INVESTIGATION OF THERMAL COMFORT OF SELECTED TEMPORARY EVACUATION CENTER IN TROPICAL CLIMATE AT MELAKA

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2022

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Mechanical and Manufacturing Engineering Technology

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

Faculty of Mechanical and Manufacturing Engineering Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2022

DECLARATION

I declare that this Choose an item. entitled " Investigation Of Thermal Comfort Of Selected Temporary Evacuation Center In Tropical Climate At Melaka" 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 : 

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

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Date : 20/01/2022

DEDICATION

To my beloved parents, I acknowledge my sincerity and gratitude to them for their love, support, dream and sacrifices throughout my life. Initially, I am thankful for their sacrifice, patience and understanding that were inevitable to make this work completely. Their sacrifice had inspired me to learn how to study and write since the day I was born. I couldn't find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to achieve my dreams. Lastly, I would like to send my gratitude to any person that contributes to my final year project whether it is directly or indirectly. I would like to acknowledge their comments and suggestions, which are crucial for the completion of this investigation successfully.

ABSTRACT

Temporary evacuation centers (TECs) are especially important in the event of a disaster. Unexpected disasters will cause property to be destroyed and the victims involved will have no place to shelter. With the TEC, it is able to place the victims involved in one area. TEC has some problems when too many victims are in the area. Among the problems that occur are uncomfortable conditions, hot areas due to overcrowding and the health of individuals will be disturbed. This study will examine the relation of thermal comfort in TEC. Factors identified in this study are air temperature, wind speed, humidity, ambient heat temperature, type of clothing and activities performed. To find out the comfort of the individual in the place, the software "CBE thermal comfort tool" is used to solve the problems encountered. The data obtained will be used in the software. The areas used are schools in the state of Melaka, namely SK Durian Tunggal, SJK (C) Sin Wah and SMK Bukit Katil. In the school, four things were taken into account in the data collection, namely the readings of air temperature, wind speed, humidity, and ambient heat temperature. For data collection for ambient temperature, humidity and heat temperature, the method used was by placing a globe thermometer with a height of 1m from the floor. The globe thermometer is placed in the center of the tent to get a good reading. For wind speed data, an anemometer is used to obtain the readings. An anemometer is placed in front of the tent to get a more accurate reading, this is because the passage of the tent door is one of the passages for air to enter. As the data from SK Durian Tunggal at 2.00 pm the temperature is 32.1℃ is the high from the reading. When hot weather the air humidity that get is 47% to 67%, besides that the reading for air velocity is between 0.1m/s to 0.5m/s and the range of globe temperature is 23℃ to 25.2℃. In addition, the survey method, which is by using a google form, is distributed to the victims involved. Based on the results obtained, several factors will affect the readings collected, among them are natural factors. Natural factors such as hot weather or rain will make the data obtained be in a comfortable state or not. The findings of this study indicate that comfort in flooded areas is not only influenced by individual activities but also surrounding factors.

ABSTRAK

Pusat pemindahan sementara (TEC) amat penting apabila berlakunya bencana. Bencana yang tidak disangka berlaku akan membuatkan harta benda musnah dan mangsa-mangsa yang terlibat tidak mempunyai tempat untuk berteduh. Dengan adanya TEC, ia dapat menempatkan mangsa-mangsa yang terlibat di satu kawasan. TEC mempunyai beberapa masalah apabila terlampau ramai mangsa yang berada di kawasan tersebut. Antara masalah yang berlaku ialah keadaan tempat yang tidak selesa, kawasan yang panas disebabkan terlalu padat dan kesihatan individu akan tergangu. Kajian ini akan mengkaji berkaitan keselesaan terma di TEC. Faktor yang dikenalpasti dalam kajian ini ialah suhu udara, kelajuan angin, kelembapan, suhu haba sekitar, jenis pakaian dan aktiviti yang dilakukan. Untuk mengetahui keselesaan individu di tempat tersebut, perisian "CBE thermal comfort tool" digunakan untuk menyelesaikan masalah yang dihadapi. Data-data yang diperoleh akan digunakan dalam perisian tersebut. Kawasan yang digunakan adalah sekolah di dalam negeri Melaka iaitu SK Durian Tunggal, SJK(C) Sin Wah dan SMK Bukit Katil. Di sekolah tersebut, empat perkara diambil kira dalam pengumpulan data iaitu bacaan suhu udara, kelajuan angin, kelembapan,dan suhu haba sekitar. Untuk pengumpulan data bagi suhu, kelembapan dan suhu haba sekitar, kaedah yang digunakan ialah dengan meletakkan termometer glob dengan ketinggian 1m dari lantai. Thermometer globe itu diletakkan di tengah-tengah khemah untuk mendapatkan bacaan yang baik. Untuk data kelajuan angin, anemometer digunakan untuk mendapatkan bacaannye. Anemometer diletakkan di hadapan khemah untuk mendapatkan bacaan yang lebih tepat, ini kerana laluan pintu khemah merupakan salah satu laluan untuk udara masuk. Berdasarkan data dari SK Durian Tunggal pada pukul 2.00 petang, suhu 32.1°C adalah tertinggi daripada bacaan. Apabila cuaca panas, kelembapan udara yang diperoleh ialah 47% hingga 67%, selain itu bacaan halaju udara adalah antara 0.1m/s hingga 0.5m/s dan julat suhu glob ialah 23°C hingga 25.2°C. Selain itu kaedah tinjauan iaitu dengan menggunakan borang google diagihkan kepada mangsa-mangsa yang terlibat. Berdasarkan hasil yang diperoleh, beberapa faktor akan mempengaruhi bacaan yang dikumpul, antaranya ialah faktor alam. Faktor alam seperti cuaca panas atau hujan akan menjadikan data yang diperoleh berada dalam keadaan yang selesa atau tidak. Dapatan kajian ini menunjukkan keselesaan di tempat banjir bukan sahaja dipengaruhi oleh aktiviti individu tetapi juga faktor sekeliling.

ACKNOWLEDGEMENTS

In the Name of Allah, the Most Gracious, the Most Merciful

First and foremost, I would like to thank and praise Allah the Almighty, my Creator, my Sustainer, for everything I received since the beginning of my life. I would like to extend my appreciation to the Universiti Teknikal Malaysia Melaka (UTeM) for providing the research platform. Thank you also to the Malaysian Ministry of Higher Education (MOHE) for the financial assistance.

My utmost appreciation goes to my main supervisor, Ts. Dr. Amir Abdullah Muhamad Damanhuri, for all his support, advice and inspiration. His constant patience for guiding and providing priceless insights will forever be remembered. Not forgotten, to all of my friends that have given their support and idea to me in step to complete the dissertation.

Finally, I also want to show my appreciation to my family for supporting me at our back and their encouragement especially my parent and siblings. They are always supporting and advising me to make me stronger when carry on the study.

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LIST OF SYMBOLS AND ABBREVIATIONS

TEC	-	Temporary evacuation center
PMV	-	Predicted mean vote
PPD	-	Predicted percentage of dissatisfied
km	-	Kilometer
℃	-	Celsius
℉	-	Fahrenheit
%	-	Percent
ASHRAE	-	American Society of Heating, Refrigerating, and Air-Conditioning Engineers
ms^{-1}	-	Meter per second
HSE	-	Health and Safety Executive

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

1.1 Background

Malaysia is a Southeast Asian country that experiences heavy rainfall for most of the year. The effects of this heavy rain have resulted in Malaysia experiencing several natural disasters, such as floods, mudslides and landslides. Apart from that, Malaysia is also experiencing natural disasters such as haze due to forest fires in Indonesia. Apart from natural disasters, Malaysia also experiences disasters due to human actions, such as technological disasters, transportation accidents, damage to production and damage to public places (Ahmadun, 2006).

In Malaysia, floods are listed as 9 out of 10 natural disasters that have affected society. Floods have occurred in Malaysia as early as 1886, 1926, 1967, 1971 and 1986. The worst floods occurred on 3 December 1965, involving 300 thousand people (Emdat, 2012). Flood disasters occur due to heavy rains that result in high water levels in major rivers and, in turn, cause the river water to overflow in some areas (Ho, 2002). Other than that, flood disasters also occur due to human negligence. Among them are solid waste disposal activities, forest land development, unplanned urban development and inefficient water drainage systems (Ishak, 2013). This flood disaster is known as a flash flood. For example, the flash flood disaster that occurred in Melaka. As a result of the small drainage system, it is unable to hold water when it rains heavily and continuously for a day (Hashim, Muhamad, 2011).

In recent years, Malaysia has faced floods almost every year. For example, in December 2006 and January 2007, Johor is a Malaysian state have experienced floods within two weeks due to heavy rains. As a result, there are 100 000 flood victims who have been evacuated to over 100 evacuation centers (Norwawi, Katuk, 2009). Meanwhile, the floods in Kedah in 2002 claimed the lives of 124 000 people and cost the country $30.20 million in costs (Nurzawati, 2015). Figure 1.1 shows the flood area in Malaysia.

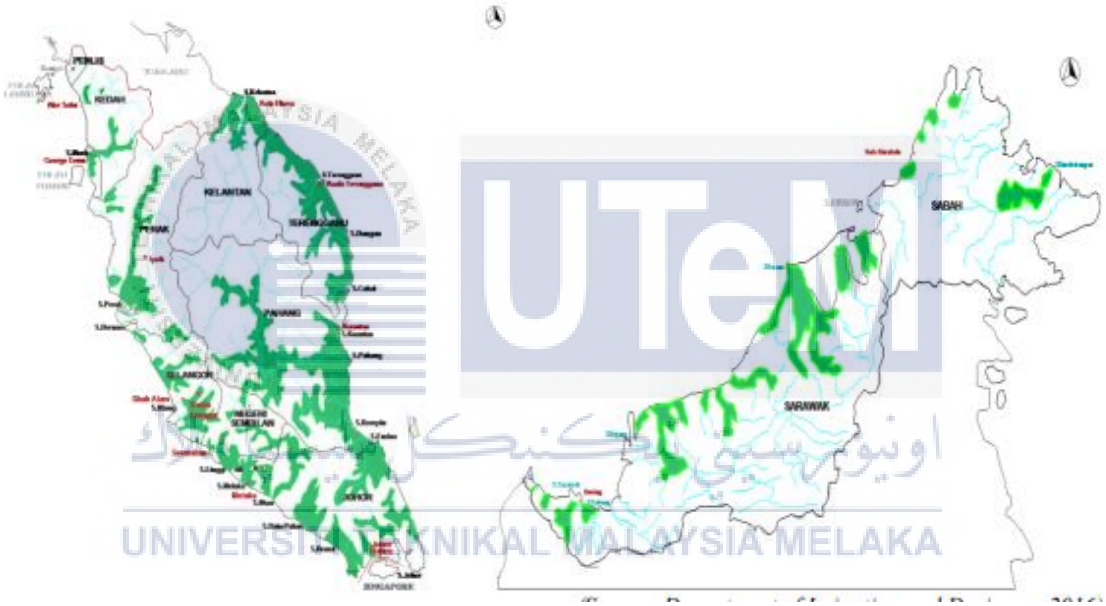


Figure 1.1Flood area in Malaysia (N.S. Noor Haryantie, Z. Munirah, H. Nur Hasinah, 2016)

When floods occur, temporary evacuation centers (TEC) need to be opened for the flood victims involved. It allows the victim to be in a safe and comfortable place. There are some places that are used as flood evacuation centers, such as schools, multipurpose halls, mosques, and community halls. TEC that are opened need to have several factors so that the victims who are there feel comfortable (Yu et al., 2016).

In this study, the factor highlighted is thermal comfort. When a temporary evacuation facility is opened, one of the most significant factor is thermal comfort. This is because a comfortable place will keep the victim involved in a calm and comfortable state. In these circumstances, the parties involved can do the work well and efficiently (Singh et al., 2018).

1.2 Problem Statement

A TEC should be free of external physical risks and provide stability for those who live there to recover their mental health and physical health (UNISDR, 2010). Prior research has highlighted the need to apply the habitability concept to the TEC. The availability of a shelter, heating system, sanitary conditions to avoid infection, indoor quality (noise, smoking, drugs), and a source of drinking water is referred to as habitability. It also has more general characteristics, such as close ties to local communities, people's desire to recover, and consideration of a variety of needs based on people's physical and mental states (Choi, 2020).

Habitability should not be seen of as a bare minimum for survival, but rather as a means of building a soft environment that humans can love and treat with care. In order to better promote the concept of habitability, TEC for disaster survivors should provide a psychologically and physically secure living environment that addresses safety, hygiene, health and a protracted rehabilitation period in various disaster scenarios (KoreaKim et al., 2021).

Building a physically and mentally healthy living environment is critical for providing survivors with good quality of life and better service. When thermal comfort is not in a comfortable state. The problem that will be faced is that the health of the individual will be disturbed (Sansaniwal et al., 2020). Eliminating potential health hazards is also a very important aspect of maintaining ideal thermal comfort. It will result in the productivity of each individual not being at its best. A person's feelings will also be affected when the situation is uncomfortable. Moreover, the victims involved are in a hot state when the space

does not have adequate equipment for good air circulation (Abdelgaied & Mardaljevic, 2021).

1.3 Research Objective

The primary goal of this study is to look at thermal comfort at a temporary evacuation center. Specifically, the objectives are as follows:

a) To investigates selected indoor parameter that influence to the thermal comfort at temporary evacuation center in Melaka.

b) To access predicted mean vote (PMV) and predicted percentage of dissatisfied (PPD) for selected Melaka temporary evacuation center using CBE tool.

1.4 Scope of Research

The scope for this study is several factors identified to maintain thermal comfort in TEC. The factor is broken down into two namely human factor and environment factor. The criteria for human factors are the activities performed in the area, metabolic rate, and cloth insulation. The metabolic rate is depend on the age and the physical body for human. Environment factors are air temperature, air speed, relative humidity, and ventilation at that area. The air temperature will take by time to time to get the difference of temperature in a day. Air speeds are affected based on the condition of the TEC. Relative humidity will take to get the comfortable condition at that place. Ventilation is an important part to make sure, the people will satisfaction when in comfortable condition (Ormandy, D., and Ezratty, 2012). The location to be visited is a TEC in the state of Melaka. The place used was a school near the flood affected area. The school that have visited is SK Durian Tunggal and SMK Bukit Katil that use class for TEC and SJK (C) Sin Wah is use a hall.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction Temporary Evacuation Center (TEC)

In order to create and manage TEC, the concept of habitability is important. It is to make sure the victim can live safely in the long term. It is a humanitarian reaction aimed at establishing an environment that prioritizes the quality of crisis recovery, welfare, health, and life (Sanderson, 2013). People can only live a healthy life and prepare for future disasters if they have a safe and appropriate place to live. To this aim, considering survivors' perspectives on a safe environment, sanitation, comfort, flexibility, privacy, community connections, and functioning may aid in the creation of an environment that enhances a person's willingness to recover (Kronenburg, 2013).

The idea of habitability in a temporary evacuation center has been supported by previous studies. According to Um, privacy, security, psychological stability, safety, health services in the form of medical care, hygiene, and pollution management are all important variables in determining habitability (Um, Shin, 2014). Cleanliness or hygiene, safety, care for vulnerable individuals, diversity, and privacy are all mentioned by the American Red Cross. According to Sphere, each disaster-affected family should be provided enough space to accommodate local culture, basic living, and lifestyle in order to meet family members' diverse requests for food preparation, sleeping, and dining. Consider physical security, privacy, weather protection, adequate lighting, comfort, heat, and ventilation (Sphere., 2018).

2.1.1 Statistic of Flood at Melaka

Melaka is a Malaysian state on Peninsular Malaysia's west coast. Melaka is a state in which all of the major rivers run into the sea and the total size is 1651 km² and a coastline of 73 km. The Central Melaka District, Alor Gajah District, and Jasin District are the three districts that make up the state of Melaka as Figure 2.1. Table 2.1 depicts the location of the flood and statistics about the flood victims in Melaka. Meanwhile, Table 2.2 shows the frequency of floods in the state of Melaka by district in 2019.

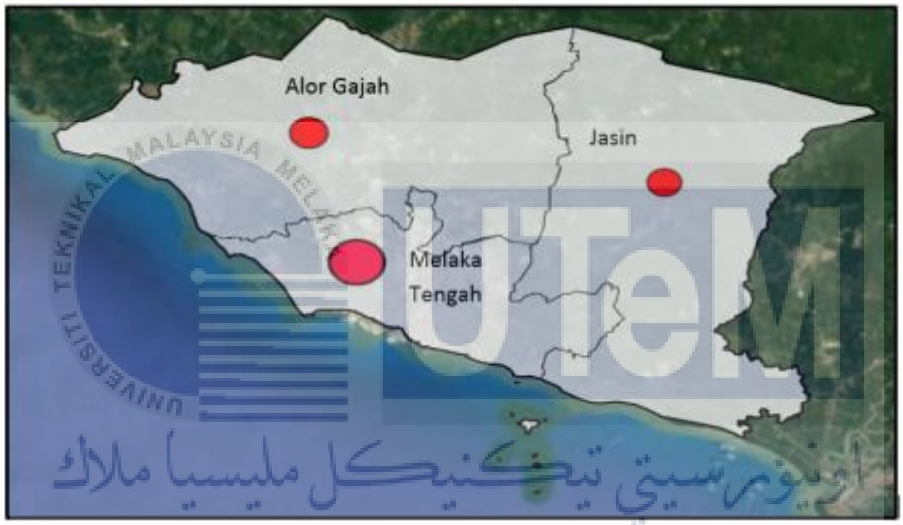


Figure 2.1Melaka district area (N.S. Noor Haryantie, Z. Munirah, H. Nur Hasinah, 2016)

Table 2.1 Flood statistics in the State of Melaka in 2019 (Tahunan, 2019)

No	Date	District	Place	Total victim
1	03-04-2019	Jasin	Selandar town	No
2	11-06-2019	Melaka Tengah	Taman Bachang, Taman Merdeka, Taman Malim, Taman Melaka Baru Fasa 2 Taman Limbongan, Bukit Pulau village, Pulau Kelapa village, Taman Seri Jati, Taman Kerjasama, Taman Bukit Beruang, Balai Panjang village	Community hall Taman Anika – 18 Family (90 people)
3	26-06-2019	Melaka Tengah	Chetty village Tanjung Minyak Taman Rambai Utama Taman Bukit Beruang	No
4	26-06-2019	Alor Gajah	Gangsa village	No
5	30-06-2019	Alor Gajah	Sg Tuang village	No

Table 2.1 (cont) Flood statistics in the State of Melaka in 2019 (Tahunan, 2019)

No	Date	District	Place	Total victim
6	7-7-2019	Alor Gajah	Tambun hill Belimbing Dalam village Sungai Tuang village Gadek Dalam village Taman Seri Bayu 1 &2 Panchor village Dalong village Ganun village Bukit Balai village Beringgin village	951 People
7	7-7-2019	Melaka Tengah	Tampoi Lanjut Manis village Taman Krubong Jaya	TEC SK Krubong – 18 Family (90 people)
8	17-10-2019	Melaka Tengah	Pulau Gadong Taman Bertam Perdana	No
9	22-10-2019	Jasin	Taman Pulai Indah Pulai village	No
10	28-10-2019	Alor Gajah	Gangsa village Nelayan village	No

Table 2.1 (cont) Flood statistics in the State of Melaka in 2019 (Tahunan, 2019)

No	Date	District	Place	Total victim
11	01-12-2019	Melaka tengah	Pulau Kelapa village Solok Sikumi village Tun Razak village Sungai Putat village Taman Bukit Beruang Taman Seri jati Ayer Keroh road	No
12	01-12-2019	Alor gajah	Gangsa village	No

Table 2.2 Melaka flood frequency by district for the year 2019 (Tahunan, 2019)

District	Frequency
Alor gajah	5
Melaka Tengah	5
Jasin	2
Total	12

2.1.2 Average Temperature in Malacca

Based on Figure 2.2, the average annual temperature in Malacca is 81.0°F (27.2°C). February is the warmest month, with an average temperature of 82.0°F (27.8°C). December is the coolest month, with an average temperature of 80.0°F (26.7°C).

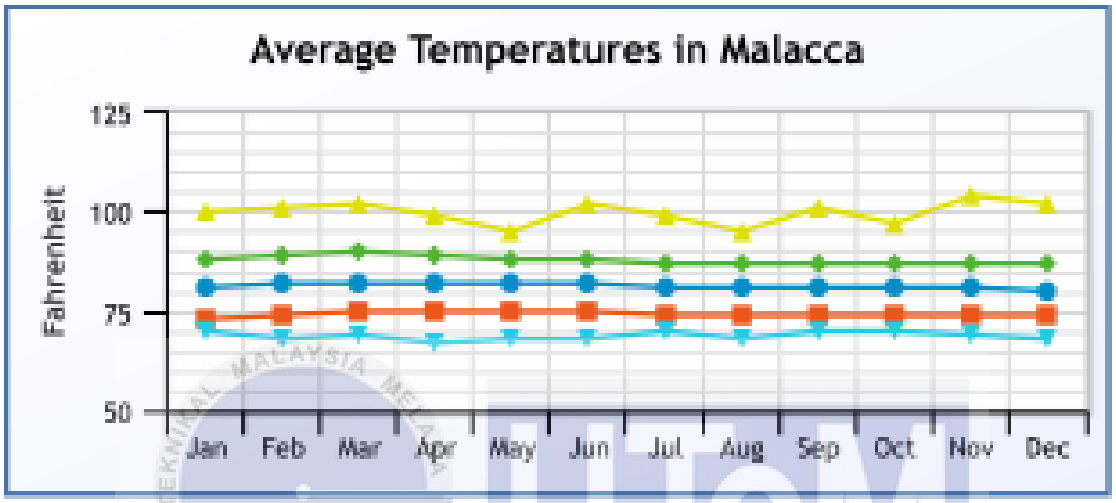


Figure 2.2Graph average temperature in Malacca (Weatherbase, 2020)

2.1.3 List of Temporary Evacuation Center

There are several places in the Melaka Tengah district, such as the TEC. Based on Table 2.3, there are 14 places for temporary evacuation centers. There are two community halls and the remaining buildings are schools. The capacity for school at zone "Dun Kota Laksamana" can accommodate 200 people and for community hall only 30 people. For zone "Dun Kesidang", there is one school that can accommodate 800 people, three schools can accommodate 400 people and 200 people and another two only 150 people can be there. The final zone is "Dun Bandar Hilir," which has a community hall that can only accommodate 80 people.

Table 2.3 List of temporary evacuation center (Jabatan Kebajikan Masyarakat)

No	Zone	Evacuation Center	Latitude	Longitude	Capacity
1	Dun Kota Laksamana	SJK (C) Notre Dame	2.207292	102.241472	200
2	Dun Kota Laksamana	Sek. Keb. Bukit Cina	2.203547	102.256462	200
3	Dun Kota Laksamana	Community Hall (Reading Room) Chetti	2.200567	102.238427	30
4	Dun Kesidang	Sek. Men. Gajah Berang	2.202811	102.240864	400
5	Dun Kesidang	Sek. Men. Katholik	2.206764	102.241449	400
6	Dun Kesidang	Sek. Men. Notre Dame Convent	2.207537	102.242444	400
7	Dun Kesidang	Sek. Keb. Methodist (Acs) Kesidang	2.204937	102.236442	200
8	Dun Kesidang	Sek. Keb. (P) Methodist 1	2.204265	102.233924	200
9	Dun Kesidang	Sek. Keb. (P) Methodist 2	2.204265	102.233844	200
10	Dun Kesidang	Sek.Ren. Jenis Keb. Tengkera 1	2.203678	102.232202	150
11	Dun Kesidang	Sek. Keb. Limbongan	2.208581	102.220463	150
12	Dun Kesidang	Sek. Keb. Taman Merdeka	2.270917	102.236571	800
13	Dun Kesidang	SJKC Malim, Melaka	2.237005	102.224989	300
14	Dun Bandar Hilir	Community Hall Kampung Bukit Cina	2.307923	102.172604	80

2.2 Introduction Thermal Comfort

Humans require thermal comfort. When thermal comfort isn't suitable for humans, it will be difficult for them to stay anywhere. Thermal comfort is a mental state that conveys happiness in the thermal environment and is measured by subjective analysis (ASHRAE Standard 55, 2010). The body does not unharness enough heat in hot situations, and the body loses additional heat to the atmosphere in cold environments. Each the recent and cold situations result will be in discomfort (Abdullah et al., 2016).

Thermal comfort isn't something that can be quantified in degrees or described by an average temperature range. It's a very personal experience that varies from person to person in the same situation due to a multitude of reasons. The Health and Safety Executive defines acceptable comfort as when at least 80% of indoor occupants are pleased with the thermal environment (Calis & Kuru, 2015).

Thermal neutrality is maintained until the warmth generated by human metabolism has dissipated, allowing the environment to retain homeostasis. The most important factors that influence thermal comfort are people who verify heat gain and loss, notably rate, air temperature, clothing insulation, air speed, and ratio. Individual expectations, as well as psychological factors, influence thermal comfort. The thermal comfort temperature can vary greatly between people depending on factors including activity intensity, humidity, and apparel (Luo et al., 2018).

Thermal comfort is a study topic that spans multiple fields, including physiology, medicine, geography, and climatology (A.Auliciems, 1997). With his bioclimatic approach to design, Olygyay was the first to define the notion of thermal comfort for architectural objectives (Olgyay, 1953). Thermal comfort is a crucial goal in building design in order to achieve an adequate internal thermal temperature. Thermal comfort is crucial for providing people with satisfaction by providing a comfortable temperature, safeguarding people's health, and producing delight, as well as for limiting energy consumption and establishing and enacting regulations, legislation, and recommendations for indoor temperature (Nicol, 2012).

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) proposes the most frequently accepted definition of thermal comfort, which is defined as "that state of mind that conveys contentment with the thermal environment and is evaluated by subjective evaluation" (ASHRAE Standard 55, 2010). Skin and deep body temperatures are kept within specific limits, skin dampness is kept to a minimum, and physiological effort to regulate body temperature is minimal. It is also affected by conscious or unconscious behavioral actions, such as changing one's posture or location, changing one's clothing or activities, adjusting the thermostat setting, complaining, opening a window, or leaving a space, that are initiated and directed by thermal or moisture sensations to alleviate discomfort (ASHRAE Handbook., 2013).

2.3 Thermal Comfort Parameter

The variables that influence the thermal comfort of the occupants have a part in creating pleasant environments. Indoor thermal comfort is determined by six basic criteria, as shown in Figure 2.3 includes four exterior variables, such as air temperature, mean radiant temperature, humidity, and air motion, as well as two personal factors, such as human activity and clothing (Al-ajmi, 2010).

Figure 2.3Factor human comfort (ASHRAE Standard 55, 2010)

The temperature of the surrounding air is measured in degrees Celsius (°C) or degrees Fahrenheit (°F). It is the most important determinant of convective heat loss from the body. The human body is affected by the mean radiant temperature, which equates to heat loss or gain from and to the environment via radiation. Air velocity (measured in ms^{-1}) can accelerate heat loss by convection, resulting in a cooling effect (Abdullah et al., 2016). The rate of evaporation from the body is affected by relative humidity. The thermal sense of a sedentary participant is unaffected by medium ranges of humidity (30-70 %) at moderate temperatures (26°C) (Wales, 2016).

Air temperature is the most often used measure of thermal comfort since it is the easiest to use and rate. However, though it is critical, it is not the only characteristic that can be used to precisely characterize thermal comfort (Hussein & Rahman, 2009). The two local climatic conditions that impact interior comfort are temperature and relative humidity, whereas the building envelope, orientation, shading, glazing type and size, vegetation, and thermal mass are design-dependent aspects that contribute to the thermal comfort conditions in buildings. Despite the fact that these elements are unrelated to one another, they have a significant influence when taken together (Calis & Kuru, 2015).

2.4 Environment Factor

The average temperature of the air surrounding the body, with respect to location and time, is defined as the air temperature in many studies. The temperature inside a building is affected by the season and the number of people in the building (Simion et al., 2016). The air temperature, according to the Health and Safety Executive (HSE), is the temperature that surrounds the body and can be measured in degrees Celsius or Fahrenheit. When we talk about air temperature, we're talking about the most influential element in all of the environmental parameters. This is due to the fact that humans are extremely sensitive to temperature changes (Alwetaishi, 2016).

The mean radiant temperature is defined as the temperature of a uniform, black enclosure that exchanges the same amount of heat radiation with the resident as the real enclosure. It's a single figure for the entire body that can be thought of as a spatial average of the temperature of surfaces around the occupant, weighted by their distance from the individual (ASHRAE Handbook., 2013).

Humidity refers to the amount of moisture in the air. It is calculated using vapour pressure, dew-point temperature, and humidity ratio, among other thermodynamic factors. In the same way that air temperature is averaged geographically and over time, water temperature is averaged regionally and over time (ASHRAE Standard 55, 2010). Humphreys defines humidity as the quantity of water vapour pressure in the air that influences evaporative heat loss (Humphreys & Fergus Nicol, 2002). The percentage of humidity in the air rises when water is heated and evaporates in the surrounding area. Relative humidity is defined as the percentage difference between the current amount of evaporative water and the exact amount of water that the air can hold at a given air temperature (Yang et al., 2014). Seasonal temperature and relative humidity are shown in Table 2.4.

Thermal comfort is unaffected by relative humidity levels of between 30% and 70%. When the relative humidity exceeds 70%, sweat does not evaporate, resulting in hot weather and discomfort for the occupants. When the relative humidity is less than 30%, it causes a dry sensation and has a negative impact on the mucosal membranes (Simion et al., 2016). Figure 2.4 show the table for relative humidity.

Table 2.4 Values for temperature and air humidity based on season (Musat R., 2009)

Season	Outside temperature (℃)	Inside temperature (℃)	Minimum relative humidity (%)	Maximum relative humidity (%)
Winter	≤ ± 20	22	35	70
Summer	+ 20	22	Not available	70
	+ 25	23	Not available	65
	+ 30	25	Not available	60
	+ 32	26	Not available	55

Dry-Bulb Temperature (°C)	*Depression of Wet-Bulb Temperature* (Dry-Bulb Temperature − Wet-Bulb Temperature = Depression of the Wet Bulb)																					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
−20	28																					
−18	40																					
−16	48	0																				
−14	55	11																				
−12	61	23																				
−10	66	33	0																			
−8	71	41	13																			
−6	73	48	20	0																		
−4	77	54	43	11																		
−2	79	58	37	20	1																	
0	81	63	45	28	11																	
2	83	67	51	36	20	6																
4	85	70	56	42	27	14																
6	86	72	59	46	35	22	10	0														
8	87	74	62	51	39	28	17	6														
10	88	76	65	54	43	33	24	13	4													
12	88	78	67	57	48	38	28	19	10	2												
14	89	79	69	60	50	41	33	25	16	8	1											
16	90	80	71	62	54	45	37	29	21	14	7	1										
18	91	81	72	64	56	48	40	33	26	19	12	6	0									
20	91	82	74	66	58	51	44	36	30	23	17	11	5	0								
22	92	83	75	68	60	53	46	40	33	27	21	15	10	4	0							
24	92	84	76	69	62	55	49	42	36	30	25	20	14	9	4	0						
26	92	85	77	70	64	57	51	45	39	34	28	23	18	13	9	5						
28	93	86	78	71	65	59	53	47	42	36	31	26	21	17	12	8	2					
30	93	86	79	72	66	61	55	49	44	39	34	29	25	20	16	12	8	4				
32	93	86	80	73	68	62	56	51	46	41	36	32	27	22	19	14	11	8	4			
34	93	86	81	74	69	63	58	52	48	43	38	34	30	26	22	18	14	11	8	5		
36	94	87	81	75	69	64	59	54	50	44	40	36	32	28	24	21	17	13	10	7	4	
38	94	87	82	76	70	66	60	55	51	46	42	38	34	30	26	23	20	16	13	10	7	5
40	94	89	82	76	71	67	61	57	52	48	44	40	36	33	29	25	22	19	16	13	10	7

Relative Humidity Values

Figure 2.4The table for find relative humidity. Source

(https://chartwalls.blogspot.com/2019/03/dry-bulb-and-wet-bulb-relative-humidity.html)

Another name for air movement is air velocity. The average speed of the air to which the body is exposed in terms of place and time is known as air velocity. The human body is extremely sensitive to air movement, particularly in specific areas such as the neck, head, and feet, and this sensitivity varies greatly from person to person (Simion et al., 2016). When the flow rate is too high or irregular, local thermal pain arises. As a result, having easy control over air velocity and flow direction is critical (Riachi Y., 2014). People are particularly sensitive to air velocity, so it is an important consideration.As a result, depending on the current interior conditions, such as relative humidity and temperature, the space may need to be cooled or heated. These two variables, along with air speed, have the biggest impact on human thermal comfort indoors (Hall, 2010).

2.5 Human Factor

One of the most important factors influencing thermal comfort is metabolic rate. There are numerous types of structures, each with its own function and level of activity. As a result, people's activities at schools differ from those in offices, resulting in considerable temperature awareness differences. It is described as heat that we produce inside our bodies as we carry out physical activity (Mustapa,Zaki,and Rijal, 2016). We produce more heat as we become more active. Table 2.5 shows the metabolic rate for each activity.

Humans require energy to work and produce heat in order to keep their internal body temperature at 36.5°C. The higher the intensity of the activity, the more heat is generated. If too much heat is produced, the body will sweat, causing discomfort. When too little heat is created, blood is drained from the hands and feet, the skin temperature drops, and the person becomes cold and uncomfortable (Appah-Dankyi J., 2012).

Table 2.5 Basic exercise metabolic rate (Simion et al., 2016)

Activity	Metabolic Rate	
	Met Units	W/m²
Resting		
Sleeping	0.7	40
Reclining	0.8	45
Quietly seated	1.0	60
Relaxed standing	1.2	70
Walking (on level surface)		
0.9 m/s, 3.2 km/h, 2.0 mph	2.0	115
1.2 m/s, 4.3 km/h, 2.7 mph	2.6	150
1.8 m/s, 6.8 km/h, 4.2 mph	3.8	220
Office Activities		
Reading while seated	1.0	55
Writing	1.0	60
Typing	1.1	65
sat while filing	1.2	70
Filing, standing	1.4	80
Walking	1.7	100
Lifting/packing	2.1	120
Driving/Flying		
Automobile	1.0 – 2.0	60 - 115
Aircraft/ routine	1.2	70
Aircraft, instrument landing	1.8	105
Aircraft, combat	2.4	140
Heavy vehicle	3.2	185

Table 2.5 (cont) Basic exercise metabolic rate (Simion et al., 2016)

Activity	Metabolic Rate	
	Met Units	W/m²
Miscellaneous Occupational Activities		
Cooking	1.6 – 2.0	95 – 115
House cleaning	2.0 – 3.4	115 – 200
Seated, heavy limb movement	2.2	130
Machine work		
Sawing (table saw)	1.8	105
Light (electrical industry)	2.0 – 2.4	115 – 140
Heavy	4.0	235
Handling 50 (100 lb) bags	4.0	235
Pick and shovel work	4.0 – 4.8	235 – 280
Miscellaneous Leisure Activities		
Dancing, social	2.4 – 4.4	140 – 255
Calisthenics/exercise	3.0 – 4.0	175 – 235
Tennis, single	3.6 – 4.0	210 – 270
Basketball	5.0 – 7.6	290 – 440
Wrestling, competitive	7.0 – 8.7	410 – 505

Before this the man used animal furs as clothing to defend himself from the cold in primordial times (Alwetaishi, 2016). The body's insulation, which includes both clothing and skin, serves to protect it from the environment. As far as the study of human thermal exists, Oliveira stated that assessing the thermal insulation of clothes is quite significant (Oliveira, A., 2011).

Clothing protects the human body from harsh weather conditions and aids in body thermoregulation by maintaining a thermal balance between the skin and the environment. The ability of materials to maintain skin temperature and allow perspiration to be transferred from the body is referred to as thermal comfort (Li Y, 2001). The insulation properties of clothing it is measured in clo. Table 2.6 show insulation value for clothing.

Table 2.6 Clothing insulation values for typical ensembles (ASHRAE Standard 55, 2010)

Description of the Outfit	Clothing combination	I , (clo)
Trousers	Short-sleeved shirt and trouser	0.57
	Long-sleeved shirt and trousers	0.61
	Suit jacket, trousers, long-sleeved shirt	0.96
	T-shirt, slacks, a long-sleeved shirt, a suit jacket, a vest	1.14
	T-shirt, trousers, long-sleeve shirt, long-sleeve sweater	1.01
	Trousers, a long-sleeved shirt, a long-sleeved sweater, a T-shirt, a suit jacket, and long underwear bottoms.	1.30
Skirts/Dresses	Short-sleeved shirt and knee-length skirt	0.54
	Full slip, knee-length skirt, long-sleeved shirt	0.67
	Long-sleeve shirt, knee-length skirt, half slip, long-sleeve sweater	1.10
	Knee-length skirt, long-sleeve shirt, half slip, suit jacket	1.04
	Suit jacket, ankle-length skirt, long-sleeved shirt	1.10
Shorts	Short-sleeved shirt with walking shorts	0.36
Overalls/Coveralls	T-shirt and long-sleeve coveralls	0.72
	T-shirt, overalls, and long-sleeve shirt	0.89
	Insulated coveralls, long-sleeve thermal underwear tops and bottoms	1.37
Athletic	Sweat pants, long-sleeve sweatshirt	0.74
Sleepwear	Pajama tops with long sleeves, long pajama trousers, and a short 3/4-length robe (slippers, no socks)	0.96

2.6 Thermal Comfort Tool Software

A screenshot of the CBE Thermal Comfort Tool's home page may be found in Figure 2.5. The tool has six different pages that include ASHRAE 55, EN 16798, Compare, Ranges, Upload, and other CBE tools. The navigation bar at the top of the page can be used to browse between pages. On the left side of each page are the input parameters that users can adjust and change (except for the Upload and other CBE tools). The findings are displayed on the right side, which usually includes an interactive chart. As users adjust the input values, the chart and the results are updated in real time. When the mouse is hovered over the plot area on some charts, psychometric parameters are displayed (Tartarini et al., 2020).

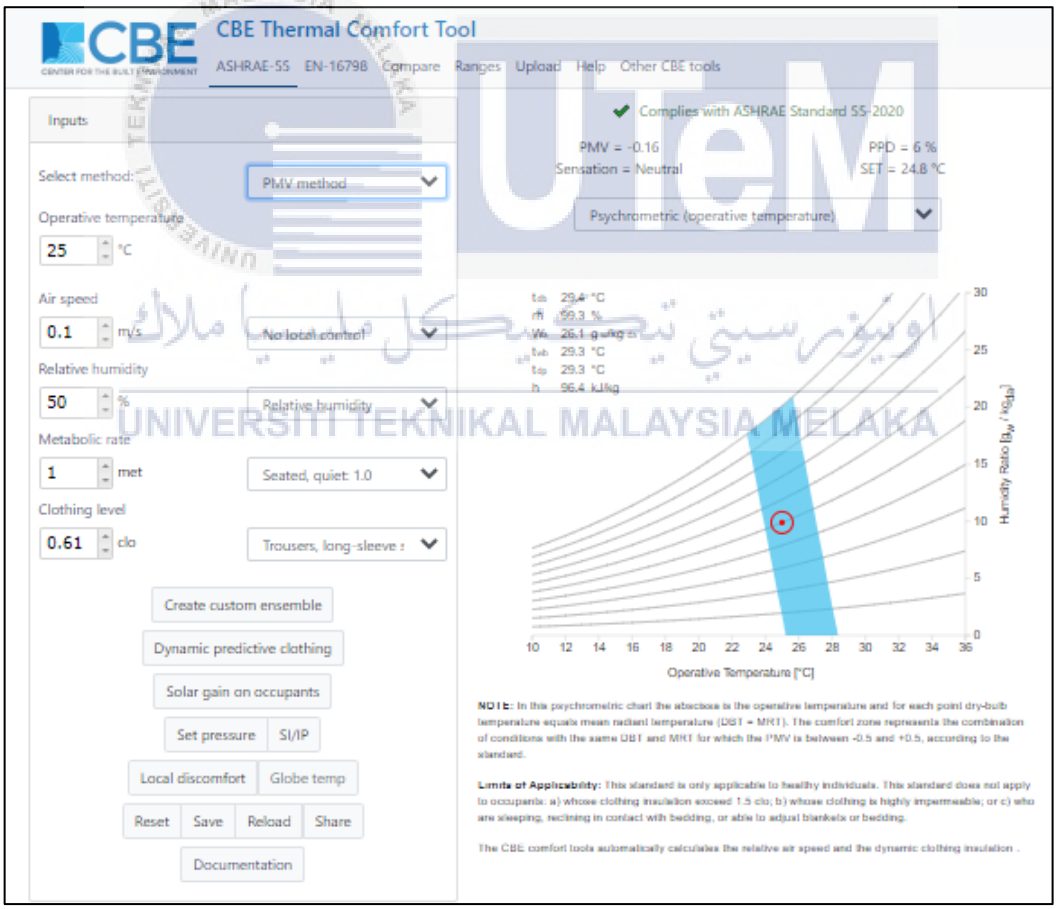


Figure 2.5CBE Thermal Comfort Tool home page. Source (https://comfort.cbe.berkeley.edu/)

2.6.1 Function of Software

Display of thermal comfort indices – When the user changes the input setting, the programmer automatically updates the chart and associated thermal comfort indices (Predicted Percentage of Dissatisfied (PPD), Predicted Mean Vote (PMV), Cooling Effect (CE), and SET. PMV and PPD can be calculated using ASHRAE 55 or EN 16798. Users can also see the data on one of three charts: air speed vs operative temperature, a psychrometric chart with either operative or air temperature on the x-axis, or relative humidity vs air temperature. Finally, viewers can see how a user-defined input parameter affects human body heat loss (calculated using the PMV approach) (Tartarini et al., 2020).

Users can examine thermal comfort zones on a chart with the interior operative temperature as the ordinate and multiple outdoor temperature indices as the abscissa using adaptive models from the ASHRAE 55 or EN 16798 Standards. From the dropdown option at the top of the input box, select this graphic. Both the graphics and the results are updated in real time as the user changes the input data (Tartarini et al., 2020).

Thermal Comfort Comparison (Compare Page) - A psychrometric chart can estimate and plot up to three different thermal comfort levels at the same time. The impact of various input circumstances on thermal comfort can then be compared (Tartarini et al., 2020)

Ranges of Thermal Comfort (Ranges page) - Because thermal ambient conditions in real buildings vary depending on location and time, comfort indices are typically calculated with predefined input parameters. The CBE Thermal Comfort Tool addresses this issue by allowing users to specify a range of discrete intervals during which metabolic rate, average air speed, or garment insulation can fluctuate. This feature allows users to investigate how the thermal comfort zones change as a result of their input values (Tartarini et al., 2020).

Comfort Indexed calculation (upload page) - It allows users to upload time-series data or large sets of input parameters, and the SET, CE, PMV, and PPD are automatically calculated. For simulated or real-world structures, this function can be used to predict annual or seasonal excess (Tartarini et al., 2020).

Evaluation of local discomfort - To use this feature, press the 'local discomfort' button. Many local discomfort models, such as radiant temperature asymmetry, ankle draught, and vertical air temperature differential, are defined in the ASHRAE and EN Standards. Evaluation of local discomfort - To use this feature, press the 'local discomfort' button. Many local discomfort models, such as radiant temperature asymmetry, ankle draught, and vertical air temperature differential, are defined in the ASHRAE and EN Standards (Wang, Schiavonn, 2020).

From the drop-down menu, you can choose reference values for metabolic rates for common tasks and clothing insulation for common clothing items. You can access the 'Dynamic predictive clothing' capability by clicking the 'Dynamic predictive clothing' button. It calculates garment insulation using the exterior dry-bulb temperature at 6:00 a.m. You can use the 'Create custom ensemble' feature by pressing the 'Create custom ensemble' button. Add separate items together to get overall clothing insulation. The international system of units (SI) and the imperial system of units are available to users (IP) (Huang, Zhang, 2015).

2.6.2 Step of Software

The collected data will be used in the CBE thermal tool software. This software will show the result of thermal comfort in good condition or not. It also displays the PMV and PPD values for the locations that received the data. Figure 2.6 depicts the first page of the CBE thermal comfort tool when accessed via the internet.

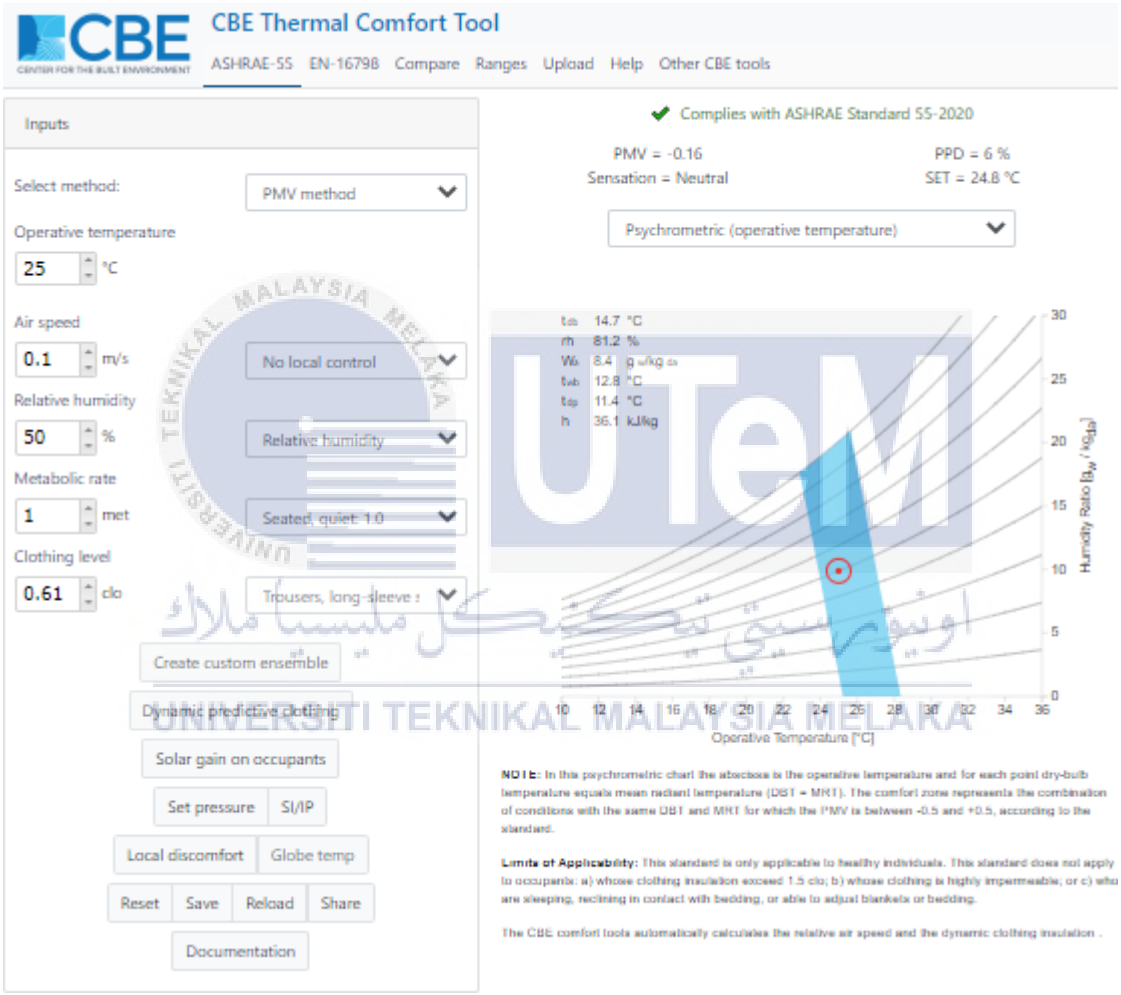


Figure 2.6Page of CBE thermal comfort tool

The first step to do for CBE thermal comfort tool is selected the standard that will use for the data. Figure 2.7 show the selected standard of ASHRAE 55 will use for this research. After that, the data that get from the selected place will use. As in Figure 2.8 show the method will use is PMV method and Figure 2.9 show the part for enter the data of air temperature.

Figure 2.7Selected function tool

Figure 2.8Select method

Figure 2.9Air temperature part

The value of mean radiant temperature will get after the air temperature, air speed and globe temperature are insert to the table in the Figure 2.10. Then the value of velocity are insert at air speed part as show in Figure 2.11.

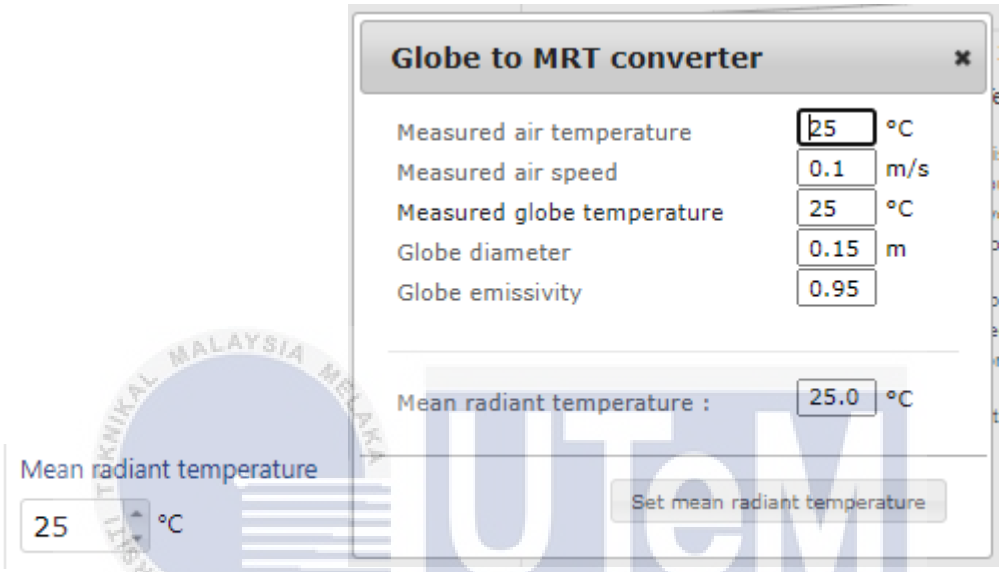


Figure 2.10 Mean radiant tempearature part

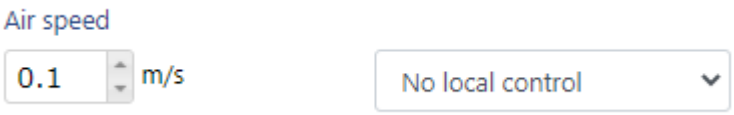


Figure 2.11 Air speed part

The value for metabolic rate is depend on the situation. Then choose the situation in the Figure 2.12 that need to use for this research. The value of clothing level will show when select the cloth that need to use as show in Figure 2.13.

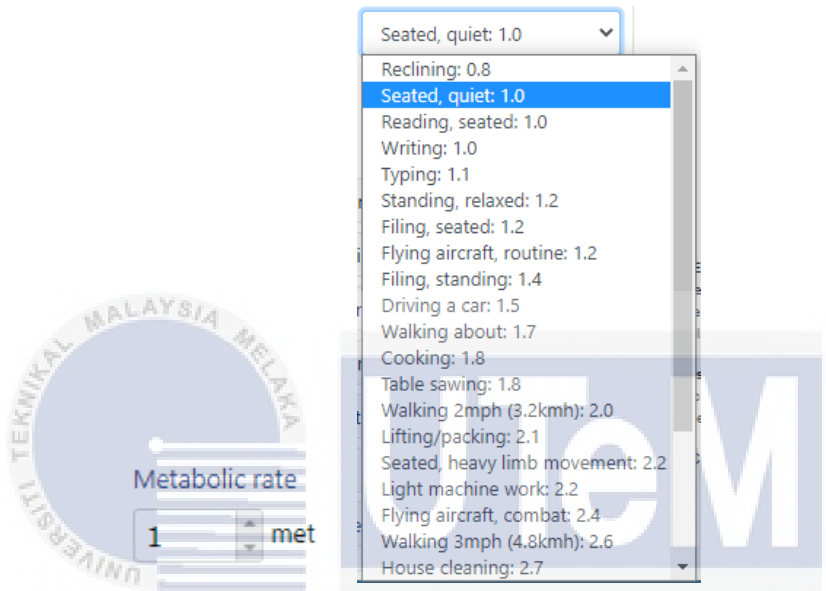


Figure 2.12 Metabolic rate part

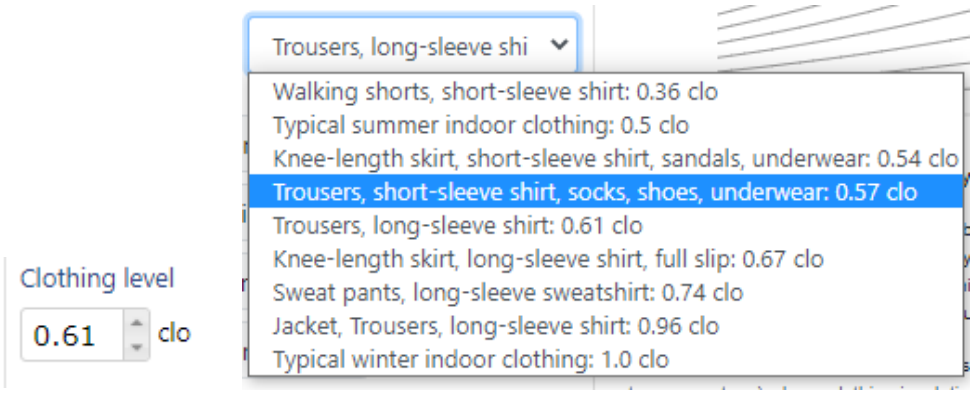


Figure 2.13 Clothing level part

The result will show as Figure 2.14. It shows the value of PMV and PPD that are in good condition or not. Based on graph, the condition for the selected place for thermal comfort zoom are in blue colour area.

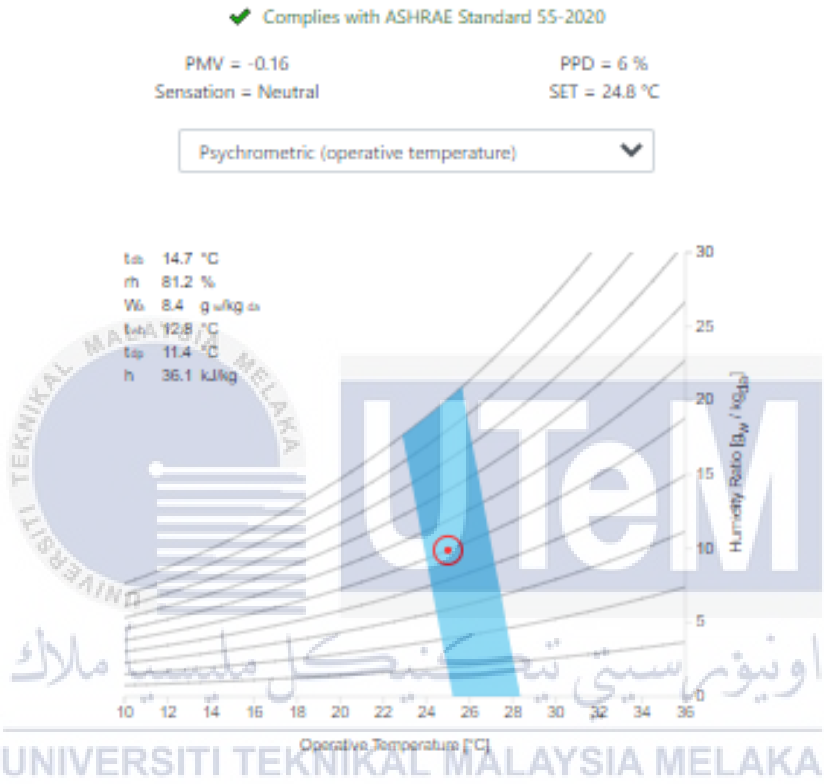


Figure 2.14 The result

2.7 PMV and PPD

User can select reference values for metabolic rates for common tasks and clothing insulation for common clothing items from drop-down menus. The 'Dynamic predictive clothes' feature can be accessed by clicking the 'Dynamic predictive clothing' button. The outside dry-bulb temperature at 6:00 a.m. is used to compute garment insulation. By pressing the 'Create custom ensemble' button, you may use the 'Create custom ensemble' feature. To acquire total clothing insulation, combine separate materials. Users can choose between the international system of units (SI) and the imperial system of units (IP) (Mohamed Kamar et al., 2019).

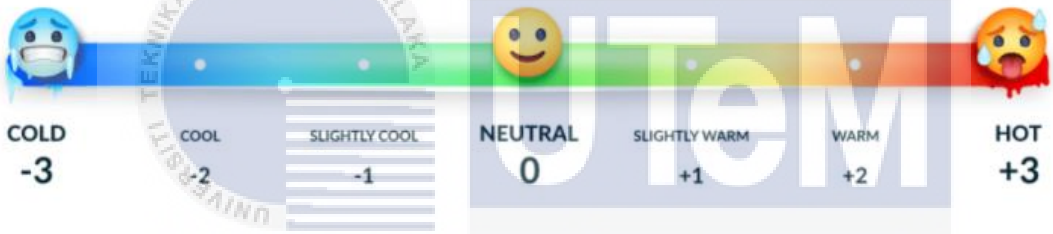


Figure 2.15 PMV index (Mohamed Kamar et al., 2019)

The PPD, or index, that establishes a quantitative prediction of the percentage of thermally unhappy inhabitants (too hot or too chilly) can be established once the PMV has been created as Figure 2.15. The percentage of those who are expected to have local pain is calculated using PPD. The most common causes of local pain are unwanted cooling or heating of an occupant's body (Mohamed Kamar et al., 2019). Figure 2.16 show the relationship between PMV and PPD indices.

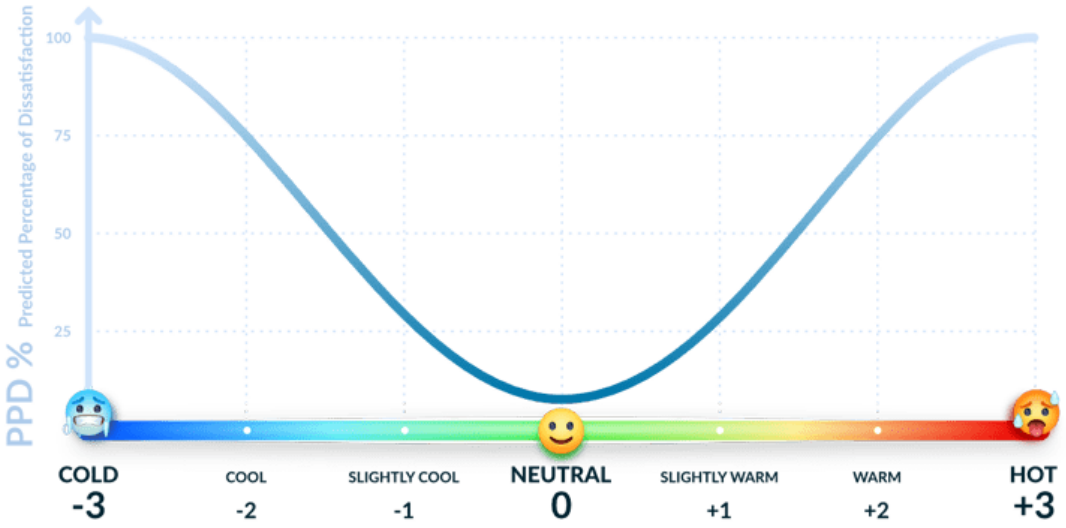


Figure 2.16 The relationship between PMV and PPD indices (Mohamed Kamar et al., 2019)

2.8 International Standard for Thermal Comfort

For the assessment of thermal comfort in the indoor environment, there are three well-known standards that are regularly used:

i. ISO Standard 7730: Thermal environment ergonomics—To determine and interpret thermal comfort, the PMV and PPD indices, as well as local thermal comfort criteria, are used (ISO 7730, 2005).

ii. ASHRAE Standard 55: Thermal Environmental Conditions for Human Occupancy (ASHRAE Standard 55, 2010).

iii. CEN Standard EN 15251: Indoor environmental input parameters for design and assessment of energy performance of buildings address indoor air quality, thermal environment, lighting and acoustics (CEN., 2007).

2.8.1 ISO 7730

The PMV and PPD indices are based on a mathematical model of the heat balance, and the ISO 7730 international standard contains methodologies for calculating and applying them (Haddad et al., 2009). The PMV-PDS equations are used by ISO 7730 to predict the thermal sensation and satisfaction of people in a moderate temperature setting. In addition to the whole-body thermal comfort condition, ISO 7730 includes parameters for local thermal discomfort using the PMV-PDD index. Draught, which is determined by the draught rate (DR) and the vertical air temperature difference between the head and ankles, cool floors or radiant temperature asymmetry, or warm, which is determined by the percentage of dissatisfied (PD) equations, cause local discomfort. The standard includes a table of metabolic rates for various activities, as well as thermal insulation values for popular apparel garments and ensembles (ISO 7730, 2005).

2.8.2 ASHRAE 55

The American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE) has sponsored and developed an international standard to evaluate thermal comfort needs. ASHRAE Standard 55's main purpose is to describe the combinations of six fundamental characteristics that produce acceptable interior thermal conditions for the majority of occupants: air temperature, radiant temperature, humidity, air speed, metabolic rate, and garment insulation. ASHRAE Standard 55 is typically suggested for workplaces with sedentary or near-sedentary physical activity of less than 1.3 MET because it is based on thermal comfort data acquired from these settings. Other types of buildings and their occupants are permitted to utilize the criterion "provided it is carefully applied to groups of tenants, such as those found in school conditions." Despite this, no more information or

explanation about children's thermal comfort needs is provided (ASHRAE Standard 55, 2010).

2.8.3 Created European Standard EN 15251

EN 15251 was created by the Comité Européen de Normalisation (CEN) in 2007. "How to determine environmental input parameters for building system design and energy performance calculations," according to this European standard. The specifications of this standard are largely important in non-industrial structures such as residential buildings, offices, and educational facilities for building design and energy performance evaluations (CEN., 2007).

European Standard EN 15251 establishes a set of criteria for evaluating mechanically cooled and free-running buildings, similar to ASHRAE Standard 55. EN 15251 specifies comfort criteria for the evaluation of the thermal environment in mechanically heated and/or cooled buildings based on the PMV-PPD index, equal to ISO 7730, with assumed typical values of the metabolic rate and summer/winter clothing, as provided by ISO 7730 (CEN., 2007).

2.9 Standard Parameter

The measurement of the specific physical parameters and indoor air contaminants is as listed in Table 2.7. The standard for air temperature is acceptable in the range of 23 – 26 °C. In terms of relative humidity, a value in the range of 40 – 70% is acceptable. The last parameter is air movement. The range of acceptable is 0.15 – 0.50 m/s (DOSH, 2010)

Table 2.7 Acceptable range for specific physical parameters

Parameter	Acceptable range
Air temperature	23 – 26 ℃
Relative humidity	40-70%
Air movement	0.15 – 0.50 m/s

CHAPTER 3

METHODOLOGY

3.1 Introduction

This section will look into the methods and processes used during the research. The approach used in a study or project is crucial. The methodology aids the study's procedure in order to ensure that it may be completed effectively. In order to meet the study's aims, the methodology section contains numerous sections. In addition, the methods of measurement described in this chapter. A diagram helps to clearly illustrate and detail the flows in this study. This is because it allows researchers to perform the investigations in a more expedient manner. Hence, the whole flow chart is showed below as in Figure 3.1. There are the research beginning, carry out literature reviews, methodology, data collection, analysis of data and lastly for conclusions & recommended solutions for the research.

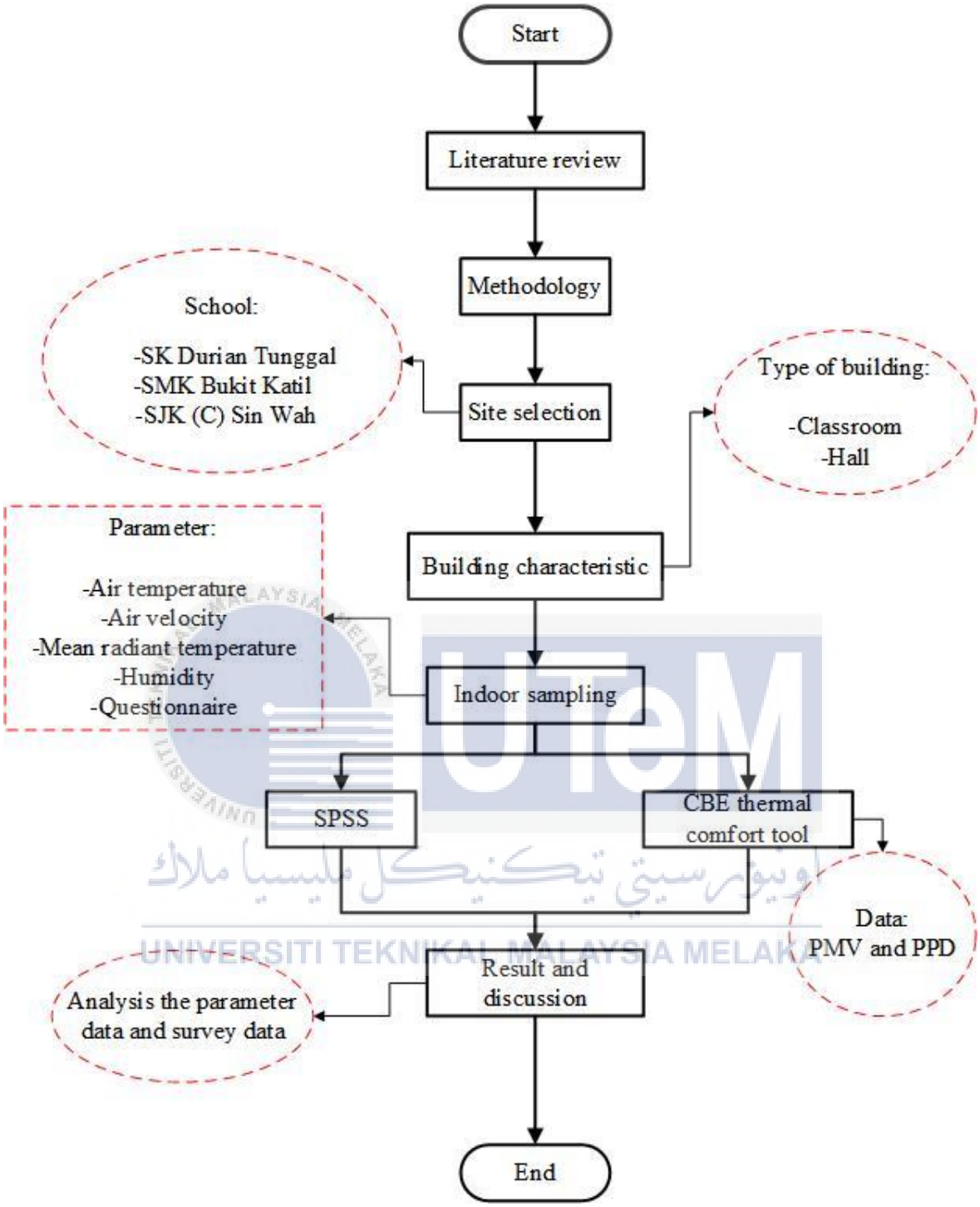


Figure 3.1Research flow chart

3.2 Site Selection

Malacca is a state in Malaysia that covers a total size of 1,664 km² (642 sq mi). As seen in Figure 3.2, it is located on the southwestern coast of the Malay Peninsula, opposite Sumatra, with the states of Negeri Sembilan to the north and west and Johor to the east. It is located at latitudes of 2°23′16.08″N to 2°24′52.27″N and longitudes of 102°10′36.45″E to 102°29′17.68″E. Malacca is two-thirds of the way along Malaysia's west coast, 148 kilometers (92 miles) south of Kuala Lumpur, and occupies a key position on the Malacca Straits. With the exception of a few small hills, Malacca is a lowland area with an average elevation of less than 50 meters above sea level.

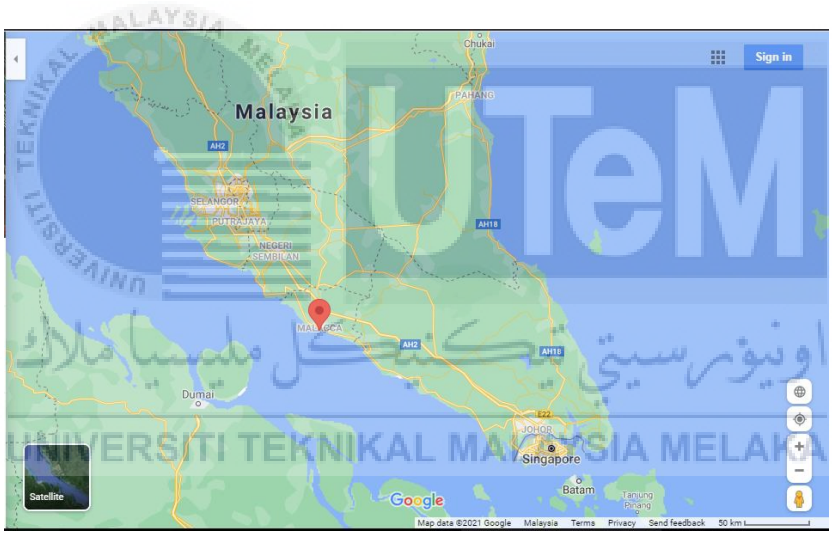


Figure 3.2Map of Melaka (source: google map)

3.2.1 SK Durian Tunggal

SK Durian Tunggal is one of the schools in Durian Tunggal. It was one of the earliest schools in the area. The school has four building blocks as show in Figure 3.3, Figure 3.4, Figure 3.5, and Figure 3.6. Only Three building blocks were used as flood evacuation centers. The block used is a classroom. There are two blocks in front of the football field, the block in front of the field has good airflow as there are no obstructions from trees and other buildings. The other block is an old block, the block has two levels and is surrounded by trees.

Figure 3.3Building block 1

Figure 3.4Building block 2

Figure 3.5Building block 3

Figure 3.6Building block 4

3.2.2 SJK (C) Sin Wah

Sekolah Jenis Kebangsaan (C) Sin Wah or its short name SJK (C) Sin Wah, is a Chinese national type of school located in Durian Tunggal. It has a large hall and several building blocks. The place used as a temporary evacuation center in this school is the hall as in Figure 3.8 and Figure 3.9. As Figure 3.7 show the label of Dewan SJK (C) Sin Wah that locate at back of school.

Figure 3.7The label of Dewan SJK (C) Sin Wah

Figure 3.8Beside of hall

Figure 3.9In front of hall

3.2.3 SMK Bukit Katil

The third school used for this study is SMK Bukit Katil as in Figure 3.10. The position of this school is at the top of the hill. The school has several blocks and each such block has three levels or four levels as show in Figure 3.11 and Figure 3.12. In this school one of the school blocks is used as a flood evacuation center. All classes in the block are used for temporary placement.

Figure 3.10 Label of school

Figure 3.11 The building block 1

Figure 3.12 The building block 2

3.3 Building Characteristic

The school has several buildings that can be used as temporary evacuation sites. For this study, the classroom area, as in Figure 3.13 and Figure 3.14 and the hall area, as in Figure 3.15, was used as a place to test the thermal comfort conditions. Several building factors will be considered in order to determine the thermal comfort conditions in the class and hall. Such as the area of the classroom and hall that will be used as a temporary evacuation site, the wind path that enters the building by looking at the area of windows and doors used and also the electrical goods that are in the building.

Figure 3.13 Sample of classroom at SK Durian Tunggal

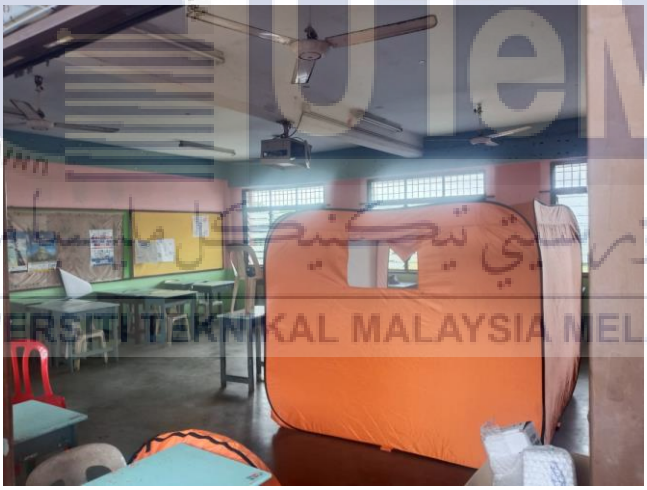


Figure 3.14 Sample of classroom SMK Bukit Katil

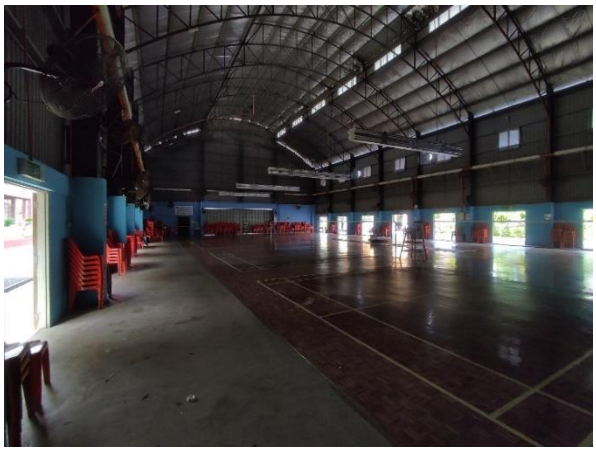


Figure 3.15 Sample of hall

3.3.1 Parameter of Class

For this research, the dimension of classroom need to measure by using measuring tape. Not only that the size of door and the window also need to take and the quantity of them need to count at classroom. The equipment in the classroom also important to get the thermal comfort. Table 3.1 show the sample parameter in classroom.

Table 3.1 The parameter in classroom

Category	Dimension	Quantity
Area of class	9144 mm x 7315 mm	-
Window	600mm x 1211mm	20 set
Fan	-	3 unit
Door	1215 mm x 1828 mm	2 set

3.3.2 Parameter of Hall

For this research, the dimension of hall need to measure by using measuring tape. Not only that the size of door and the window also need to take and the quantity of them need to count at hall. The equipment in the classroom also important to get the thermal comfort. Table 3.2 show the sample parameter in hall.

Table 3.2 The parameter in hall

Category	Dimension	Quantity
Area of hall	34860 mm x 21000 mm	-
Window	1400mm x 1600mm	16 set
Fan	-	31 unit
Door	2100 mm x 1770 mm	17 set

3.3.3 Solidwork

Solidworks is used to build mechatronics systems from start to finish. Project management, planning, visual ideation, modeling, feasibility evaluation, prototyping, and feasibility assessment are among the first applications of the software. The program is then used to design and manufacture mechanical, electrical, and software components. Solidworks was used to create the hall building plan as Figure 3.16 and classroom building plan as Figure 3.17.

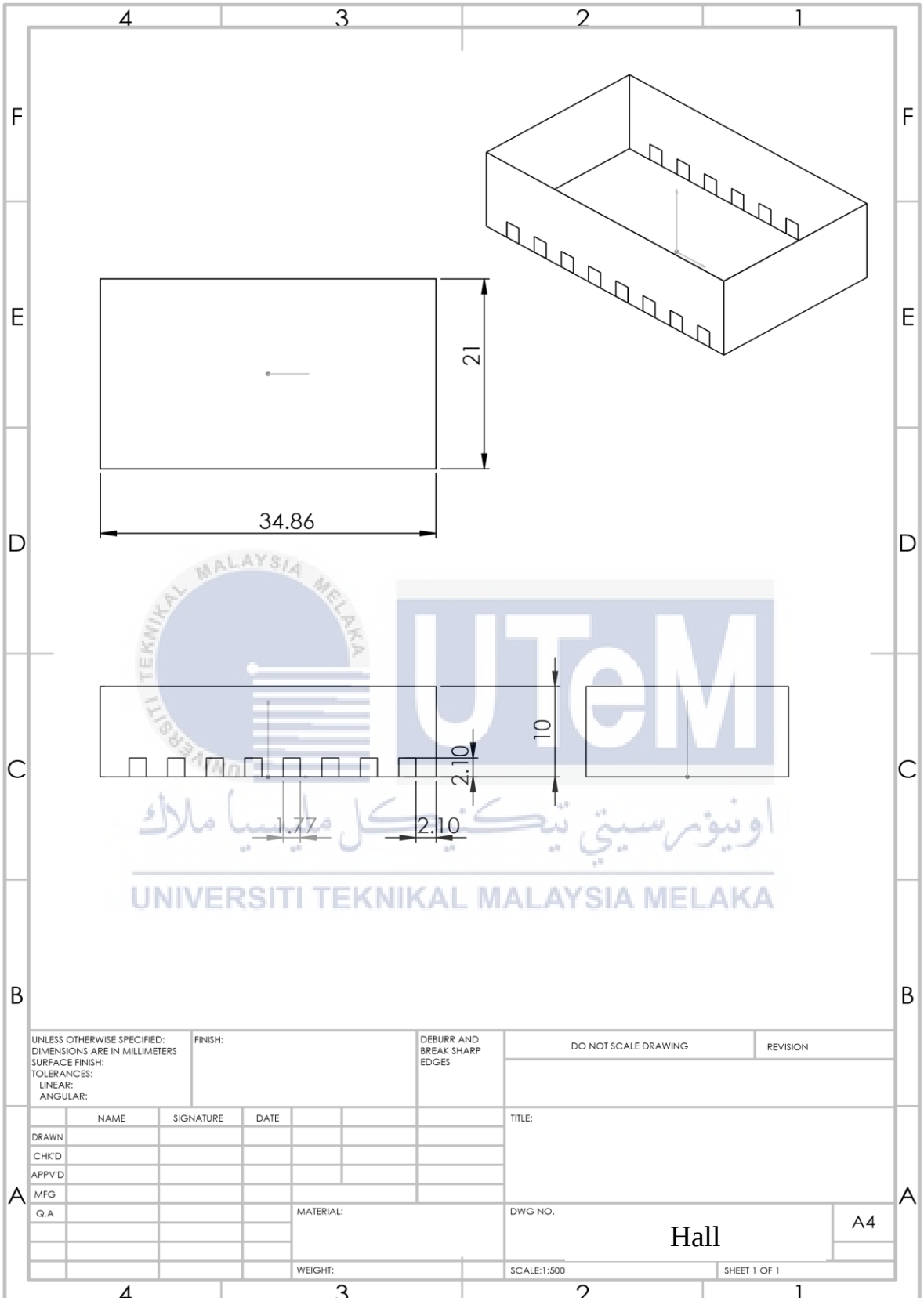


Figure 3.16 Hall building plan

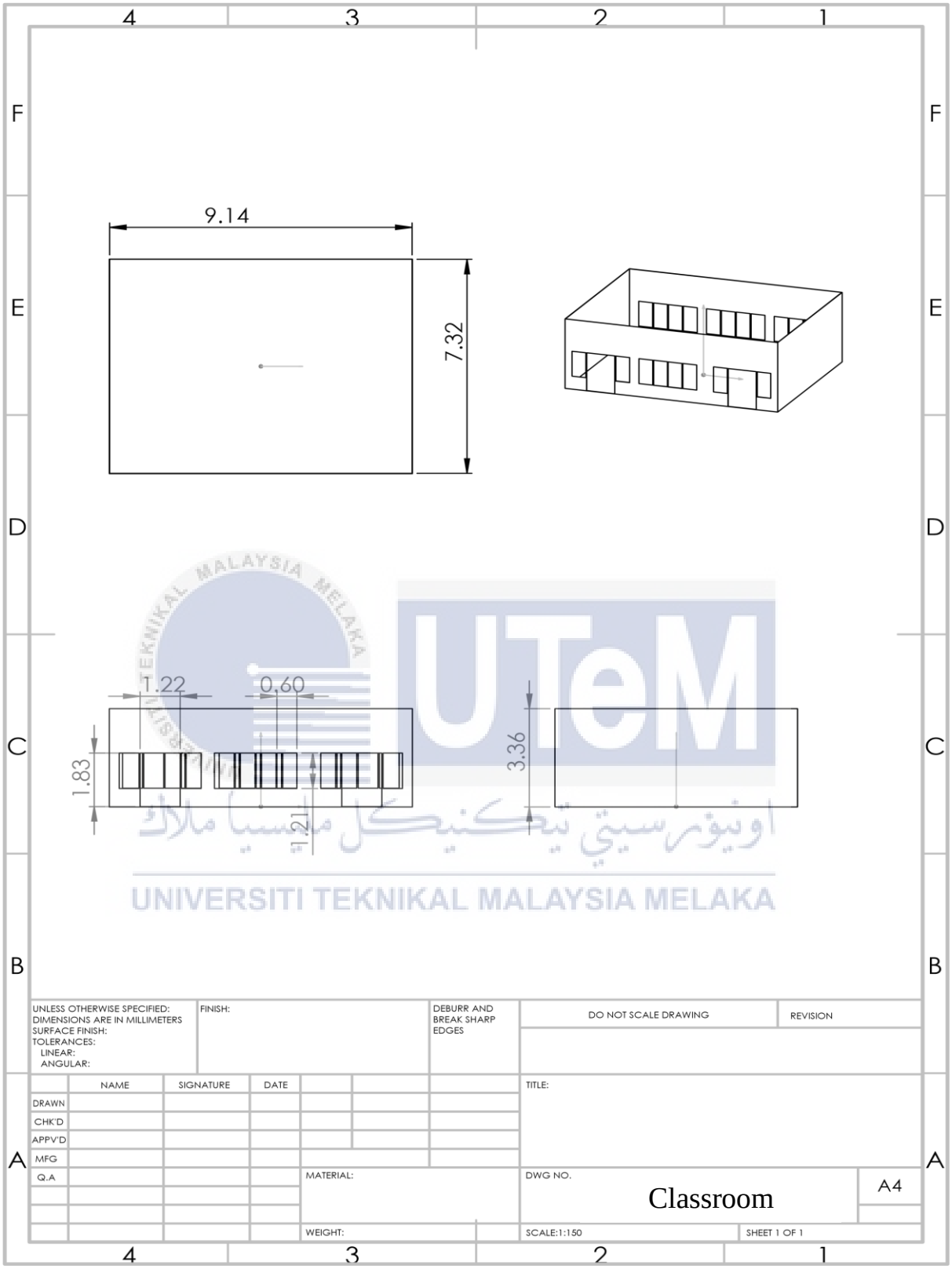


Figure 3.17 Classroom building plan

3.4 Indoor Sampling

For this research, there are a few data that be take at the selected area. The data that been taken were temperature, relative humidity, air velocity, metabolic rate and clothing level. All this data will use in the CBE tool to get the value of the thermal comfort. The method that use for this sampling by using globe thermometer and anemometer. The reading that will collected as manually from 8.00 am to 6.00 pm and each 15 minute the data will collected (Haddad et al., 2009).

3.4.1 Air Temperature

The importance of air temperature, which is the most important factor, must be taken in the tent at classroom and hall. From 8.00 a.m. to 6.00 p.m., the temperature in the classroom and hall will be measured. This is because at noon the situation in the room is at its most dramatic. Temperature data will be collected every 15 minutes (Haddad et al., 2009). Its purpose is to improve the accuracy of the data. A globe thermometer as in Figure 3.18 will be placed in the tent to determine the temperature in classroom.

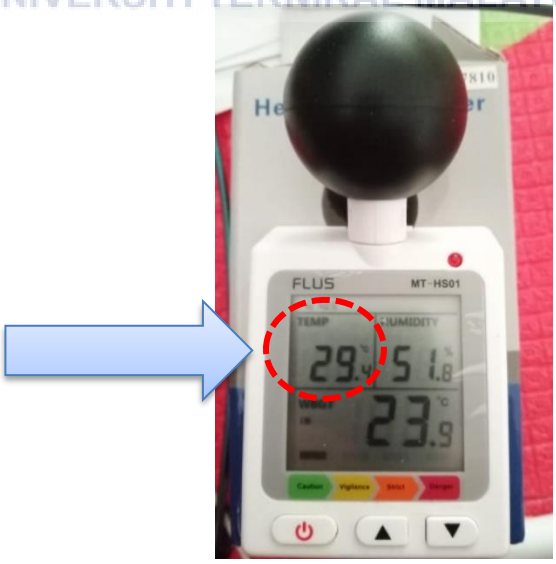


Figure 3.18 A globe thermometer show reading of air temperature

3.4.2 Mean Radiant Temperature

Another piece of equipment is used to obtain data on the mean radiant temperature. The average temperature of the surfaces in a classroom is measured as the mean radiant temperature. The mean radiant temperature for the class will be calculated by globe temperature in CBE tool and using the globe thermometer to get data of globe temperature shown in Figure 3.19. This equipment's parameters will place it in the middle of the class. The neck and ankles are the two most draft-sensitive parts of the body. Indoor environmental variables were gathered for this investigation in accordance with ASHRAE 55, with instruments set at 1m above the floor, as shown in Figure 3.20.

Figure 3.19 A globe thermometer show reading of globe temperature

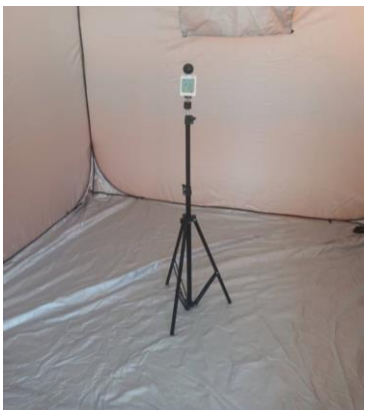


Figure 3.20 The height of instruments

3.4.3 Air Velocity

A second factor to consider for the CBE comfort tool is air velocity. The anemometer will locate at in front of tent door. It is as a main flow to air get inside. From the beginning of the research, the data will be collected every 15 minutes. An anemometer, as shown in Figure 3.21, is a tool for measuring velocity and the height is 1m.

Figure 3.21 Anemometer

3.4.4 Relative Humidity

The relative humidity of a water-air mixture is a measurement of how much water vapor is present compared to the maximum quantity attainable. RH is a comparison of a water-air mixture's humidity ratio to the saturated humidity ratio at a given temperature (dry-bulb). It's worth noting that knowing the dry-bulb temperature as well as the RH is required to determine the relevance of relative humidity to a certain application. For instance, the quantity of moisture in a water-air combination at 80% relative humidity at 40°C differs from the quantity of water vapour in a water-air combination at 80% relative humidity at 10°C.

The relative humidity in the selected area will be displayed by the globe thermometer, as shown in Figure 3.22. For this equipment, it will have the value of a globe temperature. After determining the values, the data will be collected in the middle of the tent every 15 minutes from 8.00 am to 6.00 pm.

Figure 3.22 A globe thermometer show reading of humidity

3.4.5 Metabolic Rate

The metabolic rate in the selected place will affect the thermal comfort in the room. The work done will produce heat from the body according to the physicality of the body, the age of each individual and the types of work done. Based on Figure 3.23 and Figure 3.24, only a few metabolic rates will be considered for this study.

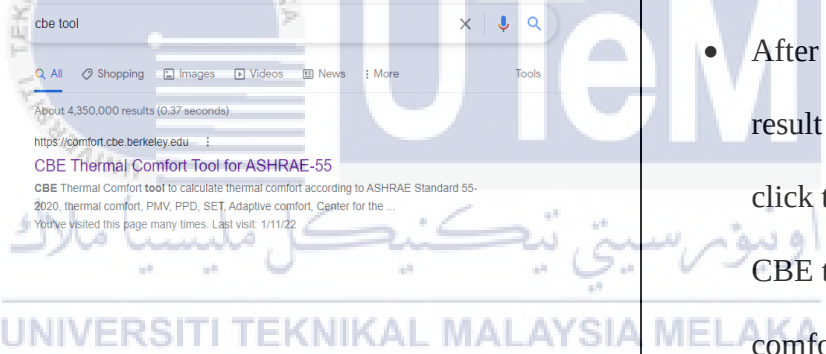
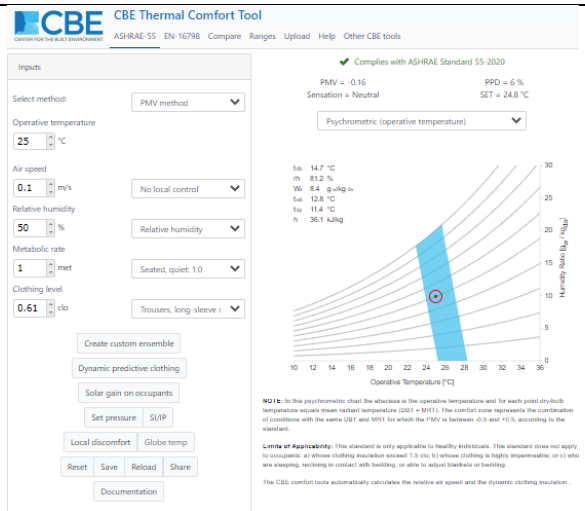
Figure 3.23 Reclining position

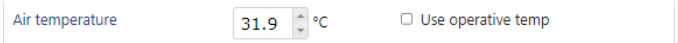
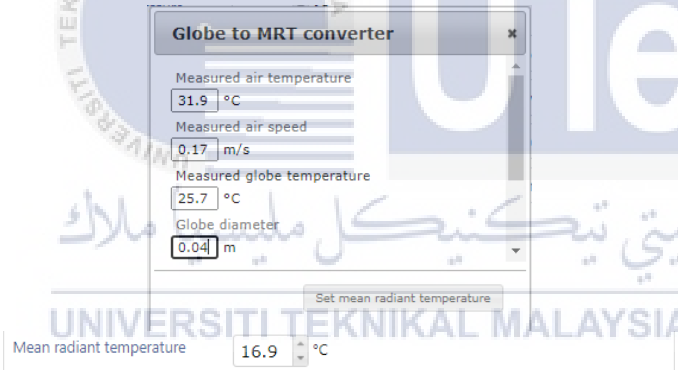
Figure 3.24 Sitting position

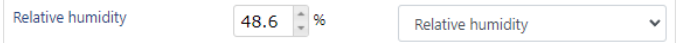
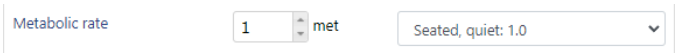
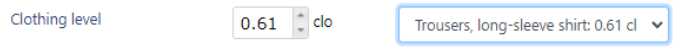
3.5 Procedure CBE Thermal Comfort

The collected data will be used in the CBE thermal tool software. This software will show the result of thermal comfort in good condition or not. It also displays the PMV and PPD values for the locations that received the data. As in Table 3.3 show the procedure of CBE tool that will be followed to get the result.

Table 3.3 The procedure of CBE tool

No	Figure	Description
1		• Search the cbe tool at google chrome. • After that, the result appear and click the link of CBE thermal comfort tool.
2		• The page were appear like the figure. • Insert the data that needed.

3		• The PMV method were select
4		• The value of air temperature were insert is 31.9℃
5		• Insert the value of air temperature 31.9℃. • Insert the value of air speed 0.17m/s • Insert the globe temperature 25.7℃. • Insert the globe temperature 0.04m. • Selected the set mean radiant temperature button to get the value of mean radiant.
6		• Insert the value of air speed 0.17m/s.

7		• Insert the value of relative humidity 48.6%.
8		• Select the seated, quiet for metabolic rate
9		• Select the trousers, long-sleeve for clothing level

3.6 Flow Process

From this study, the thermal comfort need to determine with assistance of the data that recorded. Thus, the data are measured and recorded with several standard measuring equipment or devices. This equipment were chosen because it suitable for thermal comfort parameter. This equipment are used to collect the data in the whole process from 8.00 am to 5.00 p.m. Plus, the data will record in table and transform into the graph in the form of Microsoft Excel after finished collecting it from the equipment. Finally, the generated graph in this software will analyze clearly with its definition and description.

3.6.1 Set up The Class

The condition of the tables and chairs in the classroom is as Figure 3.25. The chairs and tables will be arranged in advance to vacate the capacity space of temporary tents supplied as Figure 3.26. When the tables and chairs have been arranged at the edge of the classroom the empty space will be erected temporary tents.

Figure 3.25 The condition of the class

Figure 3.26 The condition of the class after arranged

3.6.2 Set up The Temporary Tent

Temporary tents are set up in the classroom according to the airflow or the part of the tent door facing the window. So that the airflow will enter the tent. For one class, one or two tents were provided for one family. When covid 19 occurs, there is only one family in the class. It is to reduce the risk of covid 19 infection. Based on the Figure 3.27 it is one example of the position of the tent in the classroom

Figure 3.27 The temporary tent

3.6.3 Set up The Equipment

For this study two tools were used to take the data namely anemometer and globe temperature. Based on the Figure 3.28 it shows the position of the anemometer is at the tent door and the height of the anemometer is 1 m to collect the velocity reading. For the Figure 3.29, globe temperature is used to take the temperature, humidity, and globe temperature. The height of the globe temperature is 1 m.

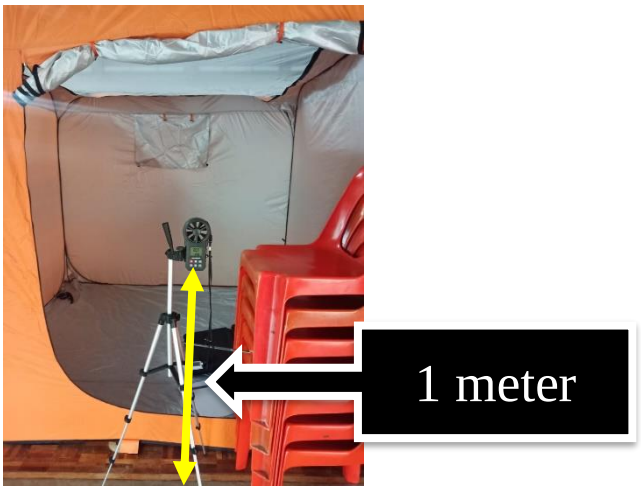


Figure 3.28 The condition of the anemometer

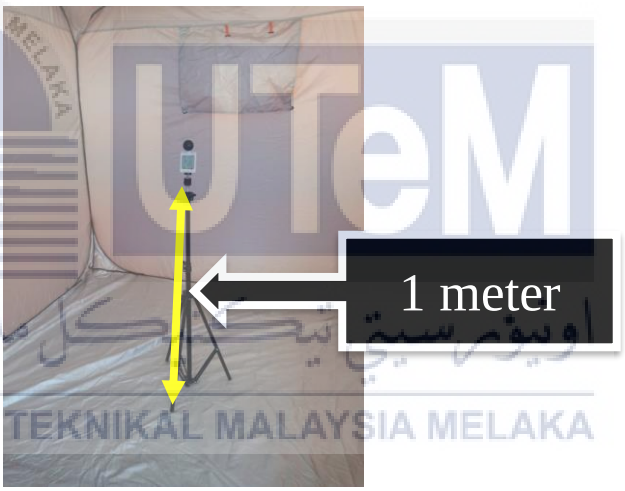


Figure 3.29 The condition of globe temperature

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

For this study a total of three schools have been used to collect data related to the comfort of individuals in temporary evacuation centers. Among the three, two schools use the classroom as a temporary evacuation center and the other uses the hall as a temporary evacuation center. The data taken in the three places are air temperature, humidity, air velocity and globe temperature.

4.2 Data

From the school that have been visit, there are four data have collected. For this study data were taken from 8.00 a.m. to 6 p.m. This data is used to consider the thermal comfort of individuals, who are in temporary evacuation centers during the day. As is known during the day there are weather conditions during very heavy rains and hot conditions.

4.2.1 Data Collected at SK Durian Tunggal

For the first school, SK Durian Tunggal, the weather during this study was hot, and the air flow conditions were also sometimes fast, sometimes slow, this will affect the thermal comfort of individuals in the area. The data were show in Appendix E.

4.2.1.1 Graph for SK Durian Tunggal

Based on the air temperature graph as Figure 4.1 taken from SK Durian Tunggal at 8.00 am the air temperature is 27℃. It increases from time to time until 12 noon. This is because at 8.00am to 12.00noon is a change in temperature from a condition categorized as cold to a hot condition. When 12.00 noon the air temperature is in a stable state that is between 31℃ to 32℃ because at noon it is the peak time. After that, the air temperature was only in the 31℃ to 32℃ range until evening which is a reading taken during hot weather.

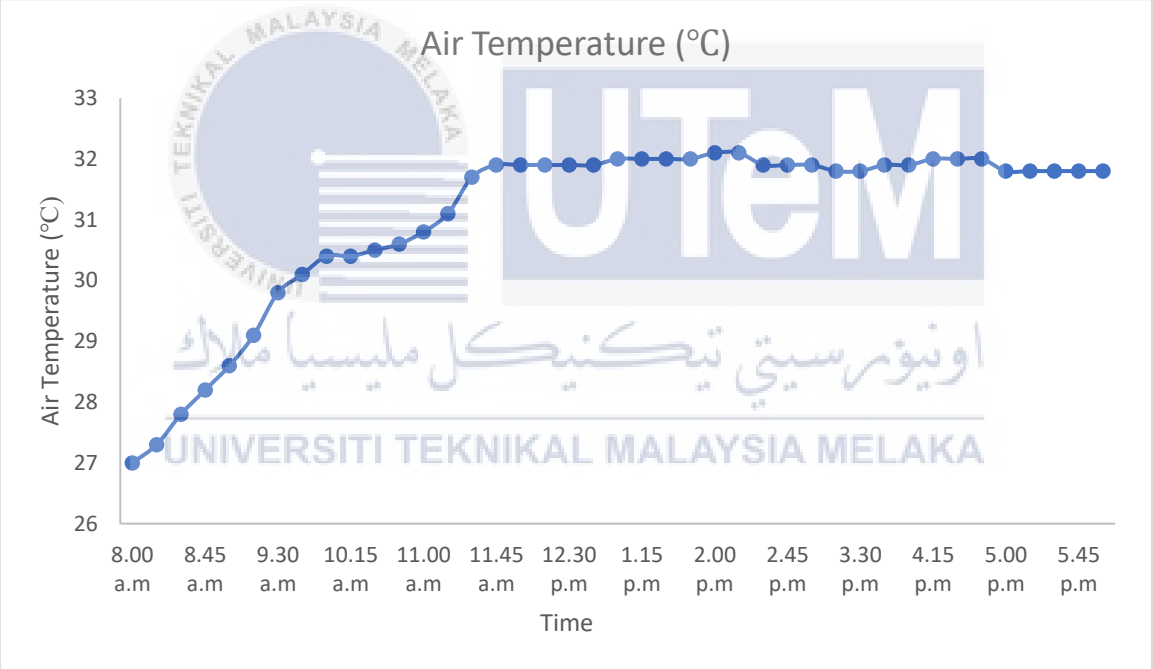


Figure 4.1The air temperature graph for SK Durian Tunggal

Based on the air velocity graph as Figure 4.2, the data reading obtained is between 0.1m/s to 0.5 m/s. From 8.00 am to 6.00 pm the velocity condition changes, it is influenced by the outside air flow entering the classroom and the fan condition in the classroom. High velocity readings are influenced by outside air as well as air from the fan. When there is no outside air the velocity will decrease and only the velocity of the fan is available.

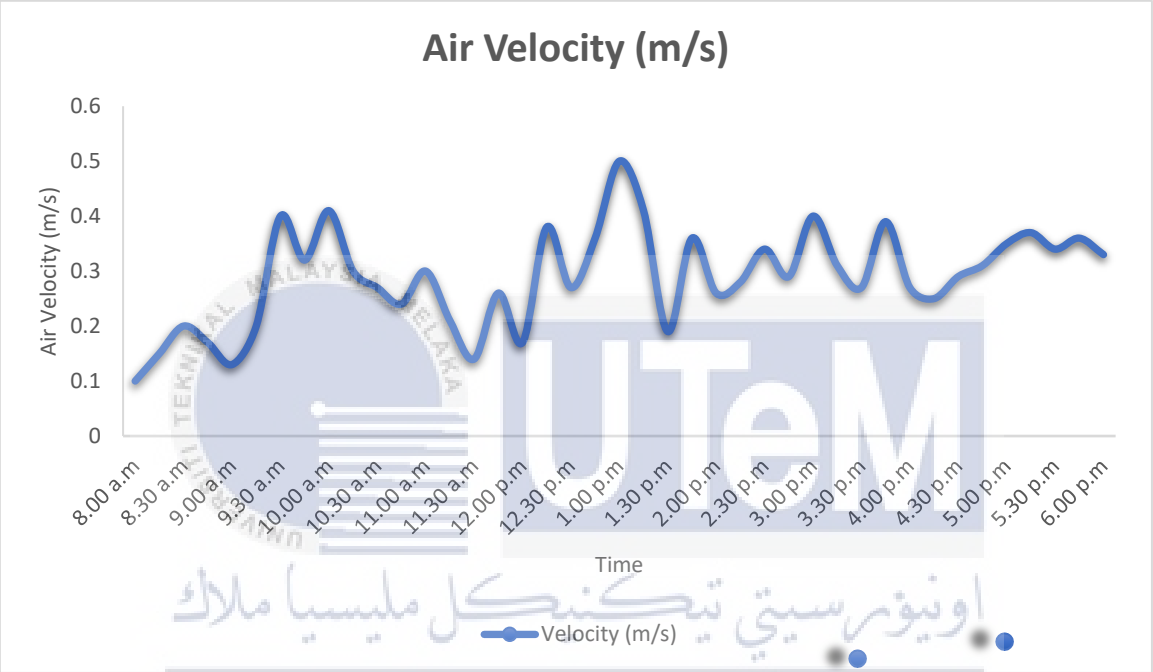


Figure 4.2The air velocity graph for SK Durian Tunggal

The value of mean radiant temperature is based on the globe temperature graph as Figure 4.3, the temperature in the morning is 23.1℃. The temperature of the globe rose from 8.00am in the morning until 1.00pm in the afternoon. After 1.00 pm the temperature reading was only 25.5℃ to 26℃ until 4.30 pm and the temperature dropped slightly.

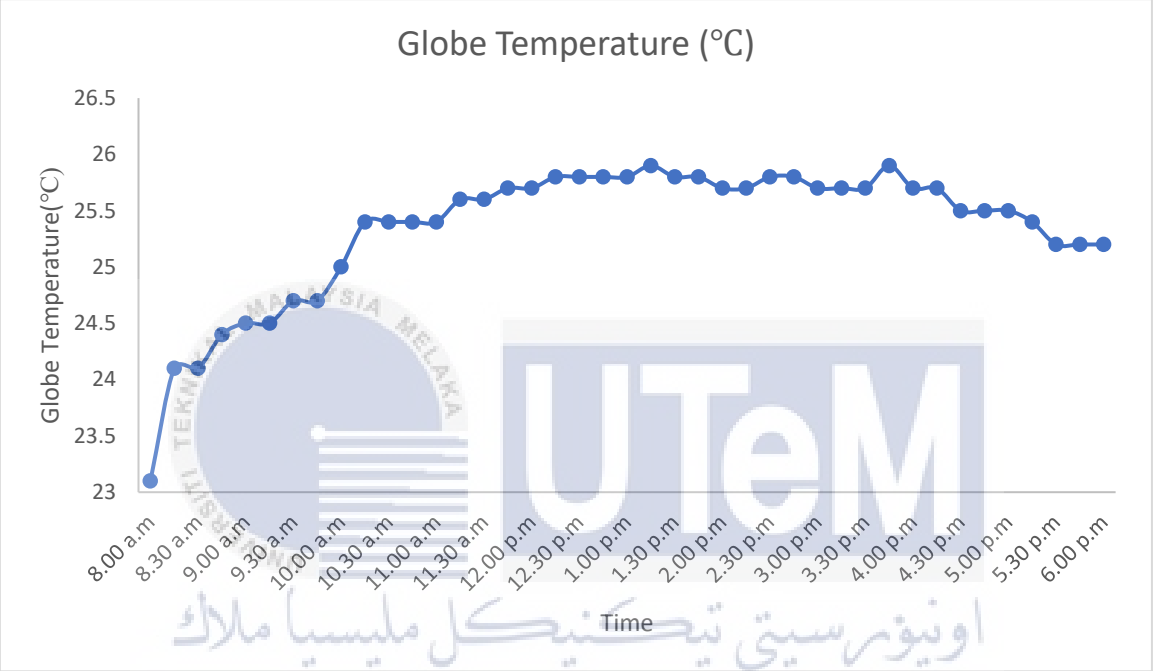


Figure 4.3The globe temperature graph for SK Durian Tunggal

Based on the humidity graph as Figure 4.4 at 8.00am in the morning the data obtained is 67%. The humidity temperature graph decreased from 8.00 am to 11.00 am and after that the data obtained was only between 45.5% to 50% until 6.00 pm.

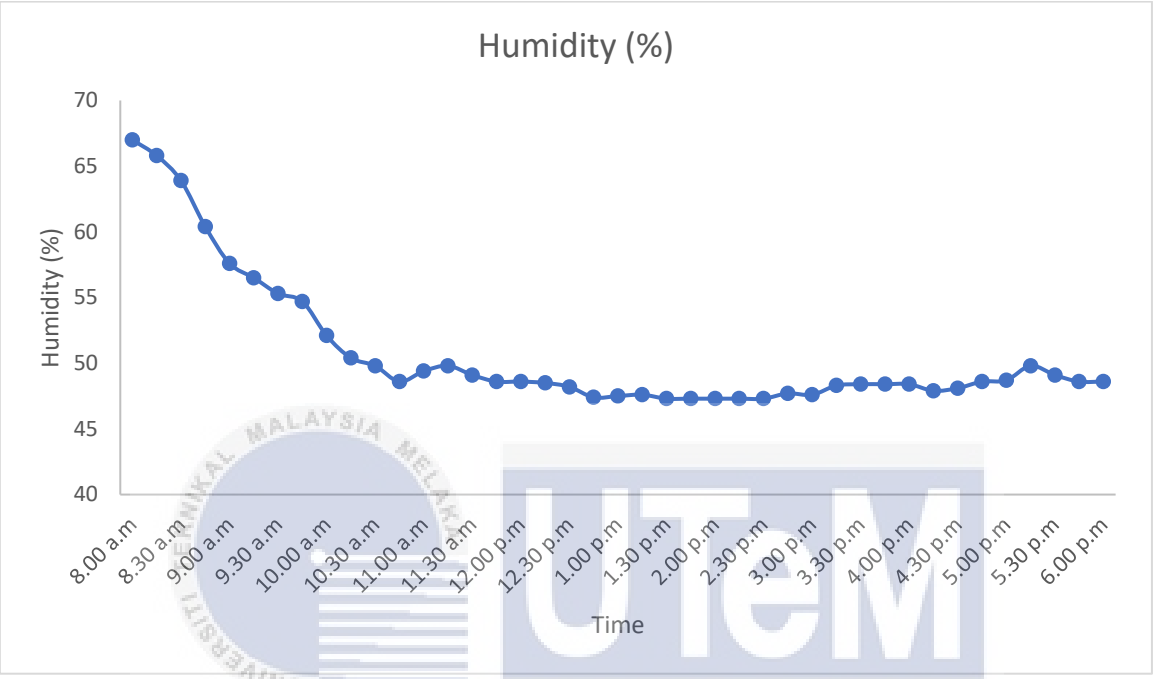


Figure 4.4The humidity graph for SK Durian Tunggal

4.2.2 Data Collected at SJK (C) Sin Wah

When a study was conducted at SJK (C) Sin Wah which used the Hall as a flood evacuation center. In the morning the weather when at school was in the rain. Rain occurs from morning until noon. This will also affect the data of the air temperature, air velocity, humidity and globe temperature to be obtained in Appendix F.

4.2.2.1 Graph for SJK (C) Sin Wah

The air temperature graph as Figure 4.5 shows the state from the data obtained which is 26 ℃ at 8.00 am until 12 noon. After 12 noon the temperature reading increased until 2.00 pm, which is at 31℃. After 2.00 pm, the reading is increased slightly until 6.00 pm in the afternoon. This indicates the temperature when it rains in the morning is in a cold state when the rain stops the temperature will rise Along with the weather from time to time.

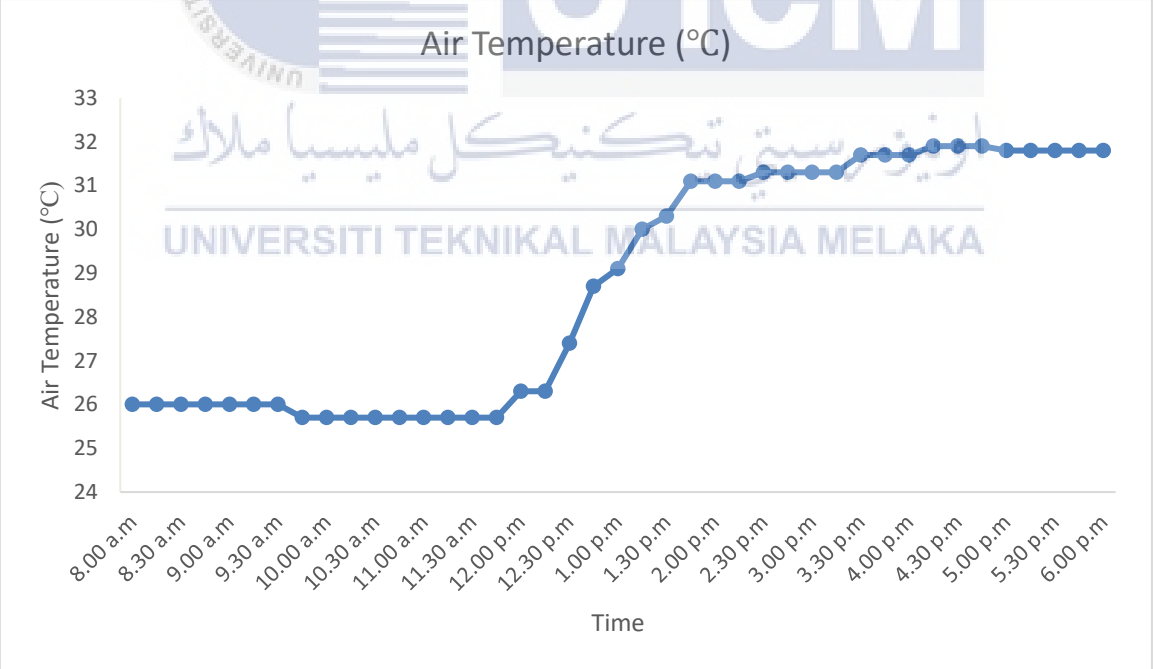


Figure 4.5The air temperature graph for SJK (C) Sin Wah

The air velocity graph as Figure 4.6 readings between 0.1m/s to 0.8m/s. The highest reading of 0.8 m/s is due to wind during rainy season. When rainy season the influence of wind entering the hall is very high. It causes the velocity readings obtained to be also high but when the rainy conditions stop the wind velocity will decrease. That causes the velocity reading at 11.30am to 3.00 pm to be only between 0.1 m/s and 0.4 m/s. In the evening at 4.30pm the reading is 0.5 m/s it is due to the wind from outside which is sometimes strong and sometimes slow as the next reading.

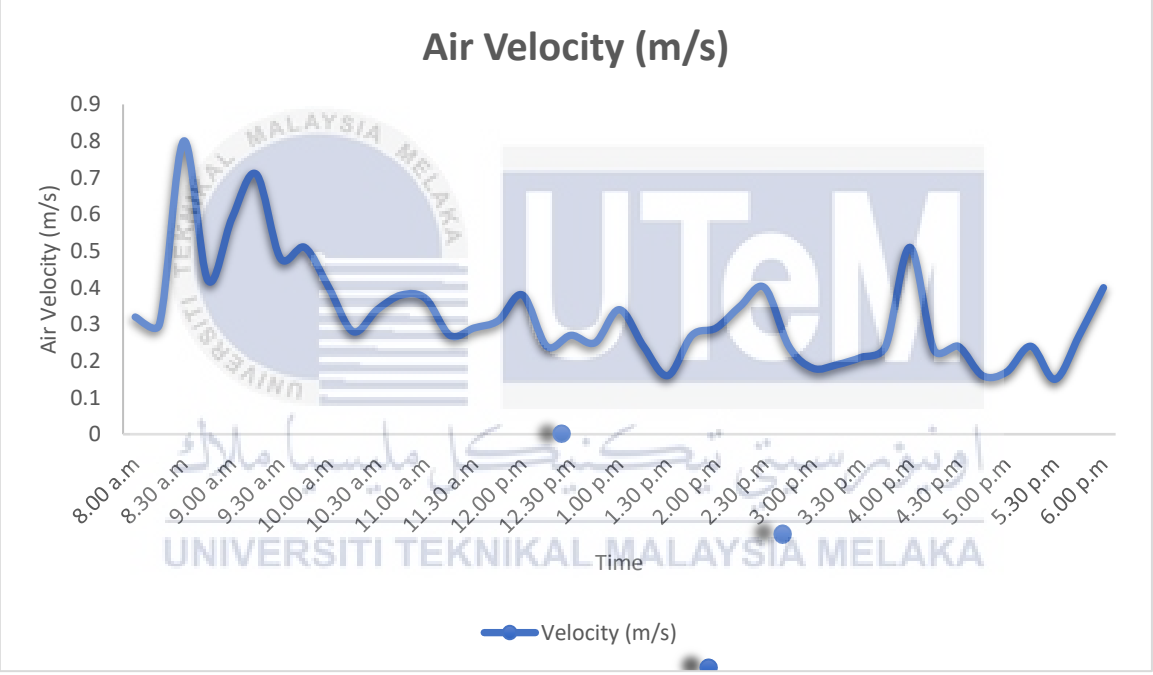


Figure 4.6The air velocity graph for SJK (C) Sin Wah

For globe temperature readings as Figure 4.7 at 8.00 am until 11.00 am, the data is between 23 ℃ to 24 ℃. After 11.30 am when the rain stopped the globe temperature continued to rise to 26 ℃ at 2 pm. At 2.15pm to 6.00pm the globe temperature is only between 26 ℃ to 27 ℃.

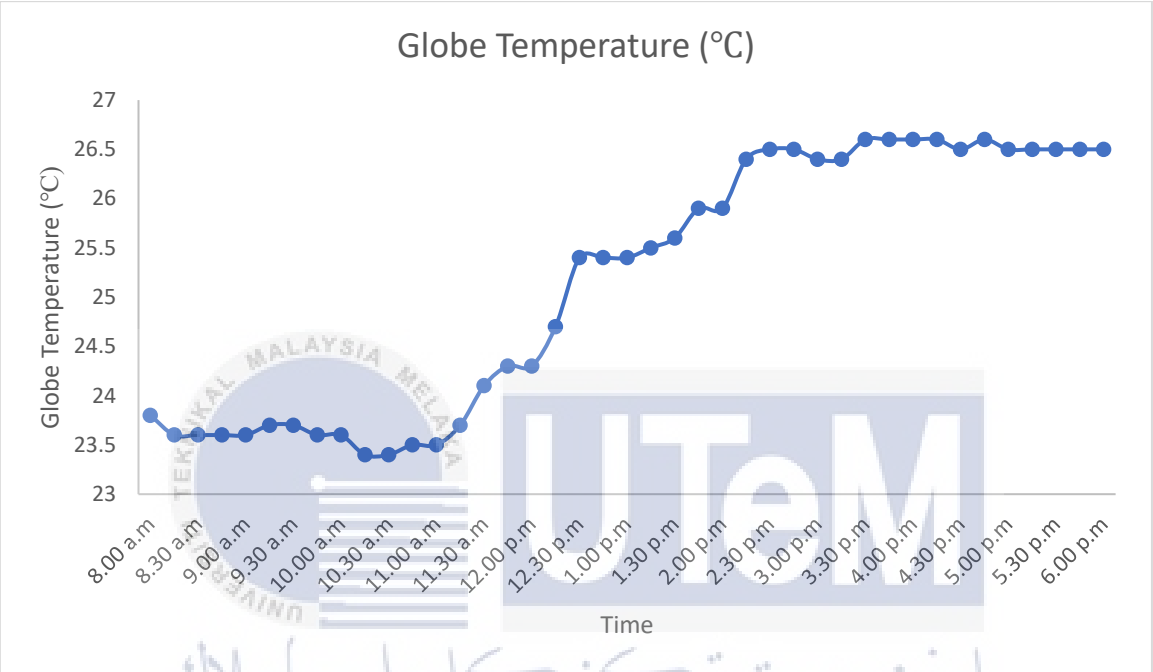


Figure 4.7The globe temperature graph for SJK (C) Sin Wah

As Figure 4.8, humidity data obtained at 8.00 am to 12.00 noon is the highest which is between 70 % to 82 %. this is due to the influence of rain which increases the percentage rate of air humidity in the Hall area. When the rain stopped the humidity in the area dropped from 80 % to 60 % at 2.00 pm. After 2.00 pm the humidity reading was only flat and decreased slightly at 4.00 pm until 6.00 pm the reading was 50 %.

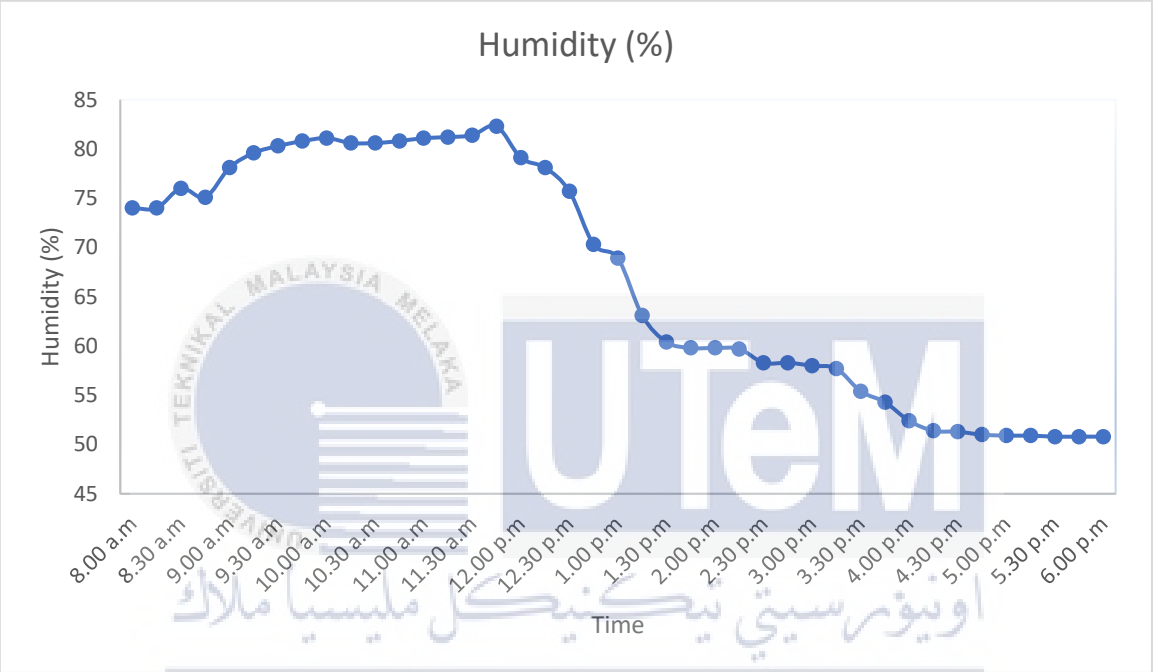


Figure 4.8The humidity graph for SJK (C) Sin Wah

4.2.3 Data Collected at SMK Bukit Katil

The third location used as the study site is SMK Bukit Katil. The weather in SMK Bukit Katil when taking data in drizzle in the morning and cloudy throughout the day. The data obtained during the day is also influenced by the position of the class. The class was on the second floor. The data as in Appendix G.

4.2.3.1 Graph for SMK Bukit Katil

The air temperature graph as in Figure 4.9, shows at 8.00 am the data obtained is 26 ℃ and it increased until 9.00 am. This increase was due to the drizzle that stopped. After that the air temperature reading is only flat and increases slightly from 10.00 am to 6.00 pm. It was due to cloudy conditions at the time. This air temperature also increases due to the heat from sunlight.

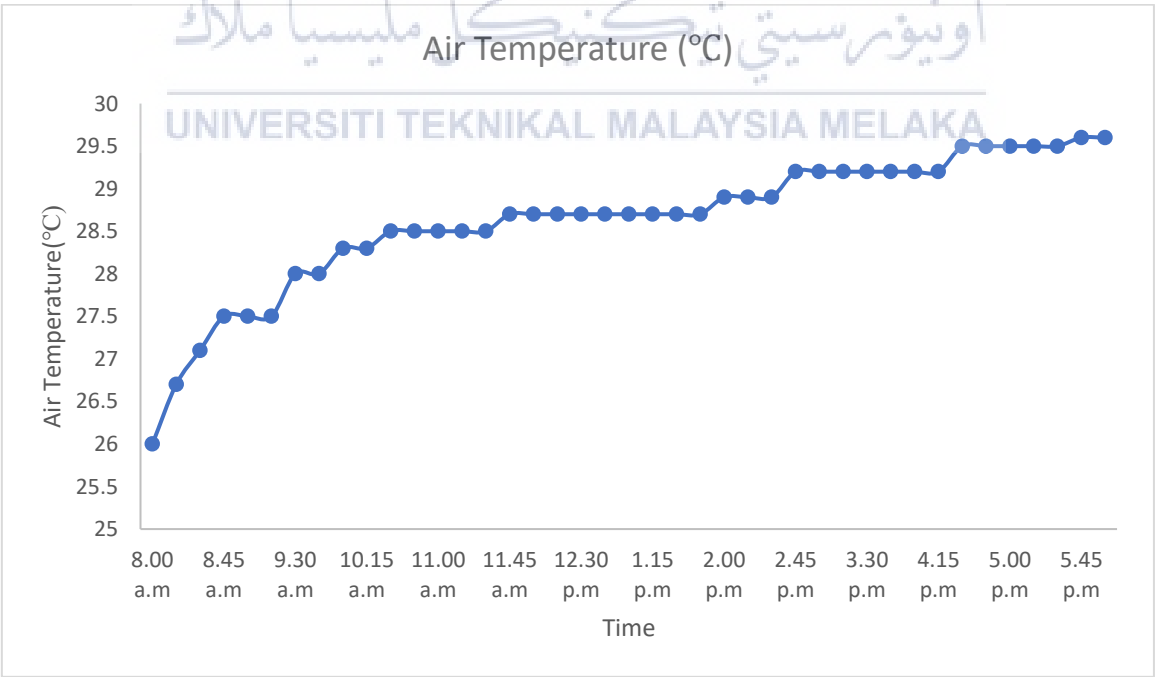


Figure 4.9The air temperature graph for SMK Bukit Katil

Based on the air velocity graph as Figure 4.10 the reading obtained is between 0.1m/s to 0.5m/s. These readings obtained are among the highest for this study due to the height of the class being on the 2nd floor. It also affects the airflow that enters the classroom. The higher the position the more air enters and the higher the air velocity in the class.

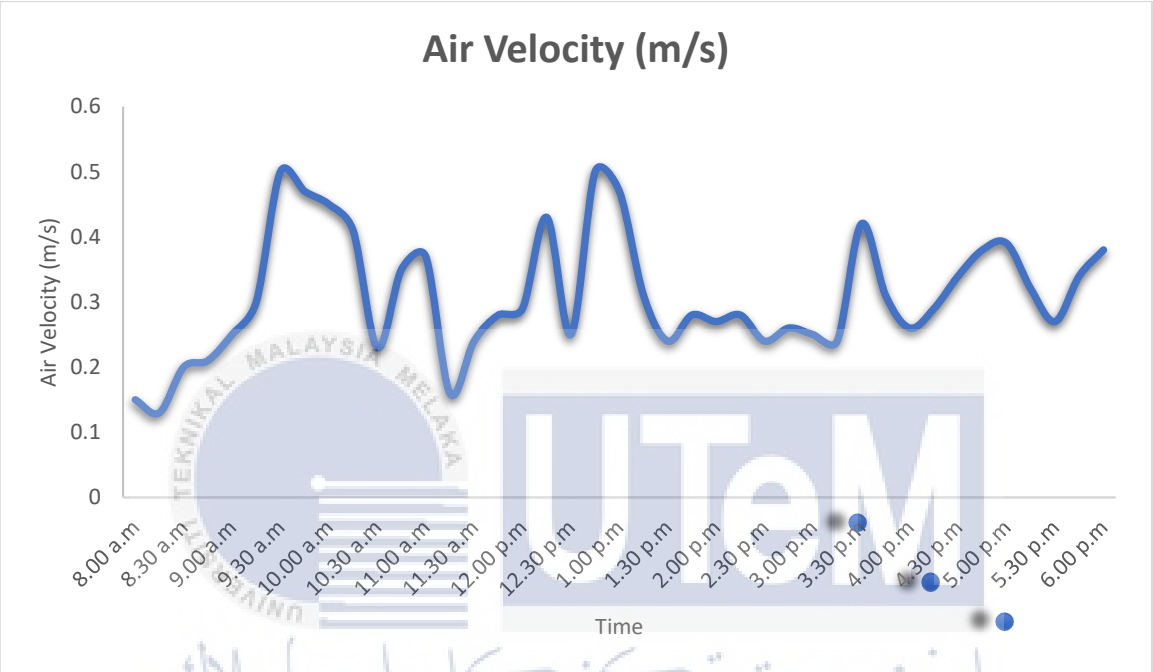


Figure 4.10 The air velocity graph for SMK Bukit Katil

The globe temperature graph shows in Figure 4.11, an increase from time to time. At 8.00 am the reading obtained is 24 ℃ increased to 25.8 ℃ senses at 6.00 pm.

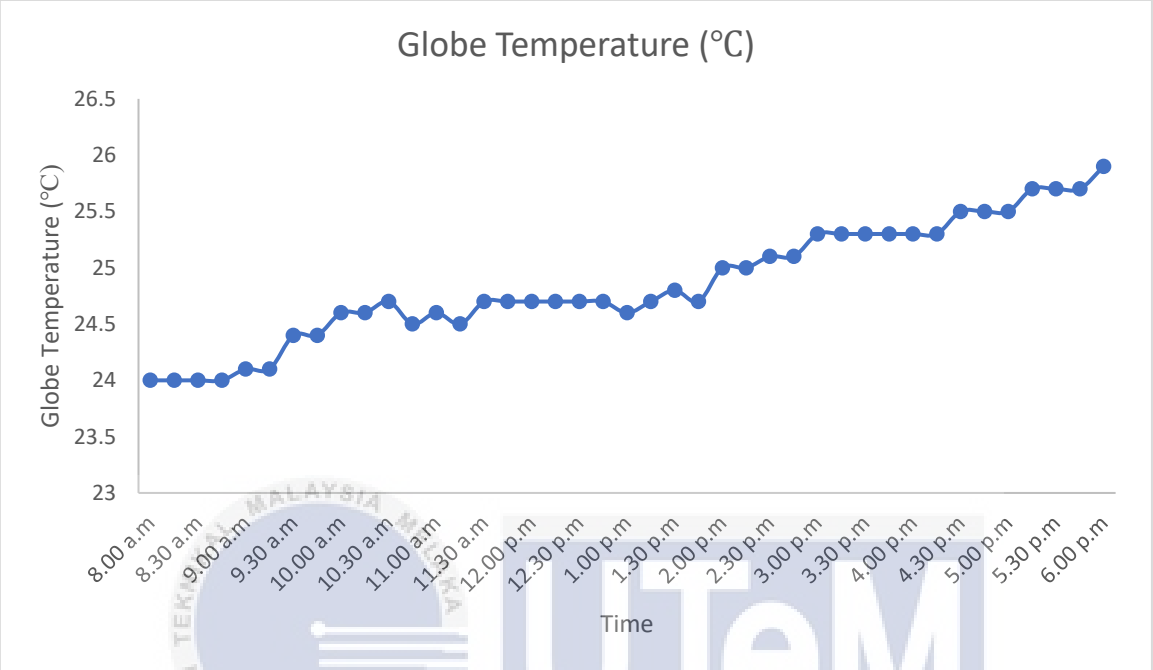


Figure 4.11 The globe temperature graph for SMK Bukit Katil

The humidity graph in Figure 4.12 shows, forms the highest reading at 8.00 am which is 69 %. The reading after that decreased over time until 6.00 pm that reached a reading of 59%.

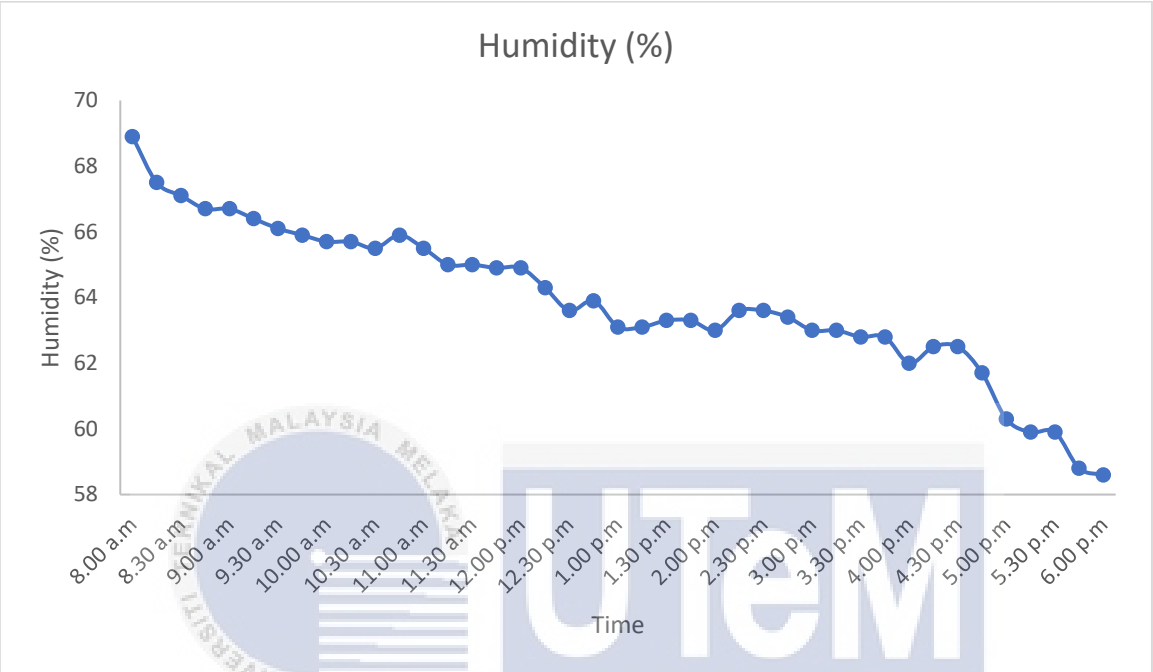


Figure 4.12 The humidity graph for SMK Bukit Katil

4.3 Data From Survey

Demographic information in a questionnaire helps in gathering the background information of respondents. The basic variables for this part such as gender, age, state, place, and basic question about TEC are believed to be related and important for this research. For this part, the analysis of the demographics profile of the respondents was discussed in detail.

4.3.1 Gender

Figure 4.13 shows the comparison of gender from the 57 respondents in the data collection process. The Table 4.1 has shown there are 21 female respondents and 36 of male respondents out of a total of 57 respondents which resulted in 36.8% were female respondents while 63.2% were male.

Table 4.1 Respondents by gender

Gender	Frequency	Percent
Male	36	63.2
Female	21	36.8
Total	57	100.0

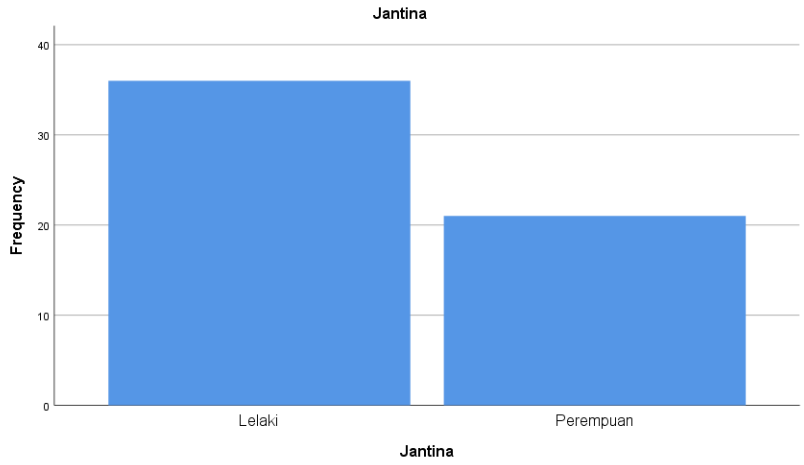


Figure 4.13 Respondents by gender

4.3.2 Age

Figure 4.14 shows the comparison of age among the respondents of this research. Table 4.2 shows that there are 2 respondents in the age group of under 19 which resulted in 3.5% while in the age group of 20-30 has 28 respondents which are 49.1%. Other than that, there are 13 respondents in the age group of 31-40 (22.8%). Last but not least is 6 respondents for 40-50 (10.5%) and 8 respondents for 50 above which 14%.

Table 4.2 Respondents by age

Age	Frequency	Percent
Under 19 years old	2	3.5
20-30 years	28	49.1
31-40 years	13	22.8
40-50 years	6	10.5
50 years and above	8	14.0
Total	57	100.0

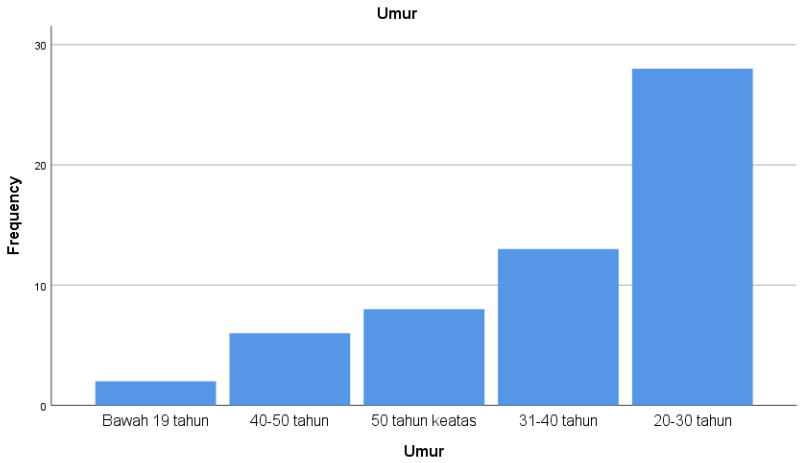


Figure 4.14 Respondents by age

4.3.3 Coming from the state

Figure 4.15 shows that the comparison of the state status of the respondents involved in the data collection in this research. Based on Table 4.3, the high respondent is from Melaka that has 18 respondent (31.6%), then Terengganu has 16 respondent (28.1), from Kelantan has 11 respondent (19.3%), and Kedah has 4 respondent which 7%. For Johor and Pahang has 1 respondent which result 1.8% and Perak and Selangor have 3 respondent which result 5.3%.

Table 4.3 Respondents by state

State	Frequency	Percent
Johor	1	1.8
Pahang	1	1.8
Perak	3	5.3
Selangor	3	5.3
Kedah	4	7.0
Kelantan	11	19.3
Terengganu	16	28.1
Melaka	18	31.6
Total	57	100.0

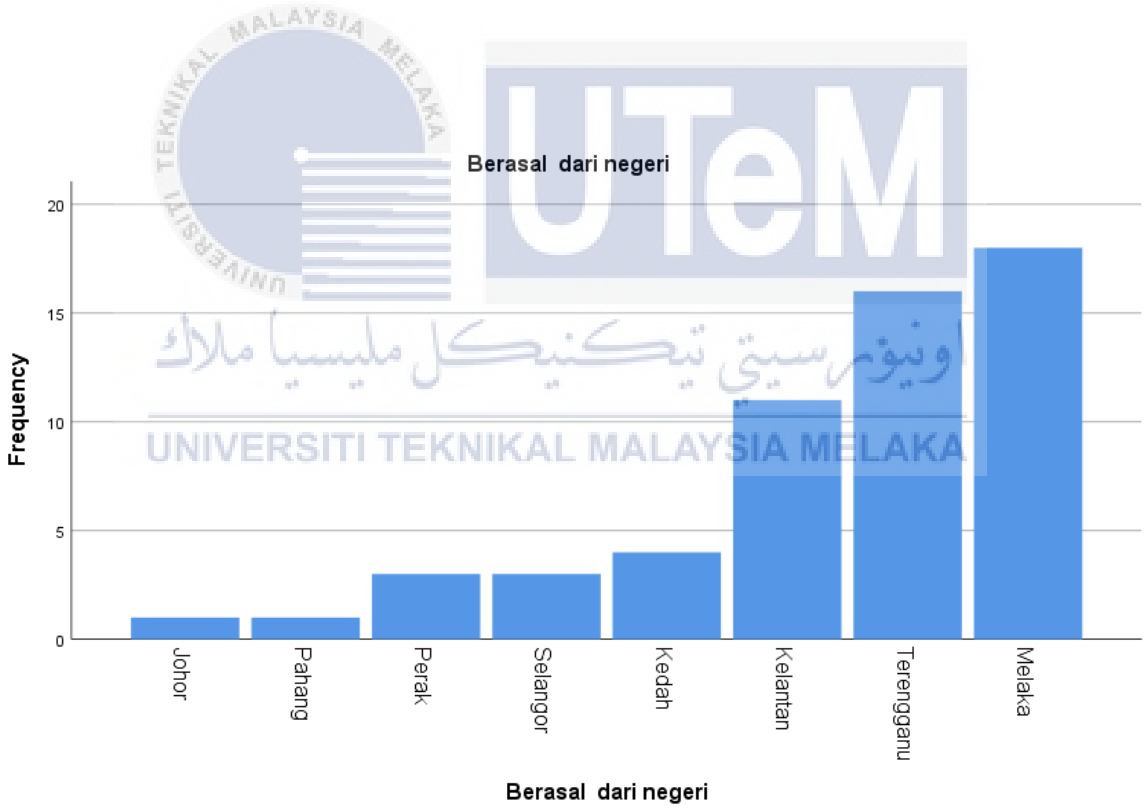


Figure 4.15 Respondents by state

4.3.4 Place of flood evacuation center

Figure 4.16 shows that the comparison of the place of flood of the respondents involved in the data collection in this research. Based on Table 4.4, out of 57 respondents, there are 37 of them are at School which resulted in 64.9%. Other than that, there are 10 (17.5%) from Hall building, and 5 respondents from Mosque and community hall that 8.8% from the total.

Table 4.4 The place of flood

Place	Frequency	Percent
Community Hall	5	8.8
Mosque	5	8.8
Hall	10	17.5
School	37	64.9
Total	57	100.0

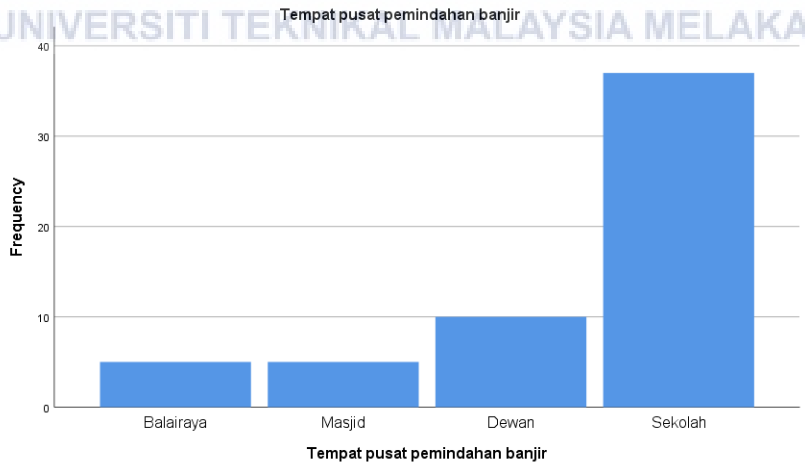


Figure 4.16 The place of flood

4.3.5 How long have you been at the center of flood removal?

Figure 4.17 shows that the comparison of the how longer at TEC of the respondents involved in the data collection in this research. Based on Table 4.5, out of 57 respondents, there are 24 of them are choosing 3 days which resulted in 42.1%. Other than that, there are 17(29.8%) choosing 2 day, 8(14%) of them are choosing 5 days above, 5(8.8%) of them are choosing 4 days and 3 respondents are choosing 1 day with 9.9%.

Table 4.5 The day at temporary center

Day	Frequency	Percent
1 day	3	5.3
2 days	17	29.8
3 days	24	42.1
4 days	5	8.8
5 days and above	8	14.0
Total	57	100.0

Figure 4.17 The day at temporary center

4.3.6 How does the amount of air entering the flood control center room that you are occupied with?

Figure 4.18 shows that the comparison of the amount of air entering the flood control center room of the respondents involved in the data collection in this research. Based on Table 4.6, out of 57 respondents, there are 2 of them are choosing weak which resulted in 3.5%. Other than that, there are 14 (24.6%) choosing very good and medium, and 27 respondents with 47.4% are choosing good.

Table 4.6 The amount of air enter the flood center room

Rate	Frequency	Percent
Very good	14	24.6
Good	27	47.4
Medium	14	24.6
Weak	2	3.5
Total	57	100.0

Figure 4.18 The amount of air enter the flood center room

4.3.7 How is the air quality in the room of the flood evacuation center you are sitting in?

Figure 4.19 shows that the comparison of the air quality in the room of the flood control center room of the respondents involved in the data collection in this research. Based on Table 4.7, out of 57 respondents, there are 13 of them are choosing very good which resulted in 22.8%. Other than that, there are 17 (29.8%) choosing medium, and 27 respondents with 47.4% are choosing good.

Table 4.7 The air quality in the room of the flood evacuation center

Rate	Frequency	Percent
Very good	13	22.8
Good	27	47.4
Medium	17	29.8
Weak	0	0
Total	57	100.0

Figure 4.19 The air quality in the room of the flood evacuation center

4.3.8 How comfortable are you when you are in a flood evacuation center room?

Figure 4.20 shows that the comparison of the comfort at the place of evacuation center of the respondents involved in the data collection in this research. Based on Table 4.8, out of 57 respondents, there are 1 of them are choosing uncomfortable which resulted in 1.8%. Other than that, there are 7(12.3%) choosing very comfortable, 20 (35.1%) are choosing medium, and 29 respondents with 50.9% are choosing comfortable.

Table 4.8 The comfort at the place of evacuation center

Rate	Frequency	Percent
Very comfortable	7	12.3
Comfortable	29	50.9
Medium	20	35.1
Uncomfortable	1	1.8
Total	57	100.0

Figure 4.20 The comfort at the place of evacuation center

4.3.9 How do you feel about the room temperature of the flood evacuation center during the afternoon?

Figure 4.21 shows that the comparison of the feel about the room temperature of the flood evacuation center during the afternoon of the respondents involved in the data collection in this research. Based on Table 4.9, out of 57 respondents, there are 4 of them are choosing very cold which resulted in 7%. Other than that, there are 8(14%) choosing hot, 21(36.8%) are choosing cold, and 24 respondents with 42.1% are choosing medium.

Table 4.9 The feel about the room temperature of the flood evacuation center during the afternoon

Rate	Frequency	Percent
Very cold	4	7.0
Cold	21	36.8
Medium	24	42.1
Hot	8	14.0
Total	57	100.0

Figure 4.21 The feel about the room temperature of the flood evacuation center during the afternoon

4.3.10 Without the use of the fan or air conditioning are the flood evacuation centers comfortable?

Figure 4.22 shows the comparison of The use of the fan or air conditioning at flood evacuation centers from the 57 respondents in the data collection process. The Table 4.10 has shown there are 11 of respondents choose yes and 46 of respondents choose no out of a total of 57 respondents which resulted in 19.3% were female respondents while 80.7% were male.

Table 4.10 The use of the fan or air conditioning at flood evacuation centres

	Frequency	Percent
Yes	11	19.3
No	46	80.7
Total	57	100.0

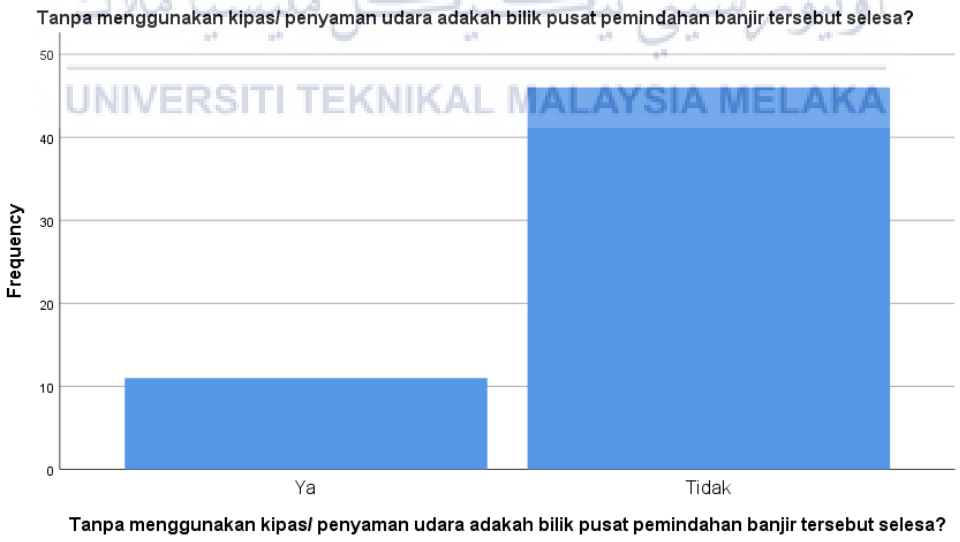


Figure 4.22 The use of the fan/ air conditioning at flood evacuation centres

4.3.11 How do you feel about flood evacuation center rooms in terms of humidity?

Figure 4.23 shows that the comparison of feeling about flood evacuation center rooms in terms of humidity of the respondents involved in the data collection in this research. Based on Table 4.11, out of 57 respondents, there are 35 of them are choosing medium which resulted in 61.4%. Other than that, there are 17(29.8%) choosing damp, 2(3.5%) of them are choosing very humid and very dry, and 1 respondent are choosing 1 day with 1.8%.

Table 4.11 The humidity at evacuation center

Rate	Frequency	Percent
Damp	17	29.8
Very humid	2	3.5
Medium	35	61.4
Dry	1	1.8
Very dry	2	3.5
Total	57	100.0

Figure 4.23 The humidity at evacuation center

4.3.12 What do you wear in flood evacuation centers?

Figure 4.24 shows that the comparison of the used clothing at evacuation center of the respondents involved in the data collection in this research. Based on Table 4.12, out of 57 respondents, there are 12 of them are choosing sports pants, sports shirts which resulted in 21.1%. Other than that, there are 20(35.1%) choosing trousers, long-sleeved shirt, and 25 respondents are choosing pants, short sleeves with 43.9%.

Table 4.12 The used clothing at evacuation center

Type cloth	Frequency	Percent
Sports pants, sports shirts	12	21.0
Trousers, long-sleeved shirt	20	35.1
Pants, short sleeves	25	43.9
Total		

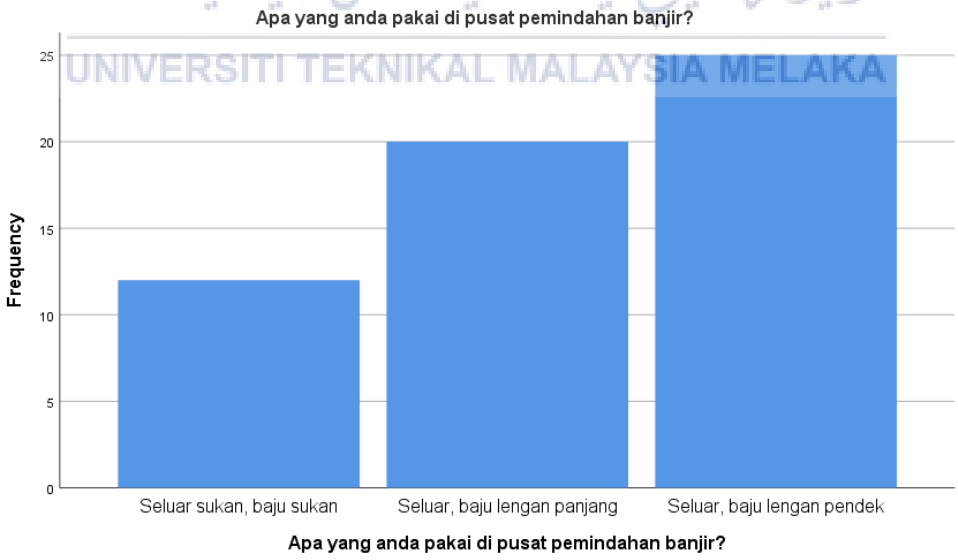


Figure 4.24 The used clothing at evacuation center

4.3.13 What are you doing in the flood evacuation center room?

Figure 4.25 shows that the comparison of doing activity in the flood evacuation center room of the respondents involved in the data collection in this research. Based on Table 4.13, out of 57 respondents, there are 39 of them are choosing sitting quietly which resulted in 68.4%. Other than that, there are 7(12.3%) choosing reading while sitting down, 6(3.5%) of them are choosing lie down, 4(7%) are choose sleep and 1 respondents are choosing walk with 1.8%.

Table 4.13 The activity

Activity	Frequency	Percent
Walk	1	1.8
Sleep	4	7.0
Lie down	6	10.5
Reading while sitting down	7	12.3
Sitting quietly	39	68.4
Total	57	100.0

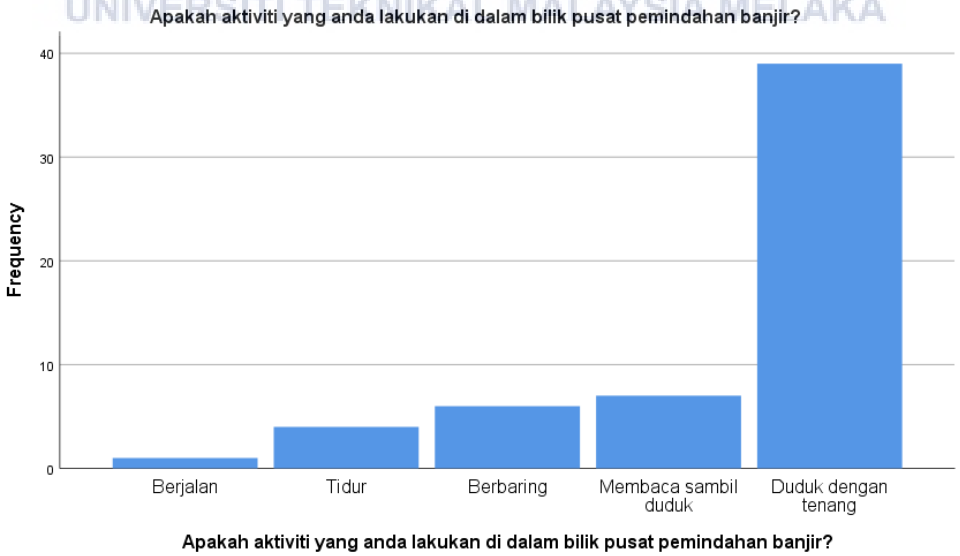


Figure 4.25 The activity

4.3.14 How many people were in the tents of the flood evacuation center at the time of the incident?

Figure 4.26 shows that the comparison of the how many people were in the tents of the flood evacuation center of the respondents involved in the data collection in this research. Based on Table 4.14, out of 57 respondents, there are 6 of them are choosing 2 people which resulted in 10.5%. Other than that, there are 11(19.3%) of respondent are choosing 4 people, and 20 respondents with 35.1% are choosing3people and 5 people above.

Table 4.14 The people were in the tents

Number	Frequency	Percent
2 people	6	10.5
3 people	20	35.1
4 people	11	19.3
5 people up	20	35.1
Total	57	100.0

Figure 4.26 The people were in the tents

4.4 Graf from CBE Tool

For the result of CBE tool, the use data only take at 12.30 noon of each school. It because to see the PMV and PPD at the peak of weather between 12.00 pm to 1.00 pm at that time. Based on the data that insert to the CBE tool the value of PMV, PPD and graph will get.

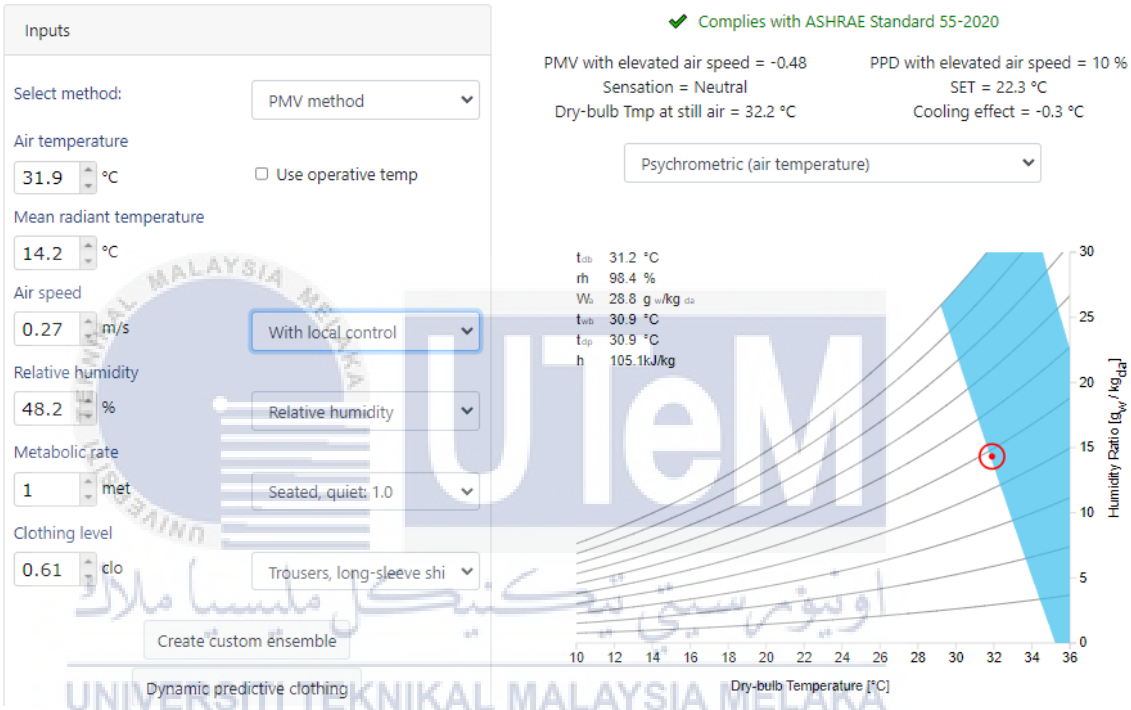


Figure 4.27 The CBE tool graph for SK Durian Tunggal

Based on the graph Figure 4.27 the PMV show the value -0.48 with elevated air speed and PPD show the value 6%. It shows that area at 12.30 pm is comfortable for the victim as it complies with ASHRAE Standard 55. As the red dot is in the blue zone the space is still in comfortable for victim. Although the air temperature is not in acceptable range, but with air speed is high will make the space in comfortable.

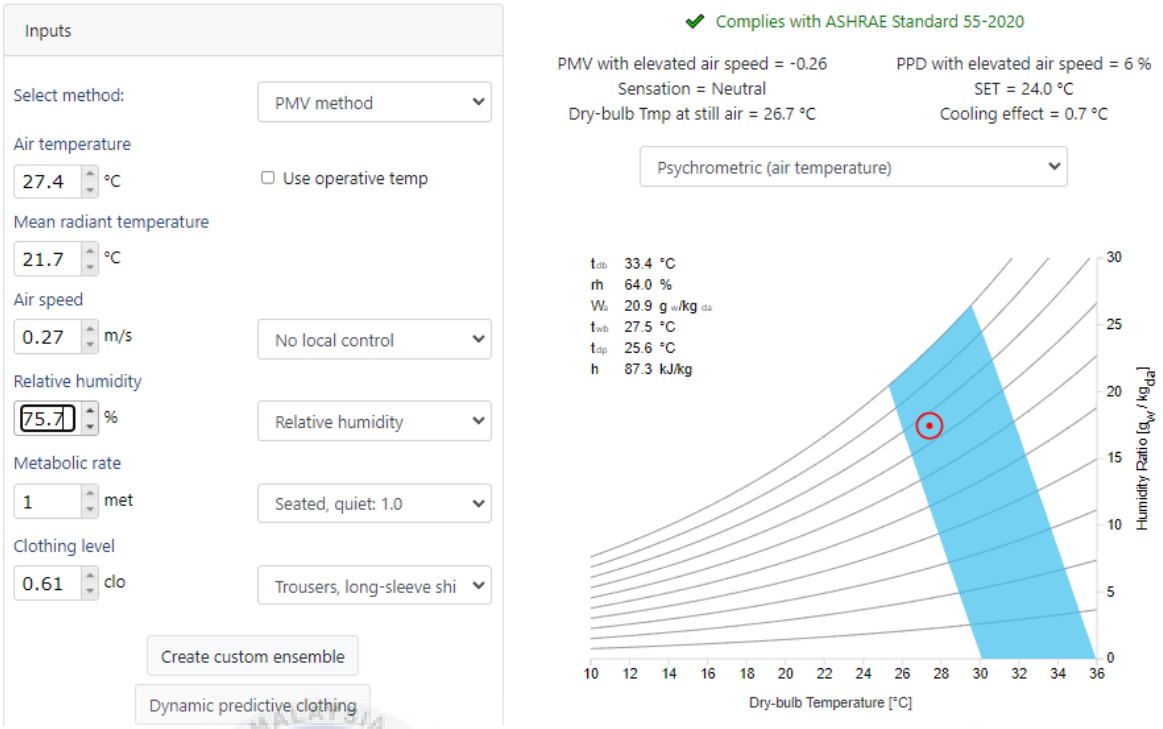


Figure 4.28 The CBE tool graph for SJK (C) Sin Wah

Based on the graph Figure 4.28 the PMV show the value -0.26 with elevated air speed and PPD show the value 6%. It shows the hall space at 12.30 pm is comfortable for the victim as it complies with ASHRAE Standard 55. As the red dot is in the blue zone the space is still in comfortable for victim. Although the air temperature and humidity are not in acceptable range, but with air speed is high from outside will make the space in comfortable.

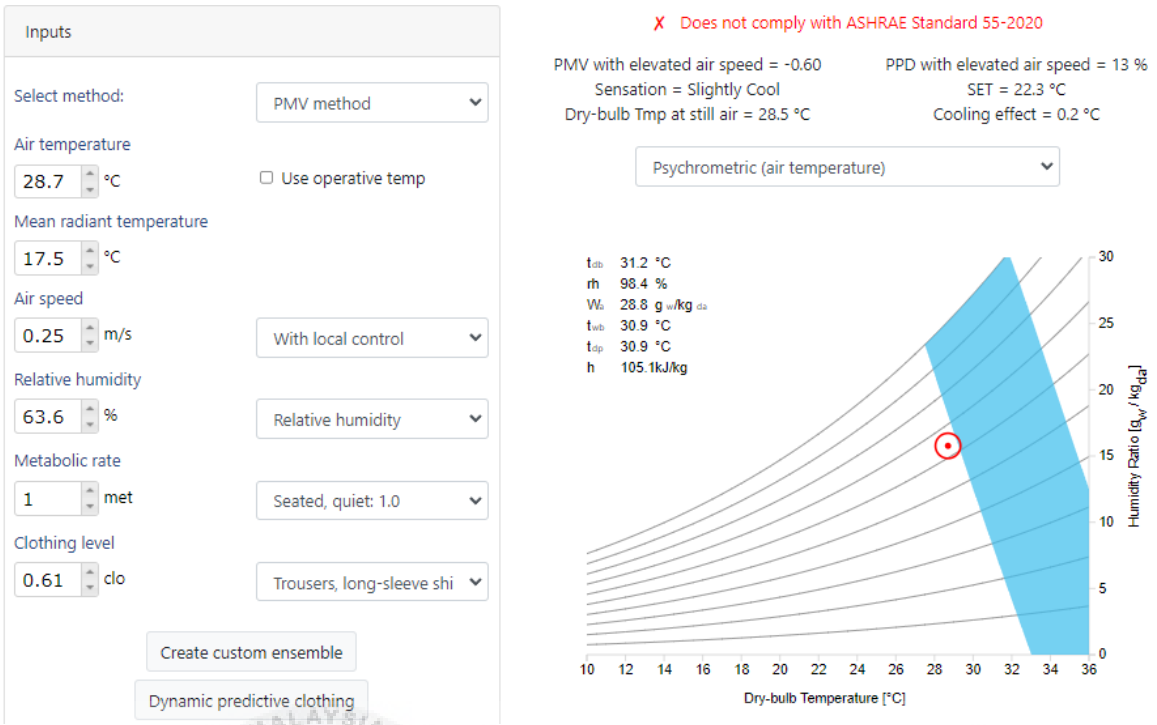


Figure 4.29 The CBE tool graph for SMK Bukit Katil

Based on the graph Figure 4.29 the PMV show the value -0.60 with elevated air speed and PPD show the value 13%. It shows the class at 12.30 pm is slightly cool for the victim that are only seated as it not complies with ASHRAE Standard 55 but if the victim do some activity the thermal will be comfort. As the red dot is out a little the blue zone the space are slightly cool for victim that are seated.

CHAPTER 5

CONCLUSSION AND RECOMMENDATIONS

5.1 Introduction

This chapter discusses about the conclusion and recommendations. Conclusion will be provided according to the data collections from the standard measuring equipment. The value of PPV and PMD are getting from the CBE tool. Thus, the measurements have been clarified and analyzed.

5.2 Conclusion

Based on this study, several factors need to be considered in temporary evacuation centers. Among the factors considered are current conditions factors and also physical factors for current weather conditions factors affect the data obtained. When hot conditions for the value of humidity are at low level as 45% to 70 %, for air temperature and globe temperature are at high conditions as 30℃ and 25℃ above, but for wind speed depends to wind conditions during strong sometimes slow. But when cold conditions for humidity are at high levels, for air temperature and globe temperature are at low conditions.

The physical factor, such as the activity and the cloth wearing will change the condition of the comfort for a person. As the value of PMV and PPD that from CBE tool only show one activity and one set of cloth. But if the activity and type of clothing are change, the value PMV and PPD will change. Although the data of collected is same but the value of PMV and PPD will change based on selected of activity and cloth.

Based on the CBE tool graph two school is in a neutral condition. It is SK Durian Tunggal during this hot weather condition and SJK(C) Sin Wah that early morning are raining to noon. One more school were in this cold condition because during the weather study it was rainy and also had high airflow at that time. It shows that the situation at the temporary evacuation center is in good condition and the comfort of the flood victims in the area is in good condition.

Based on the questionnaire, 70% of victim that are at temporary evacuation center are in good condition and comfortable with the situation. The rest was only comfort a little because of the health of the individual and the activity that are doing. In a nutshell, the thermal comfort at the temporary evacuation center are comfortable based on the research has do. The real events of the temporary evacuation center only open when had flood. The weather at that time is rainy until the flood are end. Based on the data, although the space is slightly cool but it still in comfortable zone.

5.3 Recommendations

Based on the Studies that have been made, the main purpose is to test the thermal comfort in temporary evacuation centers. From the data obtained, there are data that are not in does not exceed the standard value, but thermal comfort requires between one of the data so that the flood victims are in a comfortable condition. For the Future research can record more data at temporary evacuation center and understand the limitations of the individual comfort. Hence, several recommendations and suggestions provided as below to reduce the exposures in this study.

1. Use more sensitive tools to obtain more accurate data. That can record data by every interval.

2. Use more device at the temporary evacuation center to get the comparison based on the difference place that be located.

3. Take the data at difference of building and level to make the more comparison and at which space are more comfortable.

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APPENDICES

APPENDIX A Gantt Chart 1

Progress / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Briefing final year project (FYP)														
Title FYP														
Objective, problem statement and scope														
Literature review														
Methodology														
Final Proposal Preparation														
Presentation Project														
Proposal Submission														

APPENDIX B Gantt Chart 2

Progress / Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Briefing final year project (FYP)														
Meeting with supervisor														
Preparation the form to Jabatan Pendidikan Negeri Melaka														
Project Planning														
Collecting data														
Project presentation														
Final report preparation														
Final report submission														

APPENDIX C Turnitin

ORIGINALITY REPORT

20%	15%	11%	10%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	hdl.handle.net Internet Source	2%
2	ro.uow.edu.au Internet Source	2%
3	Mikyung Kim, Kyeonghee Kim, Eunjeong Kim. "Problems and Implications of Shelter Planning Focusing on Habitability: A Case Study of a Temporary Disaster Shelter after the Pohang Earthquake in South Korea", International Journal of Environmental Research and Public Health, 2021 Publication	1%
4	en.wikipedia.org Internet Source	1%
5	www.datataker.com Internet Source	1%
6	thescipub.com Internet Source	1%
7	Submitted to Federal University of Technology Student Paper	1%

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Pensyarah
Jabatan Teknologi Kejuruteraan Mekanikal
Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuatan
Universiti Teknikal Malaysia Melaka

APPENDIX D Permission Form to Conduct Research

JABATAN PENDIDIKAN MELAKA,
JALAN ISTANA,
PETI SURAT NO.62,
75450 MELAKA.

Pengarah : 06-2323782
Timbalan : 06-2323781
Pejabat Am : 06-2323777
06-2323780
06-2323779
Penerikaan : 06-2323780
Faks : 06-2320500
Laman Web : www.moe.gov.my/jpnmelaka

Ruj. Kami : JPNM.SPS.MT6.600 -11/1/1Jld.3(48)
Tarikh : 02 Disember 2021

1. **Ooi Qi Xiang (M042010044)**
2. **Mohamad Asraf Aidee bin Mohd Baseri (B091810017)**
3. **Muhammad Nazirul bin Hassan Baseri (B091810103)**

Universiti Teknikal Malaysia Melaka,
Hang Tuah Jaya,
76100 Durian Tunggal,
Melaka.

Tuan,

KEBENARAN MENJALANKAN PENYELIDIKAN

Dengan segala hormatnya perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan bahawa Jabatan Pendidikan Negeri Melaka tiada halangan bagi pihak tuan untuk menjalankan kajian yang bertajuk;

" PENYELIDIKAN TENTANG KUALITI UDARA DAN ALIRAN UDARA DI SEKOLAH YANG MENJADI PUSAT PEMINDAHAN BANJIR NEGERI MELAKA " diluluskan.

3. Dimaklumkan juga di sini bahawa kajian ini adalah semata-mata untuk memenuhi syarat kursus yang diduduki sahaja dan bukan untuk tujuan lain. Dan pihak tuan diminta untuk mematuhi **"Standard Operation Procedure (SOP)"** yang telah ditetapkan oleh **Majlis Keselamatan Negara (MKN). Borang atau data soal selidik perlu dibuat secara dalam talian.**

4. Surat kelulusan ini sah digunakan bermula **30 November 2021 hingga 11 Mei 2022.**

5. Walau bagaimanapun, pihak tuan adalah dinasihatkan menghubungi pihak Pengetua/ Guru Besar sekolah terlebih dahulu untuk berbincang dan mendapatkan persetujuan. Sebarang pertanyaan, sila hubungi **Encik Azli bin Musalleh, Penolong Pengarah Unit Sekolah Menengah, dan Tingkatan 6** di talian 06-2322459.

Sekian, terima kasih.

"WAWASAN KEMAKMURAN NEGARA 2030"
"MELAKAKU MAJU JAYA, RAKYAT BAHAGIA, MENGGAMIT DUNIA"
"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

(HAJI KARIM BIN TUMIN)
Timbalan Pengarah Pendidikan,
Sektor Pengurusan Sekolah,
b.p Pengarah Pendidikan Negeri Melaka,

"Pendidikan Berkualiti, Insan Terdidik, Negara Sejahtera"
#jpnmelakajanamakerajaannombor1
(Sila catatkan rujukan Jabatan ini apabila berhubung)

APPENDIX E Data at SK Durian Tunggal

Time	Temperature (°C)	Velocity (m/s)	Humidity (%)	Globe Temperature (°C)
8.00 a.m	27.0	0.1	67	23.1
8.15 a.m	27.3	0.15	65.8	24.1
8.30 a.m	27.8	0.2	63.9	24.1
8.45 a.m	28.2	0.17	60.4	24.4
9.00 a.m	28.6	0.13	57.6	24.5
9.15 a.m	29.1	0.2	56.5	24.5
9.30 a.m	29.8	0.4	55.3	24.7
9.45 a.m	30.1	0.32	54.7	24.7
10.00 a.m	30.4	0.41	52.1	25.0
10.15 a.m	30.4	0.3	50.4	25.4
10.30 a.m	30.5	0.27	49.8	25.4
10.45 a.m	30.6	0.24	48.6	25.4
11.00 a.m	30.8	0.30	49.4	25.4
11.15 a.m	31.1	0.21	49.8	25.6
11.30 a.m	31.7	0.14	49.1	25.6
11.45 a.m	31.9	0.26	48.6	25.7
12.00 p.m	31.9	0.17	48.6	25.7
12.15 p.m	31.9	0.38	48.5	25.8
12.30 p.m	31.9	0.27	48.2	25.8
12.45 p.m	31.9	0.36	47.4	25.8
1.00 p.m	32.0	0.5	47.5	25.8

Time	Temperature (°C)	Velocity (m/s)	Humidity (%)	Mean Radiant Temperature (°C)
1.15 p.m	32.0	0.41	47.6	25.9
1.30 p.m	32.0	0.19	47.3	25.8
1.45 p.m	32.0	0.36	47.3	25.8
2.00 p.m	32.1	0.26	47.3	25.7
2.15 p.m	32.1	0.28	47.3	25.7
2.30 p.m	31.9	0.34	47.3	25.8
2.45 p.m	31.9	0.29	47.7	25.8
3.00 p.m	31.9	0.40	47.6	25.7
3.15 p.m	31.8	0.31	48.3	25.7
3.30 p.m	31.8	0.27	48.4	25.7
3.45 p.m	31.9	0.39	48.4	25.9
4.00 p.m	31.9	0.27	48.4	25.7
4.15 p.m	32.0	0.25	47.9	25.7
4.30 p.m	32.0	0.29	48.1	25.5
4.45 p.m	32.0	0.31	48.6	25.5
5.00 p.m	31.8	0.35	48.7	25.5
5.15 p.m	31.8	0.37	49.8	25.4
5.30 p.m	31.8	0.34	49.1	25.2
5.45 p.m	31.8	0.36	48.6	25.2
6.00 p.m	31.8	0.33	48.6	25.2

APPENDIX F Data at SJK (C) Sin Wah

Time	Temperature (℃)	Velocity (m/s)	Humidity (%)	Globe Temperature (℃)
8.00 a.m	26	0.32	74	23.8
8.15 a.m	26	0.30	74	23.6
8.30 a.m	26	0.8	76	23.6
8.45 a.m	26	0.42	75.1	23.6
9.00 a.m	26	0.59	78.1	23.6
9.15 a.m	26	0.71	79.6	23.7
9.30 a.m	26	0.48	80.3	23.7
9.45 a.m	25.7	0.51	80.8	23.6
10.00 a.m	25.7	0.4	81.1	23.6
10.15 a.m	25.7	0.28	80.6	23.4
10.30 a.m	25.7	0.34	80.6	23.4
10.45 a.m	25.7	0.38	80.8	23.5
11.00 a.m	25.7	0.37	81.1	23.5
11.15 a.m	25.7	0.27	81.2	23.7
11.30 a.m	25.7	0.29	81.4	24.1
11.45 a.m	25.7	0.31	82.3	24.3
12.00 p.m	26.3	0.38	79.1	24.3
12.15 p.m	26.3	0.24	78.1	24.7
12.30 p.m	27.4	0.27	75.7	25.4
12.45 p.m	28.7	0.25	70.3	25.4
1.00 p.m	29.1	0.34	68.9	25.4

Time	Temperature (℃)	Velocity (m/s)	Humidity (%)	Globe temperature (℃)
1.15 p.m	30.0	0.24	63.1	25.5
1.30 p.m	30.3	0.16	60.4	25.6
1.45 p.m	31.1	0.27	59.8	25.9
2.00 p.m	31.1	0.29	59.8	25.9
2.15 p.m	31.1	0.35	59.7	26.4
2.30 p.m	31.3	0.4	58.3	26.5
2.45 p.m	31.3	0.24	58.3	26.5
3.00 p.m	31.3	0.18	58.0	26.4
3.15 p.m	31.3	0.19	57.7	26.4
3.30 p.m	31.7	0.21	55.4	26.6
3.45 p.m	31.7	0.24	54.3	26.6
4.00 p.m	31.7	0.51	52.4	26.6
4.15 p.m	31.9	0.23	51.4	26.6
4.30 p.m	31.9	0.24	51.3	26.5
4.45 p.m	31.9	0.16	51	26.6
5.00 p.m	31.8	0.17	50.9	26.5
5.15 p.m	31.8	0.24	50.9	26.5
5.30 p.m	31.8	0.15	50.8	26.5
5.45 p.m	31.8	0.27	50.8	26.5
6.00 p.m	31.8	0.4	50.8	26.5

APPENDIX G Data at SMK Bukit Katil

Time	Temperature (℃)	Velocity (m/s)	Humidity (%)	Globe Temperature (℃)
8.00 a.m	26.0	0.15	68.9	24.0
8.15 a.m	26.7	0.13	67.5	24.0
8.30 a.m	27.1	0.2	67.1	24.0
8.45 a.m	27.5	0.21	66.7	24.0
9.00 a.m	27.5	0.25	66.7	24.1
9.15 a.m	27.5	0.3	66.4	24.1
9.30 a.m	28.0	0.5	66.1	24.4
9.45 a.m	28.0	0.47	65.9	24.4
10.00 a.m	28.3	0.45	65.7	24.6
10.15 a.m	28.3	0.41	65.7	24.6
10.30 a.m	28.5	0.23	65.5	24.7
10.45 a.m	28.5	0.35	65.9	24.5
11.00 a.m	28.5	0.37	65.5	24.6
11.15 a.m	28.5	0.16	65	24.5
11.30 a.m	28.5	0.24	65	24.7
11.45 a.m	28.7	0.28	64.9	24.7
12.00 p.m	28.7	0.29	64.9	24.7
12.15 p.m	28.7	0.43	64.3	24.7
12.30 p.m	28.7	0.25	63.6	24.7
12.45 p.m	28.7	0.5	63.9	24.7
1.00 p.m	28.7	0.47	63.1	24.6

Time	Temperature (℃)	Velocity (m/s)	Humidity (%)	Globe Temperature (℃)
1.15 p.m	28.7	0.31	63.1	24.7
1.30 p.m	28.7	0.24	63.3	24.8
1.45 p.m	28.7	0.28	63.3	24.7
2.00 p.m	28.9	0.27	63	25.0
2.15 p.m	28.9	0.28	63.6	25.0
2.30 p.m	28.9	0.24	63.6	25.1
2.45 p.m	29.2	0.26	63.4	25.1
3.00 p.m	29.2	0.25	63	25.3
3.15 p.m	29.2	0.24	63	25.3
3.30 p.m	29.2	0.42	62.8	25.3
3.45 p.m	29.2	0.31	62.8	25.3
4.00 p.m	29.2	0.26	62	25.3
4.15 p.m	29.2	0.29	62.5	25.3
4.30 p.m	29.5	0.34	62.5	25.5
4.45 p.m	29.5	0.38	61.7	25.5
5.00 p.m	29.5	0.39	60.3	25.5
5.15 p.m	29.5	0.32	59.9	25.7
5.30 p.m	29.5	0.27	59.9	25.7
5.45 p.m	29.6	0.34	58.8	25.7
6.00 p.m	29.6	0.38	58.6	25.9

APPENDIX H Questioners

Soal selidik keselesaan individu di tempat pusat pemindahan banjir

Assalamualaikum dan salam sejahtera kepada semua responden.

Saya Muhammad Nazirul bin Hassan Basari, pelajar tahun akhir yang mengikuti pengajian dalam Sarjana Muda Teknologi Mekanikal dari Universiti Teknikal Malaysia Melaka. Saya sedang menjalankan kajian penyelidikan tentang keselesaan terma di pusat pemindahan banjir. Saya dengan rendah hati ingin menjemput anda untuk mengambil bahagian dalam soal selidik ini. Sasaran responden adalah individu yang terlibat di pusat pemindahan. Identiti responden akan dirahsiakan sepenuhnya dan tanpa nama. Tinjauan ini akan mengambil masa kira-kira 5 minit untuk disiapkan dan saya amat menghargai kerjasama dan masa anda yang telah diluangkan untuk melengkapkan soal selidik ini. Semua jawapan kepada soal selidik ini akan digunakan untuk tujuan kajian ini dan akan dikawal dengan ketat

* Required

1. Jantina *

Mark only one oval.

- ( ) Lelaki
- ( ) Perempuan

2. Umur *

Mark only one oval.

- ( ) Bawah 19 tahun
- ( ) 20-30 tahun
- ( ) 31-40 tahun
- ( ) 40-50 tahun
- ( ) 50 tahun keatas

3. Berasal dari negeri *

Mark only one oval.

- ( ) Johor
- ( ) Kedah
- ( ) Kelantan
- ( ) Melaka
- ( ) Negeri Sembilan
- ( ) Pahang
- ( ) Perak
- ( ) Perlis
- ( ) Pulau Pinang
- ( ) Selangor
- ( ) Terengganu
- ( ) Sabah
- ( ) Sarawak
- ( ) Wilayah Persekutuan

4. Tempat pusat pemindahan banjir *

Mark only one oval.

- ( ) Sekolah
- ( ) Balairaya
- ( ) Dewan
- ( ) Masjid

5. Berapa lamakah anda berada di pusat pemindahan banjir? *

Mark only one oval.

- 1 hari
- 2 hari
- 3 hari
- 4 hari
- 5 hari keatas

6. Bagaimanakah jumlah udara yang memasuki bilik pusat permindahan banjir yang anda diduduki? *

Mark only one oval.

- Sangat bagus
- Bagus
- Sederhana
- Lemah

7. Bagaimanakah kualiti udara di dalam bilik pusat pemindahan banjir yang anda duduki ? *

Mark only one oval.

- Sangat bagus
- Bagus
- Sederhana
- Lemah

8. Sejauh manakah keselesaan anda ketika berada di bilik pusat pemindahan banjir? *

Mark only one oval.

- Sangat bagus
- Bagus
- Sederhana
- Lemah

9. Bagaimana perasaan anda tentang suhu bilik pusat pemindahan banjir semasa waktu tengahari? *

Mark only one oval.

- Sangat sejuk
- Sejuk
- Sederhana
- Panas
- Sangat panas

10. Tanpa menggunakan kipas/ penyaman udara adakah bilik pusat pemindahan banjir tersebut selesa? *

Mark only one oval.

- Ya
- Tidak

11. Bagaimanakah anda merasakan bilik pusat pemindahan banjir dari segi kelembapan? *

Mark only one oval.

- Sangat lembap
- Lembap
- Sederhana
- Kering
- Sangat kering

12. Apa yang anda pakai di pusat pemindahan banjir? *

Mark only one oval.

- Seluar, baju lengan pendek
- Seluar, baju lengan panjang
- Seluar sukan, baju sukan
- Kemeja lengan pendek dengan seluar pendek
- Kemeja lengan pendek dan skirt paras lutut
- Skirt paras lutut, baju lengan panjang

13. Apakah aktiviti yang anda lakukan di dalam bilik pusat pemindahan banjir? *

Mark only one oval.

- Tidur
- Berbaring
- Duduk dengan tenang
- Menulis, menalip
- Berjalan
- Membaca sambil duduk

14. Berapa orang yang berada dalam khemah pusat pemindahan banjir pada waktu kejadian? *

Mark only one oval.

- 1 orang
- 2 orang
- 3 orang
- 4 orang
- 5 orang keatas

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA

TAJUK: INVESTIGATION OF THERMAL COMFORT OF SELECTED TEMPORARY EVACUATION CENTER IN TROPICAL CLIMATE AT MELAKA

SESI PENGAJIAN: **2021/22 Semester 1**

Saya MUHAMMAD NAZIRUL BIN HASSAN BASARI

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3. Hal ini adalah kerana IANYA MERUPAKAN PROJEK YANG DITAJA OLEH SYARIKAT LUAR DAN HASIL KAJIANNYA ADALAH SULIT.

Sekian, terima kasih.

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