



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**STUDY THE INDOOR AIR QUALITY (IAQ) AT  
MELAKA INTERNATIONAL BOWLING CENTRE  
(MIBC), MELAKA**

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology Heating Ventilating and Air Conditioning (HVAC) with Honours.

by

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## DECLARATION

I hereby, declared this report entitled STUDY THE INDOOR AIR QUALITY (IAQ) AT MELAKA INTERNATIONAL BOWLING CENTRE (MIBC), MELAKA is the results of my own research except as cited in references.

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## **APPROVAL**

This report is submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of Universiti Teknikal Malaysia Melaka (UTeM) as a partial fulfilment of the requirements for the degree of Bachelor of Mechanical Engineering Technology (Heating Ventilating and Air Conditioning (HVAC) with Honours. The member of the supervisory is as follow:

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## ABSTRAK

Pada era modenisasi ini, sistem penghawa dingin sangat penting dalam kehidupan harian kita untuk memberikan keselesaan dan peredaran udara yang baik di dalam bilik. Kekurangan penyelenggaraan dan pengetahuan tentang kualiti udara dalaman (IAQ) akan menyebabkan masalah lain muncul. Antara contoh kesan kualiti udara dalam yang buruk adalah penyakit legionella, penyakit berkaitan bangunan (BRI), sindrom bangunan sakit (SBS) dan hal akan membuat penghuni tidak selesa bila-bila masa di dalam bangunan. Untuk projek PSM ini, bangunan MIBC adalah tapak pilihan untuk penilaian. Projek ini akan bermula dari Mac 2018 hingga Januari 2019. Terdapat beberapa masalah kualiti udara dalaman di MIBC yang dapat dikesan oleh penilai. Antaranya ialah suhu udara rendah, kelembapan relatif yang tinggi dan kelajuan pergerakan udara yang rendah. Berdasarkan susun atur di dalam bilik penyelenggaraan mesin bowling, hanya terdapat sekitar 6 unit penghawa dingin di bahagian kiri lorong. Berdasarkan bilangan dan kerusi lorong, pelanggan dan kakitangan anggaran purata sekitar 300 orang pada satu masa untuk memasuki MIBC. Lokasi eksperimen adalah dilorong kiri bilik penyelenggaraan. Untuk penyelesaian, penilaian kualiti udara dalaman (IAQ) perlu dilakukan untuk mengenal pasti masalah sebenar. Terdapat contoh yang perlu diambil bagi melakukan penilaian ini, antara parameter yang perlu diambil data ialah suhu udara persekitaraan, kelembapan relatif dalam, halaju udara persekitaraan, bahan zarah (PM<sub>10</sub>), TVOC dan kepekatan karbon dioksida (CO<sub>2</sub>). Seterusnya, perbincangan atau sumbang saran diperlukan untuk mencari faktor yang boleh menjejaskan yang boleh menyumbang kepada kualiti udara dalaman yang teruk (IAQ) di MIBC. Terdapat beberapa alat dan perisian yang akan digunakan dalam projek ini iaitu peranti pemantauan EVM, Minirae 3000 dan pengesan siasatan udara (air probe). Projek penilaian IAQ ini akan diadakan di MIBC dari jam 11 pagi hingga 8 petang pada dua keadaan. Mudah-mudahan projek ini akan membantu pengurusan MIBC, para pekerja mengetahui faktor yang boleh menjejaskan masalah IAQ di MIBC dan cuba untuk memperbaiki masalah tersebut yang telah dicadangkan agar memberi keselesaan kepada pelanggan apabila mereka berada di dalam MIBC.

## ABSTRACT

In this era of modernization, air conditioning systems are essential in our daily lives to provide comfort and good air circulation in the room. Lack of maintenance and knowledge of indoor air quality (IAQ) will cause other problems to arise. Among the examples of poor indoor air quality effects are legionella disease, building-related illness (BRI), sick building syndrome (SBS) and things that will make the residents uncomfortable any time inside the building. For this PSM project, the MIBC building is the preferred site for assessment. The project will commence from March 2018 to January 2019. There are some indoor air quality problems in MIBC that can be detected by the assessor. Among them are low air temperatures, high relative humidity and low air velocity. Based on the layout in the bowling machine maintenance room, there are only about 6 units of air conditioning on the left side of the hallway. Based on the number and lane seats, the average customer and staff estimates around 300 people at a time to enter MIBC. Experiment location is the left-hand side of the maintenance room. For solutions, indoor air quality (IAQ) assessments need to be done to identify real problems. There is an example that should be taken to perform this assessment, among the parameters taken from the data are environmental temperature, relative humidity, environmental air velocity, particulate matter (PM<sub>10</sub>), TVOC and carbon dioxide concentration (CO<sub>2</sub>). Subsequently, discussions or brainstorming are needed to find a detrimental factor that can contribute to severe indoor air quality (IAQ) at MIBC. There are several tools and software to be used in this project, EVM monitoring devices, Minirae 3000 and air probe detectors. This IAQ assessment project will be held at MIBC from 11am to 8pm on two occasions. Hopefully this project will help MIBC management, employees are aware of factors that can affect the IAQ problem at MIBC and try to fix the proposed problem that it is intended to provide convenience to customers when they are in MIBC.

## **DEDICATION**

Special appreciation, I wish and dedicates this thesis to my beloved family

**MOHD NOOR BAKRI BIN MOHD YUSOF**

**NORIZAN BINTI KAMARUDDIN**

Special dedicated to my great supervisor

**PUAN SAFFREENA BINTI HAMDAN**



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## LIST OF ABBREVIATIONS

<b>ppm</b>	parts per millions
<b>CFM</b>	Cubic Feet per Minute
<b>IAQ</b>	Indoor Air Quality
<b>CO<sub>2</sub></b>	Carbon Dioxide
<b>PM<sub>10</sub></b>	Particulate Matter 10
<b>TVOC</b>	Total Volatile Organic Compound
<b>ASHRAE</b>	American Society of Heating, Refrigerating & Air Conditioning Engineers
<b>EPA</b>	U.S. Environmental Protection Agency
<b>ISO</b>	International Standards Organization
<b>ANSI</b>	American National Standards Institute
<b>RH</b>	Relative Humidity
<b>AHU</b>	Air Handling Unit
<b>HEPA</b>	High Efficiency Particulate Arresting
<b>OSHA</b>	Occupational Safety and Health Administration
<b>BRI</b>	Building Related Illness
<b>SBS</b>	Sick Building Syndrome
<b>ETS</b>	Environmental Tobacco Smoke
<b>TWA</b>	Total Weighted Average



# CHAPTER 1

## INTRODUCTION

### 1.1 Project Background

In this modern era, the air conditioning system is important in everyday life. Air conditioning systems ensure our level of comfort is in good condition either in the room or in the room. Without air conditioning system, there will be a big problem regarding to temperature and comfort level at certain place or an event. Air conditioning system is very related to indoor air quality (IAQ) because the function of air conditioning system is to recirculate air and stabilize the humidity at certain room or space. Individuals spent most 90% doing the indoor action. These days greater part of the building has a ventilation and cooling framework and there are numerous unfortunate propensities that will influences the indoor air quality inside the building. Indoor Air Quality (IAQ) is air quality in the interior or around the building and space. Indoor air quality is also closely related to the health and comfort of the occupants in a building. There are various problems that will arise if air quality is at a bad level. People nowadays are ignorant about air quality problems because for them, movement of air cannot be control. Normally, the acceptable indoor air quality is the air where there is no known pollutant at a hazardous concentration as found by a conscious authority and with majority 80% or more exposed person not expressing dissatisfaction with in the building or room (Stanke et al., 2007). Among the illnesses regularly connected with indoor air quality (IAQ) are headaches, asthma, bothersome skin, watery eyes, wiped out building disorder and sickness related structures. SBS happens when 20% of the respondents report indications related with their particular work environment with the particular relationship with air quality (Norhidayah, Lee, Azhar, & Nurulwahida, 2013). Building-related illnesses refer to illnesses defined by an authorized agent or doctor are due to exposure to dirty air building.

Various referred to maladies, for example, legionnaires illness, asthma, touchy pneumonitis, and humidifier fever, have been straightforwardly identified on building issues. This is known as a building-related disease (DOSH, 2010). The IAQ level can be measured base on nine parameter that has been identified from the Industrial Code Of Practice (ICOP) which are carbon dioxide (CO<sub>2</sub>), total volatile organic compounds (TVOC), respirable particulates (PM<sub>10</sub>), relative humidity (RH), temperature and air movement (Mohd, Noraini, Leman, Sayuti, & Abidin, 2013). Bad indoor air quality (IAQ) will occur due to many factors such as chemical contaminant, suspended particle, microbes, humidity, ventilation and temperature. Most common place that usually having bad IAQ is office, classroom laboratory veterinary care and hospital.

## 1.2 Problem Statement

Nowadays, bowling is one of top indoor game that had been play by many people. Maintenance of air conditioning systems is essential in every building including MIBC. There are special technicians who will check for any damage or problems at the MIBC's air conditioning system. MIBC's manager is very alert about this air conditioning system problem because it will affect the player performance due to hot temperature in there. There is some problem in MIBC which is air temperature, air velocity and relative humidity problem in the bowling machine hallways. The hallway only uses 6 unit of split unit to maintain the temperature in that place. In the bowling centre, centralized unit is used and cool air from the middle bowling centre is not distributed well into the hallway. Distance between the middle bowl to the hallways, is in range 30m to 35m. There is a control system and a sensitive component in the component box. Suitable temperature is needed in the hallway to make sure that the control system is not break down. It will control all the bowling machine in the hallways. MIBC's temperature surrounding is quite well to cover up the system break down. Based on the hallway layout, there are only about 6 split Daikin and York units. There have several wall fans to help the distribution of the cooled air from the split unit to the entire hallways. If the temperature in the room is too hot, damage will occur on the control system and the component inside it will melting. As result, the bowling machine cannot be used break down for a few hours. Next, air conditioning system cannot accommodate and support the cooling load in there because of several factors such as high number of occupants entering premise, too many electrical appliances, bad ducting layout, low tons output of chiller and used an air-cooled chilled system which is less efficiency. Based on the lane number and seats, estimation customers and staff are average around 300 persons at one time to enter in MIBC. The least temperature can reach is 21°C, this reading only can get whenever there is rainy outside. Based on the information that explained, MIBC is having a few problems regarding to indoor air quality (IAQ) which can affect occupant's comfort level.

### 1.3 Objectives

- i. To do inspection and distribute survey among occupant in MIBC
- ii. To perform an indoor air quality (IAQ) assessment and take the air temperature, relative humidity, air movement, particulate matter (PM<sub>1.0</sub>), total volatile organic compound (TVOC) and carbon dioxide (CO<sub>2</sub>) in Melaka International Bowling Centre (MIBC)
- iii. To find the factor that can contribute to bad indoor air quality (IAQ) and give suggestion to encounter the problem in MIBC

## **1.4 Project Scope**

This project will be held at the Melaka International Bowling Centre (MIBC). The air conditioning system of MIBC will run during the data collection. Location of experiment is at the bowling machine hallway which is in the right side of bowling centre. There are only about 6 split Daikin and York units on left sides. In the hallways, there are several fans to effectively help to distribute the cooled air. This project will be held on 10 a.m. to 7 p.m. on two conditions. Condition 1 is referring to normal condition which estimated only 30 persons in the bowling centre. Condition 2 is referring to crowded condition which estimated 200-300 persons in the bowling centre. Besides, when have highest number of people or customer in bowling centre, the survey data get will more accurate. There are a few tools and software that will used in this project which is environmental monitoring (EVM), MINIRAE 3000 and air probe. The measured data will be compared standard from Department of Occupational Safety and Health (DOSH), Malaysia.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Introduction About Indoor Air Quality (IAQ)

Indoor air quality (IAQ) is the air quality level in the room or a space. Indoor air quality (IAQ) is a term which refers to the air quality in and around buildings and structures, especially as it relates to the health and comfort of building occupants. Temperature surroundings, relative humidity, percentage of outside air (poor ventilation) and air velocity are example of factor that might affect the indoor air quality and comfort level in the room or building. In addition, building design plays an important role in achieving good indoor air quality too for example, location of the building, number of tinted mirrors, air conditioning system use and type of material use for the building. For IAQ cases, there are a few places that frequently having Indoor air quality (IAQ) issues such as office space, classroom and test research facilities. Based on the article, most place researcher do the IAQ experiment are at office, classroom and laboratory. By understanding and learning the main causes of pollution in a building, as occupant can help reduce the risk of disease associated with indoor air quality. There are causes affecting the bad IAQ, for example carbon monoxide gas in a space, high density carbon dioxide and excessive or low humidity levels. Furthermore, ventilation should be emphasized and recirculate to ensure that high concentration of carbon dioxide air in a room are released to the surrounding. In Addition, hot temperature and elevated level of humidity can also increase concentrations of some pollutants. Relative humidity of occupied space will be limited to 65% or less when the system performance is analysed by indoor air at dehumidification design conditions and with internal load which is sensible and latent heat (Stanke et al., 2007). Based on data from Canadian Centre for Occupational Health and Safety, relative humidity levels below 20% can cause discomfort and will cause dry eyes and skin disorders. Low levels of humidity can also cause static electricity

combustion and affect operation of some office equipment. However, if the relative humidity level of more than 70% can cause condensation on the surface of the mirror and will make the walls of the building be moulded. Relative humidity level which exceeds 70% will cause condensation and will occur on the surface of the building's mirror. There are the locations which most concerned about relative humidity such as are libraries and hospitals. Furthermore, the book will also be damaged in the library if the relative humidity readings are too high. Furthermore, this will also disrupt the surgical procedure at the hospital. For an acceptable IAQ, it should require at least 20% to assume that the air at the premises is unacceptable and having bad air quality

## **2.2 Potential Sources of Indoor Air Quality (IAQ) Problem**

Indoor air quality is very important in our daily lives. If this is not the case, it is likely that many serious illnesses will overtake us. So, for prevention, the occupant must know that resources can contribute to poor indoor air quality (IAQ). There are various sources of pollution that affect indoor air quality, the HVAC system used, the inside environment and the environment outside the building. For the HVAC system, the fresh air distribution in ventilation systems is very important as it figures out the comfort of the occupants in space or room. Dust in the ductwork will make air distributed is dirty. Dust in ducting also will reduce the airflow to the supply diffuser. These two factors are not good for food processing industry and will make the food in bad quality and for sure the person who eat the food will sick. Some of the filter is rewash able and should be changed periodically. For indoor factors that cause bad IAQ, they include cleaning work community activities that use strong odorous chemicals, maintenance or repair activities, emissions from office equipment and tools, fluid spillage or leakage and cooling load in room occupants. Next for outdoor factor, contaminated outdoor air such as vehicle exhaust, nearby source emissions like garbage dumpsters and lastly most dangerous which is soil gas including radon, and pesticides.