

Study on the Utilization and Implementation of Urban Residual Space Renewal under the Perspective of Inventory Renewal

--Taking Suzhou Main City as an Example

Xiaonian Yuan

Gold Mantis School of Architecture, Soochow University, Suzhou, 215123, Jiangsu, China.

ABSTRACT

Under the contradiction between residents' growing demand for diversified public space and the increasing tension of available space in urban built-up areas, revitalization of surplus space has become a new trend. With land within the urban built-up areas, there is a lack of street-level public space or even lower-level small and micro-public space in the land use arrangement, therefore, starting from the low-efficiency or surplus space and transforming it into a new functional space that meets citizens' needs has become an important way to cope with the imbalance in the distribution of public space and the diversification of residents' spatial needs. However, there is a lack of clear and systematic discussion on residual space in domestic research. Firstly, it clarifies the definition and characteristics of residual space, secondly, this paper studies the problems and reasons for the formation of some residual space, clarifies the value of residual space, discusses its subdivision and puts forward improvement opinions, and puts forward the implementation of co-creating mode, implementation and management paths, and safeguards for residual space.

KEYWORDS

Remaining Space; Micro-Renewal; Built-Up Area; Implementation Management.

1. INTRODUCTION

In the process of rapid urbanization, China's "big cake" expansion has led to an average annual growth rate of 5.2% in built-up areas, accompanied by urban diseases such as spatial fragmentation and functional disorder. The "14th Five-Year" New Urbanization Implementation Plan puts forward the strategy of "strictly controlling incremental growth and revitalizing stock", which pushes urban renewal into a new stage of spatial reproduction. As the core carrier of urban stock transformation, the remaining space carries the important mission of reconstructing spatial value and meeting the diversified needs of residents. As a model city in Jiangnan, Suzhou needs to solve common problems such as functional revitalization and quality improvement in street space renovation, but also has the responsibility of exploring innovative paths that synergize the continuation of regional characteristics and high-quality development, so as to provide exemplary and local practice samples for the spatial regeneration of Yangtze River Delta urban agglomerations.

2. REVIEW DEFINITION AND CHARACTERISTICS OF RESIDUAL SPACE RESEARCH

2.1. Research Overview

Remaining spaces, which are often hidden in the corners of the city, contrast with squares and streets. These corners, known as negative spaces, are often regarded as urban spaces that cannot function [1]. The adoption and widespread practice of modern urban planning theory has attracted sustained scholarly attention to different “negative” spaces in the city, and this discourse has reflected and critiqued the theory and practice of urban planning [2]. In 1961, Jane Jacobs informally proposed in her book *The Death and Life of American Cities* that in 1961, Jane Jacobs, in her book “*Death and Life in the American City*”, informally introduced the concepts of “dead ends”, “dead zones” and “empty zones” to describe the “vacuum” areas of cities [3]. In addition, Yoshiharu Tsukamoto defined “extra space” and “negative space” from an architectural point of view, suggesting that negative space implies that space exists naturally and is not subjectively altered by people [4]. Roger Trancik introduced the concept of “lost space” to describe unauthorized and disappearing spaces in cities and developed the reasons for this spatial image, these concepts and perspectives give us important insights and perspectives into urban planning and space utilization [5].

In other studies, more formal and complete conceptualizations of similar urban spaces have been developed. For example, Loukaitou-Sideris A uses the term “government space” to define areas of the city that have not yet been defined as functional or functional, including gray space under bridges, undeveloped areas of vacant buildings, and Karen Frank argues that areas without clear rules of ownership, support, use, control, and enforcement can be referred to as “government space”. Karen Frank believes that areas without clear rules of ownership, support, use, control, and enforcement can be referred to as “open space,” including street boundaries, railroads, and green space around unemployed land. These types of spaces are also characterized by similar concepts such as 'open space', 'view strings' and 'unread land' [6], which, although defined slightly differently, enrich our understanding of urban space. Although the definitions are slightly different, these concepts enrich our understanding of urban spaces and give us new perspectives and insights on how to better utilize these spaces.

Domestic scholars focus on learning spaces. Wang Jianfeng proposed the concept of “residual space” as early as in his study of Shanghai's urban space, and he defined this type of space in terms of four characteristics: urban, non-thematic, non-definitional, underutilized, and current [7]. However, scientists like Li have shown that residual space is the second and remaining part of urban space, which implies the necessity of cognition, lack of social relations, and other students have conducted more research and analysis on one type of other space, as well as on development and use strategies [8]. Although the related research has accumulated some results, it still does not involve a comprehensive and systematic study of space, including a clear definition of spatial concepts from a spatial point of view and a clear categorization system of categories, so the focus and main content of future research should be to create a more absolute framework to explore the remaining spaces in order to better understand, categorize and use them.

The practice of restoring the area of residual spaces at home and abroad continues to evolve under the regulation and control of theoretical research. The Spanish architect ManueldeSolà proposed the model of “urban acupuncture”, which precisely engages key spatial nodes and transforms negative spaces into high-quality public spaces [9].

2.2. Basic Definition

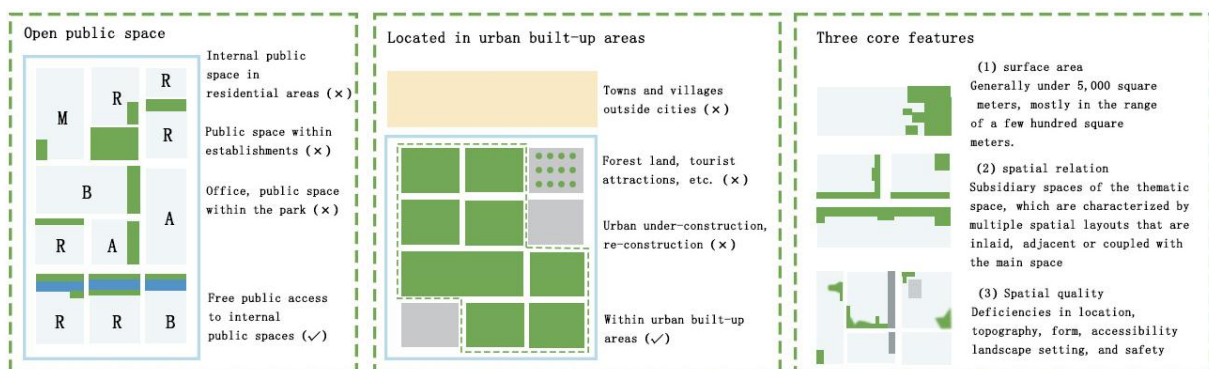
Narrowly defined residual spaces can be defined as the underutilized stock of spaces in the city that are open to the public as a whole, which are adjacent to or coupled with a variety of main urban

spaces, and exhibit diverse spatial layout characteristics, with the key trait of relativity or subsidiarity. These remaining spaces are also public spaces completely open to the public, suitable for all kinds of social activities, such as walking, resting, fitness, games and gatherings. It emphasizes small and micro public spaces that are closely related to residents' daily lives and can provide more places for social and cultural activities, enhance residents' quality of life and promote sustainable urban development.

2.3. Main Characteristics

Residual space presents three core features: spatial attributes with public openness and social potential, as an organic part of the urban public space system; spatial location is concentrated in the built-up area with mature development, forming an embedded symbiotic relationship with the main functional space, which distinguishes it from the idle land in the transition zone between urban and rural areas; spatial utilization shows the composite qualities of miniaturization, blurring of the boundaries, and generation of spontaneity, which often originates from the flexibility of urban planning. The space utilization level shows the composite characteristics of miniaturization, boundary blurring and spontaneity, which often originates from the lack of elasticity in urban planning or the legacy of functional iteration, leading to the inefficiency of the space although it has public accessibility (Figure 1).

Figure 1. Schematic diagram of the main characteristics of the remaining space



3. ANALYSIS OF THE CURRENT SITUATION OF RESIDUAL SPACE UTILIZATION IN SUZHOU

3.1. Causes of surplus space in Suzhou

3.1.1. Topographic characteristics of Suzhou

Suzhou maintains a double checkerboard pattern of “parallel waterways and river streets”, with streets and lanes parallel to the waterways. Its special topography adds a good environment for the city, but with the increase of urban functions, the double checkerboard pattern can not meet the functional space of the city, and some waterfront residual space is generated. The residual space is also generated at the edge of some open space or on both sides of the urban linear space. For example: in some street ends, small corners next to residential houses, open spaces in old residential areas, etc., these generated spaces are often found everywhere.

3.1.2. The inevitable result of rapid urban development

Functional replacement brought about by large-scale construction is often accompanied by a waste of space, and the area not reasonably utilized is gradually reduced to a “gray zone”. At the same time, spatial value differentiation within the city: the core area compresses the remaining space through high-intensity development, while the peripheral area forms a vicious cycle of space abandonment

due to imbalance in resource allocation and functional decline, exacerbating the structural contradiction in the utilization of urban space. These remaining spaces are not only the product of urban diseases, but also an important carrier for activating spatial efficiency and reconstructing human scale in the era of stock renewal.

3.1.3. Functionalist planning and design domination and lack of urban management

In recent years, the blind pursuit of large-scale urban infrastructure has led to the inefficiency of plazas and green spaces, the fragmentation of architectural texture, and the derivation of a large number of residual spaces on the edges of buildings. Developers focus on construction within the red line, neglecting spatial integration at the boundaries, forming “gray gaps”. Blurred management rights and responsibilities, lack of departmental coordination, and insufficient public participation in urban renewal have resulted in ineffective spatial governance, impeded functional revitalization, and ultimately reduced to a negative space that lacks both human scale and the spirit of place.

3.2. Characteristics of remaining space problems in Suzhou

3.2.1. Overall distribution pattern of “gathering in the old city and dispersing around”.

The core area of the ancient city of Suzhou is densely populated and highly built-up, resulting in fragmented small and micro residual spaces; although there is sufficient land in the peripheral new city, due to the influence of the functional layout, the eastern part of the space is utilized in a compact manner, while the western part is sparsely populated, resulting in an increase in unused space. Inefficient spaces are formed around the infrastructure such as under the ring road viaducts, ultimately constituting a pattern of “high-density agglomeration in the old city and inefficient dispersion in the new city”.

3.2.2. Awareness of governance is relatively advanced, but a widely leading system has not been formed.

Suzhou's current residual space management takes the renewal of ancient city streets and alleys as a guide, focusing on the revitalization of waterfront/under-bridge spaces, but the systematic transformation of other types of residual space is insufficient. In recent years, the “Garden Style Extension” program has implemented micro-renewal of street corners, creating pocket parks, slow-moving stations and other nodes to promote spatial quality improvement. However, most of the existing renovations remain in the physical form of renewal, and a complete system of decoding cultural genes, reshaping the spirit of place, and synergizing community governance has yet to be established, so the spatial narrative excavation of historic districts and the linkage effect of micro-renewal projects have yet to be deepened.

3.2.3. Programmed use of micro-habits, single path of development and utilization

The remaining space renovation in Suzhou stays in basic function replacement: green parking is the main feature under elevated/overpasses, waterfront space is only equipped with simple rest facilities, and hardened parking is common in street corners, presenting a single pattern of “greening+parking” as a whole. Lack of local cultural elements in the space transformation of innovative translation, color, light and shadow, art installations and other design methods tend to be the same, failing to carry the community memory and urban culture. It is worth noting that due to the immediate need for parking and ownership restrictions, a large number of spaces have been reduced to inefficient parking lots, and the development of their composite functions and the creation of the spirit of place are still facing practical bottlenecks.

4. EXPLORING THE RENEWAL AND UTILIZATION OF SURPLUS SPACE IN SUZHOU

4.1. System Construction

4.1.1. Residual Space Classification System

Residual space is generated due to the lack of integration and coordination with its dependent main functional space. According to the type of its dependent main functional space, and combining with the characteristics of urban space in Suzhou, this study classifies the residual space into five categories, namely, transportation residual space, waterfront residual space, residual space around buildings, residual space around infrastructures, and inefficient open space. “The residual space is categorized into five major categories: transportation residual space, waterfront residual space, residual space around buildings, residual space around infrastructure and inefficient open space.

Table 1. Classification and definition of residual space

serial number	category I	category II	define
1	Transportation type surplus space	Space under the viaduct	Space underneath viaducts on urban roads
		Space under the overpass	Block site underneath the overpass ramp
		Corner Space	Fragmented plots on both sides of the street that lack design and maintenance and have poor visual appeal
		green belt	Vegetation planting monoculture cluttered green space in the form of informal green spaces
		road space	Roads that are not reasonably zoned resulting in blurred right-of-way boundaries, underutilized road space, and chaotic parking
2	Waterfront Remaining Space	intersection space	Unutilized space due to large turning radii of roads
		Waterfront Space	Waterfront lots with weak ecological and recreational landscapes and where the environment, functions and quality of the waterfront need to be upgraded
3	Waterfront Remaining Space	anterior region of a building	The space between the red line of the road and the side line of the building immediately adjacent to the building along the street, in the form of pedestrian zone, green space, public ancillary facilities, etc.
		Roof space	Rooftop spaces of buildings open to the public, including cultural centers, gymnasiums and community public service support buildings
4	Remaining space around infrastructure	Space on both sides of the railroad	Space along both sides of the railroad tracks, including within and adjacent to the railroad control area
		Space around neighboring facilities	Includes ineffectively utilized space around neighboring facilities such as refuse transfer stations and public toilets

		Space around transportation facilities	Refers to low-quality, inefficiently used space around subway entrances, bus stops, and other transportation facilities
5	Inefficient open space	Park square space	Parks and green spaces with a single function, weak service capacity, outdated facilities, and difficulties in meeting the public needs of the community, as well as squares with a single landscape and function

4.1.2. Exploration of Residual Space Value

Residual spatial value is an important dimension of renewal, the core of which lies in activating the aesthetic gene of the city through refined design and reconstructing the visual dialog relationship between people and space. In Suzhou, a city with deep cultural heritage, the aesthetic remodeling of residual space needs to take into account the traditional mood and modern aesthetics, and through micro-intervention techniques, the fragmented plots can be transformed into landscape nodes with narratives. In practice, the concept of “weaving and mending” can be used to integrate fragmented spaces such as street corners and architectural gaps, and soften hard boundaries through three-dimensional greening and permeable walls to form continuous and rhythmic visual corridors. Drawing on the borrowing and framing techniques of Jiangnan gardens, regional symbols such as Taihu Lake stones and leaky windows are implanted in pocket parks and other small and micro-spaces, so as to form a space-time dialog between modern landscape devices and traditional gardening wisdom.

Technological innovation provides a new path for aesthetic enhancement. With the help of parametric design, the paving texture and lighting system are arranged artistically, so that the concrete corner is transformed into a digital art exhibition site with light and shadow interaction. Through the combination of permeable paving and ornamental herbs, both sponge function and seasonal ecological scrolls are realized. This multi-dimensional aesthetic creation not only enhances the spatial value, but also allows the urban culture to continue to grow in the smallest detail through the local translation of visual language.

4.2. Specific transformation cases

4.2.1. Remaining transportation space

For the remaining traffic space, it is necessary to focus on solving the problem of accessibility and functional adaptation. The space under the viaduct is limited by the dense column network, insufficient lighting and traffic noise. Vertical greening can be used to eliminate the sense of oppression, implant modular fitness facilities and intelligent parking lots, and improve the microclimate by combining sound barriers and fog forest systems. Underneath the overpass, due to the complex traffic flow, it is appropriate to create a closed recreational park, using sunken rain gardens to purify the runoff from the bridge surface, installing circular jogging paths and rest stops, and isolating the noise through a three-dimensional green wall. Corner plots, on the other hand, give full play to its interface penetration advantages, use the framing techniques of Suzhou gardens, lay out the Taihu Lake stone landscape wall and curved paths and flower streets in a miniature space of 50-200 square meters, and simultaneously embedded in the sharing of book bars, intelligent lockers and other convenient services to realize the ancient city flavor of “meeting the garden around the corner”. The green belts and intersections focus on the balance between safety and art, define the space with light-permeable concrete flower pools, and combine with dynamic light and shadow installations to shape an interactive street art gallery.

4.2.2. Remaining waterfront space

The remaining space along the waterfront needs to be transformed into an ecological-functional composite system. For the polluted riverbank space, adopt stepped ecological berms with reed wetlands, set up water-friendly platforms and bird-watching corridors, and enhance the self-purification ability of the water body through floating wetland modules. At the interface of the chronic system, the retired embankment is utilized to create multi-level activity space, implant boating clubs, waterfront bazaars and other businesses, and connect the breakpoints with folding bridges and trestles to reproduce the Soviet-style waterfront pattern of “water and land running in parallel”.

4.2.3. Remaining space of surrounding buildings

The remaining space around the building emphasizes the balance of function and ownership. The front area of the building releases a 3-5 meter buffer zone by retreating from the boundary, sets up movable flower box seats and folding commercial pendulums, and adopts a perforated aluminum plate view wall to take care of lighting and visual penetration. Rooftop space renovation needs to break through the structural load-bearing limitations, promote lightweight ceramic granule planting system, create cloud tea room, starry sky viewing platform and other special scenes, and realize the three-dimensional connection of rooftop gardens through the connecting corridor system.

4.2.4. Remaining space around infrastructure facilities

The transformation of remaining space around infrastructure focuses on resolving the neighbor avoidance effect. Along the railroad, soundproof green walls and scenic overlooks are set up, abandoned tracks are used to pave memory walks, and a railroad-themed sculpture park is implanted. Around substations and other avoidance facilities, equipment is hidden through openwork artistic fences, and green technologies such as photovoltaic pavilions and kinetic energy floor tiles are combined to transform technical facilities into popular science exhibition spaces.

4.2.5. Inefficient Open Space

The renewal of inefficient open space focuses on efficiency improvement and cultural injection. Old squares can adopt the “invisible zoning” method, shaping children's rock-climbing mounds, Taiji sunken plazas and other special areas through microtopography, and using permeable art paving to form rainwater interactive devices. In the ancient city of Suzhou, focusing on the restoration of historical streets and alleys of the “courtyard - alley - garden” space sequence, the unused land will be transformed into a micro-plaza with the theme of commentary, the use of intelligent paving sensors pedestrian footsteps triggered by the kunqu light show, so that the traditional culture of the new life in the contemporary space. This kind of transformation not only improves spatial efficiency, but also continues the urban culture through local design, providing an innovative paradigm for the organic renewal of high-density built-up areas.

5. SPATIAL GOVERNANCE MEASURES

5.1. Building a governance platform

Build a governance platform for the remaining space, create a synergistic model of government+social cooperation+public participation, and encourage the community, entrepreneurship, social welfare organizations, volunteers, and other communities to work together and participate in the entire process. “Collecting and designing a plan for the rehabilitation of the receiving space is the overall plan for transforming the remaining space. A good plan to rehabilitate the remaining space must have some degree of innovation and demonstration, including but not limited to content enlightenment, the use of new technologies, and full demonstration of design solutions. The optimal choice will be supported through, for example, a “competition for the renewal

of the remaining micro-spaces” and will be brought to the attention of experts and the community during the selection phase, which will serve as a basis for determining the prizes.

5.2. From project implementation to space operation and maintenance

The implementation of the remaining space renewal projects introduces a full life cycle management mechanism, where entities have to complete different processes such as investment calculation, contract, contract management and construction. Project implementation actively allows public participation in the construction of other spaces, supporting volunteer teams, cultural enthusiasts, student clubs, and other parties to participate in relatively simple and safe implementation processes, such as the design of the song wall, and the restoration of the remaining space. The full action of restoration of the remaining space must include permanent space operation and support mechanisms. Well-supported and operated spaces can be explored for additional possibilities, increasing their attractiveness and revitalizing their operations. When creating a project to renew the rest of the space, you need to explain the operation and support of the space, which may be the subject of ownership, the market, the community, or the neighborhood committee, responsible for the day-to-day support of the project, as well as to strengthen the connection between the rest of the space and the community, forming a common covenant and encouraging the residents to organize the management and support of the space.

5.3. Develop strong implementation safeguards

The governance of the remaining space needs to be categorized: for public spaces with clear ownership, implementation should be guaranteed by regulations, while Suzhou's high incidence of space under bridges and along the waterfront can be utilized innovatively on a pilot basis first, and then promoted throughout the region after a replicable model is formed. The source of funding should be “government-led + social sharing” - public space should be financed, while community-led micro-renewal projects should encourage residents to raise funds for construction, forming a synergistic input system between government underwriting and grassroots autonomy.

5.4. Explore efficient implementation and management paths

To build a coordinated governance mechanism for regeneration space, the natural resources department should establish a hub platform for urban public space, link up with transportation, housing and construction departments to implement “list-based” space management, and integrate fragmented tenure space into the regeneration resource pool. The street office organizes the community to participate in demand solicitation, screens priority projects based on the annual renewal plan, and simplifies the approval process simultaneously. Implementing the “one map, three systems” model: integrating planning programs and implementation paths with spatial renewal maps, realizing full-cycle dynamic control of the project through a three-meeting mechanism of joint consultation in the early stage, construction coordination in the middle stage, and operation and maintenance assessment in the late stage, and guaranteeing a closed-loop governance led by the government and involving the public.

6. CONCLUSION

As urban renewal enters the stage of inventory and quality improvement, the revitalization of remaining space becomes the key to break the contradiction between space supply and demand. The study focuses on 13 types of typical residual spaces, such as under viaducts and corner plots, and reveals that the root causes of their inefficiency lie in the fragmentation of property rights, functional singularity and cultural rupture. By building a mechanism of “total governance”, we activate spatial functions with demand orientation, enhance spatial resilience with technological empowerment, and

guarantee implementation effectiveness with institutional innovation. It is also necessary to take precautionary measures to incorporate the governance of remaining space into the urban design system, to avoid the trap of spatial abandonment in the construction of new cities through functional pre-embedding and dynamic assessment, and to ultimately realize the paradigm shift from passive transformation to active prevention, and from physical renewal to spiritual remodeling of the place, so as to provide a path of spatial reproduction for the sustainable development of high-density cities.

REFERENCES

- [1] Zhang Zhe. Research on the design of living street space based on the spirit of place [D]. Tsinghua University, 2017.
- [2] Luo Sidong. From rationalism to social critique: the theoretical construction of contemporary western urban planning[J]. Journal of Xiamen University (Philosophy and Social Science Edition),2024,74(02): 49-58.
- [3] Jane Jacobs, Jin Hengshan. The Death and Life of Great American Cities[J]. Expanded Books,2020,(10): 35.
- [4] Ashihara Yoshinobu. Design of Exterior Spaces[J]. Urban Housing,2017,24(09): 93.
- [5] Bai Congxia, Chen Xiaoji. Research on the identification of lost public space in cities[J]. Urban Architecture,2021,18(10):42-45.
- [6] zhang Jiayi. Study on revitalization strategy of “remaining space” in Shaoxing urban renewal[J]. Architecture and Culture,2023,39(11):181.
- [7] Liu Lijun. Research on revitalization design of urban residual space[D]. Hunan University,2015.
- [8] Zhou DZ. Exploration of renewal utilization of residual space around infrastructure--Taking Zhenhai District of Ningbo City, Zhejiang Province as an example[J]. Residential Industry,2024,(02):43-45.
- [9] Zhang Yaofang. Research on streetscape design based on the theory of “urban acupuncture”[D]. Hunan Institute of Technology, 2024.