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User-centric Student Housing Performance Evaluation Approach: A Case Study in the Netherlands

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User-centric Student Housing Performance Evaluation Approach: A Case Study in the Netherlands

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Abstract. In the Netherlands, the development of student housing has been increasing with the significant growth of the student recruitment in recent years. As such, there is a pressing need for a retrospective reflection of the performance of student housing built in previous years. However, a user-centric building performance evaluation framework (BPEF) for student housing is not available. From the user perspective, this study aims to develop a BPEF to support student housing management. Based on a thorough literature review, 14 building performance attributes (BPAs) applicable to student housing were identified, structured and incorporated into a preliminary three-level hierarchy of BPEF. A focus group discussion, which was conducted to verify the preliminary BPEF, established an improved BPEF that comprises 15 BPAs. A Dutch student housing case was selected to test the established BPEF using the data collected through a survey. The qualitative and quantitative data complement each other to provide in-depth examination of the student housing's performance, and the survey results prove the validity of the BPEF. This study serves as a pilot case in establishing the BPEF from the user perspective, and the validated BPEF can be used in future research or practical evaluation on other student housing developments.

1. Introduction

Building performance evaluation (BPE) is a key component in the field of facilities management (FM) and thus, it is an essential task in facilities managers' scope of work. As the FM discipline advances, BPE has been widely accepted as a scientific building management approach and it contributes to closing the building life cycle knowledge loop by providing practical feedback to building design and construction professionals. However, BPE has not attracted enough attention from the building occupants. They often perceive BPE as a routine activity of the facilities managers and fail to see the scientific significance of BPE in ensuring occupants' well-being in the built environment.

Over the years, numerous cases have demonstrated the benefits and necessity of involving building occupants in a BPE process. Occupant comfort has been commonly recognized as a reason to involve building occupants in BPE while it is often neglected that their behavior also impacts on the building performance, such as energy consumption. In other words, engaging building occupants in BPE not only helps them understand the level of "suitability" – how well the building is operating to suit the occupants' needs, but also provides the occupants the knowledge of building performance. While involving building occupants in BPE has been proved beneficial and necessary, the discussion on the level and approach of occupant involvement in BPE is rare in the existing BPE literature. There lacks a mechanism that can systematically embrace building occupants' perception and transform them into valid and measurable evaluation indicators.

This paper shed lights on student housing, one type of purpose-built buildings commonly found in campuses around the world. Comparing with other building types, the development purpose and design features of student housing are consistent as they typically are not linked with the private property market. The design and management of residential housing/buildings, offices, and even elderly housing, are to a certain extent driven by the preferences of the local occupants, while for student housing, occupants' preferences are relatively consistent across the world. This enables an advantage - for taking consistent samples of the housing for investigation, but also reflects a disadvantage as the occupants' perception can be easily ignored in the development and management processes. Therefore, a credible building performance evaluation framework (BPEF) that incorporates occupants' perception of building performances is needed for both building designers and facilities managers.

In the Netherlands, the development of student housing has been expanded significantly due to the increasing student enrolment in recent years. Meanwhile, the demand for upgrading the current student housing has been initiated by students and supported by relevant Dutch government policies. Based on a student housing in the Netherlands, this study adopts a user-centric BPE approach to develop a BPEF based on qualitative data collected through focus group discussion with student residents and verify the BPEF using survey data. Both the qualitative and quantitative data reveal that student housing residents' perceived importance of building performance attributes reflects their personal preferences on those attributes. It implies that the performance evaluation framework should be tailor-made to strengthen the human-building relationship and to collect valid data to reflect the dynamics of the relationship. The structure of this paper is outlined as follows: section 2 provides a review on building performance evaluation studies and applications of the AHP method in building performance evaluation; section 3 explains the methodology of this study; section 4 presents the findings of a focus group discussion and the results of an AHP survey; section 5 concludes the study.

2. Literature Review

2.1. An overview of building performance evaluation

The perception of building performance has evolved in the past two decades. People's understanding of building performance has been changing: with the initial focus on buildings' physical life shifted to the increasing emphasis on their service life, especially under circumstances of decision-making for maintenance. Essentially, buildings' service life reveals their capacities in fulfilling the users' needs and their financial value in the market. A valid evaluation of a building's performance facilitates the building operators to make effective decisions for the building's long-term management and helps the investors to accurately estimate the value of the building. In recent years, the BPF approach has been influenced and developed to be in line with some social concepts, such as sustainability, well-being, resilience, circularity, etc. The social development trends behind these concepts have driven human perception changes on building performance. Furthermore, the research paradigm of building performance analysis/evaluation have also shifted from purely concerning technical performance attributes to increasingly integrating "user needs" into the evaluation framework, from focusing on a building's static condition to embracing the life cycle information for a more synthetic analysis [1].

Even though the adoption of the BPE approach is to develop a list of essential performance attributes of a building and collect empirical data to measure the selected attributes, the same set of attributes cannot be generally used to form a standardised evaluation framework. In other words, there is no generally accepted framework to evaluate building performance. As building performance evaluation emphasizes developing tailor-made framework for performance evaluation, the performance attributes used for different types of buildings vary. The performance attributes were developed based on both overall building performance or specific building functional performance, such as energy performance, indoor environmental quality performance, and safety performance.

The selection of performance attributes is influenced by: 1) building use type, 2) building stakeholders involved, 3) local climate condition, 4) local building regulations, and 5) other contextual factors [2]. Researchers' persistency in studying and developing scientific building performance evaluation frameworks on one hand contributes to the knowledge body of building performance analysis/evaluation, while on the other hand implies the evolution of human-built-environment relationships. In the past decade, building performance evaluation has been investigated and a research paradigm has been formed, which consists of the identification, selection and verification of the performance attributes based on specific buildings, development and utilization of proper tools for measuring the performance attributes, and the integration of both qualitative and quantitative data for performance measurement, etc.

2.2. Student housing performance evaluation

In the literature of student housing, studies on building performance evaluation is scant. Student housing is a type of building that falls between residential building and commercial building (e.g. hotel, hostel, service apartment) in terms of scope of facilities and occupants' right of possession. Students are allowed to live in the student housing for a certain period of time, which can be as short as a few weeks or as long as a few years. It is a short-term lease subject to certain restrictions or rules set by the respective management association. The standardised design, facilities provision and delivery models are similar worldwide and people would regard them to be soundly accepted. In other words, the homogeneity would have undermined the research significance of student housing performance evaluation. Thus, it worth further investigate the student housing performance and its evaluation approach based on different countries and cultural background.

Student housing is an important component in campus development and nowadays has proved to be a driving element for attracting international students, the amount of which is influential to university ranking. Furthermore, the interaction among youngsters could be a major transmission channel for the spread of COVID-19 virus as confirmed COVID-19 cases have been found in student dorms [3]. As such, the building performance of student housing should be examined and any potential measures for preventing the spread of the COVID-19 virus should be investigated.

Hassanain [4], using a post-occupancy evaluation approach to study the overall performance of student housing facilities, divided the overall performance into two categories: technical performance requirements and functional performance requirements. The former category includes thermal comfort, acoustical comfort, visual comfort, indoor air quality, and fire safety. The latter category contains interior and exterior finish systems, room layout, and furniture quality, support services, efficiency of circulation and proximity to other facilities on campus [4-5]. Amole [6] investigated student housing from a psychology perspective with satisfaction survey. A satisfaction model was developed to test the relationships between objective variables, subjective variables, demographic characteristics of the students and students' residential satisfaction. Residential satisfaction was measured by four questions, asking the student residents to indicate their subjective feelings towards the student housing. Objective variables are measured by physical attributes, such as the morphological configuration of the hall, number of persons in the bedroom, presence or absence of reading room, common room, kitchenette and a balcony (terrace at the back of the bedroom). Subjective variables are measured by attributes about comfort, including bedroom furnishing, number of persons in the bedroom/on the floor, privacy in bedroom, the sanitary facilities, number of persons using the sanitary facilities, the kitchenette in general, design of the hall, number of persons in the hall, location of the hall.

Lai [7] was the first to use the gap theory to investigate student residents' perception gap towards building performance attributes. Supported by a focus group meeting with student residents and a site visit, he identified six performance attributes for overall building performance, namely visual aspect (e.g. windows, electric lights), thermal aspect (e.g. air-conditioners), aural aspect (e.g. acoustic barriers to road, traffic noise, anti-vibration device for air-conditioners), fire aspect (e.g. means of firefighting access, automatic sprinklers), hygiene aspect (e.g. flush water cisterns, water closets) and communication (e.g. network cables, personal computers). The attributes were integrated and an AHP method-based questionnaire was used for measuring student residents' perceived importance levels of these attributes. Furthermore, student residents were asked to indicate their expectation level and satisfaction level of the six performance attributes, and a gap analysis was conducted on the findings. Applying this same approach, viz. gap theory based post-occupancy evaluation (GTbPOE), Hou et al. [8] conducted a comparative case study on two dormitories, which confirmed the validity of the GTbPOE method in building performance evaluation.

2.3. AHP in building performance evaluation

2.3.1. AHP application in evaluating building performance
Developed by Saaty [9], the AHP method has been frequently used to derive the relative importance for multi-criteria decision-making problems [2]. It helps to transform a decision-making problem into a hierarchy composed by a set of critical criteria and enables decision-makers to indicate their perception based on the pre-designed systematic hierarchical framework in a logical manner. In the past decade, AHP has gained popularity among construction management, sustainable building rating, and post-occupancy management research [8,10-13].

2.3.2. AHP application in student housing evaluation
The AHP method has been proved to be effective in understanding building residents' perceived importance of certain building performance attributes and they can reflect the residents' preferences on the building's facilities [8,14]. It was proved to be a useful evaluation tool that can facilitate facilities manager to understand the "other side of the story" aside from making judgement on the performance attributes based on their professional knowledge.

3. Research Methodology
This study was divided into three parts: i) development of the student housing performance attribute hierarchy, ii) focus group discussion for refining the hierarchy, and iii) AHP survey to verify the validity of the hierarchy. A student housing from a Dutch university was sampled to conduct data collection. The focus group participants were randomly approached within this student housing and the AHP survey was also conducted within this student housing. The data was collected through online platform. The online questionnaire was distributed in two stages: in the first stage, the student housing association was involved and it assisted to send an email to all the student residents which includes the web-link of the online questionnaire; as the response rate was not satisfactory, in the second stage, a project assistant (student helper) was recruited to deliver paper-based questionnaire door by door to collect student residents' response. The student residents were allowed to fill in the paper-based questionnaire or scan the QR code to access the online questionnaire. The data collection process is still at an on-going basis. An ethical approval was obtained to support the data collection.

4. Findings and Discussion

4.1. Refining the hierarchy based on focus group discussion results
Seven student residents - five females and two males - were invited to participate in the focus group discussion. Two students have previous experience of living in another student housing before moving into the sampled student housing. Their periods of stay in the sampled student housing ranged from 9.5 months to 1.5 year. The focus group discussion invitation emails were sent to potential participants to invite them to take part in the study. The purpose and background of this study were explained in the email and at the beginning of the focus group discussion by the project investigator. Students were required to reply the invitation emails to indicate their consent of participation.

The focus group discussion was held online in a virtual meeting room. The focus group discussion was divided into three stages. First, the focus group participants were asked to have a discussion based on an open-end question: what aspects of student housing do you concern the most? Second, the initial version of the student housing performance attribute hierarchy (figure 1) was shown through the share-screen function and the definitions of all the performance attributes included in figure 1 were provided. The participants were requested to review the definitions of the building performance attributes and indicate their perceived importance level of each performance attribute. Third, they were asked to propose new performance attributes, remove any of the existing ones, or propose an alternative hierarchy structure based on their experience of living in the student housing.

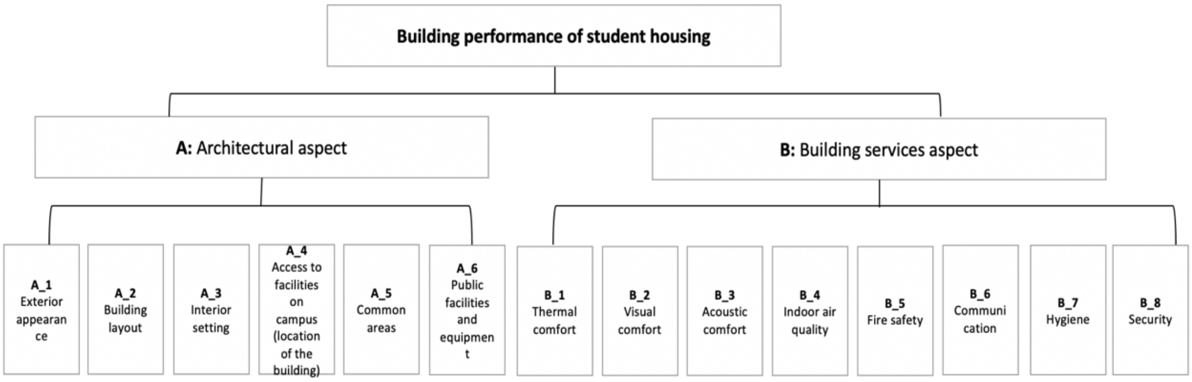

Figure 1. Student housing performance attribute hierarchy (initial version)

Notes were taken during the focus group discussion. The contents of the focus group discussion were categorised based on: 1) whether to include the performance attributes in the framework, 2) discussion intensity, and 3) perceived importance of specific performance attributes. Table 1 shows the descriptive summary of the focus group discussion results based on the three categories.

Under "architectural aspect", "access to facilities on campus", "common areas" and "public facilities and equipment" were suggested to be removed from the third hierarchy. The focus group participants' perceived importance of these three performance attributes could not reach agreement. Even though the three attributes were regarded as important by two students, their discourses were more about the liveability level of the student housing instead of the functionality and operability of the building. Considering the discussion intensity among the participants and that the remaining five participants suggested excluding these three performance attributes, they were removed from the hierarchy.

Under "building services aspect", "communication" was suggested to be excluded from the hierarchy. Furthermore, the participants suggested that "health" is an important aspect that can reflect the building performance, and it should be included in the hierarchy. During their elaboration on "health", they related to examples that also reflect "indoor air quality". Also, the discussion of "hygiene" was twofold: the hygienic issues of a building reflect both the "cleaning service quality" as well as "health level" of the building. "Fire safety" and "security" were also discussed in an interweaving manner. Thus, the focus group discussion facilitator proposed to re-group the seven performance attributes in addition to removing "communication", under three categories: "comfort", "hygiene and health" and "safety and security". The three categories were integrated into "building services aspect" and the seven performance attributes form an additional level of the hierarchy – refer to figure 2.

Table 1. Descriptive summary of the focus group discussion results

	Whether to be included in the framework	*Perceived importance in general*	*Discussion intensity*
A: Architectural aspect (technical design)			
1. Exterior appearance	Y	•••	***
2. Building layout	Y	•••	***
3. Interior setting	Y	•••	***
4. Access to facilities on campus	N	#	**
5. Common areas	N	#	*
6. Public facilities and equipment	N	#	*
B: Building services aspect (functional design)			
1. Thermal comfort	Y	•••	**
2. Visual comfort	Y	•••	***
3. Acoustic comfort	Y	•••	***
4. Indoor air quality	Y	•••	*
5. Fire safety	Y	•••	***
6. Communication	N	•	*blank*
7. Hygiene	Y	••	**
8. Security	Y	••	*

Perceived importance in general: ••• important; •• neutral; • not important at all; # disagreement on the importance of a certain aspect
Whether to be included in the framework: Y-yes; N-no;
Discussion intensity: *** more than five participants used more than 15 minutes to a certain aspect; ** more than four participants used 10-15 minutes to a certain aspect; * more than two participants used 5-10 minutes to a certain aspect; "*blank"* no specific discussion was conducted on this aspect.

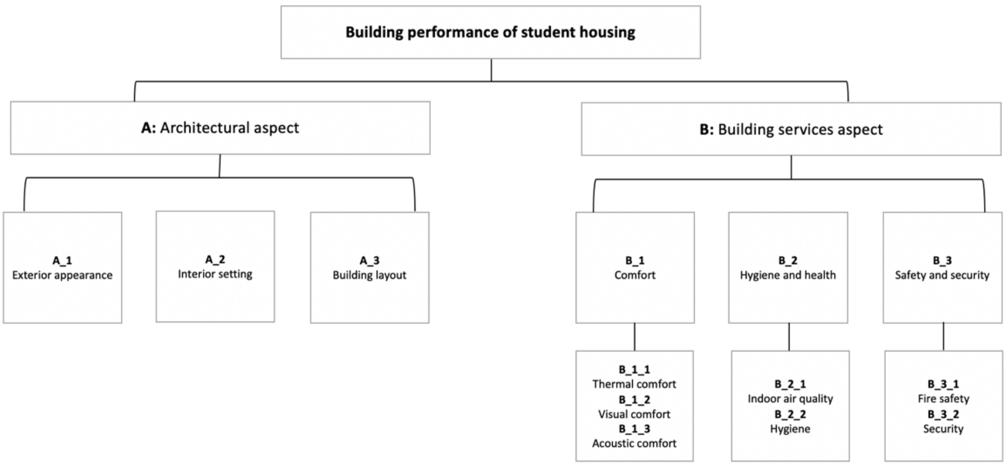

Figure 2. Student housing performance attribute hierarchy (final version)

The contents of the focus group discussion included both objective and subjective comments. The participants were encouraged to integrate their own living experience in the building to comment on the proposed framework for calibration. The framework development shall integrate professional building knowledge and consider building residents' preferences of the facilities. Literature review and focus group discussion were organised to support the development of the framework. The findings of the focus group discussion reflect that building residents are able to articulate their opinions on the building performance and provide constructive comments on the framework development.

4.2. The building performance evaluation survey

63 residents from the selected student housing participated in the survey; 65.1% were male and 34.9% were female; 31.75% were undergraduate students and the rest (68.25%) were postgraduate students; local and non-local students accounted for around 50% respectively. Among the survey participants, 63.49% of the student residents lived in studio, which is the major room type in the selected student housing – refer to table 2.

Table 2. Profile of the student residents

Gender	Male	41 (65.1%)
	Female	22 (34.9%)
Education level	Undergraduate	20 (31.75%)
	Post-graduate	43 (68.25%)
Local or non-local students	Local	31 (49.2%)
	Non-local	32 (50.79%)
Typical days per week staying in the student accommodation	0 day	2 (3.17%)
	1 day	1 (1.59%)
	2 days	5 (7.94%)
	3 days	4 (6.35%)
	4 days	3 (4.76%)
	5 days	7 (11.11%)
	6 days	13 (20.63%)
	7 days	30 (47.61%)
% of time staying in the student accommodation on an average day (e.g. 8 hours / 24 hours per day = 33%)	0% - 10%	3 (4.76%)
	20% - 49%	8 (12.70%)
	50% - 69%	28 (44.44%)
	70% - 100%	23 (36.51%)
	N/A	1 (1.59%)

4.2.1. Student residents perceived importance of building performance attributes

The relative importance rating given by the interviewees on the provided building performance attributes were processed by the AHP method. Of all the 63 survey samples, 53 passed the consistency check (CR ≤ 0.1), which accounts for 84% of the total number of survey participants – refer to table 3.

Table 3. Classifications of the samples

	Overall
Total sample	63
Usable sample (CR ≤ 0.1)	53
Non-usable sample (CR > 0.1)	10
% Usable sample	84

In this part of the survey, the residents were asked to indicate their perceived importance of building performance attributes through a series of pair-wise comparisons at each level of the hierarchy. For each pair of comparisons, they were required to indicate their perceived importance based on a nine-point rating scale: from 1 (equally important) to 9 (most important, no compromise acceptable). For example, if the architectural aspect is absolutely more important than the building services aspect and is rated at 9, then the building services aspect must be absolutely less important than the architectural aspect and is valued at 1/9. The perceived importance level can be reflected through the weightings of the performance attributes. Based on the 53 responses which passed the consistency test, the AHP weightings of the performance attributes were calculated, based on which the rankings of the attributes were also determined (Table 4).

Table 4. AHP weightings and ranking of the student housing performance attributes

Hierarchy level	Code	Performance attributes	Weighting (%)	Ranking
Level 1	A	Architectural aspect	36.67%	2
	B	Building services aspect	63.33%	1
Level 2	A_1	Exterior appearance	18.70%	3
	A_2	Interior setting	38.52%	2
	A_3	Building layout	42.97%	1
	B_1	Comfort	26.85%	3
	B_2	Hygiene and health	35.39%	2
	B_3	Safety and security	37.75%	1
Level 3	B_1_1	Thermal comfort	39.80%	1
	B_1_2	Visual comfort	22.54%	3
	B_1_3	Acoustic comfort	37.52%	2
	B_2_1	Indoor air quality	54%	1
	B_2_2	Hygiene	46%	2
	B_3_1	Fire safety	57%	1
	B_3_2	Security	43%	2

At level 1, the student residents considered "building services aspect" (B) as significantly more important than "architectural aspect" (A). B was regarded twice more important than A (63.33% vs. 36.67%). At level 2, under A, the student residents ranked "building layout" (A_3) to be the most important performance attribute (weighting: 42.97%), followed by "interior setting" (A_2) (weighting: 38.52%), and "exterior appearance" (A_1) (weighting: 18.70%). Under B, the student residents ranked "safety and security" (B_3) slightly higher than "hygiene and health" (B_2), with only 2.36% difference away from each other. "Comfort" (B_1) was ranked the lowest among the three performance attributes, but still obtained 26.85% weightings. B_2 and B_3 received relatively even weightings, which means that student residents, on an average basis, regarded them equally important. At level 3, under "comfort" (B_1), student residents ranked "thermal comfort" (B_1_1) the highest (weighting: 39.80%), followed by "acoustic comfort" (B_1_3) (weighting: 37.52%) and "visual comfort" (weighting: 22.54%). Under "hygiene and health" (B_2), "indoor air quality" (B_2_1) was ranked 8% higher than "hygiene" (B_2_2). Under "safety and security" (B_3), "fire safety" (B_3_1) was ranked 14% higher than "security" (B_3_2).

According to the results, "building services aspect" was regarded significantly more important than "architectural aspect". This reflects that building residents concern building functional elements more than building design elements. Even though living experience was emphasised by the residents, the results of the survey showed that student residents ranked “hygiene and health” and “safety and security” more important than “comfort”, and the previous two performance attributes received similar level of perceived importance.

4.2.2. Comparison of perceived importance of building performance attributes

Table 5. AHP weightings and ranking between male and female student residents

Hierarchy level	*Code*	*Performance attributes*	*Male*		*Female*	
			Weighting	*Ranking*	*Weighting*	*Ranking*
Level 1	A	Architectural aspect	33%	2	44.26%	2
	B	Building services aspect	67%	1	56.81%	1
Level 2	A_1	Exterior appearance	15.07%	3	25.17%	3
	A_2	Interior setting	38.57%	2	38.43%	1
	A_3	Building layout	46.58%	1	36.36%	2
	B_1	Comfort	29.07%	3	22.78%	3
	B_2	Hygiene and health	38.34%	1	29.98%	2
	B_3	Safety and security	33%	2	47.23%	1
Level 3	B_1_1	Thermal comfort	40.59%	1	39%	1
	B_1_2	Visual comfort	24.48%	3	21.47%	3
	B_1_3	Acoustic comfort	34.97%	2	38.88%	2
	B_2_1	Indoor air quality	55.90%	1	50%	1
	B_2_2	Hygiene	44.10%	2	50%	1
	B_3_1	Fire safety	55%	1	58%	1
	B_3_2	Security	45%	2	42%	2

Table 6. AHP weightings and ranking between undergraduate and postgraduate student residents

Hierarchy level	*Code*	*Performance attributes*	*Undergraduate*		*Postgraduate*	
			Weighting	*Ranking*	*Weighting*	*Ranking*
Level 1	A	Architectural aspect	36.36%	2	36.84%	2
	B	Building services aspect	63.64%	1	63.16%	1
Level 2	A_1	Exterior appearance	25.42%	3	14.93%	3
	A_2	Interior setting	31.42%	2	42.39%	2
	A_3	Building layout	43.14%	1	42.88%	1
	B_1	Comfort	36.41%	1	25.48%	3
	B_2	Hygiene and health	28.98%	3	34.41%	2
	B_3	Safety and security	34.57%	2	40.11%	1
Level 3	B_1_1	Thermal comfort	40.59%	1	41.5%	1
	B_1_2	Visual comfort	24.48%	3	19.32%	3
	B_1_3	Acoustic comfort	34.97%	2	39.09%	2
	B_2_1	Indoor air quality	58%	1	52%	1
	B_2_2	Hygiene	42%	2	47%	2
	B_3_1	Fire safety	57%	1	57%	1
	B_3_2	Security	43%	2	43%	2

Both female and male student residents regard “building services aspect” (B) as more important than “architectural aspect” (A). The weightings and ranking of the performance attributes at the third level between female and male residents are almost identical (except for the ranking of “indoor air quality” and “hygiene”). The comparison of the perceived importance values obtained from the AHP survey among resident groups can further understand the specific preference of certain groups of residents. The inter-group and intra-group comparisons of the perceived importance value of the performance attributes help to reveal detailed information of the building, which used to be “hidden”. The results of the comparison have revealed a lot of information which cannot be detected through technical measurement or satisfaction survey. For example, female resident students emphasized more on “exterior appearance” (A_1) and less on “building layout” (A_3), when compared with male student residents. Female residents placed significant importance on “safety and security” (B_3), whose weighting was twice more than “comfort” (B_1) and 1.5 times more than “hygiene and health” (B_2). While male residents focused on “hygiene and health” (B_2), their weightings on the three performance attributes were relatively even. For the comparison of the perceived importance level of the building performance attributes between undergraduate and postgraduate students, the weighting and ranking show a high level of homogeneity between these two groups of student residents, except for attributes B_1, B_2 and B_3. The result shows that postgraduate student residents especially cared about safety and security.

5. Conclusions

This study adopted a user-centric approach to develop a BPEF and conducted an AHP-based questionnaire survey to solicit student residents’ perceived importance of the performance attributes of a student housing. The findings of the survey revealed student residents’ preferences on building performance and proved that the AHP method, as a tool, enables a user-centric building performance evaluation in the context of student housing. Student residents’ preference on the building performance attributes was captured by a three-level performance attribute hierarchy; the comparisons of the perceived importance of the building attributes between different groups of student residents further demonstrated that the user-centric approach can help facilities managers differentiate the importance levels of the building performance attributes.

The novelty of this study lies in that the user-centric approach takes account of the preferences and needs of various student residents; through conducting the focus group discussion, residents’ preferences were solicited and the AHP-based survey was designed considering students’ concerns over the building performance aspects. The AHP method scientifically synthesised various students’ preferences and generated cohesive values that indicate the overall ranking of the building performance aspects. This approach, centred on building user perceptions, provides practical implications: enabling facilities managers of student housing to integrate student residents’ sharing into a systematic method that supports building performance evaluation.

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