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A preliminary study of thermal comfort and lighting in IHL library building

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Abstract. IHL (Institute of Higher Learning) library building is greatly utilized to access information from IT connection and materials. This building as a place to study, reading and writing for students and academics in the university. However, the indoor air quality and lighting system in the library building is not comfort and not satisfactory. In this paper, the investigation of thermal comfort and lighting in IHL library buildings. The library building of LBA, LBB and LBC has been selected. This study has been done with distribution of 350 set of questionnaires. The result shows that 63% of respondents claimed that uncomfortable with the environment because is very cold, which is indoor temperature in average of 20°C. Meanwhile, 54.3% of respondents are unsatisfied with lighting level because it is too dimmed and most of them prefer to study near the window because of daylight. By lux meter reading, the illumination in average of 225 lux. From the reading, recommendations were made in order to enhance the thermal comfort and potential energy saving.

1. Introduction

Library design is one of the major factors to ensure the comfortable environment. The architects, internal designers, engineers and who is responsible to library design are adhere to the guidelines by ASHRAE and Malaysia Standard. One of the most efficient design is a sustainability building design which is built in an environmentally to ensuring the health and well-being of occupants. Activities such as study, writing, and reading usually done in a closed environment in order to protect people from weather and uncomfortable conditions. The poor quality of indoor temperature and relative humidity could affect the occupants, books and building material itself. Mould and pest activity can growth in high relative humidity, while the low relative humidity leads to desiccation. This mould can be harmful to humans, so that the occupants need to be protected with good indoor air quality.

One of the initial factors in offering acceptable environment for occupants is thermal comfort. There are four environmental parameters such as air temperature, air velocity, relative humidity and mean radiant temperature that need to be accessible in adequate scopes for occupants to be comfortable in their living area. Besides that, air temperature also often taken as the key design



parameter for thermal comfort[1]. Based on the definition by the US Environmental Protection Agency, good indoor air quality is symbolized by concentrations of pollutants and thermal (temperature and relative humidity) circumstances that do not negatively affect the health, comfort, and performance of occupants. Indoor environment quality has mediating effects and helps to increase the energy efficiency and overall occupant's satisfaction.

Good lighting is required for good visibility of the environment and should provide a luminous environment to perform task perfectly, increase in productivity and prevention of health effects. The quality of lighting can affect the motivation, emotion, and physical health and avoidance of glare. Traditional library more to reading activities. According to literature [2], modern libraries similar to most office buildings because the purpose is not for reading only but also incorporated widely with IT based workplaces. Lighting design should be considered more like in offices rather than in traditional libraries. Proper light makes the occupants makes all the tasks with easier and accurately. The human receive about 85% of their information through their sense of sight [2]. Inappropriate light encourages to human health emotion such as eye strain, headache. According to previous researcher [3], luminance level and work tasks can form a link to each other so as to determine that luminance level is main factor for working efficiency.

The main objective of this study is to determine the thermal comfort and lighting in IHL library building. In order to achieve the objective, this preliminary study involves measuring the temperature, relative humidity and lux. The scope of this study is to identify the thermal comfort such as indoor air temperature and relative humidity, and lighting level of library building in location A, B and C. This study focuses only on the library users as a respondents. As a preliminary study, the respondents had been provided with question surveys and walk-through assessment was carried out.

2. Methodology

In this case study, the library building in location A has been selected in order to identify the thermal comfort. The library building has been investigated which is a standalone building and located at the Merbok campus (5.7138° N, 100.4505° E). Fig. 1.(a) presents a view of the library in location A. The library building consists of 3-storey and total area of library building is 2143 square meters. Meanwhile, the second building is located at the location B which is Bertam campus (latitude 5.5314°, longitude 100.4755°) experiencing hot and humid weather trough out the year. The library building consists of 3-storey and the total area of library building is 6244.32 square meter [4]. A library building is shown in Fig. 1.(b). The third building is located at the location C, Permatang Pauh campus, Fig. 1.(c). This building consists three stories and construction area 5707.02 square meters, the total volume is 25681060 cubic meters and the ceiling height of each level is 4.5 meter [5].

A set of questionnaire was designed in order to identify the thermal comfort in the library building, which consisted of three sections. The first section is to present respondent's background such as type of programs, gender, and frequency of incoming to library building, while in second section is about thermal comfort and third section for lighting in library building.



(a) Library Building A (LBA)



(b) Library Building B (LBB)



Figure 1. View of the library building.

3. Result and Discussion

The questionnaire had been distributed to 350 respondents. 276 respondents in LBA are participated in this survey and complete the questionnaire while 74 did not, thus the overall completion rate was 78.9%. More than 80% are participated in order to complete the question survey in LBB and LBC, and less than 20% did not complete it. Based on the analysis, the frequency of students incoming to the library building in twice a weeks is 22% and more than 3 to 6 times a weeks is 52%. Mostly, the students like coming to the library building because they like using the library internet connection especially in LBA. The library internet connection is very good and faster for the students and their studies. However, the 44% respondents claims that incoming once a month in the LBC. The reasons of their comings because to complete their assignments.

The second section in question survey is about thermal comfort in library building. The purpose of this section is to know the satisfaction of the lighting level and indoor temperature. This satisfaction analysis is needed in order to improve the thermal comfort and utilization of library building. Table 1 shows the percentage of occupants satisfaction of indoor temperature and lighting level.

The indoor temperature and humidity are needed to measure in order to identified the occupants satisfaction. For the LBC, 63% of respondents are unsatisfied with indoor temperature. Most of them complained about their feeling uncomfortable because it is very cold. The setting temperature in LBC is 17°C [5] and indoor temperature in average of 20°C. Because of that, the students cannot proceed their activities such as reading and writing not more than 2 hours. The temperature should not below than 22.5C or the occupants will feel discomfort with the environment [6]. But, in average 50% respondents are unsatisfied with indoor temperature in LBA and LBB. In LBC, the indoor temperature is in range 22°C to 23°C, the relative humidity is 68% to 71%. Table 2 is shows the setting temperature for each library building.

From Table 1, more than 70% of respondents are satisfied with lighting level in LBB and LBC. Most of them agreed that lighting level is good for them in doing activities such as reading and writing. However, the 54.3% of respondents in LBA are claimed that feeling unsatisfied with lighting level in LBA. Most of them complained that the environment is too dimmed for them to doing activities. According to literature [7], the lux, lumen/m² that suitable for study in the library is 500 lux, so that the occupants has feeling uncomfortable with lighting. In other words, the LBA need to improve the lux by increasing the numbers of lamps. The lack of lighting will lead to the depression in condition such as seasonal adjustment disorder [8]. In this case, 53 zones has identified in order to measure the light level in LBA. Based on reading by lux meter (Testo), the result shows that average of illumination is 224 lux at ground floor, 226 lux at first floor and second floor with area 228 meter square is 153 lux. But, a few zones with windows have more than 300 lux and 500 lux. Based on the question survey, more than 51.4% of respondents like to choose the reading area nearest to window glass which is limited. The LBA more to 70 to 80% of concrete and the rest is window glass. From literature [9], the office workers prefer the daylight to source lighting and most of them like to work near windows because it enhances their productivities compared to the ones sitting far from window . Because of that, the LBA installing the variuos types of lamps for lighting system such as fluorescent lamps and downlight. The purpose is to give more bright and comfort for occupants. There is no

complaint about lighting is too dimmed in LBB and LBC. Observation by lux meter shows that the illumination in LBB and LBC is 500lux and 900lux, respectively.

Table 1. Percentage of satisfaction in library building

Building	Indoor temperature		Lighting level	
	Satisfied	Unsatisfied	Satisfied	Unsatisfied
LBA	45.3	54.7	45.7	54.3
LBB	46.2	53.8	70.5	29.5
LBC	37.0	63.0	88.3	11.7

For the setting temperature and lux level in library building as shown in Table 2, the human body temperature needs to be maintained at a constant $37\pm5^{\circ}\text{C}$ regardless of the prevailing ambient condition. According to MS1525, the guideline for a standard indoor environment design for Malaysian building is in the range of 24°C to 26°C [5]. Previous researcher [10] shows that the raising set point from 22°C to 26°C encourages to energy saving. The light level for library building is more in the range 500 to 1000 lux but it is depending on the type of activities.

Table 2. Setting temperature and lux level in library building

Building	Setting temperature	Lux level
LBA	21°C	225
LBB	22°C	500
LBC	17°C	900

4. Conclusion

This paper use a set of question survey in order to identify the occupants satisfaction regarding on thermal comfort in library building. This case study analysed three library building such as LBA, LBB and LBC. From the question surveys, the library building need to improve their thermal comfort especially indoor temperature and lighting. Around 63% of respondents had expressed their uncomfot feeling with the environment because is was too cold. In order to provide the comfort, the best solution is to re-setting the temperature. Most of the previous research works are studied on the resetting temperature for thermal comfort and potential energy saving. In LBA, 54.3% of respondents are unsatisfied with lighting level and most of them complained that the environment is too dimmed. Illumination in LBA in average 225 lux and need to improve with referring to ASHRAE90.1-2013 which is 500 lux. Installation of LED fluorescent lamps or green lighting is recommended to improve the situation. In addition, it contributes to minimize energy consumption.

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