INDOOR ENVIRONMENT ANALYSIS FOR NEW LABORATORIES BLOCK OF FKM

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This report is submitted
in fulfillment of the requirement for the degree of
Bachelor of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DECLARATION

I declare that this project report entitled “Indoor Environment Analysis for New Laboratories block of FKM” is the result of my own work except as cited in the references

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APPROVAL

I hereby declare that I have read this project report and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature : .....

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Date : .....

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DEDICATION

To my beloved mother and father

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ABSTRACT

Thermal comfort condition features, which are indicators of user's satisfaction in an environment. There are few environmental factors in thermal comfort such as air temperature, radian temperature, air velocity and relative humidity. The main purpose of this study is to investigate the thermal comfort level in the UTeM FKM laboratories block and compare with ASHRAE Standard 62.1-2016 and Malaysian Standard MS 1525-2019. The physical measurement carried out with occupants and without occupants condition in two selected laboratory which is HVAC and IDP laboratory. Two different session which is morning and evening selected for physical measurement to compare the indoor air quality (IAQ) parameters. IAQ parameters such as air temperature, relative humidity, air velocity, carbon dioxide level and air particles was recorded and compared with standard requirement. The average air temperature of HVAC and IDP laboratory was found 24.37 ºC and 28.78 ºC respectively which is air temperature of HVAC laboratory within the MS 1525-2019 standard requirement but IDP laboratory not acceptable. The analysis of this study included the Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD) for physical measurement and also the clothing value and metabolic rate estimated using Delta-log software. Thermal Sensation Vote (TSV) was analysed in this study through subjective assessment which questionnaire survey among laboratory occupants. Based on findings, technical design suggestion such as RCI system, mechanical ventilation and exhaust fan are recommended in this study in order to improve thermal comfort in HVAC and IDP laboratory.

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ABSTRAK

Ciri-ciri keadaan keselesaan termal, yang merupakan petunjuk kepuasan pengguna dalam persekitaran. Terdapat beberapa faktor persekitaran dalam keselesaan termal seperti suhu udara, suhu radian, halaju udara dan kelembapan relatif. Tujuan utama kajian ini adalah untuk mengkaji tahap keselesaan termal di blok makmal UTeM FKM dan membandingkannya dengan ASHRAE Standard 62.1-2016 dan Malaysian Standard MS 1525-2019. Pengukuran fizikal dilakukan dengan penghuni dan tanpa keadaan penghuni di dua makmal terpilih iaitu makmal HVAC dan IDP. Dua sesi berbeza iaitu pagi dan petang dipilih untuk pengukuran fizikal untuk membandingkan parameter kualiti udara dalaman (IAQ). Parameter IAQ seperti suhu udara, kelembapan relatif, halaju udara, tahap karbon dioksida dan zarah udara dicatat dan dibandingkan dengan keperluan standard. Suhu udara purata makmal HVAC dan IDP masing-masing didapati 24.37 ºC dan 28.78 ºC yang merupakan suhu udara makmal HVAC dalam keperluan standard MS 1525-2019 tetapi makmal IDP tidak dapat diterima. Analisis kajian ini merangkumi Undian Purata Jangkaan (PMV) dan Jangkaan Peratusan Ketidakpuasan (PPD) untuk pengukuran fizikal dan juga nilai pakaian dan kadar metabolisme yang dianggarkan menggunakan perisian Delta-log. Undian Sensasi Termal (TSV) dianalisis dalam kajian ini melalui penilaian subjektif yang meneliti soal selidik di kalangan penghuni makmal. Berdasarkan penemuan, cadangan reka bentuk teknikal seperti sistem RCI, pengudaraan mekanikal dan kipas ekzos disyorkan dalam kajian ini untuk meningkatkan keselesaan termal di makmal HVAC dan IDP.

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LIST OF SYMBOLS

SYMBOLS	DESCRIPTION
m	Meter
h	Hour
s	Seconds
˚C	Degree Celsius
%	Percentage
m/s	Meter per square

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LIST OF ABBREVIATIONS

ABBREVIATIONS	DESCRIPTION
ASHRAE	American Society of Heating, Refrigeration and Air-conditioning Engineers
AC	Air-conditioner
CO_2	Carbon dioxide
HVAC	Heating, ventilation and air conditioning
IAQ	Indoor Air Quality
MS	Malaysian standard
PMV	Predicted Mean Vote
PPD	Predicted Percentage of Dissatisfied
RH	Relative Humidity
V	Air velocity
UTeM	University Teknikal Malaysia Melaka
FKM	Fakulti Kejuruteraan Mekanikal
MRT	Mean Radian Temperature
SBS	Sick Building Syndrome
TVOC	Total Volatile Organic Compounds
VOC	Volatile Organic Compound
IDP	Integrated Design Project
API	Air Pollutant Index
PPM	Part Per Million
CNC	Computerized Numerical Control

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CHAPTER 1

INTRODUCTION

1.1 Background

The laboratory is a closed area where experiment and test activity are carried out. Safety, comfort and energy efficiency are considered main requirement to maintain the laboratory. Indoor environmental analysis refers to the quality of air in buildings as it refers to the comfort of health and the users of buildings. The consistency of indoor air can also be influenced by the outside atmosphere and weather conditions combined with occupant behavior. Weather conditions influence whether windows are retained open or closed by building occupants and whether air conditioners, humidifiers, or heaters are regulated, all of which may affect the quality of indoor air. Some climatic conditions will increase the potential for indoor moisture and mould formation if not controlled by sufficient ventilation or air conditioning. It is very important because it can be affecting the health of human. For example, irritation of eyes and nose, headache dizziness and fatigue. In addition, there was long term effect to human which is respiratory disease, heart disease and cancer.

Besides that, thermal comfort is one of main criteria for the indoor environment. Thermal comfort is a biological study state when experiencing a sensation of considerable heat or cold. Thermal comfort is the experience of being cold, cool, slightly colder, neutral, warmer, wet, and hot in terms of bodily sensations. Thermal comfort arises from a scientific standpoint of view when there is a healthy heat exchange between the body and the environment of a person, characterized by the absence of regulatory sweating. There are few environmental factors in thermal comfort such as air temperature, radian temperature, air velocity and relative humidity. Air temperature is temperature of air surrounding the body. Radian temperature is heat that radiates from warm object. Radiant heat can be present when heat sources are present in the atmosphere. Radiant temperatures have a greater effect on how we lose or absorb heat from the atmosphere than air temperatures. Air velocity is

measured by sensing the pressure that is comes from air movement and measured in m/s. The faster the air moves, the greater the heat exchange between the person and the air. For example, small air movement at cold or hot environment result to uncomfortable feeling to people in a building. Relative humidity is the ratio between the actual amount of water vapor and the maximum amount of water vapors in the air. Between 40% and 70% relative humidity does not have a major impact on thermal comfort. Relative humidity may be higher than 70% in workplaces that are not air conditioned, or where the weather conditions outdoors can affect the indoor thermal environment. Humidity can vary significantly in indoor environments and may depend on whether there are drying processes where steam is released.

1.2 Problem Statement

This project aims to study the indoor environment analysis and thermal comfort of FKM faculty new laboratories. Laboratories are a place where student use the machine process and function which is very useful to their future. The comfort level and health issues of students and lab assistant depend on thermal comfort and the IAQ of laboratories. Poor thermal comfort in laboratory will affect to students cannot concentrate well in laboratory and laboratory occupants face some health issues such as irritation of eyes, fatigue and dizziness. The thermal comfort of the human level can be evaluated by Malaysia standard MS1525; 2019 and ANSI/ASHRAE standard. The internal air quality (IAQ) is main role to this project. The purpose of this project is investigating or analysis indoor environment condition and the IAQ of the FKM faculty laboratories and the way to improve the indoor environment condition and IAQ of laboratories. Figure 1.1 show FKM faculty new HVAC laboratory.

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Figure 1.1: FKM faculty new HVAC laboratory

1.3 Objective of The Project

The objectives of this project are as follows:

1. To conduct indoor environmental measurement for new mechanical engineering laboratory block.
2. To analyze the indoor environment condition by comparing with relevant standard.
3. To propose measures to improve indoor environment and IAQ of new FKM's laboratories.

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1.4 Scope of The Project

The scopes of this project are:

1. Target on FKM's new laboratories.
2. Air conditioner laboratory and without air conditioner laboratory select to analyse and compare the thermal comfort.
3. Analysing indoor environment condition in FKM's laboratories.
4. Investigate the relationship between indoor environment analysis and occupants of the new FKM's laboratories.

5. Identify the relationship between the indoor air quality and occupants of the new FKM's laboratories.

1.5 General Methodology

In term of achieving the objective of the project, the journal's related literature, newspapers, textbooks, theses or other document published and unpublished relating to the project will be reviewed. The measurement of physical quantities measured in current amounts in order to review the data on the subject matter and buildings will be evaluated. Then the evaluation and physical survey also will be conducted to some selected building. Questionnaire survey will be prepared for indoor environment analysis and IAQ meters. The data and analysis will be written in this report. Basically, it's up to each person to analyse their thermal comfort, which makes it hard to monitor the thermal environment in order to satisfy the needs of everyone, but when it comes to the FKM faculty new laboratory students in order to make them more comfortable, the level of thermal comfort is very important, particularly during their experiment time in laboratory.

Then, building codes for indoor environmental quality (IEQ) parameters such as indoor air quality (IAQ) minimize irritation and discomfort and no any single set of parameters be convenient for everyone. IAQ component of a healthy indoor climate, and can help prevent or quickly respond to problems such as cough, eye pain, headache, and, in extreme cases. So Indoor Air Quality (IAQ) is very important for the occupants because the occupant's health and comfort depend on IAQ for health environment. Finally, the report on this study will be written at the end of the project. Figure 1.2 below shows that the general methodology flow chart.

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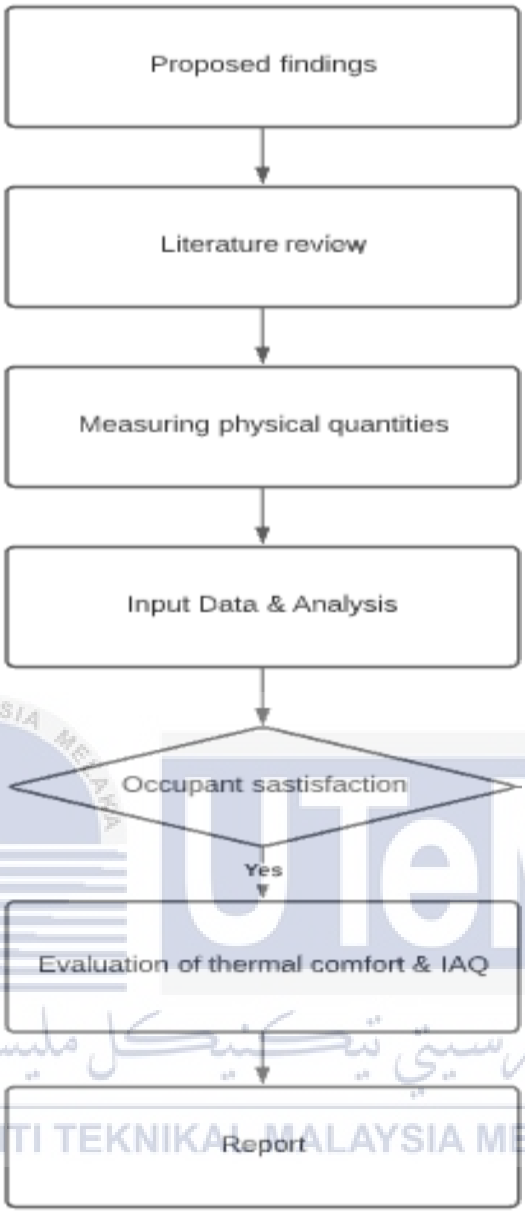

Figure 1.2: Flow chart of the general methodology

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1.6 The Importance of Research

The main focus of this research is on indoor environment analysis and thermal comfort of the occupant in the laboratory. Indoor air quality measures the air condition inside of and surrounding of the building in a good state which gives a better environment and a good satisfaction to the occupants. Bad IAQ in building can creates an unhealthy condition to the occupants such as cause heart disease, cancer and other potentially fatal illness. For example, high surrounding temperature can affect occupant's health and lack of productivity it might causes stress among the occupants. So, IAQ and thermal comfort are very important for the occupant's health and comfort level. The measurement data on the indoor environment will also contribute to the evaluation on the current condition in term of healthy environment to the occupants. It is hoped that this study will be a benchmark study for awareness about the importance of IAQ in university buildings.

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CHAPTER 2

LITERATURE REVIEW

2.1 Indoor air quality (IAQ)

Indoor air quality (IAQ) refers to the air quality of buildings and structures inside and around them, especially as it relates to the health and comfort of occupants of buildings. Understanding and managing common indoor contaminants will help reduce the risk of concerns about indoor health. The effect of human health has been split into two terms which is long-term and short-term. The short-term effects are eye irritation, headache, dizziness, irritation nose and fatigue; long term effects are respiratory disease, heart disease and cancer. The concentration of carbon dioxide, temperature, humidity and thermal comfort influence indoor air quality.

I. Carbon dioxide concentration

Carbon dioxide is an odorless gas that is colorless. It is produced both naturally and through human activities, such as the burning of gasoline, coal, oil, and wood. In the atmosphere, individuals exhale carbon dioxide gas, which adds to the levels of carbon dioxide level in the air. Indoor carbon dioxide levels be clouded and may even pose a wider danger to human health.

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II. Temperature

Temperature is one of the most significant parameters that gives us a sense of comfort. The indoor temperature influences occupants in two ways, which can also accelerate the growth of mould and bacteria in a comfortable and healthy living environment.