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Demand-Oriented Renovation Strategies for Public Spaces in University Dormitory Squares: A Case Study of the LZH Campus at North China University of Water Resources and Electric Power

Jiaxuan Yu*

School of Humanities and Arts, North China University of Water Resources and Electric Power, Zhengzhou, Henan Province, 450046, China

**Corresponding author: Jiaxuan Yu*

Abstract

As a key node in the campus public space system, the small squares in dormitory areas carry important functions for students' informal learning, social interaction, and leisure relaxation, making them one of the significant public activity spaces on campus. As high-frequency daily public spaces frequently used by students, the current quality of university dormitory area small squares stands in sharp contradiction with students' growing diversified and individualized needs. Based on demand theory, environmental behavior studies, participatory design, and other theoretical foundations, this study employs methods such as literature analysis, case studies, and field surveys to systematically investigate the existing problems in current dormitory small squares, including underutilized facilities, single-function layouts, insufficient vitality, and lack of humanistic care. The research shows that in the renovation process, priority must be given to responding to the common "basic needs" related to safety, shelter, and wayfinding, while strategically integrating and elevating the differentiated "expectation needs" concerning leisure, socialization, and aesthetic enhancement. The core lies in adopting a student demand-oriented approach and implementing four major strategies—functional compounding, flexible boundaries, natural integration, and smart empowerment—to construct a "dormitory living room" that promotes interaction and stimulates vitality. This study provides a theoretical framework and practical pathway for the "micro-renewal" of existing public activity spaces in university dormitory areas. It holds significant reference value for improving the quality of campus living environments and promoting student community integration.

Keywords

demand-oriented, environmental behavior research, micro-renewal, public space renovation

1. Introduction

In the current planning of university campuses, public activity spaces in dormitory areas—commonly known as "dormitory small squares"—have become a widespread orientation under the "people-oriented"

campus planning philosophy. However, surveys reveal that these activity spaces suffer from low usage frequency and poor environmental quality, failing to fulfill their intended role in supporting students' public activities. Outside peak commuting hours, dormitory public spaces are often sparsely populated and atmospherically cold, exhibiting a pronounced "transit-oriented" rather than "stay-oriented" character. Although students pass through these areas daily, they rarely take the initiative to utilize them for leisure, social interaction, or learning activities. This prevalent idleness of dormitory squares highlights a clear disconnect between existing spatial planning and actual user needs.

At its root, this situation largely stems from the disconnection between the design and usage phases. First, the initial planning of dormitory public spaces is predominantly driven by considerations of "centralized campus management," emphasizing uniformity, ease of control, and low-cost maintenance while overlooking the diverse and dynamic real activity needs of the student population. Second, due to the lack of research from an environmental behavior perspective on how space influences and supports behavior, subsequent renovations fall into a vicious cycle of "facility idleness–damage–replacement–idleness again." Renovation methods are limited to superficial interventions such as replacing paving, adding greenery, or updating facilities, which fail to effectively stimulate vitality and activate the spatial potential of dormitory squares.

Therefore, to address the current passive and inefficient state of these spaces, renovation efforts must achieve a dual shift: in terms of starting point, moving from a management-oriented perspective to a student demand-oriented approach; and in terms of methodology, transitioning from "basic facility updates" to "behavior-supportive design" grounded in environmental behavior principles. This study aims to explore, through empirical investigation, how students' behavioral patterns and spatial needs can be translated into practical and feasible optimization design strategies for dormitory small squares. Taking the LZH Campus of North China University of Water Resources and Electric Power as the empirical research object, the study seeks to theoretically analyze the translation pathway of "demand–behavior–design" and, through its design outcomes, provide reference frameworks and case support for the public space renovation of similar university campuses.

2. Theoretical Foundations and Research Methods

This study adopts an interdisciplinary perspective, systematically introducing the principles and methods of demand hierarchy theory and environmental behavior studies, and applying them to micro-scale spatial optimization problems in the field of architecture. It constructs an empirical design research framework that progresses from "demand diagnosis" to "behavior support."

2.1 Demand Hierarchy Theory: Analyzing the Internal Structure and Dynamic Priorities of User Needs

Demand theory provides a structured model for understanding users' differentiated demands on spatial functions. Maslow's hierarchy of needs theory categorizes human needs into five levels from low to high: physiological, safety, social, esteem, and self-actualization [1]. Subsequently, Clayton Alderfer's ERG theory (Existence–Relatedness–Growth) further simplifies the framework and emphasizes the coexistence of needs and the frustration-regression principle [2]. In architectural environment research, scholars often use these theories to analyze the correspondence between spatial functions and human needs. For example, Christian Norberg-Schulz, in *Genius Loci: Towards a Phenomenology of Architecture*, discusses the hierarchical progression of space from providing "shelter" (existence needs) to fostering "identity" (growth needs)[3]. Domestic scholars such as Chang Qing have also applied demand theory to analyze how historic district renewal can balance residents' basic living improvements with the shaping of cultural belonging [4].

This study translates the abstract psychological demand hierarchy into a functional configuration sequence for the specific physical space of dormitory small squares. Interview data clearly validate the feasibility of this transfer: students' universal priority for "surveillance, wayfinding, and shelter" corresponds to survival and safety needs; their emphasis on "resting seats and greenery" aligns with belonging and esteem needs for socialization, leisure, and aesthetics. Of particular importance, the ERG theory's "frustration-regression" mechanism offers strong explanatory power in this context: when a student attempting social or leisure activities leaves due to the absence of basic safety and comfort in the space, their behavior confirms the dynamic linkage between demand levels. Therefore, applying demand theory enables us to move beyond

simple function listing, scientifically distinguish "basic security needs" from "enhancement quality needs," and provide a clear priority order for design decisions—"secure the basics first, then elevate quality."

2.2 Environmental Behavior Studies: Establishing an Empirical Link Between Behavior Observation and Spatial Design

The core of Environment-Behavior Studies (EBS) is to examine the mutual interaction and influence between people and their physical environment. Its commonly used research methods include systematic observation, questionnaire surveys, structured interviews, and cognitive mapping. In micro-scale spatial design, Jan Gehl's work in *Life Between Buildings: Using Public Space* is most representative; through extensive field observations, he summarized spatial design principles that promote public life [5]. Kevin Lynch's *The Image of the City* employs cognitive mapping to explore how people perceive and remember urban spatial structures [6].

This study employs environmental behavior studies as the bridging mechanism between "user needs" and "spatial form." First, at the problem diagnosis stage, structured interviews and behavioral preference statistics are used to capture users' perceived deficiencies in existing spaces and their expected behavioral patterns. Second, at the scheme generation stage, classic conclusions from environmental behavior studies directly guide the design. For instance, the majority of students' demands for "clear wayfinding" and "efficient circulation" echo Lynch's emphasis on the clarity of "paths" and "nodes"; while some students' desire for a "leisure core zone" fully aligns with Gehl's principle of encouraging interaction through the creation of "active edges" and "micro-environments suitable for staying." Thus, environmental behavior studies provide this research with a reverse design tool of "inferring space from behavior," ensuring that renovation schemes are no longer formal speculations but precise support and guidance for specific behavioral patterns, thereby achieving refined and human-centered design at the small scale.

In summary, by integrating demand hierarchy theory and environmental behavior studies, the research constructs a pathway of "demand hierarchy analysis–behavior pattern interpretation–spatial element translation." It provides theoretical grounding and an empirical design foundation for demand-responsive and refined design of dormitory small squares on university campuses, while also responding to and improving upon the prevailing campus planning issues of "emphasizing management over demand, and form over behavior" in public space design.

3. Literature Review

With the development of higher education and the evolution of campus construction concepts, research on the quality and efficiency of campus public spaces has increased year by year. In particular, the renovation and optimization of "lifestyle-oriented" public spaces closely related to students' daily life—such as small squares and courtyards in dormitory areas—urgently require theoretical and methodological guidance. This review organizes existing research achievements around two core dimensions—"campus public space research" and "micro-renewal theory and practice"—to clarify the positioning and innovation points of the present study.

3.1 Campus Public Space Research: From Morphological Planning to Refined Measurement of Behavior and Vitality

In the area of spatial cognition and behavioral research, scholars have introduced methods from environmental psychology and anthropology to deeply interpret the interactive relationship between students and space. For example, Zhang Xia and Xu Sixing [7], taking Wuhan University as a case, comprehensively applied quantitative analysis of hand-drawn cognitive maps, space syntax analysis, and POI (Point of Interest) analysis to explore students' campus spatial cognition patterns. Their study provides empirical evidence for spatial optimization based on activity needs. Similarly, using Wuhan University as the research object, Huang Zhengyu, Zhang Xia et al. [8] introduced the "affordance" theory from ecology and, with the aid of ArcGIS software for spatiotemporal and behavioral pattern analysis, conducted a systematic study of "alternative behaviors" in campus public spaces. This research treats users' spontaneous and unconventional behaviors as authentic feedback on spatial potential, offering a new perspective for designing more flexible and inclusive campus spaces.

In terms of quantitative assessment of spatial vitality and performance, research has trended toward constructing comprehensive measurement models. Gao Tao, Jiang Ying et al. [9], in their study of the Jiangpu Campus of Nanjing Tech University, innovatively adopted SDNA (Spatial Design Network Analysis) to build a three-dimensional network model. They quantified indicators such as accessibility and through-movement, supplemented by pedestrian counting to collect pedestrian flow data, and used multiple linear regression models to reveal the correlation between factors such as spatial functional mix and vitality. This led to precise strategies for improving accessibility and functional compounding.

3.2 Micro-Renewal Theory and Practice: Small-Scale Intervention and Participatory Creation

In response to the quality improvement and revitalization of built environments, "micro-renewal" has emerged as a renewal model advocating "small-scale, incremental, low-cost, and highly participatory" approaches, playing an important role in urban renewal practice. The core methods of micro-renewal lie in "light intervention" and "clever activation." For instance, the renovation of Yongqing Fang in Guangzhou employed a micro-renovation model of "repairing the old as old, integrating new and old." Ultimately, while preserving historical texture and neighborhood warmth, the project successfully transformed the old neighborhood into a vibrant place integrating culture, tourism, and commerce, achieving dual social and economic benefits. Facing the dilemma of limited spatial resources in old residential communities, the "Eight Buildings" community in Wuhan realized "big quality improvement through small incisions" via "inserting needles where space allows" detailed renovations. The renovation focused on removing dilapidated railings, constructing three-dimensional greenery with flower trellises, adding elderly activity centers and courtyard lighting, etc. This process not only improved the physical environment but also stimulated residents' enthusiasm for co-construction and co-governance, fostering a community culture of loving and protecting the neighborhood. Another example is the renovation design of the Zhongguanyuan community in Beijing, which demonstrates precise micro-renewal based on the needs of specific user groups. Addressing the community's "dual aging" of population and environment, the study started from the cognitive characteristics of the elderly and proposed micro-renewal principles of "reducing information volume, improving readability, slowing renewal rate, increasing participation, and continuing sense of place." It then implemented incremental, co-construction renewal strategies, providing a theoretical framework for spatial renovation targeted at special groups.

4. Research Object and Methods

4.1 Research Object

This empirical study selects the public space adjacent to the 4A dormitory building at the LZH Campus of North China University of Water Resources and Electric Power as the research object. Located in the core linkage area of the student dormitory cluster, the site serves as a high-frequency circulation corridor connecting dormitories, the cafeteria, and teaching buildings. It features a composite spatial morphology comprising a small square, pedestrian pathways, and green vegetation belts. As a typical public activity space in campus planning, it was originally designed to accommodate students' behavioral needs around the dormitory area, including parking, charging, quilt drying, staying and resting, and social interaction and recreation. The site is of moderate scale with clearly defined problems, making it well-suited to the small-scale intervention principles of micro-renewal in this study. It serves as a practical validation carrier for the theoretical framework and provides reference experience for the renovation of similar campus spaces.

The current significant problems are as follows: the space is functionally singular, primarily serving transit purposes and lacking leisure supporting facilities for staying and socializing; facilities are inefficiently configured, with disordered electric vehicle parking encroaching on pedestrian space, no centralized drying facilities leading to disrupted landscape order, and insufficient wayfinding signage and nighttime lighting reducing the safety and convenience of space use; the greenery is monotonous in layering, the paved surfaces are worn with ponding, and the connection between hard spaces and greenery is abrupt, failing to meet students' diverse daily usage needs. The current site conditions are shown in Figures 1, 2, 3, and 4.

Figure 1 Condition figure

Figure 2 Condition figure

Figure 3 Condition figure

Figure 4 Condition figure

4.2 Research Methods

Firstly, this study adopted the questionnaire survey method, distributing a total of 103 questionnaires, of which 98 were valid. The questionnaire content included four sections: basic information, parking behavior and needs survey, facility usage and needs survey, and behavioral space and needs survey. It investigated current satisfaction levels and students' demands, with results statistically analyzed using the SPSS data analysis tool.

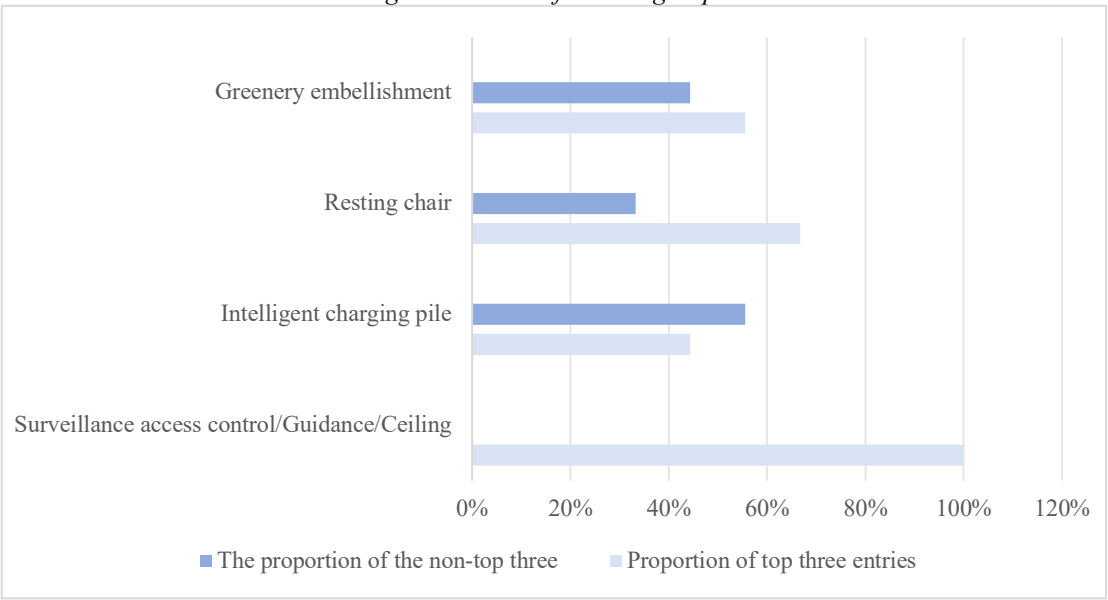
Secondly, for the environmental behavior studies approach, this research employed on-site stationary observation to analyze "time–space–behavior" patterns and conducted semi-structured interviews with 20 public space users. During the interviews, participants were asked, in addition to basic parking functions, what additional functions or facilities they hoped the new parking area would include, as well as their views on a reasonable functional zoning layout for the open space.

5. Results

Through structured interviews, this study obtained the following quantitative findings, which precisely reveal the core structure of user needs and their clear implications for design:

1. Regarding the priority of functional configuration, the student group exhibits a clear demand spectrum ranging from "basic safety" to "quality enhancement." The order of student group needs is shown in Figure 5.

Figure 5: Order of student group needs



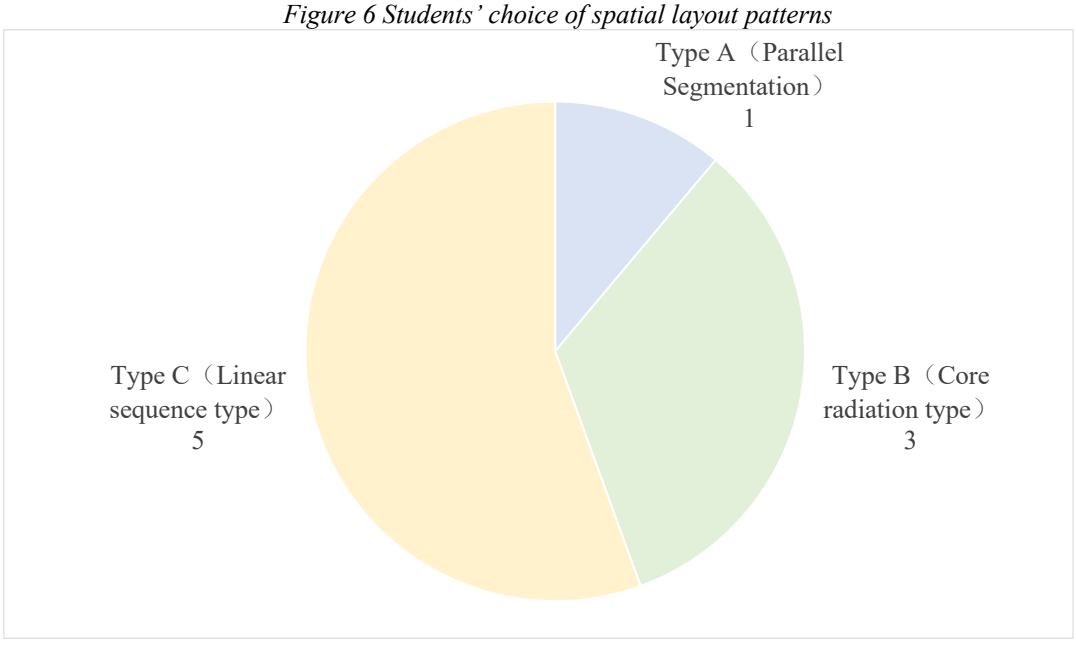
100% of the student interviewees included at least two of the three items-"surveillance and access control systems," "clear wayfinding systems," and "rain- and sun-proof shelters"-among their top three personal needs, reflecting the fundamental demand for basic safety and protection.

Approximately 44.4% (4/9) of the students (mainly electric vehicle or car commuters) ranked "smart charging piles" in their top two needs, while approximately 55.6% (5/9) of the students (those without private vehicles or who prioritize leisure) placed it in the bottom three, indicating that this need is highly group-specific.

As high as 66.7% (6/9) of the students selected "simple resting seats" in their top three personal rankings, and 55.6% (5/9) showed similar preference for "modest greenery embellishment." Together, these point to experiential and quality-enhancement needs that go beyond basic parking functions.

2. Regarding the choice of spatial layout patterns, the data empirically demonstrate how user behavioral logic directly determines spatial preferences, with significant divergence within the student group. Students' choice of spatial layout patterns is shown in Figure 6.

Figure 6 Students' choice of spatial layout patterns



Among all students surveyed (9 respondents), the support rates were: C-type (linear sequential) 56% (5 persons), B-type (core radiation) 33% (3 persons), and A-type (parallel zoning) 11% (1 person). This near-

even split intuitively reflects the fundamental opposition between the two core behavioral modes within the student group—"efficient circulation" versus "place-oriented staying."

All students who chose the C-type layout explicitly stated in interviews reasons directly related to commuting behavior, such as "path efficiency" and "quick access."

2. Regarding the effectiveness of participatory design methods, this study verifies that structured tools can transform vague "user voices" into precise "design parameters."

Through the ranking method, the macro concept of "functional compounding" was successfully quantified into "mandatory priorities" for different facility configurations and "user group profiles."

Through the choice method, the abstract proposition of "layout optimization" was successfully transformed into an empirical revelation of the core conflict between "efficiency and experience," while clearly identifying the specific behavioral archetypes served by each layout scheme.

These quantitative research findings indicate that the renovation of dormitory small squares cannot rely on a single optimal solution. The essence of its design is a configuration process that precisely responds to different user behavioral patterns and balances their competing demands.

6. Discussion

6.1 Ordering of Demand Hierarchy

Both questionnaire and interview results show that "increasing the number of charging piles" is one of the students' loudest and most urgent demands. This finding directly reflects the sharp contradiction between the widespread use of electric vehicles on campus and the severe shortage of supporting charging facilities. However, after examining the underlying logic of the demand ranking, it becomes clear that students' strong demand for charging piles is essentially a manifestation of unmet higher-level "convenience needs."

Therefore, design decisions must go beyond the single response of "increasing quantity." While prioritizing the planning of sufficient and centralized charging facilities, they must be incorporated into a more comprehensive "basic needs" guarantee system. This system includes clear wayfinding signage for charging areas, safety shelters equipped with surveillance and fire protection facilities, and integrated standardized parking spaces.

6.2 Spatial Zoning under "Demand-Behavior" Coupling

Interview data indicate that the C-type linear sequential layout received the highest support rate among students and became the most preferred zoning scheme by a clear margin. This suggests that, in the specific context of dormitory small squares, convenience and high efficiency are the primary considerations for the majority of users. Whether commuting faculty and staff, students relying on electric vehicles or shared bikes, or logistics personnel, all tend to choose the layout that best aligns with daily behavioral flows and allows the fastest completion of parking and retrieval actions. This reveals that the site must simultaneously serve two core yet distinctly different activity patterns: "efficiency-oriented transit and access behavior" and "experience-oriented leisure and social interaction behavior." Any single or rigid zoning approach cannot reconcile this contradiction. Therefore, this study proposes a dynamic composite zoning strategy under "demand-behavior" coupling, dividing the site into three mutually permeable yet differentially focused primary and secondary zones: "high-efficiency service zone," "flexible vitality zone," and "serene leisure zone."

High-Efficiency Service Zone: Arranged along the main circulation paths and building entrances in a clear linear sequence. This zone primarily satisfies basic needs by centrally locating an array of smart charging piles, standardized non-motorized vehicle parking spaces, comprehensive information signage, and covered rain- and sun-proof shelters. Its design emphasizes clear circulation, prominent signage, and efficient access, serving the behavioral pattern of "completing necessary tasks in the shortest time" and acting as the "service backbone" that guarantees the site's basic functions.

Flexible Vitality Zone: Located in the open central area of the site, this is the core of the design and the carrier of the "dormitory living room" concept. It aims to meet expectation-type needs by providing movable

modular seating combinations, lightweight outdoor tables, modular greenery planters, and flat areas suitable for small gatherings or exhibitions, forming a highly attractive and flexible activity core. Its boundaries are softly defined through changes in ground materials and low hedges rather than rigid divisions, allowing activities to naturally spill over into adjacent zones.

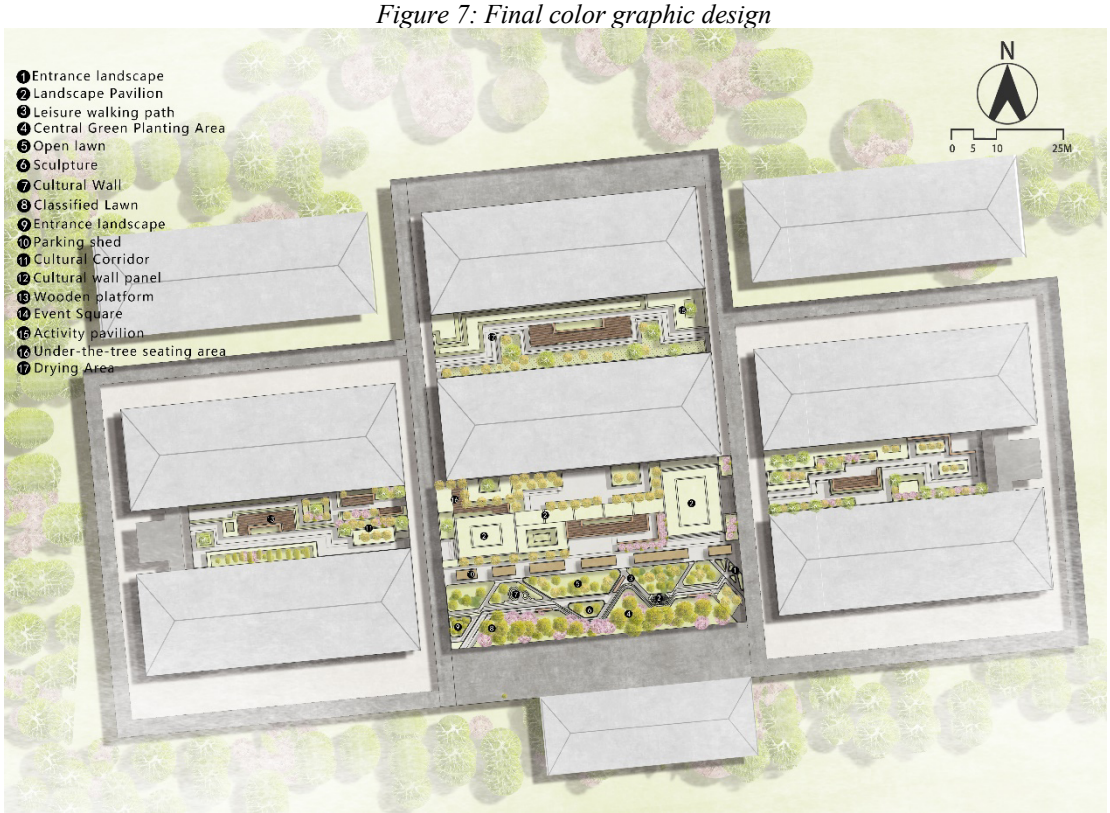
Serene Leisure Zone: Created by leveraging existing trees or newly added shaded corners, kept at an appropriate distance from the "high-efficiency service zone" to minimize interference. It features fixed comfortable backrest seats, interesting landscape elements, and suitable nighttime lighting. This zone satisfies students' needs for solitude, quiet reflection, or small-scale intimate conversations, providing a "sanctuary" experience away from noise and responding to the psychological needs of belonging and self-esteem.

The rationale and advantages of the zoning strategy are: 1) precise response to behavioral differences—acknowledging and separating the two behavioral flows of "efficiency" and "experience" to avoid mutual interference; 2) realization of demand hierarchy superposition—from peripheral "safety/survival" guarantees to central "social/esteem" enhancement, with the spatial sequence reflecting demand escalation; 3) creation of flexibility and inclusiveness—zones are connected through soft boundaries and transitional spaces, allowing students to choose different usage modes according to time and mood, or to trigger spontaneous behavioral transitions.

6.3 Final Design Outcomes

The final design color plan is shown in Figure 7.

Figure 7: Final color graphic design



1. Anchoring basic functions with the "high-efficiency service axis": The plan clearly shows that the charging and parking shelters are arranged linearly along the main entrances/exits of the dormitory buildings and the main roads, forming an efficient "service axis." Through efficient layout and intelligent management, this area solidly addresses the most basic and urgent needs for safety and convenience.

2. Stimulating site potential with the "composite vitality core": The center of the site is shaped into an open "vitality core." The ground uses durable, visually guiding paving. The core area features ring-shaped seating flowerbeds and a flexible lawn suitable for temporary activities. This is the concentrated realization zone for

"expectation-type needs," encouraging interaction, observation, and participation through diverse choices and facilities that support spontaneous activities, aiming to transform students' "passing through" into "staying."

3. Achieving organic connection through "flexible boundaries and permeable paths": The design abandons rigid walls or railings. The three zones are connected through tree-lined paths, landscape seating belts, and gradually changing paving materials. While ensuring the smoothness of the "high-efficiency service axis," the path design intentionally adds secondary winding paths that traverse the "vitality core" and "serene corners" to encourage exploration and serendipitous encounters. This fluid spatial structure transforms functional zoning from isolated islands into an organic whole with mixed functions and continuous experiences.

7. Conclusion

This study, drawing on demand theory and environmental behavior studies, combined with field surveys and semi-structured interviews, clearly identified the hierarchy of students' needs for dormitory small squares and translated them into renovation pathways for optimizing and upgrading public spaces in dormitory areas. Through empirical research, it demonstrated the feasibility of this design pathway. The research process and empirical design outcomes not only fill the existing research gaps in the refined demand analysis and layout preferences for dormitory small square planning and design, but also construct a bridge that directly translates "student needs" into "design language," thereby providing a more precise and operable academic and practical reference for the quality improvement and upgrading of university dormitory small squares. However, this study focuses only on the reconstruction of existing functions and has not yet systematically analyzed or explored the blank areas of students' diverse needs. Limited by sample size and the boundaries of empirical research, there remains room for improvement in design innovation for public spaces. For the "people-oriented" diversified demands, more precise and in-depth exploration is needed in future research. At the same time, the connection and interaction between dormitory public spaces and overall campus planning should be further explored and clarified in subsequent studies.

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Conflicts of Interest

The authors declare no conflict of interest.

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