



Noise Study of Air-Conditioning System at UTHM Pagoh: A Facility Management Approach

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Abstract: Human spend most of their time indoor. So, the quality of indoor environment should be assessed and improved ensure a comfortable and safe indoor environment. However, in UTHM Pagoh there do the building occupants face a major facility problem, which is the noise, coming from the air-conditioning system. In this study, the objectives are to identify the causes and the effects of air-conditioning system noise in UTHM Pagoh and to propose the solution to control the problem. There are three main method used to verify the objectives. The first one is by questionnaire distribution to all building occupants. It is found that their physiology, communication and performance are affected by the noise produced. Secondly, physical data were measured using sound level test. It is found that the Total Average Noise Level in all laboratories exceeded the standard by WHO and ASHRAE, which is 55dBA. Lastly, the interview sessions were conducted to determine the causes and the effects of the noise. Through these interviews, it is found that the causes of the noise are location of air-conditioning blower and return air duct from the room that are too close to the laboratories. The solution listed is design stage control. The solutions proposed is installation of noise insulation using acoustic material and relocation of the return air duct from the room to a higher position.

Keywords: Air-conditioning Noise, Facility Management

1. INTRODUCTION

Human spend most of their time indoor. According to The National Human Activity Pattern Survey (NHAPS), the Americans spend averagely 90% of their time inside a building doing work, studying or doing daily routines. International Labour Organization stated that 70% of work labours around the world are working indoor. These numerical facts telling that indoor environment plays significant role on human development and life itself. Students either in primary, secondary or tertiary levels give high percentages in the usage of indoor space of building. In 2012 alone, 1.3 million out of 27 million people in Malaysia are sitting for their tertiary level education and these numbers are rapidly grow by years (MOHE, 2016). They mainly use indoor spaces for learning and teaching processes Therefore, the quality of the indoor spaces should be sufficiently assessed and improved from time to time to ensure a healthy, comfortable and safe indoor environment as well as keeping learning and teaching process going well. The condition and atmosphere of education spaces or areas can significantly affect the learning process (Hutchinson, 2003). It is observed that minor aspects might lead to augmented difference in learning process compared to grand architectural statements

(Temple, 2008). There are includes important aspects of facility management (FM), such as the inconvenience facilities and improperly working technologies. From the allocation of resources to education and support, facility services significantly contribute towards educational achievement (Crampton, 2009). Over the years, facility management has evolved and become a vital and development. People start looking at this area as an important aspect to be considered before choosing or using a building or a space. Good facility management is demanded in today's market as it provides a better space environment that is included safety and well-being of the building occupants and the building's function itself. Facility management also responsible to ensure hazards and discomforts of building spaces are identified assessed and controlled. These responsibilities, if correctly discharged will definitely contribute to the prevention of unexpected incidents causing discomfort, injury, illness, death, environment degradation and property damage at the workplace. These responsibilities will also give a major and positive factor in favor of productivity and image of an organization. In this study, an investigation on facility management in UTHM Pagoh will be conducted. Since UTHM Pagoh is a new campus, there

are few major facilities' issues that affecting all building occupants such as inconvenience facilities and improperly working technologies. These two issues lead to inconvenience studies environment and thus affect the students who are encompasses 83% of total building occupants. According to the Facility Unit of UTHM Pagoh, the number of complaints on the air-conditioning system noise received is surprisingly high thus this issue will thoroughly discuss in this study. The spaces between the building blocks are very limited. Under these conditions, the noise generated by any air-conditioning systems would propagate, without much attenuation, to the In addition, because of the proximity of the adjacent spaces or areas, severe reverberation of the noise generated occurred. Furthermore, the design and position of the air-conditioning duct system also contributed to the noise generated. Therefore, this study will thoroughly focuses on the causes, effects and solution to this noise.

2. METHODOLOGY

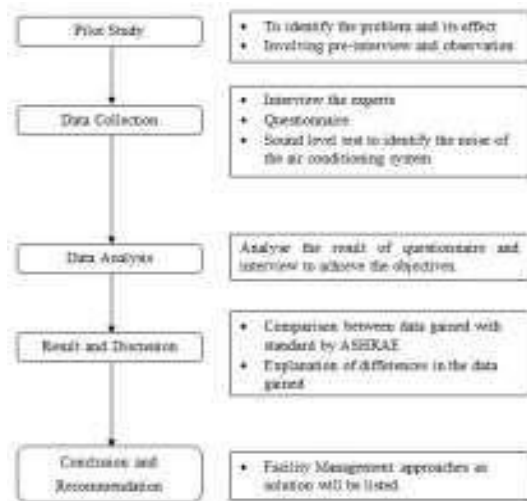


Fig. 1 - Flow chart of methodology

2.1 Pilot Study

In the pilot study, there are two methods involve which are pre-interview and physical data measurement. For the pre-interview, common and simple questions are asked to 30 respondents. It consists of 4 major questions regarding noise pollution and its impact on the building occupants. As for the physical data measurement, a laboratory is selected as the subjects of this pilot study. The laboratory chosen was Building Services Engineering Technology Laboratory. The sound level of the laboratory is recorded to set as initial data of this research. The data collection process is the step whereby the objectives of this study can be achieved. There are two objectives highlighted in this study which are: 1) To identify the causes and the effects of air-conditioning system noise in UTHM Pagoh and 2) To identify and propose the solution to control the problems that is related to Facility Management. Each data collection methods used is based on these objectives.

2.2 Data Collection

After the pilot study is done, the actual problem faced by the building occupants in UTHM Pagoh is identified which is the disturbance of air conditioning system noise during teaching and learning session. Hence, in order to obtain more precise data of this problem, data collection is carried out. This section involves three methods, which are

the interview, questionnaire and sound level test. In order to identify the causes and effects of the air-conditioning system noise, questionnaire forms are distributed to be filled by the building occupants. In order to verify the objectives of this research, experts' opinions should be included. Therefore, to gain their opinions, interview sessions were conducted. As for these interview sessions, there are two groups of experts chosen. They are the academicians and industrial players. There are six experts were selected in this study as suggested by Donabedian, A. (1988) and Saiful Li (2017). The reason of this selection is because they have trusted and sufficient knowledge and experiences to give their point of view in order to fulfil the objectives. This method is used to identify the causes and solutions to the problem. These experts are asked with same questions to obtain consistency in this research. Before data analysis is perform, physical which is a device measuring the noise level in an environment for five minutes and showing the maximum and minimum noise level for that period. In this way, valid and reliable noise measurements were performed without being affected by instantaneous noise levels. In addition, all of the measurements were made on a noise pollution mapping based on the previous research by Buchari and Nazruddin Motandang (2017). A sound level test is carried out in this experiment to numerically and scientifically evaluate the level of noise from the air conditioning system in the classroom and laboratory of UTHM Pagoh. Data processing for this study was carried out by using measurement point mapping. There are two types of measurement point mapping grid. The first one is by using 10x10 meter grid. This type of grid is suitable for overall noise measurement of a facility or area for example, overall noise level for school, university or factory. As for this study, noise level is assessed partially by laboratory in a university. Therefore, the second type of measurement point mapping grid, which is equal square grid, is used. For this type, the total size of the laboratory is measured, and then the point is marked by dividing all the area equally. The recommended distance from one point to another is range from two to three meters. The measurement point mapping for this study is shown in Fig. 2.

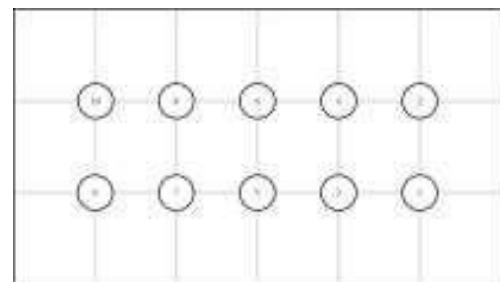


Fig. 2 - Measurement Point Mapping

3. RESULTS AND DISCUSSION

This study found that the laboratories investigated exceeded the standard allowed as shown in Figure 3. Based on the methods carried out in this study, the causes, effects and solutions for this problem are obtained. The causes of the noise pollution in UTHM Pagoh are generally due to the location of the AHU room. The closed location between AHU room and laboratories leading to main causes of this problem which are propagation of noise coming from return air duct due to its low height location and the direction of the air-conditioner blower as shown in Table 1. It is also proven that this noise has significantly affected the building occupants in three aspects, which are physiology,

communication and performance as shown in Fig. 4, Fig. 5 and Fig. 6 respectively.

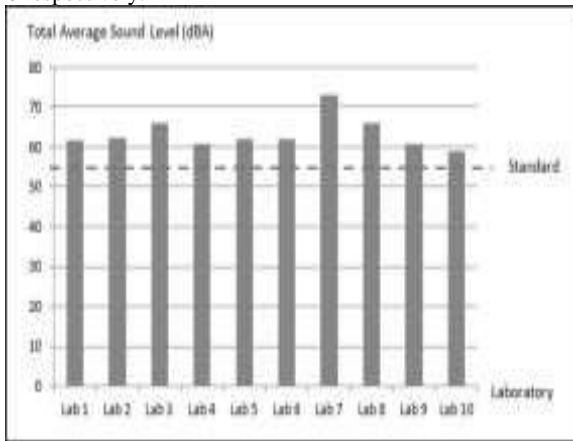


Fig. 3 - Total Average Sound Level in Each Laboratories exceeded the standard

Table 1- Causes of the noise based on the interview sessions

Possible Causes	Agree	Disagree
Surrounding and environment factors		
- Traffic	0	6
- Shop/Residential	0	6
- Construction	0	6
- Size of the room	1	5
Internal factors		
- Machine and devices	0	6
- Building occupants	0	6
Air-conditioning system		
- Blower	6	0
- Return air duct	5	1
- Design of internal ducting system	2	4

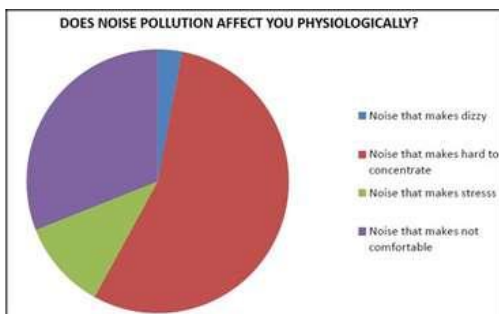


Fig. 4 - Physiology impact of the noise

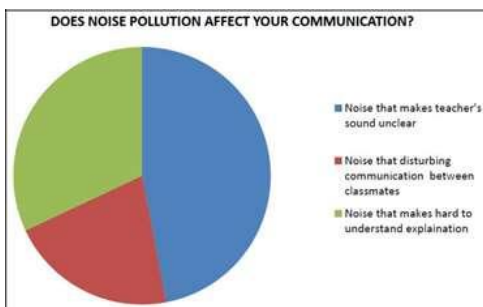


Fig. 5 - Communication impact of the noise

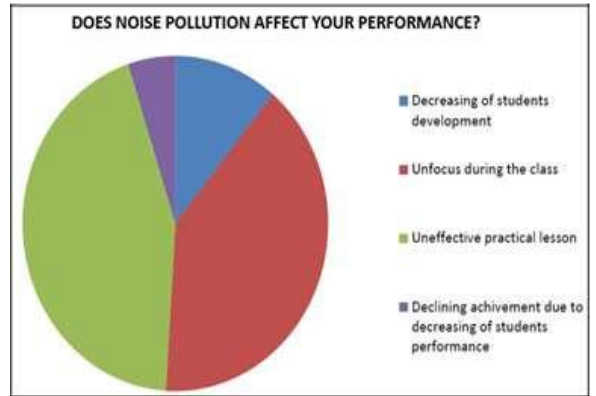


Fig. 6 - Performance impact of the noise

Conclusion

The conclusions that can be taken from this study are the noise level in ten JTKA laboratories investigated exceeded the standard set by ASHRAE and WHO which is 55 dBA for the noise in the laboratory. The noise level in the observed areas based on the data processing was range from 58.9 to 72.91 dBA, which exceeded 55 dBA. There are three laboratories recorded the highest Total Average Noise Level namely Environmental Engineering Technology Laboratory, Civil Engineering Technology Laboratory and Building Services Engineering Technology Laboratory. Meanwhile Wood Engineering Technology Laboratory, CAD Civil Engineering Laboratory I and CAD Civil Engineering Laboratory II recorded lowest reading of Total Average Noise Level. The impact of noise generated by distributing questionnaires resulted found that this noise affected building occupants in all three aspects, which are physiology, communication and performance. This impact brought physiological impact ,which is often experienced by students in the form of difficulties in concentration during class or practical lesson while the psychological impacts include dizziness and uncomfortable feeling. It also affected the communication process since the teacher’s voice becomes unclear. The respondents also agreed that this noise disturbing their communication between classmates. And finally, there are respondents said that this noise makes them hard to understand explanations. In perspective of students’ performance, it is shown that the noise pollutions make the practical lesson ineffective. Other performance impacts of this noise is causing the building occupants unfocused during class and declining achievement due to decreasing of performance. The proposed improvements to reduce the noise are to install sound insulation using acoustic material in the AHU room. Since the causes and sources of the noise is majorly coming from this room, it is suggested to treat the problem from the source. The second solution proposed is to relocate the return air duct from the room to a higher location. This is believed to help minimizing the propagation of the noise, hence control the problem.

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