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Spatial Organization and Efficiency Optimization of College Student Apartments

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Abstract. After the outbreak of era, as a densely crowded residential buildings and the space types where students stay for the longest time, the demand of the public function is larger than ever. At the moment, the old college student flats are inefficient and backward in terms of space organization and efficiency, and they are far from the use demand for apartments among students in the current period. This paper analyzes the current status of student apartments, investigates the needs of college students for apartments, discusses the ways of spatial organization and efficiency optimization, and optimizes the spatial organization and resources according to the characteristics of intensive student apartments in the post epidemic era through the field inquiry, questionnaire survey, on-site consultation and data collection from student dormitories, in order to provide a new direction for solving the needs of students and the lack of apartment functions.

Keywords. Post-epidemic era, student apartment, spatial organization, efficiency of optimization

1. Introduction

The main place for college students to reside, study, and rest is the college student apartment. It is characterized by a dense population flow and high mobility [1]. Most student apartments currently have space organization issues, such as lack of elastic space, single architectural form, limited living space, low design standards, and lack of humanistic care and so on [2-4]. The student residences mostly meet the functional criteria, but little consideration is given to their comfort, energy efficiency, lighting, noise, and natural harmony [5-9]. Students' demands for housing space have also changed in the post-epidemic era. Many measures are taken to relieve students' psychological pressure when the emergency mechanism is activated, such as reasonable streamline organization, perfect isolation steps, some public space functions performed by the apartment, comfortable indoor environment, good landscape layout, and so on [10]. As a result, flexible space, humanistic care space, more adaptable architectural forms, and green and low-carbon interior space should all be given more consideration. Space design optimization and green building simulation technologies can be used to improve student residences by optimizing space organization and efficiency. Finally, we will improve the architectural form, elastic space, and

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humanistic space of college residences, expand green sustainability research, shorten the communication between human and natural landscape, and optimize resources.

2. Current Situation and Demand Analysis of the Apartment

Wuhan, where the apartment North area of Huang Jia Hu Campus of Wuhan University of Science and Technology is located, has a characteristic of south subtropic monsoon: plenty of rainfall, much heat, cold or wet winter and hot summer, and four distinctive seasons.

2.1. Apartment Area and Layout

The apartment lies in the university town of Hong Shan District, Wuhan, to the northeast of Wuhan University of Science and Technology's new campus. The standard floor has an interior gallery plan, whereas all units have a short panel arrangement (figure 1). Natural ventilation and lighting are used in the inner hallway, and each basic room can accommodate four people with a per capita use area of 5.1 square meters. The restroom is located in the common area, which allows for natural ventilation and illumination, and the dormitory has air conditioning.

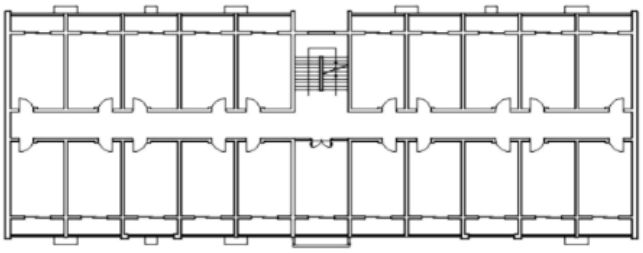

Figure 1. Original Structure of Apartment.

2.2. Existing Problems of the Apartment

We gathered the current flaws and functional expectations of the students' residences through an online questionnaire survey of undergraduate students at our school, and obtained 50 valid questionnaires. We came at the following conclusions after sorting and analyzing the data:

2.2.1. Lack of Public Space

Eighty percent of students claimed they don't have access to public spaces for recreation and debate. The development of college apartments is primarily aimed at satisfying the needs brought on by the large growth in the number of students. As a result, only fundamental transportation and living needs are considered, while the benefits of indoor public space in apartment buildings to students' long-term growth are overlooked [11].

2.2.2. Unreasonable Space Layout

According to the survey and analysis, nearly half of the students believe that the inside atmosphere of apartment complexes is humid, hot in the summer and chilly in the winter, has poor air quality, and lacks enough illumination. The major aim of consideration in the large-scale building of schools and universities is function and cost, ignoring geographical location, climate, comfort, and other factors.

2.2.3. Lack of Application of Architectural Psychology

Early apartment building, based on the principle of how fast to save construction apartment, omitted many in terms of money "more input low returns" apartment internal use space construction, but with the improvement of society as a whole economic level and the improvement of students' quality, according to Maslow's hierarchy of needs to show (figure 2), as people elementary and intermediate level needs are satisfied, they will pursue more advanced needs, which is manifested in the lack of "shared space" and "comprehensive space" design of apartments in terms of architecture, which is the neglect of students' psychological development.

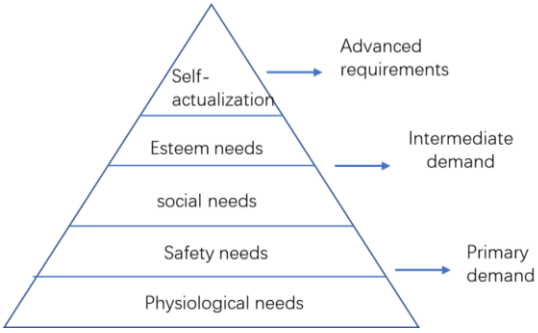

Figure 2. Maslow's hierarchy.

2.3. Analysis of Students' Needs

With the transformation of college students' consumption concept and the improvement of family economic conditions, the traditional apartment model has been unable to meet students' daily life and learning needs, and students in the new era also have new spiritual and material requirements [10]. A large number of cases at home and abroad show that open space is considered to be the inevitable trend of the future development of indoor public space in university apartment buildings, which can effectively increase the communication between students and strengthen the interpenetration between disciplines, and is conducive to the future development of students [12-14]. According to the questionnaire survey conducted above, the common needs of most students for missing functions have the following aspects.

2.3.1. Change of Learning Mode

In the post-epidemic era, online learning and communication have become normal, and students have become accustomed to and rely on this learning mode to some extent, which is bound to bring more possibilities and changes to the future learning mode.

Under the background of "the outbreak era", how to make the students' safety and health of the closed school learning, to overcome the negative thoughts, New requirements are put forward for the spatial organization of apartment.

2.3.2. Mental Health Needs

Safe and comfortable apartment building is the foundation of normal operation of campus. According to the latest survey, more than 80% of college students spend at least 4 hours in their apartments every day except for basic rest [15]. When the epidemic situation is severe, students need to occupy the apartment for an extended period of time.

3. Spatial Organization of Student Apartments

3.1. Building the Connecting Corridor of the Apartment

The corridor part of the apartment is added, which solves the following problems:

- Set up functional rooms for students' study and activity needs during the epidemic management period to complement the functions of the apartment;
- Optimize the spatial layout to create a dialogue between human and natural landscape;
- Improve building comfort by means of green building.
- The design combines the above main renovation objectives to create a relatively isolated green activity space by adding to the middle portion of the apartment building, which is less space-efficient.

3.2. Dormitory Balcony Reconstruction

"Sun room" is set on the balcony of each room in order to minimize the impact of adverse climate by taking advantage of the favorable climate in combination with the climate characteristics.

The setting of "sun room" reduces the wall surface of each room directly to the outside, which is conducive to the thermal insulation of each room and other functional spaces to a certain extent.

The "sunshine room" on the south side can absorb solar radiation in winter, improve the indoor temperature, reduce the hours of air conditioning. The "sunshine room" on the north side can effectively block the invasion of prevailing wind in winter as a temperature damping zone, which is conducive to the heat preservation of each room in order to strengthen the effect of heat preservation and heat insulation.

4. Efficiency Optimization through Green Building Analysis

Based on "Evaluation Criterion of Green Buildings" (GB 50378-2019) and " Green Retrofit Standard of Existing Buildings" (GB/T51141-2015), from the aspects of thermal engineering, acoustic environment, and light environment, we analyze the existing problems of the apartment, and propose corresponding green and energy-saving renovation measures.

4.1. Thermal Environment

In view of the special situation of the old apartment, the renovation of its outdoor thermal environment and indoor thermal comfort is the key point. In addition to the renovation of the thermal insulation performance of the envelope structure, this scheme has carried out a number of auxiliary renovation measures.

- The first layer is laid with seepage floor tiles, so that rainwater can quickly penetrate into the ground to facilitate rainwater collection, and can maintain the soil humidity to improve the living conditions of plants.
- Plant deciduous broad-leaved trees, which can shade and dissipate heat in summer, and will not affect sunlight in winter when the leaves fall.
- Layout vertical greening, the combination of vertical greening and building can not only provide the landscape of the sub-buildings, but also effectively improve the internal microclimate of the building.
- Set the exterior wall combination thermal insulation suitable for hot summer and cold winter areas, which is fireproof, safe, and resistant to aging, and at the same time it is convenient for construction.

After determining the renovation measures, according to the requirements and regulations of "Code for Thermal Engineering Design of Civil Buildings" (GB50176-2016) and "Evaluation Standards for Green Buildings" (GB 50378-2019), the thermal performance of the building envelope is calculated. And according to the provisions of Appendix C.3 of "Code for Thermal Engineering Design of Civil Buildings" (GB50176-2016), the following hour-by-hour temperature chart of the inner surface of the enclosure is obtained.

The results show (table 1) that the inner surface temperature of the room envelope is lower than the maximum inner surface temperature given in the Code for Thermal Engineering Design of Civil Buildings. After renovation, the thermal insulation performance of the apartment building envelope meets the requirements of "Code for Thermal Engineering Design of Civil Buildings" and "Evaluation Standards for Green Buildings".

4.2. Acoustic Environment

The main noise sources affecting the apartment are traffic noise and living noise, and most of the external noise is transmitted from doors and windows. Therefore, the key point to control indoor noise pollution is doors and windows [7]. Combined with the layout of the apartment, one is to change the ordinary glass window to PA broken bridge aluminum alloy insulating glass window (5mm+12Ar+5mm+12Ar+5mmLowE), which can usually reduce the noise by 30 to 50 decibels; Add porous sound-absorbing materials to the walls; third, add sound-proof sealing strips. Noise level noise level in the home after renovation complies with the minimum requirements of the current national standard " The Civil Buildings Sound Insulation Design Code".

Table 1. Comparison of Maximum Value and Limit Value.

Type	construction	time	Maximum Temperature	Limit Value	Conclusion
roof	roof	19:00	38.86	39.3	reach the standard
exterior	East	18:00	38.56	39.3	reach the standard

wall	west	118:40	38.69	39.3	reach the standard
	south	18:05	38.58	39.3	reach the standard
	north	18:00	38.23	39.3	reach the standard

4.3. Light Environment

In the transformation of the light environment, increasing the lighting area and transforming the indoor and outdoor veneer materials are important means to improve the indoor light environment. The daylighting analysis software Dali is used for simulation analysis. The three reflections are calculated under the condition that the CIE is completely cloudy, and the functional room is 0.75 meters near the ground. The daylighting coefficient of each room meets the requirements. The light environment analysis diagram (figure 3) is drawn from the calculated data. The average daylighting coefficient in the apartment is about 4%, and there are better light conditions in the "sun room". According to the calculation results, the reconstructed "sun room" can make the interior meet the requirements for the lighting coefficient of the building.

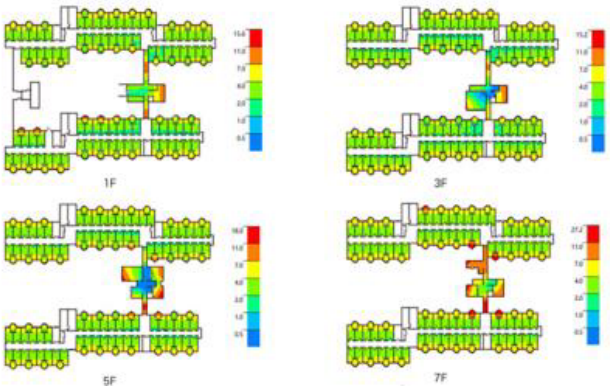

Figure 3. Light Environment Analysis.

5. Conclusion

This paper expands the use scenarios of students in apartments by adding apartment corridors and sun rooms, so that apartments become a multi-purpose "comprehensive space" for socializing, learning, and thinking, and the spatial organization of the apartment is optimized. The apartment's efficiency has also been improved as a result of the refurbishment. For university apartment buildings, safe, healthy and comfortable public space is not only a current demand, but also a future development. It is hoped that the research can provide some reference for the development of indoor public space in university apartment buildings in the future.

- The greening and water body layout of the apartment's outside space, as well as the building's outer envelope structure's thermal insulation design, have resulted in a comfortable indoor thermal environment that meets energy-saving criteria.

- External windows and partition walls can be easily renovated. The apartment interior meets the minimum sound insulation requirements, resulting in a pleasant sound environment.
- The design maximizes the "sun room," expands the apartment's lighting area, and changes the inside veneer materials. The lighting coefficient in the apartment is under 4%, which means less lighting energy is used.
- Through the multi-area network method, different areas are connected by connected doors and windows, and the ventilation frequency of all spaces is more than 2 times/h.

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