

Article

Improving Residential Satisfaction of University Dormitories through Post-Occupancy Evaluation in China: A Socio-Technical System Approach

Yan Ning * and Jiaojiao Chen

Department of Construction and Real Estate, Southeast University, Nanjing 210096, China; chen260347@163.com

* Correspondence: ningyan@seu.edu.cn; Tel.: +86-25-8379-5807

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Abstract: Residential satisfaction of university dormitories serves as one of the significant aspects in the framework of sustainability in higher education. This study aims to develop a framework for post-occupancy evaluation (POE) of university dormitories in China grounded on the socio-technical systems approach and to identify factors contributing to students' residential satisfaction. Two focus groups were carried out to build the socio-technical framework. A case study was undertaken to evaluate the post-occupancy status of university dormitories, and structured-questionnaire was used to collect the data. The results show that university dormitories are equipped with quality physical facilities. However, they failed to provide satisfied services and supporting infrastructure. This indicates that “hardware” could generally meet students' requirements, while the “software” is still less competent. It is also found that the socio-technical systems approach has the feature of being embedded into the social, regulatory and geographic contexts. In order to enhance post-occupancy satisfaction, occupants' participation would be helpful. This study contributes to the body of knowledge by presenting a socio-technical framework of POE and its embeddedness feature. Implications for research and practices are also provided.

Keywords: socio-technical systems; post-occupancy evaluation (POE); social embeddedness; university dormitories; China

1. Introduction

It is increasingly recognized that achieving sustainability in higher education should be placed as a prioritized agenda globally [1–4]. Sustainability in higher education covers education, research, operations and community outreach activities [2]. Sammalisto et al. developed a model of sustainability competence development and investigated how it would be institutionalized in a Swedish university [1]. Wals investigated the learning and institutionalization processes of sustainability in higher education in the context of the UN's Decade of Education for Sustainable Development (UN DESD) [2].

These global initiatives also inspired China's sustainability development in higher education [3–5]. Yuan and Zuo's study of a Chinese university found that university students are aware of sustainability issues and place great importance to the social aspect of the sustainability [4]. Zou et al. carried out a comparative case study between Indiana University in US and Tsinghua University in China and found that the former emphasizes the environmental, economic, and social aspects of university sustainability equally, while the latter focuses more on the environmental aspect [5]. A local standard titled Evaluation Standard for Green Campus (ESGC) (CSUS/GBC 04-2013) as a voluntary scheme was launched in 2013. This standard comprises seven sections: plan and sustainable site, energy conservation, water saving, material saving, indoor environmental quality, operation

management and promotion. The purpose of ESGC is to guide the achievement of harmonization between campus and the natural environment. Green campus is featured by resource reduction (i.e., energy saving, water conservation, material saving and land saving), environmental protection and pollutant minimization. It aims to provide a healthy, user-friendly, effective teaching and living environment. This standard provides an effective guideline for achieving green campuses in China.

One of the significant aspects in sustainability of higher education is the residential satisfaction of university dormitories. Along with the national strategy of accelerating urbanization in China, universities expanded their enrollment significantly. The number of higher education institution reached 2845 in 2015, as compared to 1041 in 1999 [6]. The total number of undergraduate and post-graduate students arrived at 35 million in 2015 and annual graduates stabilized at eight million per year. The expansion of student enrollment brought about a considerable increase of new university campuses where students' dormitory buildings are essential.

While the ESGC it raises various standards about the institution building and other supporting facilities, like canteen, office building and library, there are no specific requirements about achieving high quality dormitory operation. In addition, insufficient attention was paid to the dormitory operation compared to the plan, design and construction stages. The operation management focuses on the policies and regulations for daily operation events, but falls short of addressing the sustainability issues from the occupant perspective.

Assessing building performance from the occupant perspective is pervasive in green building development [7–9]. Post-occupancy evaluation (POE), for example, involves a systematic evaluation of occupants' opinions about actual building performance [7]. Besides the technical aspects, POE studies increasingly emphasized social aspects, such as occupants' behavior and experiences [10]. Embracing occupants' behavior and experiences in POE would help to capture building operation deficiencies [10–12]. However, despite the increasing emphases on social aspects, the systems approach is seldom made explicit in the sustainable dormitory development.

This study considers POE as complex socio-technical systems. The socio-technical system approach argues that the POE exercise should not take technical and social aspects alone [10,11], but should take their interaction and embeddedness feature into consideration. The embeddedness feature implies a dual effect between the POE and the social, geographical and regulatory context. One the one hand, POE is shaped by the context as the indicators of POE should reflect the contextual nature. On the other hand, the feedback collected from POE will further influence how the context would evolve.

This study aims to develop a POE tool for evaluating university dormitories grounded on the socio-technical systems approach; and identify factors contributing to students' residential satisfaction. The findings may help designers to better understand end-users' requirements, and provides university dormitory managers with valuable feedback on improving their services. This would further contribute to the sustainability development in higher education.

The paper is organized as follows. Section 2 presents the literature review of POE and the socio-technical systems theory. Section 3 reports on the focus group study with the aim to developing a socio-technical framework. The framework was validated through a case study through which factors contributing to university dormitory satisfaction were identified. Implications for research and practices are provided in the Conclusions Section.

2. Literature Review

2.1. Post-Occupancy Evaluation and Residential Satisfaction

POE is “an activity originating in an interest regarding the performance of a building once occupied” [13]. Tools employed in POE include monitoring of building performance (e.g., indoor environment quality and thermal performance) and surveys (e.g., observations, questionnaire-survey and interviews) [14]. The main purpose of these tools is to delineate the interrelation among the

building, operation system and its occupants [14]. Through providing feedbacks, POE can inform the decision-making and practice over the building life-cycle.

In the POE exercise, residential satisfaction is often considered as a criterion for assessing residential quality [15]. Satisfaction is derived from comparing occupants' actual and preferred situations [16]. When the real situation does not meet occupants' requirements, dissatisfaction will occur. Besides physical building performance, assessing occupants' satisfaction covers factors even beyond the building level (e.g., neighborhood facilities and maintenance services) [17,18]. Francescato, et al. [19] referred the housing systems as a composite of physical and social components. Thus, clarifying the scope of the housing system would be crucial to identifying factors contributing to occupants' satisfaction.

Frameworks used to examine residential satisfaction vary considerably, rendering a systematic comparison fairly difficult. For example, Vera-Toscano and Ateca-Amestoy [20] grouped it into individual, housing and neighborhood attributes. Hui and Zheng [21] used the framework of service and management quality. Jansen [16] built a framework of a combination of personal characteristics, dwelling aspects and mismatch variables. Ibem and Amole [22] suggested a four-dimensional framework: housing unit characteristics, neighborhood facilities and environment, management, and services. It is also possible to classify them into objective measures (e.g., dwelling unit features, support services, and public facilities), subjective measures (e.g., satisfaction with facilities) and household characteristics [23]. Carpenter et al. classified the components into physical system, environmental quality, functional system and behavior factors [24].

It is worth noting that the results of residential satisfaction might not be wholly applicable to university dormitories due to the disparities with respect to their attributes [25] and occupants' demographic background. Some factors of residential buildings do not exist in the university dormitory context, such as ownership and ways to purchase [26,27], distance to work, location of schools [28], building age and safety [29], satisfaction with community services [30] and neighbors [16,31]. In addition, difference also lies into the demographic background of the occupants [32], such as number of family members [16,23,33].

2.2. University Dormitories Evaluation from Occupant Perspective

Studies adopted different concepts to describe university dormitories, for instance, halls of residence [34], student accommodation [35], student dormitory [36], catered halls [37] and hostels [38,39]. Despite the conceptual variabilities, studies identified a low level of satisfaction in Nigeria [40], South Africa [41] and Saudi Arabia [42]. The factors contributing to dissatisfaction are shown in Table 1. This indicates that there exist great potentials to achieve sustainability in university dormitories.

Table 1. Studies on university dormitories.

References	Location	Design	Key Findings
Najib et al. (2011a) [18]	Malaysian	Survey	Students are satisfied with the provided housing facilities (e.g., leisure room, washroom, and study-bedroom), but dissatisfied with the pantry and support services.
Amole (2009b) [25]	Nigeria	Survey	Factors contributing to satisfaction consist of the social qualities (e.g., the social densities; the kitchenette, bathroom and storage facilities) and some demographic characteristics of the students. Hall configuration is a predictor of satisfaction.
Amole (2005) [34]	Nigeria	Survey	Living conditions are stressful and occupants use nine coping strategies. The major coping strategies used are studying away from the room and decorating personal space.
McGrath and Horton (2011) [35]	UK	Survey	The main concern of the residents is intrusive noise.
Kaya and Erkip (2001) [36]	Ankara	Case study	Students on the highest floor perceive their rooms as larger and feel less crowded than residents of the lowest floor.

Table 1. Cont.

References	Location	Design	Key Findings
Khozaei and Ayub (2010a) [38]	Malaysia	Case study	Satisfaction with fees, distance from university facilities, room safety, room size, hostel security, and hostel facilities determine students' satisfaction.
Amole (2007) [40]	Nigeria	Survey	Students' halls of residence are poor overall quality and key determinates are the socio-physical characteristics.
Hassanain (2007) [42]	Saudi Arabia	Survey	Students are satisfied with thermal comfort, acoustical comfort, visual comfort, indoor air quality and overall satisfaction.
Alborzfard and Berardi (2013) [43]	United States	Conceptual framework	Framework comprises water and energy consumption, indoor environmental quality, and occupant behaviors.
Adewunmi et al. (2011) [44]	Nigeria	Survey	Deficiency lies into the building maintenance.
Bashir, Sarki, and Samidi (2012) [45]	Malaysia	Survey	Services quality is manifested by reliability, responsiveness, assurance, empathy and tangibles
Amole (2011) [46]	Nigeria	Survey	Gender differences are found to be the most significant with respect to the use of domestic facilities, social densities and design issues.
Amole (2009a) [47]	Nigeria	Survey	Three levels of environment, namely, the bedroom, the floor, and the hall emerge from the analysis, and satisfaction is significantly different across these levels.
Bonde and Ramirez (2015) [48]	USA	Case study	The green rated buildings outperform the conventional buildings. This holds true for indoor comfort indicators such as indoor room air temperature and air quality, but falls short regarding lighting qualities.
Foubert et al. (1998) [49]	United States	Survey	Physical facility quality is the most important. Other factors, such as positive roommate relationships, strong floor communities and quiet study environments, are desirable.
Oladiran (2013) [50]	Nigeria	Survey	Students are more satisfied with noiselessness, indoor temperature, natural lighting, ventilation and water supply than electrical fittings, space, cleanliness and comfort.
Najib et al. (2011b) [51]	Malaysian	Survey	Students are satisfied with the student housing facilities. Overall satisfaction is positively related to loyalty behaviors.
Vadodaria (2014) [52]	UK	Case study	Factors contributing to energy saving include high levels of insulation, thermal mass, ventilation heat recovery, decentralized electric heating, reliance on internal heat gains for space heating and proactive building management approach.

Components of the university dormitories examined in different studies vary considerably. Distinguished from residential buildings, the basic function of university dormitories is to provide a living place for students. They may contain multiple beds in one room [38]. Bedrooms are the core physical components. Following this, some studies only examined students' satisfaction with the bedroom [43]. Other studies expanded the scope, including pantry and leisure rooms [18]. Najib et al. [18] examined a musalla or prayer room for Muslims as compliance with regulations in Malaysia. Besides the physical components, Najib et al. [18,44] added that university dormitories should also encourage friendships and provide a study environment. Khozaei et al. [38] added soft factors such as management and fees.

However, prior studies failed to provide a cohesive framework for POE of university dormitories. A simple way is to measure occupants' satisfaction with the building components one by one. For example, Najib et al. [18,44] developed an index consisting of the satisfaction with study-bedroom, washroom, pantry, common and recreation room, and support services (e.g., vehicles parking lots). Other studies developed more abstract frameworks, depending on specific criteria adopted. Amole [43], for example, built a framework of objective (e.g., physical attributes), subjective variables and demographic characteristics. Najib et al. [18] summarized that studies often include physical aspects (e.g., facilities and extra services), social aspects (e.g., student relationships, financial support, crowding and privacy) and a combination of these. The level of environment was also considered as

a classification criterion. For instance, the framework developed by Amole [25] included three levels of environment, namely the bedroom, the floor, and the hall. Studies also adopted the framework of thermal, acoustical, visual comfort and indoor air quality [42].

Combing the studies on POE of residential and dormitory buildings, it is found that studies mainly focused on examining specific categories and components of the dormitory building performance. The knowledge gap of providing a consistent framework for examining residential satisfaction is still evident.

2.3. Socio-Technical Systems Approach

Socio-technical systems are referred to “a somewhat abstract, functional sense as the linkages between elements necessary to fulfill societal functions” [53]. Socio-technical systems consist of actors, institutions and technical systems [53,54].

One of the key features in the socio-technical systems approach is the interdependence between systems elements [53,55]. For instance, actors could maintain and change the technical systems; institutions would guide actors’ perceptions and activities [53]. Another feature is the open systems issue, indicating that the socio-technical systems have mutual interaction with the social, regulatory and geographic contexts [56–58].

Drawing up on the analytical framework of socio-technical systems [58], this study considers the POE of university dormitories as complex socio-technical systems. The socio and technical aspects of the systems have interdependent with each other. The POE systems are considered to be embedded into the regulatory, social and geographic contexts.

3. Developing Indicators for Post-Occupancy Evaluation

This study adopted focus groups to derive indicators for the POE. Focus groups were useful for assessing complex concepts of socio-technical frameworks [59]. This method was also employed by prior studies [60]. In order to develop indicators for the POE of university dormitories, two types of unit of analysis (i.e., individual and interaction) were adopted [59]. The individual unit of analysis was used to triangulate the specific indicators, whereas the interactive unit of analysis was appropriate for exploring the possible indicators [59].

At the start of each focus group, participants were informed that the purpose of the discussion was to develop indicators for POE of university dormitories [59]. The participants were thereafter required to: (1) suggest the technical and social aspects; (2) list specific indicators under each category; and (3) discuss why the categories and associated indicators are essential for the POE of university dormitories. Purposive sample strategy was adopted to select participants. The main selection criterion is whether the participants have the experience of living in the university dormitories or not. In the end, two sets of focus groups discussion were held (see Table 2). Participants of the first focus group were excluded in the second.

Table 2. Description of focus group characteristics.

Groups	Purpose	No. of Participants	Profile of Participants	No. of Hours
Focus group one	Explore the socio-technical aspects	Six participants; one moderator	Four of the six postgraduate students have not lived in in the new university dormitory; three female and three male; moderator is the author	1.5
Focus group two	Pre-test the questionnaire	Five participants; one moderator	All are undergraduate students currently living in the university dormitories, three female and two male; moderator is the author	2

After the first focus group, a preliminary questionnaire was obtained, which were then sent to the second focus group participants before the group interview. The second focus group aimed to pre-test the questionnaire. In the end, consensus was reached on a set of criteria for the POE of

university dormitories (see Figure 1, details shown in Table 3). Participants' comments combined with the face-to-face interview results are presented in Section 6.

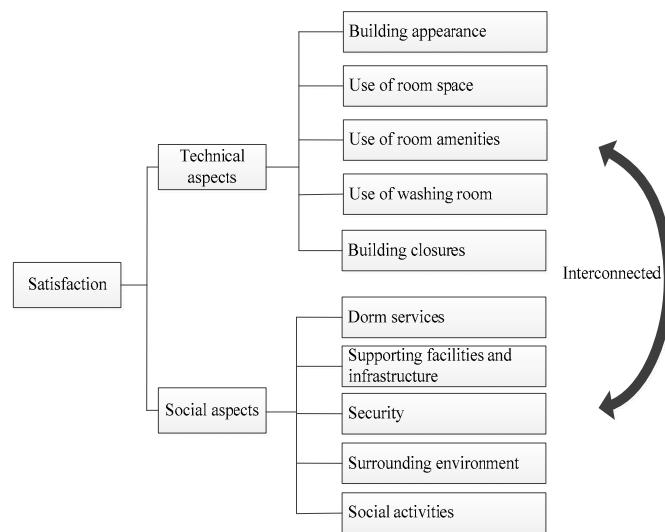


Figure 1. Socio-technical systems framework for post-occupancy evaluation (POE) of university dormitories.

Table 3. Descriptive analysis of the results.

	Frequency	Percentage
Number of floors		
1st	52	15.6
Middle floors	222	66.7
Top floor	59	17.7
Total	333	100.0
Years of residence		
1 year	183	55.0
2 years	86	25.8
3 years	64	20.2
Total	333	100.0
Daily hours of staying in the dormitories		
Below 1	2	0.6
1–3	64	19.5
3–5	144	43.9
5–7	76	23.2
Above 7	42	12.8
Total	328	100.0
Bills for water and energy usage		
Below 20	19	6.0
20–40	133	42.0
40–60	111	35.0
Above 60	54	17.0
Total	317	100.0
Gender		
Female	122	37.2
Male	206	62.8
Total	328	100.0
Age		
Mean	19.87	-
Std deviation	1.161	-
Min and Max	17, 23	-
Total	318	-
Preference of indoor and outdoor activities		
More indoor activities	33	10.1
More outdoor activities	141	43.0
Equal	154	47.0
Total	328	100.0

4. Research Methods

4.1. Research Design

A university located in the east China was selected based on its typical characteristics [61]. Case study design was also adopted in green universities research before [1,4,62]. This university was chosen for two reasons: it has a fairly good ranking in China, indicating that it is a satisfactory representative of the university sample; and it shares similarities to other universities in terms of university size, areas and number of students.

The new campus was completed in August 2005, coming into partial operation in September 2006. There are three dormitory districts located in three corners of the new campus, all except for the northwest direction. The library and lecture buildings sit in the middle of the campus. Each dormitory district is connected with four or eight buildings, constituting as a closed district. All buildings face north or south.

Each dormitory district has a laundry room and bicycle park. Student card could be used to pay the wash services and the entrance control system. Each dormitory building has six floors, ten rooms on each floor. Each room is 3 m in height, 18–20 m² in area, and designed for four persons. The washing room is about 3 m². Typical layout of dormitory room is shown in Figure 2. Each room is equipped with ceiling fan, air condition and water heater. Annual (two semesters) residence fee is 1200 RMB for each student.

Unlike the university dormitories of foreign countries [18], there are no kitchen, study room, pantry, common room and television room available in this campus. This further confirms the importance of developing POE indicators for university dormitories in China as indicators developed elsewhere are not applicable to the China context.

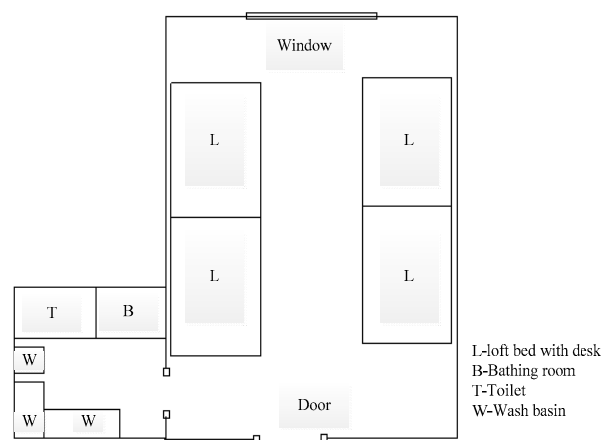


Figure 2. Typical layout of four-person-suite.

4.2. Data Collection Instruments

The questionnaire comprises three sections. The first section asks about the general information of the dormitory. The second section covers the satisfaction measurements and ten POE components. The indicators were assessed on a five-point scale (1 for very dissatisfied to 5 for very satisfied). The third section is about the respondents' profiles. One open question was added in the end.

After the questionnaire was initially completed, it was sent to four students who are currently living in the university dormitories to pretest the usability of the questionnaire. Feedbacks were elicited to clarify the measurement instruments and appropriateness of the terminologies. One comment provided by the four students is that the length of the questionnaire is a bit long. Therefore, to make up this disadvantage, face-to-face interviews were adopted to collect the questionnaire, although it was time-consuming. The fieldwork was carried out in September 2015. In total, 341 questionnaires were

received. Since face-to-face interview was employed in the fieldwork, the same number of interviews was also conducted.

The statistical analysis covers three stages. First, *t*-test of the satisfaction level was undertaken to gauge students' residential satisfaction. Second, linear regression was used to link the specific satisfaction factors to the overall satisfaction. Thus, factors contributing to the overall satisfaction were identified. Last, *t*-test of the POE indicators was carried out to identify the areas with which students are dissatisfied.

5. Results

5.1. Descriptive Analysis

The results show that respondents have a nearly equal distribution across different floors (see Table 3), indicating that results will not be biased towards a specific floor. Over one-year residence for all respondents suggests that they are fully qualified to fill the questionnaire. There are no respondents living less than one-year period because, at the time of the survey, all year-one students just started their first semester. Thus, they were excluded from completing the questionnaire.

The results show that the majority choose to stay in dormitories over three hours in addition to the night sleeping time. Respondents are also inclined to have more outdoor activities. This indicates that the satisfaction with the dormitory will be very important for them as the increase of satisfaction will potentially benefit their university life quality.

5.2. Level of Dormitory Satisfaction

The results show that the levels of satisfaction are significantly greater than the mean value of three except for study efficiency (see Table 4). This study confirms that due to a significant improvement of the general conditions and function, the university dormitories could meet students' overall requirements. However, respondents' dissatisfaction with the study efficiency indicates a great potential for further improvement. It is recognized that dormitories are not the ideal setting for study compared to facilities such as library, and study room. However, the results show that students generally spend more than three hours in rooms (see Table 3), indicating that if study efficiency in dormitories could be enhanced, students' productivity would be further enhanced.

Table 4. Level of satisfaction.

Satisfaction	N	Mean	Standard Deviation	t-Value	Significance	Rank
Overall satisfaction	340	3.76	0.742	18.779	0.000	1
Satisfaction with dormitory district	340	3.61	0.747	15.036	0.000	2
Satisfaction with residence	337	3.60	0.818	13.522	0.000	3
Privacy satisfaction	339	3.57	0.862	12.161	0.000	4
Sense of belonging	332	3.53	0.809	11.869	0.000	5
Acoustics performance	339	3.41	0.910	8.352	0.000	6
Thermal comfort	339	3.37	0.906	7.557	0.000	7
Visual comfort	340	3.31	0.935	6.088	0.000	8
Air quality	340	3.23	0.912	4.637	0.000	9
Study efficiency	340	2.81	1.029	−3.477	0.001	10

Note: *t*-values for a two-tailed test are 1.65 (significance level = 10%), 1.96 (significance level = 5%) and 2.58 (significance level = 1%).

The results show that factors contributing to overall satisfaction consist of satisfaction with the dormitory district, air quality, satisfaction with the staying and sense of belonging (see Table 5). This further confirms that the level of satisfaction is determined by a set of socio-technical factors rather than one aspect alone. It seems reasonable that other factors such as lighting and thermal comfort were excluded because these factors are the basic factors. If these basic factors are not fully met in the dormitory, students will show strong dissatisfaction.

It is interesting to note that sense of belonging is important to overall satisfaction. This might be because the students in Eastern culture have a strong sense of collective belonging. Another finding is that in order to increase the satisfaction, attention should also be paid to the dormitory district level (such as the bicycle parking, the grass terrace) rather than limiting to the building level.

Table 5. Determinants of overall satisfaction.

Variables	B	Std. Error	Standardized Beta	t-Value	Significance
Constant	0.554	0.147		3.759	0.000
Satisfaction with dormitory district	0.356	0.046	0.356	7.819	0.000
Air quality	0.265	0.034	0.324	7.874	0.000
Satisfaction with the residence	0.182	0.041	0.198	4.406	0.000
Sense of belonging	0.116	0.036	0.126	3.238	0.001

Note: Dependent variable: overall satisfaction; Adjust $r^2 = 0.625$. t -values for a two-tailed test are 1.65 (significance level = 10%), 1.96 (significance level = 5%) and 2.58 (significance level = 1%).

5.3. POE Results

The POE results show that the majority of the indicators are rated as significantly satisfied. This suggests that quality building performance has been achieved thus far. Indicators that have high level of dissatisfaction deserve more attention (see Table 6). These factors are thus discussed below.

Table 6. Post-occupancy evaluation (POE) results.

	Mean	Standard Deviation	t-Value	Significance
1 Building Appearance				
Overall configuration of the dormitory district	3.19	0.813	4.412	0.000
Shape of the dormitory building	3.04	0.830	0.983	0.326
Height of the dormitory building	3.29	0.810	6.632	0.000
Color of building appearance	2.92	0.882	−1.598	0.111
Aesthetics of building appearance	2.90	0.868	−2.196	0.029
Aesthetics of the entrance and lobby	3.02	0.844	0.450	0.653
2 Use of Room Space				
Adequacy of living space	3.21	0.921	4.246	0.000
Adequacy of storage space	2.94	0.921	−1.179	0.239
Room layout	3.26	0.799	6.112	0.000
Amount of wash room space	3.43	0.872	9.032	0.000
Room space utilization	3.32	0.825	7.177	0.000
Dormitory room height	3.32	0.977	6.118	0.000
3 Use of Room Amenities				
Ease of using loft beds with desk	3.72	0.764	17.456	0.000
Furniture adjustability	3.29	0.828	6.429	0.000
Quality of windows and doors	2.99	0.964	−0.169	0.866
Ease of room cleaning	2.77	1.007	−4.225	0.000
Use of air conditions and fans	3.72	0.792	16.580	0.000
Ease of using desk and chairs (e.g., comfort)	3.47	0.785	10.997	0.000
Ease of using electric fittings (i.e., sockets)	3.29	1.001	5.377	0.000
4 Use of Washing Room				
Sewer block	2.95	1.038	−0.890	0.374
Provision of hot water	3.80	0.802	18.291	0.000
Air ventilation in washing room	2.93	0.998	−1.201	0.231
Cleanliness of washing room	3.12	0.921	2.373	0.018
5 Building closures				
Air tightness of windows	3.55	0.785	12.707	0.000
Air tightness of doors	3.62	0.715	15.889	0.000
Thermal insulation	3.28	0.827	6.133	0.000
Privacy protection	3.14	0.901	2.787	0.006
Sound insulation	2.98	0.941	−0.406	0.685
6 Dormitory Services				
Maintenance service for room amenities	3.47	0.839	10.276	0.000
Maintenance service for communality areas	3.43	0.791	9.911	0.000
Cleanliness of the communality areas	3.31	0.821	6.851	0.000
Location and adequacy of rubbishing bins in communality areas	3.35	0.845	7.572	0.000
Laundry services	3.05	0.960	1.022	0.307
Internet service	2.93	1.061	−1.232	0.219
Use of clothes hang in the corridor	2.91	0.978	−1.778	0.076
Disturbance of outdoor lighting on indoor rest	3.54	0.764	12.926	0.000

Table 6. Cont.

7 Supporting Facilities and Infrastructure				
Accessibility of the supermarket	3.12	0.976	2.235	0.026
Accessibility of restaurants	2.77	1.001	−4.135	0.000
Availability of recreation nearby (i.e., cinemas, KTV)	2.47	1.016	−9.559	0.000
Availability of post office	2.46	1.012	−9.747	0.000
Availability of fast express	2.61	1.015	−7.083	0.000
Bicycle parking and service	2.99	0.979	−0.223	0.824
Availability of ATMs and banks nearby	3.36	0.893	7.501	0.000
Accessibility to public transportation and shuttle bus in campus	3.13	0.953	2.573	0.011
Availability of health care center	2.77	1.083	−3.829	0.000
Availability of accommodation for visitors	2.55	1.048	−7.871	0.000
8 Security				
Stealing of personal items	3.90	0.757	21.823	0.000
Security service (i.e., CCTV)	3.57	0.793	13.074	0.000
Dormitory building access control system	3.45	0.806	10.171	0.000
Free of block in the corridor (i.e., any block item)	3.70	0.719	17.787	0.000
Rules for dormitory security	3.22	0.852	4.754	0.000
Provision and position of fire extinguisher	3.12	0.848	2.582	0.010
Notice and information about security exits	3.14	0.888	2.897	0.004
9 Surrounding Environment				
Nature views from windows	3.25	0.856	5.208	0.000
Outdoor noise	3.11	1.008	1.909	0.057
10 Social Activities				
Personal privacy	3.04	0.901	0.911	0.363
Availability of space for gathering	3.20	0.851	4.245	0.000
Availability of space for social	3.29	0.796	6.733	0.000

Note: *t*-values for a two-tailed test are 1.65 (significance level = 10%), 1.96 (significance level = 5%) and 2.58 (significance level = 1%).

5.3.1. Technical Aspects

The results show that, overall, the five technical aspects achieved high level of satisfaction, although in each aspect there exists of one or two less satisfactory areas.

(1) Building appearance

Respondents attributed low satisfaction to the grey color of the building appearance (mean = 2.92). Respondents commented that grey color does not suit young generation's preference. It is better to have multiple or bright colors. Another reason respondents showed a low level of satisfaction is that the dormitory building color has no difference from the institutional buildings. Thus, color would not help to tell the functional difference. Another indicator with which respondents showed dissatisfaction is the aesthetics of building appearance (mean = 2.90) and entrance and lobby (mean = 3.02). Respondents commented that rectangle shape is too common and stylish.

(2) Use of room space

Their dissatisfaction with the use of room space is associated with the inadequacy of storage space (mean = 2.94). The respondents commented that the storage space is quite limited expect for the study desk and a small storage space. Through our observation, it is found bedrooms are quite crowded, especially for the seniors or female students who have more personal items.

(3) Use of room amenities

Respondents indicated the quality of the windows and doors (mean = 2.99) is dissatisfied. This is because some room doors are difficult to close and also cause loud noises. Some doors in the washing room also lost its shape. The windows for air ventilation are too high to reach. In addition, the quality of the plastic window frame is poor. Other places, such as bolts and lockers, are also easy to break. Another problem of using room amenities is the difficulties in room cleaning (mean = 2.77). This is because several areas in the dormitory room, for instance, the gap between desk and wall, and the fixed ceiling fans, are difficult to clean.

(4) Use of washing room

The survey results show that it is easy to cause sewage block (mean = 2.95), especially for female dormitories. Another problem is bad air ventilation in washing room (mean = 2.93). There are only two tiny windows in the washing room, which are too high to reach. Besides, due to a lack of mechanical ventilation system, the washing room is easily filled with residual odors. After taking bath, the vapor cannot be blown away expediently.

(5) Building closures

Results show that sound insulation of the enclosure is less satisfied (mean = 2.98). Respondents explained that it is hearable if students in next door speak a bit loud; indicating poor sound insulation of the partition walls. It also suffers from bad sound insulation of the slabs as it is common to hear the sound from upstairs. In addition, occasionally the noise of airplanes passing by interrupts students' rest and study in the dormitories.

5.3.2. Social Aspects

This results show that compared to the technical aspects, social aspects suffered from greater deficiencies, particularly in terms of supporting facilities and infrastructure.

(1) Dormitory services

Respondents are more dissatisfied with the dormitory services than the technical aspects. For example, they showed dissatisfaction with laundry services (mean = 3.05). Respondents explained that since the laundry is self-service and no personals are in charge of the daily operation, some students are unable to use it properly. Another problem is the poor Internet service (mean = 2.93). University WIFI connection is not stable. Especially during the peak time (e.g., 7:00 p.m.–10:00 p.m.), the occurrence of Internet connection interruption is not uncommon. Other commercial Internet services (e.g., telecom) are either too expensive or too slow to meet students' requirements. This finding is consistent with Najib et al who found that students in Malaysia are dissatisfied with the Internet service as well [18].

Respondents are not satisfied with use of clothes hang in the corridor (mean = 2.91). Clothes hangers are placed upfront of the corridors. During the rainy days, clothes would easily get wet and even get blown away by wind. Another problem is that water dropped from wet clothes hung upstairs will also wet clothes hung in the corridor.

(2) Supporting facilities and infrastructure

Respondents indicated a great deficiency of facilities and infrastructures (e.g., restaurant, bicycle parking and services, recreation and post offices). Accessibility of restaurants (mean = 2.77) is a serious problem. Respondents explained that some small cafes only provide a limited number of cuisines, which far meet the requirement of students who come from different regions. Students from different provinces in fact have quite varied tastes. As this campus is far away from the downtown, it is inconvenient for students to hang out (mean = 2.47). They have to take multiple transfers and interchanges.

There are limited bicycle parking spots (mean = 2.99). As this new campus is quite large (over 3000 m²), bicycling is inevitable. However, there exists a great deficiency of parking lots in the dormitory district. Another reason cause this deficiency is the mess organizing. For example, discarded bicycles occupied the parking lots are not moved away in time. As the bicycles parking are not well organized, bicycles parked inside of the parking are hard to get out.

Respondents expressed their satisfaction with the post office service (mean = 2.46). It is inconvenient to both collecting and sending postal mails. The campus office does not provide the service of delivering large packages. Thus, students have to collect their large package from the

district agency out of the campus. In addition, respondents indicated great hope to improve fast express services (mean = 2.61). There is no fast express agency operation in the campus. The strong demand is boosted by increasing use of online shopping. All packages delivered to the university are inconvenient to collect. Another impediment is the time constraints as only a fixed time slot are available for package collection.

Respondents indicated their dissatisfaction with the health care services (mean = 2.77). The campus health center is a bit far from the dormitories. In addition, health care service packages are quite limited. Last, they are dissatisfied with the lack of accommodation for visitors (mean = 2.55). Near the new campus, there are only a few quality hotels.

(3) Surrounding environment and social activities

Respondents indicated their dissatisfaction with the outdoor noise (mean = 3.11). One reason might be the poor insulation conditions. Respondents are dissatisfied with the personal privacy protection (mean = 3.04). It is recognized that this would be difficult to overcome as university dormitories generally accommodate multiple students in one room. Within one room, mutual disturbance is inevitable.

6. Embeddedness Features of the Socio-Technical Systems

The results show that *technical aspect* of POE still constitutes the major components of POE. However, the results show that only examining technical aspects would be insufficient. POE should also pay attention to the *social aspects*, which are intertwined with the technical aspects (see Figure 3).

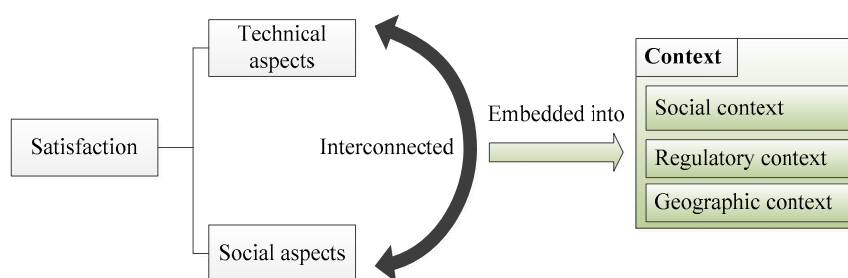


Figure 3. Embeddedness feature of socio-technical framework.

The interview results combined with the focus group studies present noticeable evidence on the embeddedness feature of the socio-technical systems. The social embeddedness feature might be reflected in four levels, namely the ease of using amenities in dormitory rooms, dormitory services, the development of college life and wider social context.

- (1) First, it is concerned with the ease of using the amenities in dormitory room. The case study shows that the windows are not reachable and some indoor areas are difficult to clean. This indicates that occupants in fact seek for adaptive opportunities, such as opening windows or adjusting furniture. This concurs with Zalejska-Jonsson [63] and Brager and Baker [64] who advocated user-friendly technical installations and the ability to control indoor environment. Occupants would highly value the ease of use. The operable windows, for example, would be helpful to adjust the thermal environment, increase air movement, and connect to the outdoors [65]. Thus, the ease of use of the amenities should be taken into account in the design.
- (2) Second social aspect refers to dormitory services. It is quite often that residents' dissatisfaction is not caused by the facility itself, but by the inferior operation and maintenance. One example is the bicycle parking where the facility is well prepared, but there is a lack of superb management service. Therefore, it requires a social aspect to complement the technical aspect in this regard.

- (3) Third, students' life activities should be incorporated as the physical structure overall enables the students' interactions and friendship development in their college life. For example, the provision of restaurant and recreations is important for them to develop friendship and enjoy the leisure time. However, a great deficiency currently exists.
- (4) Fourth, the POE reflects the wider social context feature. One feature is that students in Eastern countries have collective thinking. Therefore, the residence should be customized to enhance their connection and increase their sense of belonging. University life is an important experience in their life.

From the social aspect, achieving high residential satisfaction is not sole responsibility of one party, but left to the key stakeholders. These would include students, facility managers, dormitory service providers and even outside university parties (e.g., hotel, health care services, public transportation, fast express providers, restaurants and Internet providers).

The results show that POE should also take the *geographic context* into consideration. It is apparent that the geographic location of the dormitory influences satisfaction. It is very common for a new campus to be built outside of the downtown. The key infrastructure nearby is deficient of providing crucial support. Moreover, China, as a developing country, is faced with a high level of infrastructure deficiency. This finding extends the scope of Amole's study [25] that ascertained that setting of university dormitories is only concerned with the campus environment. Although key stakeholders could be identified, it is still difficult to draw a clear scope of the geographic context [65].

The results indicate that POE reflects the *regulatory context*. Najib et al. [18], for instance, found the perceived quality could contribute to the loyalty behavior (e.g., longer staying, and retention in the same house). However, this is not applicable to the China's context as the allocation of beds and rooms are fully regulated by the facility manger. Students have no choice to select dormitory room or prefer to stay longer. When carrying out the POE, various regulations and rules should be taken into consideration.

As POE embodies embeddedness features, many facets are not pre-determined and held constant over time. This further reinforces the necessity of a participatory approach [60]. Such participation would largely increase the understanding of the deficiency and status of the facility operation. It would also bring about a learning curve where students would acquire the knowledge of effective operation and utilization of the facilities.

7. Conclusions

Residential satisfaction of university dormitories serves as one of the significant aspects in sustainability in higher education. This study aims to develop a framework for the POE of university dormitories in China grounded on the socio-technical systems approach, and to identify factors contributing to students' residential satisfaction. Two focus groups were carried out to build the socio-technical framework. A case study was undertaken to evaluate the post-occupancy status of university dormitories in China.

One of the key findings is that POE is a complex socio-technical system. Considering the technical and social aspect alone renders great limitations. Through focus groups, this study developed a socio-technical framework to examine university dormitories in China. This framework comprises ten intertwined socio-technical components. Five technical aspects are building appearance, use of room space, use of room amenities, use of washing room and building closures. Five social aspects comprise dormitory services, supporting facilities and infrastructure, security, surrounding environment and social activities.

Through a case study of a typical university dormitory, it is supported that the socio-technical systems framework is valid to the POE for the university dormitories. The case study results show that respondents indicated a high level satisfaction with the university residency in terms of the basic functions. However, they face deficiencies in the social aspect of providing quality services.

This indicates “hardware” nowadays could meet students’ requirements, whereas the “software” is still less competent.

Another important finding is that the POE is embedded into the social, geographic and regulatory context. The social embeddedness feature might be reflected in four levels, namely the ease of using amenities in dormitory rooms, dormitory services, the development of college life and wider social context. Given the unique embeddedness feature, it is noted that indicators under the ten POE components might not be generable to other geographic contexts. However, the socio-technical framework will be helpful to customize POE indicators to different geographic regions.

This study contributes to the knowledge by presenting a socio-technical framework of POE and its embeddedness feature. The practical implications of this study are twofold. For feedback, this study identified the drawbacks for current university dormitory operation. This will provide facility manager with clear understanding of the problems in the dormitory operation. For feed-forward, this study provides design professionals with important guidance for university dormitory design. It is also informed that designing should well recognize “one size does fit” all due to the evident embeddedness feature of POE.

One limitation of this study is single case study research. Although a typical case of university dorms examined in-depth would generate rich data and evidence [1,4,62], the generalization of the studies to other context should be taken with care. It is also suggested to adopt a participatory approach in enhancing residential satisfaction. As can be seen from the results, the satisfaction is not achieved through the provision of high quality facilities, but an integration of the technical and social aspects. There exists a clear learning process after occupancy.

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