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COMPLIANCE OF THERMAL COMFORT PARAMETERS WITHIN THE STUDENTS' DORMITORY, RESIDENTIAL, AND PUSAT ISLAM ENGINEERING CAMPUS, USM BASED ON INDUSTRY CODE OF PRACTICE ON INDOOR AIR QUALITY (ICOP) 2010

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ABSTRACT

This study assessed occupants' satisfaction with their surrounding temperature conditions. The study was carried out at the student's dormitory, residential and prayer hall of Pusat Islam Engineering Campus, USM. It entailed determining the compliance of thermal comfort parameters; temperature (T), relative humidity (RH) and air movement (AM). The parameters are then used as input in the Center for the Built Environment (CBE) Thermal Comfort Tool to obtain Predicted Mean Value (PMV) and Predicted Percentage Dissatisfied (PPD) for ASHRAE Standard-55. The monitoring for this study was conducted for three hours in a three-time period; 6 A.M. - 9 A.M., 11 A.M. - 2 P.M., and 5 P.M. - 8 P.M. for students' dormitory and residential. For monitoring at Pusat Islam, it was conducted in two slots; 11 A.M. - 2 P.M. and 6 P.M. - 10 P.M., and it was assessed during Ramadan when the Muslims perform the Teraweh prayer. Overall, the finding indicates that most of the time, the thermal comfort parameters at the three monitoring places did not comply with the (Industry Code of Practice on Indoor Air Quality) ICOP limit. Hence, it also influenced the PMV and PPD values which did not adhere to the ASHRAE Standard-55. This could be due to the poor design of the building where the plan itself does not promote cross-ventilation, the high outdoor temperature, and insufficient indoor air movement, thus causing discomfort to the occupants.

Keywords: Indoor, PMV, PPD, Prayer Hall, Thermal Comfort, Ventilation

1. INTRODUCTION

Thermal comfort is a state of mind in which a person is satisfied with their thermal surroundings. A person's sense of thermal comfort is primarily due to the body's heat exchange with the environment. Four parameters influence this condition; air temperature, radiant temperature, humidity, and airspeed, which constitute the thermal environment. Meanwhile, two personal parameters; are clothing and activity level or metabolic rate Olesen and Brager (2004).

According to Wafi and Ismail (2010), thermal comfort which is highly associated with climatic and human factors, is crucial for hostel occupants regarding students' physical and psychological wellbeing. The factors like solar radiation, surface reflection from walls and the orientation of buildings are highly associated. One of the ways that contribute to better comfort is by improving ventilation. The sound ventilation system provides thermal comfort by controlling temperature and humidity, distributing sufficient air to occupants, and eliminating contaminants.

Adequate ventilation is crucial as people spend more than 90% of their time indoors Lee and Chang (2000). The same goes for the students, who also spend most of their time indoors. Therefore, excellent indoor air quality is necessary for their well-being.

The thermal comfort in the dormitory, residential and prayer hall is crucial as it is closely related to comfort and functional performance. Hence, knowing the compliance of thermal comfort parameters in students' dormitory, residential and prayer halls can ensure their comfort and working performance.

2. MATERIALS AND METHODS

2.1. SAMPLING LOCATION

University Science Malaysia, (USM) Engineering Campus Nibong Tebal is located south of Seberang Perai and strategically situated amid three small towns of three neighbouring states: Nibong Tebal, Pulau Pinang, Bandar Baharu, Kedah and Parit Buntar, Perak. It was the only higher learning institution in the vicinity. The modern concept of the landscape and the layouts of the building add to its uniqueness and distinctive. This campus is the only higher learning institution in the suburb.

This campus can be accessed via North-South Highway (E1) route and the exit tollway at Jawi Toll (from the North) and Bandar Baharu Toll (from the South). There were three sampling locations, which are at SH3 Lembaran, the student's dormitory, residential and prayer hall at Pusat Islam USM, Engineering Campus.

Each student's dormitory consists of three students and three single beds at each corner of the room. Natural ventilation through the windows is the common ventilation form in the dormitory. Figure 1 and Figure 2 show the students' dormitory location and the furniture arrangement. The overview of residential and Pusat Islam are shown in Figure 3 and Figure 4, respectively

2.2. SELECTION OF MONITORING INSTRUMENTS

There were two types of instrumentation to measure the parameters. The T-RH Data Logger and air Flow Meter were used to measure T, RH, and AM. The T-RH Data Logger is placed 1.2 m above the ground at one sampling point and at least 0.5m from any walls, corners, or vertical surfaces ICOP-IAQ. (2010).

2.3. SAMPLING METHOD

The monitoring events in the dormitory and residential were conducted based on three hours in a three-time period; 6 A.M. to 9 A.M., 11 A.M. to 2 P.M. and 5 P.M. to 8 P.M. for three days. In comparison, monitoring for the prayer hall was conducted based on two slots: 11 A.M.-2 P.M. and 6 P.M.-10 P.M. Also, the outdoor data collected provide some hints associated with the indoor environmental parameters. This includes air temperature, relative humidity, and air movement, measured simultaneously outdoors and indoors Wafi and Ismail (2010). The dormitory and prayer hall rely on active ventilation such as fan and passive ventilation, windows, and doors. For the site at Pusat Islam, both windows and doors are kept open during the monitoring period, and fans only switch on during prayers time, while for monitoring at the students' dormitory, only windows are kept open, and fans switch on during the monitoring. For Pusat Islam, all the windows are kept open at 45°. The orientation of the window can influence the solar penetration through the window and the indoor temperature Givoni (1981).

The T-Rh Data Logger was mounted 1.2 m above the ground, and the output parameters were downloaded via T-RH instrument Software. There were 30 minutes to one hour to stabilise the instruments before reading for all parameters. The location is then set according to the current time and date of monitoring. The devices were placed at least 0.5 m from corners, windows, walls, partitions, and other vertical surfaces. The selected sampling location is also not directly in front of floor fans ICOP-IAQ. (2010).

Figure 1

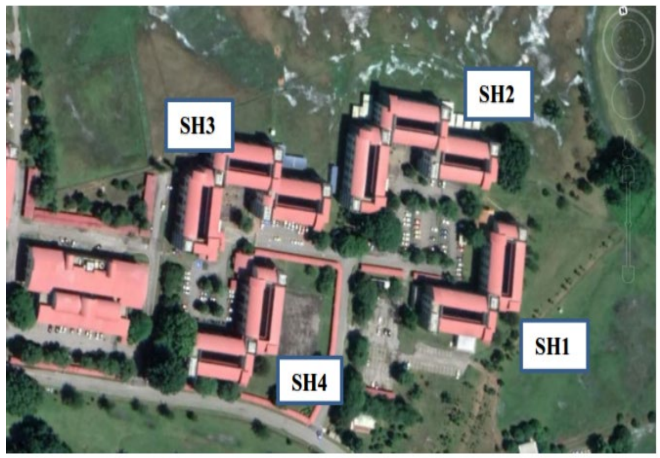


Figure 1 The location of students' dormitory SH3 Lembaran

Figure 2

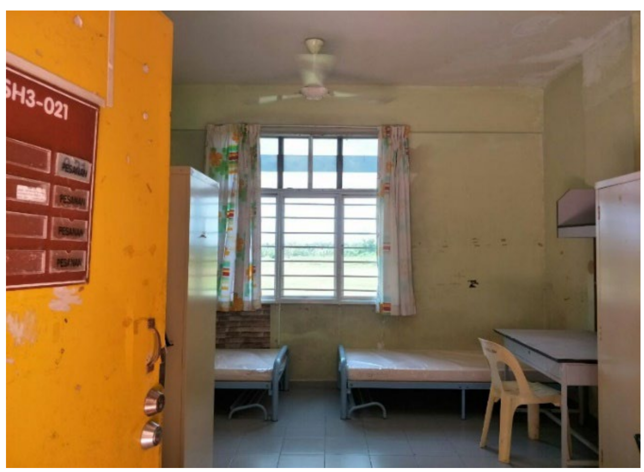


Figure 2 The overview of student dormitory

Figure 3

Figure 3 The overview of the bedroom where monitoring was done at residential

Figure 4

Figure 4 The overview of prayer hall of Pusat Islam, USM Engineering Campus

2.4. ANALYSIS METHOD

For Predicted Mean Vote (PMV) and Predicted Percentage Dissatisfied (PPD) calculation, a free online tool for thermal comfort calculations and visualisations; Center for the Built Environment (CBE) Thermal Comfort Tool that follows the ASHRAE 55–2017, ISO 7730:2005, and EN 16798–1:2019 standards were used. The CBE Thermal Comfort Tool for ASHRAE-55.

2.5. THERMAL COMFORT ANALYSIS

The calculation of the PPD and PMV was carried out using the CBE Thermal Comfort Tool. For PMV and PPD method, five parameters were included as inputs in this tool: operative temperature, airspeed, relative humidity, metabolic rate, and clothing level. The average 5 minutes interval of physical parameters obtained at the site could significantly impact the estimation of PPD. There are seven thermal sensation scales of PMV ranging from -3 (cold) to +3 (hot). Table 1 shows the definition of the ASHRAE thermal sensation scale, which presents people's thermal perception of the building.

Table 1

Table 1 PMV and its relation to the thermal comfort scale

Value	Sensation
+3	Hot
+2	Warm
+1	Slightly warm
0	Neutral
-1	Slightly cool
-2	Cool
-3	Cold

The correlation between PMV and PPD is shown in Figure 5. By referring to the figure, PPD rises as PMV shifts away from zero, either in the positive or negative direction. According to the ASHRAE standard, the acceptable limit for PMV value ranges from -0.5 to +0.5 and PPD value less than 10%, as shown in Table 2.

Figure 5

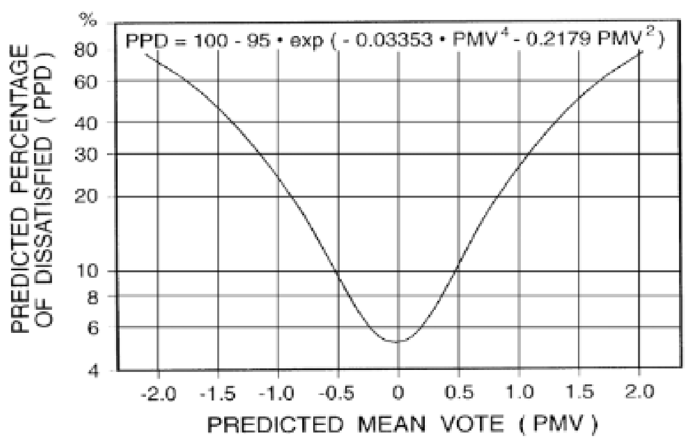


Figure 5 PPD as a function of PMV

Table 2

Table 2 Acceptable Thermal Environment for General Comfort

PPD	PMV Range
<10	$-0.5<PMV<+0.5$

2.6. OPERATIVE TEMPERATURE, AIR SPEED AND RELATIVE HUMIDITY

The input for operative temperature, airspeed and relative humidity is obtained from the data collected during the monitoring. All the data was recorded in minutes and then averaged to 5 minutes intervals. The acceptable limits for air temperature, airspeed and relative humidity are compared with the Industry Code of Practice on Indoor Air Quality ICOP-IAQ. (2010). The permissible limit of these three parameters is shown in Table 3.

Table 3

Table 3 Acceptable range for specific physical parameters based on ICOP 2010

Parameter	Acceptable Range
Air temperature	23-26 °C
Relative humidity	40-70%
Air movement	/s

2.7. METABOLICA RATE AND CLOTHING INSULATION

According to ASHRAE (2004) the insulation levels of 0.5 clo and 1.0 clo are typical for warm and cool outdoor clothing. Since the weather in Malaysia is more likely to be warm, the clothing insulation used in CBE Thermal Comfort Tool is 0.5 clo. Worshippers practise worshipping in the mosque during prayer time, and the movements, such as standing, bowing, prostrating, and sitting, are pretty relaxed. The estimated value of metabolic rate and clothing insulation in this study are shown in Table 4 based on ASHRAE (2004) and previous research.

Table 4

Table 4 Estimated value of metabolic rate and clothing insulation

Metabolic rate (met)	Clothing insulation value (Clo)
1.3	0.5

3. RESULTS AND DISCUSSIONS

3.1. RESULTS OF OPERATIVE TEMPERATURE, AIR SPEED AND RELATIVE HUMIDITY

Table 5 depicts the minimum, maximum and average value of air temperature (T), relative humidity (RH) and air movement (AM) within the students' dormitory in compliance with Malaysia ICOP's acceptable limit. Based on the results, the average temperature is the lowest during 6 A.M. - 9 A.M. compared to other times (11 A.M. – 2 P.M. and 5 P.M. – 8 P.M.). Nevertheless, all-temperature from 6 A.M. - 9 A.M., 11 A.M. - 2 P.M. and 5 P.M. - 8 P.M. exceed the limit based on ICOP of 23-26 °C. The same goes for relative humidity, where none of the results complies with the ICOP limit (40-70 %). This condition happens as a result of the bad design of the dormitory. The cross ventilation could not occur as there was no opening on the opposite side of the window. The door, located on the opposite side of the window, must always be open to allow cross ventilation. Cross ventilation happens when there is a wind pressure difference. However, this situation is dangerous for the occupants' safety. In addition, the outdoor temperature also affects the higher indoor temperature as the outdoor temperature increase.

Table 5

Table 5 Results of monitoring at the dormitory from 6 A.M. - 9 A.M., 11 A.M. - 2 P.M. and 5 P.M. - 8 P.M. on Day 1, Day 2, and Day 3 based on ICOP limit

Parameter	T			RH			AM		
ICOP limit	23-26 °C			40-70%			0.15-0.50 m/s		
Time	6 A.M. - 9 A.M.								
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Day 1	27.4	28.6	27.72	73.1	79.5	77.48	0.02	0.15	0.08
Day 2	26.2	30.1	27.98	74.1	79.9	76.94	0.03	0.32	0.13
Day 3	28.8	30	29.25	73.3	78.5	77.07	0.02	0.49	0.17
Time	11 A.M. – 2 P.M.								
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Day 1	29.8	30.9	30.39	70.0	75.4	73.10	0.15	0.54	0.26
Day 2	30.1	31.7	31.06	70.1	75.9	72.41	0.06	0.31	0.17
Day 3	30.1	31.7	31.03	69.4	76.8	72.83	0.07	0.51	0.22
Time	5 P.M. - 8 P.M.								
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Day 1	29.9	30.5	30.21	74.0	78.4	75.43	0.05	0.28	0.38
Day 2	30.6	31.3	31.12	70.9	73.7	72.70	0.08	1.02	0.58
Day 3	29.1	30.3	29.43	76.4	78.3	77.13	0.07	0.54	0.22

For monitoring at residential, the minimum, maximum and average values of T, RH and AM are tabulated in Table 6. Based on the results, the average temperature is the lowest during 6 A.M. - 9 A.M. compared to other times (11 A.M. – 2 P.M. and 5 P.M. – 8 P.M.). However, all-temperature for all monitoring sessions exceeded the limit based on ICOP of 23-26 °C. Monitoring during 5 P.M. - 8 P.M. shows that RH complies with the ICOP limit where the value is 40%-70%.

Table 6

Table 6 Results of monitoring at residential for 6 A.M. - 9 A.M., 11 A.M. - 2 P.M. and 5 P.M. - 8 P.M. on Day 1, Day 2, and Day 3 based on ICOP limit

Parameter	T			RH			AM		
ICOP limit	23-26 °C			40-70%			0.15-0.50 m/s		
Time	6 A.M. - 9 A.M.								
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Day 1	27.4	28.8	28.45	52.6	76	74.21	0.40	3.77	1.32
Day 2	27.4	29.2	28.02	44.6	79.4	74.93	0.87	3.29	2.73
Day 3	28.1	28.7	28.28	56.7	79.4	76.36	0.27	1.22	0.85
Time	11 A.M. – 2 P.M.								
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Day 1	30.3	31.9	30.83	66.1	72.1	69.64	0.71	3.11	2.17
Day 2	30	32	30.86	67.5	73.8	70.85	0.18	1.12	0.73
Day 3	29.9	31.6	30.53	67.7	75	71.55	0.23	1.15	0.61

Time	5 P.M. - 8 P.M.								
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Day 1	31.6	32.8	32.35	60.5	70.5	66.92	1.87	3.26	2.52
Day 2	32.1	34.3	32.92	59.4	68.9	64.14	0.28	1.54	0.79
Day 3	31.7	33.1	32.24	62.4	68.5	65.53	0.28	1.54	0.79

The physical parameters of thermal comfort for the prayer hall are illustrated in Table 7. Based on Table 7, Day 1 recorded the lowest temperature compared to Day 2 and Day 3. Besides, after the Zohor prayer (between 11. A.M. – 2 P.M.), all occupants left the prayer hall since no activity was conducted after the Zohor prayer. Even though it recorded the lowest temperature (30.98 °C), the T still exceeded the ICOP limit of 23-26 °C. The T and RH on Day 3 were highest because, during the Zohor prayer, there were 77 occupants, and there was Tazkirah right after the congregational of Zohor prayers. The increased metabolic rate of many occupants during that time could also contribute to high indoor T.

Besides, the highest RH and AM were recorded on Day 3 from 6 P.M. - 10 P.M in the prayer hall due to heavy rain. The relative humidity will increase when it rains due to evaporation.

Table 7

Table 7 Results of monitoring at prayer hall for 11 A.M. - 2 P.M. and 6 P.M. - 10 P.M. on Day 1, Day 2, and Day 3 based on ICOP limit

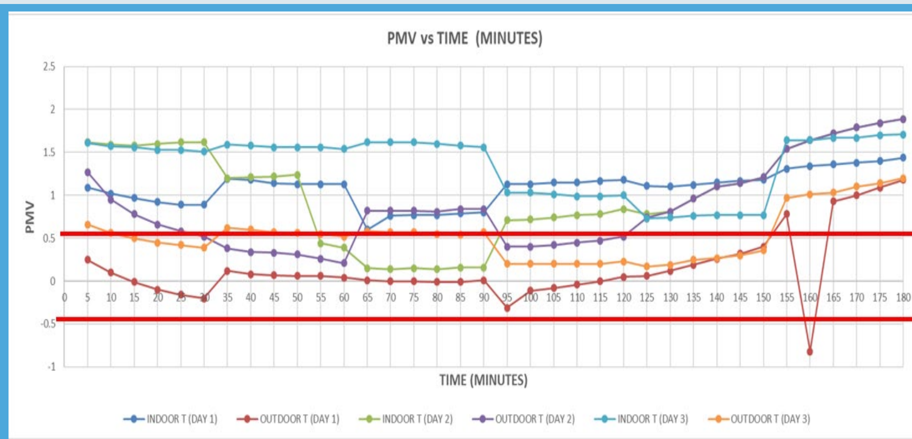
Parameter	**T**			**RH**			**AM**		
ICOP limit	23-26 °C			40-70%			0.15-0.50 m/s		
	11 A.M. - 2 P.M.								
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Day 1	29.2	32.2	30.98	58	67.1	61.76	0.01	1.12	0.21
Day 2	29.7	32	31.15	58.5	71	63.79	0.01	0.99	0.28
Day 3	30.2	32.1	31.39	60.1	70.6	65.85	0.01	3.10	0.89
	6 P.M. - 10 P.M								
	Min.	Max.	Avg.	Min.	Max.	Avg.	Min.	Max.	Avg.
Day 1	29.2	31.7	30.38	63.3	79.5	79.5	0.01	2.37	1.19
Day 2	28.5	29.6	29.02	70.9	82.4	78.51	0.01	3.38	1.31
Day 3	26.7	28	27.13	75.7	85.1	82.94	0.02	0.42	1.47

3.2. PMV AND PPD

Table 8 depicts the PMV plotted against time and PPD vs time during 6 A.M. - 9 A.M., 11 A.M - 2 P.M. and 5 P.M. - 8 P.M. at one of the students' dormitories, respectively. Based on the ASHRAE seven-point scale, it can be seen that none of the conditions was within the acceptable limit of PMV value ranging from -0.5 to +0.5. Most of the time, the ASHRAE seven-point scale ranges from 'slightly warm' to 'hot'. Meanwhile, the percentage of occupant's satisfaction (PPD) with their indoor environment's thermal comfort correlates with PMV values. Based on the results, none of the results is within the acceptable limit, and even worse, most PPD values are more than 20%. This shows the dissatisfaction of the occupant with the environment in the dormitory.

This is due to the high outdoor temperature that affects the indoor temperature. Besides, the occupants occupied the room throughout the monitoring, contributing to higher indoor temperature.

Table 8

<table>
<tr><th colspan="2">Table 8 PMV is plotted against time and PPD vs time during 6 A.M. - 9 A.M., 11 A.M - 2 P.M. and 5 P.M. - 8 P.M. at one of the students' dormitories</th></tr>
<tr><th>Time</th><th>Graph</th></tr>
<tr><td>6 - 9 A.M.</td><td>
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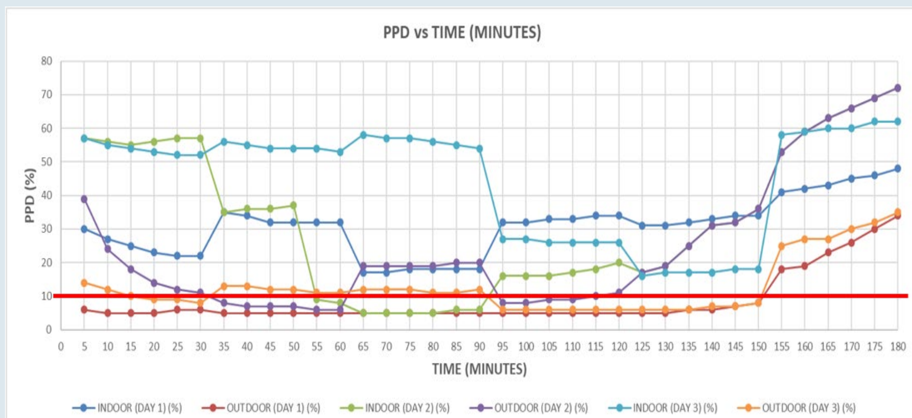
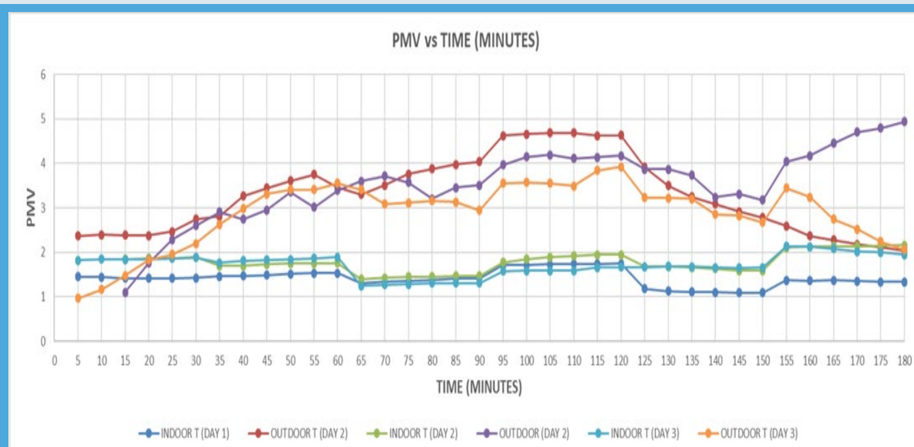
<tr><td></td><td>
</td></tr>
<tr><td>11 - 2 P.M.</td><td>
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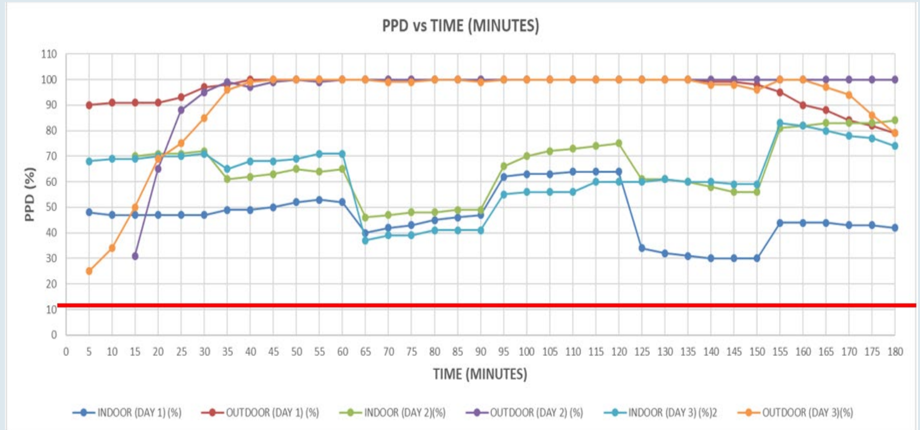
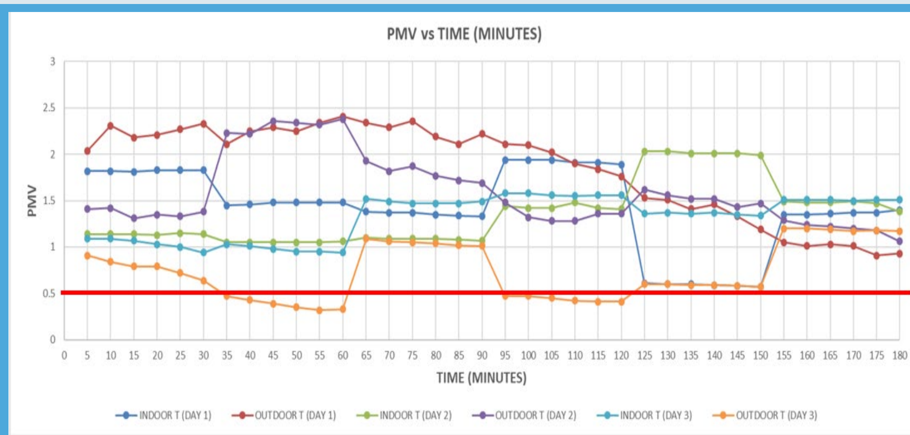
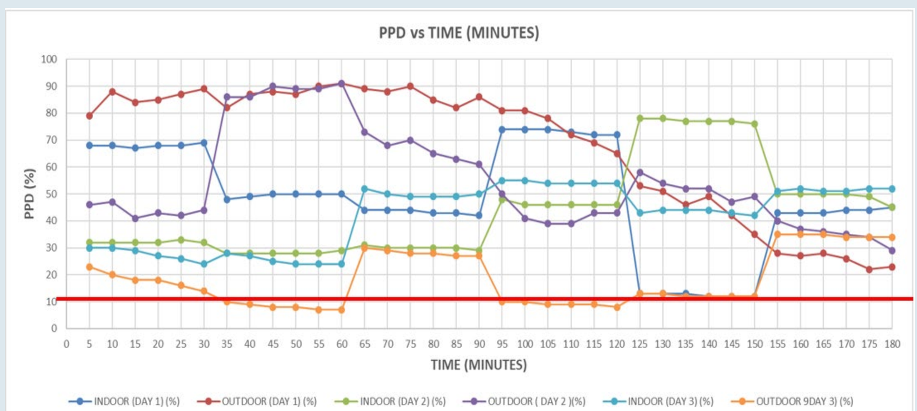
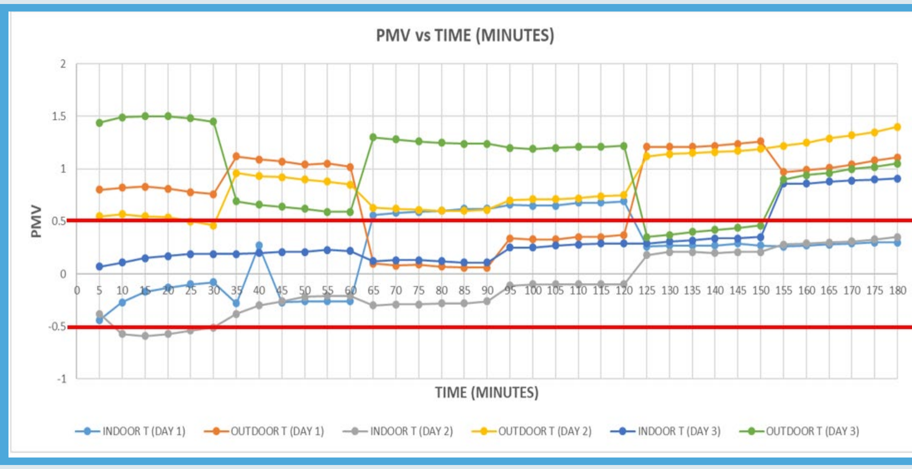
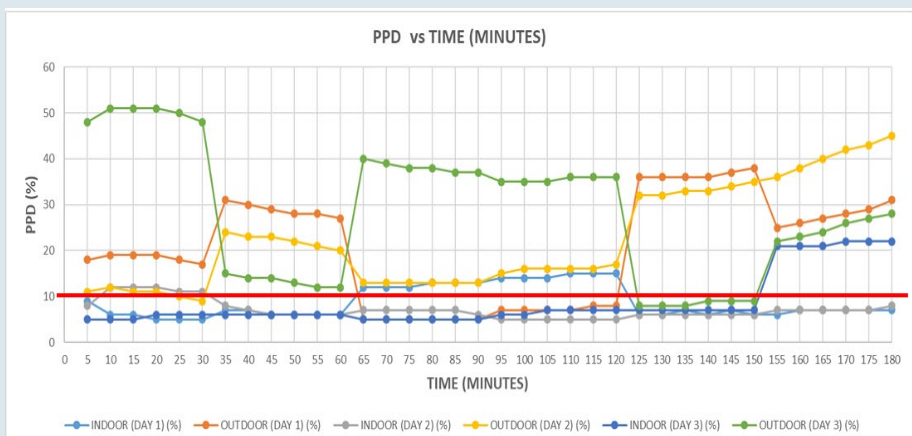
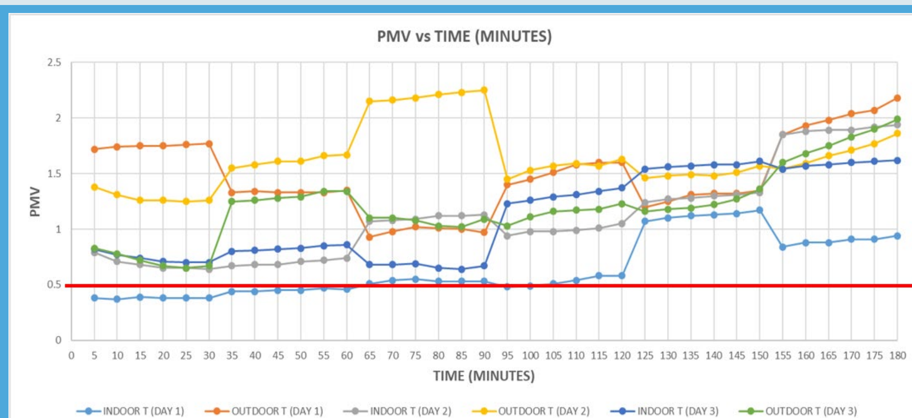
	
5 - 8 P.M.	
	

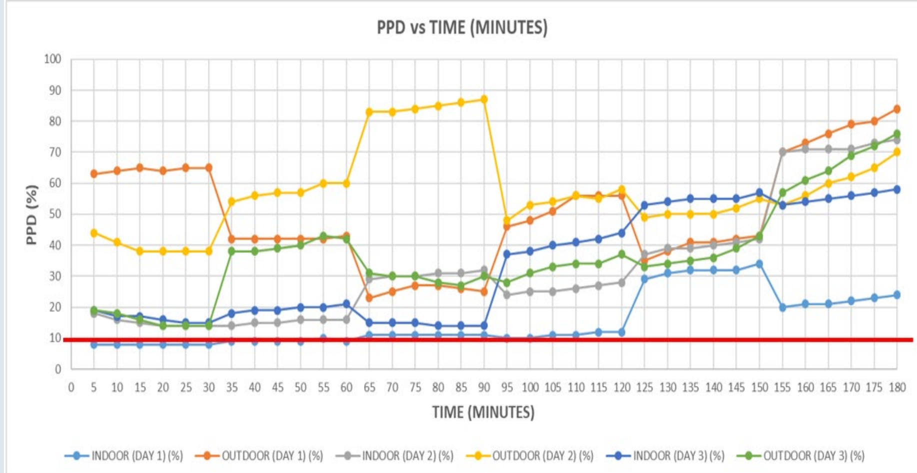
For domestic monitoring. The monitoring is done in one of the house's bedrooms, where sunlight penetrates the room. There was active and passive ventilation during the monitoring, where the ceiling fan was switched on, and all the windows were kept open throughout the monitoring session. Occupants did not occupy the bedroom during the monitoring and only got into the room for prayer. By means, they do not stay too long in the room. Table 9 depicts the PMV plotted against time during 6 A.M. – 9 A.M., 11 A.M.- 2 P.M. and 5 P.M. – 8 P.M. at residential. Based on Table 9, the indoor T for Day 1 and Day 2 is within the ASHRAE limit value. This is due to the surrounding condition where it was raining and windy on both days. Residential building thermal comfort highly depends on the weather, particularly the outdoor temperatures Peeters et al. (2009). None of the results is within the limit during evening monitoring.

The results also showed that the PPD values correlate with the PMV values. The value of PPD in residential is below the limit, which is less than 10% on Day 1 and Day 2 during 6 A.M. - 9 A.M. monitoring. This means the occupant is satisfied with the indoor environment within that time as it is within the allowable limit. Compared to results during 11 A.M. - 2 P.M. and 5 P.M. - 8 P.M., the PPD value exceeded the limit. This indicates that there is discomfort towards the occupants.

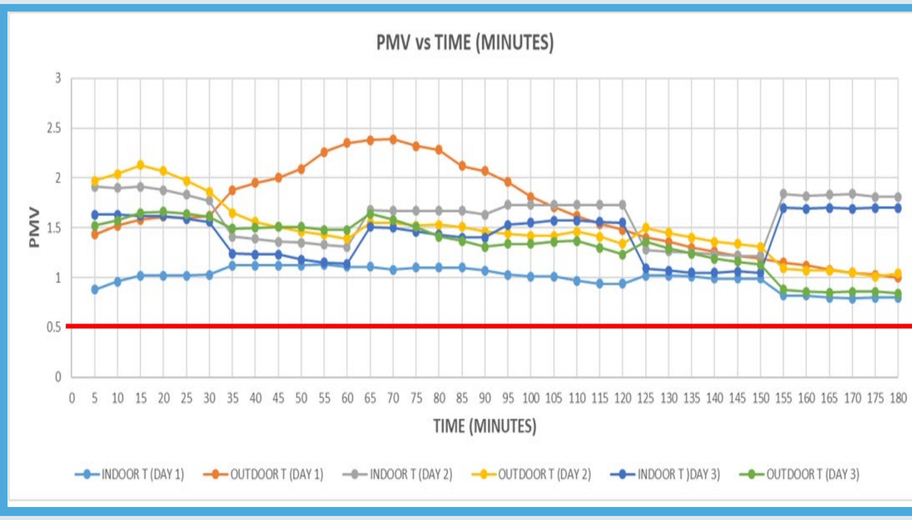
Table 9

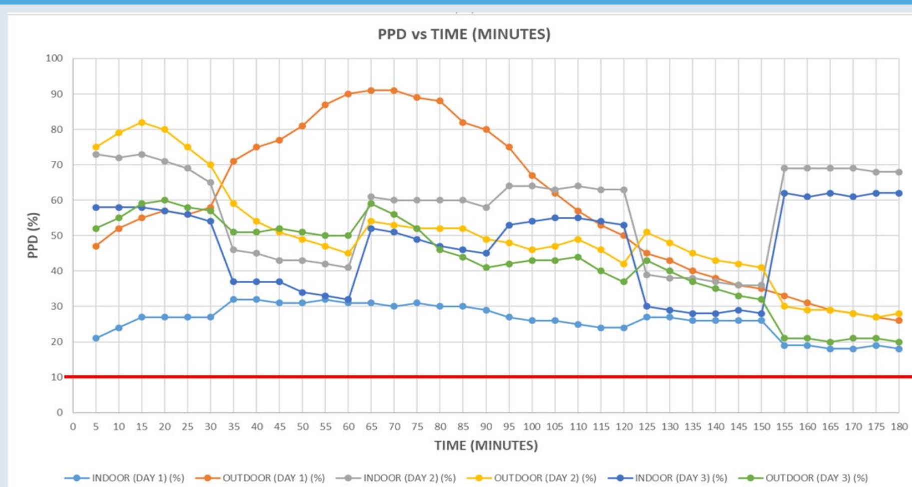
Table 9 PMV is plotted against time and PPD vs time during 6 A.M. - 9 A.M., 11 A.M - 2 P.M. and 5 P.M. - 8 P.M. at residential

Time	Graph
6 – 9 A.M.	
	
11- 2 P.M.	



5 – 8 P.M.





Besides, monitoring for Pusat Islam is conducted for two slots: 11 A.M. - 2 P.M. and 6 P.M. - 10 P.M. The monitoring for 11 A.M. - 2 P.M. was conducted for 3 hours, and the monitoring period from 6 P.M. - 10 P.M 4 hours according to the prayer period. The results for 11 A.M. – 2 P.M. monitoring of the current study is compared with the existing data to determine whether the physical parameters of indoor thermal comfort at the prayer hall of Pusat Islam comply with the ICOP limit. The results for PMV against time and PPD vs time for this study are presented in Table 10.

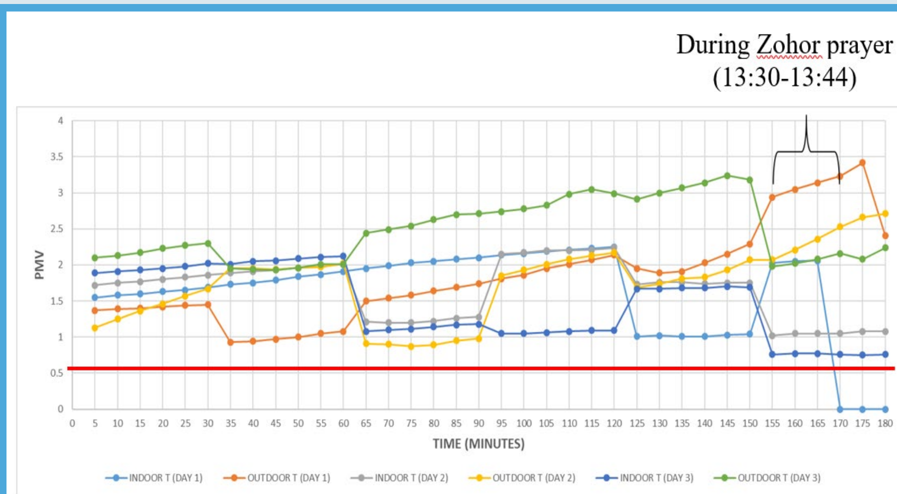
Table 10 shows that the PMV value exceeds the limit most of the time. This happens due to no active ventilation used during that time. Only a few fans are switched on during Zohor prayer, which does not significantly differ in the PMV value during prayer and non-prayer times. The PMV values on Day 2 and Day 3 are near the acceptable limit, which is the thermal comfort scale sensation, ranging from 'neutral' to 'slightly warm', while the PMV value for Day 1 recorded the highest. This can relate to the outdoor PMV, where Day 1 recorded the highest PMV value compared to other days.

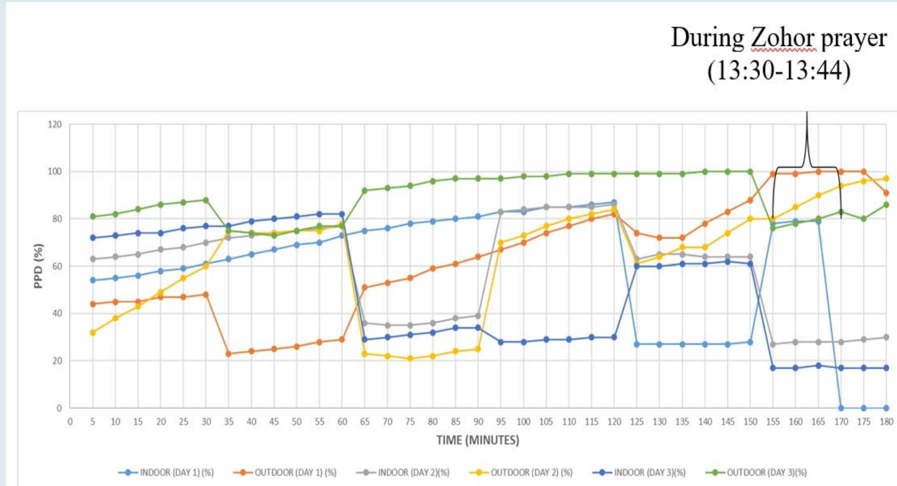
During prayer time at night (6. P.M. – 10 P.M.), the PMV value drops within the acceptable limit, ranging from -0.5 to +0.5. This is due to active ventilation in operation, and natural ventilation such as doors and windows are always kept open. During Maghrib prayer on Day 2, the PMV value is higher than on other days and is not within the limit. This happens as there were many occupants during Maghrib prayer on Day 2, around 122 occupants. Meanwhile, the number of occupants during Magrib prayer on other days is much lesser.

Meanwhile, PPD values representing the percentage satisfaction of occupants with their indoor thermal comfort in the prayer hall also correspond to the PMV value. Based on the results of this study, the PPD values are still above the ASHRAE limit. Table 10 shows that occupants are discomfort as the PPD value is more than 10%. This is because, during Zohor prayer, only a few fans were switched on. On top of that, during the non-prayer time, all fans are switched off, and only natural ventilation such as windows and doors are kept open. However, during prayer times, Maghrib, Isya' and Teraweh prayer, the PPD values drop below the acceptable limit. All fans are switched on during the prayers, resulting in the occupants' comfort. The PPD value on Day 2 during Maghrib prayer does not fall within the acceptable limit even though all fans are switched on as there is a higher number of occupants on that day compared to other days. This shows the occupants' discomfort as the number of people occupying the space increases.

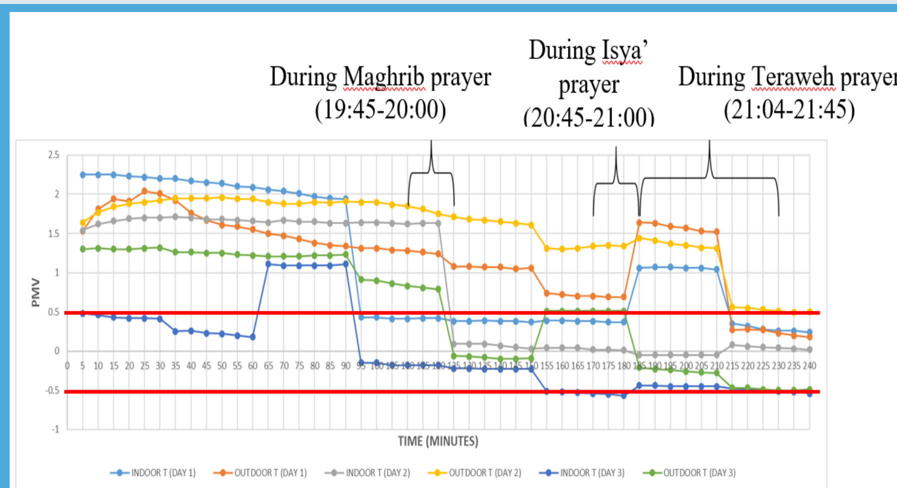
Table 10

Table 10 PMV is plotted against time and PPD vs time during 11 A.M - 2 P.M. and 6 P.M. - 10 P.M. at the prayer hall

Time	Graph
11 - 2 P.M.	



6 - 10 P.M



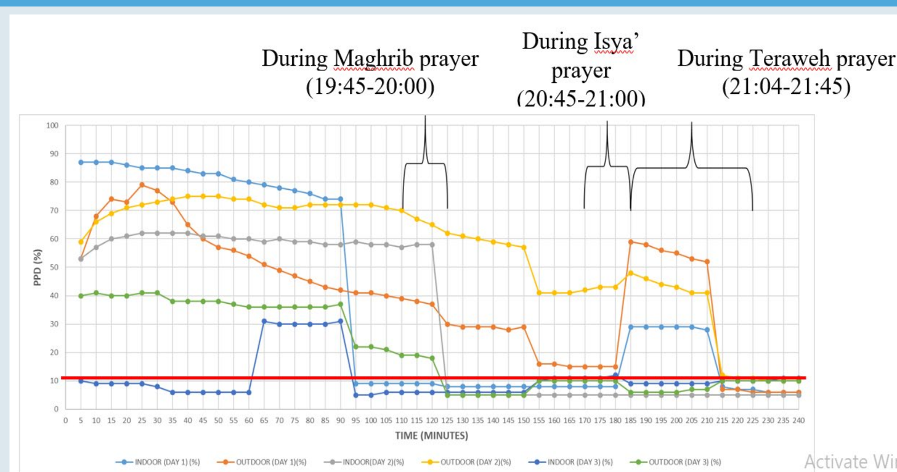


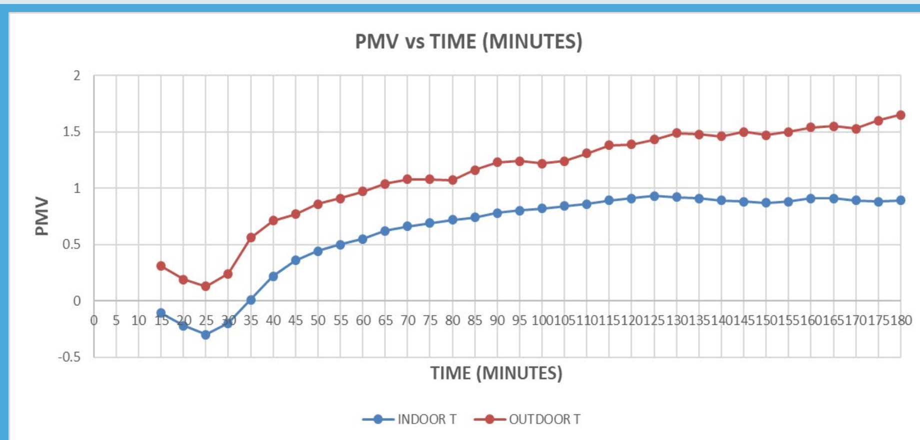
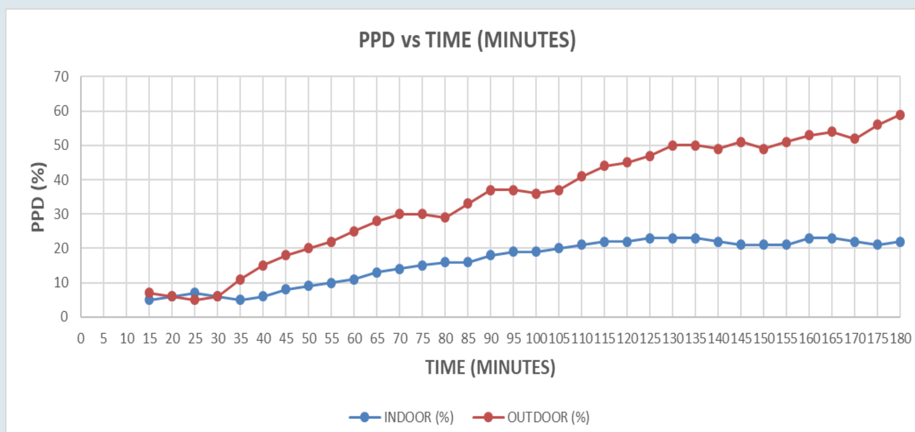
Table 11 shows the results of the existing data. It indicates that the PMV value most often exceeds the ASHRAE limit, even during Zohor prayer. This can be correlated with the increase in outdoor temperature towards the end of the monitoring session. According to the current study results, the PMV value is still not within the acceptable limit based on ASHRAE Standard. This condition is mainly because the active ventilation, such as fans, only operated during prayer time.

During non-prayer time, all fans are switched off and only depend on natural ventilation.

Meanwhile, the PPD value exceeds the limit of 10% starting from minutes 60. This indicates occupants' discomfort as all fans are switched off, and only natural ventilation such as windows and doors are kept open during the non-prayer time. Only a few of the fans were switched on during the Zohor prayer. The same reason applies to the current study. Therefore, the PPD value is still above the limit.

Table 11

Table 11 PMV is plotted against time and PPD vs time during 11 A.M - 2 P.M. monitoring at the prayer hall for the existing data

Time	Graph
11 - 2 P.M.	
	

4. CONCLUSIONS

This study was conducted to determine the compliance of thermal comfort in the dormitory, residential and prayer halls based on ICOP 2010. The physical parameters: T, RH, and AM are compared with the ICOP limit, while the PMV and PPD were calculated using CBE Thermal Comfort Tools for ASHRAE-55.

The experimental results show that most of the time, the thermal comfort parameters are not within limits for students' dormitory, residential and prayer halls. The poor design of the students' dormitory does not support cross ventilation, and there are no openings on the opposite side of the window. Hence, cross ventilation cannot occur effectively unless the door is open, as the door is on the opposite side of the window.

Meanwhile, for monitoring at residential, PMV and PPD are within the acceptable limit ranging from -0.5 to +0.5 and 10%, respectively, during 6 A.M.-9 A.M. monitoring. This is due to the surrounding condition where it was raining and windy on both days. Thus, resulting in comfort for the occupants at that time. However, the PMV and PPD values still exceed the limit during other monitoring times.

The results from 11 A.M.-2 P.M. monitoring at the prayer hall of Pusat Islam shows that none of the products is within the acceptable limit. This is because no active ventilation operates during the non-prayer time and only depends on natural ventilation such as doors and windows. Only a few fans are switched on during Zohor prayer, which does not significantly differ between PMV value during prayer and non-prayer times. Thus, resulting in discomfort for the occupants. During the monitoring 6 P.M. - 10 P.M, the results illustrate that during prayer time, the PMV value drops within the acceptable limit, which ranges from -0.5 to +0.5. This happens due to low outdoor T besides the active ventilation and natural ventilation such as doors and windows being kept open at all times. However, a higher number of occupants during Maghrib prayer also causes discomfort for the occupants.

This study indicates that better thermal comfort happens when both active and cross ventilation is incorporated; despite the physical, thermal comfort parameters are not within the limit.

CONFLICT OF INTERESTS

None.

ACKNOWLEDGMENTS

None.

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