

Impact of Poor Maintenance Work of Air-Conditioning in UTHM Lecture Hall Towards the User Comfort

Mohammad Fateh Hisham¹, Norliana Sarpin^{1,2*}, Roshartini Omar^{1,2}, Sulzakimin Mohamed^{1,2}, Nor Hazlin Md Gharip³, Norddin Ismayatim⁴

¹ Department of Construction Management, Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Johor, 86400 MALAYSIA

² Centre of Sustainable Infrastructure and Environmental Management (CSIEM), Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, Johor 86400, MALAYSIA

³ Politeknik Sultan Salahuddin Abdul Aziz Shah, Persiaran Usahawan, Seksyen U1, Shah Alam, Selangor 40150, MALAYSIA

⁴ Shiya Sdn. Bhd. Unit 5-06, Level 5, Plaza DNP, No. 59, Jalan Dato' Abdullah Tahir, Johor Bahru, Johor 80300, MALAYSIA

*Corresponding Author: norliana@uthm.edu.my

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Abstract

Air conditioning has become indispensable, especially in warm climate to ensuring thermal comfort in various settings. Poor air conditioning system maintenance in university buildings can have a bad impact on the user comfort. Therefore, the research objectives of this study are to identify the issues faced by users related to maintenance work of air-conditioning at Universiti Tun Hussein Onn Malaysia (UTHM) lecture hall, to identify the impact of poor maintenance work of air-conditioning towards the user comfort and to suggest the ways of maintaining air-conditioning to give comfort to the user of the building. This study implemented quantitative method, where a questionnaire survey was distributed to the Faculty of Technology Management and Business, UTHM students. The data was collected from 215 respondents, which represents a 100% response rate. The data analysis method used was descriptive analysis by using Statistical Package for Social Science (SPSS) software. Study findings reveal that inefficient learning, productivity loss, and class availability issues are predominant challenges stemming from poor air conditioning maintenance. Additionally, health problems, poor exam results, and noxious odors emerge as adverse consequences. The research advocates environmental initiatives, regular filter replacement, and sealing/insulation as effective strategies for air conditioning maintenance. Ultimately, this study offers insights to enhance UTHM's facility maintenance, aiming to create a conducive environment for users by addressing critical issues and implementing proactive measures.

1. Introduction

One of the industries that is crucial to the growth and improvement of an economy as well as the development of a nation is the construction business. The importance of the building industry to a nation's socioeconomic and sustainable development has been recognized and understood by both developing and developed countries (Dwikojuliardi, 2016). Construction projects are strongly related to a nation's various stages of economic development. At the macroeconomic level, there has been discussion about this for a while. Construction work has been associated with the rise of industry and cities ever since the Industrial Revolution began. When the economy expands, construction output increases faster than national output, and the opposite is true (Alaloul *et al.*, 2021).

1.1 Research Background

In the new global economy, poor maintenance work has become a central issue for facility management. It is well known that the primary goal of maintenance is to keep buildings in their original states of functionality, structural integrity, and aesthetic appeal to ensure they maintain their current condition and investment value over an extended length of time. On the other hand, many amenities are both abandoned and still operational. Although numerous ideas and hypotheses are put forth daily on building related issues, particularly building maintainability, maintenance issues still need to be solved. Many believe that the widespread inefficiency of the facilities in most of our structures results from poor maintenance management.

On the one hand, this may be true, but it only discusses maintenance as a repair service that is needed when a building breaks down or when the facilities are partly or entirely damaged. (Adejimi. 2005). Thermal comfort in buildings has become a key concern in both residences and commercial structures as global temperatures rise, as it can impair workers' productivity and efficiency. (Samuel Kalu.2019). 80–90% of people's lives are spent in buildings. (N.E. Klepeis. 2001). The health, comfort, and productivity of employees are all affected by a variety of environmental conditions. (Y. Al Horr. 2016). Researchers are increasingly cognizant of the impact of individual differences when detailed investigations are conducted. (Z. Wang. 2018). Individual thermal preferences and the body's local thermal sensitivity are the main ways that these variances are represented at the research level. (M.Luo. 2020).

Environmental control behaviour also reflects variations in preferences. People may have a wide range of opinions and ideas about what constitutes appropriate control. According to a report by Tsinghua University's Building Energy Research Centre. (Building Energy Research Center of Tsinghua University. 2017). More than 80% of people who use air conditioners do so with a preset temperature; the other 20% select a setting and then change it to their preference. This practice causes air conditioners to use an excessive amount of energy. The energy used for building operations makes for about 30% of the total energy used worldwide. (Building Energy Research Center of Tsinghua University. 2017).

1.2 Problem Statements

Poor air conditioning system maintenance in university buildings can have a negative impact on user comfort, influencing factors such as cooling capacity, air quality, and noise levels. Inadequate maintenance of air conditioning systems can result in a decrease in cooling capacity, resulting in insufficient cooling during hot weather. This might cause discomfort for students, instructors, and staff since they may struggle to maintain a comfortable indoor temperature. Poon (2016) discovered that poor maintenance techniques were connected with a decrease in cooling capacity, resulting in inadequate cooling and decreased user comfort.

Neglected air conditioning systems in university buildings can lead to the collection of dust, filth, and toxins, which are subsequently circulated within the indoor environment. This can lead to a decrease in air quality, which can cause discomfort and significant health issues such as allergies and respiratory disorders. Shendell (2004) conducted a study that discovered poorly maintained air conditioning systems had greater levels of airborne particles and microbiological contamination, severely compromising indoor air quality and occupant comfort. Unmaintained air conditioning systems may develop mechanical difficulties or have loose parts, resulting in increased operational noise levels. Excessive noise can be distracting and annoy consumers. Themelis (2015) investigated the effect of maintenance on noise levels produced by air conditioning equipment and discovered that poor maintenance techniques, such as inadequate lubrication or failure to tighten loose components, were associated with higher noise levels, negatively affecting user comfort. Prioritising proper air conditioning system maintenance is critical in university buildings to maintain optimal comfort, energy economy, and user satisfaction. According to Ahmad Suffian (2013), building maintenance, including air conditioning systems, should be treated holistically, with considerations for mechanical, electrical, civil, and

structural concerns. Neglecting structural aspects during repairs can lead to repeated problems. According to S.R. West (2011), optimal maintenance scheduling is critical to minimising the negative effects of decreased HVAC system efficiency, preserving thermal comfort, and avoiding excessive CO2 emissions. Universities can establish a friendly and comfortable atmosphere for students, faculty, and staff by developing thorough maintenance methods and schedules that support good teaching, learning, and research activities.

1.3 Research Questions

The research questions of the study are as follows:

- (i) What are the issue face by user related to maintenance work of airconditioning at UTHM hall?
- (ii) What are the impact of poor maintenance work of air-conditioning towards the user comfort?
- (iii) What are the ways of maintaining air-conditioning to give comfort to the user of the building?

1.4 Research Objectives

The research objectives of the study are as follows:

- (i) To identify the issue face by user related to maintenance work of airconditioning at UTHM hall
- (ii) To identify the impact of poor maintenance work of air-conditioning towards the user comfort.
- (iii) To suggest ways to maintaining air conditioning to give comfort to the user of the building

1.5 Scope of the Study

The scope of this study was limited to construction industry. Prior to the data collection phase of research method, the scope of the study is established. Research scope, also known as "scope of study," specifies what will and won't be covered in the endeavour. Objectives and outcomes can be accomplished to help focus on work and time. (Simon, 2013). This study will focus on the maintenance work of university building. The university building chosen for this study is Dewan G3 in University Tun Hussein Onn Malaysia (UTHM). This is because students' comfort has a direct impact on their ability to concentrate, study, and achieve academically. Inadequate indoor conditions caused by poor air conditioning maintenance might impede student participation, comprehension, and productivity.. Thus, classes, study sessions, research activities, and administrative responsibilities are often held from early morning until late evening in university buildings. This continuous use of the facilities places a high strain on air conditioning systems, making them more vulnerable to performance concerns caused by inadequate maintenance. It is focused on the critical challenges of maintenance work of air conditioning , impact of poor maintenance work of air-conditioning towards the user comfort and the ways to maintaining air conditioning to give comfort to the user of the building. The respondent of this case study would be the facility manager at UTHM, that handles all maintenance work in UTHM

1.6 Significance of the Study

This research aims to benefit and provide references to the parties like academic purpose. Relevant academic experts, such as graduates and undergraduates, can use the related topic and problems in this study as a point of reference. In the future, it is used to help students in the same field of study. The next one was, facility managers can gain benefit from this because this study helps facility managers find safety problems and possible risks that come with using escalators. By knowing how people act, how they move around, and what risks are involved, facility managers can put in place the right safety measures and protocols to keep accidents and injuries to a minimum. This study can be used to make sure that both passengers and staff are safe when training program, maintenance procedures, and emergency plans are made. Also, researchers were able to contribute to the existing body of knowledge in disciplines such as transportation engineering, human factors, psychology, and ergonomics as a result of this study. Researchers generate new insights, theories, and empirical evidence by investigating escalator usage patterns, passenger behaviors, and safety considerations. This adds to the academic discourse and advances our understanding of escalator dynamics.

2. Literature Review

2.1 Introduction

This section includes a detailed literature review that utilizes various sources, such as print media (journals, books, newspapers, and reports) and electronic media (web surfing), to gather information on the impact of poor maintenance work on air conditioning systems and user comfort. The literature review provides specific insights into the challenges faced in air conditioning maintenance and the impact of poor air conditioning maintenance on user comfort. It identifies different types of maintenance that contribute to poor care. Furthermore, the chapter explores ways to maintain air conditioning systems to enhance user comfort in the building.

2.2 The importance of facility management

Facility management is critical to cost reduction, operational efficiency, tenant happiness, and environmental sustainability. Organizations can save up to 15% on maintenance expenses by implementing preventative maintenance programs and efficient asset management (IFMA, 2017). Effective facility management practice also boosts worker productivity and fosters a welcoming environment (BOMA, 2020). Facilities that are well-maintained contribute to tenant satisfaction and staff engagement (CFaR, 2019). Furthermore, facility managers can support environmental sustainability by implementing energy-efficient measures and adopting sustainable practices, which can result in significant water and energy savings (USGBC, 2021). Overall, facilities management is critical to meeting organizational objectives and fostering a successful workplace environment.

2.3 Definition of Facility

A facility is described as a physical site or movable structure that houses people, equipment, and operations and is defined by its built environment, location, and assets (IFMA, 2020).

2.4 Facility management practices in Malaysia

The application of specialized information technology (IT) in facilities management (FM) operations has the potential to greatly improve FM in Malaysia. Data monitoring, maintenance tracking, space management, and energy consumption are all possible with computer software and systems. However, the efficacy of the collaboration between specialized FM IT and the FM process is determined by the strengths of both. While computerized systems provide integrated capabilities for property management, building operation, services management, maintenance, and security, there is still a lack of understanding and efficient use of FM. The ultimate goal is to establish autonomous building management through a synergistic interaction of FM procedures and IT breakthroughs. (Jamal, 2010).

2.5 Definition of air conditioning

According to Ashrae (2016) Air conditioning is the process of modifying the air to simultaneously manage its temperature, humidity, cleanliness, and distribution to satisfy the needs of the conditioned environment.

2.5.1 Basic component on HVAC system

According to Sugarman (2005). Mixed-air plenum and outdoor air control, Air filter, Supply fan, Exhaust or relief fans and an air outlet, outdoor air intake, ducts, terminal devices, return air system, heating and cooling coils, self-contained heating or cooling unit, cooling tower, boiler, control, water chiller, humidification and dehumidification equipment is the list of the fundamental parts or equipment of an HVAC system.

2.5.2 Classification of HVAC system

According to Ashrae (2016), Central and de-centralized or local systems are the two main categories of HVAC systems. The major equipment location determines whether a system is centralized, conditioning the entire building as a whole unit, or de-centralized, preparing a specific zone independently as part of a building.

2.6 Definition of maintenance

According to Cen (2001), maintenance is defined as the sum of all technical, administrative, and managerial actions intended to keep it in or return it to a state where it can perform the necessary function (function or a combination of functions of an item that are considered necessary to provide a given service).

2.7 Types of maintenance

According to Leong (2004), has separated maintenance into two primary sections through the program and its administration, namely planned maintenance, and unplanned maintenance.

2.7.1 Planned maintenance

According to Ahuja & Khamba (2008), The effectiveness of implementing Total Productive Maintenance (TPM) program depends on an organization's capacity to perform planned maintenance in an effective, organized, and efficient manner.

2.7.1.1 Preventive maintenance

In clinical engineering, preventive maintenance (PM) is critical for guaranteeing the continuous effectiveness and safety of medical devices, as well as maximizing their lifespan and protecting the investment. However, establishing and administering an effective PM program is difficult. Determine appropriate methods and frequencies based on real-world evaluation, failure modes, risk assessment, and incorporating field experience are all important factors. In the evaluation and improvement of the PM program, cost savings and greater effectiveness are also significant elements to consider (Hyman, 2003).

2.7.1.2 Corrective maintenance

According to McKenna (1997), Corrective maintenance, sometimes called reactive or breakdown maintenance, is to get assets back to working order following a failure or malfunction. It comprises identifying the issue, making the required fixes or replacements, and restoring the asset to full functionality.

2.7.1.3 Condition based maintenance.

According to S.K Sethiya (2009), "CBM is a set of maintenance procedures based on a real-time or nearly real-time evaluation of the equipment state derived via embedded sensors and external tests & measurements done by portable equipment.

2.7.2 Importance of maintenance

Preventive and corrective maintenance are critical for ensuring safe and comfortable surroundings for engineering project users. It eliminates the need for costly repairs while also minimizing disruptions. Quality service delivery is critical for client pleasure as well as the endeavor's overall efficacy and profitability. Maintenance processes improve equipment reliability, asset life, operational efficiency, downtime reduction, and compliance and safety standards (Costa, 2005; Castelli, 2001; DOE, 2010).

2.8 Definition of comfort

According to the IWBI (2020), "Comfort: The state of physical ease and freedom from pain or constraint, and the provision of a feeling of emotional well-being and satisfaction.

2.8.1 Types of comfort

According to the IWBI (2020), "Comfort: The state of physical ease and freedom from pain or constraint, and the provision of a feeling of emotional well-being and satisfaction." There are four types of comfort which are physical comfort, emotional comfort, social comfort and environmental comfort.

2.8.1.1 Physical comfort

According to World Well Building Institute (2020), Physical comfort is the state of well-being brought on by internal and external circumstances that are perceived as acceptable and linked to satisfaction and contentment.

2.8.1.2 Emotional comfort

According to (Matuska & Christiansen (2008), a state of calm, an upbeat outlook on life, pleasant, positive sensations, and a high level of spirit are all examples of emotional comfort. Physical discomfort is inversely correlated with emotional comfort.

2.8.1.3 Social comfort

According to Baumeister & Leary (1995), Social comfort is a term used to describe a person's sense of community, acceptance, and connection. It entails being comfortable in social situations, having satisfying connections, and being a member of a community that is encouraging.

2.8.1.4 Environmental comfort

According to Ulrich (1991), a setting that encourages environmental comfort fosters harmony and alignment with one's surroundings, improving overall comfort and well-being.

2.9 Challenges of maintenance work of air-conditioning

Classroom air conditioning system neglect, estimated at 30% of a student's time in school (V. De Giuli *et al.*, 2012), poses multifaceted challenges. Poor indoor air quality, caused by neglect, can lead to health issues like allergies and infections, impacting attendance and grades. Malfunctioning systems hinder focus, causing discomfort and reduced academic performance. According to (NIH, 2018), students' motivation and satisfaction decline because of poor indoor air quality, affecting their educational experience. Neglected systems increase energy consumption, elevating utility costs for institutions and potentially affecting student programs and resources, ultimately influencing the quality of learning.

2.10 Impact of poor maintenance work of air-conditioning towards the user comfort

- 1) **Insufficient Cooling:** Insufficiently maintained air conditioning systems may have trouble maintaining a reasonable indoor temperature. Users may encounter hot areas, inconsistent cooling, or inadequate cooling, which can be uncomfortable and lower user satisfaction. (Patel, V. M., *et al.*, 2018)
- 2) **Temperature Fluctuations:** Poor maintenance can cause temperature changes in enclosed spaces. Users could suffer abrupt temperature changes, which makes it challenging to keep a constant and comfortable environment.
- 3) **Reduced Airflow:** The air conditioning system may have less airflow due to clogged or dirty filters, blocked ducts, or broken fans. Inadequate ventilation can result in stagnant or stuffy air, which makes the indoor atmosphere uneasy and less enjoyable.
- 4) **Increased Humidity:** Air conditioning systems that aren't properly maintained may have trouble dehumidifying the air adequately. Users may experience feelings of stickiness and discomfort due to an environment that is overly muggy and uncomfortable.
- 5) **Poor Indoor Air Quality:** Poor maintenance can cause the air conditioning system to fill up with dust, debris, and microbial growth. The indoor environment may be exposed to these toxins, which would reduce the quality of the air there. Due to poor air quality, users may develop allergic reactions, respiratory problems, or discomfort. (Farhan, M. *et al.*, 2016)
- 6) **Increased Noise Levels:** When the air conditioning system is operating, worn-out or improperly maintained parts might generate excessive noise. Increased noise levels can make it difficult to concentrate, disturb sleep, and make users uncomfortable.
- 7) **Higher Energy Consumption:** Inefficiently maintained air conditioning systems tend to use more energy to function adequately. Higher energy costs and a worsening of the environment may result from this. (Fumo, 2019)
- 8) **System Unreliability:** Failure to execute regular maintenance might increase the likelihood of system failures and malfunctions. Unreliable functions can disturb the cooling process, causing users pain and necessitating emergency repairs or replacement, resulting in inconvenience and increased costs. (Othman, A., *et al.*, 2019).

2.11 Ways to maintain air-conditioning.

Air conditioning systems require regular maintenance to provide optimal performance, energy efficiency, and user comfort (Patel *et al.*, 2018; Farhan *et al.*, 2016). Air filters should be cleaned or replaced on a regular basis to prevent clogging and provide proper airflow (Qiu *et al.*, 2021). Regularly cleaning the condenser coils removes dirt and debris, enhancing heat transfer and system performance (Patel *et al.*, 2018). Inspection and cleaning of evaporator coils, on the other hand, improves heat transfer and overall system performance (Yang *et al.*, 2019). Maintaining system performance and preventing water damage by inspecting and clearing the

condensate drain line (Farhan *et al.*, 2016). Regular electrical connection inspection and tightening ensures safe operation and reduces energy waste (Fumo, 2019). Finally, inspecting and calibrating the thermostat ensures precise temperature management for user comfort and energy efficiency (Othman *et al.*, 2019). These maintenance practices reduce malfunctions, enhance indoor air quality, and increase the lifespan of air conditioning systems (Patel *et al.*, 2018; Farhan *et al.*, 2016).

3 Research Methodology

3.1 Research Design

The general framework or structure that directs the collecting and analysis of data in a research study is referred to as research design. It describes the actions, procedures, and methods that will be used to answer the research questions or objectives. Decisions about the sort of study, the sampling strategy, data gathering methods, and data analysis methodologies all fall under the purview of research design. (Cresswell, 2014). This study uses quantitative methods to obtain data from a specific sample group in a quantitative manner. This method is used to investigate and determine the 'what' issues, impact and strategies for air conditioning maintenance.

3.2 Data Collection

A questionnaire can be described as a research instrument comprising a series of inquiries or prompts designed to gather data from a participant. Generally, these consist of a combination of closed-ended and open-ended inquiries. Long form questions provide the participant with the chance to provide further details regarding their thoughts. Sections of the questionnaire questions include respondent background (Section A), recognizing issues faced by user related to maintenance work of air-conditioning at UTHM hall. (Section B), impact of poor maintenance of air-conditioning towards the user comfort. (Section C) and providing ways of maintaining air-conditioning to give comfort to the user of the building (Section D).

3.3 Data Analysis

Following data collection, data analysis is a critical phase in research to meet the study's objectives. The obtained data is processed and analyzed utilizing content analysis tools, which provide important insights and a comprehensive grasp of the topic under investigation. This study's data was gathered through a questionnaire with chosen respondents. The information gathered is then organized and compiled into a table for future examination (Fellows & Liu, 2003).

4 Research Findings and Discussions

This section describes the research findings from the interview questions that were administered to respondents to determine the elements of efficient escalator maintenance and to offer strategies to improve escalator maintenance for the safety of users in the shopping complex building. The study used a qualitative approach and a semi-structured interview tool to collect data. Written notes, audio recordings, and email were used to collect data. The collected data has been analyzed using the content analysis method.

4.1 Respondent background

Table 1 presents the gender composition of the respondents, indicating that male students comprise 54.9% of the sample, while female students comprise 45.1%. Diagram 4.2 illustrates the distribution of respondents according to their year of study. The data reveals that Year 3 students make up the largest proportion at 42.33%, with Year 2 students comprising 24.19%, Year 4 students at 21.86%, and Year 1 students at 11.63%. Regarding the department of FPTP faculty, there are 5 departments involved in this research. The results show out of 215 respondents. It is evident that the largest proportion of respondents are BPC students, comprising 27.44% of the total. This is followed by BPP students at 26.05%, BPA students at 17.67%, BPB and BPD students at 14.42%. Fan and Yan (2010) determined through a meta-analysis that the mean response rate for online surveys was approximately 32%, with substantial variability contingent upon the particular attributes of the study.

Table 1 Respondent's Background

No.	Respondent	%
1.	Gender:	
	1.Male	54.9
	2.Female	45.1

		Total = 100
2.	Year of study:	
	1.Year 1	11.63
	2.Year 2	24.19
	3.Year 3	42.33
	4.Year 4	21.86
		Total =100
3.	Programmed of study/ Course:	
	1. BPA	17.67
	2. BPB	14.42
	3. BPC	27.44
	4. BPD	14.42
	5. BPP	26.05
		Total=100

4.2 The Issue Face by User Related to Maintenance Work of Air- Conditioning at UTHM Lecture Hall

Table 2 Responses from respondent for the issue face by user related to maintenance work of air-conditioning at UTHM hall

No.	The issue face by user related to maintenance work of air-conditioning at UTHM hall	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Rank
				Percentage (%)				
1.	Lower Cooling Efficiency	0.9	0.9	28.9	54.0	15.3	3.82	4
2.	Temperature control inconsistent	0.5	9.8	30.7	59.1	0	3.50	9
3.	Air Quality issues	0.5	0.9	42.8	23.7	32.1	3.86	3
4.	Noise Level Have Increased	0.5	1.4	32.6	53.5	12.1	3.75	5
5.	Noxious Odors	0.9	0.5	51.6	20.9	26.0	3.71	6
6.	Discomfort	0.5	10.2	27.4	44.2	17.7	3.68	7
7.	Productivity Loss	0.9	0.5	42.3	20.5	35.8	3.90	2
8.	Inefficient Learning	0.5	36.3	34.9	28.4	0	3.91	1
9.	Dissatisfactions Among Users	0.5	16.3	16.3	53.5	13.5	3.63	8
10.	Lack Availability of Class	0.5	39.1	30.2	30.2	0	3.90	2

According to Table 2 Inefficient learning was ranked as a top issue faced by users related to maintenance work of air-conditioning in UTHM lecture hall with the higher interpretation with 3.91. The overall classroom environment can impact student learning, so a conducive classroom may be able to provide the proper conditions for students to learn (Kamaruzzaman, 2017). Productivity loss and lack availability of class was ranked 2 with the mean 3.90. According to (Chao,2020). Students' development and growth are the primary reasons why classroom comfort level satisfaction must be assessed. Air quality issues were ranked in 3 with the mean 3.86. According to the (UBBL,1984). The specifications for ventilation and lighting as stipulated in Clause 39(3), natural lighting and ventilation in the classroom must be achieved through the installation of one or more windows. These windows should cover a minimum of 20% of the clear floor area of the room. Additionally, the

openings in the windows should permit unobstructed airflow for no less than 10% of the floor area. Lower cooling efficiency was ranked in 4 with the mean value 3.82. As per the Malaysian Meteorological Department's classification (Jamaluddin, 2020), Malaysia has an equatorial or tropical maritime climate characterized by year-round high temperatures and humidity. Noise level have increased was ranked 5 with a mean value of 3.75. Noxious odors were ranked in 6 with the mean value 3.71. Discomfort was ranked 7 with a mean value of 3.68. Appropriate levels of efficiency and comfort in educational facilities may boost the concentration and productivity of students throughout the teaching and learning process. (Wong, 2018). Dissatisfaction among users was ranked 8 with the mean value 3.63. According to (Khalil, 2018). The Post Occupancy Evaluation POE comprises occupant satisfaction ratings that evaluate the performance of a structure. Temperature control inconsistent was ranked in 9 with the mean value 3.50.

4.3 The impact of poor maintenance work of air-conditioning towards the user comfort

Table 3 *The impact of poor maintenance work of air-conditioning towards user comfort*

No.	The impact of poor maintenance work of air-conditioning towards the user comfort	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Rank
		Percentage (%)						
1.	Induce excessive heat or coldness in the atmosphere.	0.5	11.6	32.6	39.5	15.8	3.59	10
2.	Unease and interruption	0.5	0	30.2	56.3	13.0	3.81	6
3.	The ambient noise contributes to noise pollution	0.5	0.9	42.8	23.7	32.1	3.86	5
4.	Allergic responses are caused by airborne dust and fungus	0.9	0.5	38.1	44.37	15.8	3.74	7
5.	Noxious odors	0.5	0.9	32.1	38.6	27.9	3.93	3
6.	Health Issues	0.9	14.4	1.9	47.0	35.8	4.02	1
7.	Increased the number of absences	0.5	1.4	31.2	40.5	26.5	3.91	4
8.	Experience heat intolerance	0.9	0.9	39.1	43.7	25.3	3.72	8
9.	Decreased Focus	0.5	11.6	32.1	31.6	24.2	3.67	9
10.	Exam Results are Poor	0.9	1.9	25.6	42.3	29.3	3.97	2

According to Table 3 health issues were ranked as a top impact of poor maintenance work of air-conditioning towards the user comfort with the mean value of 4.02. According to (Turunen, 2016). Classroom cleanliness must be enhanced, as dust is one of the factors that negatively impact the health of students. The exam results are poor and was ranked in 2 with the mean value 3.97. As stated by (David,2017), the physical environment of a classroom has the potential to impact student achievement and enhance student performance. Noxious odors were ranked in 3 with the mean value 3.93. Increased the number of absences was ranked at 4 with the mean

value 3.91. The ambient noise contributes to noise pollution was ranked in 5 with the mean value of 3.86. Unease and interruption were ranked in 6 with the mean value of 3.81. The country experienced an increase in average temperature to 27 degrees Celsius in 2017 because of the El Niño Southern Oscillation Index (ENSO), which elevated the national mean temperature beyond its typical range. The increasing mean temperature has the potential to impact the comfort of students throughout the instructional and learning phases. (Bae,2020). Allergic responses are caused by airborne dust and fungus was ranked 7 with the mean value of 3.74. According to (Smith *et al.*, 1997) Asthma and respiratory infections are factors that contribute to increased absenteeism. Experience heat intolerance was ranked in 8 with the mean value of 3.72. According to (Y.Sun *et al.*, 2016) Students may be prompted to utilise their air conditioning (AC) when the indoor environment fails to meet their specific temperature preferences. Decreased focus was ranked in 9 with the mean value of 3.67. According to (Chao, 2020). Students' development and growth are the primary reasons why classroom comfort level satisfaction must be assessed. Induced excessive heat or coldness in the atmosphere was ranked in 10 with the mean value of 3.59.

4.4 Ways of Maintaining Air-Conditioning to Give Comfort to the User of the Building

Table 4 *Ways of maintaining Air-Conditioning to give comfort to the user of the building*

No.	ways of maintaining air-conditioning to give comfort to the user of the building	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Rank
		Percentage, (%)						
1.	Ongoing Maintenance	0.5	14.0	27.0	32.6	26.0	3.70	9
2.	Zoning for Temperature Control	0.5	0.5	29.3	54.0	15.8	3.84	7
3.	HVAC Systems that Use Less Energy	0	11.6	16.7	40.0	31.6	3.92	6
4.	Thermostats With Wifi	0	0	48.8	35.8	15.3	3.67	11
5.	Ventilation Enhancement	0	0	43.3	44.2	12.6	3.69	10
6.	Sealing and Insulation	0	0.5	15.8	46.0	37.7	4.21	3
7.	Window Covering	0	16.3	27.9	53.0	2.8	3.42	15
8.	Automation Of HVAC System	0.5	0	15.3	60.9	23.3	4.10	4
9.	Filter Replacement on A Regular Basis	0	0	15.3	42.3	42.3	4.23	2
10.	Education for Users	0	0.5	55.3	29.3	14.9	3.59	13
11.	Occupancy Detectors	0	11.6	2.3	57.7	28.4	4.03	5
12.	Audits of Energy Consumption	0	37.7	17.7	4.7	40.0	3.47	14
13.	Mechanism of Reaction	0	0.9	46.5	38.6	14.0	3.66	12
14.	Initiatives for	0	0.9	1.9	48.4	48.8	4.45	1

	The environment							
15.	Budget Distribution	0	0	27.0	70.32	2.8	3.76	8
16.	Collaboration with Subject Matter Experts	0	0.9	22.8	59.5	16.74.9	3.92	6

According to Table 4 Initiative for the environment was ranked as a top of ways of maintaining air-conditioning to give comfort to the user of the building with the mean value of 4.45. Filter Replacement on a Regular Basis was ranked 2 with the mean value of 4.23. According to (Sharpe,2019). The evaluation, inspection, maintenance, and repair processes all of which are associated with indoor environmental factors that can be significant for all buildings determine the performance success of a structure. Sealing and insulation was ranked in 3 with the mean value of 4.21. Automation of HVAC system was ranked in 4 with the mean value of 4.10. According to (ASHRAE,2001). An airflow monitoring station was installed in the exterior air duct of an airside economizer. This station comprised a series of velocity pressure pick-up tubes, which were capable of supplying reasonably precise data for the BAS to calculate air volume. Occupancy detectors were ranked in 5 with the mean value of 4.03. By leveraging occupancy detection and monitoring networks' current and historical data, buildings have the ability to forecast occupancy profiles and subsequently adapt their heating, ventilation, and air conditioning (HVAC) operations. (W. Shen *et al.*, 2017). Collaboration with subject matter experts was ranked in 6 with the mean value of 3.92. Zoning for temperature control was ranked 7 with the mean value of 3.8. In order to predict the optimal set points of the HVAC system during transient load and to solve the minimization problem of energy cost for each considered control strategy, MATLAB®-implemented optimization procedures utilizing genetic algorithms (M. Zaheer, 1994) will be utilized (S. Wang *et al.*, 2000). Ongoing maintenance was ranked in 9 with the mean value of 3.70. Air conditioning performance will inevitably deteriorate as energy consumption rises in tandem with neglected maintenance (Energy.gov, 2016). Ventilation enhancement was ranked in 10 with a mean value of 3.69. According to (P. Valdiserri *et al.*, 2017) Energy retrofitting of HVAC systems is critical due to its potential to significantly decrease energy consumption. According to (Thomas,2006) Smart WiFi thermostats synchronise set point schedules, measured temperature and humidity, and heating/cooling status with the cloud. This enables further processing and facilitates communication between the thermostats and the cloud, as well as the archival of individual residence thermostat data. Mechanism of reaction was ranked in 12 with the mean value of 3.66. Education for users was ranked 13 with the mean value of 3.59. Audits of energy consumption were ranked in 14 with mean value of 3.47. Window covering was ranked 15 with the mean value of 3.42.

5. Conclusion

To conclude, effective escalator maintenance in a shopping complex building is crucial for various reasons. Visitors are protected by frequent maintenance, which reduces the danger of accidents and injuries. Due to careful maintenance, escalators run smoothly and safely, making the complex safer and easier to navigate. This improves the shopping experience, highlighting the need of well-executed maintenance procedures in ensuring user safety, contentment, and escalator system operation in busy shopping environments. Additionally, proper maintenance minimizes escalator downtime, avoiding inconvenience and disruptions for shoppers. It also helps in extending the lifespan of escalators and reducing long-term repair costs. Furthermore, well-maintained escalators project a positive image of the shopping complex, instilling confidence and trust among customers. Overall, effective escalator maintenance plays a crucial role in ensuring customer satisfaction, safety, and the overall success of the shopping complex building.

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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:** Mohammad Fateh Hisham, Norliana Sarpin, Norddin Ismayatim; **data collection:** Mohammad Fateh Hisham; **analysis and**

interpretation of results: Mohammad Fateh Hisham; **draft manuscript preparation:** Mohammad Fateh Hisham, Norliana Sarpin, Roshartini Omar, Sulzakimin Mohamed, Nor Hazlin Md Gharip. All authors reviewed the results and approved the final version of the manuscript.

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