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Air-Conditioning Performance Assessment in an Educational Building: A Case Study in Malaysia's Hot and Humid Region

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Abstract

In regions with high temperatures and humidities, the operation of air-conditioning (AC) systems accounts for a sizable portion of buildings' energy use, ranging from 60% to 70%. This energy expenditure is necessary to maintain a thermally comfortable environment inside interior spaces. Therefore, the inadequate functioning of the cooling system has a significant impact on both energy usage and the interior thermal comfort conditions inside the building. Excessive cooling is a common phenomenon observed in Malaysian buildings, with educational institutions and libraries being especially affected. This research aims to identify the underlying cause of excessive cooling in an educational building by assessing the thermal comfort and energy consumption of a fan coil unit (FCU) placed in a selected room in Malaysia's hot and humid environment. A data acquisition system, comprising sensors and a data logger, was set up in multiple locations inside the case study room and the cooling system. This system was used to quantify performance variables, namely temperature, humidity, and airflow, across four FCU process air lines. The measurement data were gathered from 8 AM to 6 PM over the course of one week. Data analysis was carried out using the acquired data to ascertain the distribution of cooling load, assess thermal comfort, and compute the FCU's energy usage. The findings of the cooling load analysis indicate that 52% of the total cooling load, amounting to 9.4 kW, may be attributed to latent loads, while the remaining 48% is associated with sensible loads. The findings of the thermal comfort investigation reveal that the temperature and relative humidity inside the classroom during the operation of the FCU were recorded as 24.3 °C and 77.1%, respectively. These values do not align with the desired thermal comfort level of 25 °C and 50% humidity. It was discovered that due to the high latent load of the classroom, the FCU is unable to control the humidity level to the appropriate value; therefore, in order to control the humidity, the sensible cooling will be drastically reduced, and overcooling will occur in the space. To attain the optimal interior atmosphere, an optimized FCU has been designed. Compared to the current FCU, the optimized FCU consumes 1.4 times more energy.

1. Introduction

The thermal comfort of a building area is contingent upon the functioning of the air-conditioning (AC) system, specifically the dehumidification and sensible cooling that occur inside the cooling coil of the AC. To evaluate the performance of AC systems, it is necessary to examine both the processes involved and their outcomes using appropriate measurement techniques. Building energy measurement is a crucial aspect of energy conservation initiatives [1]. Typically, energy audits are conducted to ascertain where, when, and how much energy is consumed in buildings [2, 3], as well as to provide advice on methods for reducing energy costs. In tropical environments, the utilization of AC systems accounts for a substantial percentage (nearly 50–70%) of the total amount of energy that is consumed in buildings [4, 5]. The primary contributor to this issue is the high humidity levels found in tropical environments. For the air conditioner to be effective in its role as a cooler, it must eliminate both latent and sensible loads from each space [6]. The location of a building can be classified as either a low or high latent heat ratio space [7, 8]. The latent heat ratio (LHR) and the sensible heat ratio (SHR) are used to determine the relative amounts of humidity and thermal load that need to be eliminated from a building in order to attain thermal comfort [9, 10]. The SHR represents the ratio of the sensible load to the total load, while the LHR refers to the ratio of the latent load to the total load [11, 12]. When designing an air conditioner for a low LHR space, it is common to use an electric chiller with an integrated cooling coil to cool the air to a temperature below the dew point [13]. The cooled liquid from the chiller then flows into the cooling coil, where the dehumidification and chilling processes take place [14, 15]. To achieve effective dehumidification in buildings with a high latent load, a significant amount of chilled water (either an increased water flow rate or a lower water temperature) is required from the cooling coil. In this setup, the cooling coil also functions as a dehumidifier, allowing the system to operate as a hybrid heating, ventilation, and air-conditioning (HVAC)/ dehumidification unit. Excessive dehumidification can cause the air temperature to drop below the desired level. In such cases, the supply air temperature must be raised through re-heating to meet the specified requirements [16, 17]. Since a high LHR necessitates extensive dehumidification and re-heating, the cooling system in such a structure consumes more energy than one designed for a low LHR [18].

When AC is employed without proper dehumidification, issues such as condensation on walls and sick building syndrome (SBS) may occur due to the overworking of the cooling coils. Similarly, in hot and humid climates, using AC directly without preheating can lead to issues including overcooling and poor indoor air quality (IAQ) [19, 20]. Because cooling coils perform both dehumidification and cooling functions, the primary issue with traditional AC systems in tropical regions is their excessive energy usage. It seems that ordinary AC systems are used in this location rather than those requiring significant dehumidification and re-heating to keep up with the high demand for cooling. As a result, SBS becomes a more likely threat in tropical regions [21, 22]. The inflammation of the upper respiratory tract, which may affect the nose, throat, eyes, hands, and/or facial skin, manifests as severe illness from SBS [23]. Due to the elevated relative humidity, the dew point of the indoor air rises above the ambient temperature of the walls, leading to moisture condensing onto the walls [24, 25]. Mold and fungi thrive in the stagnant air of the room, exacerbated by the accumulated water on the walls. In hot and humid climates, the risk of SBS is further amplified by the high humidity of indoor air [26].

In hot and humid regions, the first step in solving the problem of overcooling in buildings is to measure the energy consumption of the air conditioning system as well as the thermal comfort performance throughout the whole structure. Several studies have been carried out to evaluate the thermal comfort conditions in areas of buildings located in hot and humid locations. One example is the study by Zaki et al. [27], which looked at the relative humidity and temperature comfort in three distinct university classrooms. The universities included were KU in Japan and Universiti Teknologi MARA (UiTM) in Malaysia. According to their data, the average pleasant temperature in Malaysia was 25.6 °C and the relative humidity was 59.7 percent, but in Japan it was 26.2 °C and 69.8 percent, respectively. Thermal comfort at an office building at Malaysia's Universiti Kebangsaan Malaysia (UKM) was the subject of another research by Ahmad [28]. In a comfortable environment with a relative humidity of 73% and temperatures between 24.5 and 28.0 °C, the research found favorable results. At the Universiti Putra Malaysia (UPM) administrative building, researchers measured the effects of different window and door configurations on the relative humidity and temperature of air-conditioned rooms [29]. The results showed that, depending on the window opening scenario, the temperature ranged from 22.5 to 28.5 °C and the relative humidity from 50 to 71%. Three different kinds of office spaces in Johor, Malaysia were thermally evaluated for comfort by Abass et al. [30]. One of the conference rooms had temperatures between 24 and 26 °C, while the other two had problems with overcooling. In addition, according to the standards established by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), three areas of the office had higher humidity levels.

Most of the prior research on thermal comfort measurement suggested a comfort temperature scope of 24.5 to 26 °C in the case-studied rooms, while relative humidity was reported to be between 50 and 75%. In other words, most classrooms were able to achieve the standard temperature, but relative humidity could not reach the standard level of 50%. Consequently, there is a research gap concerning why some cooling systems in hot and humid climates are unable to maintain a standard humidity level in office buildings and classrooms. The lack of research led us to evaluate both thermal comfort and the performance of the cooling system to identify the source of the issue.

In this paper, a case study involving a cooling system and a classroom in a hot and humid region of Malaysia was selected for measurement purposes to evaluate thermal comfort and the performance of the cooling system simultaneously. The efficiency of the cooling system was measured in terms of both its cooling coil capacity and its energy usage. The measurement results were then compared to an optimized FCU that was developed in accordance with the ASHRAE standard.

Nomenclature

AC	Air-Conditioning
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
FCU	Fan Coil Unit
HVAC	Heating, Ventilation, and Air-Conditioning
IAQ	Indoor Air Quality
KU	Kyushu University
LHR	Latent Heat Ratio
SHR	Sensible Heat Ratio
SBS	Sick Building Syndrome

2. Methodology

The methodology of the current study comprises three stages, as depicted in Fig. 1: measurement, data analysis, and optimization. These procedures are employed to determine how effectively an FCU manages high temperature and humidity to provide thermal comfort in a given zone and to assess its energy consumption. After selecting a case study that includes an FCU and a thermal zone, key variables for assessment were chosen. Several metrics, such as cooling load, cooling coil performance, and air characteristics, are typically used to evaluate the efficiency of an FCU in a hot and humid climate. Various properties at different case study locations were considered for measurement to detect performance variables.

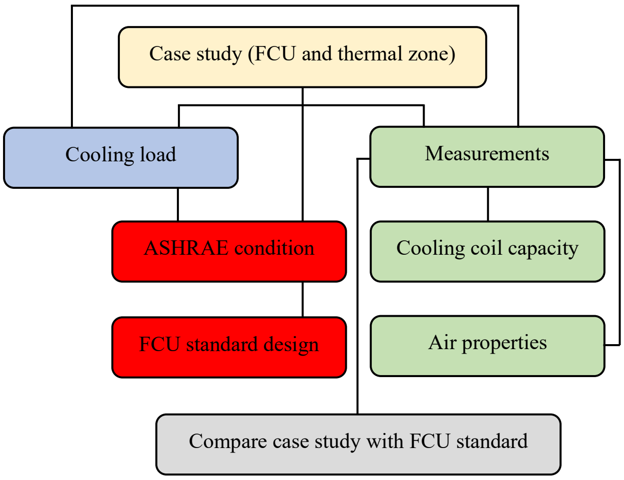


Fig. 1 *Methodology used in this study*

In the second stage, an ASHRAE-compliant FCU was designed based on thermal and cooling loads. The findings from the optimized FCU were then compared to the measurements of the installed FCU in the third stage. The classroom on Level 5 of the National University of Malaysia building was equipped with one FCU as its primary cooling system (Fig. 2). The tropical nation of Malaysia has hot and humid weather, with extremes of humidity ranging from 70 to 90% and maximum air temperatures reaching 29 °C. Featuring an integrated fan, filter, and heating/cooling coil, the FCU is a multi-function device. Typically, FCUs are installed indoors. However, the FCU investigated in this study is mounted to the classroom's overhead truss. There are three components in a chiller that use the most energy: the fan, the pump, and the unit itself. Table 1 displays the detailed FCU specifications.

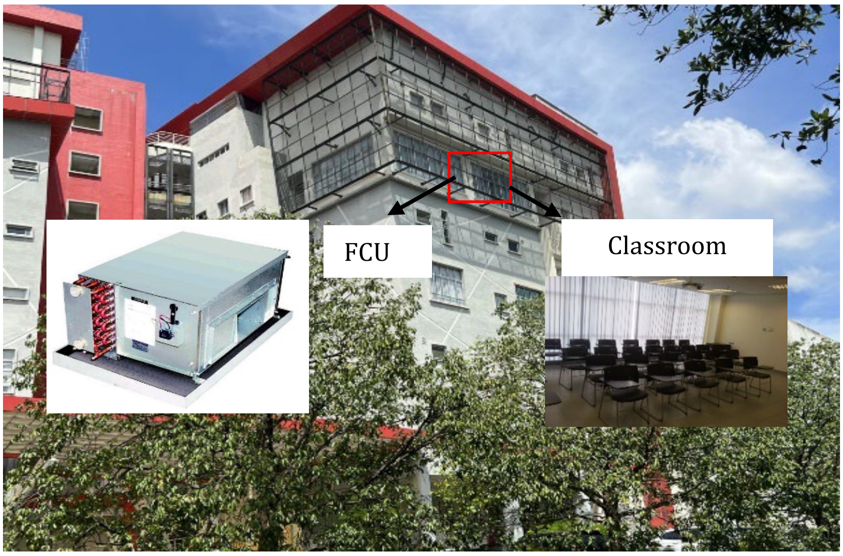


Fig. 2 *Case study thermal zone and cooling system*

Table 1 *Specification of cooling system*

Parameters	Description
Brand	DCP-20
Type	Ducted
Capability (BTU/hr)	56,278
Mass flow rate (igpm)	9.26
Size (cm)	429 × 899 × 1475
Weight (kg)	103.4

The performance of the FCU in the case study was evaluated using the specified method. The following sections will provide a detailed explanation of each step.

2.1 Measurement

The research conducted an observation on the installed FCU, revealing that the airflow mechanism in the case study included four distinct air types: supply air, return air, fresh air (outside air), and mixed air, as illustrated in Fig. 3. The distribution of cold air to the room is facilitated by a primary supply air duct and six diffusers. Outdoor air, also known as fresh air, is introduced into the room and mixed with the existing room air. The ratio of the airflow rate is 20:80, with 20% being fresh air and 80% being room air. The mixed air located at the ceiling of the thermal zone is directed back to the FCU by means of two diffusers. Data on temperature, humidity, and airflow were collected from four locations within the case study.

Temperature and humidity transmitters were placed in various positions throughout the FCU and the thermal zone in order to ascertain the total cooling load, the cooling coil performance, and the indoor thermal conditions. In order to gather data on the temperature and humidity of the supply air, a transmitter was mounted on the supply air duct, as shown in Fig. 4a. Similarly, to collect data on the temperature and humidity of the mixed air resulting from the combination of room air and fresh air, a transmitter was positioned at the ceiling, as illustrated in Fig. 4b. Figs. 5a and 5b depict the placement of temperature/humidity sensors, which have been put in the exterior and interior areas of the thermal zone, respectively. These sensors have been positioned to gather air property data related to the outdoor and indoor environments. The supply airflow rate was determined by measuring the airflow rates of the six diffusers. As shown in Fig. 6a, the supply airflow rate is derived by quantifying the airflow rates of six diffusers. Measurements were taken for temperature and relative humidity at the four specified locations. Fig. 6b illustrates the arrangement used for data collecting.

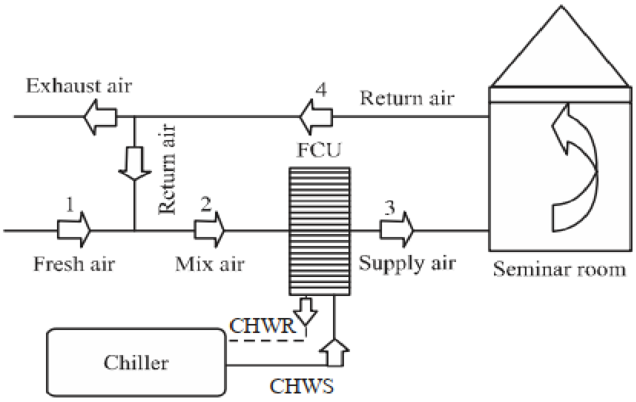
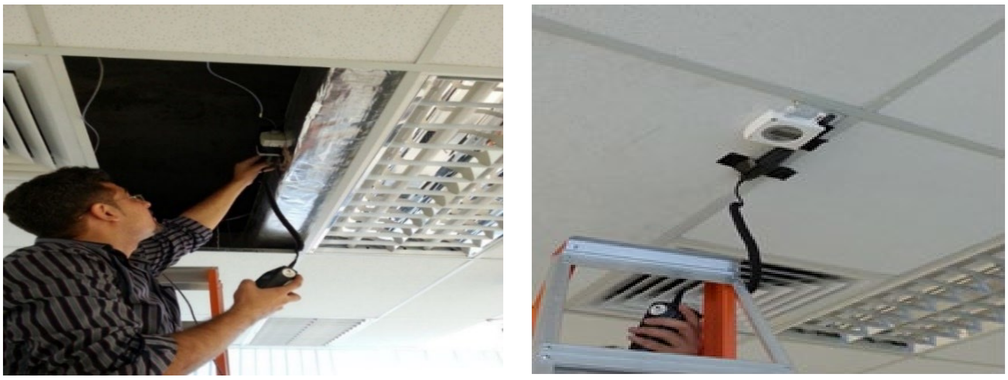
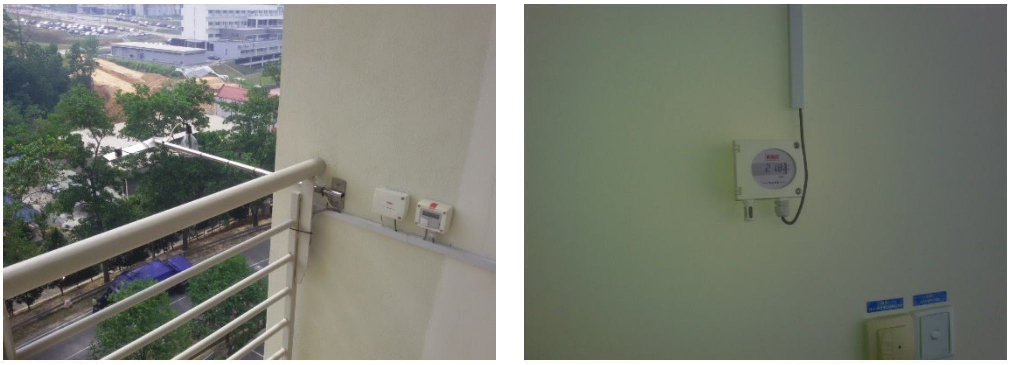


Fig. 3 *Graphic depicting the site's cooling operations*



(a) **(b)**

Fig. 4 *Temperature and humidity measurement (a) supply air; and (b) mixed air*



(a) **(b)**

Fig. 5 *Temperature and humidity measurement (a) outdoor air; and (b) room air*

(a) **(b)**

Fig. 6 *Case study measurement (a) Airflow rate; and (b) Data collection*

2.2 Data Analysis

An optimized FCU is an FCU that effectively controls the temperature and humidity of the classroom. Due to ASHRAE guidelines, there are three criteria that can be used to assess the air characteristics and performance of a refrigeration coil system: cooling load, external conditions, and indoor design conditions. The following describes the cooling load, exterior and interior design conditions:

- The sensible load: 1.29 tons,
- The latent load: 1.359 tons,
- Outdoor condition design: 32 °C and 80% RH,
- Interior condition design: 25 °C and 50% RH.

For the purpose of designing an optimum FCU, Eqs. (1) and (2) can be used to calculate the supply air temperature and humidity.

$$Q_{sc} = 1.26 \times \dot{m} \times (T_{bc} - T_{ac}) \tag{1}$$

where Q_{sc} (kW) represents the sensible cooling capabilities of the refrigeration coil, $\dot{m}$ (m^3/hr) signifies the ventilation rate, T_{bc} (°C) represents the air temperature before the refrigeration coil, and T_{ac} (°C) denotes the air temperature after the refrigeration coil.

$$Q_{du} = 0.8232 \times \dot{m} \times (HR_{bc} - HR_{ac}) \tag{2}$$

The volume of dehumidification of the refrigeration coil is represented by Q_{du} (kW), while the humidity ratio of the air prior to the refrigeration coil is denoted as HR_{bc} (kg/kg), and the humidity ratio of the air subsequent to the refrigeration coil is represented by HR_{ac} (kg/kg).

2.3 Optimization

The performance of the FCU in the case study is evaluated by comparing the measurement results with those of an optimized FCU. These two FCUs mentioned above enable a comparison of the indoor thermal conditions and energy consumption in the thermal zone.

3. Results and Discussion

All four aspects of the case study's measurements—cooling load, cooling coil capacity, air properties, and energy distribution—are evaluated according to the ASHRAE standard.

3.1 The Trend of Cooling Demand

The first step in the design process for cooling systems is the calculation of the cooling load, which directly impacts thermal comfort, energy efficiency, and IAQ. The size of the cooling systems must be determined based on the cooling load. An undersized cooling system is incapable of achieving thermal comfort conditions, while an oversized cooling system may result in issues such as excessive cooling and high energy consumption. Fig. 7 illustrates the cooling load measurement findings for one week during office hours in the thermal zone (from 8 AM to 6 PM on June 21-25, 2021). Based on the examination of the cooling load averaged over time, it may be deduced that the latent load in the specified area exceeds the sensible load. The results reveal that both the sensible and latent loads experience periodic fluctuations between 4 and 5 kW every 20 minutes. The total sensible and latent loads were 1.30 and 1.37 tons, respectively. The latent load is mainly affected by infiltrations occurring via the door and windows, while the sensible load is primarily influenced by solar gain from the windows. The total cooling capacity amounted to 2,677 tons.

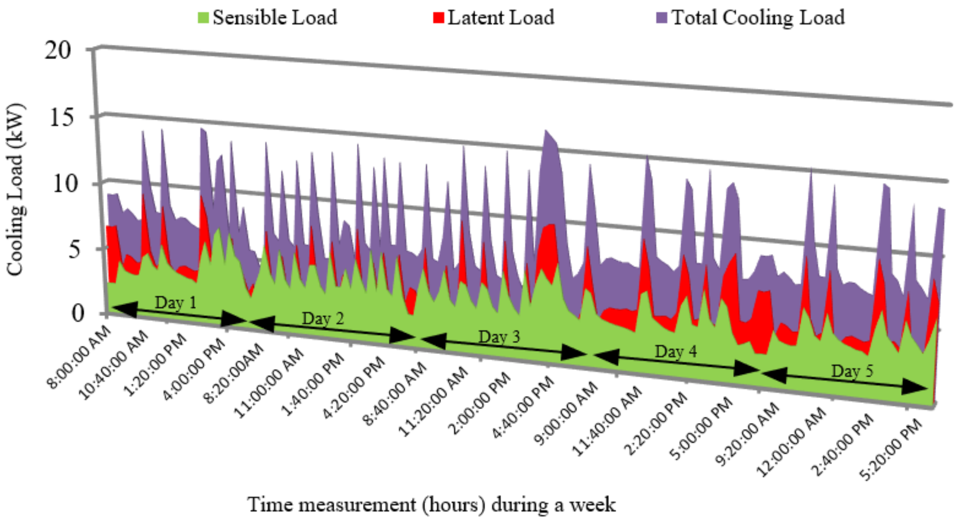


Fig. 7 *Cooling load distribution in thermal zone during working hours*

3.2 The Trend of Cooling Coil Capability

The capability of the cooling coils is a measure of how much heat a cooling system can remove. Since the cooling coil of an FCU removes the same amount of sensible and latent heat, the sensible and latent capabilities of the FCU are equal. From 8 AM to 6 PM, the FCU's sensible, latent, and total capacity are shown in Fig. 8. When looking at the distribution of FCU capacity across time, the latent capacity is shown to be greater than the sensible capacity. The overall capacity is predicted to be about 11 kW, with latent and sensible capacities ranging from 4 to 5 kW.

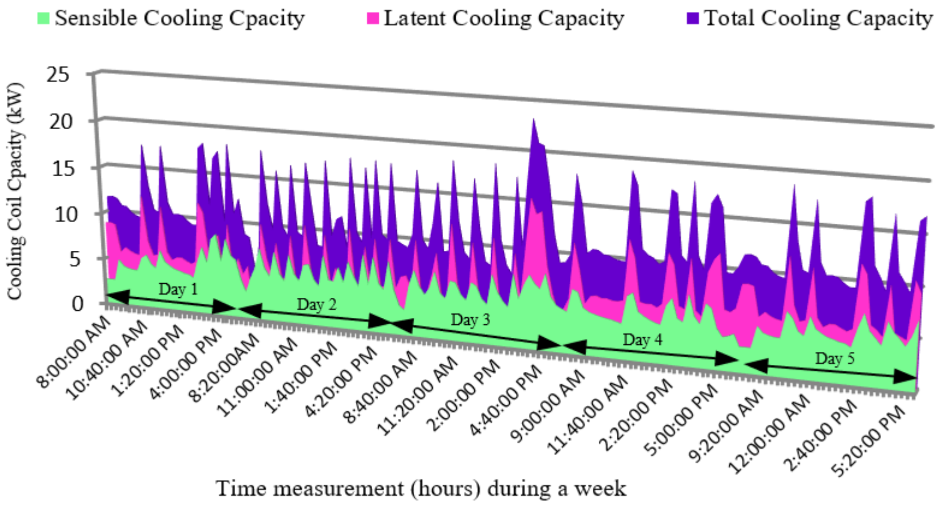


Fig. 8 *Cooling coil capacity of FCU during working hours*

3.3 Temperature and Humidity Ratio in the Case Study

In line with the parameters specified in the case study, measurements were conducted to assess the air quality of four distinct process air lines: outdoor air, mixed air, supply air, and room air. This evaluation took place during the first week of April 2021. The graphs in Figs. 9 and 10 demonstrate the temperature patterns observed in the four process air lines over a single day (from 8 AM to 6 PM) and an entire week (Monday to Friday), respectively. The maximum temperature is correlated with the ambient temperature in Malaysia. The upward trend line is associated with the rise in ambient temperature, whereas the downward trend lines signify a decrease in temperature during the given period. The outside temperature exhibits diurnal variation, fluctuating between 20 and 38 °C throughout the time period from 8 AM to 6 PM. The minimum temperature is correlated with the air that is provided. The temperature of the air being provided refers to the temperature of the air after it has passed through the cooling coil, typically falling within the range of 15 to 20 °C. The temperature inside the classroom remains quite stable, maintaining an approximate value of 25 °C. The mixed air temperature surpasses the room temperature due to the inclusion of external air.

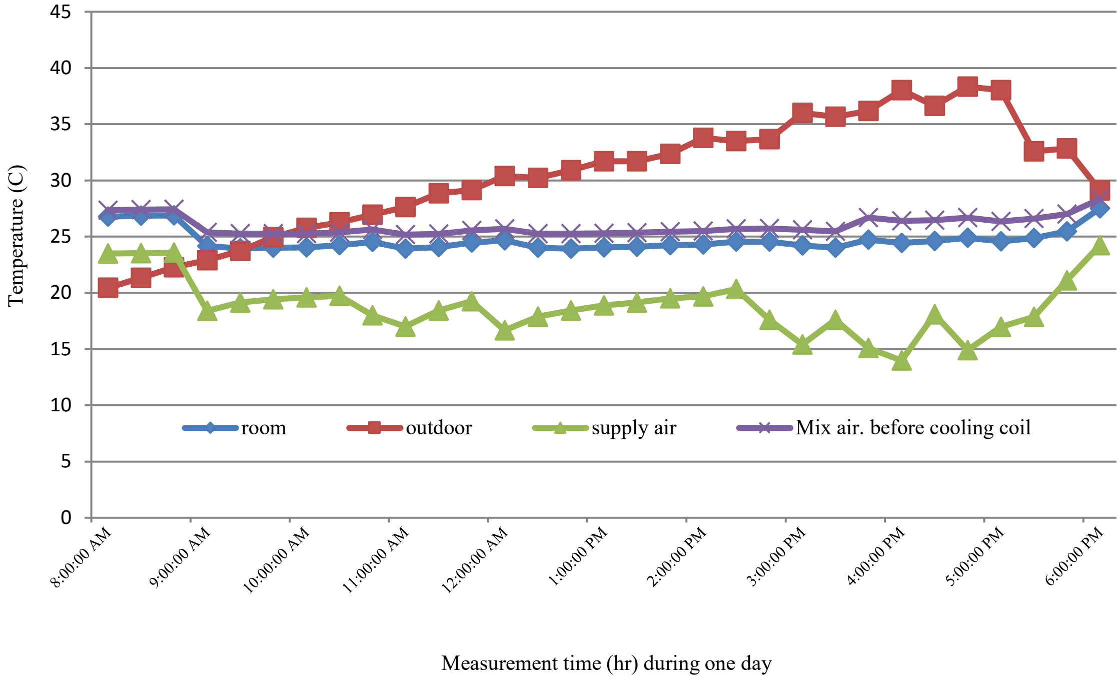


Fig. 9 *Temperatures of the four process air lines during a day*

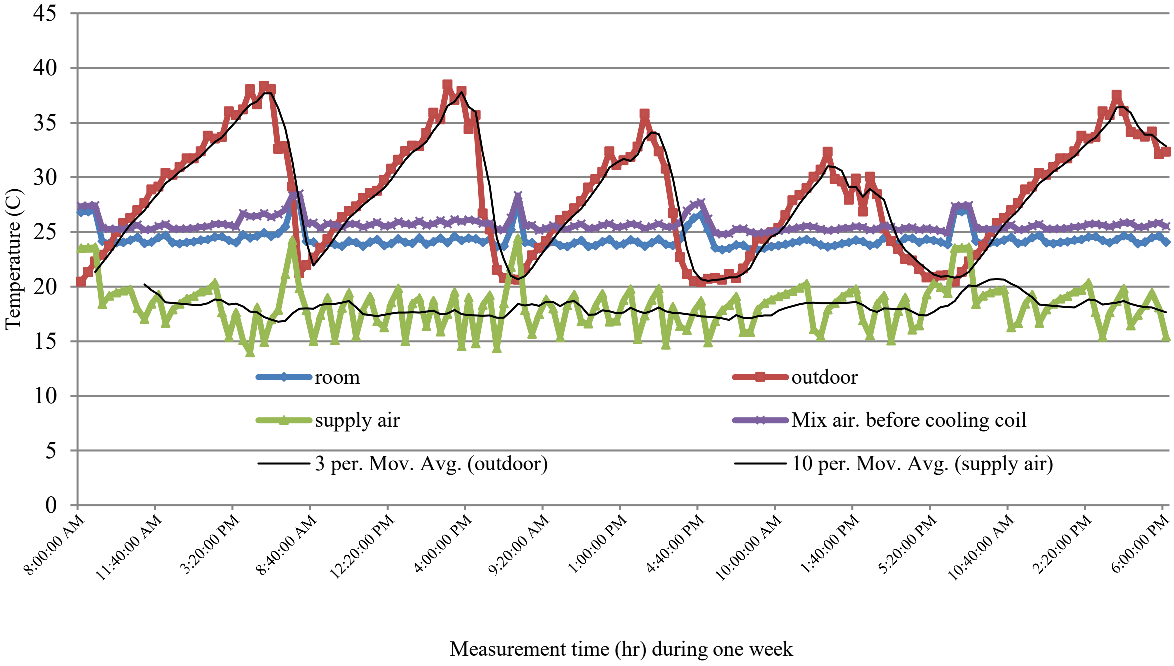


Fig. 10 *Temperatures of the four specified locations of the case study*

Humidity ratios, also known as the moisture content of air, were used as a secondary measurement parameter following temperature to determine elements present in each of the four air processing pathways. The humidity ratio measurements over one day and one week are depicted in Figs. 11 and 12, respectively.

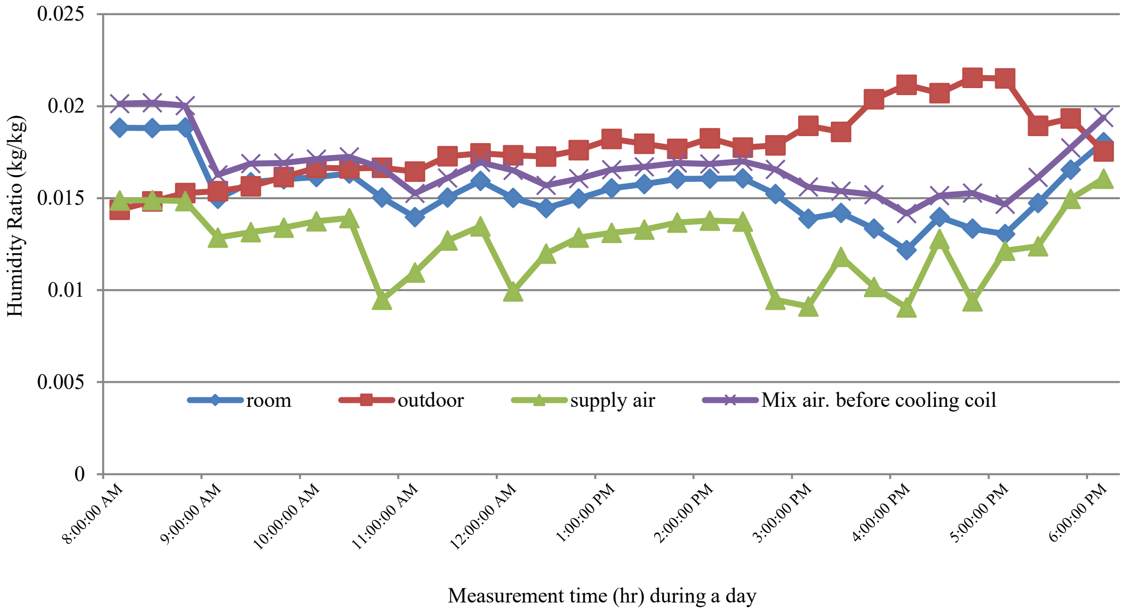


Fig. 11 *Humidity ratio of the four process air lines during a day*

The supplied air has a much lower moisture content than the ambient air. Humidity levels in the room vary between 0.013 and 0.017 kg/kg, whilst those in the supplied air are between 0.007 and 0.013 kg/kg.

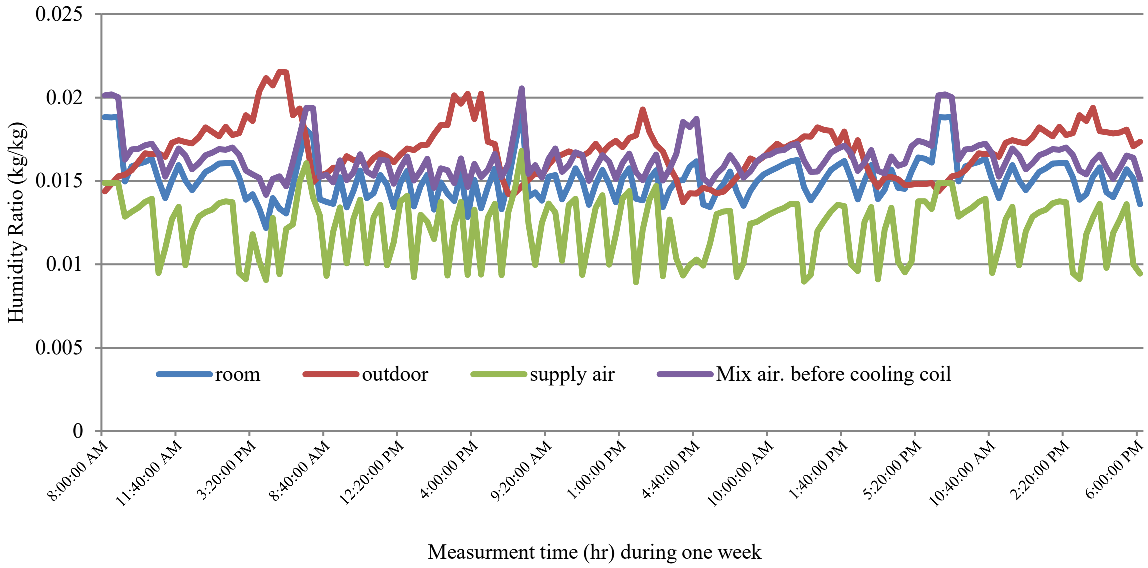


Fig. 12 *Humidity ratio of the four specified locations of the case study*

Several indicators, such as temperature, relative humidity, humidity ratio, and airflow velocity, were measured at specified points inside the research site to assess the thermal comfort characteristics of the case study room. At several FCU locations, we measured airflow rate, relative humidity, temperature, and humidity ratio on a weekly basis; these average data are shown in Table 2. Outside air (point 1), mixed air (point 2), supply air (point 3), and room air (point 4), respectively, are related to different qualities.

After the supply air passed through the cooling coil at point 3, the temperature was 17.7 °C and the humidity ratio was 0.0118 kg/kg. Because to the circulation of air inside the chamber, the temperature reached 24.2 °C and the relative humidity reached 77.2%. To construct a mixed air process line (point 2) with a temperature of 25.9 °C and a humidity ratio of 0.0163 kg/kg, a part of the outside air at point 1 with 29 °C and a humidity ratio of 0.0201 kg/kg was mixed with inside air. It is advised to keep the interior at 25 °C with 50% relative humidity and a humidity ratio of 0.0098 kg/kg, as per the comfort conditions criteria set by ASHRAE. The case study room had a relative humidity of 77.2%, which meant that the cooling system and room circumstances were not conducive to thermal comfort.

Table 2 *Result of air properties measurement*

Point No.	Temperature (*℃*)	Humidity (*kg/kg*)	Humidity (*%*)	Volume flow rate (*CFM*)
	Measurement parameters			
One	29.2	0.0201	76.9	245
Two	25.8	0.0164	77.2	1210
Three	17.7	0.0118	92.8	1210
Four	24.2	0.0148	77.2	965

Fig. 13 shows a psychrometric chart of the FCU that shows the air's behavior in the room and at different FCU locations. In addition, the cooling coil (points 2-3) reduces the humidity to 0.0118 kg/kg and the temperature to 17.7 °C by chilling the air. When new air is brought into a space, both the sensible and latent heat are removed from it (points 3-4). During this event, the temperature in space may drop to 24.2 °C and the humidity can reach 77.2%, both of which are far higher than the thresholds for what is deemed a "comfortable" environment.

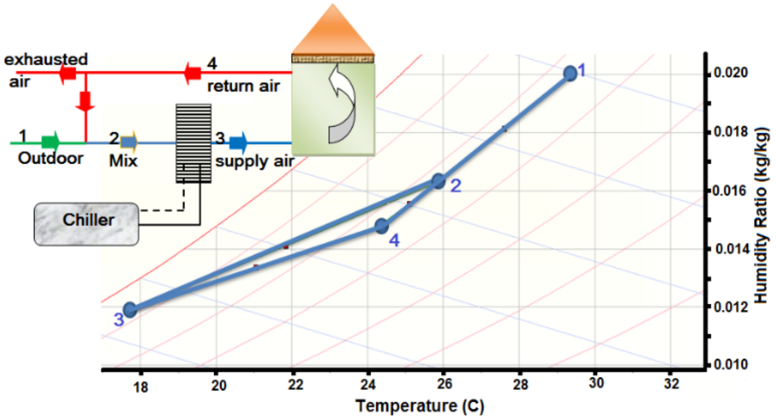


Fig. 13 *Psychrometric air properties of the installed FCU*

The relative humidity of the supplied air is determined by the dehumidification process that occurs within the cooling coil. This, in turn, affects the relative humidity of the room air. The insufficiency of the cooling coil's dehumidification capacity is identified as the primary factor contributing to the excessive moisture in the air. To attain thermal comfort in the current study, it was essential to ensure that the provided air possessed a temperature of 18.3 °C and a humidity ratio of 0.007 kg/kg. However, it should be noted that the FCU was unable to deliver the specified air conditions for the designated area.

3.4 Comparison of Air Properties and Energy Usage: Optimized FCU vs. Case Study

The results of the measurements indicate that the classroom's indoor environment is not appropriate due to the excessive humidity levels. There are two ways to achieve appropriate indoor thermal comfort: (1) enlarging the cooling coil and re-heating it thereafter, and (2) employing a desiccant cooling system. This section focuses on the initial solution. Eqs. (1) and (2) are utilized to calculate the air characteristics of an FCU. Fig. 14 shows the psychrometric chart that shows the points used to represent the FCU's dehumidification and cooling activities. It also shows the results of the air characteristic calculations at different optimal FCU locations. Point 3 is where the airflow rates of the fresh air (point 1) and return (point 2) are mixed. The fresh air makes up 20% of the total airflow rate, while the return air makes up 80%. The supplied air is then cooled and dehumidified to the required condition.

Due to the elevated humidity levels at the mixed air point, it is not feasible for any cooling coil to effectively reduce the humidity to a more optimal level within the range of points 3–5. However, implementing the 3–5 coil method is not viable as this line fails to meet the saturation curve. Consequently, the selection of the coil line that intersects the saturation curve is determined by process lines 3–4. By employing the 3–4 technique, it is possible to achieve the desired relative humidity for the supplied air in the mixed air. However, this process causes a sudden drop in temperature to 10.3 °C. As a result, a warming process of 4–5 hours are required to raise the air temperature from 10.5 to 18.4 °C. The psychrometric chart utilized in the optimized FCU design denotes four distinct points: supplied, mixed, fresh, and room air.

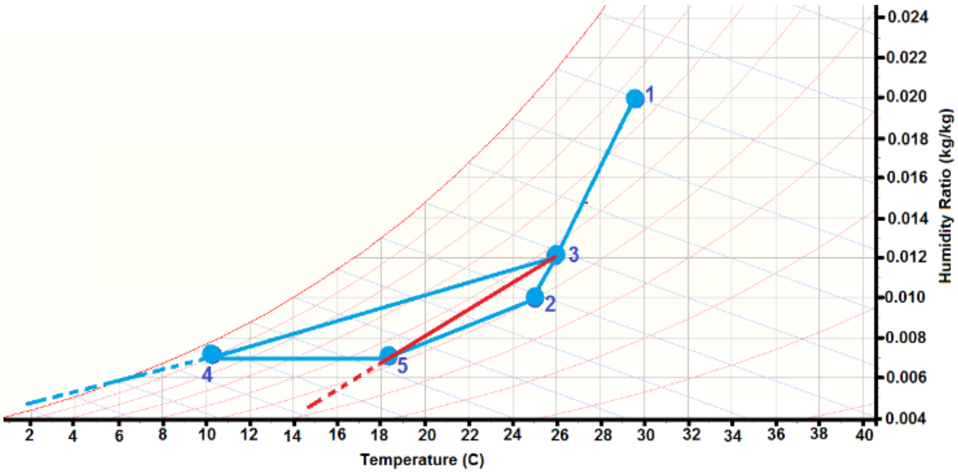


Fig. 14 *Psychrometric air properties of the optimized FCU*

Table 3 presents a comprehensive analysis of the differences in the air qualities between the FCU case study and the optimized FCU. In light of the heightened latent load in the region, the results obtained from the optimized operations of the FCUs suggest that achieving thermal comfort depends on the implementation of re-heating procedures after the cooling coil process. The case study revealed that the FCU did not employ re-heating as a cost-saving strategy. As a result, the desired level of thermal comfort in the specified area is not attained.

Table 3 *Air features of the FCU and the optimized FCU*

	Temperature (℃)		Relative humidity (%)	
Air Point	Case Study FCU	Optimized FCU	Case Study FCU	Optimized FCU
Indoor air	24.4	25	77.2	50
Mixed air	25.6	25.9	76.8	57
Distribute air	17.7	18.2	92.8	53.3
Ambient air	29.2	29.2	76.8	76.8

Table 4 presents a comparison of the monthly energy usage during office hours between the case study FCU and the ASHRAE-optimized FCU. The enhanced FCU has a greater total energy consumption compared to the FCU used in the case study, primarily as a result of improved dehumidification procedures and re-heating mechanisms. The energy consumption for sensible cooling and dehumidification in the FCU case study is recorded as 360 and 456 kWh per month, respectively. In contrast, the optimized FCU exhibits higher energy consumption levels, with 684 kWh for sensible cooling and 522 kWh for dehumidification per month.

The results suggest that although the FCU case study demonstrated lower energy consumption compared to the optimized FCU, and effectively maintained temperature comfort in the classroom, it was unable to regulate the relative humidity of the room to the desired standard level of 50%.

Table 4 *Energy usage of the FCU and the optimized FCU*

Type of process	Energy consumption (*kWh*)	
	Case study FCU	Optimized FCU
Dehumidification	455.9	522
Sensible cooling	359.9	684
Re-heating	-	384
Fan	86.2	86.6
Total	902	1,676.2

4. Conclusion

This study assessed the cooling load, cooling coil capacity, and indoor thermal conditions of a standard cooling system operating in Malaysia's hot and humid region. The obtained measurements were juxtaposed with those of a benchmark FCU constructed in accordance with the ASHRAE standards. Regarding thermal comfort and energy analysis, the outcomes obtained from building measurements were as follows:

- The measured latent load and sensible load in the given room contribute to 51 and 49% of the overall cooling load, respectively. The classroom in Malaysia experiences a latent load that surpasses its sensible load due to the country's hot and humid climate.
- The data collected from the measurements indicates that the cooling coil of the FCU exhibits mean values of 7.28 kW for dehumidification, 5.78 kW for sensible cooling, and 13.06 kW for total cooling. Therefore, it can be inferred that the cooling coil operates at these average levels. The given data indicates that the dehumidification process utilizes 55% of the total capacity of the cooling coil, whereas the sensible cooling process utilizes 45%. Stated differently, the cooling coil of the FCU exhibits a greater capacity for dehumidification in comparison to its cooling capacity, which is deemed appropriate.
- The classroom's temperature and relative humidity were recorded by instruments as 24.4 °C and 77.2%, respectively, while the FCU was in use. Therefore, the FCU is unable to produce sufficient conditioned air to meet thermal comfort requirements.
- An optimized FCU is designed to deliver suitable indoor environmental conditions. According to the results, the standard FCU exhibits a power consumption of 123 kWh, while the FCU in the case study demonstrates a lower power consumption of 90 kWh. In order to achieve typical indoor temperature conditions utilizing a traditional cooling system, it is necessary to augment the cooling coil's capacity to 3 kW and subsequently subject it to re-heating afterward. The optimized FCU exhibits a 1.4-fold increase in energy consumption compared to the installed FCU.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *M.M.S. Dezfouli, A.R. Dehghani-Sanij;* ***data collection:*** *Sh. Rostami, R. Suhairi, K. Kadir;* ***analysis and interpretation of results:*** *M.M.S. Dezfouli, A.R. Dehghani-Sanij;* ***draft manuscript preparation:*** *All authors. All authors reviewed the results and approved the final version of the manuscript.*

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