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A Descriptive analysis of civil engineering maintenance in government hospital buildings

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Abstract Technical maintenance management was established to monitor the serviceability of some assets or buildings in providing the conducive environment to end users. Hospital classified as the most complex and heavily used buildings in government sectors and requires efficient maintenance schedule due to its functions to occupied patient almost all the time. Therefore, the scope of a maintenance management system in the government hospital is to ensure the preservation of its assets from defects and failures, thus optimize its function to serve the community accordingly. This research seeks to investigate the type of defects that normally occurred at the selected governments hospitals within Northern Peninsular Malaysia and the process of daily maintenance activities is to assess the hospital building performance with respect to their services and maintenances. In addition, this research also focuses the major problems that may arise during maintenance activities, thus offers the effective strategies to overcome them. In order to obtain the data, a set of questionnaire has been prepared and distributed to the selected hospitals. Data obtained from the survey is analyzed using IBM SPSS software. The result of the study presents the feedback and suggestion from the maintenance staff about the overall defects that have been identified in the government hospital building. Most of the respondents agreed that cracking is the major defect occurred in the selected hospital building. Improper installation during construction recognized as the vital factor leads to cracking in building structure. Based on the analysis, insufficient cost tends to constrain the maintenance work activities.

Keywords descriptive analysis, maintenance, hospital building

2010 Mathematics Subject Classification 62-07.

1 Introduction

Building defects may arise through several factors such as inappropriate or poor design, improper installation of components or structures, quality issues of material construction as well as insufficient attention given to building maintenance after completion of the projects. A thorough investigation should be carried out before any repair work is undertaken. Therefore, the technical requirement of investigating and diagnosing faults to assess condition, the organizational needs to specify, select, implement, and supervise, and corrective program are needed to be handled properly. There is no doubt that improved quality increases costs in labor and supervisor. However, this careful construction of structures attracts a proportionate consequence in necessary maintenance and repair cost during the life of a building. It is true the old paradigm prevention is better than cure, now is extended to a

new concept that prevention care is economically sound, socially desirable, technologically possible and environmentally friendly [**?**].

Malaysia is currently in the intermediary phase of development and industrialization whereby many construction projects are being developed. There are many projects that have been constructed such as commercial buildings, residential buildings, public buildings and industrial buildings. The project of public buildings includes educational buildings, hospital buildings and government buildings [**?**]. Government-operated public hospitals are to provide accessible, cost effective specialist services that are safe and respond to individual needs, with efficient health-care delivery regardless of geographic location. Public hospitals are usually large buildings that have significant impact on the environment and the economy of the surrounding community. The physical surroundings in hospitals constitute health problems in public health delivery [**?**].

Healthcare and a good hospital facility management are constantly required to sustain a clean and healthy environment. It is important for medical facilities to ensure service requests are responded to quickly and efficiently and preventive maintenance schedules are set up in order to maintain operations without interruption. Building defects are the failures that usually occur after a period of time of usage, or just after the completion of the construction. A thorough inspection and management during construction and maintenance should be performed to ensure that all the works is done according to structure plan. Leaky roofs and walls, wall cracks, and bad plumbing are the most communal problems of building defects. Due to very poor workmanship or bad quality material used for construction, most of defects may show up in the building as soon as the construction is completed instead of after a period of time [**?**].

2 Methodology

2.1 Preparation of questionnaire

During the preparation of questionnaire, journals and dissertations which related to this research are referred with the aim to extract the input and ideas from previous research in order to enhance the quality of the questionnaire. The data obtained are comprised two parts; primary and secondary data. Primary data is the data analyzed from the direct source, originally from the answered questionnaire, while secondary data may be obtained through journals, dissertations and proceedings. This research adopts the method of questionnaire and used as a raw data for software analysis. The questionnaire is widely known as a practical method in obtaining and analyzing the data. It allows evaluating large amounts of information from a large number of people in a short period of time and in a relatively cost effective way. In addition, the results of the questionnaires can be easily quantified through the usage of IBM SPSS software. So, using questionnaire as the primary source offers more accurate data compared to the other methods.

2.2 Sampling procedure

This survey was conducted at 11 hospitals within the Northern Region of Peninsular Malaysia. Since the study focuses on the civil maintenance works, the population size is the total number of staff that holds various positions in the maintenance company for selected hospitals. The population size of the respondents is 70. But, a population commonly

involved many individuals to study conveniently, thus a sample size is limited to certain number of respondents. Sample size is basically a part of the population. To estimate a reliable sample size, an example from [**?**] had been used as a reference. Based on the example, the sample size required for this research is 59 out of 70.

2.3 Pilot study

A pilot study is a smaller scale preliminary study conducted to obtain the validity of the questions. This test also required to design a full-scale experiment. For this study, 10 respondents from various positions at a maintenance company have been chosen to answer the questionnaire. The answers from the pilot study are then evaluated its reliability using SPSS software. Cronbachs Alpha is a method that used to measure the reliability of the questionnaire. According to [**?**], the minimum accepted value for test is 0.7. For this research, the value obtained is 0.771 and it can be concluded that this questionnaire is valid to be used throughout this research.

2.4 Descriptive analysis

Descriptive statistics are values that used to describe, present and summarize the data. For this research, mean was utilized to analyze the results. Descriptive analysis approach used five-point Likert scale questions only. Mean is used to show the average index class of the answers from the respondents. The values are able to demonstrate the opinion of the respondents. Tables 1 show the representation of the average index for five-point Likert scale questions.

Table 1: Average index of the Likert scale

Average index	1.00-1.49	1.50-2.49	2.50-3.49	3.50-4.49	4.50-5.00
Description	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

3 Result and discussions

3.1 Areas of civil engineering maintenance

The respondents come from different demographic backgrounds such as age, gender, educational qualification, position, working experience and job description. All of the respondents are maintenance staff and worked at the selected hospitals in Perlis, Kedah and Penang. The result obtained as shown in Figure 1 through classification of the major areas in civil engineering maintenance.

Most of the respondents involved in structural areas; the building itself. 55 out of 59 respondents are given a task to monitor building defects every day. The similar number of respondents has covered a scope of sewerage and water supply areas. 50 of maintenance staff required to monitor defects in drainage area. However, there are 12 respondents are not involved directly into the major areas as stated above. According to the feedbacks that have

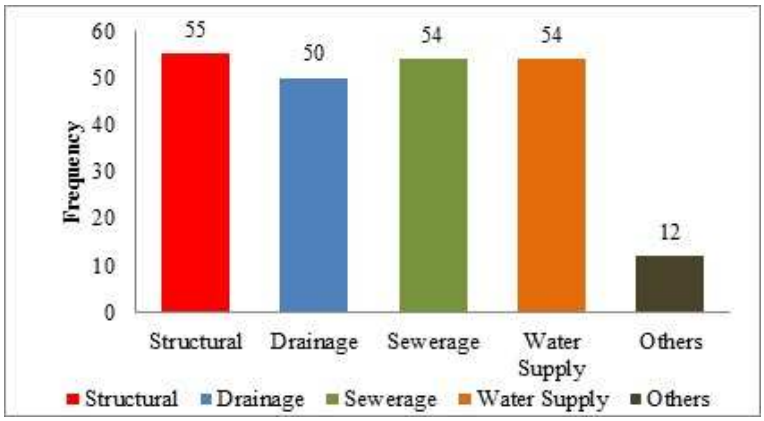

Figure 1: Scope of works

been extracted from the questionnaire, this others area is related to road and pavement. The maintenance of road and pavement at hospital areas classified as civil maintenance works. However, the defects occurred in this area is not critical as compared to others major areas.

3.2 Types and causes of the building defects

Figure 2 and Figure 3 shows the relationships between types of building defects and the factors was triggered those defects. Based on bar charts above, it can be concluded that the majority of the respondents agrees that cracking at structural elements is the most occurred defects and it is caused by improper installation during construction. Improper installation during construction leads to the major defects in hospitals. As a consequent, once cracking occurred, it will normally introduce other defects such as leakages, dampness, corrosion of reinforcement and roof defects.

For water leakage, most of the respondents stated that the major factor is due to the improper plumbing installation and concrete shrinkage. Water leakage causes nuisances to the occupants, especially to the patients. Dripping water from slabs and beams create moisture changes on the concrete surface and this may lead to water seepage and fungi attack. The durability of the structure is also decreased due to reinforced corrosion that caused by carbonation in concrete by the presence of carbon dioxide.

Furthermore, some of the respondents also agree that overloading and soil settlement causing cracking at walls, columns and beams. Overloading may occur due to several factors, such as construction material not comply the specific requirement as decided at the construction stage, thus reduces the capacity of building to carry the loadings. Soil settlement and design failure also leads to the defects of road pavement. Overloading from the structure is transmitted to the soil underneath and resulting in settlement issue and for worse scenario, influences by unstable foundation and increase of ground water level had occurred. However, unstable foundation is the result of design failure and cause soil settlement. Subsequently, all defects are related each other and caused by one or more sources of defects.

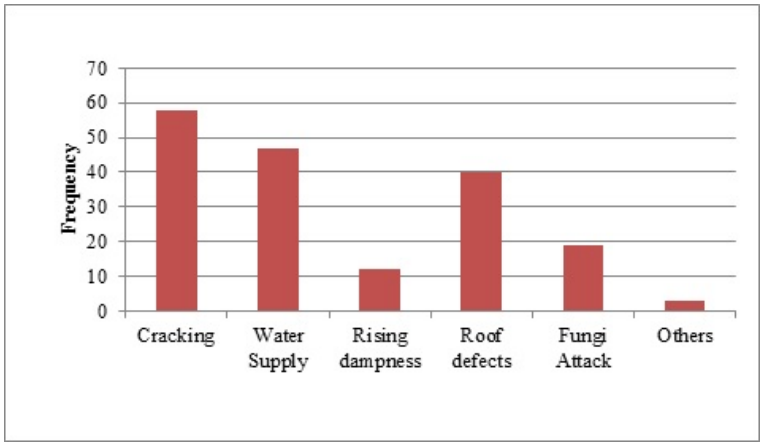

Figure 2: Types of building defects

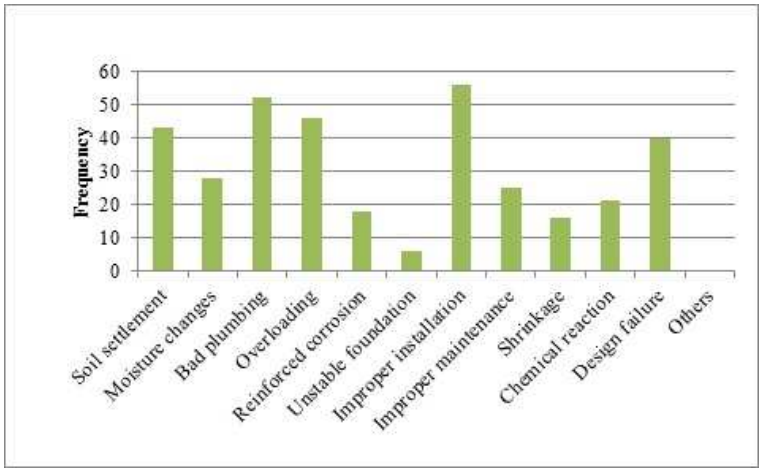

Figure 3: Causes of building defects

3.3 Types of maintenance

Figure 4 shows the types of maintenances practiced by maintenance staff. There are 3 types, known as preventive, corrective and predictive maintenance. Among those three, all of the respondents have selected preventive maintenance. This type of maintenance is the most important steps during maintenance activities. Preventive maintenance is a measure taken by the staff to prevent the defects from occurring again.

Corrective maintenance is usually taken after the defects were identified and create a nuisance to the occupants. Corrective maintenance is not a perfect measure because when the defects appear, the only solution in hand is to repair the structures and no safety measures are taken. Meanwhile, predictive maintenance is also performed by the maintenance staff. Predictive maintenance is usually practiced alongside with preventive maintenance, but this type of maintenance is rarely used by the maintenance staff. Predictive maintenance means staff should have the initiative to do some investigation and predict what types of defects may occur after some period of time. Predictive maintenance is a good measure taken to avoid defects to continuously occur.

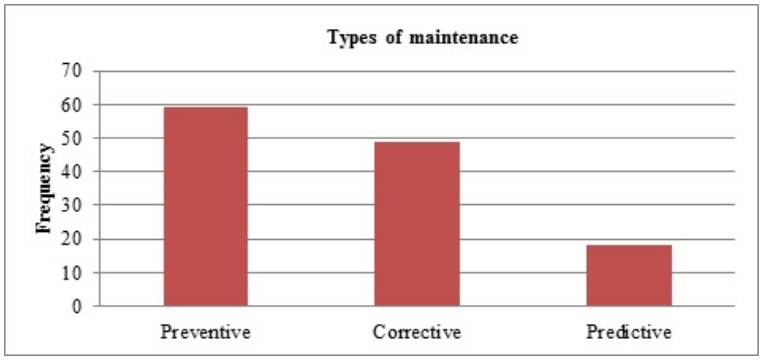

Figure 4: Types of maintenances used by workers

3.4 Physical conditions versus maintenance works

Table 2 shows the average index for questions that being asked regarding to agreement of climate will increase maintenance works and age of building does not define the number of maintenance works. Based on the scale designed, majority of the respondents was selected Neither agree nor disagree for both questions. Most of them, not sure about number of maintenance works required due to affect of physical conditions such as climate and age of the building.

3.5 Maintenance regularity versus company performance

Table 3 shows the average index for several questions as stated in the table above. Based on the scale designed, the majority of the respondents ticked Neither agree nor disagree for item 1 and 2 while selected agree for item 3. Data shows most of the respondents not sure about working hours will reflect the numbers of maintenance works and higher numbers in

Table 2: Physical conditions versus maintenance works

Item	Average Index
Climate increase maintenance works	3.49
Age of building does not define the number of maintenance works	3.14

maintenance activities are closely related to bad performances or quality. Item 3 show the agree opinion among the respondents demonstrated performance of maintenance will affect the performance of buildings.

Table 3: Maintenance regularity versus company performance

Item	Average index
Working hours shows the number of maintenance works	3.14
Higher maintenance needed, lower its work quality	3.46
Performance of maintenance affects performance of buildings	3.61

3.6 Types of problems during maintenance works and strategies to overcome maintenance problems

Set of questionnaire that distributed to respondents, allows respondents to share their opinions to minimize the failure, defects and maintenance issues at hospital buildings, through open ended question. Open ended question is selected because staff normally based on their experiences, may provide some brilliant ideas to solve the problems related to maintenance in government hospital building.

Figure 5 shows the types of problems during performing maintenance works and Figure 6 is their responsiveness towards those problems. Based on Figure 5, insufficient cost is the most frequent problem that becomes a constraint for maintenance staff and this problem answered by most of the respondents suggested to allocate enough budgets for maintenance purposes by related parties. According to pie chart above, most of the respondents agree if they are provided with enough costs for maintenance purpose, the problems arise will be solved. 26 of them (25.84%) agree with costs as the best solution to solve the problems. High costs limit the maintenance activities. Furthermore, statistical value shows that 25.84% of the respondents also stated that they should use higher quality materials during maintenance activities.

4 Conclusions

The result obtained shows the government hospital building have several types of defects that possible to create a nuisance to its occupants. The major defects in government hospital building are cracking and incorporated with problem of water supply and roof defects. This defect was occurred due to improper installation during construction stages. Aside

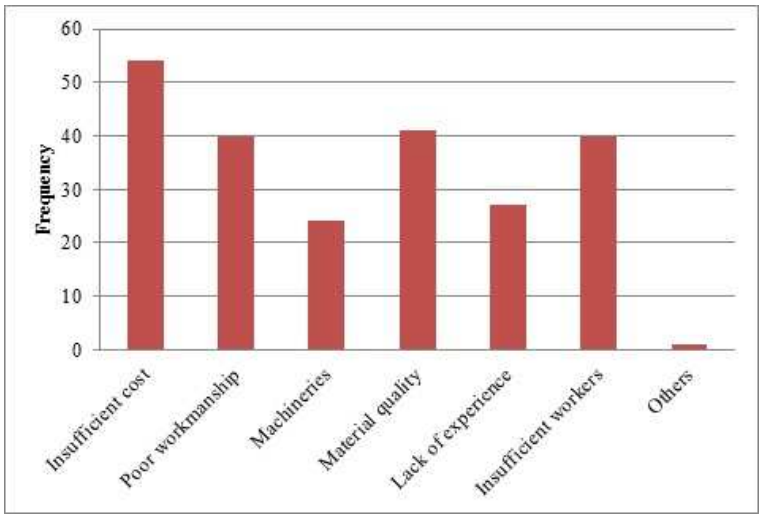

Figure 5: Problems during maintenance

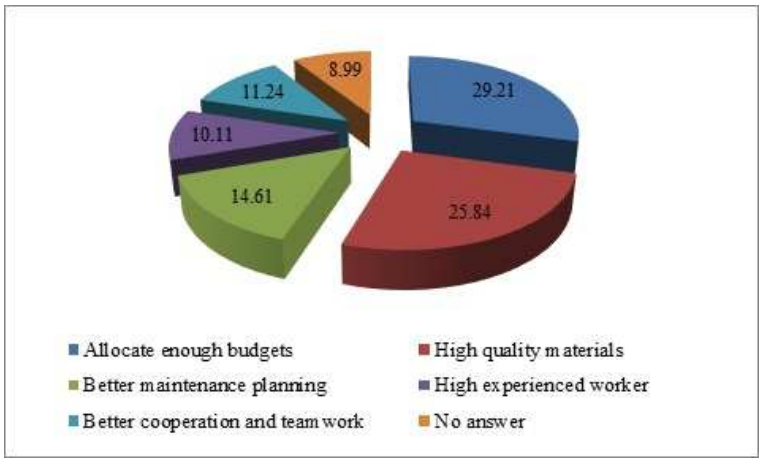

Figure 6: The strategies proposed by the respondents

that, bad plumbing and overloading also identified as another reasons that leads to these defects and most of the respondents practicing preventive and corrective maintenance rather than predictive method. Insufficient cost is the biggest barrier they faced during performs the maintenance activities. Some of the maintenance activities cannot be performed due to insufficient cost. Limited financial allocation will contribute to lack of tools and machineries, thus affecting the process of daily maintenance. Low material quality also mentioned as a part of the maintenance problems. As summary, most of the respondents suggest they should be provided with enough budgets to maintain the conducive environment for government hospital buildings.

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