

An Evaluating Facility Management Maintenance Strategies of Laboratory Building at UTHM, Pagoh in Comparison with the ISO 41001:2018 Standard

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Abstract

This study evaluates the facility management (FM) maintenance practices strategies of laboratory building at Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh Campus. The research aims to identify the effectiveness, consistency, and adequacy of current maintenance management, evaluate the building's operational performance in terms of functionality, responsiveness, safety, and sustainability, and propose strategies for improvement. The study was conducted using a quantitative approach through structured questionnaires distributed to UTHM students, laboratory technicians and Sime Darby Property Facility Management staff. A total of 52 respondents participated, representing key personnel directly involved in maintenance and facility operations. Data were analyzed using the Statistical Package for the Social Sciences (SPSS) to obtain demographic analysis, descriptive statistics, including means, frequencies, and standard deviations, and to test reliability using Cronbach's Alpha. The findings revealed that while existing maintenance practices are functional, challenges remain in preventive maintenance scheduling, communication, and the integration of technology-based facility management systems. The study concludes that adopting data-driven and preventive maintenance strategies can significantly improve efficiency, sustainability, and user satisfaction. The findings provide valuable insights for UTHM facility managers and contribute to the broader discourse on improving FM practices in higher education laboratory environments.

1. Introduction

The effective operation, maintenance and improvement of educational facility buildings is essential in supporting the health and productivity of the building's occupants, and facility management fulfils this role. UTHM, Pagoh, the laboratory building, serves as a central piece of infrastructure for research and innovation in the academic enterprise. Facility management practices including the operation of the building and planned or cyclical maintenance routines and additionally the performance assessment of the building is very important to ensure safety, function and sustainability. Affordable laboratory buildings are inherently complex, with challenges associated with options for customization and strict operational requirements on regulatory compliance [4].

The issue that this thesis confronts originates from ongoing issues in facility management that continue to impact the performance and utility of laboratory buildings, specifically at UTHM, Pagoh. The need for FM processes continues to grow in importance among academic institutions in order to improve the safe, efficient, and sustainable operation of facilities. However, Malaysian institutions including UTHM are impacted by barriers such as funding, skilled labour, aging facilities, and a lack of proactive technology implementation into maintenance and operations [6]. These barriers have resulted in deferred maintenance, safety issues, and reduced occupant satisfaction in specialty environments such as laboratories that need to adhere to regulations and environmental parameters [6].

Laboratory buildings must be properly maintained continuously and effectively in order to be safe, functional, and sustainable. Nevertheless, there is a paucity of empirical studies that assess the efficacy and sufficiency of FM operations in college laboratory buildings, specifically at UTHM Pagoh Campus. The current research tends to utilize general building maintenance, whereas less attention is paid to operational performance applicable to the laboratory [7]. This is the gap that shows the necessity of an organized evaluation of existing maintenance practices and their effect on building performance. Without such assessment, the maintenance inefficiencies might remain, which could impact such aspects as safety, equipment behavior, and satisfaction among users [5].

The research aimed to identify the effectiveness, consistency, and adequacy of current maintenance management, evaluate the building's operational performance in terms of functionality, responsiveness, safety, and sustainability, and propose strategies for improvement. The data was collected through questionnaire survey. The data collected will be analyzed using SPSS to produce demographic, reliability test (Cronbach's Alpha) and descriptive. In adopting a methodical approach to data collection, data obtained remains reliable, valid and systemically interpretable.

2. Methodology

The research was done through a systematic research process that was initiated by initial research that led to the development of the background, objectives, and scope of the research. The main problems associated with FM in building maintenance in laboratories were ascertained during this phase. The topical literature sources were analysed, such as journals, articles, websites, and past studies to provide an excellent theoretical background and help with research framework development. Structured questionnaires were then used to collect data by administering them to the selected respondents who comprised of students, laboratory technicians and Sime Darby Property staff at UTHM Pagoh Campus. The data collected was summarised and analysed with the help of relevant data analysis methods. The analysis of data was aimed at the assessment of maintenance practices and building performance according to the predetermined criteria. The primary form of analysis used in interpreting the data, defining patterns, and evaluating trends was the descriptive statistical analysis to understand the maintenance effectiveness, responsiveness, and safety and user satisfaction. Interpretation of findings was the last phase of the research process to answer the research objectives and give recommendations on the area of improvement of facility management practice in terms of maintenance.

2.1 Sample Size and Selection

The respondents in this study included 52 participants that included students, laboratory technicians of UTHM, Pagoh Campus and facility management staff of Sime Darby Property that are directly engaged in laboratory uses, laboratory maintenance and laboratory operations. The data were to be reliable and relevant, and thus respondents were chosen using competency and experience coupled with their active participation in the processes of facility management. The sample size was calculated based on the recommendations put forward by Krejcie and Morgan (1970), adequate representation of the population of the study, and statistically significant findings were achieved [2]. Purposive sampling was also applied to reach individuals who have direct assignments in the management and maintenance of laboratory infrastructure since they would be in a good position to give the relevant information to be used in the study.

2.2 Questionnaires Survey

The researcher will resort to using a questionnaire survey via Google Form because it is feasible and a considerable amount of data can be obtained from a lot of people within a short period. The data obtained from these questionnaires can easily be quantified. Quantification can either be done by a researcher or using a computer package. These methods allow data to be processed in a 'more scientific' way compared to other methods used in research. The researcher will make use of researcher-developed instruments to collect data. Refer to Table 1, the questionnaires will comprise four sections A, B, C and D.

Table 1 Four sections of the questionnaires

Sections	Items
Section A	Demographic Information
Section B	The Current Maintenance Management in JTKA Laboratory
Section C	Evaluate the Buildings Operational Performance
Section D	Strategies for Improvement in JTKA Laboratory Buildings

3. Results and Discussion

The results and discussion address the research questions by evaluating current maintenance management practices, laboratory operational performance, and potential improvements based on user feedback. Data were analyzed using SPSS, including demographic, reliability, and descriptive analyses to assess maintenance practices, operational performance, and recommended improvement strategies.

3.1 Demographic Analysis

Demographic analysis is the statistical analysis of the background features of respondents in a particular study. It is employed to define the respondents and give some background on how the research findings can be interpreted. The variables usually involved in the demographic analysis in research pertain to gender, age, occupation, experience, frequency of participation or other pertinent personal or professional attributes. Frequency counts, percentages and descriptive summaries are normally used in carrying out the analysis.

Table 2 *Demographic Analysis*

Part	Items	Frequency (f)	Percent (%)
Gender	Male	26	50.0
	Female	26	50.0
Age	25-34 years	15	28.8
	35-44 years	16	30.8
	45-54 years	9	17.3
	55 years and above	2	3.8
	Below 25 years	10	19.2
Employment Category	Facility Management Personnel	9	17.3
	Maintenance Staff	19	36.5
	Technical / Laboratory Staff	15	28.8
	UTHM Student	9	17.3
Duration / Experience	1-3 years	11	21.2
	4-6 years	12	23.1
	7-10 years	17	32.7
	Less than 1 year	6	11.5
	More than 10 years	6	11.5
Laboratory Use or Engagement	Daily	10	19.2
	Monthly	11	21.2
	Rarely	11	21.2
	Weekly	20	38.5
Involvement in Maintenance	Directly responsible	4	7.7
	Frequently involved	21	40.4
	Not involved	9	17.3
	Occasionally involved	18	34.6
Awareness of ISO	Fully knowledgeable/ trained	6	11.5

41001:2018 Standard		
Not aware	9	17.3
Slightly aware	20	38.5
Very aware	17	32.7

Table 2, the demographic analysis of the 52 participants of the current study reveals that there is a balance in gender as 50 percent are male and 50 percent are female. A majority of the respondents were in the age group of 25 -44 years (59.6%), with smaller percentages below 25 years (19.2) and 45 years and older (21.1). On the type of employment, there were mostly maintenance staff (36.5%), technical/laboratory staff (28.8%), facility management personnel (17.3%), and UTHM students (17.3%). The respondents had a mix of experience in laboratory-related work and the majority (55.8) had between 4 and 10 years of experience, and others (32.7) had less than 4 years of experience and (11.5) had more than 10 years of experience. Regarding the laboratory participation, 38.5 percent utilized the laboratories on a weekly basis, 21.2 percent on monthly basis, 21.2 percent on rare basis, and 19.2 percent on a daily basis. In the maintenance activities, 40.4 were always involved, 34.6 were sometimes involved, 17.3% were never involved, and 7.7% were directly responsible. There was knowledge of MS ISO 41001:2018 with a very aware, slightly aware, not aware, and fully knowledgeable or trained of 32.7, 38.5, 17.3, and 11.5 percent respectively. Altogether, this distribution represents the heterogeneous sample in terms of demographics, experience, engagement, and the ISO awareness that gives the general idea about the practices of laboratory facility management.

3.2 Reliability (Cronbach's Alpha)

Reliability refers to the consistency of a measuring device and its ability to measure what it is intended to. This study utilized Cronbach's Alpha to measure the degree of internal consistency among the items in the questionnaire.

Table 3 Cronbach's Alpha for three sections, B, C and D

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
0.87	0.87	35

As shown in Table 3, the combined construct comprising Sections B, C, and D demonstrates strong reliability in assessing overall building operational performance. The Cronbach's Alpha value of 0.87 for both standard and standardized items indicate excellent internal consistency among the 35 items, confirming that the sections collectively measure the same underlying construct. Cronbach's Alpha values above 0.80 are considered good to excellent, and the identical results for both versions suggest the absence of scaling issues, supporting the robustness of the measurement.

3.3 Descriptive Analysis

A descriptive analysis presents the overall characteristics of a dataset. It describes average characteristics of average or the middle and measures the average degree of difference or variability between observations or groups, as well as how the overall data is spread out.

Table 4 Mean and Standard Deviation descriptive analysis

Section	Mean	Standard Deviation
The Current Maintenance Management in JTKA Laboratory	3.142	0.673
Functionality	3.142	0.683
Responsiveness	3.196	0.722
Safety and Sustainability	3.250	0.674
Strategies for Improvement in JTKA Laboratory Buildings	3.177	0.577

Table 4 presents the mean descriptive analysis for the evaluation of JTKA Laboratory facilities by 52 respondents using a Likert scale [3]. All constructs recorded mean values between 3.14 and 3.25, indicating neutral to slightly positive perceptions of current performance and improvement potential, with moderate

response variability reflected by standard deviations ranging from 0.57 to 0.72. Safety and sustainability achieved the highest mean (3.25), suggesting perceived strengths in this area, while satisfaction with maintenance management and functional adequacy shared the lowest mean (3.14) with wide response variation. The lower standard deviation for strategies for improvement indicates greater consensus among respondents compared to responsiveness.

3.4 Comparison of Research Findings with MS ISO 41001:2018 Standard

This part compares the research results with the requirements of MS ISO 41001:2018 facility management systems to assess the correspondence of the existing laboratory management practices with the principles of the standard related to the functionality, responsiveness, and safety and sustainability. The study compares the descriptive analysis against the applicable ISO 41001: 2018 clauses and defines the areas of compliance, partial compliance, and condition to improve as the foundation of the proposals to improve the effectiveness and the efficiency of managing the laboratory facilities [1].

Table 5 Comparison between of research findings and MS ISO 41001:2018 Standard

Research Construct	Mean Score	Level	Relevant ISO 41001:2018 Clause	Compliance Level	Comparison
Current Maintenance Management	3.14	Moderate	Clause 8: Operation	Partially aligned	Maintenance practices show partial compliance, requiring more systematic operational control and planning.
Functionality	3.14	Moderate	Clause 8.2: Outsourcing & Service Delivery	Partially aligned	Facilities meet basic operational needs but require improvement to enhance service efficiency
Responsiveness	3.19	Moderate	Clause 8.3: Risk Management	Partially aligned	Service responsiveness is moderate, indicating a need for more proactive risk management and timely response.
Safety and Sustainability	3.25	Moderate	Clause 6: Planning; Clause 6.2; Clause 10: Improvement	Partially aligned	Practices require further enhancement to support planning, sustainability, and continuous improvement.

4. Recommendation

Following the results of this paper and the comparison with the MS ISO 41001:2018 and MS ISO 55001:2014, a number of suggestions are made that could be used to improve the effectiveness, efficiency, and sustainability of facility management and maintenance practices in the JTKA laboratory buildings at UTHM Pagoh. These recommendations aim at reinforcing the preventive maintenance planning by using a structured and well documented programmers' that involves scheduled inspection, routine servicing, calibration, and planned replacement of critical or ageing assets prioritized based on the criticality of the asset and its usage as a way of minimizing downtimes and the need to engineer corrective maintenance. It is also advisable that the Reliability-Centred Maintenance (RCM) be applied on critical laboratory systems to enhance reliability, safety, and cost efficiency by harmonizing the maintenance activities with the functions of the asset, failure modes, and risk associated with them. Also, the incorporation of digital facilities management system like CAFM, BIM or asset management software is promoted to facilitate real time maintenance tracking, automated work order, proper documentation, and data-driven decision making in accordance with ISO requirements.

A formal framework must be adopted to improve asset management practices that meet the requirements of MS ISO 55001:2014, which includes a formal asset register, a periodic condition assessment, a lifecycle costing approach, and risk-based prioritization of maintenance in order to enhance long-term sustainability. Moreover, better communication and coordination between facility management teams, laboratory technicians, academic users, and external service providers are to be created with effective SOPs, formal reporting lines, and feedback provisions to promote service responsiveness and transparency. The facility management standards,

equipment handling and safety procedures constant training and awareness programmers' must be encouraged in order to achieve compliance, minimize operational risks and proactive maintenance culture. Lastly, more attention should be given to sustainability and continuous improvement through the adoption of energy saving systems, environmentally friendly practices of maintenance, and regular performance evaluation based on KPIs, audits, and management review to make sure that laboratory facilities will be safe, efficient and flexible to the future academic and technological demands.

5. Conclusion

This study achieved the FM strategies of maintenance in the laboratory buildings of UTHM, Pagoh Campus, against MS ISO 41001: 2018 and MS ISO 55001: 2014. The performance in operational, in terms of adequate functionality, safety, and appropriateness in teaching and research, was moderate-to-good though gaps were identified in the sustainability practices, energy efficiency, systematic environmental monitoring, long-term asset planning, and technology-based FM tools. They were compared to ISO standards, which showed partial compliance: FM practices are partly in line with the ISO 41001 requirements of operational control and service delivery but the key components are not leadership commitment, structured planning, risk-based thinking, and continuous improvement mechanisms, and asset management practices are informal with limited lifecycle management, asset tracking, and risk-based prioritization. Comprehensively, the laboratory FM at UTHM Pagoh is operationally competent but still reactive and not proactive. The preventive maintenance plans must be strengthened, integrated with digital FM and maintenance and asset management processes enhanced to be more aligned with ISO 41001 and ISO 55001 to be able to have sustainable, efficient, and compliant operations. The results obtained will be of great value to the UTHM facility managers and can be applied to the overall knowledge of effective FM within higher education laboratory settings.

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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 methods were carried out by Nur Intan Balqis Binti Roslizuri and Mohd Fahmi Bin Abdul Rahman. Data collection was performed by UTHM lab technicians and Sime Darby Property staff. Analysis and interpretation of results were conducted by Nur Intan Balqis Binti Roslizuri and Mohd Fahmi Bin Abdul Rahman. The draft manuscript prepared by Nur Intan Balqis Binti Roslizuri. All authors reviewed the results and approved the final version of the manuscript.

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