

**6th UNDERGRADUATE  
SEMINAR ON BUILT  
ENVIRONMENT  
AND TECHNOLOGY  
(USBET) 2023**

**SUSTAINABLE BUILT  
ENVIRONMENT**

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# e-Proceeding

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# BUILDING COMFORT IN TERMS OF INDOOR AIR QUALITY IN UITM SERI ISKANDAR PERAK BUILDINGS

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## ABSTRACT

*Indoor air quality (IAQ) is an important consideration in building design and maintenance because it has a direct impact on occupant health, comfort, and overall happiness. Indoor air quality refers to the quality of air within buildings, which includes contaminants, temperature, humidity, and ventilation rates. Poor indoor air quality can cause a variety of health concerns, including allergies, respiratory disorders, and other acute or chronic illnesses. This study aims to summarize the relationship between indoor air quality and building occupant satisfaction. To accomplish this objective, this study used a quantitative strategy in which an online questionnaire was provided to respondents and the data acquired was analysed using mean statistical analysis. The mean statistical analysis helps to understand further how indoor air quality can lead to occupant satisfaction. This shows that problems of indoor air quality can be avoided by optimizing ventilation systems, minimizing energy consumption, and reducing pollutants. The research recommendations can contribute to creating environmentally friendly buildings and reducing carbon footprints.*

**Keywords:** *indoor air quality, occupant satisfaction, quantitative approach, mean analysis*

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## **INTRODUCTION**

The last few decades have seen a shift in the indoor environment for people as a result of efforts to preserve energy and construct more energy-efficient buildings (Alagoz, 2019). Recent years have seen an increase in public and scientific interest in indoor air quality. Since we spend more time indoors and numerous studies have shown that indoor pollution levels are higher than outdoor levels, excellent indoor air quality is crucial to us (Alagoz, 2019).

The right comfort and efficiency levels in educational buildings may encourage users' productivity and focus during the teaching and learning process (Norazman et al., 2021). Both actual and imagined effects of the built environment have an impact on residents. One of the many factors influencing the office or commercial setting and an occupant's capacity to carry out their duties is indoor air quality (IAQ). IAQ issues can have a direct influence on the productivity, comfort, and health of the occupants (Nur Aishah Mohd Noor & Ding, 2020).

The goal of this study is to summarize the relationship between indoor air quality and building occupant satisfaction in UiTM Seri Iskandar Buildings. By examining existing literature, conducting surveys, and analysing relevant data, this research aims to provide valuable insights into the impact of indoor air quality on occupant comfort and identify potential areas for improvement.

## **INDOOR ENVIRONMENT QUALITY**

The words comfort and IEQ (Indoor Environment Quality) refer to the study of psychological perceptions and physiological aspects, such as the combination of acoustics, thermal conditions, visual and Indoor Air Quality (IAQ) using a mechanically regulated heating/cooling ventilation system (Ganesh et al., 2021). The IEQ of a building includes the conditions within and their effects on occupants or residents. Strategies for tackling IEQ include safeguarding human health, improving quality of life, reducing stress, and preventing sickness. Inadequate indoor comfort can lead to occupant discontent and significantly impact productivity and performance, as well as a variety of concerns such as dryness, health, morale, and the well-known sick body syndrome (SBS). Humans spend the majority of their time indoors, which is insufficient (Ganesh et al., 2021). It has been shown that poor IAQ can harm human health by producing building-related sickness. Short-term and long-term exposure to indoor air pollution can induce a variety of ailments. As a result, it is critical to determine their primary sources and concentrations, as well as develop measures for controlling and improving IAQ (Van Tran et al., 2020).

## **OCCUPANT SATISFACTION**

A high-performance green building increases occupant productivity, which can be considered the ultimate economic outcome, given that studies have shown that green buildings result in higher productivity, healthier occupants, less absenteeism, and lower compensation for health insurance and claim returns (Esfandiari et al., 2021). The most essential and widely adjusted parameter in the IEQ is thermal comfort. Humans are constantly looking for comfort in their working environment. Thermal interaction between the human body as a system and its surroundings occurs primarily through three modes of heat transfer: convection, radiation, and evaporation (Ganesh et al., 2021).

## **METHODOLOGY**

In general, this study used a quantitative technique in which an online questionnaire was issued to respondents and the data gathered was assessed using mean statistical analysis. All of the data gathered has contributed to the case study. Furthermore, respondents from diverse case studies, such as BS and QS buildings, are required for this research. This is to provide more specific information on the location, surroundings, temperature, and time spent at the facility. This research methodology allows for the use of two types of questions in research: closed-ended questions and scale questions. A closed-ended question allows the respondent to choose from a list of multiple-choice answers that are relevant to them. The scale answer is a question that requires assigning a rating based on the respondent's perception. This type of inquiry allows respondents to express their level of satisfaction with indoor air quality.

This quantitative approach includes data collection, sampling, data analysis, and research design. It is crucial to have a precise and well-defined research design. The study's general methodology, including the research questions, data gathering strategies, and data analysis methodologies, are laid out in this design. Surveys, questionnaires, observations, and experiments are common organized approaches used to gather data for quantitative research. These techniques are intended to collect numerical data that can be measured and statistically analysed. In order to choose a portion of the population for their study, researchers frequently employ sampling procedures. Statistical methods are used to analyse quantitative data. These comprise both inferential statistics, which are used to draw conclusions about the population based on sample data, and descriptive statistics, which are used to summarise data (e.g., mean, median, standard deviation).

## QUANTITATIVE DATA

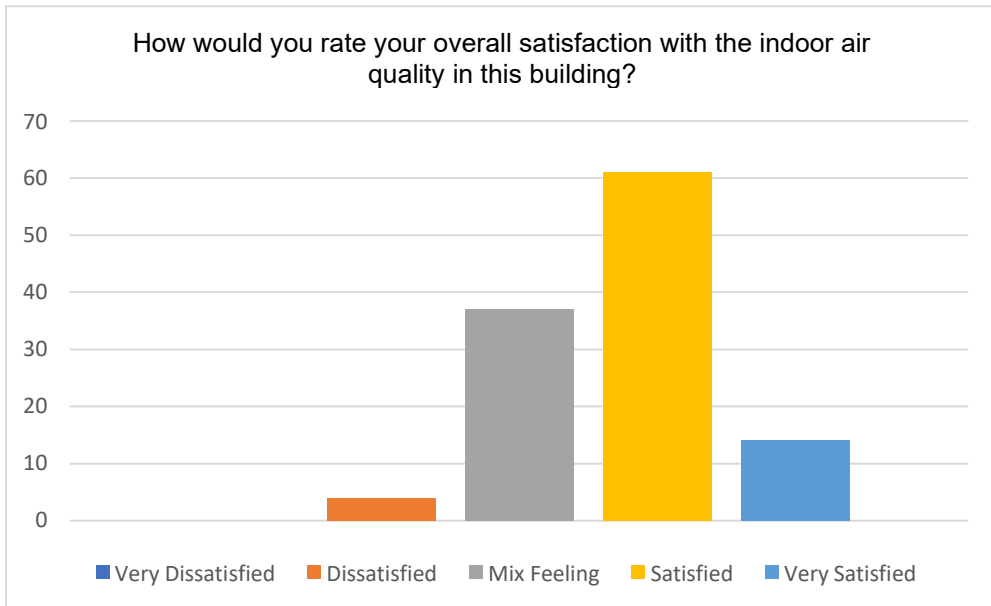
The online survey questionnaire is divided into four sections, each with 16 structured questions meant to collect data in order to achieve the study's objectives. The Google form received 116 responses. Section A contains four (4) questions, the first of which is a demographic inquiry that specifies the respondent's background, including gender, age, type of respondent, and case study location. Section B has four (4) questions about indoor air quality awareness. Section C comprises four (4) questions about respondents' overall satisfaction with the building. Section D, the questionnaire's final section, discusses the relationship between indoor air quality and building occupant satisfaction. In order to obtain the mean value, the frequency of each score will be computed using a formula based on the selected scale. By adding the mean value and dividing it by the number of questions, the average of the overall scores achieved for each question in the section is calculated. The following is the formula:

Formula:	
Weighted mean	$= \frac{\sum (\text{number of the respondents chose the rating} \times \text{rating scale})}{\text{Total number of respondents}}$
Mean range	$= \frac{\text{large scale} - \text{small scale}}{\text{Number of scales}}$

**Figure 1: Formula for mean analysis**



**Question 4a:** Rating of overall satisfaction with IAQ



**Figure 2 : Rating of overall satisfaction**

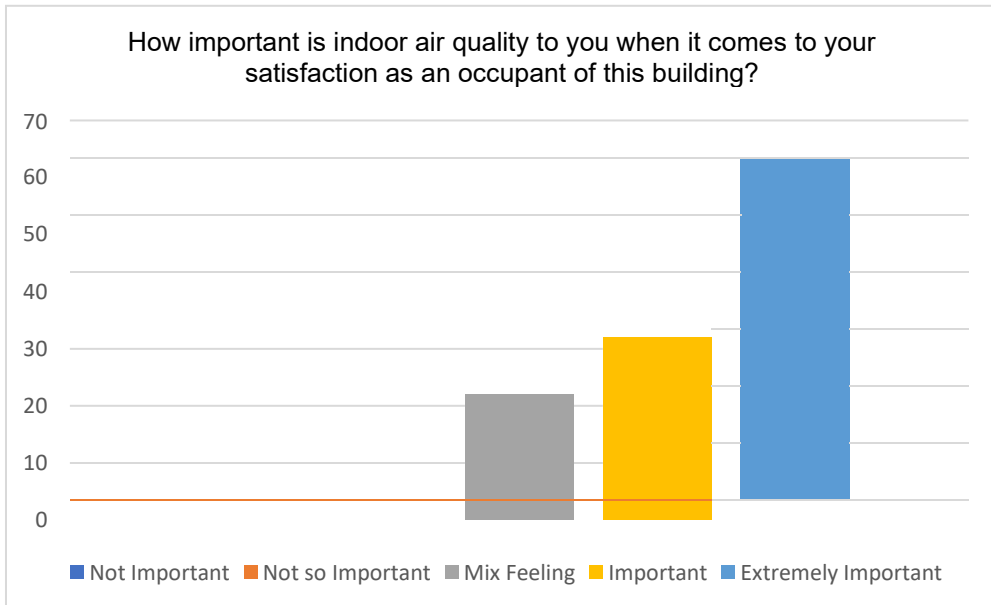
**Table 1: Assessment of respondents' rating**

Frequencies of Likert Scale						Mean Score
1	2	3	4	5	Total	
0	4	37	61	14	116	3.73

$$\begin{aligned} \text{Mean Score} &= \frac{(1 \times 0) + (2 \times 4) + (3 \times 37) + (4 \times 61) + (5 \times 14)}{4 + 37 + 61 + 14} \\ &= 3.73 \end{aligned}$$

The chart is divided into five groups, with each area indicating the proportion of respondents in each category. The average score of 3.73 shows modest overall satisfaction with indoor air quality. Overall, the pie chart shows that the majority of respondents were pleased with the indoor air quality, however a sizable proportion expressed mixed opinions. The lack of "Very Dissatisfied" replies and the tiny number of unsatisfied participants imply that most people found the indoor air quality to be satisfactory.

**Question 4b:** Rating of importance of IAQ toward occupant satisfaction



**Figure 3 : Importance of indoor air quality**

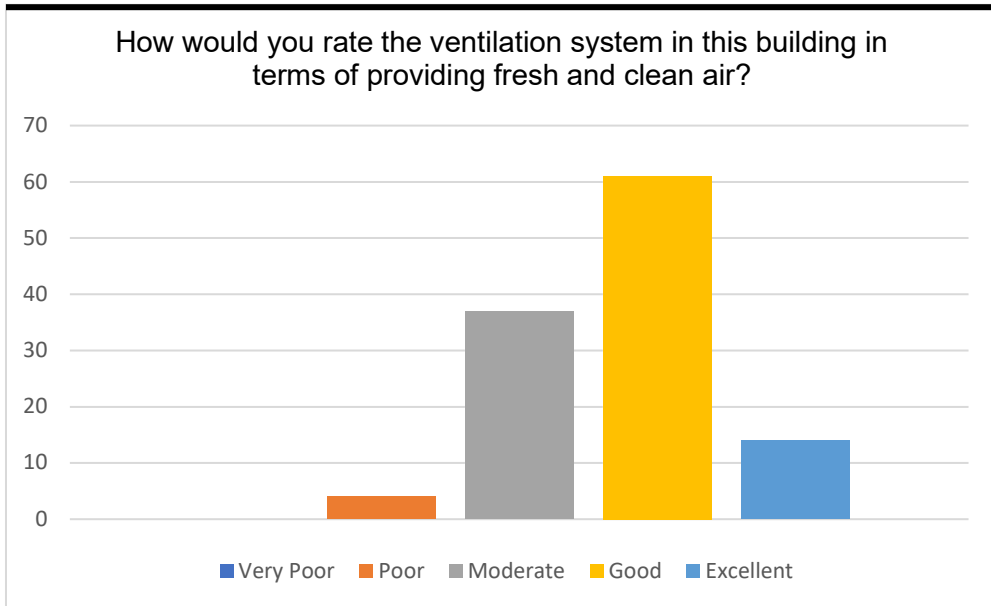
**Table 2 : Assessment of respondents' rating**

Frequencies of Likert Scale						Mean Score
1	2	3	4	5	Total	
0	2	22	32	60	116	4.29

$$\begin{aligned} \text{Mean Score} &= \frac{(1 \times 0) + (2 \times 2) + (3 \times 22) + (4 \times 32) + (5 \times 60)}{2 + 22 + 32 + 60} \\ &= 4.29 \end{aligned}$$

The mean score of 4.29 indicates that the average importance is rather high. This suggests that, on average, respondents consider indoor air quality to be important and understand its impact on their health. The majority of respondents rated it as either highly or significant, emphasizing the importance of maintaining excellent indoor air quality. They place the most value on indoor air quality. They are aware of the negative effects it can have on their health and well-being.

**Question 4c:** Rating of ventilation system in the building that provides fresh/clean air



**Figure 4 : Rating of ventilation system**

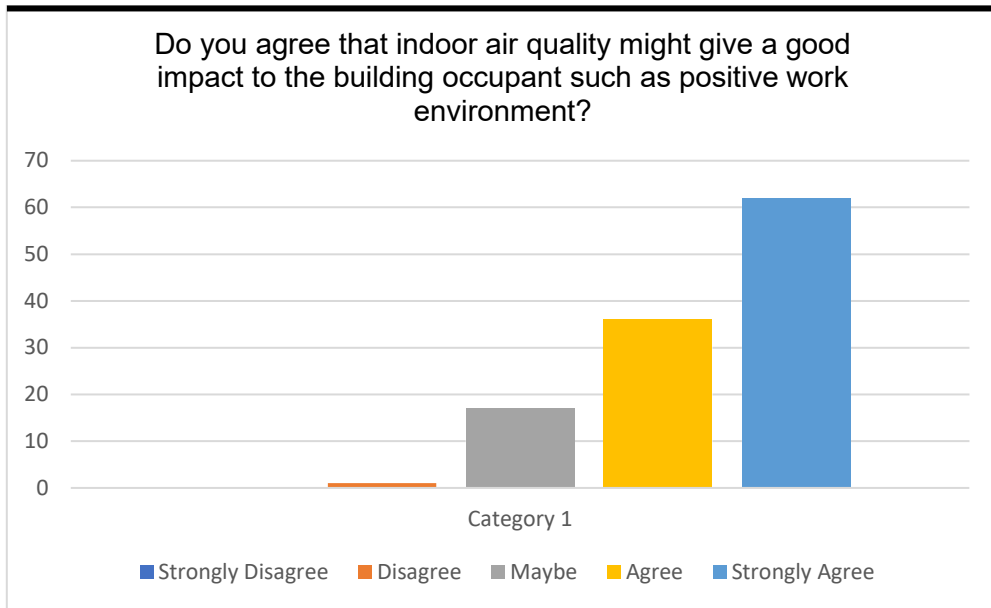
**Table 3: Assessment of respondents' rating**

Frequencies of Likert Scale						Mean Score
1	2	3	4	5	Total	
0	6	32	68	10	116	3.71

$$\begin{aligned} \text{Mean Score} &= \frac{(1 \times 0) + (2 \times 6) + (3 \times 32) + (4 \times 68) + (5 \times 10)}{6 + 32 + 68 + 10} \\ &= 3.71 \end{aligned}$$

Based on the responses and the mean score, it can be concluded that the majority of the respondents were satisfied with the ventilation system, with a sizable number rating it as good. This feedback can help identify areas for improvement and ensure that the ventilation system constantly supplies fresh and clean air to fulfil the expectations of all users.

**Question 4c:** Rating of impact of IAQ toward building occupant



**Figure 5 : Rating of ventilation system**

**Table 4: Assessment of respondents' rating**

Frequencies of Likert Scale						Mean Score
1	2	3	4	5	Total	
0	1	17	36	62	116	4.37

$$\begin{aligned} \text{Mean Score} &= \frac{(1 \times 0) + (2 \times 1) + (3 \times 17) + (4 \times 36) + (5 \times 62)}{1 + 17 + 36 + 62} \\ &= 4.37 \end{aligned}$$

The mean score of 4.37 represents the participants' overall opinion numerically. The mean score shows that the average level of agreement is relatively high, since it is closer to "agree" than "maybe" on the response scale. This indicates that, on average, respondents showed a favourable attitude toward the idea that high indoor air quality benefits building inhabitants. This shows that a sizable number of people polled believe that maintaining adequate interior air quality is helpful to those who occupy the building.



The following is a summary of the mean scores:

**Table 5: List of rating of relationship between IAQ and occupant satisfaction**

No	Rating of IAQ and occupant satisfaction	Mean Score
1.	Overall satisfaction with IAQ	3.73
2.	Importance of IAQ toward occupant satisfaction	4.29
3.	Ventilation system in the building provides fresh/clean air	3.71
4.	Impact of IAQ toward building occupant	4.37

Overall, the data shows that IAQ has a considerable impact on occupant happiness within a structure. Occupants place a high value on IAQ, which is favourably related to their overall contentment. The slightly lower mean score for ventilation system performance, on the other hand, implies that there may be opportunity for development in this area to further improve IAQ and occupant comfort.

Building managers and owners should prioritise and invest in adequate ventilation systems and IAQ maintenance measures to improve occupant satisfaction. Regular maintenance, filtration, and optimum ventilation design are critical in providing inhabitants with a healthy and comfortable interior environment. Regularly monitoring IAQ data can also assist in identifying possible issues and ensuring ongoing improvement in the overall IAQ of the facility.

## **DISCUSSION AND ANALYSIS**

Based on the information received from the questionnaire, the link between IAQ and building occupant satisfaction is an important consideration when evaluating the overall indoor air quality. The first dataset is the "Rating of overall satisfaction with indoor air quality," with a mean score of 3.73 on a Likert scale ranging from "very dissatisfied" to "very satisfied." This data represents the tenants' subjective estimate of their IAQ satisfaction levels. Overall, the mean score indicates a modest level of pleasure. The second dataset, "Importance of indoor air quality," has a mean score of 4.29 on a Likert scale ranging from "not important" to "extremely important." This statistic illustrates inhabitants' perceptions of the importance they place on IAQ. The comparatively high mean score implies that inhabitants place a high value on IAQ in their overall happiness with the indoor environment. The third dataset is the "Rating of ventilation system," which has a mean score of 3.71 on a scale of "very poor" to "excellent." This data focuses on the occupants' assessment of the ventilation system, which is a significant component impacting IAQ. The average score indicates modest satisfaction with the ventilation system. Finally, the fourth dataset is the "Impact of indoor air quality toward building occupants," which has a mean score of 4.37 on a Likert scale ranging from "strongly disagree" to "strongly agree." This information examines tenants' perceptions of the impact of IAQ on their well-being. The comparatively high mean score suggests that inhabitants strongly agree that IAQ affects their comfort and health.

Overall satisfaction with IAQ is limited, while the emphasis placed by occupants on IAQ is very high. This shows that there is potential for development in terms of meeting occupants' expectations and increasing their satisfaction. Second, the ventilation system rating is very close to the total satisfaction rating, showing that the ventilation system is quite important in determining occupants' contentment with IAQ. As a result, boosting the ventilation system's performance and effectiveness may result in increased occupant satisfaction. Finally, the high mean score in the dataset measuring the impact of IAQ on building occupants suggests that inhabitants believe IAQ has a significant impact on their well-being. This research emphasises the importance of adequate IAQ in creating a healthy and comfortable indoor environment.

## **RECOMMENDATIONS**

Based on the information received from the questionnaire, the research can determine the respondents have a solid understanding on the importance of indoor air quality to them. The researcher should make recommendations for improvement based on the objectives, findings, and analysis.

The first recommendation to improve the quality of indoor air is to carry out regular maintenance and cleaning. This is to ensure that the HVAC (Heating, Ventilation, and Air Conditioning) systems are maintained and cleaned on a regular basis. Changing air filters, cleaning air vents and ducts, and inspecting the ventilation system for any blockages or faults that could impact air quality are all part of this process. Dust, grime, and other particles, for example, collect in the air ducts and HVAC system components over time. When the system is turned on, these particles can be pumped into the indoor air, resulting in lower air quality and perhaps provoking allergies or respiratory disorders in inhabitants. Regular cleaning aids in the removal of toxins, preventing their redistribution into living areas.

Furthermore, the space should have adequate ventilation. This is to optimise the ventilation system of the building in order to provide a consistent supply of fresh air and effective elimination of interior contaminants. Consider employing demand-controlled ventilation to modify ventilation rates based on occupancy levels and assessments of indoor air quality. For example, air purification systems with HEPA filters can supplement ventilation efforts by eliminating particles and contaminants from the interior air in locations where outdoor air quality is poor or in places with unique air quality problems.

## **CONCLUSION**

To summarise, improving the indoor air quality and occupant satisfaction at UiTM Seri Iskandar necessitates a multifaceted approach that involves education, awareness, system upgrades, maintenance, and continual evaluation. Implementing the aforementioned ideas will contribute to occupiers' well-being and productivity by creating a healthier and more comfortable indoor environment. This research concludes that, with good performance of IEQ in the buildings. Therefore, proactive measures should be taken to monitor, maintain, and improve IAQ in office spaces.

Finally, indoor air quality is critical in determining occupant contentment and well-being. Positive indoor air quality has been related to increased levels of comfort, productivity, and overall contentment among building inhabitants. Poor IAQ, on the other hand, might have negative health consequences and lower levels of enjoyment. Understanding the significance of indoor air quality (IAQ) and applying effective techniques to improve it are critical for creating healthier and more enjoyable indoor environments for occupants. Building owners, designers, and occupiers must collaborate to ensure that IAQ is given top priority in all indoor spaces.

## **ACKNOWLEDGEMENT**

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Tarikh : 20 Januari 2023

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Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”

Saya yang menjalankan amanah,

**SITI BASRIYAH SHAIK BAHARUDIN**  
Timbalan Ketua Pustakawan

*nar*

*Setuju.*

*27.1.2023*

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