The Consideration of Building Maintenance at Design Stage in Public Buildings: The Current Scenario in Malaysia

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Abstract

Effective building maintenance management is vital in reducing the impact of building defects and costly building maintenance work. Such practice can provide significant contributions to the public sector in term of cost reduction; improved effectiveness and efficiency in maintenance works; increasing safety and well-being of the occupants; expanding the life of building stocks; and expanding the value of investment for the government building assets. In developed countries such as the United Kingdom, United States of America, Japan, and Singapore, building maintenance management are more advanced; whilst, by contrast, the maintenance practice in Malaysia is still emerging. The aim of this research is to determine the current scenario of building maintenance approach at design stage in public buildings in Malaysia. Extensions to that, an extensive questionnaire survey were held involving the key players in Malaysia. The survey questionnaires involved 312 key players (38% out of 820 predetermined participants). The analysis showed that the current practice of building maintenance in public building in Malaysia is still in reactive approach. Despite the Malaysian government adoption of a proactive maintenance approach, unfortunately there some are misunderstanding among the key players on proactive maintenance approach. The research results demonstrated that the key players were lack of understanding the concept of the proactive maintenance management approach. Many of the key players are either ignorant or have insufficient awareness of proactive maintenance approach. The contribution of this study is useful for the government to adopt a more proactive building maintenance policy at design stage; to give awareness on proactive building maintenance to the key players in their construction project; and as a guide to the key players to adopt maintenance plan of work at design stage.

Keywords
Building maintenance, Building design, current scenario of building maintenance in Malaysia.

1. Introduction

The concept of building maintenance is to keep, restore or improve every facility to an agreed standard and the benefit of having effective maintenance is to obtain a maximum value for money that is invested in the property In order to prolong the lifespan of a building, it needs a proper and systematic maintenance planning. Thus the effective and efficient maintenance of the building is mandatory. Effective maintenance can be achieved with proper maintenance objective; strategy, and policy at the early stage. Meanwhile the efficiency in maintenance can be obtained by proactive maintenance execution.

However, in Malaysia, the building maintenance management has been dealing with the ineffective policies and inefficient procedures or based on ad-hoc basis or reactive basis (Abdul-Rashid and Ahmad, 2011, Ali et al., 2013, Ahmad, 2006, Mohd-Noor et al., 2011, Zailan, 2001, Hashim, 1994). Building maintenance is about to optimise benefit from the property maintenance activities to the property investment itself (Lateef, 2009). Therefore, it needs an innovative strategy in order to implement effective building maintenance for future sustainability (Mohd-Noor et al., 2011). From the academics perspective, the consideration for maintenance during the design stage has major impact on the building performance (Arditi and Nawakorawit, 1999a). In supporting this, many researchers agreed that most of the building defects can be easily reduced if the awareness on maintenance is considered at the design stage (Hashim, 1996). In the context of maintenance management in Malaysia, certain issues are needed to be explored as to why building maintenance factors were not well considered by the key players in their project. This research intends to expose and highlight the current scenario and factors governing the difficulties in

considering and implementing building maintenance factors at the early stage of the building development process of public buildings in Malaysia.

2. Building Maintenance Management Perspective

According to British Standard Institution, BS 3811, Glossary of term used in general maintenance organisation 1964, building maintenance is defined as 'work undertaken in order to keep or restore every facility, i.e. every part of a site, building and contents to an acceptable standard' (Allen, 1993). From the definition, it is clearly that the building maintenance is the work to improve any facilities i.e. every part of a building, its services and surrounding area to a currently acceptable standard and value of the facility.

Acceptable standard is about the acceptance of quality that affects the functionality where it represents the level of performance. Meanwhile, the term quality is referred to the delivery of product at a set of standard (Godfrey, 1999). Standard determination is highly dependable on the needs and resources in an organization. The balance between these two elements resulting in effectiveness and efficiency in maintenance management can be achieved.

In order to understand the related issue on the fundamental problem in maintenance management, it is important to review the maintenance management process. The process in the maintenance management practise can be divided into two parts (Uday et al., 2009). The first part is about maintenance policy, maintenance objective, and maintenance strategy. This is the initial stage of the maintenance process where the success in it will determine the effectiveness in maintenance management. Effectiveness in maintenance management is measured by the level of satisfaction of the building user (Lateef et al., 2010).

The second part is about the implementation of that maintenance policy and strategy such as maintenance plans, schedules, control, and maintenance work activities. This part will deal with the efficiency in managing the building maintenance. Efficiency is viewed as acting to produce something with minimum waste and minimum unnecessary effort. Therefore, efficiency in maintenance management is about the optimization of resources in order to improve the value of a building (Lateef et al., 2010).

In obtaining the high impact in maintenance management, the effectiveness of maintenance management is mandatory (Crocker, 1999). Effectiveness means the concentration on doing the right strategy and policy to produce the required result. Diagram 1 illustrates that maintenance management should start with an effective strategy and direction at the initial stage in order to achieve efficiency for future maintenance works and procedures.

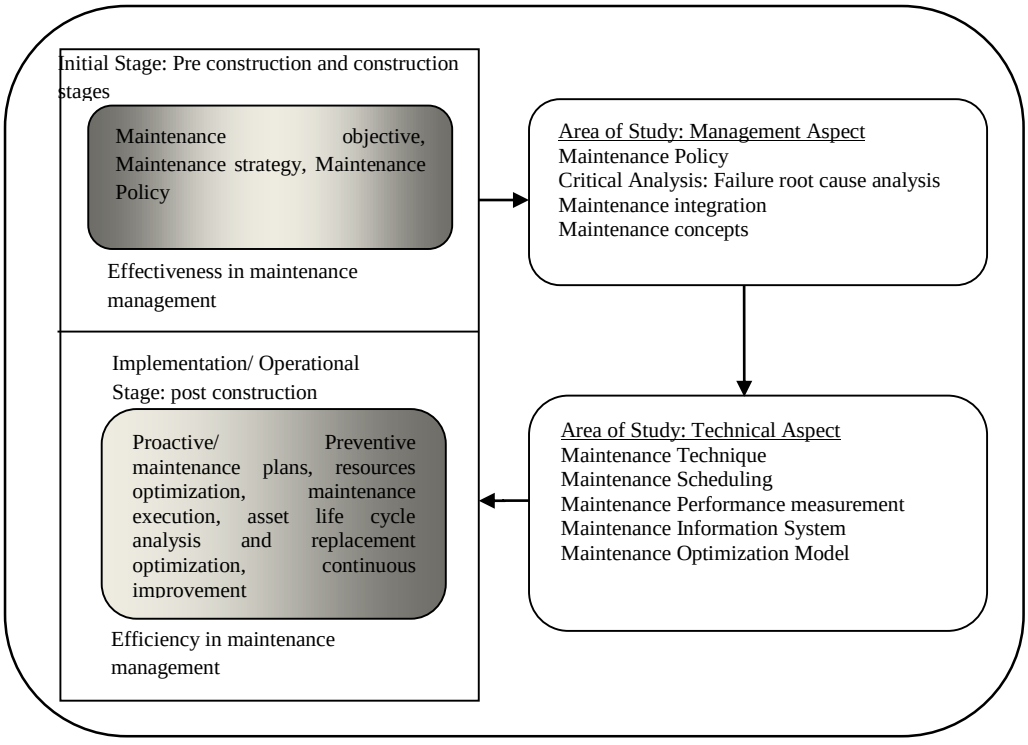

Diagram 1: Effectiveness and Efficiency in Maintenance Management Process

2.1 The Important of Maintenance Policy at Initial Stage

According to BS 3811, maintenance policy is refers to a "strategy within which the decision on maintenance is taken". This refers to the effectiveness of using limited resources in an efficient manner within the alternative types of maintenance action available to the management at the time. Reginald Lee (1993), explained that the maintenance policy as "the ground rules for the allocation of resources between the alternative types of maintenance actions"(Wordsworth and Lee, 2001). The maintenance policy should cover what to achieve in short-term, mid-term and long-term. The maintenance policy must be started at early stage of the building development process where the influence of design on the building maintenance is greater than ever (Arditi and Nawakorawit, 1999b,(Hamzah and Kobayashi, 2013). The policy needs to balance between the preventive maintenance work and corrective maintenance work within the appropriate maintenance strategy. (Tsang and Brown, 1998). Besides that, the maintenance priority, strategies and tactics should be aligned with the organization objectives. For instance, in the government sector, the priority is to maximise the good service for the public, and then maintenance priorities should be focus on maximizing building utilisation, building condition, and customer satisfactions.

2.2 The Effect of Building Design towards Building Maintenance

Diagram 2 illustrates the relationship between building design and building maintenance, where building maintenance consistently stressed on the building maintainability meanwhile the design of building needs to fulfil the standard of product quality. The Oxford English Dictionary defines quality as "a particular property inherent in body or substance". The quality in maintenance is inherent in the property with faultless execution of the maintenance task. Furthermore, the quality of maintenance is also defined as "a probability that maintenance tasks will be completed without any faults, resulting from maintenance process" (Knezevic and Knezevic, 2012).

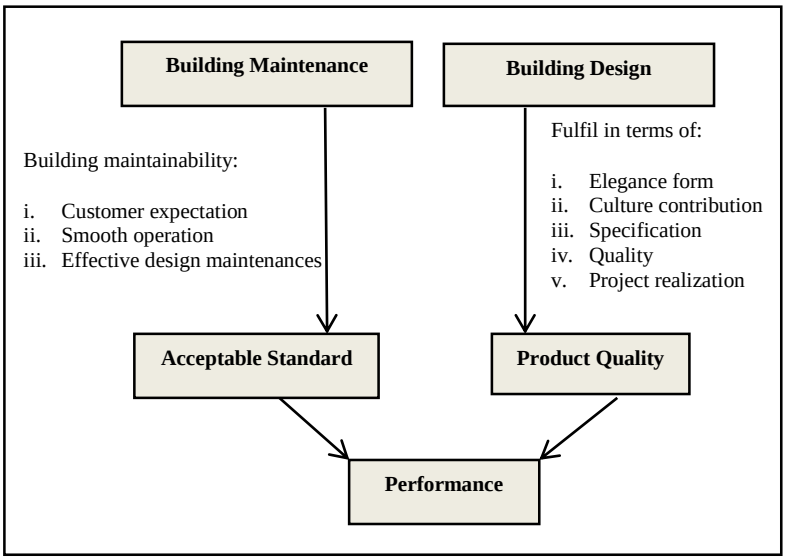

Diagram 2: Connection between Design, Maintenance and Building Performance

Defect in building are the measurement of building deficiency when it compared against a predetermined standard. Building defect will act as a yardstick to benchmark the underperformance of a building against the standard of construction quality. As a result, high building qualities will produce low number of building defects. On the other hand, building quality is therefore reciprocal to the amount of building defects (Boothman et al., 2012). To emphasis this, the condition of the building is central to the building performance and it should be considered in all phases of the building development process. This concept must be treated as a key element in formulating the maintenance policy (Chanter and Swallow, 2008). Unfortunately, it is common to see that maintenance and design were treated as two different activities and not connected to each other. In addition, this concept is rarely applied at the strategy level.

The quality of a building depends on the design as it requires performing the specific requirements. The benchmark of building performance is measured by the capability of the building to achieve the stipulated set of

specific standard. The flow and the relationship in the diagram 2 describe the essence of building performance. It is clearly shown that to achieve the specific performance in building, it needs the correlation of building design and proactive building maintenance approach. Therefore, the collaboration between building design and building maintenance conceptual is vital to reduce the building performance deficiency.

The maintenance issues arise when the building performance does not achieve the required standard and quality. For example, most defects in buildings in Malaysia was contributed by design-related negligence (Ramly et al., 2006, Shah Ali et al., 2009). Deteriorated performance in building will decrease the building value unless the proactive maintenance is carried out on the building (Lateef et al., 2010).

2.3 Building Maintenance at Design Stage

There are many claims that problems pertaining to maintenance in building should start with a chapter on the building design. The question that probably can be asked in this chapter is to what extent the key players in public construction project are willing to incorporate building maintenance into their design? Currently, the government of Malaysia have a great interest in considering building maintenance in building design. However, the designers traditionally rarely consult the client upon the matters at the design stage. The main problem in defining maintenance at the design stage is to define the standard that is acceptable to a specific building (Hashim, 1996). The owners have to establish their own standard that is reliable to the building. The standard requirement for building maintenance is dependable on the owner's objective, building categories, and building's characteristic. Therefore, it is very difficult to define the maintenance standard. However, the maintenance standard should have at least the following priorities such as; work necessary to remove any danger, building must kept waterproof, work necessary for the operational efficiency of the occupant and hygienic condition of the premises and work necessary for appearance of the building.

The maintenance policy is highly dependent on the standard determination. The maintenance policy will influence the amount of maintenance work in a building. The main problem in today's maintenance management is due to the reactive approach and this happens because commonly the owner and the design team in construction have little interest in the upkeep for maintenance priority. The critical area in considering maintenance is at the design stage during the design feedback process. The design of a building will be subject to a policy throughout two levels of the process. First, at the conceptual level i.e. the type of building is required to perform the function and second is the development of the detailed design (Chanter and Swallow, 2008).
During the process of preparing the feasibility study and detailed brief, the communication between the designer and the maintenance expert is vital in order to maintain a clear picture of the maintenance prioritization when designing a building.

During this process, the maintenance policy, maintenance objective, and maintenance strategy should be in clear form. This is the initial stage of maintenance intervention in designing buildings where the success in it will determine the effectiveness in maintenance management. After the design is completed with consideration of maintenance factors, the second part is about the implementation of the maintenance strategy such as maintenance plans, schedules, control and maintenance works. This part will deal with the efficiency in managing the building maintenance.

2.4 The Fundamental Issues Pertaining to the Building Maintenance Practice in Malaysia

In the context of maintenance management of public buildings in Malaysia, two fundamental problems are recognised, first for the existing building, the maintenance procedure is not in proactively engaged where the maintenance is carried out base on ad-hoc basis or unplanned maintenance approach. This situation is left the problem with improper maintenance work procedure and difficulties in determining budget allocation (Shah Ali, 2009). Second, for the new construction project, it has no clear policy on the aspect of considering building maintenance at the design stage. This has caused the public building confront to have a high number of defects and it becomes very expensive to maintain (Arditi and Nawakorawit, 1999b). Because of that, the cost in maintaining the public building is going to increase rapidly (Abdullah et al., 2011).

There is a need to review the existing maintenance policy and procedure with serious consideration in order to prevent or reduce the maintenance problems of existing buildings and for future building development. In 2007, the government of Malaysia has formed the government asset management policy as a new approach to ascertain the maintenance direction and principle in the hope that it meets the delivery system, documentation, adaption and monitoring of total asset management. However, the concept of interrelation between design and maintenance

is still in ambiguity, especially at the design stage of the building development process. Currently, it is normal to find building with special design characteristics and with special functions but very hard and costly to maintain.

In Malaysia, the maintenance has consistently been given less attention. This, perhaps due to poor financial returns compared to other professional interests and may be because of the lack of depth of education in maintenance management, materials technology and low status of maintenance work in the building industry (Hashim, 1996). Fortunately, the government of Malaysia has slowly begun to draw attention to the need to improve construction and maintenance practise for the benefit of the client and country. Therefore, there is a need for a change in mind-set and more emphasis on the enforcement of the procedures that have been legislated for. However, very often these enforcement ends up with failure due to various reasons.

3. Research Method and Methodology for the Study

Taking into consideration the nature of this study is to test the variables found in literatures, the most appropriate method is the quantitative research method. Adaptation of this method will allow the researcher to answer and understand the current conditions of the building maintenance management practice at the design stage. This research adopted a quantitative methodology or descriptive research in conducting the research procedures.

In terms of research strategy, the survey study has been selected in practising research methodology. This is due to the nature of the study that is not to find a new theory rather it is to test the variables that had been found in the previous studies (Amaratunga et al., 2002). In addition to this, Creswell (1994) quoted that a quantitative study can be referred as 'an inquiry into social or human problems, based on testing a theory composed of variables, measured with number and analysed with statistical procedures in order to determine whether the predictive generalizations of the theory hold true' (w Creswell, 2009). The questionnaire survey form is selected as a research procedure to undertake the research methodology. These questionnaire survey forms are distributed among the respondents in postal, technique, face to face technique, and telephone technique. The summary of the research methodology used in this research study can be as follow (Table 1 and Figure 5.1):

Table 1: The research approach

Research Method	Quantitative Method
Research strategy	Survey study (Quantitative Approach)
Research procedure	Questionnaires form distributed in face to face technique, postal technique, and telephone technique.

3.1 Sample Recruitment

This study provided a printed survey instruments to be distributed among 820 selected participants to surpass the minimum response rate at 23 per cent as suggested by Bonner and also to fulfil the requirement of minimum sample of 300 persons from the population (Bonner et al., 2002, Tabachnick and Fidell, 2007). For the purpose of this study, the researcher explored each Public Work Department's and State Government's website in every state in Malaysia Peninsular for contact details such as email address and telephone number. As a result, based on the availability of their contact details, a phone call was made to each department for invitation and confirmation of participating in answering the questionnaire survey. For other participants such as architects, engineers, building maintenance practitioners who are categorised as non-government staff, a similar process was conducted to invite them to participate voluntarily in the questionnaire survey process. After they agreed to the invitation, then an official letter (attached with the questionnaire survey form) was sent by post. Together with the official letter, the researcher also attached an introduction letter that explained the purpose of the research and scope of the study. For some respondents, the researcher had to travel to the respondents' location to drop off the questionnaire and collected them after the respondents completed their answering process.

Table 2: Organisations and number of questionnaire sent to the participants

No	Destination	Set of

		Questionnaire
1	JKR Headquarter Kuala Lumpur	20
2	JKR Pahang	20
3	JKR Kelantan	20
4	JKR Terengganu	20
5	JKR Perak	20
6	JKR Negeri Sembilan	20
7	JKR Johor	20
8	JKR Pulau Pinang	20
9	JKR Kedah	20
10	JKR Perlis	20
11	JKR Melaka	20
22	Others (non government staffs)/ private sector: Architect Engineer Building maintenance practitioners'	 200 200 200
	Total	**820**

Overall, 820 questionnaires were sent to the respondents (See Table 2). However only 312 of the respondents participated in the questionnaire survey. This number represents 38.048% of the participants responded to the survey study.

Table 3: Distribution of participants' sector, education, experience, and position

Sector	**Frequency**	**Percentage (%)**
Public	110	35.26
Private	202	64.74
Education		
Diploma	28	9.0
First degree	192	61.5
Master's	52	16.7
PhD	22	7.1
Others	18	5.8
Experience (years)		
1-5	74	23.7
5-10	106	34.0
10-15	58	18.6
More than 15 years	74	23.7
Position in Organisation		
Architect	78	25.0
Engineer	128	41.0
Building Maintenance	90	28.8
Others	16	5.1

Table 3 shows that the majority of the participants were from the private sector which consist of 202 persons (64.74%) and the rest 110 (35.26%) were from the public sector. The percentage of the participants from the government sector is lower because the number of the positions offered in this sector is limited compared to the number of position in the private sector. Participation of respondents showed a huge difference in number between public sector and private sector (public=110/220, private= 202/600). The participants from the public sector represent 50 per cent of the 220 questionnaires distributed among the government staffs. While for the private sectors participants, it showed that 33.66 per cents of them were willing to participate in the survey. An initial difference between public and private participants is about 6 per cent which is acceptable for the study analysis. The different number between the public sector and private sector does not affect the analysis of the study because the critical part is their background as key players and some of them had been involved directly in the government project. In term of education, most of the participants possessed first degrees with 192 persons (61.5%), followed by Master Holder's which consisted of 52 persons (16.7%). Participants with diploma holders consisted of 28 persons (9%), for PhD holders, the figure was 22 persons (7.1%); and lastly, participants with other qualifications

were 18 persons (5.8%). This outcome indicated that the number of the participants with first degree qualifications was more than half of the respondents participating in the survey. In terms of the participants' position in organisation, engineers were indicated as the majority of the respondents which consisted of 128 persons (41%) and followed by 90 building maintenance officers (28.8%). Architects made up 78 persons (25%); and the lowest number of 16 persons (5.1%).participants came from other backgrounds involved directly in the study field.

In the context of the participants' experience, most of them, consisting of 106 persons had experiences that ranged from 5 to 10 years (34%). Meanwhile, the number and percentage of participants with experience ranging from 1 to 5 years is 74 persons (23.7%), and those with more than 15 years (74 persons/ 23.7%) were the same. Participants with experience of 10 to 15 years had the lowest number in this category, which represent 58 persons (18.6%).

4. Research Analysis

For data analysis, The Statistical Package for Social Science software version 22 (SPSS version 22) was used. (As suggested by Kerlinger, every variable in the research needs to be tested in order to ensure that variables are the right measuring tools and represent the concept being measured in the study) (Pedhazur, 1997). The statistical methods that are employed in the research using this software are as follows:

4.1 Cronbach's Alpha Test

This analysis is to test the clarification, strength, validity, reliability and internal consistency of the designed questionnaires. After completing the data collection, the screening and cleaning process of data was performed by doing the reliability test (Collis and Hussey, 2013). This test was conducted for the purpose of clarifying the strength and consistency of the questionnaire. This test also carried to minimize the errors (Amaratunga et al., 2002). Normally, the range of Cronbach's alpha is between "0" to "1".

4.2 Descriptive Analysis

The purpose of this analysis is to process raw data into a summarised form of data that can be understood easily by a researcher and used to organise and describe the data's characteristics. This method also demonstrates the measure of tendency among the respondents in the survey (Tan, 1995, White, 2002). This includes the frequency analysis, analysis of central tendency, dispersion analysis, and standard deviation analysis. In other words, the method provides the analysis of the mean score, standard deviation, frequencies, cross tabulation, and central tendency of the data (Sekaran, 2006). In this analysis, the mean value ranking is used to examine the level of importance of each variable in the research. The mean of each variable will be computed into low moderate and high levels. The Five Likert scale ranging from 1 to 5 is used to measure the tendency of the respondents. The five scales are as follow:

1 = strongly disagree
2 = disagree
3 = neither agree nor disagree
4 = agree
5 = strongly agree

Table 5: Summary of statistical techniques used to analyse the questionnaire survey data

Test	Purpose
Cronbach's Alpha	To test the clarification, strength, validity, reliability and internal consistency of the designed questionnaires. The closer the score is to 1, the greater the internal consistency of the item in the scale (Nebot et al., 1994)
Frequencies Analysis	To produce the statistics for describing type of variables. The collected data can be arranged for frequency counts, means, median, mode, standard deviation, percentage, and cumulative percentages

Table 6: Detail analysis Alpha Cronbach for the scenario of the public buildings maintenance

No.	Item	Cronbach's Alpha
1	Design fault cause difficulties in building maintenance	**.653**
2	Lack of maintenance management approach	**.681**
3	Inappropriate selection of building material cause difficulties in building maintenance	**.633**
4	Lack of consideration on environmental impact at design stage cause difficulties in building maintenance	**.725**
5	Construction fault cause difficulties in building maintenance	**.627**
6	Misuse cause difficulties in building maintenance	**.691**
7	Ignorance of maintenance aspect at design stage cause difficulties in building maintenance	**.628**
8	Lack of proactive maintenance policy at design stage	**.630**
9	Current building maintenance practise is to achieved toward maintainability	**.585**
10	Current maintenance practise is designed to achieve serviceable building	**.585**
11	Current maintenance practise is designed to achieve maintenance accessibility	**.592**
12	Current maintenance practise is based toward durability	**.581**
13	Current maintenance practise is based toward cost efficiency	**.571**
14	Current maintenance practise is based on reactive mode	**.627**
15	Inadequate budget in building maintenance	**.612**
16	Budget allocation is not based on actual maintenance's requirements	**.620**

From Table 6, the Cronbach's alpha analysis for the reliability and internal consistency of the items has resulted in a coefficient of 0.725, which means the questionnaires were reliable and acceptable. All sixteen questions achieved a score with a reliability coefficient of 0.571 – 0.725. Among the variables, the higher score of Cronbach's alpha value which is Lack of consideration on `environmental impact at design stage cause difficulties in building maintenance` (0.725). Meanwhile, the lowest score that is on `the current maintenance practice is based toward cost efficiency` (0.571). Therefore, all sixteen items are considered as reliable and should not be subjected for further analysis.

Descriptive Analysis: Frequency Analysis for the Scenario of the Public Buildings Maintenance

Table 7: Frequency analysis for the scenario of the public building's maintenance

No.	Item	N1	N2	N3	N4	N5	Total
1	Lack of maintenance management approach		10 (3.2%)	30 (9.6%)	114 (36.5%)	158 (50.6%)	312 (100%)
2	Lack of proactive maintenance policy at design stage		2 (0.6%)	14 (4.5%)	168 (53.8%)	128 (41%)	312 (100%)
3	Inadequate budget in building maintenance		2 (0.6%)	76 (24.4%)	114 (36.5%)	120 (38.5%)	312 (100%)
4	design fault cause difficulties in building maintenance		6 (1.9%)	64 (20.5%)	176 (56.4 %)	66 (21.2%)	312 (100%)
5	Construction fault cause difficulties in building maintenance		12 (3.8%)	38 (12.2%)	210 (67.3%)	52 (16.7%)	312 (100%)
6	Misuse cause difficulties in building maintenance		12 (3.8%)	72 (23.1%)	150 (48.1%)	78 (25%)	312 (100%)
7	Inappropriate selection of building material cause difficulties in building maintenance	4 (1.3%)	10 (3.2%)	86 (27.6%)	116 (37.2%)	96 (30.8%)	312 (100%)
8	Lack of consideration on environmental impact at design stage cause difficulties in building maintenance	2 (0.6%)	38 (12.2%)	66 (21.2%)	86 (27.6%)	120 (38.5%)	312 (100%)
9	Ignorance of maintenance aspect at design stage cause difficulties in building maintenance	4 (1.3%)	4 (1.3%)	112 (35.9%)	160 (51.3%)	32 (10.3%)	312 (100%)

10	budget allocation is not based on actual maintenance's requirements		56 (17.9%)	84 (26.9%)	82 (26.3%)	90 (28.8%)	312 (100%)
11	Current maintenance practise is designed to achieve maintenance accessibility	2 (0.6%)	10 (3.2%)	166 (53.2%)	120 (38.5%)	14 (4.5%)	312 (100%)
12	Current maintenance practise is based on reactive mode		10 (3.2%)	200 (64.1%)	82 (26.3%)	20 (6.4%)	312 (100%)
13	Current maintenance practise is based toward cost efficiency	2 (0.6%)	72 (23.1%)	128 (41.0%)	82 (26.3%)	28 (9%)	312 (100%)
14	Current maintenance practise is based toward durability	2 (0.6%)	66 (21.2%)	134 (42.9%)	94 (30.1%)	16 (5.1%)	312 (100%)
15	Current maintenance practise is designed to achieve serviceable building		116 (37.2%)	54 (17.3%)	130 (41.7%)	12 (3.8%)	312 (100%)
16	Current building maintenance practise is to achieved toward maintainability		116 (37.2)	82 (26.3%)	102 (32.7%)	12 (3.8%)	312 (100%)

Note: n1 = strongly disagree, n2 = disagree, n3 = neither agree nor disagree, n4 = agree, n5 = strongly agree

Data from Table 7 show the frequency analysis of the current scenario of building maintenance which indicated that on average, the respondents agreed that the public building maintenance scenario in Malaysia was due to the 16 situations stated in questionnaire.

However, frequencies analyses of the 5 variables indicated with their numbering order (as in the questionnaire) below showed that some of the respondents did not either agree or disagree to the items on the scenario:

1	current maintenance practise is designed to achieve maintenance accessibility
2	current maintenance practise is based toward cost efficiency
3	current maintenance practise is based toward durability
4	current maintenance practise is designed to achieve serviceable building
5	current building maintenance practice is to achieved toward maintainability

Nevertheless, in conclusion, majority of the respondents did agree that all the sixteen variables in objective one did indicate various situations of the building maintenance scenario.

Descriptive Analysis: Mode, Mean and Standard Deviation Analysis of the Scenario of the Public Building's Maintenance

Table 8: Descriptive analysis of the scenario of the public building's maintenance

No.	Item	Mode	Mean	Std. Deviation	Level of Tendency
1	Lack of maintenance management approach	5	4.35	0.783	**High**
2	Lack of proactive maintenance policy at design stage	4	4.35	0.598	**High**
3	Inadequate budget in building maintenance	5	4.13	0.800	**High**
4	design fault cause difficulties in building maintenance		3.97	0.703	**High**
5	Construction fault cause difficulties in building maintenance		3.97	0.665	**High**
6	Misuse cause difficulties in building maintenance		3.94	0.796	**High**
7	Inappropriate selection of building material cause difficulties in building maintenance		3.93	0.908	**High**
8	Lack of consideration on environmental impact at design stage cause difficulties in building maintenance		3.91	1.066	**High**
9	Ignorance of maintenance aspect at design stage cause difficulties in building maintenance		3.68	0.726	**High**

10	budget allocation is not based on actual maintenance's requirements	3.66	1.079	**Moderate**
11	Current maintenance practise is designed to achieve maintenance accessibility	3.43	0.662	**Moderate**
12	Current maintenance practise is based on reactive mode	3.36	0.651	**Moderate**
13	Current maintenance practise is based toward cost efficiency	3.20	0.917	**Moderate**
14	Current maintenance practise is based toward durability	3.18	0.845	**Moderate**
15	Current maintenance practise is designed to achieve serviceable building	3.12	0.965	**Moderate**
16	Current building maintenance practise is to achieved toward maintainability	3.03	0.924	**Moderate**

Table 8 describes the level of importance of each variable in the study. To determine the level of importance of every variable, its mean value was indicated. The mean value was divided into three categories importance : low (mean value=1.00 to 2.33), moderate (mean value = 2.34 to 3.66), and highest (mean value = 3.67 to 5.) (Hwang and Ng, 2013). The range of mean value for the variables is 3.03 to 4.35. The overall mean value for the items ranged between `moderate` to `high` importance level.

5. Findings

For the purpose of the this study is to find the building maintenance current scenario in public sector, only the top ten variables will be picked up as a major contributor to the current scenario of building maintenance management in public building in Malaysia. The scenarios are primarily caused by the absence of an instituted proactive building maintenance policy. The survey showed that generally, most of the respondents agreed that the prevalent practice of building maintenance for both at planning or implementation stage is of reactive maintenance in approach. The findings are as follows:

a) Lack of maintenance management approach

This finding is similar to a previous study (Lateef, 2009), which indicated that building maintenance management in Malaysia is not considered as a factor of production but rather a burden to the stakeholders. The findings also suggested that building maintenance management should be broader in practices, for example, the focus should not only on building completion. Instead, concurrent maintenance should be emphasised and commenced at the early stage of the building development.

b) Lack of proactive maintenance policy at design stage

The findings also indicate that the lack of maintenance policy at design stage has significant effects on the future of building maintenance management. The evidences proof that the maintenance policy must be started at the very early stage, especially during the building design stage where the influence of the design on future building maintenance is greater (Arditi and Nawakorawit, 1999b).

c) Inadequate budget in building maintenance

This situation was deemed as a consequence of ineffective maintenance management approach (Miles and Syagga, 1987, El-Haram and Horner, 2002, Horner et al., 1997, El-Haram, 1995, Lee and Scott, 2009, Wordsworth and Lee, 2001, Garg and Deshmukh, 2006). It seemed that a regular oversight in maintaining the government assets is that the budget allocation is not based on the careful evaluation of the actual needs for building maintenance requirements. Any allocation for assets maintenance was provided in a reactive manner. Besides that, maintenance works were driven by short-term requirements, instead of the long term (Zailan, 2001). Thus, budget allocation for Malaysian public building maintenance should be proactively provided according to actual building maintenance needs and requirements.

d) Design fault cause difficulties in building maintenance

The findings revealed the need for the stakeholders and key players to pay a greater intention to the building design and its effects on future building performance. Therefore, a preventive maintenance strategy is a must and needs to be adopted during the design process. For instance, a building should be designed to be operationally effective, reliable, maintainable, durable and supportable for future improvement. Besides that, the key players should be cautioned that the quality of a building maintenance depends on the inherited quality building design

(Seeley, 1987, Chanter and Swallow, 2008, Ramly et al., 2006, Hashim, 1996, Olanrewaju and Abdul-Aziz, 2015, Heyman, 1997).

e) Construction fault cause difficulties in building maintenance

The findings suggested that minimisation of construction fault is very crucial to produce a maintainable, durable, reliable, and cost effective building. Majority of the key players seemed to overlook the long term benefits of building maintenance, (Lateef, 2009, Olanrewaju and Abdul-Aziz, 2015, Chong and Low, 2005, Chong and Low, 2006).

f) Misuse cause difficulties in building maintenance

The misuse of building facilities wreaked havoc on building maintenance work. This particular problem can be attributed to the users` ignorance, attitudes, lack of civic consciousness in their use of the building facilities. Therefore, it is important for the designers to proactively try to address this particular issue in their design development (Assaf et al., 1995, Chong and Low, 2005, Chong and Low, 2006).

g) Inappropriate selection of building material cause difficulties in building maintenance

As stated in the earlier chapter, a good building design should incorporate appropriate materials in their design, to optimise building components and functions. Many studies have indicated that most building defects are due to the failure to match building design with proper building materials (Ramly et al., 2006, Shah Ali et al., 2009, mohd zulakhmar, 2006, Shah Ali, 2009, Lateef et al., 2010, Assaf et al., 1996, YACOB, 2005b). It is therefore crucial for the designers to get a maintenance expert for advice in materials selection during the design stage.

h) Lack of consideration on environmental impact at design stage cause difficulties in building maintenance

The study show that without consider local environment, regular maintenance work would not efficiently solve the problem. Therefore, environmental impact is crucial due to its capability to accelerate adverse affects on the integrity of buildings physical itself.

i) Ignorance of maintenance aspect at design stage cause difficulties in building maintenance

Although many researchers in the field highlighted the significant interrelations of building performance and building defect; yet, ignorance and neglect among stakeholders are still prevalent. The consequences of such attitudes may be harmful to building users in terms of their safety and health.

j) Budget allocation is not based on actual maintenance's requirements

In reality, building maintenance in Malaysia commonly carried out base on a predetermined budget, given the fact that a proactive maintenance policy is not enforced. For example, current building maintenance policy is excludes during the design stage. Thus, the current building maintenance policy largely emphasizes only on implementation and completed building projects (Mohd-Noor et al., 2011, Isa et al., 2011, Ramly et al., 2006, Ahmad, 2006, Abdullah et al., 2011)(Malaysia, 2009).

6. Conclusion

The fundamental problem of building maintenance management in Malaysia are having reactive maintenance approach either in managing a new building construction project or managing an existing building stock. All the sixteen variables revealed that lack of proactive maintenance management approach has been the fundamental problem in public building maintenance management in Malaysia. Combination of design faults and ineffective building maintenance procedures have brought hazardous and catastrophic consequences to several government building projects. Yet, to -date, this fundamental issue is still prevalent and unresolved. As a conclusion, the incorporation of proactive maintenance policy should be the highest priority for maintenance of present and new building development projects. The results also confirmed that current scenario of public building maintenance is predominantly reactive in approach; and building maintenance and building design are treated as two different aspects.

References

ABDUL-RASHID, R. & AHMAD, A. G. 2011. The Implementation of Maintenance Works for Historical Buildings–A Review on the Current Scenario. *Procedia Engineering*, 20**,** 415-424.

ABDULLAH, S., ABDUL RAZAK, A., HANAFI, M. H. & SALLEH, M. N. 2011. Managing Government Property Assets: The Main Issues From The Malaysian Perspective. *Journal of Techno-Social*, 3.

AHMAD, R. 2006. Maintenance Management and Services (Case Study: PERKESO, Buildings in Peninsular of Malaysia). *Unpublished Master's Thesis, University Technology Malaysia*.

ALI, A., KEONG, K., ZAKARIA, N., ZOLKAFLI, U. & AKASHAH, F. 2013. The effect of design on maintenance for school buildings in Penang, Malaysia. *Structural Survey*, 31**,** 194-201.

ALLEN, D. 1993. What is building maintenance? *Facilities*, 11**,** 7-12.

AMARATUNGA, D., BALDRY, D., SARSHAR, M. & NEWTON, R. 2002. Quantitative and qualitative research in the built environment: application of "mixed" research approach. *Work study*, 51**,** 17-31.

ARDITI, D. & NAWAKORAWIT, M. 1999a. Designing buildings for maintenance: designers' perspective. *Journal of Architectural Engineering*, 5**,** 107-116.

ARDITI, D. & NAWAKORAWIT, M. 1999b. Issues in building maintenance: property managers' perspective. *Journal of Architectural Engineering*, 5**,** 117-132.

ASSAF, S., AL-HAMMAD, A.-M. & AL-SHIHAH, M. 1996. Effects of faulty design and construction on building maintenance. *Journal of performance of constructed Facilities*, 10**,** 171-174.

ASSAF, S., AL-HAMMAD, A. & AL-SHIHAH, M. 1995. The effect of faulty construction on building maintenance: The results of a survey of 90 contractors, 30 architectural/engineering firms and 20 owners from the eastern province of Saudi Arabia identified 35 defect factors during the construction stage. *Building research and information*, 23**,** 175-181.

ATKINSON, A. 1998. Human error in the management of building projects. *Construction Management & Economics*, 16**,** 339-349.

BONNER, J. M., RUEKERT, R. W. & WALKER, O. C. 2002. Upper management control of new product development projects and project performance. *Journal of Product Innovation Management*, 19**,** 233-245.

BOOTHMAN, C., HIGHAM, A. & HORSFALL, B. ATTAINING ZERO DEFECTS WITHIN BUILDING SCHOOLS FOR THE FUTURE: A REALISTIC TARGET OR A SISYPHEAN TASK? Proceedings 28th Annual ARCOM Conference, 2012. 3-5.

CHANTER, B. & SWALLOW, P. 2008. *Building maintenance management*, John Wiley & Sons.

CHONG, W.-K. & LOW, S.-P. 2005. Assessment of defects at construction and occupancy stages. *Journal of Performance of Constructed facilities*, 19**,** 283-289.

CHONG, W.-K. & LOW, S.-P. 2006. Latent building defects: causes and design strategies to prevent them. *Journal of Performance of Constructed Facilities*, 20**,** 213-221.

CROCKER, J. 1999. Effectiveness of maintenance. *Journal of Quality in Maintenance Engineering*, 5**,** 307-314.

EL-HARAM, M. A. 1995. *Integrated approach to condition-based reliability assessment and maintenance planning*. University of Exeter.

EL-HARAM, M. A. & HORNER, M. W. 2002. Factors affecting housing maintenance cost. *Journal of Quality in maintenance Engineering*, 8**,** 115-123.

GARG, A. & DESHMUKH, S. 2006. Maintenance management: literature review and directions. *Journal of Quality in Maintenance Engineering*, 12**,** 205-238.

GODFREY, A. B. 1999. Juran's quality handbook.

HAMZAH, S. & KOBAYASHI, K. 2013. Utilizing Mid-long Term Maintenance Management Policy for Sustainable Maintenance of Infrastructure Facilities. *Procedia Environmental Sciences*, 17**,** 478-484.

HASHIM, E. 1994. the design maintenance: Designers, their design and procedure in relation to the improvement in the quality and efficiency of maintenance works. *The surveyor*, 29 No. 4**,** 11.

HASHIM, E. 1996. the evaluation of design maintenance at design stage. *The surveyor*, 31 No. 2**,** 3.

HEYMAN, J. 1997. *The stone skeleton: structural engineering of masonry architecture*, Cambridge University Press.

HORNER, R., EL-HARAM, M. & MUNNS, A. 1997. Building maintenance strategy: a new management approach. *Journal of Quality in Maintenance Engineering*, 3**,** 273-280.

ISA, H. M., ISNIN, Z. & SAPECIAY, Z. Learning from defects in design and build hospital projects in Malaysia. International Conference on Social Science and Humanity, 2011. 238-242.

KNEZEVIC, J. & KNEZEVIC, J. 2012. Quality of maintenance: Mirce Mechanics axiom. *Journal of Quality in Maintenance Engineering*, 18**,** 216-226.

LATEEF, O. A., KHAMIDI, M. F. & IDRUS, A. 2010. Building maintenance management in a Malaysian university campus: a case study. *Construction Economics and Building*, 10**,** 76-89.

LEE, H. H. Y. & SCOTT, D. 2009. Overview of maintenance strategy, acceptable maintenance standard and resources from a building maintenance operation perspective. *Journal of building appraisal*, 4**,** 269-278.

MILES, D. & SYAGGA, P. 1987. *Building maintenance*, Practical Action Publishing.

MOHD-NOOR, N., HAMID, M., ABDUL-GHANI, A. & HARON, S. 2011. Building maintenance budget determination: an exploration study in the Malaysia government practice. *Procedia Engineering,* 20**,** 435-444.

MOHD ZULAKHMAR, B. Z. 2006. Strategic Planning in Maintaining Sports Facilities in Malaysia in Teluk Danga International Games, Johor, Malaysia.

OLANREWAJU, A. L. & ABDUL-AZIZ, A.-R. 2015. *Building Maintenance Processes and Practices*, Springer.

RAMLY, A., AHMAD, N. & ISHAK, N. 2006. The Effects Of Design On The Maintenance Of Public Housing Building In Malaysia-Part One. *ABE, Retrieved from: www. abe. org. uk/www. abe. org. uk/.../May_06*.

SEELEY, I. H. 1987. *Building maintenance*, Macmillan Education.

SHAH ALI, A. 2009. Cost decision making in building maintenance practice in Malaysia. *Journal of Facilities Management,* 7**,** 298-306.

SHAH ALI, A., NIZAM KAMARUZZAMAN, S. & SALLEH, H. 2009. The characteristics of refurbishment projects in Malaysia. *Facilities,* 27**,** 56-65.

SHAH ALI, A., RAHMAT, I. & HASSAN, H. 2008. Involvement of key design participants in refurbishment design process. *Facilities,* 26**,** 389-400.

TABACHNICK, B. & FIDELL, L. 2007. Multivariate analysis of variance and covariance. *Using multivariate statistics,* 3**,** 402-407.

TSANG, A. & BROWN, W. Managing the maintenance performance of an electric utility through the use of balanced scorecards. Proceedings of the 3rd International Conference of Maintenance Societies, Adelaide, Australia, 1998. 1-10.

UDAY, K., PARIDA, A., CRESPO MÁRQUEZ, A., MOREU DE LEÓN, P., GÓMEZ FERNÁNDEZ, J., PARRA MÁRQUEZ, C. & LÓPEZ CAMPOS, M. 2009. The maintenance management framework: A practical view to maintenance management. *Journal of Quality in Maintenance Engineering,* 15**,** 167-178.

WORDSWORTH, P. & LEE, R. 2001. *Lee's building maintenance management*, Citeseer.

YACOB, S. B. 2005b. *Maintenance management system through strategic planning for public school in Malaysia.* Universiti Teknologi Malaysia.

ZAILAN, M. The management of public property in Malaysia. International Conference FIG Working Week 2001, 2001. 6-11.