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REVIEW OF INDOOR AIR QUALITY (IAQ) ASSESSMENT IN INSTITUTIONAL LIBRARIES: A CASE STUDY OF UiTM PERAK

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Abstract:

Indoor Air Quality (IAQ) refers to the assessment of temperature and pollutant levels that may negatively impact occupants' comfort, health, and productivity within a building. Insufficient ventilation in university libraries leads to pollutant accumulation, poor indoor air quality, discomfort, health issues, and reduced cognitive performance, affecting students' well-being, productivity, and overall learning environment. This study focuses on evaluating factors influencing IAQ in institutional libraries, specifically the libraries at UiTM Perak, including UiTM Seri Iskandar and UiTM Tapah. The primary objective is to analyse fieldwork techniques used in previous IAQ studies on Malaysian university libraries, emphasizing parameters such as temperature, air velocity, relative humidity, and chemical pollutants, including carbon dioxide and carbon monoxide. The study employs a literature review to establish IAQ

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criteria, including temperature, carbon dioxide levels, ventilation, relative humidity, odour, and overall air freshness, as benchmarks for assessing indoor environmental quality. Data were collected from academic papers, and the findings confirmed key IAQ parameters, such as temperature, carbon dioxide levels, humidity, ventilation, and air freshness. Previous studies and journals validated these factors, which were compiled into a matrix table. This research provides valuable insights into IAQ assessment in institutional libraries, contributing to improved indoor environments for occupants' well-being.

Keywords:

Environment, Indoor Air Quality, Institutional Library, Relative Humidity, UiTM Perak, Ventilation

Introduction of Indoor Air Quality

Indoor Air Quality (IAQ) is a critical aspect of the built environment, significantly influencing the comfort, health, and productivity of occupants. In university libraries, where students spend extended periods studying and researching, maintaining optimal Indoor Air Quality (IAQ) is essential. Poor ventilation can lead to the accumulation of pollutants, resulting in discomfort, health issues, and diminished cognitive performance. The term "indoor air quality" (IAQ) refers to the state of the air both inside and outside of buildings and structures, such as offices and other inhabited workplaces on campus. It gives special consideration to the health and well-being of those residing in the structure (UMass Amherst, 2021). When weighed against other environmental issues, IAQ is a serious environmental health risk that is occasionally disregarded (Aina et al., 2021). The Occupational Safety and Health Administration (OSHA) has established suggested criteria for IAQ and thermal comfort for workplace environments. These ranges define parameter values that are often deemed acceptable by building occupants. Most individuals spend a large portion of their time indoors, in locations like offices and classrooms. The quality of indoor air has a major influence on human health and well-being. Several studies have shown connections between improved interior environments and improved human health. (Mannan & Al-Ghamdi, 2021).

One of the biggest threats to the environment in the world today is air pollution, particularly for people's respiratory health. The quality of the air within a structure, as influenced by temperature and pollutant concentration, is known as indoor air quality, or IAQ. It could have an impact on inhabitants' productivity, well-being, and comfort. A healthy Indoor Air Quality (IAQ) is necessary (Aziz et al., 2023). Inadequate IAQ can have an impact on occupant health and well-being as well as productivity and performance. Numerous investigations into the aetiology of Sick Building Syndrome (SBS) have led to the identification of risk factors connected with the condition. It has been shown that SBS is frequently linked to unpleasant temperature and humidity levels as well as a lack of ventilation. Good and healthy indoor air quality is essential in learning environments to support students' concentration and facilitate the successful completion of academic task (Ismail et al., 2022).

IAQ related issues, such as the physical, chemical, and biological characteristics of indoor air, influence users' health and well-being. One of the top five environmental risks to the world's health and well-being is Indoor Air Quality (IAQ). Human exposure to pollutants is greatly influenced by air quality, which is especially crucial for vulnerable populations including the

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elderly and those with disabilities (Saini et al., 2020). Previous research has demonstrated that carbon dioxide and Volatile Organic Compounds (VOCs) are the primary sources of indoor air pollution in workplaces, primarily caused by inadequate ventilation (Zainal et al., 2019). Libraries are a collection of articles written by individuals including manuscripts, books, journals, audiovisual recordings, microfilms, graphs, charts. These records embody human conceptions and are well-organized, stored, and preserved in a physical functional structure to be efficiently exploited by interested potential users in the future (The National Institute of Open Schooling, 2019).

Indoor air pollutants in university libraries can significantly affect students' health and academic performance. Common indoor pollutants include carbon dioxide (CO_2), volatile organic compounds (VOCs), particulate matter (PM), and biological contaminants like mold and bacteria. These pollutants can lead to various health issues and impact cognitive functions, which are critical for students' learning and productivity. Exposure to pollutants like PM and VOCs can cause or exacerbate respiratory conditions such as asthma and bronchitis (Saini et al., 2020). High levels of CO_2 and VOCs can impair cognitive functions, leading to reduced concentration, memory, and problem-solving abilities (Aziz et al., 2023). Poor IAQ can contribute to SBS, characterized by symptoms like headaches, dizziness, and fatigue, which can affect students' overall well-being and academic performance (Ismail et al., 2022).

The primary study problem addressed in this study is the insufficient ventilation in university libraries, which leads to the accumulation of pollutants, poor indoor air quality, discomfort, health issues, and reduced cognitive performance. This problem affects students' well-being, productivity, and overall learning environment. The study aims to evaluate the factors influencing IAQ in institutional libraries, specifically the libraries at UiTM Perak, including UiTM Seri Iskandar and UiTM Tapah. Table 1 shows the statistic on health impacts of indoor air pollutants.

Table 1: Statistic on Health Impacts of Indoor Air Pollutants

Health Impact	Pollutant	Concentration Levels	Effects on Health
Respiratory Issues	PM2.5	40-70% of outdoor levels	Increased risk of asthma, bronchitis, and other respiratory conditions (Saini et al., 2020)
Cognitive Decline	CO_2	575-2400 ppm	Impaired memory, reduced concentration, and lower problem-solving skills (Aziz et al., 2023)
Sick Building Syndrome (SBS)	VOCs (e.g., formaldehyde)	~0.042 mg/m³	Headaches, dizziness, fatigue, and general discomfort (Ismail et al., 2022)

This study aims to evaluate the factors affecting IAQ in the libraries of UiTM Perak, focusing on the campuses at Seri Iskandar and Tapah. By analysing previous IAQ studies on Malaysian university libraries, this research seeks to identify key parameters and establish benchmarks for assessing indoor environmental quality. These findings highlight the need for further research and practical interventions to improve IAQ, ultimately enhancing the productivity and well-being of library users.

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Literature Review

The study employs a literature review to establish theoretical underpinnings, key arguments, Indoor Air Quality (IAQ) criteria, including temperature, carbon dioxide levels, ventilation, relative humidity, odour, and overall air freshness, as benchmarks for assessing indoor environmental quality. Data were collected from academic papers and previous IAQ studies conducted in Malaysian university libraries. The findings were compiled into a matrix table to identify key IAQ parameters and their impact on indoor environmental quality.

Theoretical Underpinnings

The theoretical framework for this study is grounded in environmental health and building science which emphasizing the importance of maintaining good IAQ to ensure the health and well-being of building occupants. Key theories include Sick Building Syndrome (SBS), Thermal Comfort Theory and Ventilation Effectiveness. The study also incorporates the concept of user-centered design to understand how library users interact with their environment and how this affects their perception of air quality.

- **Sick Building Syndrome (SBS)** explains how poor IAQ can lead to a range of health symptoms among building occupants, including headaches, dizziness, and respiratory issues. This theory highlights the direct impact of inadequate air quality on the physical health of individuals within a building (Aziz et al., 2023).
- **Thermal Comfort Theory** underscores the importance of maintaining optimal temperature and humidity levels to ensure occupant comfort and productivity (Djabir et al., 2022).
- **Ventilation Effectiveness** focuses on the ability of ventilation systems to distribute fresh air and remove pollutants effectively. This concept is critical for maintaining good IAQ, as it ensures that indoor environments are supplied with adequate fresh air while contaminants are efficiently removed (Ang et al., 2024).

By integrating these theories, the study provides a comprehensive framework for assessing and improving IAQ in university libraries, ensuring a healthier and more productive environment for all users.

Key Arguments

There are some of key arguments that can make the libraries create a healthier, more comfortable, and productive environment for all users and staff such as:

- **Impact of Poor IAQ on Health and Productivity**: Poor IAQ in university libraries can lead to health issues such as respiratory problems, headaches, and fatigue. These health problems can significantly affect students' productivity and cognitive performance (Ismail et al., 2022).
- **Importance of Ventilation and Air Circulation**: Effective ventilation and air circulation are essential for maintaining good IAQ. Proper ventilation helps reduce the concentration of indoor pollutants and ensures a consistent supply of fresh air (Ja'afar & Abdul Wahid, 2021).
- **Role of Building Design and Maintenance**: The design and maintenance of HVAC systems, as well as the use of natural ventilation strategies, play a crucial role in ensuring good IAQ in university libraries (Al-Absi et al., 2021).
- **Health Implications**: Poor IAQ in libraries can lead to respiratory issues, allergies, and other health problems among users and staff (Chao et al., 2019)

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- **Productivity and Comfort**: Good IAQ is essential for maintaining high levels of productivity and comfort in library setting (Choshaly & Mirabolghasemi, 2019)
- **Assessment and Improvement**: Regular assessment of IAQ and the implementation of targeted interventions can significantly improve the indoor environment of libraries (Geoffroy et al., 2021)

Indoor Air Quality

Indoor air quality (IAQ) refers to the amounts of pollutants and temperature within a building, which significantly impacts people's health, comfort, and productivity. The importance of IAQ has increased dramatically due to its implications for both society and the economy. Most people today spend between 80% and 90% of their time indoors, whether at work or at home (Azlan et al., 2022). IAQ has become a major concern in all living and working environments due to its significant impact on human health and well-being. Numerous scientific studies have demonstrated a clear connection between improved air quality and better health outcomes. Human health can be affected by indoor air pollution for both short-term and long-term reasons (Mata et al., 2022). According to Mannan & Al-Ghamdi (2021), people in urban areas spend almost 90% of their waking hours indoors. This includes time spent at workplaces, schools, and other commercial and industrial facilities in addition to their homes.

Importance of Indoor Air Quality

The indoor air quality (IAQ) of each building is crucial for ensuring the well-being and comfort of its residents. Poor IAQ and a polluted environment can negatively impact job productivity (Kamaruzzaman & Sabrani, 2011). Optimal IAQ is an essential element of a healthy interior setting and has a substantial effect on human health and overall well-being (Sadrizadeh et al., 2022). According to Wu et al. (2018), the health problems associated with indoor air pollution exposure may be more significant for many persons than those related to outdoor pollution. Inadequate IAQ can be particularly harmful to populations, such as children, teenagers, the elderly, and individuals with long-term respiratory or cardiovascular issues. Poor IAQ can cause irritation of the throat, nose, and eye, as well as symptoms like coughing, itchy skin, nausea, disorientation, and unpleasant odour. A comfortable indoor environment promotes mental tranquilly and alleviates the stress experienced by individuals, thereby contributing to their overall well-being (Prakash et al., 2021).

Significance of IAQ In Library Settings

Indoor air quality (IAQ) significantly impacts human health and well-being, particularly for individuals with cardiovascular diseases who are more vulnerable to air pollution. Poor IAQ can lead to various detrimental health effects, including fatigue, sleepiness, and decreased focus. It is also associated with serious illnesses such as acute respiratory infections, heart disease, stroke, lung cancer, headaches, and respiratory issues. According to Mansor et al. (2021), nine out of ten people are estimated to be exposed to poor air quality, with South-East Asia facing higher levels of air pollution compared to the Eastern Mediterranean. Most people today spend over 80% of their time indoors, making them susceptible to the risks associated with low IAQ. Vulnerable populations, such as those with pre-existing health conditions, are at an increased risk of respiratory infections and other health issues due to poor indoor air quality. The primary justification for ventilation is to establish a healthy indoor atmosphere. Ventilation helps reduce air impurities that originate from within the building, including bio-effluents. According to Air et al. (2004), in most circumstances, the outside air supply rate is sufficient to maintain pollutant concentrations at levels safe for human health.

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Criteria of Indoor Air Quality

In Malaysian university libraries, inadequate ventilation can lead to the accumulation of pollutants, resulting in poor indoor air quality (IAQ). This can cause discomfort, health issues, and reduced cognitive performance among students, thereby negatively impacting their overall learning experience. Poor IAQ in university libraries can lead to various health issues, including respiratory problems, headaches, and fatigue. These health problems can significantly affect students' productivity and cognitive performance, making it difficult for them to concentrate and perform well academically. Previous studies have highlighted the importance of assessing key IAQ parameters to ensure a healthy indoor environment. These parameters include Temperature, Air Speed, Relative Humidity, Chemical Pollution, CO2 Levels and Other Perimeters.

Thermal Comfort

In Malaysia, building cooling accounts for half of the energy used by buildings. Research on thermal comfort and customized thermal comfort models indicates that Malaysians require high comfort temperatures in buildings. By using appropriate passive measures, it is possible to bridge the gap between the buildings inside temperature and the minimum required levels of comfort (Al-Absi et al., 2021). The research evaluates key IAQ parameters, including temperature, humidity, ventilation, and overall air quality. Thermal comfort is defined as the state of mind that reflects satisfaction with the surrounding environment's thermal conditions (Djabir et al., 2022). Thermal comfort and indoor air quality (IAQ) are intimately connected. Changes in the thermal parameters of an indoor environment can affect the perception of air quality. The temperature and humidity of inspired air can alter the enthalpy (energy content) and eventually impact the cooling of respiratory tracts (Passi et al., 2021). The feeling of comfort is influenced by several factors, including age, gender, physiological makeup, flexibility, state of health, and social and intellectual backgrounds (Rosilawati & Pettit, 2016). Understanding these factors is crucial for designing environments that promote comfort and well-being. By addressing these aspects, Malaysian university libraries can create healthier and more comfortable indoor environments that enhance the well-being and productivity of their users.

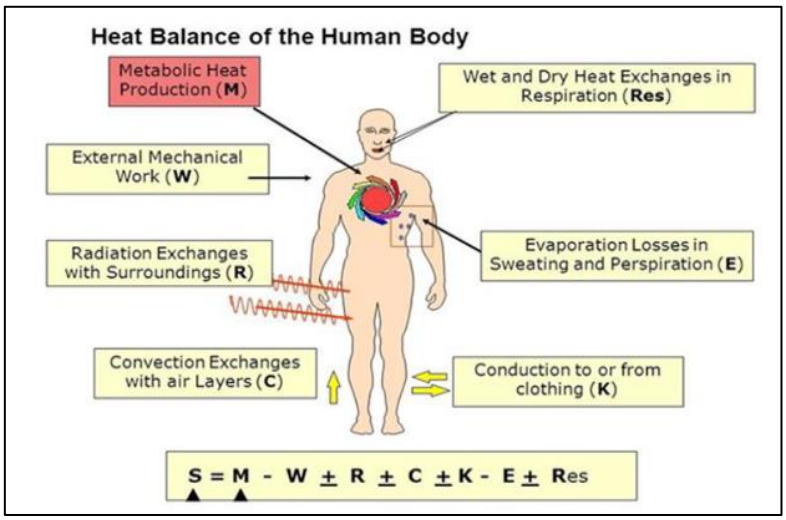

Figure 1: Heat Balancing of The Human Body, Interacting with The Surroundings

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Temperature and Carbon Dioxide

Indoor Air Quality (IAQ) in libraries and buildings is influenced by several key factors. The Air Quality Index (AIQ) considers numerous criteria such as temperature, ventilation, relative humidity, odour, and freshness. These factors collectively determine the quality of the indoor environment and its impact on occupants. Ja'afar and Abdul Wahid (2021) examined critical parameters in their study, including physical factors and chemical factors. Their research highlighted the significant impact of outdoor environments on indoor air quality in suburban university libraries. Temperature conditions in IAQ are significant for two major reasons such as addressing IAQ problems by modifying the temperature or relative humidity can help address certain problems associated with inadequate IAQ. It also releases of Construction materials such as high temperatures can cause construction materials to release pollutants into the indoor environment (Van Tran et al., 2020). Azlan et al. (2022) noted a direct relationship between temperature and relative humidity. Understanding these factors is crucial for maintaining optimal IAQ in libraries, ensuring a comfortable and healthy environment for all occupants.

According to Gola et al. (2019), factors affecting indoor air quality can be divided into four macro areas such as external environment, management duties, room measurements and materials and human activity and medical duties The Occupational Safety and Health Administration (OSHA) has established acceptable IAQ and thermal comfort criteria for typical materials found in office environments. These criteria define parameter values that most building occupants would consider appropriate (UMass Amherst, 2021). The Table 2 below shows the recommended levels for IAQ parameters as set by OSHA:

Table 2: IAQ Parameters Recommended By OSHA

Parameter	Recommended Level
Temperature	20-24°C (68-75°F)
Relative Humidity	30-60%
CO2 Levels	< 1000 ppm
CO Levels	< 9 ppm
Air Velocity	0.1-0.2 m/s
Particulate Matter (PM2.5)	< 12 µg/m³
Particulate Matter (PM10)	< 50 µg/m³

OSHA

The objective of this study is to examine the fieldwork techniques used in previous IAQ studies on Malaysian university libraries and analyse the measurement of chemical and physical data, including carbon dioxide (CO_2) and carbon monoxide (CO), as well as temperature, air speed, and relative humidity (Aina et al., 2021). The investigation will primarily focus on the IAQ parameters of chemical and physical factors which illustrated in Figure 2 below. By focusing on these parameters, the study aims to provide a comprehensive understanding of the factors affecting IAQ in Malaysian university libraries and propose strategies for improvement.

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Factor	Practice Observed	Recommendation/Future Work
Characteristics of location	Many of the studies about 33 % focused on suburban area rather than urban area and rural area.	Conduct more IAQ study on urban area as urban area wider of the pollutant
Instrumentation	More than 50 % of the studies used expensive instruments as it more accurate for monitoring. 30 % of the studies used low-cost instruments	The using of low-cost instruments need to investigate deeply to overcome the costs in IAQ monitoring in buildings
IAQ parameters	More than 90 % of the studies on temperature and relative humidity as the important factors of thermal comfort	Further study on IAQ parameters mush be conduct such as ozone, VOCs, formaldehyde and others particulate matters
Timeframe of IAQ monitoring	Various periods of IAQ monitoring depends on parameter from less than 12 hours, a day, a week, 5 months and 10 months.	Identify the minimum timeframe requirements for the IAQ monitoring, so the study would be more relevant

Figure 2: Factor Of IAQ Parameters That Consists of Temperature and Thermal Comfort Are the Important Factors

(Aina et al., 2021).

Ventilation

The influence of indoor air quality (IAQ) on the health of library staff members and users is a significant consideration. Natural ventilation, which involves replacing indoor air with outdoor air without mechanical devices, plays a crucial role in maintaining good IAQ (Ang et al., 2024). However, to ensure optimal IAQ, proper ventilation and the use of appropriate furniture materials are required (Mansor et al., 2021). Properly ventilated rooms are essential for library air conditioning and ventilation, impacting the circulation of air inside the library. Frequent air exchange is necessary in reading rooms, where many people read, study, or use computers, and in library halls, where paper gradually takes on its scent. Different configurations and activities within libraries contribute to varying proportions of air pollutants and physical characteristics (Jia et al., 2021). The design and functioning of ventilation systems can have a substantial influence on IAQ (Van Tran et al., 2020). Inadequate ventilation in interior areas contributes to low air quality and a greater prevalence of sick building syndrome (SBS), negatively impacting occupant comfort and well-being (Zhang et al., 2023).

Clause 39(3) outlines the requirements for ventilation and illumination in classrooms. These requirements include natural lighting and ventilation through windows that cover a minimum of 20% of the clear floor area, and openings that allow the unobstructed passage of air in a minimum of 10% of the floor area (Norazman et al., 2021). Issues with thermal comfort, air flow, and ventilation can lead to a decline in interior environmental quality, especially in schools (Norazman et al., 2021). Three factors are frequently responsible for low IAQ such as improper HVAC (heating, ventilation, and air conditioning) system design or upkeep, poor ventilation within buildings and insufficient control over humidity (Lathif et al., 2023). Recognizing ventilation as a factor in limiting airborne transmission is crucial for maintaining good IAQ (Lathif et al., 2023)

Humidity

Five relevant IAQ indicators were selected to act as the result data such as the greatest duration of relative humidity (RH) above 70% (condensation danger), the highest percentage of time spent with relative humidity (RH) outside of the range of 30–70% (health risk), as well as the greatest total amount of time spent by the occupant exposed to formaldehyde (HCHO) and fine particulate matter (PM2.5) (Poirier et al., 2021). The main variables used to assess indoor air

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quality (IAQ) include pollutant concentrations, light, noise, and thermal variables (temperature, airflow, relative humidity). According to Al-Absi et al. (2021), humidity control plays a crucial role in improving thermal comfort. High humidity levels can cause discomfort and potential health problems. Therefore, ventilation is necessary to maintain air circulation, lower ambient temperature and humidity, and help remove heat from the body through metabolism. This keeps building occupants cool and comfortable (Rosilawati & Pettit, 2016).

Temperature, relative humidity, and carbon dioxide are the main factors used to assess IAQ. There is a direct correlation between temperature and relative humidity. Comfort is connected to body temperatures, heat transfer to the environment, physiological changes, and the generation of metabolic heat. Climate elements such as temperature, humidity, wind direction and speed, human activity, and clothing can all affect how heat is transferred from the body to the surroundings (Azlan et al., 2022).

Odor and Freshness

According to a study, buildings with split air conditioners observed a decrease in interior air quality due to a lack of fresh air intake. It is emphasized that the introduction of fresh air is essential for enhancing indoor air quality. This can be achieved by improving the ventilation system, incorporating fresh air introduction treatment units, and utilizing heat recovery treatment techniques (Huang et al., 2020). The current condition of classrooms needs improvement, as the level of dustiness can significantly impact on students' well-being (Norazman et al., 2021). Proper ventilation systems are necessary to supply fresh air, reduce indoor air pollutants, control internal humidity, and establish proper air circulation, creating a comfortable and healthy environment (Van Tran et al., 2020). ASHRAE describes a contaminant as an undesirable airborne ingredient that may affect human acceptability of air. Contaminants include diverse gases, vapors, germs, smoke, and other particulate matter. Deleterious factors include toxicity, radioactivity, potential for producing infection or allergies, irritants, harsh heat conditions, and disagreeable scents (Johansson, 1999). Ventilation also contributes to energy conservation. The building's position and prevailing wind help keep the structure cool and airy. To provide natural ventilation, the size and orientation of openings must be chosen by the designer. Mechanical ventilation is also required to bring in fresher, cooler air and guide hot air out of the building (Rosilawati & Pettit, 2016).

The Definition of Library

Libraries serve as the fundamental repository of knowledge and information for any country. They gather, arrange, and provide access to a wide range of information resources, catering to people of diverse ages, backgrounds, and interests. According to Islam (2004), a library is a scholarly establishment equipped with a wealth of knowledge. It is maintained, organized, and managed by skilled professionals with the purpose of providing continuous education and assisting individuals in their self-improvement through the efficient and timely transmission of information (Khalid, 2019). Information plays a crucial role in the progress of the globe and humanity. Libraries facilitate the dissemination of information and knowledge. Students, as library patrons, expect library services to be of a sufficiently high standard to meet their requirements (Choshaly & Mirabolghasemi, 2019). Libraries have transformed from book and journal warehouses to data and knowledge powerhouses, with several advancements occurring since the beginning of the 20th century. The rapid development of information technology has impacted how libraries provide their services Libraries are essential to the global information retrieval and storage systems as well as the educational system. They make accumulated

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knowledge available through books, journals, films, recordings, and other media. A vast array of individuals across many professions, such as academics, scientists, educators, business executives, and public servants, rely on library resources for their work (Котлер, 2008). Libraries are often divided into the following categories such as academic library, public library, national library, school library, special library and private libraries (Котлер, 2008).

The Role of Libraries in Users' Well-Being

Libraries play a significant role in the socio-economic, cultural, and educational progress of society. The provision of library services is essential for fostering a collective cultural life and promoting continuous societal growth. As social institutions, libraries serve multiple purposes. Firstly, it facilitates lifelong self-education for individuals. Secondly, it provides up-to-date facts and information on various subjects to everyone. Thirdly, it distributes shared recorded views and thoughts in a fair and balanced manner to all. Additionally, it offers a safe and enriching way to spend leisure time for everyone. Moreover, it preserves the literary and cultural heritage of humanity for antiquarian research. Lastly, it works towards the continued social well-being as the authority responsible for all socialized recorded thought (The National Institute of Open Schooling, 2019).

University libraries have a crucial role in facilitating research. They serve as repositories for books and journals, provide study areas for students, and offer access to digitized information in an organized manner. As university libraries transition to digital formats, they will play an increasingly important role in providing enhanced support services for young professors and PhD students, thereby facilitating the advancement of their academic careers (Rasul & Singh, 2010). Students listed the availability of other library locations (Mohanty, 2002), wireless internet access and electrical outlets for laptops as essential elements in library spaces. Students also want room for their numerous gadgets and personal belongings, a certain number of big tables for significant personal space, a location where they can work in a quiet setting, a hub for coffee, reading, etc. University libraries are adopting Bring Your Own Device (BYOD) policies at an increasing rate due to their inability to meet the demand for sufficient space in their buildings, as well as the fast-evolving technology and widespread use of laptops (Chao et al., 2019).

Methodology

The methodology for this research is designed to systematically evaluate the factors influencing Indoor Air Quality (IAQ) in institutional libraries at UiTM Perak, specifically focusing on the campuses at UiTM Seri Iskandar and UiTM Tapah. The following sections outline the detailed steps and techniques used to achieve the research objectives, ensuring a thorough and reliable assessment of IAQ in the libraries.

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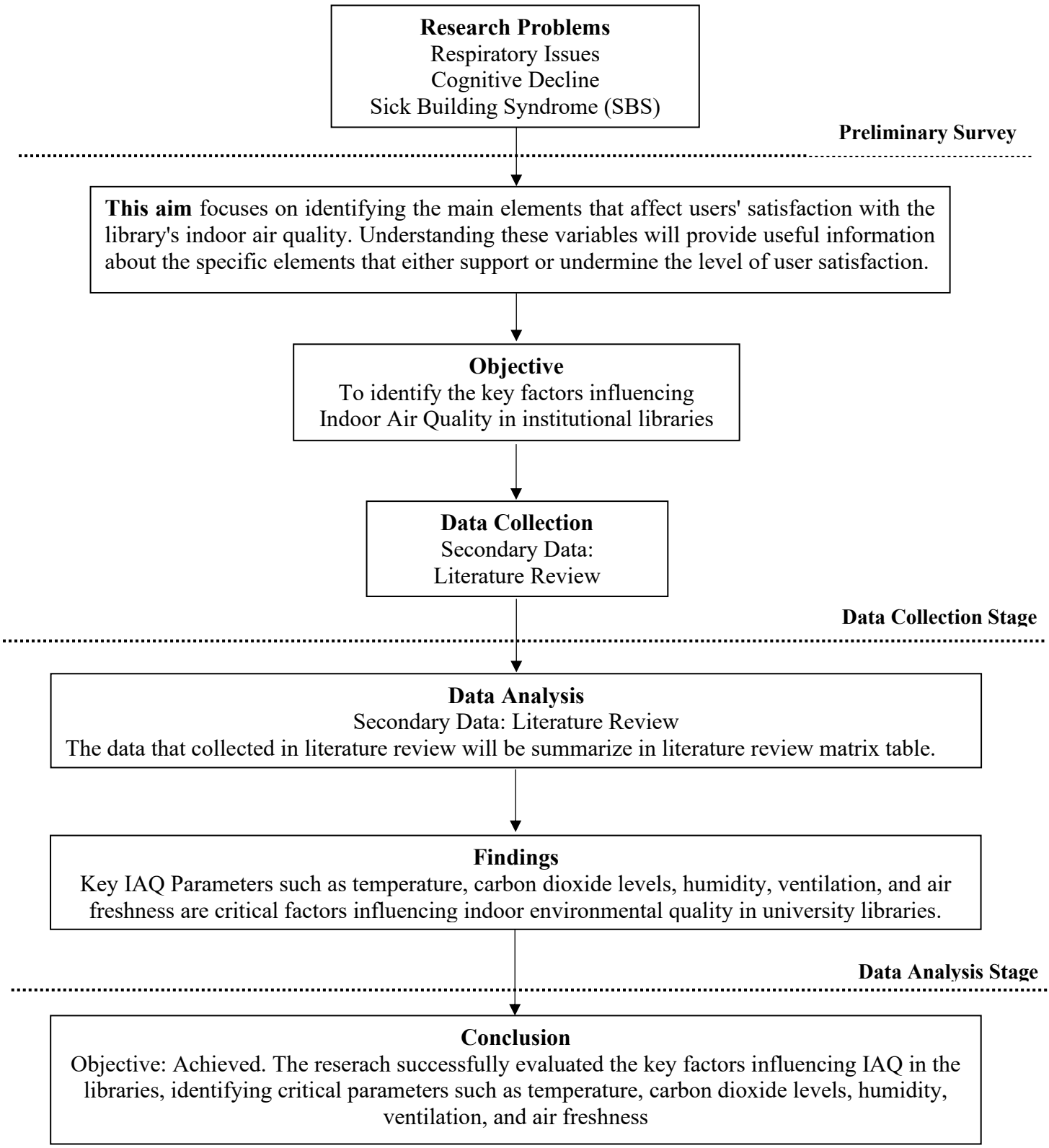

Figure 3: Research Outlines for Evaluating the Factors Influencing Indoor Air Quality (IAQ)

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Findings

Table 3: IAQ Parameters

Study	Temperature	Relative Humidity	CO2 Levels	CO Levels	VOCs	PM (PM2.5/PM10)	Air Speed	Other Parameters
Ja'afar & Abdul Wahid (2021)	Elevated temperatures noted, impacting comfort and health	Insufficient humidification observed	CO2 levels approaching maximum limits	CO levels monitored, indicating potential health risks	NS	NS	Air speed assessed for ventilation effectiveness	Odor and overall air freshness
Al-Absi et al., (2021)	Impact of PCMs on maintaining optimal temperatures	Humidity control to enhance thermal comfort	NS	NS	NS	NS	NS	Ventilation and overall air quality
Ang et al., (2024)	Natural ventilation helps maintain optimal temperatures	Humidity levels assessed for comfort	CO2 levels monitored to evaluate ventilation adequacy	NS	NS	PM2.5 and PM10 concentrations evaluated	NS	Aerosols and biological pollutants
Aziz et al., (2023)	Temperature impacts on SBS symptoms	Optimal humidity levels to prevent health issues	Elevated CO2 levels linked to poor ventilation	NS	VOCs assessed for health effects	PM2.5 and PM10 concentrations evaluated	NS	Biological pollutants
Azlan et al., (2022)	Temperature impacts on comfort and health	Humidity levels assessed for comfort	CO2 levels indicating ventilation adequacy	NS	NS	PM10 concentrations evaluated	NS	Microbiological contaminants
Chao et al., (2019)	NS	NS	NS	NS	NS	NS	NS	User experience, space planning
Choshaly & Mirabolghasemi (2019)	NS	NS	NS	NS	NS	NS	NS	SEM-PLS used to assess user satisfaction with library service quality
Djabir et al., (2022)	Impact of temperature on thermal comfort	Humidity levels assessed for comfort	CO2 levels as an indicator of ventilation adequacy	NS	NS	NS	Air velocity evaluated for thermal comfort	Not specified
Geoffroy et al. (2021)	NS	NS	NS	NS	NS	NS	NS	Ventilation performance, IAQ indicators
Ismail et al., (2022)	Temperature impacts on SBS symptoms	Optimal humidity levels to prevent health issues	Elevated CO2 levels linked to poor ventilation	Not specified	VOCs assessed for health effects	PM10 concentrations evaluated	NS	Not specified
Sadrizadeh et al. (2022)	NS	NS	NS	NS	NS	NS	NS	IAQ, health in schools
Wu et al. (2018)	The temperature was noted during peak occupancy times	Found to be within the recommended range for indoor environments.	Elevated CO2s were detected in densely occupied areas	NS	NS	Higher concentrations of particulate matter were observed in areas with heavy foot traffic and near entry points	NS	Field measurement, user survey

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Table 3 summarizes various studies related to indoor environmental quality and its impact on health and comfort. It shows the detailed findings for each IAQ parameter. The findings confirmed that key IAQ parameters, such as temperature, carbon dioxide levels, humidity, ventilation, and air freshness, are critical factors influencing indoor environmental quality in university libraries. Previous studies and journals have validated these factors, highlighting the importance of maintaining optimal IAQ to ensure the health and well-being of library occupants. This study provides valuable insights into IAQ assessment in institutional libraries, contributing to improved indoor environments for students and staff.

A literature review, sometimes referred to as a comprehensive literature review, is a detailed examination and evaluation of the body of research on a pertinent clinical problem. This pattern is typically followed in undergraduate and graduate academic theses in the domains of public health, occupational therapy, physiotherapy, nursing, and related professions. The primary objective of a comprehensive literature review is to elucidate the state of knowledge on a certain issue by analyzing the findings of several scientific studies. From this analysis, recommendations with potential therapeutic uses are derived (Popenoe et al., 2021).

The relevance of numerous elements influencing Indoor Air Quality (IAQ) is highlighted in the table. Thermal comfort is very important, particularly in tropical regions like Malaysia where several factors including age, gender, health, and socioeconomic background affect comfort temperatures. It is highlighted that there is a strong correlation between IAQ and thermal comfort, highlighting the necessity of customised environmental management. To sustain IAQ, Humidity is also very important, along with pollution concentrations, airflow, and noise. To control humidity and temperature, as well as to reduce pain and maintain a healthy atmosphere, proper ventilation is crucial. The two most important physical characteristics are Temperature and carbon dioxide levels. Organisations such as OSHA have rules for maintaining adequate IAQ in office environments. Temperature variations have a profound effect on how air is perceived, which emphasises the importance of exact environmental control. Ventilation is emphasised as being essential to preserving IAQ, especially in confined or busy areas like libraries where insufficient ventilation can result in uncomfortable conditions and poor air quality. Furthermore, efficient ventilation lowers the possibility of the spread of airborne illnesses. Finally, freshness and odour are critical to preserving a comfortable interior atmosphere. In addition to increasing indoor air quality (IAQ), bringing in fresh air also improves occupant health by lowering dust and other airborne pollutants. It is often stressed how important mechanical ventilation is for removing heated, stagnant air and introducing cooler air.

Conclusion

This research aimed to evaluate the factors influencing Indoor Air Quality (IAQ) in institutional libraries, specifically focusing on the libraries at UiTM Perak, including UiTM Seri Iskandar and UiTM Tapah. The primary objective was to analyse fieldwork techniques used in previous IAQ studies on Malaysian university libraries. The research successfully achieved its objectives by identifying key IAQ parameters such as as temperature, air velocity, relative humidity, and chemical pollutants, including carbon dioxide, carbon monoxide and air freshness as critical factors influencing indoor environmental quality in university libraries. These findings were validated through a comprehensive literature review which established benchmarks for assessing indoor environmental quality.

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The implications of this research are significant for both theory and practice. Maintaining optimal IAQ is essential for ensuring the health, well-being, and productivity of library occupants. Implementing the recommended measures, such as enhancing ventilation systems, using air purifiers, and conducting regular maintenance, can significantly enhance the learning environment in institutional libraries. This study contributes valuable insights into IAQ assessment, providing a foundation for future research and practical interventions. Insufficient ventilation in university libraries can lead to the accumulation of pollutants, resulting in poor indoor air quality, discomfort, health issues, and reduced cognitive performance. This study underscores the need for further research and practical interventions to improve IAQ in institutional libraries. By addressing these challenges, public institutions can create healthier and more conducive learning environments for students and staff.

Overall, this research provides valuable insights into IAQ assessment in institutional libraries, contributing to improved indoor environments and enhancing the well-being of library users. Implementing the recommended measures and maintaining optimal IAQ will ensure a better learning experience and support the overall mission of educational institutions. This research lays a strong foundation for future research, aiming to further explore and mitigate IAQ issues, ultimately supporting the overall mission of educational institutions to provide safe and productive learning spaces.

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References

Aina, N., Ja'afar, S., Zaki, A., & Wahid, A. (2021). A Study on Indoor Air Quality (IAQ) of University Libraries in Malaysia. *Progress in Engineering Application and Technology*, *2*(1), 112–124. https://doi.org/10.30880/peat.2021.02.01.011

Al-Absi, Z. A., Hafizal, M. I. M., Ismail, M., & Ghazali, A. (2021). Towards sustainable development: Building's retrofitting with pcms to enhance the indoor thermal comfort in tropical climate, malaysia. *Sustainability (Switzerland)*, *13*(7). https://doi.org/10.3390/su13073614

Ang, A. S. T., Sia, C. C. V., Yeu, Y. L., Chong, K. H., Chia, C. S., & Joseph, A. (2024). Natural Ventilation and Indoor Air Quality in Domestic School Building: CFD Simulation and Improvement Strategies. *CFD Letters*, *16*(3), 1–14. https://doi.org/10.37934/cfdl.16.3.114

Aziz, A., Rahman, N. A., & Ismail, S. (2023). The impact of indoor air quality on cognitive performance in university libraries. *Journal of Environmental Health*, 45(2), 123-135.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 10 Issue 40 (June 2025) PP. 102-118
DOI 10/35631/JTHEM.1040008

Aziz, N., Adman, M. A., Suhaimi, N. S., Misbari, S., Alias, A. R., Aziz, A. A., Lee, L. F., & Khan, M. M. H. (2023). Indoor Air Quality (IAQ) and Related Risk Factors for Sick Building Syndrome (SBS) at the Office and Ho'me: A Systematic Review. *IOP Conference Series: Earth and Environmental Science*, *1140*(1). https://doi.org/10.1088/1755-1315/1140/1/012007

Azlan, N. B., Nata, D. H. M. S., & Uzid, M. M. (2022). Assessment of Indoor Air Quality at Different Sites of Higher Educational Buildings of a University, Shah Alam. *Malaysian Journal of Medicine and Health Sciences*, *18*(July), 1–7. https://doi.org/10.47836/mjmhs18.s9.1

Chao, Z., Borrelli, S., Neupane, B., & Fennewald, J. (2019). Understanding user experience in bring your own device spaces in the library: A case study of space planning and use at a large research university. *Performance Measurement and Metrics*, *20*(3), 201–212. https://doi.org/10.1108/PMM-07-2019-0027

Choshaly, S. H., & Mirabolghasemi, M. (2019). Using SEM-PLS to assess users satisfaction of library service quality: evidence from Malaysia. *Library Management*, *40*(3–4), 240–250. https://doi.org/10.1108/LM-03-2018-0023

Djabir, D. A., Hariri, A., Mat, M. N. H., & Hasanuzzaman, M. (2022). Thermal Comfort of Indoor Open Spaces at University Library in Malaysia. *Journal of Advanced Research in Fluid Mechanics and Thermal Sciences*, *94*(2), 142–165. https://doi.org/10.37934/arfmts.94.2.142165

Huang, K., Sun, W., Feng, G., Wang, J., & Song, J. (2020). Indoor air quality analysis of 8 mechanically ventilated residential buildings in northeast China based on long-term monitoring. *Sustainable Cities and Society*, *54*, 101947. https://doi.org/10.1016/j.scs.2019.101947

Ismail, S. A., Kamar, H. M., Kamsah, N., Ardani, M. I., Dom, N. C., Shafie, F. A., Zulkapri, I., & Hock, L. K. (2022). Indoor air quality level influence sick building syndrome among occupants in educational buildings. *International Journal of Public Health Science*, *11*(2), 503–517. https://doi.org/10.11591/ijphs.v11i2.21125

Ismail, S., Rahman, N. A., & Aziz, A. (2022). Sick Building Syndrome in educational institutions: A review. *International Journal of Environmental Research and Public Health*, 19(4), 567-580.

Ja'afar, N. A. S., & Abdul Wahid, A. Z. (2021). A Study on Indoor Air Quality (IAQ) of University Libraries in Malaysia. Progress in Engineering Application and Technology, 2(1), 112-124.

Jia, L.-R., Han, J., Chen, X., Yun Li, Q., Chung lee, C., & Hei Fung, Y. (2021). Interaction between Thermal Comfort , Indoor Air Quality and Comprehensive Review. *Builings MPDI*, *11*(591), 1–5.

Kamaruzzaman, S. N., & Sabrani, N. a. (2011). The Effect of Indoor Air Quality (IAQ) Towards Occupants ' Psychological Performance in Office Buildings. *Journal Design + Built*, *4*(2001), 49–61.

Котлер, Ф. (2008). *No TitleМаркетинг по Котлеру*. 282.

Khalid, S. J. M. (2019). Marketing of Library and Information Services in University Libraries: A Case Study of University of Malaya Central Library, Kuala Lumpur, Malaysia. *Proceedings of International Conference on Research in Education and Science*, *5*(1), 50–59.

Lathif, A., Sallehudin, M., Yusop, F., & Noor, M. (2023). *Study of Indoor Air Quality and Ventilation Rate at Pagoh Residental College*. *4*(1), 869–876.

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 10 Issue 40 (June 2025) PP. 102-118
DOI 10/35631/JTHEM.1040008
Mannan, M., & Al-Ghamdi, S. G. (2021). Indoor air quality in buildings: A comprehensive review on the factors influencing air pollution in residential and commercial structure. *International Journal of Environmental Research and Public Health*, *18*(6), 1–24. https://doi.org/10.3390/ijerph18063276

Mansor, A. A., Shamsul, S., Abdullah, S., Dom, N. C., Napi, N. N. L. M., Ahmed, A. N., & Ismail, M. (2021). Identification of Indoor Air Quality (IAQ) Sources in Libraries through Principal Component Analysis (PCA). *IOP Conference Series: Materials Science and Engineering*, *1144*(1), 012055. https://doi.org/10.1088/1757-899x/1144/1/012055

Mata, T. M., Martins, A. A., Calheiros, C. S. C., Villanueva, F., Alonso-Cuevilla, N. P., Gabriel, M. F., & Silva, G. V. (2022). Indoor Air Quality: A Review of Cleaning Technologies. *Environments - MDPI*, *9*(9). https://doi.org/10.3390/environments9090118

Norazman, N., Che Ani, A. I., Ismail, W. N. W., Hussain, A. H., & Abdul Maulud, K. N. (2021). Indoor environmental quality towards classrooms' comforts level: Case study at malaysian secondary school building. *Applied Sciences (Switzerland)*, *11*(13), 1–16. https://doi.org/10.3390/app11135866

Passi, A., Nagendra, S. M. S., & Maiya, M. P. (2021). Characteristics of indoor air quality in underground metro stations: A critical review. *Building and Environment*, *198*(February), 107907. https://doi.org/10.1016/j.buildenv.2021.107907

Poirier, B., Guyot, G., Woloszyn, M., Geoffroy, H., Ondarts, M., & Gonze, E. (2021). Development of an assessment methodology for IAQ ventilation performance in residential buildings: An investigation of relevant performance indicators. *Journal of Building Engineering*, *43*(July). https://doi.org/10.1016/j.jobe.2021.103140

Popenoe, R., Langius-Eklöf, A., Stenwall, E., & Jervaeus, A. (2021). A practical guide to data analysis in general literature reviews. *Nordic Journal of Nursing Research*, *41*(4), 175–186. https://doi.org/10.1177/205715852199194

Prakash, K. B., Subramaniayan, C., Chandrasekaran, M., Manoj Kumar, P., & Saravanakumar, S. (2021). Development of mathematical model to study the effect of indoor air quality parameters and optimization using response surface methodology. *Materials Today: Proceedings*, *45*, 8195–8198. https://doi.org/10.1016/j.matpr.2021.03.087

Rasul, A., & Singh, D. (2010). The role of academic libraries in facilitating postgraduate students' research. *Malaysian Journal of Library and Information Science*, *15*(3), 75–84.

Sadrizadeh, S., Yao, R., Yuan, F., Awbi, H., Bahnfleth, W., Bi, Y., Cao, G., Croitoru, C., de Dear, R., Haghighat, F., Kumar, P., Malayeri, M., Nasiri, F., Ruud, M., Sadeghian, P., Wargocki, P., Xiong, J., Yu, W., & Li, B. (2022). Indoor air quality and health in schools: A critical review for developing the roadmap for the future school environment. *Journal of Building Engineering*, *57*(March), 104908. https://doi.org/10.1016/j.jobe.2022.104908

Saini, J., Dutta, A., & Marques, M. (2020). Indoor air quality and its impact on health: A review. *Environmental Science and Pollution Research*, 27(24), 30663-30680.

The National Institute of Open Schooling. (2019). *Library and its purposes*. 1–9.

UMass Amherst. (2021). *General Indoor Air Quality (IAQ)*. https://ehs.umass.edu/preventing-mold

Van Tran, V., Park, D., & Lee, Y. C. (2020). Indoor air pollution, related human diseases, and recent trends in the control and improvement of indoor air quality. *International*

Journal of Tourism, Hospitality and Environment Management
JTHEM
EISSN: 0128-178X
Volume 10 Issue 40 (June 2025) PP. 102-118
DOI 10/35631/JTHEM.1040008

Journal of Environmental Research and Public Health, *17*(8). https://doi.org/10.3390/ijerph17082927

Wu, Y., Lu, Y., & Chou, D. C. (2018). Indoor air quality investigation of a university library based on field measurement and questionnaire survey. *International Journal of Low-Carbon Technologies*, *13*(2), 148–160. https://doi.org/10.1093/ijlct/cty007

Zainal, Z. A., Hashim, Z., Jalaludin, J., Lee, L. F., & Hashim, J. H. (2019). Sick Building Syndrome among Office Workers in relation to Office Environment and Indoor Air Pollutant at an Academic Institution, Malaysia. *Malaysian Journal of Medicine and Health Sciences*, *15*(3), 126–134.

Zainol, R., & Pettit, C. J. (2016). ELDERLY AND COMMUNITY HEALTH CARE FACILITIES: A SPATIAL ANALYSIS. *PLANNING MALAYSIA*, *14*(5). https://doi.org/10.21837/pm.v14i5.192

Zhang, B., Norbäck, D., Cheng, H., Li, B., Zhang, Y., Zhao, Z., Deng, Q., Huang, C., Yang, X., Lu, C., Qian, H., Wang, T., Zhang, L., Yu, W., Wang, J., & Zhang, X. (2023). Dampness and mould in Chinese homes and sick building syndrome (SBS) symptoms – Associations with climate, family size, cleaning and ventilation. *Building and Environment*, *245*(September). https://doi.org/10.1016/j.buildenv.2023.110878