PAPER • OPEN ACCESS

A Factor Analysis to Establish a Group of Causes of Deferred Maintenance at Malaysia's Public University Buildings

To cite this article: M N Yasin *et al* 2022 *IOP Conf. Ser.: Earth Environ. Sci.* **1022** 012019

View the article online for updates and enhancements.

You may also like

- Web-based Factors Affecting Online Purchasing Behaviour
Mohd Shoki Md Ariff, Ng Sze Yan, Norhayati Zakuan et al.
- Sustainable practices barriers towards green projects in Malaysia
M Klufallah, I S Ibrahim and F Moayedi
- An empirical study on the determinants of retirement savings attitude in Malaysia!
N S M Shariff and N A M Isah

ECS Toyota Young Investigator Fellowship

For young professionals and scholars pursuing research in batteries, fuel cells and hydrogen, and future sustainable technologies.

At least one $50,000 fellowship is available annually.
More than $1.4 million awarded since 2015!

Application deadline: January 31, 2023

Learn more. Apply today!

This content was downloaded from IP address 161.139.222.42 on 15/01/2023 at 01:44

A Factor Analysis to Establish a Group of Causes of Deferred Maintenance at Malaysia's Public University Buildings

M N Yasin[1*], R Mohamad Zin[2], Mairizal[2,3], S Nagapan[1], M A Zakaria[1] , N Wahi[4] , A H Abdul Tharim[5] and M F Hasmori[1]

[1] Faculty of Civil Engineering & Built Environment, Universiti Tun Hussein Onn Malaysia, Parit Raja, Johor, 86400, MALAYSIA
[2] Universiti Teknologi Malaysia, Johor Bahru, Johor, 83000, MALAYSIA
[3] Universitas Pamulang, Banten, 15417, INDONESIA
[4]Universiti Teknologi Mara, Kota Samarahan, Sarawak, 94300, MALAYSIA
[4]Universiti Teknologi Mara (Perak), Seri Iskandar, Perak, 31750, MALAYSIA
*Corresponding author: *norazam@uthm.edu.my

Abstract. The building has deferred the maintenance activities either planned or scheduled and delayed from the original schedules by some factors and therefore cause dissatisfaction of the building users commonly become a familiar issue. The public university buildings are an important place, everyone gathers to learn and share knowledge. They are producing future leaders, engineers and industry players. Therefore, it is also the heart of the development of a country. Hence, this study is intended to establish a group of causes factors of deferred maintenance of public university buildings in Malaysia. Questionnaires survey were carried out amongst the targeted respondent and the Statistical Package for the Social Sciences **(**SPSS) software were used to analyse 220 data collections for factor analysis. The study reveals 42 factors of causes are then classified into three groups. Group 1 is the organization and it displays 20 factors, group 2 is the resources which display 13 factors and group 3 is financial display 9 factors. This study shared useful information and insight knowledge of deferred maintenance of public university buildings in Malaysia.

1. Introduction

Deferred maintenance of buildings is a maintenance and repair work that has not been carried out, which is deferred from the original planning by unavoidable factors and may dissatisfaction of the building users [1]. In addition, deferred maintenance has also been described as maintenance deficits unfinanced on a scheduled or unforeseen basis at the end of the fiscal year and postponed into or adjourning to a future budgetary period before funding is available [2]. Deferred maintenance is an error, which comes from a combination of life cycle changes to the buildings and system that reach end-of-life, and required improvement of physical condition. Therefore, the maintenance of the building is important to ensure the building's sustained peak performance during its design life to a practicable degree [3-4]. Building maintenance has great demands and has no exception in various areas, especially the education sector [5]. There are 20 public universities in Malaysia listed by the Ministry of Higher Education Malaysia with exploration and knowledge generation, as well as teaching and research activities that offer a bachelor degree, master degree and doctoral degrees in various fields of studies [6]. Thus, university building requires maintenance work to provide a valuable environment that supports and stimulates teaching, learning, innovation, research and other various academic purposes. A well-maintained

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

building in the university is essential for achieving the core function of the institution. Otherwise, it will interfere with the comfort and productivity of the university and in the end, the quality of production will plummet. The purpose of this study is to conduct a factor analysis for established a group of causes factors of deferred maintenance at public university buildings in Malaysia. This study use; Statistical Package for the Social Sciences **(S**PSS) software were used to conduct the factor analysis.

2. Causes of deferred maintenance for a public university in Malaysia

A systematic literature review to discover the causes of deferred maintenance was carried out rigorously and were extracted from journal papers related to deferred maintenance and were published between 2004- 2020 in different countries including Malaysia, which can provide a good source of data for the study [1]. Therefore, the causes of deferred maintenance are included in the table summary as shown in table 1. The causes of deferred maintenance in Malaysia's public university buildings can be grouped into several related groups. The buildings and their components not only consist of increasingly complex technical systems with interconnected parts or elements but at the same time, the issues such as financial, resources, regulation and organizational constraints greatly affect the maintenance activities [7-8]. To create a balanced plan to meet the goals and objectives, important matters such as financial, resources and organisation should be considered.

Table 1. Causes of deferred maintenance

No	Causes	Authors
1	Limited budget/ Lack of funds	[1], [9], [10], [11]
2	Unrealistic financial planning and management	[1], [9], [12], [13]
3	Poor/ lack of management	[1], [9], [14], [15]
4	Lack of knowledge	[1], [9], [14], [15]
5	Ineffective planning	[1], [9], [10], [15]
6	Lack of emphasis on training	[1], [15], [16], [17]
7	Unavailability skills in maintenance personnel	[1], [13], [16], [17]
8	Lack of understanding of the importance of maintenance	[1], [15], [16], [17]
9	Lack of sustainable policies, goals & objectives	[1], [15], [16], [17]
10	Political interference	[1], [10], [15], [18]
11	Neglect towards the importance of maintenance	[1], [4], [9], [14]
12	Lack of expertise	[1], [9], [15]
13	Lack of communication	[1], [11], [14]
14	Incorrect prioritization/ little priority on maintenance	[1], [16]
15	Unforeseen expenses	[4], [9]
16	Building age	[1], [4], [9]
17	Misunderstood needs assessment methodologies and tools	[4], [19]
18	Lack of performance indicators measure	[4], [9], [19]
19	Lack of quality and qualified professional/ maintenance managers	[1], [9], [12], [16]
20	Lack of maintenance culture	[4], [9], [19]

Table 1 (continued). Causes of deferred maintenance

No	Causes	Authors
21	Poor attitude of the maintenance team	[1], [9], [12], [16]
22	Low priority on maintenance financial planning and capital budgeting	[1, [9], [19], [20]
23	Difficult to maintain because of poor designs of buildings	[1], [9], [20]
24	Budgetary restriction on maintenance expenditure	[1], [9]
25	Inadequate management policies and practices	[1], [4]
26	Chronic resource shortage	[19]
27	No linkages between strategic and operational planning in a piecemeal approach for capital planning	[1], [19]
28	Poor of ethics	[1]
29	Ambiguous contract	[1], [4]
30	Information and Communication technology	[13]
31	Absence of regulations/ legislations/ procedure/ standard practice/ guideline/ manual	[9], [13], [16]
32	Lack of commitment	[1], [13]
33	Lack of human resources	[1], [4], [13]
34	Lack of financial control	[1], [4], [9], [16]
35	Unstable organizational structure	[1], [13], [16]
36	Lack of awareness among the maintenance staff	[16], [20]
37	Unqualified, ill-trained and unprofessional personnel	[1, [4], [16]
38	Lack of resources	[4], [16]
39	Administration system faults	[16]
40	Lack of training and continuing education inefficient	[1], [4], [13]
41	Absence of a planned maintenance programme	[1], [9], [15], [16]
42	Complexity of design	[1], [4], [11]
43	Poor strategies for maintaining	[1], [4], [9], [13]
44	The lackadaisical attitude of senior management staff	[1], [4], [13]
45	Making work not enjoyable	[12, [13]
46	No teamwork spirit	[1], [13]
47	Inaccurate of the procurement selection	[1], [9]
48	Malpractice in the financial management	[4], [15], [17]

Table 1 (continued). Causes of deferred maintenance

No	Causes	Authors
49	Understaff of maintenance	[1], [4], [11]
50	Incorrect estimation	[1], [4], [9], [20]
51	Financial crisis	[9], [12]
52	Improper documentation	[1], [4], [12]
53	Dispute and natural disaster	[1], [12]
54	Lack of technical analysis	[1], [9], [15], [16]
55	Lack of decision making	[1], [4]
56	Lack of accountability for Stewardship	[4], [15], [17], [19]
57	The efficiency of cost estimation	[1]
58	The integrity of the personnel	[1]

3. Methodology

The target respondents were selected based on their expertise on the subject matter of the study and this involved the maintenance department of public universities in Malaysia including the engineers and assistant engineers (civil, mechanical and electrical). The structured questionnaire survey form has been used as a quantitative tool for the collection of data. Based on the maintenance organization of twenty public universities in Malaysia the total number of 519 target population size (N) and the sample size (S) is 220 respondents for this study by using the table of determining sample size from [21]. The factor analysis approach is usually used for multivariate and widely applied statistical techniques in social science for data/ factors reduction to a smaller number of principal components [22]. There is a three-stage factor analysis procedure involved.

Stage 1, is to identify correlations between factors. Factor analysis was performed on the assumption that all factors were correlated with each other and that the correlation strengths between items were different from each other. Therefore, factor analysis is a technique of data reduction in which it minimises items that overlap with each other. For example, items that have a high correlation with component 1 that also have high correlations with component 2 and component 3 will be removed. This means that only items that have a high correlation with one specific component will be retained.

Stage 2 is the extraction of factors. The first step in this procedure is to choose a combination of factors that are highly correlated with each other, which contributes most of the variance to the overall change in the factors. Factor analysis will be carried out on other items, by choosing a combination of factors that are second high correlated with each other. This procedure is continued until all factors are obtained.

Lastly, Stage 3 is the rotation of factors. Because the structure of the factors produced so far is unclear and difficult to decipher. The procedure of rotating these factors is then implemented to obtain the factors that are easier to understand. The rotation was performed to obtain a clearer picture and this did not change the quality and quantity of the factors in the factor analysis. To perform the rotation of factors using the SPSS program Varimax rotation operation is usually used. The items that meet the minimum requirements will be placed in each factor in the Rotated Component Matrix table and any overlapping items must be removed from the group. Therefore, at the end of factor analysis comes the table of groups with their respective factors. Other than that, considering Bartlett's Test of Sphericity and Kaiser-Meyer- Olkin Measure of sampling adequacy (KMO) provide the minimum standard adequacy of samples factor analysis and it checks if there is a redundancy between factors that can be summarised with some factors. According to [23], the significant results of the test, where is p-value (Sig.) <0.05 indicates that the correlation between factors is adequate. The Kaiser- Meyer- Olkin Measure of sampling adequacy (KMO) test exhibits multicollinearity, if the same correlation value exists between two or more factors, the causes measure the same aspect. The Kaiser-Meyer-Olkin is the measure of sampling adequacy, which varies between 0 and 1. Factor analysis is appropriate if the value of KMO is greater than 0.50 [23].

4. Factor analysis

The data collected from the survey of respondents were included in the SPSS data editor with maximum iterations for convergence is 50 and an absolute value below 0.40 under the coefficient display or format. From table 2 below, the KMO value in this study was 0.90, which is greater than 0.5, indicating that the data has no serious multicollinearity problem, and at the same time indicating that the factors of causes are appropriate to run the factor analysis. Bartlett's Test of Sphericity is used to identify whether the correlation between the factors of causes is sufficient to perform the factor analysis. In this study, the test results are significant, where is $p < 0.05$ indicates that the correlation between factors of causes is valid and adequate for factor analysis.

Table 2. KMO and Bartlett's test of causes

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.90
Bartlett's Test of Sphericity	Approx. Chi-Square	6237.85
	Df	1485
	Sig. (p)	0.00

From Varimax with Kaiser Normalization rotation and Principal Component Analysis extraction method procedure, Table 3 showed that the factors of causes consisting of 3 components or groups of causes. Consequently, these three (3) components or groups were extracted from the data collection (questionnaire). The results also show that five (5) multi-concept factors can be loaded into two components or groups which are performance by appointed contractor, the strength of maintenance staff, commitment of maintenance team, setting priority in performing maintenance work and maintenance team attitude. However, after reviewing the factors, it was found that they are inadequate and should be removed because each factor cannot represent two components or groups in the analysis to be made later [23]. The results of factor analysis generated from 42 factors of causes are then classified into 3 groups. Group 1 is the organization and it displays 20 factors, namely, the integrity of the personnel, the efficiency of building service and system, maintenance team responsibilities, time management, teamwork spirit, the courage of the maintenance team, the pleasure of working with the team, tackling problems in maintenance work, familiarity with a maintenance task, a continuous quality improvement (CQI) by an organization, the efficiency of strategies in solving maintenance work problems, accountability for Stewardship, the status of existing operation and maintenance work, check and balance, the efficiency of cost estimation, condition assessment of buildings, ethics and compliance of the maintenance team, collaborative approach, the efficiency of the administration system and availability and technology capabilities. Meanwhile for Group 2 is the resources which display 13 factors namely, skills of maintenance personnel, management capabilities, knowledge, planning efficiency, emphasis on training, an understanding of the importance of maintenance, the adequacy of expertise, consistency and sustainability of policies, goals and objectives, assessment requirements, methods and equipment used, the efficiency of information and communication technology, the perfection of documentation and contract, relationship and communication between the parties involved and maintenance work culture. While Group 3 is financial which displays 9 factors namely, budget or funds, financial management capabilities and competencies, the economic capacity of the country, designs of buildings, decision making by the top and middle management, contractor or supplier selection for the maintenance work, availability of resources, the ageing of the buildings and unforeseen expenses.

Table 3. Rotated component matrix of causes

The Factor of Causes	Component			Group based on Literature
	1	2	3	
The integrity of the personnel	0.68			
The efficiency of building service and system	0.68			
Maintenance team responsibilities	0.67			
Time management	0.64			
Teamwork spirit	0.63			
The courage of the maintenance team	0.63			
The pleasure of working with the team	0.62			
Tackling problems in maintenance work	0.61			
Familiarity with a maintenance task	0.60			
Continuous quality improvement (CQI) by an organization	0.60			
The efficiency of strategies in solving maintenance work problems	0.59			Organization
Accountability for Stewardship	0.59			
Status of existing operation and maintenance work	0.55			
Check and balance	0.50			
The efficiency of cost estimation	0.46			
Condition assessment of buildings	0.46			
Ethics and compliance of the maintenance team	0.45			
Collaborative approach	0.45			
The efficiency of the administration system	0.43			
Availability and technology capabilities	0.40			
Skills of maintenance personnel		0.66		
Management capabilities		0.62		
Knowledge		0.61		
Planning efficiency		0.60		
Emphasis on training		0.59		
Understanding of the importance of maintenance		0.58		
Adequacy of expertise _		0.51		Resources
Consistency and sustainability of policies, goals & objectives		0.51		
Assessment requirements, methods and equipment used		0.48		
The efficiency of information and communication technology		0.44		
The perfection of documentation and contract		0.44		
Relationship and communication between the parties involved		0.42		
Maintenance work culture		0.41		
Budget/ funds			0.61	
Financial management capabilities and competencies			0.61	
The economic capacity of the country			0.60	
Designs of buildings			0.55	
Decision making by the top and middle management ion			0.55	Financial
Contractor/ supplier selection for the maintenance work			0.54	
Availability of resources			0.50	
Ageing of the buildings			0.42	
Unforeseen expenses			0.40	

5. Conclusion

The factor analysis of causes from SPSS software reveals that deferred maintenance in Malaysian public universities shall be divided into three groups. The objectives of factor analysis of causes were satisfied by identifying forty-two (42) causes of deferred maintenance of public university buildings in Malaysia which are 20 causes factors for organization, 13 causes factors for resources and 9 causes factors for financial. These findings might significantly influence the maintenance players satisfaction as the factors have not been fully addressed in the previous studies. In planning this study, the literature concerning deferred maintenance of buildings is very hard to discover and very little information is provided for study. Therefore, in conclusion, strong support from the stakeholders, institutions and practitioners are needed to be more effective in managing the maintenance of public university buildings in Malaysia. Otherwise, the deferred maintenance problems will always be an annual issue in the planning schedule.

6. References

[1] Yasin M N, Zin R M, Hamid M Y, Zakaria M A and Deraman R 2019 Deferred maintenance of buildings: A review paper *IOP Conference Series: Materials Science and Engineering* **513** 012028

[2] Kaiser H H 2004 *Reviewing the State of Deferred Maintenance* (APPA Center for Facilities Research (CFaR))

[3] Norazam Yasin M, Mohamad Zin, Halid Abdullah A, Shafiq Mahmad M and Fikri Hasmori M 2017 The most common problem facing by the maintenance department: A case Study between Universiti Tun Hussein Onn Malaysia (UTHM) and Universiti Teknologi Malaysia (UTM), *In Materials Science and Engineering Conference Series*. **271** 012047

[4] Hamid Y, Alexander K and Baldry D 2010 The Cause and Effects of Deferred Maintenance on higher education buildings (*7th International Postgraduate Research Conference, as part of 4th International Research Week (IRW) 2007*) pp 78–88

[5] Yasin M N, Abdullah A H, Mustakim F, Singh B and Abd Hamid A R 2015 Maintenance Organization at Universiti Tun Hussein Onn Malaysia (UTHM), *Trans Tech Publ.*

[6] Mujani W K, Muttaqin A and Khalid K A T 2014 Historical development of public institutions of higher learning in Malaysia, *Middle-East J. of Sci. Res.*, *International Digital Organization for Scientific Information*. **20**(12) 2154–2157

[7] Zakaria H, Arifin K, Ahmad S and Aiyub K 2012 Financial factor affecting maintenance management in safety and health practices, *Int. J. of Mod. Eng. Res*. **2**(5) 3061–3067

[8] Al-Zubaidi H 1997 Assessing the demand for building maintenance in a major hospital complex, *Prop. Managt*. **15**(3) 173–183

[9] Wuni I, Yeboah A and Boafo H 2018 Poor facility management in the public schools of Ghana, recent empirical discoveries, *Journal of Sustainable Development Studies*, **11**(1) 1–30

[10] Thohir M A, Sangadji S and As S 2017 Maintenance and rehabilitation prioritization of school buildings using Knapsack problem, *International Conference on Science and Applied Science* **2**(1) 236–248

[11] Sohu S, Abdullah A H, Nagapan S, Fattah A, Latif I and Ullah K 2017 Causative factors of cost overrun in highway projects of Sindh province of Pakistan, *IOP Conference Series: Materials Science and Engineering* **271** 012036

[12] Okosun B O and Olagunju R E 2017 Department of quantity surveying Federal University of Technology Minna, Nigeria, Department of Architecture, Federal University of Technology, Minna, Nigeria, **8**(1) 47–57

[13] Nah M N, Abdullah S and Razak A A 2015 The development of building maintenance management best practice in Malaysia, a review, *Advances in Environmental Biology*, American-Eurasian Network for Scientific Information, **9**(3) 97–99

[14] Puķīte I and Geipele I 2017 Different approaches to building management and maintenance meaning explanation, *Procedia Engineering* **172** 905–912

[15] Au-Yong C P, Ali A S and Ahmad F 2016 Enhancing building maintenance cost performance with proper management of spare parts, *Journal of Quality in Maintenance Engineering* **22**(1) 51–61
[16] Nwachukwu L, Agu E, Orji S and Okolie K 2016 Factors militating against effective maintenance of tertiary institutions, buildings in Enugu Urban, Nigeria, *The International Journal Of Science & Technoledge* **4**(10) 175–180
[17] Nah M N M, Abdullah S and Razak A A 2015a The development of building maintenance management best practice in Malaysia: a review, *Advances in Environmental Biology*. American-Eurasian Network for Scientific Information, **9**(3) 97–99
[18] Wing A C K., Mohammed A H and Abdullah M N 2016 Factors for maintenance priority in Malaysian university, *Sains Humanika* **8** 4–3
[19] Kaiser H 2004 Reviewing the State of Deferred Maintenance, *APPA Center for Facilities Research (CFaR)*
[20] Kamarazaly M A 2014 Challenges in strategic facilities management: analysis of problems faced by university facilities managers in New Zealand and Australia, a thesis presented in fulfilment of the requirements for the degree of Doctor of Philosophy (PHD) in Construction, Sc' Massey University
[21] Krejcie R V and Morgan D W 1970 Determining Sample Size for Research Activities, *Educ. and Psychol. Meas*. **30**(3) 607–610
[22] Hayton J C, Allen D G and Scarpello V 2004 Factor retention decisions in exploratory factor analysis: A tutorial on parallel analysis, *Organ. Res. Methods* **7**(2) 191–205
[23] Chua Y P 2009 *Statistik Penyelidikan Lanjutan II: Ujian Regresi, Analisis Faktor dan Analisis SEM. Buku 5* (Kuala Lumpur: McGraw- Hill Malaysia Sdn Bhd)