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Psycho-social Perception of Indoor Air Quality in Students Dormitory: A Preliminary Assessment

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ABSTRACT

Campus housing acts as an essential facility in smoothing students' lives and speeding up the learning process, thus achieving the overall university mission. This study evaluates the psychosocial perception of satisfaction with the indoor environmental quality in student housing at King Fahd University of Petroleum and Minerals (KFUPM), Dhahran, Saudi Arabia. The study used a questionnaire survey for data collection and simple descriptive statistics for data analysis. The results indicate that the respondents are satisfied with the room temperature during summer (56%), quality of air inside the room, control of natural ventilation using window openings (42%) and level of smell inside their rooms (88%). However, the respondents are dissatisfied with room temperature during winter (48%), the overall perception of thermal environment in the building (48%), mechanical ventilation control (72%), overall perception of the indoor air quality (60%) and smell throughout the corridors (54%). The outcome of this study is essential information for facility managers, building *designers and owners. The result will also benefit decision-makers to formulate policies.*

Keywords: Dormitory, Indoor air quality, Occupant perception, Students Thermal comfort.

INTRODUCTION

Infrastructure in any educational facility such as a university plays a crucial role in accomplishing the objectives of that university. Campus housing acts as an essential facility in smoothing students' lives and speeding up the learning process, thus achieving the overall university mission. Student housing comprises a specific type of building required to operate as a shelter providing students with a comfortable and serene study environment, security, privacy, and competitive interactive atmosphere.

The student housing must be designed to provide necessary indoor environmental requirements that impact the productivity and efficiency of students to fulfill this target. The student housing facility is meant to serve three primary goals, attaining mental competence, shaping personal character and shaping a pattern of behaviour, thought and imagination [1][2].

Historically, the idea of living on campus has been established by English professors who believed in the English collegiate tradition. In the fourteenth century, Oxford University in the United Kingdom established its facilities to meet both teaching and living requirements. Afterwards, universities and colleges worldwide began to adopt this approach (on-campus student accommodation). The importance of campus housing can be summarized as follows [3]:

- Campus housing will save time on travelling and transportation, thus increasing students' academic performance.

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- Campus housing will develop an atmosphere of cooperation, competition, security, involvement, and inspiration among students.
- Campus housing will create Interaction between students who have different academic and social backgrounds, raise their awareness, enrich their knowledge and enhance their skills.
- Campus housing will create institutional loyalty and eventual alumni support.

The influence of Indoor Air Quality (IAQ) on the workers or students has been well described in the literature. Vilcekova et al. [4] studied the impact of classrooms Indoor Environmental Quality (IEQ) on students and staff comfort and performance. He carried out a survey questionnaire on 34 students and five staff.

The standardized survey questionnaires, including general information on students, satisfaction with the environment, and health conditions, was employed after minor changes to evaluate the subjective quality of the indoor environment in the selected school. Objective measurements such as outdoor and indoor air temperature, sound level, particulate matter, carbon dioxide level, relative humidity, air velocity, and lighting level were also carried out. Their objective measurement showed that particulate matters mainly polluted the school's environment. Poor quality of lighting; high concentration of carbon dioxide; high level of sound were also detected by the installed monitoring devices. The subjective study further revealed that the students and staff mostly complained about the students generated sound levels. Both students and staff observed various sick building syndrome symptoms such as fatigue, heavy-headed, headache, difficulties in concentration, eye and nose irritation, and sore throat.

The results also showed that the student performance was significantly affected by the indoor environmental quality [4] and further asserted [5] the importance of user satisfaction in buildings especially the role of post occupancy evaluation.

Sulaiman et al. [6][7] evaluated indoor environmental quality on dense academic buildings, and their investigation was based on two parameters, the level of user satisfaction and the level of indoor environmental quality in a selected academic building while occupant survey is considered among the most effective method of occupant survey. The IEQ measurements involved preliminary assessment, reviewing the building plans and scientific measurements using adequate equipment to measure and collect on building temperature, humidity, noise, light, etc.

The users of the academic building in question were asked to give their opinions on how comfortable the building was, and the result showed that the overall quality of the indoor environment (IEQ) in the Academic Building was below the prescribed standard [8][9] and equally noted that among the post occupancy evaluation methods is an approach based on receiving feedback about factors of building such as performance, indoor quality and user satisfaction.

Therefore, this study aims to evaluate the psychosocial perception of satisfaction with the indoor environmental quality in student housing at King Fahd University, Dhahran, Saudi Arabia. The work will also help housing administrators and managers' shift to the proper operation mode, repair inefficient equipment, and give helpful consideration for future design.

FACTORS AFFECTING ENVIRONMENTAL CONDITIONS

Several variables determine the environmental conditions, including air temperature, relative

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humidity, ventilation, air movement, noise, lighting, and vibration. These parameters have considerable effects on human comfort.

The thermal conditions of any space are characterized by air temperature, relative humidity, and air movement. The American Society of Heating, Refrigerating and Air-conditioning Engineers (ASHRAE) Standard 55 defined thermal comfort as 'that condition of mind which expresses satisfaction with its thermal environment' (ASHRAE, 1992). A thermal environment is acceptable if it is accepted by at least 80% or more of the occupants [3]. The space temperature causes discomfort by thermal heat gain or loss conditions.

In addition to the space temperature, humidity and air movement are very important. At low humidity, the occupants are more susceptible to Sick Building Syndrome (SBS) symptoms, as airflow directly influences human comfort; excessive flow of cold air is known as draft and could be thermally uncomfortable, while the excessive flow of warm air causes eyes dryness. Seasonal air temperatures, air velocities, and radiant asymmetries associated with optimal thermal comfort are summarized in table 2 [7].

Exposure to the indoor environment directly impacts comfort, physiological and psychological health, productivity and well-being. Therefore improving the indoor environment is essential and deserves attention [8].

Student housing usually accommodates a large number of occupants, the density of occupants is a significant design factor that determines space requirements and ventilation needs. The thermal system in student accommodation should be designed in a way it can provide individual requirements. It was stated that personal control of room temperature is the optimum design method to suit students' preferences. Also, it is essential to maintain the air circulated and clean because the building is crowded and accommodates a diverse community of smokers and non-smokers [1].

Acceptable indoor air quality is defined in ASHRAE Standard 62 as 'air in which there are no known contaminants at harmful concentrations as determined by cognizant authorities and with which a substantial majority (80% or more) of the occupants exposed do not express dissatisfaction' [1]. Poor indoor air quality reduces productivity in the workplace environment by reducing work performance and increasing absenteeism.

Poor indoor air quality causes occupants to be susceptible to various symptoms, such as SBS and building-related illnesses. Student rooms must be provided with a good quality of indoor air because poor air quality could affect the health of the students, resulting in higher rates of absenteeism and lower productivity [7][10][11][12]. Figure 1 illustrates the Graphic Comfort Zone Method showing the acceptable operative temperature range that meets the specified criteria.

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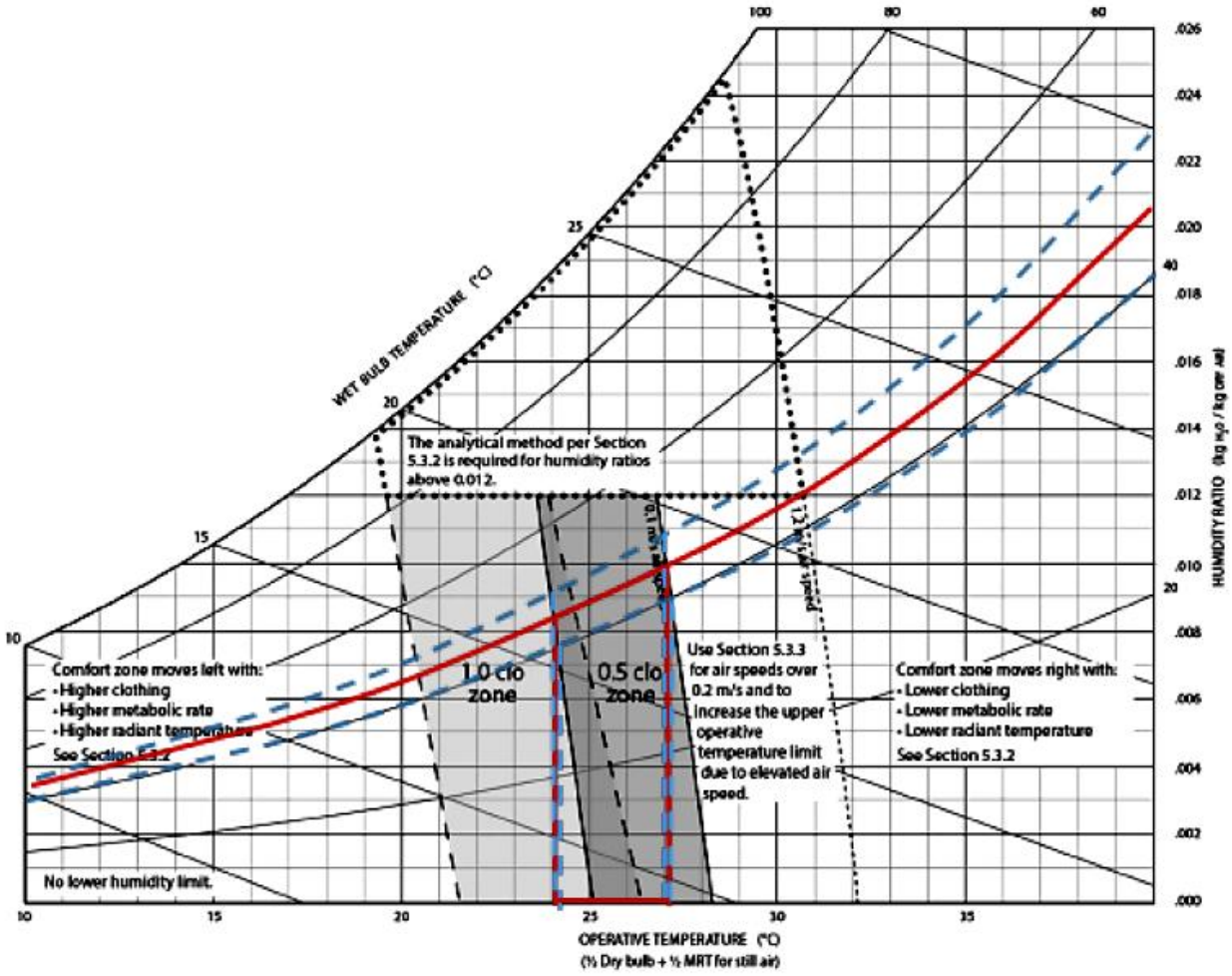

Figure 1. Graphic Comfort Zone Method: Acceptable operative temperature range that meets the specified criteria [8]

MATERIALS AND METHODS

This study is based on a survey questionnaire to evaluate the subjective quality of the indoor environment in the student housing building. After reviewing the literature on the indoor environment in student accommodation facilities, a user satisfaction survey was developed and adopted after minor changes.

The building occupants who are students residing in building 815 were asked to qualitatively evaluate the indoor environment based on their experience with the building. 'Google form' was used to deliver the survey. The form was designed as short as possible to encourage the occupants to fill it. The survey was distributed to the occupants based on their acceptance to participate in the study. The survey recorded 96 valid occupants' responses to the questionnaire; hence this figure is as result of acceptance to participate in the survey so it is participant acceptance based.

The structure of the survey form consists of three questions. In the first question, the occupants were questioned to mark the frequent complaints regarding the building environment. The second question covered the occupants' symptoms that are associated with the building environment.

In contrast, the last question measured how the students perceived the thermal environment,

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indoor air quality and olfactory comfort. At the end of the survey form, a comment section was added so that the occupants could comment on issues not mentioned in the form. Then the findings of the survey were analyzed. The methodology used in this study is presented in Figure 2.

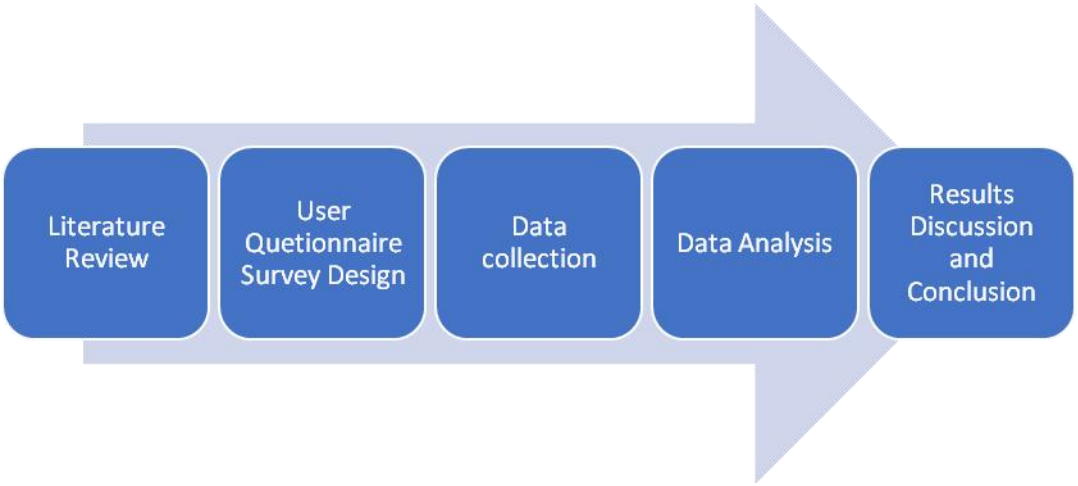

Figure 2: The flow chart of the research methodology

After collating the data from the Google form, the results were analyzed using simple descriptive statistics. Each evaluation term was given a certain weight to obtain the overall degree of satisfaction, as shown in Table 1. The evaluation term includes strongly satisfied, satisfied. Dissatisfied and strongly dissatisfied with 4, 3, 2 and 1 points respectively.

Table 1: The evaluation term and the corresponding weight

Evaluation Term	The Corresponding Weight
Strongly Satisfied	4 points
Satisfied	3 points
Dissatisfied	2 points
Strongly Satisfied	1 point

The final degree of satisfaction is determined by calculating the mean response using the relationship presented in equation 1.

$$Mean\ response\ (MR) = \frac{\sum the\ number\ of\ responses\ in\ each\ evaluation\ term\ X\ the\ corresponding\ weight}{the\ total\ number\ of\ responses} \quad (1)$$

The calibration scale used to evaluate the final degree of satisfaction is presented in Table 2. The point ranges for the four degrees of satisfaction are also presented with the abbreviations used in the table.

Table 2: The adopted calibration of mean response

	Range	Degree of satisfaction	Abbreviation
Mean Response	less than 1.5	Strongly Dissatisfied	SD
	1.50 - 2.49 inclusive	Dissatisfied	D
	2.50 - 3.49 inclusive	Satisfied	S
	above 3.50	Strongly Satisfied	SS

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Building Description

In this study, we aim at evaluating the residential satisfaction of student housing at KFUPM. The selected three-storey building (building 815) was built in 1985, covering an area of 2800 m^2, located within the King Fahd University campus. It comprises two wings with spacious courtyards. Each floor in each section contains 12 double-occupancy rooms. Each room has dimensions of 4.7 x 4.7 m. The first floor of each tower also contains one single-occupancy bedroom, allocated for graduate assistants.

Each floor has two shared washrooms located at the opposite corners. The second and third floors of each tower contain two reading standard rooms. The building was designed to accommodate 146 students in each building. Figure 3 explains the typical floor plan of building 814. The building was designed with corridors and four stairwells to ease the circulation.

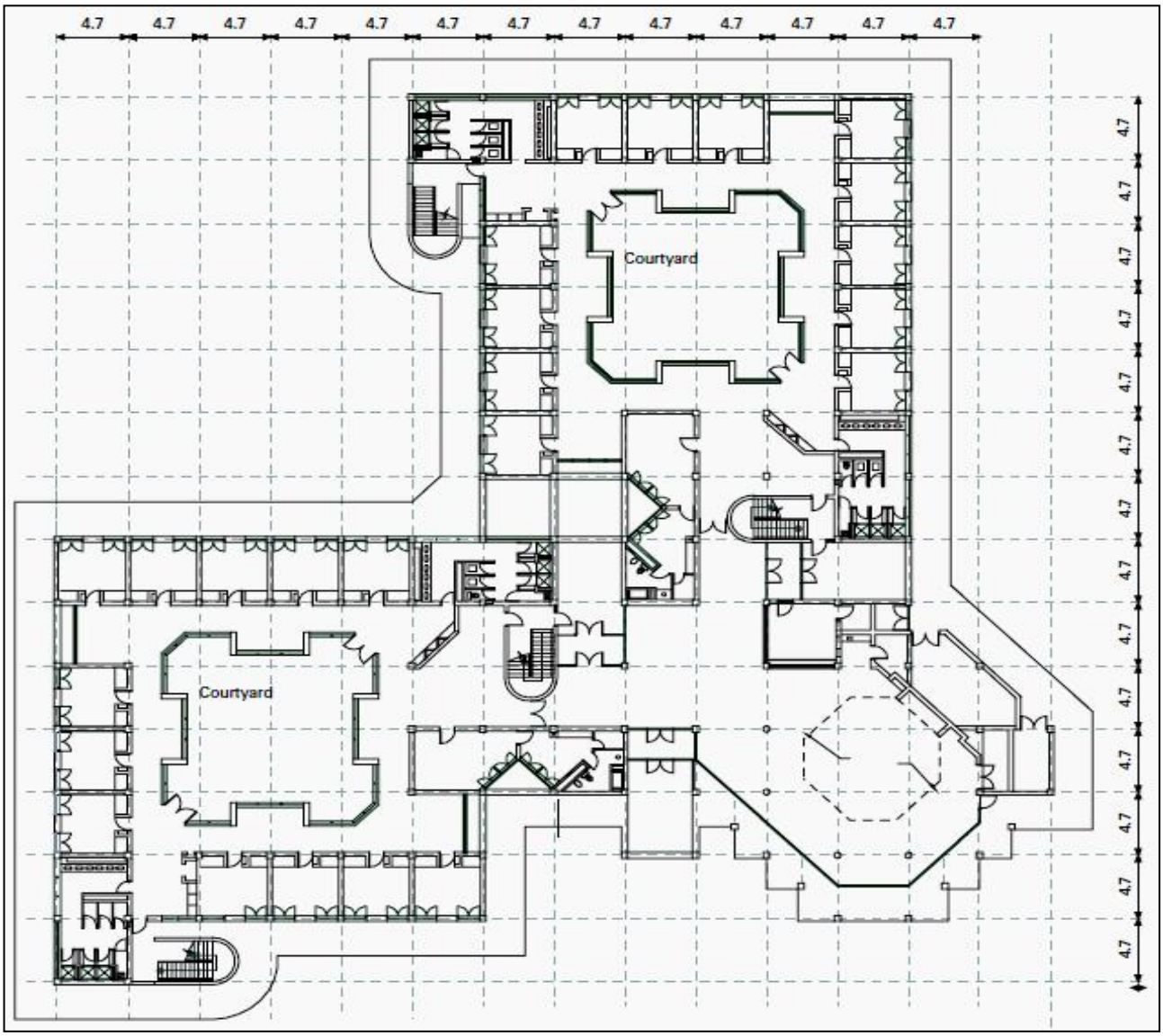

Figure 3: Floor plan of the studied building

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RESULTS AND DISCUSSION

The majority of the occupants (78 persons) suffer from poor lighting. Figure 4 shows the responses associated with the frequent complaints about indoor air quality. The second complaint was the cold temperature and noise, marked by 18 students each, 24 occupants complained about the hot environment. Furthermore, 24 occupants complained about the dusty air. Figure 5 shows the symptoms the responding occupant experienced and believed the building environment might cause. Eye irritation is the most common symptom, which 30 respondents selected. Twenty-four respondents suffer from a runny nose. The remaining symptoms have lesser impacts compared to the ones mentioned above.

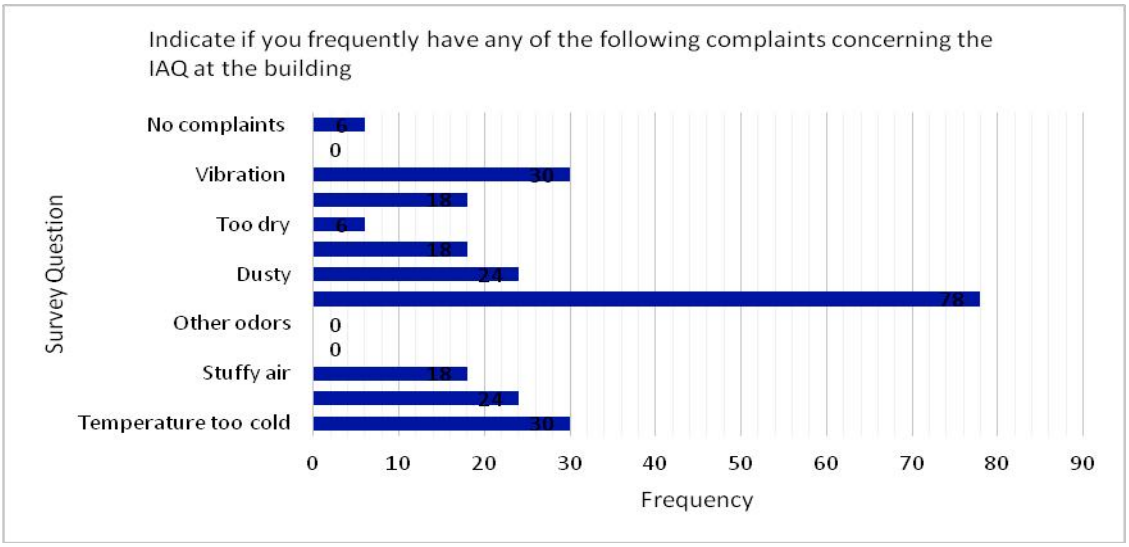

Figure 4: Responses of the IAQ complaints

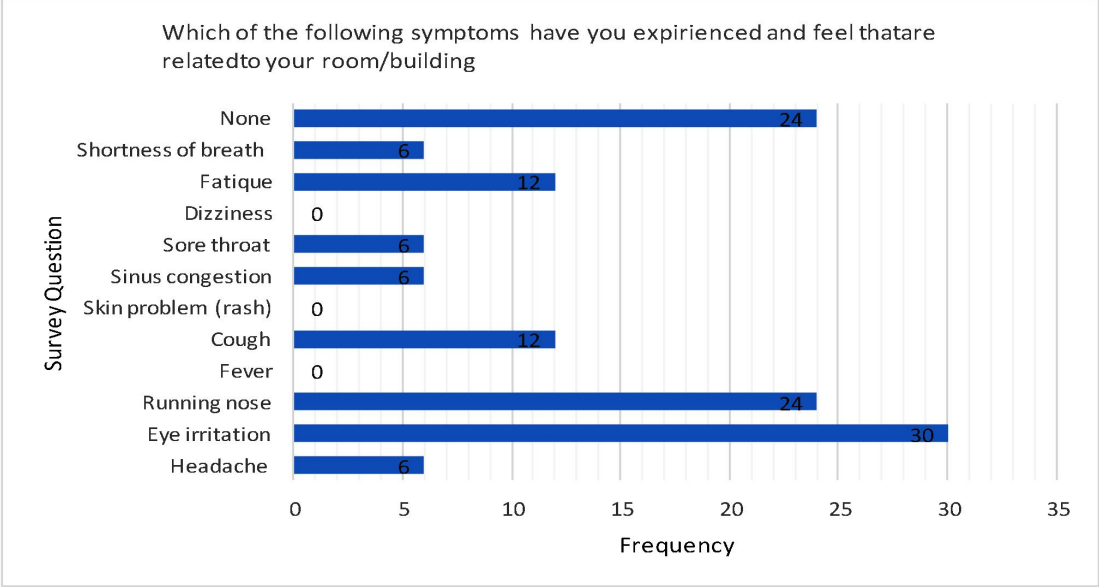

Figure 5: Responses of the symptoms caused by the indoor environment.

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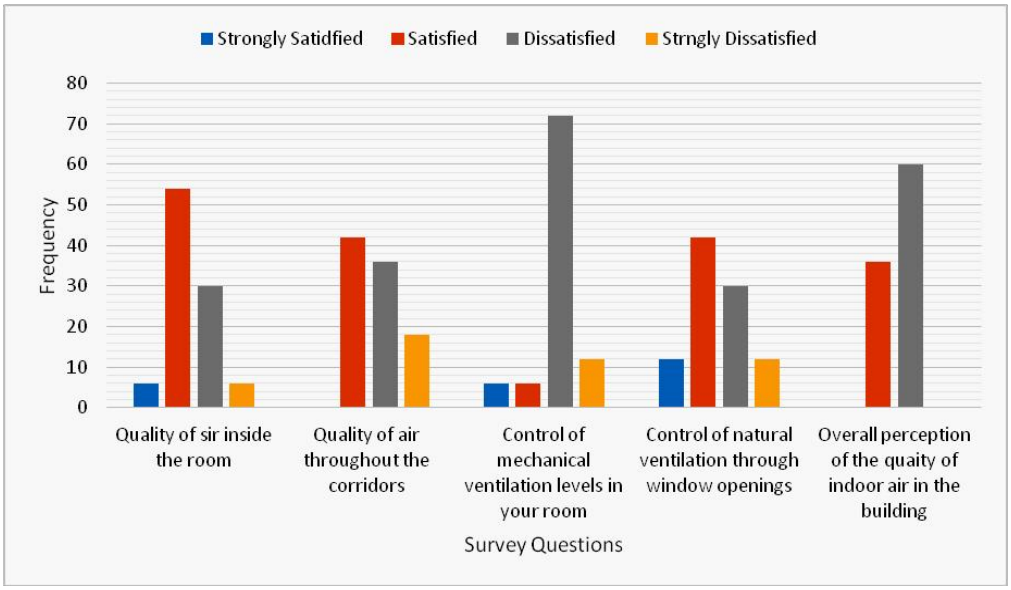

Figure 6: The level of satisfaction with indoor air quality.

Figure 6 shows the level of satisfaction with indoor air quality. The IAQ satisfaction has five elements of performance, 54 respondents are satisfied with the air quality inside the room, six are strongly satisfied, and the rest are dissatisfied and strongly dissatisfied. Forty-two respondents are satisfied with the air quality throughout the corridors, while the rest are either dissatisfied or strongly dissatisfied. For the control of mechanical ventilation inside rooms, most respondents (72) are dissatisfied. Sixty respondents are dissatisfied with the overall perception of the IAQ, while the rest are satisfied.

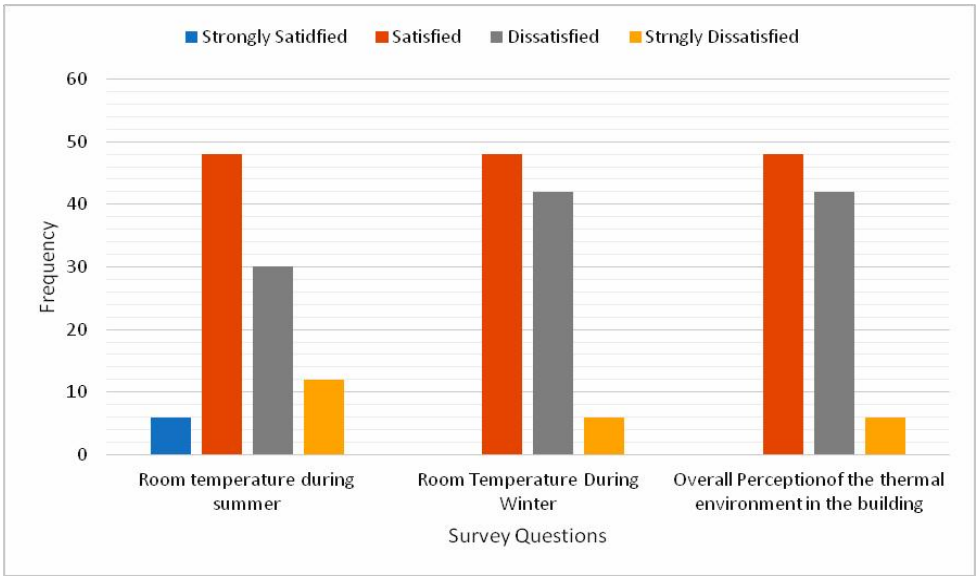

Figure 7: The level of satisfaction with thermal comfort.

Figure 7 shows the satisfaction with thermal comfort. The study set three performance elements to evaluate thermal comfort: summer temperature, winter temperature, and overall

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perception. Forty-eight of the respondents are satisfied with the room temperature during summer, forty-two are satisfied with the room temperature during winter, and forty-two are satisfied with the overall thermal environment.

In addition to the thermal evaluation and IAQ, evaluating the level of odours in the environments is essential since they directly impact health and productivity. In this regard, occupants were asked to mark their satisfaction with smells inside the rooms and throughout the corridors. Their responses are shown in Figure 8. The students have an issue with the corridor smell and are somewhat satisfied with the smells inside rooms.

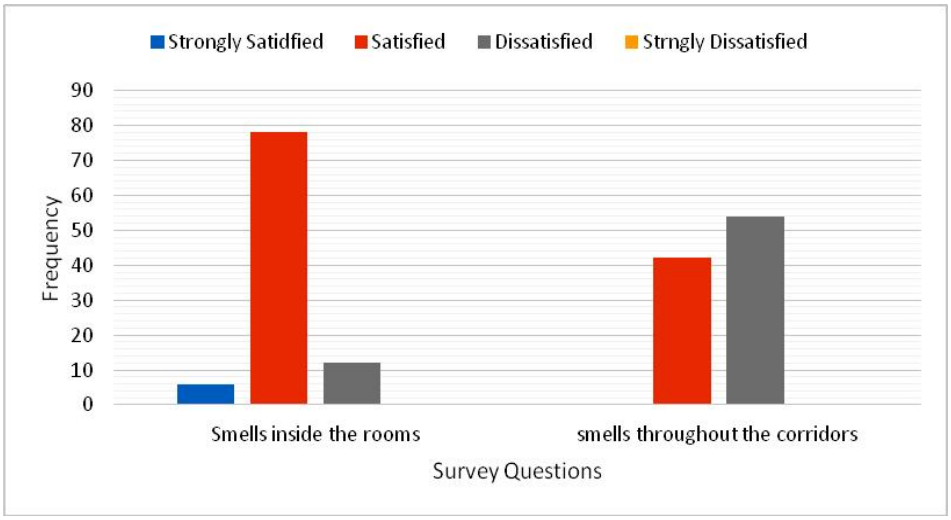

Figure 8: The level of satisfaction with the olfactory comfort.

The elements of performance and their corresponding satisfaction level are presented in Table 3. The respondents are satisfied with the room temperature during summer, quality of air inside the room, control of natural ventilation using window openings and level of smell inside their rooms. However, the respondents are dissatisfied with room temperature during winter, the overall perception of thermal environment in the building, mechanical ventilation control, overall perception of the indoor air quality and smell throughout the corridors.

Table 3: Elements of performance and level of satisfaction.

Element of performance		Evaluation term				Mean response	Degree of satisfaction
		SS	S	D	SD		
Thermal comfort							
1	Room temperature during summer	6	48	30	12	2.5	**S**
2	Room temperature during winter	0	48	42	6	2.4	**D**
3	The overall perception of the thermal environment in the building	0	48	42	6	2.4	**D**
Indoor air quality							
1	Quality of air inside the room	6	54	30	6	2.6	**S**
2	Quality of air throughout the corridors	0	42	36	18	2.3	**D**

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3	Control of mechanical ventilation levels in your room	6	6	72	12	2.1	**D**
4	Control of natural ventilation using opening windows	12	42	30	12	2.6	**S**
5	The overall perception of the quality of indoor air in the building	0	36	60	0	2.4	**D**
olfactory comfort							
1	Smells inside the room	6	78	12	0	2.9	**S**
2	Smells throughout the corridors	0	42	54	0	2.4	**D**

CONCLUSION

Based on the outcome of this study, it is evident that the respondents are satisfied with only four indoor environmental quality elements, including room temperature during summer, quality of air inside the room, control of natural ventilation using opening windows, and smells inside the room.

However, respondents are dissatisfied with the other elements, including room temperature during winter, the overall perception of the thermal environment in the building, quality of air throughout the corridors, control of mechanical ventilation levels in their room, the overall perception of the quality of indoor air in the building and smells throughout the corridors. The responses from occupants in respect their dissatisfaction have consequence on the occupants in relation to their health with noticeable eye irritation, running nose, fatigue and cough.

Therefore, the facility management team should devise means of resolving issues leading to dissatisfaction. This resolution could be achieved by collaborating with other stakeholders such as Architects and Engineers.

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