UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DETERMINATION OF BACKGROUND INDOOR AIR POLLUTANTS AND THERMAL COMFORT IN FACULTY OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY, UTEM

NABIL AIMAN BIN ALIAS
B091910461

BACHELOR OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY (REFRIGERATION AND AIR CONDITIONING SYSTEMS) WITH HONOURS

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NABIL AIMAN BIN ALIAS

A thesis submitted
in fulfillment of the requirements for the degree of
Bachelor of Mechanical And Manufacturing Engineering Technology Engineering Technology (Refrigeration And Air Conditioning Systems) with Honours

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2023

DECLARATION

I declare that this Choose an item. entitled Determination Of Background Indoor Air Pollutants And Thermal Comfort In Faculty Of Mechanical And Manufacturing Engineering Technology, Utem" 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.

Signature : *Nabil*

Name : Nabil Aiman bin Alias

Date : 11 January 2023

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 Mechanical and Manufacturing Engineering Technology (Refrigeration And Air Conditioning Systems) with Honours.

Signature : AzwanAziz

Supervisor Name : Ts. Azwan bin Aziz

Date : 27 January 2023

DEDICATION

This study wholeheartedly dedicates to beloved parents, who have been a source of inspiration and strengthened to complete this thesis by continually providing their moral, spiritual, emotional and financial support. This study also likes to dedicate this to the researcher supervisor who gives opportunities to complete this thesis.

ABSTRACT

The primary goal of this research was to identify the most critical factors affecting indoor air quality (IAQ) and thermal comfort in mechanical rooms in the Faculty of Mechanical and Manufacturing Engineering Technology. Sixteen different rooms in the lecturer's office at Factory 3, FTKMP Building, were analysed and studied to determine the concentrations of ozone (O3), the total volatile organic compound (TVOC), carbon dioxide (CO^2), carbon monoxide (CO), particulate matter (PM), temperature, and relative humidity. The experiment setup is based on 16 lecture rooms at Factory 3 of the Faculty of Mechanical and Manufacturing Engineering Technology, which was picked using random sampling. Descriptive analysis, time series plots, and Student T-Test were used to analyse the IAQ. In addition, the survey was provided to the lecturer of the lecture room at Factory 3 of the Faculty of Mechanical and Manufacturing Engineering Technology to assess the thermal comfort environment. Then, using linear regression, the most significant factor influencing IAQ and thermal comfort was determined.

ABSTRAK

Matlamat utama penyelidikan ini adalah untuk mengenal pasti faktor terpenting yang mempengaruhi kualiti udara dalaman (IAQ) dan keselesaan terma di dalam bilik mekanikal di Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan. Enam belas bilik berbeza di pejabat pensyarah di Kilang 3, Bangunan FTKMP telah dianalisis dan dikaji untuk menentukan kepekatan ozon (O3), jumlah sebatian organik meruap (TVOC), nitrogen dioksida (NO2), karbon dioksida (CO2), karbon monoksida (CO), bahan zarahan (PM), suhu, dan kelembapan relatif. Persediaan eksperimen adalah berdasarkan enam belas (16) bilik kuliah di Kilang 3 Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan, yang dipilih menggunakan pensampelan bertujuan. Analisis deskriptif dan plot siri masa digunakan untuk menganalisis IAQ. Selain itu, soal selidik telah disediakan kepada kakitangan bilik kuliah di Kilang 3 Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan untuk menilai persekitaran keselesaan terma. Keselesaan terma Bilik Pejabat Pensyarah di Kilang 3 Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan, sebaliknya, ditentukan menggunakan model penyesuaian, undian min ramalan (PMV), dan ramalan peratusan individu tidak berpuas hati (PPD).). Kemudian, menggunakan regresi linear, faktor paling ketara yang mempengaruhi IAQ dan keselesaan terma telah ditentukan.

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First and foremost, I want to thank and praise Allah SWT for his blessings that helped me finish my research successfully. My deepest gratitude goes out to Ts. Azwan bin Aziz, my supervisor, whose advice and constructive criticism was greatly appreciated. His prompt and effective assistance enabled me to complete my project. The author's future efforts will benefit from all the learned skills and experiences. Last but not least, I want to thank my family and friends for their unending encouragement and support during all the challenges I faced while doing this project.

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LIST OF SYMBOLS AND ABBREVIATIONS

IAQ	-	Indoor Air Quality
O3	-	Ozone
PM	-	Particulate Matter
TVOC	-	Total Volatile Organic Compound
VOCs	-	Volatile Organic Compounds
SO^2	-	Sulphur Dioxide
NO2	-	Nitrogen Dioxide
SBS	-	Sick Building Syndrome
CO^2	-	Carbon Dioxide
CO	-	Carbon Monoxide
HCHO	-	Formaldehyde
NO	-	Nitric Oxide
BTEX	-	Xylenes
Hb	-	Hemoglobin
AHU	-	Air Handling Unit
FCU	-	Fan Coil Unit
AH	-	Absolute Humidity
RH	-	Relative Humidity
HNO^3	-	Nitric Acid
AC	-	Air-Condition
HVAC	-	Heating, Ventilation & Air Conditioning.
IAP	-	Indoor Air Pollution
HAPs	-	Hazard Air Pollutions
PPD	-	Percentage of Dissatisfied
PMV	-	Predictive Mean Vote
ppm	-	Parts Per Million
MLR	-	Multiple Linear Regression
°C	-	Degree Celcius
mg/m^3	-	Miligram per meter cubic

m/s	-	Meter per second
%	-	Percent
>	-	Greater than
EVM		Environmental Monitor
BP	-	Bilik Pensyarah
FTKMP	-	Faculty of Mechanical and Manufacturing Engineering Technology
UTeM	-	Universiti Teknikal Malaysia Melaka
WHO	-	World Health Organization
ASHRAE	-	American Society of Heating, Refrigerating and Air-Conditioning Engineers
DOSH	-	Department of Safety and Health
ISO	-	International Organization for Standardization
m^2		Meter square

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

The quality of indoor air in the workplace is essential not only for the comfort of employees, but also for their health. Indoor Air Quality (IAQ) is a prevalent problem among humans, yet it is underrated, thus it is still overlooked. It is thought to be apodictic because many individuals spend the majority of their lives indoors. Various factors of their indoor environment have an impact on their health and performance. Indoor air pollution posed significant health risks. According to studies, people spend more than ninety percent of their time indoor (Warwicker, 2010). The representation of pollutant concentrations and thermal conditions that may negatively affect the health, comfort, and performance of a building's occupants is known as indoor air quality.

Numerous pollutants, such as ozone (O3), particulate matter (PM), sulphur dioxide (SO2), and nitrogen dioxide (NO2), have irritating effects that can lead to coughing, an increase in mucus production, and bronchial hyperresponsiveness. These respiratory symptoms are frequently mistaken for respiratory infections. Lack of control over indoor air pollution can result in both short- and long-term health issues, as well as decreased productivity, a degradation of the surrounding environment, and a loss of comfort. The term "Sick Building Syndrome" (SBS) refers to a collection of subjective, non-specific health symptoms, including weariness, aches and pains, scent sensitivity, and concentration issues. More specific symptoms include itchy eyes, skin rashes, and nasal allergy symptoms. Sick Building Syndrome (SBS) may have an effect on stress levels, productivity, and job satisfaction. Physical, chemical, and biological factors, as well as inadequate ventilation, all contribute to indoor air pollution. Carbon dioxide (CO_2), temperature, relative humidity (RH), formaldehyde (HCHO), respirable particulate matter (PM10), total bacteria, and primary air pollutants like sulphur dioxide (SO_2), nitric oxide (NO), and nitrogen dioxide are the common IAQ parameters that will be measured (NO_2).

The method in which a space is ventilated is another aspect that degrades the quality of indoor air.. According to Jung, Wu, Tseng & Su (2015), natural and mechanical ventilation systems are the two types of ventilation. Central air conditioning (such as Air Handling Units (AHU), Fan Cooling Units (FCU), and AHU mix FCU) and non-central air conditioning are examples of mechanical ventilation (such as window type and single-split type). In general, central air conditioning with a filtration system can be utilised to remove pollutants from the outdoors and improve indoor air quality. In addition to controlling temperature and humidity to offer thermal comfort, good ventilation systems also circulate sufficient volumes of air to occupants and eliminate contaminants. However, thermal comfort may be influenced by modifying the indoor air temperature and relative humidity, whereas Indoor Air Quality (IAQ) can be influenced by controlling the amount of fresh air admitted.

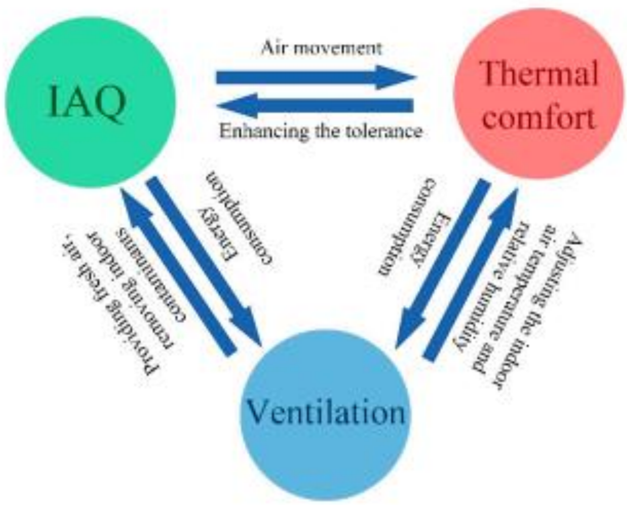

Figure 1.1 The interactions among the ventilation energy, thermal comfort and IAQ

Thermal comfort was an aspects that should be considered in a standard that aims to define acceptable indoor climates. The definition of a healthy indoor climate is crucial to a building's effectiveness, not only because it will keep its occupants comfortable, but also because it will determine the building's energy consumption and thus its sustainability.

1.2 Problem Statement

IAP is a serious health issue that claims millions of lives every year. IAP may be brought on by numerous pollutants. Thus, it is essential to identify their main sources and concentrations and to create policies for regulating and enhancing indoor air quality. Issues with a building's indoor environmental quality (IEQ) have a direct impact on people's health and productivity. Majid (2004) added that there was variable degrees of evidence linking indoor air pollution from solid fuel combustion to a number of ailments in underdeveloped countries. A new commission report states that utilising solid fuels for cooking, heating, and lighting exposes almost 3 billion people everyday to poor indoor air quality (IAQ).

This study will determine the best-selected conditions and most significant level of thermal comfort in the lecturer's office room at the Faculty of Mechanical and Manufacturing Engineering Technology, Utem. This will highlight the importance of maintaining good IAQ levels to ensure the health of the people utilizing the room. This research also benefited the maintenance of excellent health. It improved the indoor air environment of the lecturer's office room at the Faculty of Mechanical And Manufacturing Engineering Technology, Utem, by ensuring comfort.

1.3 Research Objective

The main aim of this study to determine the indoor air pollutant concentration in lecterur room at FTKMP Building based on ICOP 2010: Industry Code of Practice on Indoor Air Quality 2010. Specifically, the objectives are as follows:

1. To assess the degree of indoor air pollution and thermal comfort indicators in a lecturer office space at FTKMP

2. To determine the important variables affecting the indoor air quality and thermal comfort in a lecturer office space in the FTKMP building

3. To make a connection between thermal comfort and indoor air pollution in a lecturer office space in the FTKMP Building.

1.4 Scope of Research

The lecturer's office in the FTKMP building's indoor air quality and thermal comfort levels are the main subjects of this study. It is crucial to maintain the lecturer's office in the FTKMP building and give employees and students a clean indoor environment. The 3MTM EVM 7 Environmental Monitor Kit is the monitoring tool used to collect data on IAQ parameters. Temperature, velocity, relative humidity, total volatile organic compound and carbon dioxide, will be obtained as data parameters. These parameters are the most critical aspects of this research. The parameters that will be used to determine the level of IAQ and thermal comfort in the lecturer's office at the FTKMP building

The population size of this study was sixty-four (64) staff in Factory 3, FTKMP Building. This researcher used universal sampling to choose the potential staff that met the requirement to do this research. However, in this study, the researcher purposely chose sixteen (16) staff based on their existence and background in the office. The building is fully ventilated through mechanical ventilation, which uses air conditioning. This change variable was significant because it enhanced the pollutant concentrations that harm human health. This study will be conducted for eight days, from 10.00 a.m. to 4.00 p.m. This time was selected by presuming that the building was operating at the period that corresponded to business hours.

The data will be analyzed using descriptive analysis after the IAQ, and thermal comfort levels are monitored. Descriptive analysis is a type of analysis that can show the different levels of concentration for each condition. The thermal comfort level will be determined using a questionnaire modified from ICOP 2010 and distributed to staff, Predictive Mean Vote (PMV), and Predicted Percentage of Dissatisfied (PPD). This standard specifies the required level of thermal comfort in an indoor air environment. However, using linear regression is the most significant way to determine thermal comfort at a good level of IAQ. Linear regression was used to fit linear question data to determine the relationship between two variables.

CHAPTER 2

LITERATURE REVIEW

2.1 Indoor Air Pollution

The discharge of chemicals that are dangerous to humans and other living things into the air is referred to as indoor air pollution. Air pollutants are dangerous solids, liquids, or gases that affect the quality of our environment and are produced in large quantities. Outdoor pollutants that are frequently linked to industrial activity and automobile traffic mingle with indoor pollutants that can enter through infiltrations and natural and mechanical ventilation systems. Additionally, indoor pollutants that result from combustion sources like burning fuels, coal, wood, tobacco products, candles, the emissions from building materials and furniture, central heating and cooling systems, as well as other sources like smoking and painting, are also presentIndoor air quality is impacted by biological particles like bacteria, fungi, and pollen as well as chemicals like radon, carbon monoxide, ozone, and particulate matter (PM) and fibres. (Alessandra & Tania, 2017)

According to the World Health Organization, indoor air pollution (IAP) causes 3.8 million deaths annually (WHO). IAP can be created by people inside of homes or buildings through activities including cooking, smoking, using electrical devices, using consumer goods, or by building materials emitting IAP. According to the research (Vinh, Duckshin, & Young-Chul, 2020), there are three main elements that have a substantial impact on indoor air quality: I The state of the outside air; (ii) human activity inside the building; and (iii) the supplies, machinery, and furnishings used in its construction. Due to the probability of contaminants being transported from outdoors to interiors, it is well recognised that outdoor pollutant levels and building pressurisation significantly impact IAQ. However, the development of