

Evaluation of campus public space transformation with the analytic hierarchy process (AHP) approach: A case study from Bingwen academy of southeast university, China

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Abstract. Changes in the prevention and control situation in the post-epidemic era have spawned a more complex campus living environment, and new space requirements have gradually formed considering interpersonal relationships and distance. The campus is a space worthy of attention and transformation as it is a densely populated space. Taking Bingwen Academy of Southeast University in China as an example, this paper describes a specific space transformation project, evaluates its main advantages and problems, and proposes some suggestions with an analytic hierarchy process. There are five assessment criteria in the space transformation: functional layout, design and materials, horticultural planting, furnishings and detail decoration, and intelligent security and management. Results show that the reformed space is a multi-functional and "living-study" physical environment. It has different usage scenarios with flexible and changeable spatial layouts and provides various activities for teachers and students with the concept of living and learning integration, co-construction, and sharing. It also promotes traditional culture and history spread through furnishings and details and educates people about morality. The reformed Bingwen Academy still has problems, such as inconvenient furniture moving, limited opening hours for all spaces, and lack of activity displacement. It is proposed to add modular furniture with rollers, manage different spaces by time, and add an achievement exhibition wall. This project provides a reference value for the space transformation of other college dormitories during and after the epidemic.

Keywords: Bingwen academy, space transformation, epidemic, college dormitory, public space.

1. Introduction

The campus space is an important place for teachers and students to study, live, exercise, and socialize for a long time, which is another "home" for them. As a community on campus, the dormitory is a healthy, safe, and cultural living and learning space to guide teachers and students to communicate and help each other. Restricted by the design level and conditions at the construction time, many old campuses only considered the most basic accommodation and transportation needs in the early stages of construction [1]. It has many disadvantages, such as a dirty dormitory environment, old facilities, and poor security. The dormitory public space mainly has a single function and form, monotonous decoration styles, and poor interactive experiences. Therefore, open and diverse dormitory public

space with a pleasant environment has become the direction of renewal and exploration in colleges and universities.

Since the outbreak of the COVID-19 epidemic, the management of universities at home and abroad has been dynamically adjusted due to epidemic prevention regulations. The COVID-19 epidemic has changed learning places from traditional classrooms to dormitories. Since the activities of the students are mainly trapped in the dormitory, the original problems of the dormitory are exacerbated. For example, the unsynchronized course time inevitably leads to work and rest contradictions among individuals, such as reporting and discussion, self-study, and rest.

To cope with the existing problems in dormitories, especially under the influence of the epidemic, some colleges and universities have evaluated the factors of the space environment on the physical and mental environment and proposed improvement strategies [2]. Amistadi et al. argued for turning academic facilities with low usage rates into temporary spaces, such as changing skating rinks to vaccination, for flexible university campus design considering the impacts of COVID-19[3].

Southeast University is a comprehensive public key university with 5 campuses with over 120 years of history. Among them, the Jiulonghu campus is the largest in area and scale. However, due to the longtime of construction and use, there are many disadvantages in the campus environment and dormitory space. COVID-19 has also led to the transformation and management of the campus facing more difficulties. In order to optimize the campus community environment and create a more comfortable living space during COVID-19, Southeast University took the Bingwen Academy in the Taoyuan dormitory of the Jiulonghu Campus as a pilot to carry out renovations. This article takes the Bingwen Academy as an example to explain the transformation project of the living and learning space, applies an analytic hierarchy process (AHP) approach to evaluate the effects and deficiencies in the renovation and operation management, and then proposes optimization strategies.

2. Background

Southeast University has five campuses in total, including three in Nanjing. The Jiulonghu Campus of Southeast University is located in Jiangning District, Nanjing City, Jiangsu Province, China. It was put into use in 2006, covering an area of 2.5 km². It is the largest main campus and the main area for the school's new development and construction, with more than 15,000 students [4].

In order to improve the interaction between teachers and students, the school selected a deserted parking area with a low utilization rate and a messy environment for campus renewal. This project was completed in 2020, and the reformed area was named Bingwen Academy. Bingwen Academy uses the free public space on the first floor of the dormitory and retains the two pedestrian flow lines from the original elevated floor to the stairwell. The entrance of the academy is isolated from the student passage, which does not affect the students entering and leaving the dormitory, and ensures the quiet environment of the academy. It is located in the enclosure of dormitory 7-8 in Taoyuan on the north side of Jiulonghu Campus, close to the main entrance and exit of the school, the North Gate. As part of the key living area of the campus, Bingwen Academy is close to the Student Activity Center, Taoyuan Canteen, the school clinic, the main teaching buildings, and a campus shuttle bus station is set nearby (Figure 1).

Additionally, Bingwen Academy implements a resident tutor system based on the construction of a relaxed and diverse living and learning community, which breaks through time and space constraints, and students can get comprehensive guidance services from professional teachers without leaving the dormitory area.



Figure 1. Map of Jiulonghu Campus of Southeast University and location of Bingwen Academy.

3. Implementation of space transformation

Bingwen Academy is the first batch of pilot projects for the reform in the academy system of the General Affairs Office of the school. It is also an important part of the school community's cultural construction. The entire construction period lasted about 6 months. The construction was completed at the beginning of May 2020 and passed the acceptance inspection.

3.1. Functional layout

The overall shape of Bingwen Academy is a long and narrow rectangle with a maximum capacity of about 90 people. It is composed of static and dynamic areas. The static area on the north side is mostly set up as partitions, containing tutor rooms, a conference room, and a library, with less interference. The dynamic area in the south mainly contains an open study area, multi-functional lecture hall, dance room, tea room, and water bar (Figure 2). Among them, the open study area and multi-functional lecture hall can also be used as discussion areas, activity classrooms, and self-study rooms. The dance room has guzheng and other musical instruments and can also be used as a rehearsal room, fitness room, and performance area. All tea drinks in the tea room are self-service, and there is a water bar to clean the tea sets. The terrace is a transitional space extending from indoors to outdoors, and it is a good place for reading, tasting tea, and getting close to nature. There are two vegetable and flower gardens in the nature of community gardens that have been jointly designed, transformed, reclaimed, and planted by teachers and students since the epidemic outbreak outside the tea room and the multi-functional lecture hall.

Bingwen Academy uses screen-type folding doors and flexible design of tracks so that the space layout can be flexibly adjusted according to the needs of activities to achieve functional transformation. When opening the folding doors, the multi-functional lecture hall, forum, and booth area can be integrated to hold academic activities such as course seminars and conference lectures. When closing the folding doors, the independent functional areas or small salon spaces could be basically

undisturbed. Furthermore, linen curtains are used as partitions between the tea room and the aisle. The light and thin curtains fit the overall atmosphere, and the retractable state implies changes in functional divisions and usage scenarios.

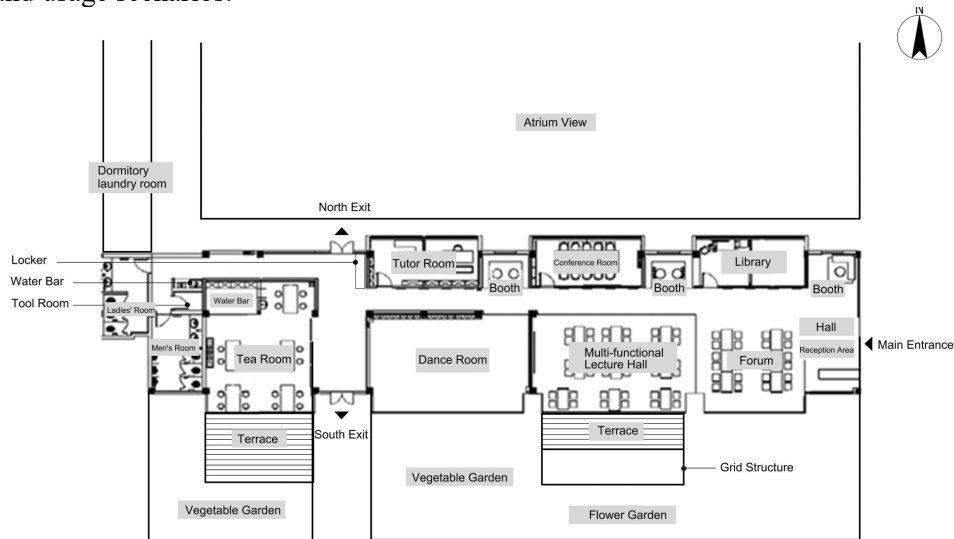


Figure 2. Layout plan of Bingwen Academy of Southeast University (modified from [5]).

3.2. Design and material

The overall style of Bingwen Academy is elegant, and the simplicity of the new Chinese style and the transparency of the modern minimalist style blend, revealing a quiet and humanistic atmosphere. Wood, dark gray cement boards, and terrazzo are mostly used for the hard decoration of the space, and imitation wood grain colours are mostly used for the grille ceiling, furniture, and folding doors, adding a little classical connotation. (Figure 3).



Figure 3. The application of materials in Bingwen Academy of Southeast University.

Casement, landscape round, and floor-to-ceiling windows combined with doors all use high-transmittance tempered glass in large areas with good lighting and ventilation. The design of the round window is similar to the hole window and moon hole door in Jiangnan Gardens. It just takes the scenery of the courtyard outside the window and pays tribute to the gardening spirit of "a masterpiece of nature". This kind of design reminds people of the elegant charm of Ming and Qing literati appraising poems and books in the garden, adding a humanistic atmosphere to the space through allusions (Figure 4).



Figure 4. The window view of Jiangnan Garden in Bingwen Academy of Southeast University.

The terrace outside the tea room is built with a canopy of stainless steel, and the floor is paved with beautiful and durable anti-corrosion wood. The hand-assembled flower ponds and wooden fences are full of natural and wild charm. Outside the multi-functional lecture hall, the black grille and hollow glass bricks form an enclosed structure, producing a wonderful light and shadow transmission effect under the sun. On the outside of the grille, teachers and students planted vines such as petunias and roses, and decorated the ground with pebbles to form a flower wall (Figure 5).



Figure 5. The grid structure outside the multifunctional lecture hall.

3.3. Horticultural planting

The design of the vegetable and flower gardens and courtyard in Bingwen Academy is inspired by the concept of "cultivating, studying, and inheriting family members" in traditional Chinese culture, which is also the inheritance and accumulation of farming culture, scholar's hermit spirit, and Jiangnan regional culture. The originally messy grass outside the tea room terrace and the multi-functional lecture hall of Bingwen Academy was reclaimed by teachers and students into two vegetable fields and a flower garden. They refurbished the land and planted various vegetables and flowers, such as radishes, lettuce, cherry tomatoes, garlic, and rose (Figure 6). The process of "planting – maintenance – observation – harvesting" has a very healing effect, and it also cultivates the labour and team spirit of teachers and students. Especially during the epidemic, taking care of plants in their spare time has become the most anticipated activity for teachers and students (Figure 7). Everyone is more proactive in caring for plants, which not only cultivates a sense of responsibility and team spirit but also increases the sense of identity and belonging of "school is home" [6]. Besides the gardens, a large area on the east side of the Taoyuan dormitory allows teachers and students to develop their creativity to plant in the future.



Figure 6. Some vegetables and flowers planted by teachers and students.



Figure 7. Land renovation and planting by teachers and students.

3.4. *Furnishing and decoration*

In terms of furnishings and decoration, the simple and generous round chandelier is the main lighting type, which fits the decoration style and echoes the round window of the facade. Moreover, the porcelain and tea table form a symmetrical end view.

The entrance wall of Bingwen Academy is decorated with the eye-catching logo of the School of Humanities of Southeast University and the academy's educational philosophy of "Being well educated and reasonable to achieve your achievement". The interior foyer and aisle walls are decorated with exhibition boards or roll-up displays of the school's history and famous teachers' achievements. The wall in the inside area is decorated with calligraphy and traditional Chinese painting works, adding to the elegant cultural connotation of the space (Figure 8).



Figure 8. Wall decoration details of Bingwen Academy.

3.5. *Intelligent security and management*

Under epidemic prevention and control, temperature measurement equipment, registration, and temporary isolation areas have become standard configurations in the public space of university dormitories in China. However, a good and secure environment requires advanced technologies and management systems to guarantee. Bingwen Academy has set up double protection at the entrance of the entire dormitory and the academy. Students living in the enclosure swipe their campus cards to pass through the gates, other teachers, students, and visitors register information, and the large electronic screen at the entrance automatically recognizes faces to match the campus identity. People can enter after testing and reporting that their body temperature is normal. At the entrance of Bingwen Academy, infrared devices automatically check the body temperature again.

4. **The evaluation of space transformation**

4.1. *Selection of criteria*

Factors such as site circumstances, school conditions, and the wishes of teachers and students affect the selection of the criteria and sub-criteria. Currently, the Bingwen Academy transformation includes not only the interior space layout but also the material and green plants, through on-site visiting, observing, and investigating.

The major assessment criteria could be concluded into five aspects: functional layout, design and materials, horticultural planting, furnishings and detail decoration, and intelligent security and management. The selection of the associated sub-criteria is based on the actual degree of transformation and the AHP methods (Table 1).

Table 1. Weight of selected design evaluation indexes in Bingwen Academy.

Main-Criteria	Weight	Sub-Criteria	Total weight
Functional layout	0.275	The dynamic area	0.1405
		The static area	0.1345
Design and materials	0.24	Windows	0.07295
		Hard decoration	0.05975
		Floor	0.05405
		Furniture	0.05325
Horticultural planting	0.185	Vegetable fields	0.11275
		Flower gardens	0.07225
Furnishings and decoration	0.17	Walls decoration	0.0665
		Lighting	0.0585
		Logo	0.045
Intelligent security and management	0.13	Body temperature monitoring	0.066
		Authentication at the entrance	0.064

4.2. Evaluation of criteria weights

The criteria weights are defined through the investigation of campus students and teachers. The nine-point scale was used to establish a judgment matrix to ensure the normalization and scientificity of data and conduct a consistency test [7]. After conforming to the consistency test, the weight indicators were calculated by the arithmetic average method, and the importance of evaluation indicators in space transformation was obtained, and they were ranked from the largest to the smallest according to the global weight (Table 1).

It can be seen that the functional layout is the most important criterion layer and then comes design and materials. The campus needs to be reasonably planned, making sure that the space can accommodate the requirements for recess activities. In addition, it needs to ensure that the space can meet the requirements [8] of diversified activities. It should have appropriate light, interactive and cultural exhibition space, and a comfortable atmosphere with a rich green landscape [9].

5. Evaluation of space transformation

In this study, Bingwen Academy's transformation was included in the scope of campus development goals for evaluation. Combined with the relative circumstances of the case study, a list of criteria and the corresponding weights were created (Table 1). The weights of these criteria have been demonstrated by experts, teachers, and students using the AHP method. After determining the relative weights, all criteria were analyzed, and the values found were normalized in the range of 0–1 [7,8]. This section discusses the advantages and disadvantages of space transformation combined with the criteria weights and the on-site investigation.

5.1. Effects

Bingwen Academy has many advantages in the physical environment, the attention to the psychological use experience, the design of functional layout and situational activities, the dissemination of cultural ideas, and reasonable management methods. From the perspective of campus reconstruction, the merits of this project can be extended to other universities. In addition, the function and activity adjustments made by Bingwen Academy in combination with the spatial layout are also of

reference significance for the renewal, utilization, and management of campus dormitory public spaces in colleges and universities in the future during and after the epidemic.

Bingwen Academy has created a healthy, comfortable, healing, and relaxing environment. It pays attention to people's perception, integrating materials, colours, shapes, smells, sounds, and light as media to create a soft, friendly, and protected environment. Especially in the post-epidemic era, the transformation of public space in college dormitories should be based on creating a comfortable, warm, and relaxing environment. The bright and open design brings natural elements into the interior, alleviating physical and psychological fears of occlusion. This will help college students relieve the pressure caused by the epidemic and feel at home in the public space of the dormitory [10]. Besides, Bingwen Academy chooses safe and comfortable, simple and gentle designs and furnishings to convey the feeling of elegance, dignity, and ancient rhyme. The rounded corners give people a feeling of safety, comfort, and protection, and the soft material can reduce the feeling of oppression and relax the mood. Moreover, the selection of furniture conforms to ergonomics and helps to improve work efficiency.

Bingwen Academy has increased and smoothed communication between teachers and students, making them closer to each other. For example, everyone can move the furniture and sit together during group exchanges and seminars, which is conducive to forming an equal, harmonious, and closely interactive teacher-student relationship. This kind of resident tutoring model and personalized service allows students to get face-to-face academic guidance from tutors, communicate with each other, and share their experiences at any time. The tea room also provides a place for team activities and emotional communication. It is an extension of the "home" scene and often holds activities for students who could not go home. As a whole, Bingwen Academy uses the humanistic concept of "farming- and reading-based to inherit the family conception" to pay tribute to the traditional Chinese culture, strengthening the concepts of "family" and "community" to give teachers and students a sense of belonging. Based on the concept of living and learning integration, participating in the design, construction, and maintenance of the dormitory public space, teachers and students have established a new "neighbourhood" relationship [11]. They also attend some activities, such as planting and arranging walls, to realize the "self-sufficiency" of small-scale vegetables and enhance the sense of accomplishment.

Bingwen Academy enhances vitality through a variety of spatial function designs, bringing different use scenarios and rich personal and collective activities (Figure 9). To expand communication venues, stimulate spatial vitality, and make up for the lack of required space functions after the epidemic restricts travel, Bingwen Academy divides the space based on their function into several areas: cultural learning areas (e.g., reading corners and self-study areas), sports activity areas (e.g., dance room), entertainment and leisure areas (e.g., tea room and water bar), and outdoor work areas (e.g., vegetable gardens and open-air seats).

Besides, the design of flexible space in Bingwen Academy has created transformable functions. The use of movable furniture and change of space separation helps to create different usage scenarios (Figure 9). This design realizes the combination of individuals and groups, online and offline, theory and practice within the limits of epidemic prevention and control. This allows the limited public space to be fully utilized to accommodate more functions and personalized needs. Teachers and students can switch from an undisturbed isolation state to an open discussion state.



Figure 9. The screen-type folding door of Bingwen Academy.

Bingwen Academy gathers scenes and behaviours from classrooms, homes, and fields into the public space of the dormitory that was once idle, considering reasonable dynamic and static partitions, rich scene creation, and flexible function switching. It realizes the close connection between composite space and various behaviours and provides an efficient and reasonable space design template. Therefore, the transformation of the dormitory public space in the post-epidemic era must break the shackles of the original single dormitory scene [12] and make good use of limited resources to explore an open, changeable, and highly cohesive new living and learning model.

The design of Bingwen Academy has the effect of spreading culture and cultivating morality. It creates a culture of connection through environmental situations, enabling people to generate cultural identity and emotional resonance in the space using memory, association, and re-evaluation. Its cultural construction, such as school history and ideological and political education, reflects the coordinated development of moral and aesthetic education. From the creation of the living environment to the cultural construction, it not only cultivates the quality of students' steadiness and thrift but also makes the space full of warmth and creates spiritual civilization in campus dormitories after the epidemic.

5.2. Deficiencies and suggestions

Although Bingwen Academy has many advantages regarding environmental design and functional layout, there are still some shortcomings. Given the deficiencies, this paper puts forward some suggestions.

At present, some designs in Bingwen Academy are more based on realizing flexible space transformation from the perspective of space division. Some furniture is more laborious to move. To alleviate inconvenient furniture moving, we propose considering lightweight and easy-to-assemble modular furniture, such as a detachable seat with rollers or storage functions. Teachers and students can arrange them into specific forms according to their needs, which can be freely combined and replaced. This will help the space transform in various modes such as discussions, exhibitions, and sports, and promote interdisciplinary and cross-grade cooperation, providing a place for online and offline learning and living after the epidemic.

Another trouble is that open time is the same for all areas. For example, during the summer vacation of 2022, due to the continuous high temperature, drought, and holiday policy, some students could not enter the tool room to get watering tools for the vegetable garden. This caused some vegetables to miss the harvest time, and some plants even died. It is suggested that the academy can set up different open times for each part. For example, it can open part of the space, such as the tool room, separately during non-working hours. It is also recommended to contact the school logistics department, dormitory staff, and volunteer associations to assist in gardening during the holidays and to share the harvest.

In the public space of this kind of dormitory, it is also suggested to consider adding a planting book display area and an achievement wall to display video clips, photos, and works that teachers and students participated in. This will help deepen the friendship between teachers and students, enable them to fully grasp autonomy, create the desired living environment, and become the master of their living and learning space.

In the post-epidemic era, the transformation of public space in college dormitories should consider the convenience of space functions and services and realize the extension of psychological and physical space. In a limited space, functions and activities should be planned with comprehensive diversity, which will help enhance overall vitality. In addition, the complex problem of individual and group behaviour should be considered [12].

6. Conclusion

This article discusses the characteristics of the transformation of Bingwen Academy of Southeast University in the context of the post-epidemic era and campus renewal, analyzes the advantages and

disadvantages of the project via AHP method, and puts forward suggestions for public space transformation in university dormitories during and after the epidemic.

Bingwen Academy has clear dynamic and static divisions, with functions such as learning, communication, sports, display, and planting, providing a safe, comfortable, and pristine physical environment. Its whole space is a combination of living and learning, which is a "home" where teachers and students build and share and enhance friendship. Furthermore, the academy adopts flexible space to make a single space with multiple functions by opening and closing the folding doors.

It has the artistic conception of cultivating reading and spreading culture. The horticultural planting has added fun to live after the epidemic. It not only cultivates the spirit of cooperation and a sense of belonging between teachers and students but also continues the traditional Chinese humanistic concept. In addition, the furnishings and detailed decoration have a strong cultural atmosphere. The arrangement of the walls reflects the history of the school and the college.

It also uses digital technology to carry out intelligent security management, has set up double protection around the dormitory area enclosure and the academy entrance, and provides health protection for teachers and students with face recognition and temperature measurement.

However, there are also problems to be improved at Bingwen Academy. Firstly, some furniture is difficult to move. It can be changed to modular furniture with rollers. Secondly, it is recommended that different spaces be opened on time-sharing and volunteers are invited to assist in the management. Thirdly, it is recommended to display some activities' achievements of teachers and students, such as images and handwork, in combination with wall decoration. Last but not least, it is suggested to pay attention to the legacy of the original space and use the idle space skillfully to create a relaxed living and learning space.

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