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INVESTIGATION ON INDOOR ENVIRONMENTAL QUALITY (IEQ) IN DIFFERENT TYPES OF CLASSROOMS IN UITM SERI ISKANDAR PERAK

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ABSTRACT

This research focuses on the indoor environmental quality (IEQ) in classrooms located in UiTM Seri Iskandar. The aim of this research is to identify possible solution that contribute to a better IEQ. The objective of this research is to investigate the level of IEQ parameters in selected classroom which is standard classroom, lecture hall and computer lab. An observation method is employed, utilizing a specialized equipment which is 4 in 1 meter and sound level meter to collect the data of IEQ elements. The research's findings appear to indicate the current IEQ conditions in the selected classrooms may be unsatisfactory, which can have an impact on student satisfaction and academic performance. Several major recommendations are made to overcome these challenges and provide a suitable learning environment. Based on the research findings, recommendations are provided to enhance IEQ conditions in classroom. These include improving the ventilation system, improving on maintenance of the building especially HVAC systems, and always monitor the level of IEQ. By implementing these recommendations, management can make informed decision-making about which variables are the most critical to ensure the maximum level of student satisfaction and performance if they have a better grasp of how these variables affect students' satisfaction and performance.

Keywords: Indoor, environmental, condition, IEQ

INTRODUCTION

Indoor Environmental Quality (IEQ)

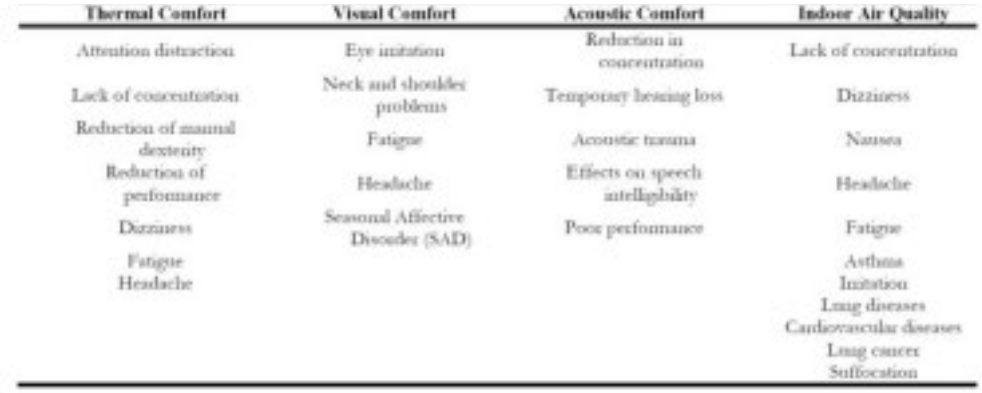
Indoor Environmental Quality (IEQ) is a significant component of people's health and well-being, particularly in institutions, where vulnerable populations spend a significant amount of time (Alexandri, 2016). According to the National Institute for Occupational Safety and Health (NIOSH), Indoor environmental quality (IEQ) is the quality of a building's environment as it relates to the health of its occupants. In addition to Indoor Air Quality, IEQ refers to acceptable levels of thermal, visual, and sound comfort (Zuhaib et al., 2018). Vital elements that influence Indoor environmental quality (IEQ), including lighting quality, air quality, thermal comfort, and sound quality. A variety of environmental parameters influence occupant acceptance of an environment. Thermal comfort, indoor air quality (IAQ), sound and visual comforts are defined as four main components for assessing acceptable indoor environmental quality (IEQ) (Lee et al., 2012). Following the Energy Performance Buildings Directive, there is now a greater emphasis on energy efficiency in both existing and new buildings. However, improving energy efficiency does not guarantee improved IEQ (Zuhaib et al., 2018). The provision of a significant level of Indoor Environmental Quality is a critical aspect in achieving healthy environments in buildings (IEQ). Ventilation is crucial to sustaining thermal comfort and IAQ (Lee et al., 2012).

PROBLEM STATEMENT

According to research, approximately 80% of human life is spent in buildings, whether at work, school, recreational facilities, or mostly in their homes (Wan Yusoff & Sulaiman, 2014). So, most of the time, students spend their life in classroom. However, in fact, most development planning and management do not prioritise IEQ. Building owners frequently do not consider improving IEQ as a tactic of lowering operating costs, and only focusing on immediate maintenance and operation (Zuhaib et al., 2018). Such irresponsible behaviour degrades a building's indoor environmental quality and affecting students' health and learning performance. Despite an increasing number of IEQ research, there is still a lack of knowledge on the impact of IEQ on student learning performance in air-conditioned classrooms (Lee et al., 2012). There are still students who encounter with sick building syndromes (SBS), which affect the learning process and resulting in bad academic performance.

Effects of Indoor Environment

The World Health Organization (WHO) have analysed and measured the effects of the indoor environment on human health and performance on a global scale. Because their bodies are still growing and developing, schoolchildren, particularly younger ones, are more susceptible to poor IEQ than adults (Alexandri, 2016). Adult students, on the other hand, are also exposed to low IEQ, which has an impact on their academic performance.



Thermal Comfort	Visual Comfort	Acoustic Comfort	Indoor Air Quality
Attention distraction	Eye irritation	Reduction in concentration	Lack of concentration
Lack of concentration	Neck and shoulder problems	Temporary hearing loss	Dizziness
Reduction of manual dexterity	Fatigue	Acoustic trauma	Nausea
Reduction of performance	Headache	Effects on speech intelligibility	Headache
Dizziness	Seasonal Affective Disorder (SAD)	Poor performance	Fatigue
Fatigue			Asthma
Headache			Irritation
			Lung diseases
			Cardiovascular diseases
			Lung cancer
			Suffocation

Figure 1: Effects of IEQ Parameters on Building Occupants (WHO)

Component of IEQ

Indoor Environmental Quality (IEQ) refers to the quality of the indoor environment and its impact on building occupants' health, comfort, and well-being. Thermal comfort, lighting, sound, and IAQ are just a few of the parameters that might have an impact on IEQ. Too high or too low humidity and temperature levels can cause discomfort and health problems for occupants. Inadequate ventilation can contribute to poor air quality and respiratory difficulties, therefore proper ventilation is critical to maintaining appropriate IEQ. Lighting and noise levels can have an impact on occupant comfort and productivity as well. Inadequate lighting can cause eye strain and headaches, while excessive noise can cause stress and decreased work productivity.

- Thermal Comfort

  The physical environmental parameters in naturally ventilated and conditioned environments are referred to as thermal comfort. It is defined as "the state of mind in which satisfaction with the thermal environment is expressed" (ASHRAE, 2013). Thermal comfort can be defined by air temperature, air velocity, relative humidity, and human perception of whether they want it to be cooler or warmer to be comfy (Dascalaki et al., 2009). The four physical environmental elements that determine thermal comfort are air temperature, mean radiant temperature, air velocity, and relative humidity,

whereas clothing value and metabolic rate are considered personal parameters. In compared to visual, sound, and indoor air quality, thermal comfort is the most recognized factor for evaluating interior comfort (Frontczak & Wargocki, 2011).

- Lighting Comfort

  Light can influence building users' comfort levels in a variety of ways, and it is extremely crucial for productivity. In terms of adequate lighting conditions, visual comfort counts for the occupant's work efficiency. Visual comfort is a subjective assessment that is affected by characteristics such as illumination, luminance and brightness, luminous spectrum, and glare risk (Zuhaib et al., 2018). The existence of a good visual environment can improve the occupants' well-being and productivity (Serghides et al., 2015). Uncomfortable lighting conditions can occur. Poor lighting can cause fatigue, drowsiness, nausea, eye irritation, and other symptoms (Naziatul et al., 2011). Lighting conditions, which include both electric and daylight sources, as well as ambient and task usage, have long been a significant IEQ parameter in the built environment. Each of these elements plays a distinct function in evaluating user experiences in the built environment.

- Sound Comfort

  Sound comfort is the existence of a pleasant acoustic environment without any distracting noises (Frontczak & Wargocki, 2011). Sound comfort is seen as critical for the IEQ of non-domestic buildings and is often preferred by occupants in workplaces and classrooms (Sakellaris et al., 2016). Acoustic comfort is a fundamental requirement for a high-quality indoor environment.

  Noise is described as unwelcome and obtrusive sounds. One of the major pressures is frequent and excessive noise. Unpleasant rises in noise levels can have a negative impact on the indoor environment's quality (Rahman et al., 2020). Noise pollution can cause stress and health effects like dizziness. Noise and vibration travel in a wave motion that can be irritating psychologically and can come from the outside, engineering services, or from person to person (Naziatul et al., 2011).

- Indoor Air Quality (IAQ)

  Indoor air quality, according to the Malaysian Department of Occupational Safety and Health (DOSH), describes how indoor air impacts people's health, comfort, and ability to work. Temperature, humidity, mould, bacteria, poor ventilation, or exposure to other chemicals are all examples. In the past, indoor air pollution received little attention in comparison to outdoor air pollution. It is now an increasing public issue, owing in part to the advent of

additional indoor air contaminants, the separation of the indoor environment from the natural outdoor environment in a well-sealed office building, and the evaluation of sick building syndrome (Rahman et al., 2020). IAQ has been shown to have both immediate and chronic impacts on the health of occupants (Zuhaib et al., 2018). It is directly strongly linked to ventilation rates and pollutant concentrations, which are related to Sick Building Syndrome (SBS) (Jurado et al., 2014).

Standard benchmarks on the IEQ elements of academic building

Table 1: Benchmark IEQ Elements of Academic Buildings (Sulaiman et al., 2013)

IEQ Measurement Elements	Reading Standard Set
Temperature	23 – 26 °C
Relative humidity	55 – 70 %
Sound	50 – 70 dB
Light	300 – 500 Lux
Air movement	0.15 – 0.50 m/s

RESEARCH METHODOLOGY

The research is about investigation on Indoor Environmental Quality (IEQ) in different types of classrooms which is standard classroom, lecture hall and computer lab. These spaces are selected for case study because students spend most of their times in classroom. The research will be carried out at UiTM Seri Iskandar selected classrooms. Those chosen classrooms have their own indoor environment characteristics that will have an effect on students, either good or else.

Research design and strategy

The aim of this research is to identify possible solution that contribute to a better indoor environmental quality (IEQ) in UiTM Seri Iskandar classroom. Before

beginning to develop the research, the research strategy must be decided. The approach for this research was chosen based on the research questions and the best method for this research. The strategy can be either quantitative or qualitative research strategy.

An observation approach was chosen to be the research instrument for collecting data using tools. Scientific measurement will be used to get a true picture of the level of indoor environmental quality (IEQ) in selected classrooms. To obtain the data of parameters that have been determined such as temperature (° C), relative humidity (percentage), air velocity (m/s), level of illumination (Lux), and the level of sound intensity (dB), scientific measurements were undertaken utilising specialised tools which is 4 in 1 meter and sound level meter.

Research instrument

To obtain the data of parameters that have been determined such as temperature (° C), relative humidity (percentage), air velocity (m/s), level of illumination (Lux), and the level of sound intensity (dB), scientific measurements were undertaken utilising specialised tools which is 4 in 1 meter and sound level meter.

Research limitation

Specialized tools such as 4in1 meters and sound level meters are borrowed from the UiTM instrument laboratory. Because many students also borrow tools, the number of available tools is limited.

RESULT AND DISCUSSION

This chapter analyses the data of the scientific measurement of IEQ in case study building. The scientific measurements performed in the research by measuring parameters such as temperature (° C), relative humidity (percentage), air velocity (m/s), level of illumination (Lux), and the level of sound intensity (dB). Three types of classroom were selected in UiTM Seri Iskandar and the measurement is done in two days. Readings are taken three times in each type of classroom to get the average daily reading. The first reading is taken between 8:00 a.m. to 10:00 a.m., the second reading is taken between 12:00 p.m. to 1:00 p.m., and third reading is taken between 3:00 p.m. to 5:00 p.m. The measurements were taken during the process of lecture to obtain accurate reading and better results.

The outcome measurement of IEQ elements in selected classrooms in UiTM Seri Iskandar is summarized in Table 2 below. These results are based on the average of three readings measurement in each type of classroom.

Table 2: Summary of Scientific Measurement Results

No.	Type of Classroom	Temperature (°C)	Relative Humidity (%)	Sound Intensity (dB)	Lighting (Lux)	Air Movement (m/s)
Standard Benchmark		**23 - 26**	**55 - 70**	**50 - 70**	**300 - 500**	**0.15 – 0.50**
1.	Lecture hall	21	67	54	280	0.1
2.	Computer lab	17	65	72	342	0.1
3.	Standard classroom	25	64	65	309	0.4

: Readings below standard benchmark

: Readings above standard benchmark

Lecture hall

According to the findings of scientific measurements, it can be shown that the readings of IEQ elements of lecture hall did not fully comply with the standards benchmark. Temperature, lighting intensity, and air movement inside lecture hall are the elements of IEQ that below the standards benchmark. However, the temperature of the room is not far below the standard. And then, the outdoor temperature also affects the body heat level. Since the weather in Seri Iskandar is very hot, it causes students to feel that the low room temperature is comfortable for them. Next, the reason lighting intensity does not comply with the standards are because the high of the ceiling is more than 3 meters and the room only has small skylight to allow natural lighting from sunlight. Other than that, there are bulbs that did not work and no maintenance that has been done despite it has been going on for quite some time. Plus, some bulbs are not functioning properly. This is most likely because of the lifetime of the out-of-date but still-in-use bulb. However, the reading of lighting intensity is not far below standards. Furthermore, the level of satisfaction is subjective due to the fact that everyone's level of vision is different. Some have clear vision, some don't. Next, air movement inside lecture hall is below standards because there

is no cross air circulation. However, the humidity level and sound intensity are compiled to the standards.

Computer lab

According to the findings of scientific measurements, it can be shown that the readings of IEQ elements of computer lab did not fully comply with the standards benchmark. Temperature, and sound intensity inside computer hall are the elements of IEQ that below the standards benchmark. Next, the sound intensity of the room exceeds the standards because of the noise from HVAC system. Meanwhile, the other elements, which is light intensity, humidity and air movement are comply to the standards and respondents were satisfied with all the three parameters.

Standard classroom (Annex 1)

According to the findings of scientific measurements, it can be shown that the readings of IEQ elements of standard classroom are fully comply with the standards benchmark. Temperature of the room is between the standards which 23 – 26 °C. Humidity level of the room is also in good condition and did not affect students' performance during the learning process. Next, light intensity of the room is also in good condition. Then, sound intensity, air movement of the room also complies to the standards.

CONCLUSION

This research identified the level of IEQ on various IEQ elements in classrooms by scientific measurement. This IEQ research at UiTM classrooms is very crucial in ensuring that the teaching and learning environment is comfortable and conducive. This research is expected to contribute to increasing awareness of IEQ performance in academic buildings on campus in order to develop a sustainable campus.

Thermal comfort, lighting, sound, and IAQ are the parameters that might have an impact on IEQ. Too high or too low humidity and temperature levels can cause discomfort and health problems for occupants. Inadequate ventilation can contribute to poor air quality and respiratory difficulties, therefore proper ventilation is critical to maintaining appropriate IEQ. Lighting and noise levels can have an impact on occupant comfort and productivity as well. Inadequate lighting can cause eye strain and headaches, while excessive noise can cause stress and decreased work productivity. Despite this, creating a comfortable thermal environment is frequently seen as the most significant aspect in obtaining overall satisfaction with IEQ (Frontczak & Wargocki, 2011).

These were the issues found when monitoring the classroom such as:

- Indoor temperatures of computer lab and lecture hall are below standards set.
- Irregular intensity of lighting in lecture hall referring to guideline.
- Level of noise in the computer lab exceeds the guideline.
- Air movement in lecture hall and computer lab are below standards set.

RECOMMENDATION

According to the issues listed in the conclusion, the improvements of thermal environment at the classroom have to be carried out. The air ventilation systems of the classroom have to be improved to ensure the air quality inside the classroom always in good condition. Other than that, improving on maintenance of the building especially HVAC systems. Poor maintenance will affect the building's environment quality and it highly influences productivity and wellbeing of the facility management (Sulaiman, Yusoff, Pawi, et al., 2013). Apart from HVAC system, facility management should maintain the lighting fixtures such as changing the bulbs that did not work. They should give priority on the maintenances aspect as this will affect the core business of university. Other suggestion is facility management should always monitor the level of IEQ in classrooms by referring to the guidelines. So, that will ensure the highest level of building users' satisfaction.

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