridor spaces. These activities are mapped spatially through behavioral maps, indicating the distribution of activities across different locations. This method helps identify spatial usage intensity and key activity nodes.

At the same time, interviews and questionnaire survey s are conducted with residents, shop owners, and tourist s to gather their evaluations and expectations regarding environmental quality, facility conditions, and spatial experiences.

Through systematic organization and analysis of behavioral and survey data, the study reveals how corridor sp aces function in daily life and commercial activities, providing a human-centered foundation for micro-renewal design strategies.

3.4.3 Analysis and Classification of Spatial Problems

Based on the spatial survey and behavioral investigation results, this study conducts a systematic analysis of the existing problems in the corridor spaces along Boat- Shaped Street.

First, spatial morphology data and behavioral activity data are compared to identify conflicts and deficiencies related to spatial scale, circulation, resting areas, interface vitality, and facility provision. For example, certain corridor segments show conflicts between pedestrian circulation and commercial activities, insufficient spaces for staying, or monotonous spatial interfaces.

Second, in accordance with principles of historic district conservation and micro-renewal theory, the identified issues are categorized into several types, including functional problems, environmental quality issues, and cultural expression deficiencies.

Finally, an analytical framework linking “spatial conditions – behavioral needs – problem categories” is established. This framework clarifies key directions and priority nodes for the micro-renewal design of corridor space s along Boat-Shaped Street, providing both theoretical and practical foundations for the subsequent spatial optimization strategies and design proposals.

4. Finding

4.1 Spatial Pattern and Morphological Characteristics of the Arcade Space on Boat-Shaped Street

4.1.1 Historical Development of the Town and Evolut ion of the Street Pattern

Luocheng Ancient Town is located in Qianwei Count y, Sichuan Province, and has a long historical background. The spatial form of the town has gradually evolved from a natural rural settlement into a commercial town. According to historical records and local chronicles, the town was initially established during the Ming Dynasty. In the early stage of development, the settlement was mainly characterized by dispersed residential clusters supported by agriculture and handicraft production.

With the gradual growth of commercial activities, the street network expanded and eventually formed a street system centered on Boat-Shaped Street. The name “Bo at-Shaped Street” originates from the unique terrain and surrounding water system, which together shaped its distinctive spatial form. The street extends primarily along a north–south axis and is intersected by several east–west alleys, creating a plan layout that resembles the shape of a boat.

Historically, Boat-Shaped Street functioned not only as the main commercial corridor of the town but also as an important venue for public interaction and market activities. As a result, it became the central spatial axis of the ancient town. From the perspective of historical evolution, the formation and development of Boat-Shaped Street are closely related to the economic growth and social life of the town. Its spatial organization reflects both the functional demands and the social order of the historical period in which it developed.

4.1.2 Spatial Structural Characteristics of Boat-Shaped Street

Boat-Shaped Street is organized along a north–south linear axis, with densely arranged buildings on both side s forming a clear linear street pattern. The width of the street is moderate, generally ranging from approximately 4 to 6 meters, which effectively accommodates pedestrian circulation while supporting commercial activities.

The buildings along the street typically follow a spatial organization characterized by the sequence of “bay – depth – courtyard,” which creates a continuous street façade and contributes to the overall spatial

coherence of the street. In terms of spatial hierarchy, important node s such as street entrances, market gathering points, and religious or public buildings are distributed along the street, forming a layered spatial structure. These nodes not only strengthen the directional perception of the street axis but also create visual focal points that enrich the spatial experience.

Overall, the spatial structure of Boat-Shaped Street integrates circulation routes, commercial functions, and public spaces through a combination of axial organization and node distribution. This spatial arrangement reflects a rational and functional planning logic typical of tradition al market towns in the region.

4.1.3 Morphology and Interface Characteristics of the Arcade Space

The arcade spaces along Boat-Shaped Street are mainly associated with traditional wooden structures. The eaves typically adopt a projecting design with an overhang ranging from approximately 1.2 to 2 meters, providing effective shelter from sun and rain for pedestrians.

The façade of the arcade space is composed primarily of grey roof tiles, blue bricks, and wooden beams and columns, which together demonstrate the craftsmanship and architectural characteristics of the local building tradition. In terms of spatial scale, the arcades generally maintain a moderate width and a relatively continuous sequence along the street. However, in some sections that have undergone later modifications, interruptions or irregular variations can be observed.

Functionally, the arcade space serves as a transitional zone between the street and the interior of buildings. Visually, it extends the linear spatial order of the street and forms a continuous interface that enhances the spatial coherence of the historic street environment. At the same time, the arcade also plays an important role in commercial activities, functioning as a semi-open space for product display and interaction between shop owner s and visitors. In this way, the arcade space becomes a n essential intermediary zone connecting public and private realms within the street environment.

4.2 Current Use and Problem Analysis of the Arcade Space on Boat-Shaped Street

4.2.1 Analysis of Activity Types in the Arcade Space

Based on field investigation and behavioral observation conducted on Boat-Shaped Street in Luocheng Ancient Town, the use of the arcade space demonstrates a multi-level and multifunctional pattern.

First, from the perspective of commercial activities, s hops along the arcades mainly operate restaurants, handicraft stores, souvenir shops, and local specialty product outlets. The front arcade space of these shops is commonly used for product display, customer reception, and temporary promotional activities, forming a noticeable commercial clustering effect.

Second, tourist activities mainly include resting, photography, and street sightseeing. The spatial distribution of tourists varies significantly at different times of the d ay. In the early morning and morning hours, the space is primarily used by local residents with relatively few visitors. In contrast, from the afternoon to evening, the number of tourists increases substantially, and the arcade becomes a major place for short-term stay and social interaction.

Third, the arcade space also accommodates various forms of daily activities of local residents, including routine circulation, neighborhood communication, and temporary resting. Typical activities include casual conversation s among residents, children playing, and small-scale community interactions.

In summary, the arcade space performs important role s in commercial services, social communication, and resting activities. However, these functions are not clearly distinguished in spatial organization, which leads to certain conflicts between activities and uneven spatial utilization.

4.2.2 Spatial Utilization Efficiency and Functional Structure

Based on the analysis of activity distribution and intensity of use, the utilization efficiency of the arcade space along Boat-Shaped Street shows significant differences in both spatial and temporal dimensions.

Commercial functions are mainly concentrated in the front arcade areas of major shops along the street. These locations experience a relatively high level of use, but due to limited spatial capacity, local congestion occasionally occurs. In contrast, the arcade spaces located in the middle sections and peripheral areas of the street are used less frequently, resulting in a spatial pattern characterized by a “high-density–low-density” distribution.

From the perspective of functional structure, commercial activities dominate the use of arcade space, followed by public interaction and social communication. In comparison, the function of resting and leisure remains relatively weak.

Furthermore, spatial use varies significantly at different times of the day. During peak hours in the morning and evening, commercial and public activities are highly concentrated, while during midday and

nighttime certain areas experience low levels of activity. These patterns indicate that there is considerable potential for optimizing the spatial use of arcade spaces.

4.2.3 Major Problems in the Arcade Space

Based on the current situation analysis, several major problems can be identified in the arcade spaces of Boat -Shaped Street:

(a) Single functional structure: Commercial activities dominate the space, while public resting and social functions are relatively weak, resulting in limited diversity of spatial use.
(b) Insufficient public facilities: Facilities such as seating, lighting, waste bins, and signage systems are either insufficient or unevenly distributed, which negatively affects the experience of residents and visitors.
(c) Declining environmental quality: Some arcade sect ions suffer from damaged paving, water accumulation n ear the eaves, and insufficient daylight due to excessive shading, which reduces spatial comfort and safety.
(d) Insufficient cultural representation: Traditional cultural elements are not fully reflected in the arcade space, and the historical context and local identity are not effectively communicated through visual or spatial design.

These problems are mainly caused by limitations in t he original spatial layout of the historic district, increasing commercial pressures, and insufficient public management and maintenance. The identification of these issues provides clear directions for subsequent micro-renewal design, focusing on functional optimization, environment al improvement, and the integration of cultural elements to revitalize the arcade space.

4.3 Micro-Renewal Design Strategies for the Arcade Space on Boat-Shaped Street

In response to the problems identified in the arcade s paces of Boat-Shaped Street—such as discontinuous spatial structure, single functional pattern, and low utilization of public spaces—this study proposes a systematic set of micro-renewal design strategies based on the theoretical framework of historic district conservation and micro-renewal. The aim is to achieve a balance between preservation and development while enhancing spatial quality and vitality within the street environment.

4.3.1 Principles of Micro-Renewal Design

Micro-renewal design should follow several key principles:

(a) Principle of historical preservation: The renewal process should respect and retain the original architectural forms, materials, and historical characteristics of the t own to avoid damaging its cultural heritage.
(b) Principle of small-scale incremental intervention: Renewal interventions should be implemented gradually and at a small spatial scale, allowing localized improvements to collectively enhance the overall environment while minimizing disruption to the existing spatial structure.
(c) Principle of cultural continuity: Traditional cultural symbols and craftsmanship should be integrated into spatial design and functional organization in order to maintain the cultural identity of the historic street.
(d) Principle of public participation: The design and implementation process should incorporate the opinions o f residents, shop owners, and visitors to ensure that renewal measures respond to community needs and strengthen the sense of spatial identity.

4.3.2 Optimization of the Arcade Spatial Structure

To address issues such as complex spatial organization and discontinuity of the arcade space, the following strategies are proposed:

(a) Optimization of street spatial organization: By adjusting street width, pedestrian circulation routes, and corner nodes, spatial order and movement efficiency can be improved.
(b) Enhancement of arcade continuity: Through coordinated control of arcade height, façade style, and material treatment, visual continuity can be strengthened and a coherent pedestrian experience can be formed.
(c) Creation of node spaces: At important intersection s or in front of historic buildings, open plazas or landscape nodes can be introduced to enrich spatial hierarchy and establish recognizable focal points.

4.3.3 Functional Integration and Spatial Revitalization

To enhance the vitality of arcade spaces, a multifunctional spatial structure should be introduced while maintaining traditional commercial activities.

(a) Integration of commercial and public functions: Shopfront spaces can be partially opened to serve both display and resting functions, improving spatial efficiency and accessibility.
(b) Insertion of cultural exhibition spaces: Intangible cultural heritage displays and handicraft experience areas can be introduced along key nodes and arcade segments to strengthen cultural continuity and visitor engagement.
(c) Creation of social and resting spaces: Public seating, small landscape installations, and greenery can be added to encourage social interaction and improve environmental comfort.

4.3.4 Environmental and Facility Improvements

To improve the overall spatial experience and functional convenience of the historic street, several environmental and infrastructural improvements are proposed:

(a) Landscape optimization: Additional greenery, lands cape elements, and lighting design can enhance environ mental quality and create a more attractive nighttime street environment.
(b) Improvement of public facilities: Waste collection systems, seating, rain shelters, and drainage infrastructure should be systematically upgraded to enhance public service quality.
(c) Design of way finding and signage systems: Clear pedestrian guidance signs and cultural interpretation panels should be installed to improve accessibility and help visitors better understand the historical and cultural significance of the street.

Through the comprehensive implementation of these strategies, the arcade spaces of Boat-Shaped Street can achieve a balanced transformation that preserves historical character while enhancing spatial quality, functional diversity, and cultural experience. These strategies also provide practical references for micro-renewal practices in similar historic districts.

4.4 Micro-Renewal Design Practice for the Arcade S pace on Boat-Shaped Street

4.4.1 Design Objectives and Overall Concept

Based on the previous analysis, this study identifies several key problems in the arcade spaces of Boat-Shaped Street, including outdated functions, disordered spatial organization, and insufficient public vitality. In response, the micro-renewal design aims to achieve several objectives: preserving the original spatial pattern and cultural heritage of the historic district, improving the quality of spatial use, strengthening public functions, and revitalizing the street environment.

The design concept emphasizes “respecting the origin al character, implementing moderate renewal, optimizing spatial functions, and highlighting cultural identity.” Through low-impact and gradual micro-renewal interventions, the design seeks to balance the protection of historical value with contemporary usage requirements, thereby integrating traditional spatial forms with modern lifestyles.

4.4.2 Overall Spatial Renewal Planning

At the overall level, the design establishes a renewal framework based on continuous spatial systems, functional zoning, and node optimization.

(a) Spatial structure optimization: By adjusting the arrangement of arcade spaces and improving pedestrian circulation through way finding systems and accessibility de sign, a continuous walkable spatial network can be formed, enhancing both mobility and the perception of historical spatial continuity.
(b) Functional zoning design: The street space is divided into several functional zones, including a historical and cultural exhibition area, resting and activity areas, commercial operation areas, and public experience spaces.
This functional differentiation helps meet the needs of tourists while also supporting the daily activities of local residents.
(c) Integration of culture and public space: Cultural display elements are embedded within pedestrian routes and spatial nodes to create an experiential environment in which visitors can engage with history while walking through the street. Meanwhile, the addition of public seating, lighting, and greenery improves spatial comfort and social interaction.

4.4.3 Design of Key Spatial Nodes

Typical nodes along Boat-Shaped Street are selected f or differentiated micro-renewal interventions to enhance spatial identity and vitality.

(a) Street entrance space: Entrance nodes are redesigned through historical signage, paving materials, and landscape features to create recognizable gateways that guide visitors into the historic district and establish a welcoming atmosphere.

(b) Arcade resting spaces: Additional seating, shading devices, and improved pavement design provide comfort able areas for temporary stay while maintaining the original architectural façade.
(c) Commercial display spaces: Flexible stall layouts, display racks, and improved nighttime lighting are introduced to strengthen commercial vitality and increase the attractiveness of the street.
(d) Cultural experience spaces: Interactive exhibition panels, handicraft experience stations, and temporary activity spaces are integrated into the street environment, enabling visitors to experience local culture while exploring the historic district.

4.4.4 Detailed Renewal Design of the Arcade Space

Based on the overall planning and node design, detailed improvements are implemented in terms of spatial interface, materials, color, and landscape facilities.

(a) Interface renovation: Protective restoration of arcade façades preserves traditional architectural elements while integrating modern functional facilities such as information signage and shading structures.
(b) Material and color optimization: Pavement materials and color schemes are carefully adjusted without dam aging the historical character, thereby enhancing spatial coherence and cultural atmosphere.
(c) Landscape and facility improvements: Small green plants, seating facilities, nighttime lighting, and cultural installations are introduced to create an interactive and comfortable arcade environment while improving safety and usability.

Through these multi-level micro-renewal strategies, the historical value of the arcade spaces along Boat-Shaped Street can be effectively preserved while significantly improving spatial quality and public vitality. The proposed design approach provides a practical demonstration for the sustainable development and revitalization of historic streets in traditional towns.

5. Conclusion

5.1 Research Conclusions

This study focuses on the existing issues of the arcade (eaves corridor) space along Boat-Shaped Street in Luocheng Ancient Town, Qianwei County, Sichuan, and proposes a systematic micro-renewal design approach. Based on both theoretical analysis and practical design exploration, the main conclusions are summarized as follows.

5.1.1 Summary of the Micro-Renewal Design Method for Arcade Spaces

Through field investigation, spatial mapping, and observation of user behavior, this study establishes a micro renewal design framework centered on four key dimensions: functional optimization, landscape improvement, cultural expression, and sustainable management. The proposed method emphasizes the protection of the historical architectural character while introducing targeted spatial improvements through detailed interventions, functional integration, and the enhancement of spatial experience. By doing so, the arcade spaces can achieve sustainable reuse while simultaneously revitalizing their historical and cultural value.

5.1.2 Summary of the Renewal Strategies for Boat-Shaped Street in Luocheng Ancient Town

Based on the principle of “micro-scale intervention combined with overall spatial coordination,” this study proposes a set of renewal strategies for the street space. These include restoring and strengthening the historic buildings and arcade structures along the street, optimizing the spatial arrangement of commercial and public areas, improving pedestrian circulation and traffic organization, and enhancing the visual and cultural continuity of the historic district. Through these measures, the vitality of the overall spatial environment and the sense of cultural identity within the district can be significantly improved. At the same time, the strategies effectively activate the functions of public spaces while preserving the historical character of the street.

5.2 Research Innovations

5.2.1 A Micro-Renewal Design Model for Arcade Spaces

This study systematically proposes, for the first time, a micro-renewal design model specifically oriented toward the arcade spaces of Boat-Shaped Street. The model integrates historical and cultural value assessment, user behavior analysis, and spatial micro-intervention strategies into a coherent and operational design framework. The results provide a practical reference for the conservation and renewal of similar arcade spaces in other historic districts.

5.2.2 Methods for Enhancing the Vitality of Public Spaces in Historic Districts

Through the implementation of micro-renewal strategies, the research develops an approach to enhancing urban vitality based on the integration of cultural expression, functional diversity, and spatial experience optimization. This approach supports the concept of living heritage conservation, balancing cultural continuity with contemporary usage demands. Consequently, it offers a practical pathway for the sustainable development of historic urban districts.

5.3 Research Limitations and Future Prospects

5.3.1 This study is primarily based on a case analysis of Boat-Shaped Street in Luocheng Ancient Town.

Due to the relatively limited research scope, the general applicability and transferability of the findings may have certain limitations. In addition, the long-term impacts of the proposed micro-renewal strategies—particularly in terms of economic development, community participation, and maintenance effectiveness—require further empirical validation.

5.3.2 Future research may focus on the following directions:

(a) Expanding the range of case studies by conducting comparative analyses of different types of arcade spaces in historic districts, thereby extracting more universally applicable micro-renewal strategies.

(b) Integrating digital technologies and intelligent management tools, such as three-dimensional modeling, digit al twin systems, and participatory design platforms, to support the dynamic optimization and management of arcade space renewal.

(c) Further exploring the influence of micro-renewal interventions on the social-ecological system of historic districts, including community participation, commercial vitality, and cultural transmission. Such research can contribute to the development of a more sustainable and evaluative theoretical framework for micro-renewal in historic districts.

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