# Analysis of Thermal and Visual Comfort by Utilising the Role of Technology in the University Canteen

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**Abstract.** One of the efforts to improve the quality of universities and achieve World-Class University (WCU) status is by enhancing university facilities. The canteen is one of the essential facilities for students, lecturers, and university employees to engage in activities, as well as a means of transportation for motorcycles. However, the uncomfortable conditions in the canteen cause the productivity level of the academic community to be less than optimal due to thermal and visual conditions that are suboptimal. The purpose of this study is to find problems that occur in the canteen of the Auditorium of the State University of Medan related to thermal comfort and visual comfort. The research approach also aims to assess the quality of thermal and visual comfort in the canteen, facilitating the activities of users and canteen managers. This study employs a qualitative-experimental method of spatial mapping, tracing the level of problem-solving that occurs with the application of technology in creating a good, safe, and comfortable spatial atmosphere. Elaboration of the analysis of space zoning as a driver of canteen activities, as the basis of the main users of the canteen, as well as the analysis of activities and industry players in it, are also supporters in finding solutions to problems with thermal comfort indicators in accordance with SNI 03-6572-2001 and also ASHRAE Standards and visual comfort indicators in accordance with SNI 03-6575-2001. The analysis of thermal comfort and visual comfort in the university canteen resulted in recommendations for the application of technology in this Role. The results of this study aim to provide alternative layouts and designs for the placement of light points to building managers, enabling them to apply technology to maximise the principles of thermal comfort and visual comfort.

**Keywords:** University canteen, Visual comfort, Thermal safety, Role of technology

## 1 Introduction

The State University of Medan, which has a superior program towards becoming a world-class university, is slowly starting to be realised, as several elements have been achieved, one of which is the availability of facilities, such as the Library, Auditorium, Sports Hall, and others. The Auditorium Canteen of the State University of Medan is one of the facilities provided to

ICIESC 2025, September 16, Medan, Indonesia

DOI 10.4108/eai.16-9-2025.2360993

meet the food and drink needs of academics and campus visitors. [1][2] All students, both from the upper and lower classes, have certainly sat and eaten in the campus canteen. The canteen is a solution for students and campus residents when they are looking for a source of energy, be it food or drink[1][4]. This canteen, located in the UNIMED Auditorium, offers a wide variety of food and beverages at affordable prices. This canteen also provides photocopying facilities to meet the needs of students, such as for assignments and thesis binding.

The activities carried out by each individual vary depending on the tasks to be completed. The frequency of using the canteen is not only related to food but also to the condition of the room [5]. As an integral part of the campus environment, service in the canteen plays a crucial role in creating a positive experience for digital business students and influencing their overall satisfaction [4][5]. Providing quality services in accordance with the needs and preferences of students is a challenge for canteen managers [6][9].

In addition to the availability of canteens, distance, lack of time, lecture schedules, and high lunch prices in canteens are the main barriers to canteen use [8]. Aspects of catering management (production process, cooking environment), hygiene and employee health management, service management and consumer response, food quality (nutrition, appearance and taste of food), environmental atmosphere and regulations imposed by building managers [9][12].

Space comfort is a crucial aspect in the design and management of public facilities, particularly in higher education environments such as universities. The canteen, as a social space and a supporting function for academic activities, plays a strategic role in enhancing the welfare of students, lecturers, and campus staff [11]. In a tropical context, such as Indonesia, thermal and visual comfort are the two primary indicators that are strongly influenced by climatic conditions, building design, and the technology used in spatial management [14] [15] [12].

Thermal comfort encompasses the user's perception of temperature, humidity, and air circulation, whereas visual comfort pertains to the quality of lighting, including both natural and artificial sources. Incompatibilities in these two aspects can lead to inconvenience that impacts the productivity and quality of users' social interactions [17]. Therefore, the integration of technology in supporting the comfort of space is becoming increasingly important, especially in the context of sustainable development and energy efficiency [18].

The university canteen is a public space with a high attendance rate, especially during break hours. Thermal and visual comfort play a crucial role in enhancing user experience, productivity, and overall well-being. However, many campus canteens face problems such as overheating temperatures, high humidity, poor air circulation, uneven lighting, and glare from direct sunlight [15][16]. **Fig. 1** below is a picture of a piece of the auditorium canteen building.

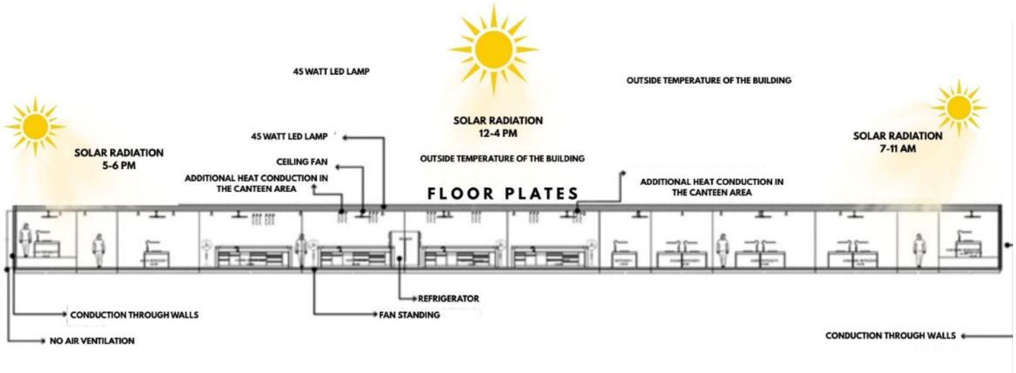



**Fig. 1.** Section of the Canteen Auditorium Building

Through this study, it is hoped to get an overview of the existing conditions of thermal and visual comfort of the UNIMED Auditorium Canteen, the extent to which technology has played a role, and what strategic steps can be taken to improve the quality of the space. The development of building technology allows real-time monitoring and control of environmental conditions. The use of IoT sensors, intelligent lighting systems, and automatic ventilation controls can be solutions to maintain thermal and visual comfort sustainably [17][18]

## 2 Method

This study uses a quasi-quantitative (post-post) spatial mapping method. This method employs a cross-sectional approach to capture the initial conditions, followed by technological interventions (IoT sensors/actuators, shading, exhaust/fans, dimmable LED lights, and automatic control), and then a post-test [23]. The analysis unit consists of space zones (dining area, photocopy queue area, open kitchen, and corridor) and peak/non-peak times. By measuring thermal conditions using indicators and parameters (Ta, Tg/MRT, RH, Va, MET, clo)[20] and measuring visual conditions using indicators and parameters (E_lux, luminance) as well as user perception (PMV/PPD, visual comfort, glare)[21]. This method will produce recommendations for assessing the impact of technology (sensors, controls, devices) on enhancing comfort and improving energy efficiency indicators.

### 2.1 Thermal Comfort

Thermal comfort is defined by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) as "a mental state that demonstrates satisfaction with the thermal environment." This concept involves not only physical parameters, such as air temperature, relative humidity, or wind speed, but also how individuals perceive these conditions [25]. The boundaries of comfort zones are also not absolute, since thermal comfort can be influenced by various things, such as culture or habits, the season of the year, the state of the individual's health, the proportion of body fat, the type of clothing worn, and most importantly, the physical activity performed. The following **Table 1. ASHRAE Standard Thermal Comfort Variables and Indicators,** shows the variables and indicators for evaluating thermal comfort in the auditorium of the State University of Medan.

**Table 1.** ASHRAE Standard Thermal Comfort Variables and Indicators

| No | Parameter | Instruments | Unit | Measurement Time | Reference Standards | Comfort Criteria |
|---|---|---|---|---|---|---|
| 1 | Air temperature (Ta) | Thermo-hygrometer / IoT Temperature Sensor | °C | Morning, Noon, Evening | ASHRAE 55, ISO 7730 | 23–26°C (Tropical) |
| 2 | Relative humidity (RH) | Thermo-hygrometer | % | Equal to temperature | ASHRAE 55 | 40–60% |
| 3 | Airspeed | Anemometer | m/s | Equal to temperature | ASHRAE 55 | 0.15–0.50 m/s (indoor comfort) |
| 4 | Mean Radiant Temperature (MRT) | Globe thermometer / Thermal camera | °C | Equal to temperature | ISO 7726 | ±2°C from Ta |
| 5 | PMV (Predicted Mean Vote) | Software PMV calculator / Spreadsheet | Value -3 s/d +3 | By area | ISO 7730 | -0.5 ≤ PMV ≤ +0.5 |
| 6 | PPD (Predicted Percentage Dissatisfied) | Calculation of PMV | % | By area | ISO 7730 | ≤ 10% |

**2.2 Visual Comfort**

Visual comfort is defined as a situation in which a person feels calm without being disturbed by environmental conditions that are perceived through their sense of sight. Generally related to the level of light found around it. This aspect of lighting encompasses both natural and artificial lighting, both of which contribute to creating visual comfort. The Importance of visual comfort:

1. Eye Health: Improper lighting can lead to eye strain, fatigue, and other vision issues.
2. Productivity: Achieving optimal visual comfort can enhance concentration and productivity, particularly at work or while studying.
3. Health: A visually pleasing environment supports a more positive mood and overall well-being.
4. Energy Efficiency: Maximum natural lighting can reduce reliance on artificial lighting, thus saving energy.
5. Aesthetics: Good lighting also has a crucial role in building a visually appealing and comfortable atmosphere.

In **Table 2.** SNI Standard Visual Comfort Variables and Indicators 03-6575-2001, the following provides a reference for determining variables and indicators of visual comfort.

**Table 2**. SNI Standard Visual Comfort Variables and Indicators 03-6575-2001

| No | Parameter | Instruments | Reference Standards |
|---|---|---|---|
| 1 | a. Number of Lights<br>b. Types of Lamps | Direct observation and calculation using formulas | a. $N = \frac{E \, x \, A}{F \, x \, UF \, x \, LLF \, x \, n}$<br>b. 45 watt (Light LED) |
| 2 | a. Total Flux<br>b. Number of Fixtures | Direct observation and calculation using formulas | a. $F_{total} = \frac{E \, x \, A}{kp \, x \, kd}$<br>b. $N_{total} = \frac{Ftotal}{F1 \, x \, n}$ |
| 3 | Reflectant | Lux meter (multi point) | Reflectant = $\frac{B \, x \, 100\%}{A}$ |
| 4 | a. Lighting design criteria: average lighting level<br>b. Minimum lighting level | Direct observation and calculation using formulas | a. $E_{average} = \frac{F \, total \, x \, kp \, x \, kd}{A}$ lux<br>b. The minimum recommended lighting measurement result, as specified in SNI 03 6575-2001, is 200 lux. |
| 5 | Power requirements | Direct observation and calculation using formulas | Power required for all armature:<br>$W_{total} = N_{lamp} \, x \, W1$ |
| 6 | Window | Direct observation and calculation using formulas | 1. The windows should be 1/6 of the floor area of the work. Reduced to at least 1/10 x the floor area.<br>2. If the window is the only path of sunlight, then the distance between the window and the floor should not exceed 1.2 meters. |

## 3. Result and Discussion

The results of the discussion in this study utilised two achievement indicators: thermal comfort indicators and visual comfort indicators, which were calculated based on values obtained from field observations using several measuring tools and calculation formulas.

### 3.1 Results on Thermal Comfort

Thermal comfort models are mathematical or scientific approaches used to predict and explain how various environmental factors interact with the physiological responses of the human body. This model considers multiple factors, including air temperature, humidity, air velocity, thermal radiation, and the type of clothing individuals wear [17]. One of the most frequently used models is the PMV-PPD (Predicted Mean Vote – Predicted Percentage Dissatisfied) model, which is designed to measure a person's comfort or discomfort in a thermal condition based on these variables.

PMV (Predicted Mean Vote) measures the level of thermal comfort based on environmental factors and the body's response. PMV values range from -3 (too cold) to +3 (too hot).

Meanwhile, PPD (Predicted Percentage Dissatisfied) is an estimate of the percentage of people who are dissatisfied with certain thermal conditions, based on PMV values.

ASHRAE Thermal Comfort Scale. This scale is used to measure an individual's perception of thermal comfort, from cold to hot. To calculate thermal comfort, the data from the measurements of the above variables are entered into the appropriate formula or method. Some studies also use software or simulation tools to calculate thermal comfort, especially for more complex analyses [18].
The following is shown in **Fig. 2**, namely the floor plan of the fan point, which is used to analyse the heat level in the room. Using measuring instruments (thermometer, anemometer, and hygrometer).

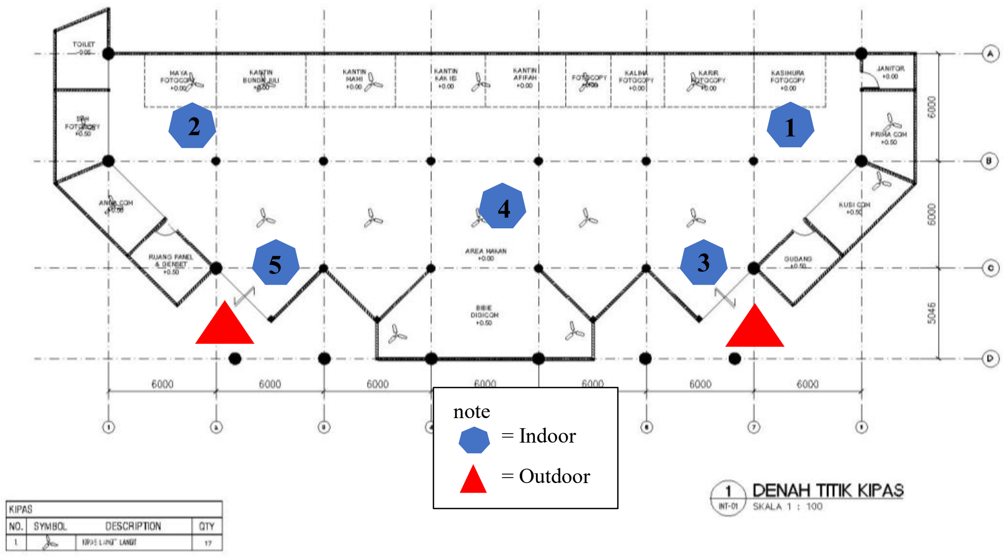



**Fig. 2.** Thermal measuring point plan

The value of the thermal category will be obtained, categorised as either comfortable or uncomfortable, as shown in **Table 3.**

**Table 3**. Data obtained with the auditorium canteen room thermal measuring device

| No. | Variabel | Auditorium Canteen Room | | | | | |
|---|---|---|---|---|---|---|---|
| | | **Tool Placement** | **09.00-10.00** | **11.00-12.00** | **12.00-13.00** | **13.00-14.00** | **15.00-16.00** |
| **1.** | Air Humidity (hygrometer) | Point 1 | 68% | 68% | 73% | 72% | 73% |
| | | Point 2 | 66% | 65% | 70% | 71% | 66% |
| | | Point 3 | 69% | 72% | 71% | 70% | 71% |
| | | Point 4 | 69% | 66% | 75% | 72% | 70% |
| | | Point 5 | 68% | 70% | 71% | 70% | 70% |
| | | Point (Out Door) | 68% | 68% | 69% | 71% | 70% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Average Score | | **68%** | **68%** | **72%** | **71%** | **70%** |
| **2.** | Air Velocity (anemometer) | Point 1 | 0.6 m/s | 1.0 m/s | 0.0 m/s | 0.0 m/s | 0.0 m/s |
| | | Point 2 | 1.0 m/s | 0.9 m/s | 0.1 m/s | 0.3 m/s | 0.0 m/s |
| | | Point 3 | 0.0 m/s | 0.0 m/s | 0.0 m/s | 0.0 m/s | 0.0 m/s |
| | | Point 4 | 0.4 m/s | 0.6 m/s | 0.8 m/s | 1.0 m/s | 0.0 m/s |
| | | Point 5 | 0.9 m/s | 0.6 m/s | 0.0 m/s | 0.5 m/s | 0.9 m/s |
| | Average Score | | **0,58** | **0,62** | **0,18** | **0,36** | **0,18** |
| **3.** | Suhu Udara (thermometer) | Point 1 | $32,3^0c$ | $32,3^0c$ | $32,3^0c$ | $33,3^0c$ | $33,1^0c$ |
| | | Point 2 | $32,3^0c$ | $32,4^0c$ | $32,7^0c$ | $33,3^0c$ | $33,1^0c$ |
| | | Point 3 | $32,4^0c$ | $32,5^0c$ | $32,8^0c$ | $33,3^0c$ | $33,0^0c$ |
| | | Point 4 | $32,4^0c$ | $32,4^0c$ | $32,9^0c$ | $33,3^0c$ | $32,9^0c$ |
| | | Point 5 | $32,3^0c$ | $32,2^0c$ | $32,8^0c$ | $33,2^0c$ | $32,9^0c$ |
| | | Point (Out Door) | $32,3^0c$ | $32,2^0c$ | $33^0c$ | $33^0c$ | $33^0c$ |
| | Average Score | | **32,3** | **32,3** | **32,75** | **33,23** | **33** |
| **4.** | Metabolic Rate (activity) | Point 1 | 1,0 | 1,6 | 1,6 | 1,6 | 1,0 |
| | | Point 2 | 1,0 | 1,6 | 1,6 | 1,6 | 1,0 |
| | | Point 3 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 |
| | | Point 4 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 |
| | | Point 5 | 1,0 | 1,0 | 1,0 | 1,0 | 1,0 |
| | Average Score | | **1** | **1,24** | **1,24** | **1,24** | **1** |
| **5.** | Clothing Insulation (type of clothing) | Universal | 0,22 | 0,22 | 0,22 | 0,22 | 0,22 |

Source: Data Processing 2025

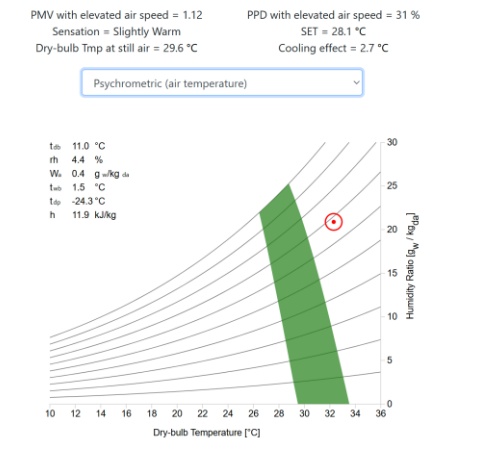
From the **Table 4. Calculation Results using Web Calculation**, the average value will be calculated at PMV and PPD levels using the CBE Thermal Comfort Tool with ASHRAE Standard 55-2023 application.

**Table 4**. Calculation Results using Web Calculation https://comfort.cbe.berkeley.edu/

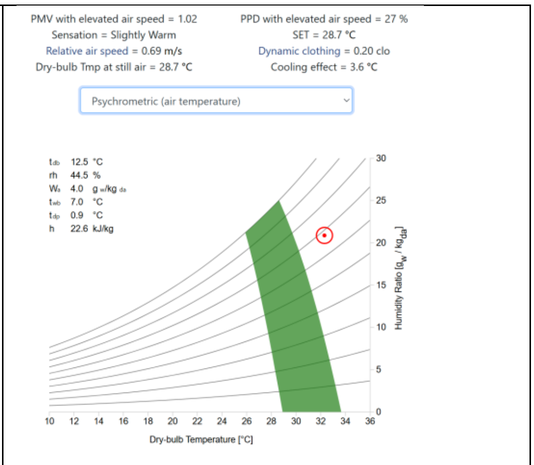
| **Variable** | **Measurement Time** | | | | |
|---|---|---|---|---|---|
| | 09.00-10.00 | 11.00-12.00 | 12.00-13.00 | 13.00-14.00 | 15.00-16.00 |
| Air Temperature ($^0$C) | 32,3 | 32,3 | 32,75 | 33,23 | 33 |
| Humidity (%) | 68% | 68% | 72% | 71% | 70% |
| Air Velocity (m/s) | 0,58 | 0,62 | 0,18 | 0,36 | 0,18 |
| Metabolic Rate (met) | 1 | 1,24 | 1,24 | 1,24 | 1 |
| Clothing Level (clo) | 0,22 | 0,22 | 0,22 | 0,22 | 0,22 |
| PMV | 1,12 | 1,02 | 2,07 | 1,61 | 2,53 |
| PPD | 31% | 27% | 80% | 57% | 94% |

Source: Data Processing 2025

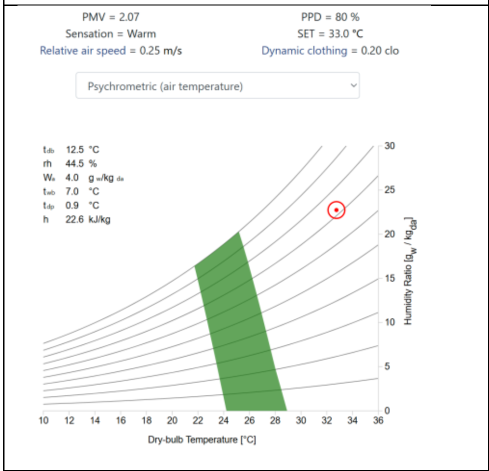
The thermal condition of the canteen does not meet ASHRAE comfort standards [20], with an average PMV of the auditorium canteen at +1 and +2, which falls outside the comfortable scale of -3 to +3. The results obtained from the data indicated that the hot temperature ranged from 12.00 to 13.00 AM in **Fig.3a**, with a PMV of 2.05 and a PPD of 80%. The peak heat occurred at 15.00 to 16.00 AM in **Fig.3b**, with a PMV of 2.53 and a PPD of 94%. This period coincided with a high humidity of 72%. The following is an overview of thermal conditions measured at predetermined times.



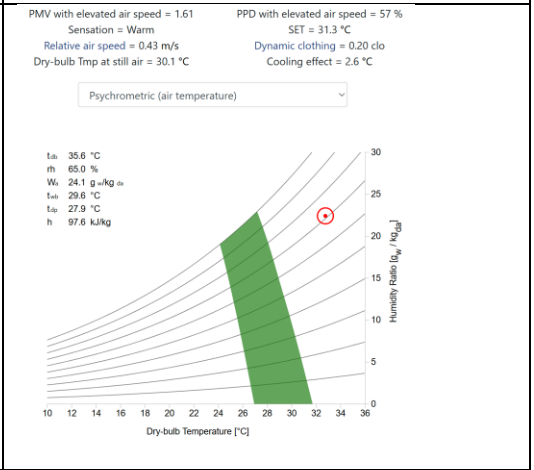

Thermal conditions at the 09.00-10.00 AM




Thermal conditions at the 11.00-12.00 AM

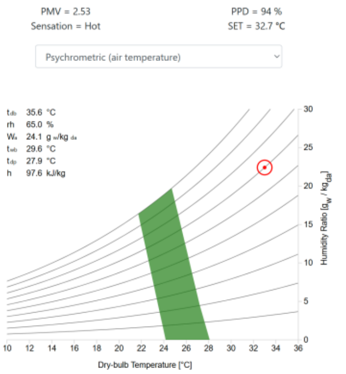



Thermal conditions at the 12.00-13.00 AM




Thermal conditions at the 13.00-14.00 AM

**Fig. 3a.** Thermal conditions measured at predetermined times at 09.00-14.00 AM




Thermal conditions at the 15.00-16.00 AM

**Fig. 3b.** Thermal conditions measured at predetermined times at 15.00-16.00 AM

If you follow SNI Standard Number 03-6572-2001 regarding "Procedures for designing ventilation and air conditioning systems in buildings" as a minimum guideline for all parties involved in the planning, construction, and management of buildings, you aim to obtain comfort and safety for guests and residents who occupy the building. This standard applies to the performance of equipment and components in accordance with the criteria for effective energy use for new installations and the replacement of ventilation and air conditioning system equipment and components. This standard does not include refrigeration equipment that is not used for ventilation or air conditioning in buildings. As shown in Table 5, the results of the ventilation system observation are explained based on SNI Number 03-6572-2001.

**Table 5**. Observation Results of Ventilation System Based on SNI Number 03-6572-2001

| No | Variabel | Calculation Based on Standards | Results in the Field |
|---|---|---|---|
| 1 | Thermal conditions in the building | Air Temperature<br>Comfortable temperature 24-26 degrees Celsius | The air temperature in the Auditorium Canteen room ranges from 32.3 to 33.3 degrees Celsius. |
| | | Relative air humidity<br>40–60% RH | The air Humidity in the Auditorium Canteen room ranges from 13.5-13.8 RH. |
| | | Quantity of air required<br>Number of people capacity ±100 people<br>Building Area 633m2<br>One person needs 7.5 L/s of clean air.<br>1 meter2 of room requires 0.6 L/s of clean air. | So:<br>People components = 100 x 7.5 = 750 L/s.<br>Room components = 633m2 x 0.6 = 379.8 L/s.<br>Total Q = 750 L/s + 379.8 L/s = 1,129.8 L/s. |

| | | | |
|---|---|---|---|
| 2 | Addition of heat from a conditioned room | People refer to 1 person per 1.2 – 1.5 m²<br><br>Lighting<br>200 lux canteen lighting | Density of people/1.2 m2 = 528 people.<br>Q1 = 528 x 75(sensible) = 39.6 kW<br>Q2 = 528 x 55 (Laten) = 29.04 kW<br>Qtotal = 68.64 Kw = 19.5 TR<br><br>The lighting results in the field are 86-130 lux only. |
| 3 | Air ventilation and infiltration | There are two iron mesh ventilation holes in the size 1.75 x 4 meters<br>Area/window = 7 meters<br>2 windows area = 14 meters<br>The minimum ventilation requirement according to SNI is 5% of the floor area. | Minimum Area = 5% x 633 meters2 = 31.65 m2<br><br>Ventilation in the field = 14 meters2 = 2.21 % of the floor area (still far from 5%) |
| 4 | Cooling load | Results in the field according to the working drawings of 17 fans:<br>Speed / fan = 633m2/17 fan<br>= 37.2 m2/ fan.<br>Up to 1 fan = 25-36 m² (adequate)<br><br>The range of 1 ceiling fan covers an area of 25–40 m² | The ceiling fan in the canteen sitting area is no longer working. It's just that there are standing fans used by some shops around the dining area, so the total number of live fans is 13.<br><br>So:<br>The Area/number of fans<br>633m2/13 fan<br>48.6 m2/ fan. (inadequate) |

Source: Data Processing 2025

**Key Findings**

From the results of calculations carried out in the field, numerical data were obtained. Based on these data, several results were found, as follows:

1. The Air Temperature
   The Air temperature is relatively stable in the morning to early afternoon (32.3–32.75 °C), then increases at 13.00–14.00 (33.23 °C) before decreasing slightly in the afternoon (33 °C).
2. Humidity
   The humidity level ranges from 68% to 72%. The highest score was recorded at 12.00–13.00 (72%) and decreased slightly in the afternoon (70%).
3. The Air Velocity
   The Air velocity fluctuates quite well in the morning (0.58–0.62 m/s), but decreases drastically in the middle of the day (0.18 m/s), increases slightly at 13.00–14.00 (0.36 m/s), and then returns to low in the afternoon (0.18 m/s).

4. Metabolic Rate & Clothing Level: Metabolic rate increases during the daytime period (1.24 MET), while clothing level remains consistently low at 0.22 clo throughout.
5. Comfort Index (PMV & PPD)
   - Morning (09.00–10.00 & 11.00–12.00): PMV around +1 (slight heat) with PPD 27–31%, indicating mild discomfort.
   - Noon (12.00–13.00 & 13.00–14.00): PMV increased to 2.07–1.61 with a PPD of 57–80%, meaning the majority of residents felt hot.
   - Afternoon (15:00–16:00): The highest PMV was +2.53, with a PPD of 94%. The conditions were very hot, and almost all residents felt uncomfortable.

Thermal comfort deteriorates over time. The morning is relatively comfortable, even though it is slightly hot. However, as the afternoon and evening approach, the condition becomes increasingly uncomfortable, marked by an increase in PMV (+2.53) and PPD (94%). The main influencing factors are an increase in air temperature, a decrease in wind speed, and high humidity during the day. According to the findings in Table 6, the researcher provides an overview of technical recommendations that can serve as a reference for improving the thermal quality of the auditorium canteen.

**Table 6**. Technical Recommendations for Thermal Conditions & Ventilation of the Auditorium Canteen

| Aspects | Standard/Calculation | Field Conditions | Problems | Technical Recommendations |
|---|---|---|---|---|
| Thermal Conditions | Comfortable temperature 24–26°C; RH 40–60% | Dry 32.3–33.3 °C; RH 13.5–13.8% | The temperature is too high, and the humidity is very low | Add a cooling system (AC/evaporative cooling), humidity control with a humidifier, shading & surrounding vegetation. |
| Air quantity | Clean air requirement 1,129.8 L/s (750 L/s from people + 379.8 L/s from room) | There is no measurable clean air supply system yet | Less fresh air intake | Install a mechanical ventilation system (including an exhaust & supply fan) to meet the standard for clean air discharge. |
| Internal Load – People | 1 person/1.2–1.5 m² (±528 people); Qtotal = 68.64 kW = 19.5 TR | Solid person, produces high heat | Large cooling load | Add an air conditioning system (AC split/central) and adjust the room density according to the number of users. |
| Lighting | Standar 200 lux (SNI) | 86–130 lux | Lighting is less than standard | Add high-efficiency LED lights, optimise the layout of the armature, and use bright ceiling reflectors. |

| | | | | |
|---|---|---|---|---|
| Natural Ventilation | Minimal 5% luas lantai = 31,65 m² | Only 14 m² (2.21% of floor area) | Ventilation area is well below standard | Add openings (such as windows/vents), use cross-vents, or install skylights. |
| Cooling Load & Fan | 1 ceiling fan serves 25-36 m² → ideally 17 active fans | 17 fans available, only 13 functional and serving 48.6 m²/fan | Uneven airflow distribution | Repair the broken ceiling fan, install a new one, and consider combining air conditioning with a fan for optimal distribution. |

**3.2 Results in visual comfort**

Artificial lighting systems are used as a tool for designers and implementers of building construction to design artificial lighting systems, and as a tool for building owners/managers to operate and maintain artificial lighting systems. To obtain an artificial lighting system that is in accordance with the requirements of health, comfort, safety and meets the applicable provisions for buildings. The SNI 03-6575-2001 standard covers the minimum requirements for artificial lighting systems in buildings. **Fig. 4.** below is a plan of the existing lighting points in the auditorium canteen. From the field observations, the calculation of thermal comfort using the SNI standard is described in T**able 7**.

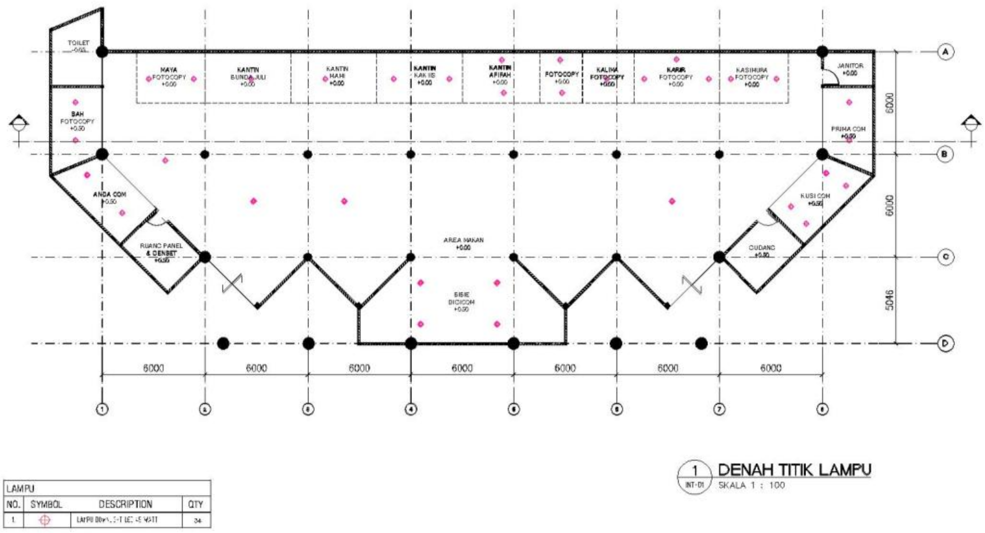



**Fig. 4**. Floor plan of light points

**Table 7** Observation Results of the Lighting System Based on SNI Number 03-6575-2001

| No | Variabel | Calculation Based on SNI Standards | Results in the Field |
|---|---|---|---|
| **1** | Lamp | | |
| | a. Number of Lights<br>b. Types of Lamps | a. N $= \frac{E \ x \ A}{F \ x \ UF \ x \ LLF \ x \ n}$<br>$= \frac{200 \ x \ 663 \ m2}{4500 \ x \ 0.8 \ x \ 0.7 \ x \ 1}$<br>$= \frac{132.600}{2520}$<br>= 52,619..<br>= 53 light point<br>45 watt (Lamp LED) | a. There are 34 lights installed.<br>b. Lamp LED 45 Watt |
| **2** | Luminaires / Lamp Houses | | |
| | a. Total Flux<br>b. Number of Fixtures | c. $F_{total} = \frac{E \ x \ A}{kp \ x \ kd}$<br>$= \frac{200 \ x \ 663 \ m2}{0.6 \ x \ 0.8}$<br>$= \frac{132.600}{0.48}$<br>= 276.250 lumen<br>d. $N_{total} = \frac{Ftotal}{F1 \ x \ n}$<br>$= \frac{276.250 \ lumen}{4500 \ x \ 1}$<br>= 61,3<br>= 61 armature | a. $F_{total} = \frac{E \ x \ A}{kp \ x \ kd}$<br>$= \frac{55.38 \ x \ 663 \ m2}{0.4 \ x \ 0.6}$<br>$= \frac{36.716}{0.24}$<br>= 152.983 lumen<br>b. $N_{total} = \frac{Ftotal}{F1 \ x \ n}$<br>$= \frac{152.983 \ lumen}{4500 \ x \ 1}$<br>= 33.96<br>= 34 armature |
| **3** | Reflectant | Reflectant = $\frac{B \ x \ 100\%}{A}$<br>a. Floor Reflection = 60-65 %<br>b. Table Reflectantce= 30-35%<br>c. Refrigerator Reflectantce=25-45% | a. Floor Reflectantce<br>$\frac{22.9 \ x \ 100\%}{4500}$<br>5.08%<br>Table Reflectantce $\frac{57.7 \ x \ 100\%}{4500}$<br>12.8%<br>b. Refrigerator Reflectantce<br>$\frac{72.4x \ 100\%}{4500}$<br>16%<br><br>Results in the field indicate that the Reflectantce remains significantly below the standard value. |
| **4** | a. Lighting design criteria: | a. $E_{average} = \frac{F \ total \ x \ kp \ x \ kd}{A}$ lux<br>$= \frac{276.250 \ x \ 0.6 \ x \ 0.8}{663}$ lux | a. $E_{average} = \frac{F \ total \ x \ kp \ x \ kd}{A}$ lux<br>$= \frac{237,575 \ x \ 0.4 \ x \ 0.6}{663}$ lux |

| | | | |
|---|---|---|---|
| | average lighting level<br>b. Minimum lighting level | $= \frac{132.600}{663}$ lux<br>= 200 lux<br>b. The minimum recommended lighting measurement result, as specified in SNI 03 6575-2001, is 200 lux. | $= \frac{57.018}{663}$ lux<br>= 86 lux<br>b. Based on the calculation results, it is 86lux. |
| **5** | Power requirements | Power required for all armature:<br>$W_{total} = N_{lamp}$ x W1<br>= 53 x 45<br>= 2.385 | $W_{total} = N_{lamp}$ x W1<br>= 34 x 45<br>= 1.530 |
| **6** | Window | a. The windows should be 1/6 of the floor area of the work. Reduced to at least 1/10 x the floor area.<br>b. If the window is the only path of sunlight, then the distance between the window and the floor should not exceed 1.2 meters. | a. Window Area = 2 x 2.25 = 4.5m2<br>In the auditorium canteen room, there are four windows, of which the area of these four windows is 17.8 m2<br>1/10 x 663 = 66.3 m2<br>b. The distance between the window and the floor is 0.5 meters. |

Source: Data Processing 2025

Note: Auditorium Canteen Area ± 663 m2
F = power (Watts) × efficacy (lumen/Watts)
F = A

**Key Findings**

From the results of calculations carried out in the field, numerical data were obtained. Based on these data, several results were found, as follows:

1. Number of Lights
   - SNI standard (theoretical calculation): It takes 53 points of 45W LED lights to meet the lighting level of 200 lux.
   - Field Conditions: There are only 34 45W LED lights available, which is insufficient for the standard.
2. Luminaires / Lamp Houses
   - SNI Standard: The total light flux requirement is 276,250 lumens → equivalent to 61 armatures.
   - Field: Light flux was recorded at 152,983 lumens → only 34 armatures. It means that the lighting capacity in the field is around 55% of the standard requirement.
3. Surface Reflection
   - Standard: Flooring (60–65%), Countertop (30–35%), Refrigerator (25–45%).
   - Field: Reflectantce values are calculated, but not all numerical data are displayed (formula only). Generally, reflective surfaces do not meet the standard.
4. Average Lighting Level (Average)

- SNI Standard: Average lighting target of 200 lux (as per SNI 03-6575-2001 recommendation).
- Field: The calculation results are only 86 lux, far below standard, so the room tends to be dim and uncomfortable.

5. Power Requirements
   - SNI Standard: Total power required is 2,385 watts (53 lights x 45W).
   - Field: Installed at only 1,530 watts (34 lights x 45W). It means that the power consumption is lower, but the consequence is that the lighting is inadequate.
6. Windows (Natural Lighting)
   - Standard: Window area of at least 1/10 of the floor area of 66.3 m² for a space of 663 m².
   - Field: The total window area is only 17.8 m² (about 27% of the minimum requirement). The distance between the windows and the floor is 0.5 m (as per the provisions). But in terms of breadth, natural lighting is very lacking.

The average number of lights, armatures, and lighting in the field does not meet SNI standards. The average lighting level (86 lux) is well below the recommended 200 lux, so the auditorium's canteen room tends to be dark. Natural lighting (windows) is also insufficient (only 27% of the minimum requirement). It is necessary to increase the number of lights/armatures and optimise window openings to achieve lighting comfort standards. Based on the results presented in **Table 8**, the researcher provides an overview of technical recommendations that can serve as a reference for improving the visual quality of the auditorium canteen.

**Table 8**. Recommendations for Improving Auditorium Canteen Lighting

| Aspects | Field Conditions | Standards / Problems | Technical Recommendations |
|---|---|---|---|
| Number of Lights | 34 lamp LED 45W | 53 45W LED lights are needed (19 lights are in deficit) | Add 19 LED lights (or replace them with high-efficiency LEDs with a luminous efficacy of≥150 lm/W). |
| Number of Armarture | 34 armatures | Need for 61 armatures (deficit of 27 armatures) | Use reflective/high-efficiency armatures, and add armatures for even light distribution. |
| Lighting Level | 86 lux | Minimum 200 lux standard (SNI 03-6575-2001) | Addition of lights & armatures, optimise the layout for light distribution. |
| Power Requirements | 1.530 W | Standard count 2,385 W | Use energy-efficient LEDs (30–35W) with 45W equivalent lumen, install light sensors/dimmers. |
| Surface Reflection | Not yet optimal (dark colours have lower reflections) | Standard: 60–65% floor, 30–35% countertop, 25–45% refrigerator | Use light (white/beige) paint on the ceiling, and a table with a medium reflective finish. |
| Daylighting | 17.8 m² (4 windows) | Min. Standard 1/10 floor area = 66.3 m² (currently only 27% of the requirement) | Increase the window area by using a large glass/skylight, and maintain a floor-to-ceiling distance of ≤1.2 m (appropriate). |

## 4. Conclusion

Thermal comfort in the university canteen has not met the standards, with high temperatures, excess humidity, and inadequate air ventilation. This affects the user's productivity and comfort. Visual comfort is still insufficient with artificial lighting. Still, the distribution of natural light remains uneven, as the only lighting pathway is limited to the two sides of the entrance and exit areas. Space security remains low: evacuation routes are unclear, fire facilities are minimal, and they are not yet disability-friendly. The use of technology is still limited to CCTV and e-wallets; there is no innovative system for environmental monitoring or active security. User responses indicate that the majority of students recognise the need to enhance thermal comfort, improve security systems, and implement sensor-based technology.

Recommended technical recommendations to improve thermal comfort include the installation of a cross-ventilation system with additional openings or exhaust fans, as well as cooker hoods specifically designed for the cooking area. Use of energy-efficient fan/air conditioning with automatic control based on temperature & humidity sensors—addition of outdoor vegetation/shading to reduce solar heat radiation. Ceiling and wall materials utilise heat insulation to reduce the room's temperature.

The recommended technical recommendations to improve Visual Comfort are Optimising natural lighting with the addition of vents or side openings. The addition of energy-efficient LED lights with even light distribution. As well as the use of automatic light sensors, so that the lighting intensity is as needed

**Acknowledgments.** Thank you to the Research and Service Institute (LPPM) at UNIMED for the basic research program for the 2025 fiscal year. Thank you also to the manager of the Auditorium canteen for their support in making this research run smoothly. In addition to support from the Faculty of Engineering at Medan State University. Respondents from the academic community (students, lecturers and staff) who have provided information needed by researchers.

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