



**STUDY ON INDOOR AIR QUALITY AND SICK BUILDING
SYNDROME IN ACADEMIC BUILDING IN FACULTY OF
MEHCANICAL AND MANUFACTURING ENGINEERING
TECHNOLOGY, UNIVERSITY TECHNICAL MALAYSIA
MALACCA**

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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**BACHELOR OF TECHNOLOGY IN MECHANICAL
ENGINEERING (REFRIGERATION AND AIR CONDITIONING
SYSTEMS) WITH HONORS**

2022



**Faculty of Mechanical and Manufacturing Engineering
Technology**



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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this Choose an item. entitled “Indoor Air Quality and Sick Building Syndrome in Academic Building in Faculty of Mechanical and Manufacturing Engineering Technology” is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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APPROVAL

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Technology in Mechanical Engineering Technology (Refrigeration and Air-Conditioning System) with Honours.

Signature : *AzwanAziz*
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Date : 27 January 2023



DEDICATION

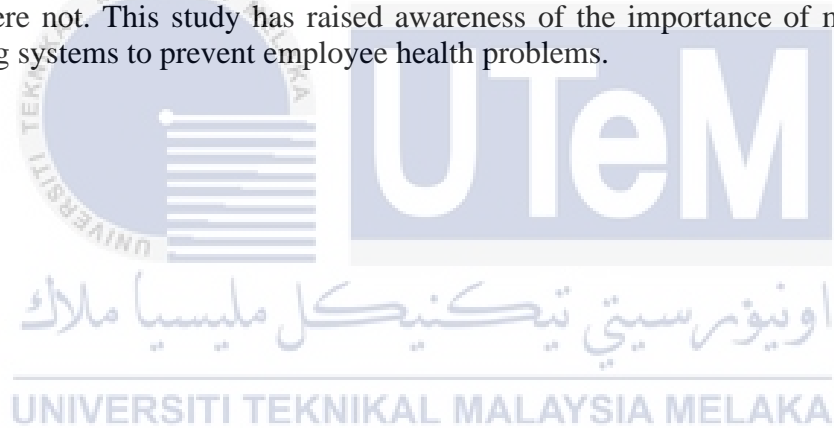
In the name of Allah, the Almighty, the Most Merciful. Nothing can ever be achieved without His will for letting it happen. This thesis work is intended for my dear parents,

Awaiah binti Mat Amri and also Mokhtar bin Yasin, who has always loved me unconditionally and for his kindness.



ABSTRACT

Sick building syndrome (SBS) is a sickness that affects employees and is linked to the amount of time they spend in a building. There are a number of factors that contribute to SBS, but the degree of indoor air quality (IAQ) has a strong link. The purpose of this study was to address the health issues that employees were having as a result of the building's air conditioning system. As a result, this study was carried out to determine the association between IAQ and SBS in the academic staff room at Universiti Teknikal Malaysia Melaka's Factory 3, FTKMP building (UTeM). A total of 21 employees took part in the survey to learn about frequent SBS symptoms such dry eyes, itching eyes, watering eyes, eyes strain and runny nose. In each work unit in the library, objective measurements of IAQ levels such as air temperature, carbon dioxide (CO₂), dust level (PM_{2.5}), and relative humidity (percent RH) were taken. These measurements took place during November and December of 2022. When the IAQ values were compared to the 2010 industry code of conduct, it was discovered that CO₂ and PM_{2.5} were still within the stated requirements, but that the other parameter readings were not. This study has raised awareness of the importance of maintaining air conditioning systems to prevent employee health problems.



ABSTRAK

Sindrom bangunan sakit (SBS) ialah penyakit yang menjejaskan pekerja dan dikaitkan dengan jumlah masa yang mereka habiskan di dalam bangunan. Terdapat beberapa faktor yang menyumbang kepada SBS, tetapi tahap kualiti udara dalaman (IAQ) mempunyai kaitan yang kuat. Tujuan kajian ini adalah untuk menangani isu kesihatan yang dialami pekerja akibat sistem penghawa dingin bangunan. Hasilnya, kajian ini dijalankan untuk menentukan perkaitan antara IAQ dan SBS di bilik staf akademik di Kilang 3 Universiti Teknikal Malaysia Melaka, bangunan FTKMP (UTeM). Seramai 21 pekerja mengambil bahagian dalam tinjauan untuk mengetahui tentang gejala SBS yang kerap seperti mata kering, mata gatal, mata berair, mata lebam dan hidung berair. Dalam setiap unit kerja di perpustakaan, pengukuran objektif tahap IAQ seperti suhu udara, karbon dioksida (CO₂), paras habuk (PM_{2.5}), dan kelembapan relatif (peratus RH) telah diambil. Pengukuran ini berlaku pada bulan November dan Disember 2022. Apabila nilai IAQ dibandingkan dengan kod kelakuan industri 2010, didapati bahawa CO₂ dan PM_{2.5} masih berada dalam keperluan yang dinyatakan, tetapi bacaan parameter lain tidak. Kajian ini telah meningkatkan kesedaran tentang kepentingan menyelenggara sistem penyaman udara bagi mengelakkan masalah kesihatan pekerja.

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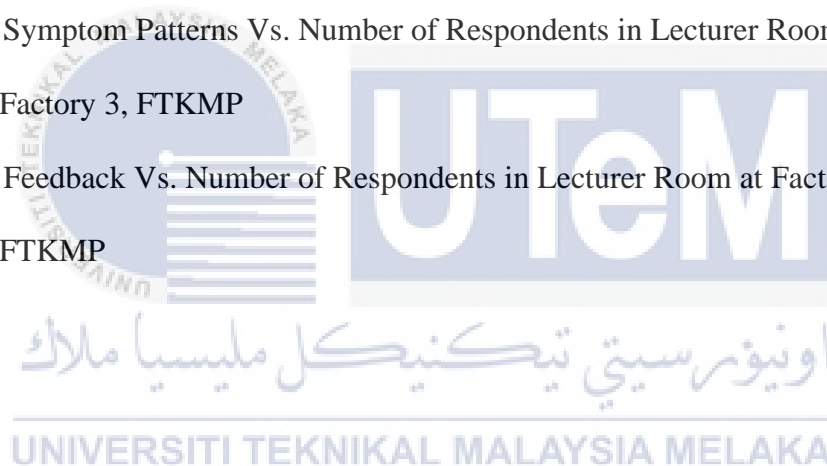
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LIST OF SYMBOLS AND ABBREVIATIONS

ACH	-	Air change per hour
CO ₂	-	Carbon dioxide
CO	-	Carbon monoxide
HCHO	-	Formaldehyde
IAQ	-	Indor air quality
mg/m ³	-	Miligram per cubic meter
ICOP	-	Industry Code of Partice on Indoor Air Quality
MICOP	-	Malaysia Industry Code of Partice on Indoor Air Quality
MVAC	-	Mechanical ventilaion and air conditioning
ppm	-	Parts per million
PM _{2.5}	-	Particular matter
SBS	-	Sick Building Syndrome
TVOC	-	Total volatile organic compound
%RH	-	Relative Humidity
°C	-	Degree celcius
<	-	Not less than
GL	-	Ground Level
FL	-	First Level
CI		

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CHAPTER 1

INTRODUCTION

1.1 Background

Sick building syndrome began to be realized in the 1960s and was officially recognized as a disease in the 1970s. The World Health Organization classified it as a medical disorder in 1983, and various countries have reported an increase in the number of cases since then. Sick Building Syndrome, Indoor Air Quality Industry Code of Practice (2010) (SBS) is characterized as a disease that appears to have something to do with occupant time spent in the structure. The causes of this disease are unknown, and it cannot be cured.

Despite the fact that most Malaysian buildings are energy efficient and have air conditioning systems, SBS has become ubiquitous in our country. This is a result of poor heating, ventilation, and air conditioning (HVAC) system maintenance and services, which results in a reduction in indoor air quality and an increase in indoor air pollutants (IAP).

SBS and indoor air quality (IAQ) have a strong relationship. Poor IAQ can result in more health complaints than predicted, and as a result, the general public has become more worried about IAQ since they are aware that exposure to insufficient supplied air and indoor air contaminants might endanger their health. IAQ problems are frequently caused by insufficient dispersion of fresh air throughout the conditioned space or a low room ventilation rate.

This study concentrated on buildings with air conditioning systems because the majority of SBS cases were documented in buildings with air conditioning systems. Although there are a variety of potential causes for SBS, air conditioning systems are by far the most common. Furthermore, subtropical climates like Malaysia have an extensive growth of air-conditioned buildings, which will help raise awareness about the importance of maintaining good IAQ and provide guidance toward a healthy working environment.

Therefore, this research was designed to determine the association between symptoms of SBS and IAQ parameters. This research is expected to raise awareness of the importance of maintaining a good IAQ and provide guidance towards a healthy workspace environment.

1.2 Problem Statement

Mostly, people spend more than 80% of their time indoor, whether at work or at home (Yang *et al.*, 2007). As a result, indoor air quality must be maintained, otherwise the IAQ may deteriorate, posing a health risk to the employee. Despite the opposite of normal or basic ventilation rates, IAQ problems can arise due to indoor air pollutants or poor pollution control, according to ICOP by DOSH (2010). A weak IAQ can cause serious health concerns, such as SBS in this case. Although SBS does not have long-term effects on those affected, its symptoms tend to worsen with time spent in sick buildings, leading to increased absenteeism and reduced productivity due to poor health.

It is necessary to attain good IAQ since it will lessen occupant SBS complaints. To do this, the air conditioning system must function effectively, ensuring that the two buildings receive a suitable amount of fresh air supply and reasonable air return. Without a proper assessment of the air conditioning system in the academic staff room, according to the Department of Occupational Safety and Health's (DOSH) Industry Code of Practice (ICOP) 2010, the

conditioned space's indoor air quality will deteriorate day by day, and occupants will be the ones to suffer the consequences, such as being affected by SBS symptoms.

As a result, the focus of this research is on resolving health issues among office workers who are affected by the building's air conditioning system. SBS among residents will increase if this issue is disregarded and no effort is made, and more airborne microorganisms will spread readily. As a result, the purpose of this study was to determine the status of IAQ and SBS among occupants in the academic staff room at Factory 3, as well as their relationship with the air conditioning system, using selected parameters. This research may aid in raising awareness among UTeM employees about the necessity of good indoor air quality and the importance of maintaining an air conditioning system.

1.3 Objectives

To determine the association between IAQ parameters symptoms of SBS in Academic Building at Faculty of Mechanical and Manufacturing Engineering Technology, University Technical Malaysia Malacca. Specifically, the objectives are as follows:

- a) To measure the level of IAQ parameter (CO₂, TVOC, PM_{2.5}, air temperature and relative humidity) at Academic Building, FTKMP
- b) To identify the symptoms of SBS (dry eyes, itching eyes, watering eyes, eyes strain, blocked or stuffy nose, runny nose, itching gace without rash and irritated skin) among academic of FTKMP.
- c) To related the association IAQ parameters and symptoms of SBS status.

1.4 Scope

The study population consisted of academic staff workstations in Universiti Teknikal Malaysia Melaka, Melaka. The results were compared with input from the Indoor Air

Quality Code of Practice (ICOP) 2010 of the Department of Occupational Safety and Health, Malaysia (DOSH Industry) to see if the values complied with the guidelines.

In November 2022, cross-sectional research was undertaken among room owner staff at Factory 3 (UTeM) to determine the most frequently reported ill building syndrome symptoms. At the study site, there were fifty-two (52) employees in the sample population. To get the data, universal sampling was utilised to pick potential workers, and purposive sampling was employed to obtain sixteen sections of staff units in the staff room. The above-mentioned objective measurements as well as subjective evaluations were examined and correlated with Factory 3's air conditioning system.



CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

A healthy indoor environment requires good IAQ. The quality of the indoor environment is critical for the occupants of a building to execute their jobs comfortably. Assume IAQ happens when there are indoor air pollutants in the environment that are a significant problem for the general population, particularly office building occupants. When employees are subjected to poor indoor air quality, they experience symptoms or health concerns known as Sick Building Syndrome (SBS), which frequently improve once they leave the building (Fauzan *et al.*, 2016).

The most crucial ingredient for human life on Earth is air. For example, in order to live a better life, humans must inhale air, particularly clean air. However, the consequences of urban outdoor and interior air pollution have been linked to more than 2 million premature deaths (WHO, 2003). According to various research on human exposure to air pollutants indoors, indoor air pollutants are higher than outside air pollutants (Brooks *et al.*, 1992). Because most individuals spend their time indoors, indoor air quality (IAQ) has become more significant (Taneja *et al.*, 2008).

2.2 Air conditioning system

Air conditioning system problems are often proposed by researchers with a mission to identify the main causes of ineffective or even weak IAQ. The system and its ability to carry

out the task are questionable. Before assess the ability of the air conditioning system in maintaining air quality, the system itself benefits the workers in the building. Air conditioning systems are developed to save lives. Air conditioning system with mechanical ventilation system serves as mixing, distribution and also air filtration. In addition, it also presents humidity and temperature control for human benefit. In general, air-conditioning systems are suppliers of clean and air -conditioner air with appropriate quantity and quality (Wang, 2001).

There is evidence showing the ability in reducing the percentage of deaths by preventing deaths from the direct effects of heat stroke. Although Chicago has seen several hot summers since 1995, the fatality rate has not approached that of that July. This is due to increased public knowledge of the threat and public health measures such as outreach to vulnerable populations, as well as efforts to provide cooling facilities and air-conditioned buildings to those at risk. According to studies, mortality during American heat waves has decreased by 80% since 1960, with almost every study suggesting that the decrease in deaths is due to the deployment of air conditioning (Franklin, 2015).

2.3 Indoor Air Quality and Physical Environment Factors

2.3.1 Indoor Air Quality

Most Americans spend 90 percent of their everyday lives indoors (Lee and Chang, 2000). Because it is intimately related to human health and job efficiency, the indoor environment has a significant impact on the occupier. According to (Hall *et al.*, 1995), maintenance activities, the presence of a pollutant source, indoor humidity and temperature, ventilation rate, and seasons can all have a significant impact on IAQ. If a building's management ignores IAQ issues, it may cause more difficulties, and tenants may begin to experience symptoms of sick building syndrome (SBS). SBS is a phrase used to describe a building in

which health concerns are more common than may be expected, and it is frequently linked to poor IAQ in the workplace (Finnegan *et al.*, 1984). Some building managers regard sick building syndrome to be harmless because inhabitants can quickly recover once they leave the 'sick' structure (May 2006). As a result, this issue has not been adequately investigated and is sometimes completely overlooked. However, depending on the amount of time spent in the afflicted building, the impact of SBS can be severe (Burge *et al.*, 1987).

Between 800,000 and 1.2 million buildings in the United States alone have a characteristic that could contribute to SBS, with 30 to 70 million workers potentially affected. Such staggering results demonstrate that SBS should be given due consideration. Air cooling offices have been linked to SBS and sick personnel, as has been seen. It is critical to maintain appropriate indoor air quality to keep the occupants healthy and pleasant. If the indoor air quality is inadequate, occupants may suffer acute and long-term health consequences (Wargoeki *et al.*, 2002).

2.3.1.1 Carbon dioxide

When entering a room with low ventilation rates, a person may have difficulty breathing or may feel stuffy. The presence of less oxygen but a high quantity of carbon dioxide in the restricted space could be a contributing element to the problem. Carbon dioxide is a type of chemical molecule that is colourless and odourless. Carbon dioxide is usually produced by the burning or respiration of living organisms. Humans take in oxygen and release carbon dioxide. Other sources of carbon dioxide include automobile exhaust, gas cooking appliances, heaters, and tobacco smoke, which are all by-products of combustion. A big proportion of existing literature argues that there is a link between absenteeism and carbon dioxide levels in Boston office buildings (Myatt *et al.*, 2002). Based on **Figures 2.1** and