

Maintenance Management Practices For Building Facility: A Case Study

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ABSTRACT

The practices of conventional methods for maintenance management in Malaysian Polytechnic faced many issues due to poor service delivery, inadequate finance, poor maintenance plan and maintenance backlogs. The purpose of this study is to improve the conventional method practices which tend to be ineffective in Malaysian Polytechnic. The case studies were conducted with eight Polytechnics from four state of Malaysia which were Selangor, Melaka, Negeri Sembilan and Johor. The selected Polytechnic is based on conventional method practices and its major problems, attempt to implement computerised technology and the willingness of staff to share their experiences. The responses from semi-structured interview with engineer and assistant engineer were recorded using video camera and transcribed verbatim. The overall findings of this research indicated; poor service delivery, inadequate financial, poor maintenance planning and maintenance backlogs. There is also need to overcome less man power competencies of maintenance management practices which existed with all eight Polytechnics. In addition, the study also found that the Polytechnics still use conventional maintenance management processes in managing building facility condition. The proposed solutions are intended to be used for maintenance management practices at Malaysian Polytechnics in order to provide high-quality of building facility with safe and healthy environments.

Keywords - Maintenance Management, Conventional Method, Maintenance Management System, Malaysian Polytechnic

I. INTRODUCTION

Nowadays, maintenance management is the essential issue in the construction industry. This issue is related to the disastrous defects as the roof collapsed at Stadium Terengganu [1] and the collapsed building at Jaya Supermarket in Petaling Jaya [2]. The reasons for those collapses are the deficiency of technical and administrative services in maintenance management. [3] stated that, the reasons for maintenance management deficiencies are delay of action taken, inefficient steps toward decision making processes and other related factors of staff weakness. Effective maintenance

management has significant value on running cost of particular building and infrastructure throughout its operation. The other identified issue of maintenance management is lack of completed system that helps to plan, implement, control and measure the maintenance performance of the facilities [4]. Although there are many systems related to maintenance management, but it still not consists of defect diagnosis for building and infrastructure in order to explain the real situation of maintenance defect [5]. Therefore, the problems emerged from treating the defect for heritage or old building structure over 25 years age to avoid it from being collapsed abruptly.

The preservation of critical building such as hospital is another issue in maintenance management. Hospital is one of the public buildings in Malaysia that has many facilities, which requires effective maintenance management to prevent it from deterioration. There are two types of maintenance presently applied at the hospital which is preventive maintenance and corrective maintenance. As an example, maintenance problem occurred at Hospital Raja Permaisuri Bainun (HRPB) when lifts was not functioning and also have limited space for car parks [6]. These scenario turns into people's disappointment to obtain medical services at hospital. The broken lifts are articulated due to insufficient attention given to building maintenance which related to poor design planning, conventional and weak management.

Presently, most organizations are still implementing conventional method rather than computerised systems to manage the maintenance of building facilities and infrastructure [7]. The conventional method such as using paper-based form and unsystematic database are apparently not able to capture long term business targets [8]. The problems emerged as a result of the need to manage huge and complicated data, for instance, data loss caused by unsuitable places for file storage, excessive retrieval time in the data files recovery and not supported with maintenance decision making.

II. ISSUES OF MAINTENANCE MANAGEMENT AT POLYTECHNIC

Polytechnic intends to transform into University status in year 2015. The Polytechnic Transformation Plan was launched by the Deputy

Prime Minister on February 25th, 2010 and three Polytechnics were transformed as Premier Polytechnic which is Ungku Omar Polytechnic, Salahuddin Abdul Aziz Shah Polytechnic and Ibrahim Sultan Polytechnic [9]. In the Second Rolling Plan of the 10th Malaysia Plan, Polytechnics has been given allocation for 17 projects development encompasses with facilities procurement, building and infrastructure [10].

Consequently, the polytechnic transformation indirectly increase maintenance development and need for sophisticated management system. Polytechnic has a department to coordinate maintenance and repair of equipment, buildings, infrastructure and facilities related work, including supporting services at polytechnic. However, the management system implemented by this department faced the problems of reporting the defect. All of the reports regarding facilities defect must utilize "Borang Laporan Kerosakan", where the student and staff have to fill up the paper-based form and being sent to the related department unit respectively. Student and staff are not motivated to report defect due to many form needed for that task. They also have to take the risk of report losses before reaching the related department. Moreover, the student and staff have to replenish the form after rejection in case of fault information and other related factor.

As a complainer, staff and student also have the difficulty to identify their complaint status whereby they have to call or send an email for action progress. In addition, the teaching and learning process cannot work smoothly and bother the lectures session of this haphazard complaint system [11].

The deficiency in maintenance management system also makes the department staff hard to totally record facilities defect periodically, thus increase the deferred maintenance. The existing system need to be improved in order to provide an efficient maintenance management processes at the polytechnics. The conventional method affects the quality and efficiency in maintenance management processes at polytechnics [12]. For example, Port Dickson Polytechnic facing the problems of the increasing number of maintenance deferred in every year [3].

According to [13], Kaduna Polytechnic in Nigeria faced the deterioration of painting on the interior wall surfaces. The cause for the problem is improper supervision of scrapping work in painting processes. Meanwhile, [12] stated that, one of the buildings at Rensselaer Polytechnic Institute (RPI) in United States of America has collapsed due to time gap of building repairs and fortunately no injury because of the incident. Mostly, RPI buildings are old structured and poses extended lifecycle services. This accident indicates the

importance of building sustainability that includes facilities maintenance management services.

As a result of the inherent weaknesses in maintenance management at polytechnic, an alternate maintenance management models are proposed, namely, Computerised Maintenance Management System (CMMS). This model is designed by integrating causes and reasons from shortcomings in the conventional process through the "constructability concept". The CMMS model is engaged in the new system to improve the characteristic element with the decision making process.

The significant factor to select a CMMS is much more advantageous than just a way to schedule maintenance management processes and able to perform the task needed without stressing the budget [14]. The CMMS does not make decision, rather it provides the maintenance manager with the best information which affects the operational efficiency of a facility [15]. Thus, the new system is equipped with the decision making process for maintenance identification, assessing and planning activity. The development system consists of three main components, which are Electronic Form (E-Form), relational database and Online Customer Complaint (OCC) for data collection as well as using an automation system to handle defect complaints from staff and student. This is important as a platform for huge data storage and to manage complicated data such as old structure building and equipment data. New system is expected to be beneficial to increase the efficiency of the maintenance management processes at the polytechnics [11].

III. METHODOLOGY

The case studies on eight Polytechnics were undertaken in order to identify the maintenance management problems, the current approaches to address the problems, the ICT implementation and the maintenance management system to obtain information relating to the maintenance identification, assessment, planning and execution processes. The interviews conducted were consisted of three types of Polytechnic, namely, 'New Polytechnic', 'Old Polytechnic' and 'Premier Polytechnic'. The case study is based on eight cases (Case A-Case H) of Polytechnic in Malaysia. There were two case studies (Case A and B) on 'Premier Polytechnic' that under the transformation plan to become a University College by 2015 and three case studies (Case C, D, and E) on 'Old Polytechnic' due to long establishment and operation such as Melaka Polytechnic which was established since January 1999. In addition, three more case studies (Case F, G, and H) are classified as 'New Polytechnic' which manages the

maintenance operation with fully equipped new amenities and facilities.

The justification for the selected case studies is according to the main criteria; exposed to the conventional method use and major problems, attempted to implement computerised technology and the willingness of staff to share their experiences in improving the maintenance management processes at the polytechnic. The combination of these different types of Polytechnics was used to gain the comparison of the maintenance management practices including the implementation of current ICT. The different types of Polytechnics also provides the variations on the maintenance management practices that is classified as old, new and premier Polytechnic respectively. The professional staffs were interviewed which either the engineer or assistant engineer and had the experiences in the maintenance management practices. The summary of the information on the eight case studies is presented in Table 1.1.

Table 1.1: List of case studies

Case	Name of Polytechnic	Type of Polytechnic	Person Interviewed	Maintenance Management System
A	Ibrahim Sultan Polytechnic, Johor	Premier	Engineer	Conventional
B	Sultan Salahuddin Abdul Aziz Shah Polytechnic, Selangor	Premier	Assistant Engineer	Conventional
C	Port Dickson Polytechnic, Negeri Sembilan	Old	Assistant Engineer	Conventional
D	Melaka Polytechnic, Melaka	Old	Assistant Engineer	Conventional
E	Merlimau Polytechnic, Melaka	Old	Engineer	Conventional
F	Mersing Polytechnic, Johor	New	Assistant Engineer	Conventional
G	Banting Polytechnic, Selangor	New	Assistant Engineer	Conventional
H	Nilai Polytechnic, Negeri Sembilan	New	Assistant Engineer	Conventional

The semi-structured interviews were conducted with either the engineer or assistant engineer due to their

responsibility for the maintenance management of the entire Polytechnic's building facility under Facility Management and Development Unit (UPPF) and Maintenance and Development Unit (UPS). The interview sessions took around half an hour to accumulate the data on the maintenance processes including the demonstration of the current maintenance management system with the implementation of ICT tools by the engineer or assistant engineer. All of the data from the interviews were recorded using video camera and transcribed verbatim.

IV. KEY FINDINGS FROM CASE STUDIES

There are eight case studies involved in this research to identify the maintenance management problems, the approaches to address problems, ICT implementation and the maintenance management system at the nominated polytechnic to improve the maintenance management practices for building facility and infrastructure. The findings from the case studies are summarised and presented in Table 1.2 below. The discussions involved a cross-case analysis and have been grouped into four main 'embedded units of analysis' that has been identified which is (1) Maintenance Management Problems, (2) Approaches to Address Problems, (3) ICT Implementation and (4) Maintenance Management System.

Table 1.2: Cross-Case Analysis

Element of Analysis	Case A	Case B	Case C	Case D	Case E	Case F	Case G	Case H
Maintenance Management Problems	<ul style="list-style-type: none"> • Nonspecific complaint • Time gap of building repairs • Limited budgets • Less competent manpower • Defect repetition • Student Vandalism 	<ul style="list-style-type: none"> • Less competent manpower • Defect repetition • Time gap of building repairs • Limited budgets 	<ul style="list-style-type: none"> • Nonspecific complaint • Time gap of building repairs • Limited budgets • Less competent manpower • Defect repetition 	<ul style="list-style-type: none"> • Less competent manpower • Defect repetition • Time gap of building repairs • Student Vandalism 	<ul style="list-style-type: none"> • Limited budgets • Defect repetition • Student Vandalism 	<ul style="list-style-type: none"> • Less competent manpower • Defect repetition • Time gap of building repairs • Limited budgets 	<ul style="list-style-type: none"> • Verbal complaint • Unsystematic database • Defect repetition • Less competent manpower • Time gap of building repairs • Limited budgets • Poor quality contractor 	<ul style="list-style-type: none"> • Lack of motivation for reporting defect • Delayed delivery complaint • Unhanded complaint • Limited budgets • Nonspecific complaint • Time gap of building repairs • Defect repetition • Poor quality contractor
Approaches to Addressing Problems	<ul style="list-style-type: none"> • To replace the old material (e.g. timber) with strong material (e.g. heavy steel) • Allocated the budget and gave punishment for vandalism cases • Training courses for technician 	<ul style="list-style-type: none"> • Training courses for technician • To replace the old material (e.g. timber) with strong material (e.g. heavy steel) 	<ul style="list-style-type: none"> • To replace the old material (e.g. timber) with strong material (e.g. heavy steel) • Training courses for technician 	<ul style="list-style-type: none"> • Provide more frequent inspection and assessment in identifying the causes of defect • Training courses for technician • Installed signage to motivate student to conserve facility 	<ul style="list-style-type: none"> • Priority on maintenance repairs • Installed signage to motivate student to conserve facility 	<ul style="list-style-type: none"> • Training courses for technician 	<ul style="list-style-type: none"> • Issued the notice to prevent verbal complaint for minor defect • Improve the maintenance assessment for the building maintenance works did by the contractor • Training courses for technician 	<ul style="list-style-type: none"> • Improve the maintenance assessment for the building maintenance works did by the contractor
ICT Implementation	MySPATA-Data inventory for immobile facilities (e.g. building) mySPA-Data inventory for mobile facilities (e.g. furniture)	MySPATA-Data inventory for immobile facilities (e.g. building) mySPA-Data inventory for mobile facilities (e.g. furniture) Email System- for managing complaints	MySPATA-Data inventory for immobile facilities (e.g. building) mySPA-Data inventory for mobile facilities (e.g. furniture) Email System- for managing complaints	MySPATA-Data inventory for immobile facilities (e.g. building) mySPA-Data inventory for mobile facilities (e.g. furniture) E-Aduan System- for managing complaints	MySPATA-Data inventory for immobile facilities (e.g. building) mySPA-Data inventory for mobile facilities (e.g. furniture)	MySPATA-Data inventory for immobile facilities (e.g. building) mySPA-Data inventory for mobile facilities (e.g. furniture)	MySPATA-Data inventory for immobile facilities (e.g. building) mySPA-Data inventory for mobile facilities (e.g. furniture) Email System- for managing complaints	MySPATA-Data inventory for immobile facilities (e.g. building) mySPA-Data inventory for mobile facilities (e.g. furniture)
Maintenance Management System	Conventional (e.g. paper-based form and unsystematic database)	Conventional (e.g. paper-based form and unsystematic database)	Conventional (e.g. paper-based form and unsystematic database)	Conventional (e.g. paper-based form and unsystematic database)	Conventional (e.g. paper-based form and unsystematic database)	Conventional (e.g. paper-based form and unsystematic database) and under DLP	Conventional (e.g. paper-based form and unsystematic database) and under DLP	Conventional (e.g. paper-based form and unsystematic database) and under DLP

Note:
DLP: Defect Liability Period

Case A: Ibrahim Sultan Polytechnic (PIS)

Case A involved Ibrahim Sultan Polytechnic which located at Kong Kong, Johor Bahru with the area of 150 acres on its development of building facility. Case A is classified as Premier Polytechnic due to the upgrade for pursuing the transformation plan to become a University College by 2015. The scope of Maintenance and Development Unit (UPS) in this Polytechnic is to manage the corrective and preventive maintenance for building facility. The engineer who is responsible in the maintenance management processes was interviewed in order to gain insight on the maintenance management problems, approaches to address problems, ICT implementation and maintenance management system at the Polytechnic.

(a) Maintenance Management Problems

The maintenance management practices in this Polytechnic had used conventional method such as paper-based form in managing the building maintenance. The maintenance processes were concerned on planning, surveying, procurement, supervision and handover project. There were several problems identified in this Polytechnic as followed:

- *Nonspecific complaint:* The complainer interpreted the defect information with general perception. As an example, the report informed that there was a damaged pipe valve at Block A. However, the actual defect was referred as a leaked pipe through the technician's inspection.
- *Time Gap of Building Repairs:* The technician unidentified the building defects in the customer complaint and need to inspect the defect at the site location. This affected the time taken for maintenance planning execution.
- *Limited budgets:* There were many departments at the Polytechnic such as Department of Civil, Mechanical and Electrical Engineering. The budget deficiency was due to upgrade of these building facilities at the Polytechnic. Besides, the unspecified database using the conventional method causing report overlook for the maintenance planning. The maintenance management staffs also found it difficult to calculate the budget amount for the particular facility because of the unspecified information on the customer complaint.
- *Less Competent manpower:* The manpower consisted of technician to perform the building inspection at the Polytechnic. The engineer and assistant engineer did not gain the specific explanation of defect that was described in the general perception. At the same time, the

defect repetition also occurred due to technician's failure to identify the actual defect at site location.

(b) Approaches to Address Problems

The defect repetition and vandalism cases frequently happened at hostel. A few students cause enormous damage by hitting the smoke detector in order to ease them smoking in the room. The maintenance management staff had to allocate the budget in the maintenance planning including the punishment towards student. Meanwhile, the old structure building contributed to the issue of defect repetition for the particular facility such as leaked pipe. The approach is to replace the old material (e.g. timber) with strong material (e.g. heavy steel). This provides the material's durability and prevents it from being damaged easily. The building improvement with the specific material replacement was executed at this Polytechnic.

(c) ICT Implementation

The technology system was used in managing maintenance consist of 'mySPATA' and 'mySPA' to record the data inventory at the Polytechnic. Both of these systems were developed by the JKR and Malaysian Administrative Modernisation and Management Planning Unit (MAMPU) to improve the inventory management of facility. The systems are to record the inventory number, equipment, department location, building level including the room number into the database system. The maintenance management staffs were not required to contact the complainer to clarify the information on particular defect and location. These systems enable the data inventory to be accessed for further corroboration in maintaining the building defect effectively.

(d) Maintenance Management System

The current maintenance management system is conducted manually and used paper-based form in managing the maintenance processes. 'mySPATA' and 'mySPA' application are also conducted in the same way. The interviewees recommended improving the system through paperless office in performing the building maintenance at the Polytechnic.

Case B: Sultan Salahuddin Abdul Aziz Shah Polytechnic (PSA)

Case B was concerned with Sultan Salahuddin Abdul Aziz Shah Polytechnic as the Premier Polytechnic that took area of 112 acres on its development of building facility. The main scope of Maintenance and Development Unit (UPSG) is to manage the customer complaint and planned and unplanned maintenance for building facility. There are two categories of maintenance

repairs consisted of 'Civil and Structural Section' (C&S) and 'Mechanical and Electrical Section' (M&E). The interview with the assistant engineer was undertaken to collect the data on key problems areas, current approaches to address the problems, ICT implementation and the maintenance management system at the Polytechnic.

(a) Maintenance Management Problems

The maintenance management processes was implemented by using the conventional method such as paper-based form and email system at the Polytechnic. The assistant engineer identified certain problems involved in the maintenance management as follows:

- *Less competent manpower:* The defect repetition always happened at the Polytechnic. The building facility was old and had long life span of services since it began its operation on July 1997. In addition, the number of students increased every year and presently, there are 6000 students. Defect repetition was due to student vandalisms including the lack of technician's competencies to find out the causes of defect in order to prevent the recurrence defect at different duration of time. The time gap of building repairs affected to the budget allocated for the Polytechnic.

(b) Approaches to Address Problems

The training courses were carried out for the technician in enhancing their skills in the maintenance management practices. The engineer also took other approaches with the defect repetition including replacing the old material (e.g. timber) with strong material (e.g. heavy steel) to the building facility.

(c) ICT Implementation

Generally, this Polytechnic utilised email system and paper-based form in managing complaints. Furthermore, 'mySPATA' and 'mySPA' were also used to improve the inventory. The assistant engineer suggested transforming from the paper-based into the electronic form with computer network.

(d) Maintenance Management System

In this Polytechnic, the conventional process was undertaken in the maintenance management system.

Case C: Port Dickson Polytechnic (PPD)

Case C involved the Port Dickson Polytechnic with the area of 100 acres on its development of building facility. This Polytechnic is among the old Polytechnics in Malaysia and established in year 1990 at Port Dickson, Negeri Sembilan. The Facility Management and

Development Unit (UPPF) was organised to manage the maintenance operation and to renovate the building facility at the Polytechnic. The type of building facility included hostel, building department, lecturer room and examination hall. The assistant engineer was interviewed to collect the data on the maintenance management problems, the current approaches to address the problems, ICT implementation and the maintenance management system.

(a) Maintenance Management Problems

The maintenance management processes was conducted at the Polytechnic manually and used the paper-based form and email system. The assistant engineer found several problems in managing the maintenance processes as follows:

- *Nonspecific complaint:* The defect findings from the inspection were not similar with the customer complaint. This was due to unspecific information related to the explanation of the building defect. The technician required additional time to inspect the actual defect at the site location.
- *Time gap of building repairs:* The time range for inspection increased due to the unspecific information in the customer complaint. The customer was less technical in knowledge on the building facility defect. The technician faced the time constraints to execute the maintenance for the instant action.
- *Limited budgets:* The allocation of budget was planned early every year. This budget consisted of corrective and preventive maintenance including the renovation of the building facility at the Polytechnic. The ad hoc maintenance such as exploded cable or leaked pipe caused burden to the maintenance management staff. In addition, the staff also found it difficult to estimate the budget expenses for many departments due to mishandling and unhandled many complaint reports.
- *Less competent manpower:* The engineer and assistant engineer found less explanation on the building defect identification from the technician. In addition, the extended time for identifying the defect in the inspection affected the costing for building maintenance.

(b) Approaches to Address Problems

The training courses were carried out for the technician in developing their skills on the inspection of defect in the maintenance management practices. The assistant engineer also took other approaches with the defect repetition such as replacing the old material (e.g. timber) with strong material (e.g. heavy steel).

(c) ICT Implementation

This Polytechnic provided ICT tools to support the maintenance management. These include: (a) email system; (b) mySPATA; (c) mySPA. The email system is to facilitate customer in reporting the building facility defect. The implementation of 'mySPATA' and 'mySPA' is for recording the data inventory including location of defect in detail.

(d) Maintenance Management System

The conventional method such as paper-based form and email system was adopted to provide the maintenance identification, assessment, planning and execution at the Polytechnic. The suggestion from the assistant engineer is to transform the paper-based form into a computerised system that has the potential to reduce the cost on the maintenance repairs at the Polytechnic.

Case D: Melaka Polytechnic (PMK)

Case D involved the Melaka Polytechnic (PMK) with the area of less than 100 acres on its development of building facility. PMK comprised of 25 units fully modified shop lots equipped with the basic amenities and facilities required by an institution of higher learning. The Maintenance and Development Unit (UPS) is to manage the maintenance for building facility. This unit also has 'E-Aduan' system in the website portal of Melaka Polytechnic to manage customer complaint. The assistant engineer was interviewed to collect the data related to the key problems areas, approaches to address problems, ICT implementation and the maintenance management system at the Polytechnic.

(a) Maintenance Management Problems

The maintenance management practices used the conventional method such as paper-based form. The online customer complaint in so called 'E-Aduan' system facilitated the report transmission without having to send the paper-based form directly to the UPS office. The most significant problems faced by the assistant engineer were as follow:

- *Less competent manpower:* Mostly, two to three complaints with different building defects were identified in one day. The technician was less competent in identifying the causes of the defect for the particular facility such as substation cable at the Polytechnic. These problems affected the maintenance execution, as illustrated, during the quotation for the specific task including the selection of an appropriate contractor.
- *Repetition defect:* The reason for the defect repetition was due to the maintenance

assessment and student vandalism. The failure of the technician to identify the causes of the building defect increased the time consumed on the inspection. Meanwhile, the student vandalism was referred to the bad attitude in preserving the building facility and infrastructure at the Polytechnic.

(b) Approaches to Address Problems

The technician had conducted daily inspection to resolve the frequency of defect at the Polytechnic. The training courses were carried out for the technician in improving their technical knowledge on ad hoc and preventive maintenance for building facility. The assistant engineer installed a signage to motivate student and Polytechnic's staff for conserving the building facility properly.

(c) ICT Implementation

Generally, this Polytechnic was supported by basic ICT tools together with an information system to support the maintenance management. These include: (a) E-Aduan System; (b) mySPATA; (c) mySPA. The E-Aduan system is used to improve the management of complaint using the paper-based form while mySPATA is used to manage the data inventory for immobile facilities (e.g. building). The mySPA is used for recording the data inventory of mobile facilities (e.g. furniture).

(d) Maintenance Management System

Melaka Polytechnic was supported by the conventional process in maintenance management including online customer complaint to facilitate the customer satisfaction in reporting defect.

Case E: Merlimau Polytechnic (PMM)

Case E involved the Merlimau Polytechnic with the area of 100 acres on its development of building facility. The Maintenance and Development Unit (UPS) was responsible to manage the maintenance processes at the Polytechnic. The interview was carried out with the engineer to find out the maintenance management problems, approaches to address problems, ICT implementation and maintenance management system at the Polytechnic.

(a) Maintenance Management Problems

The maintenance management at this Polytechnic used the conventional method such as paper-based form. The building facility had long life span of services and able to capture the capacity of 5000 students. The engineer identified a problem relating to the maintenance management as follows:

- *Limited Budgets:* The building facility age more than 10 years services life span and need the frequency of building maintenance. The excessive budget especially on ad hoc maintenance restricted the technician for executing the maintenance in the particular duration. The negative perception of students toward building conservation was also the main reason for the budget constraints at the Polytechnic. The students do not appreciate the advantages of the building facility that provided them the comfortable place to develop knowledge at the Polytechnic.

(b) Approaches to Address Problems

Priority maintenance plan were used to overcome the budget constraints for building maintenance. In addition, the engineer has installed the signage to motivate student and Polytechnic's staff to conserve the building facility properly.

(c) ICT Implementation

The 'mySPATA' and 'mySPA' were used in managing maintenance. The use of 'mySPATA' and 'mySPA' is to record the inventory number, equipment, department location, building level and the room number for the inspection activity.

(d) Maintenance Management System

The current maintenance management system was conducted manually and used the paper-based form. The interviewees were aware of the potential to implement ICT in improving the maintenance management processes in the future.

Case F: Mersing Polytechnic (PMJ)

Case F was concerned with the Mersing Polytechnic that took area of 122 acres on its development of building facility. The Maintenance and Development Unit (UPS) at the Polytechnic had the responsible to manage the maintenance operation in ensuring the sustainability of the building facility. The assistant engineer was interviewed to collect the data related to the maintenance management problems, approaches to address problems, ICT implementation and maintenance management system at the Polytechnic.

(a) Maintenance Management Problems

The conventional method such as paper-based form was used to manage the corrective and preventive maintenance for the building facility. The assistant engineer identified the problems involved in the maintenance management as follows:

- *Less competent manpower:* The example of the defect repetition was leaked pipe at the hostel. The causes for the particular building defects

were unidentified by the technician and impacted the time for the inspection works. The budget constraint was due to the number of defects repetition especially on the ad hoc maintenance for the building facility.

(b) Approaches to Address Problems

The training courses were carried out for the technicians in enhancing their skills in the inspection works.

(c) ICT Implementation

Generally, this Polytechnic utilised paper-based form in managing the complaints. Furthermore, 'mySPATA' and 'mySPA' is under the new stage of implementation and had been used to assist the technician for recording the data inventory and location of defect in detail.

(d) Maintenance Management System

In this Polytechnic, the conventional process was undertaken in the maintenance management conducted by the main contractor due to defect liability period (DLP) till year 2014.

Case G: Banting Polytechnic (PBS)

Case G involved the Banting Polytechnic with the area of less than 100 acres on its development of building facility. The Banting Polytechnic can accommodate about 2400 students. The assistant engineer was interviewed to collect the data of maintenance management problems, approaches to address problems, ICT implementation and maintenance management system at the Polytechnic.

(a) Maintenance Management Problems

The maintenance management practices used the conventional method such as paper-based form and verbal communication. The Maintenance and Development Unit (UPS) that consisted of assistant engineer and technicians is to manage the building facility and infrastructure that took area less than 100 acres. The assistant engineer identified several problems in the maintenance management as follows:

- *Verbal complaint:* The customer such as student and staff report the defect verbally without going to the UPS office. The information had not been recorded into the database and affected the budget estimated for the particular facilities. In addition, this difficulty bothered the maintenance planning at the Polytechnic.
- *Defect repetition:* The contractor's work ethic was among the causes of defect repetition. Several contractors had repaired the defect under certain purpose to take more profits. This situation had been referred to the

preventive maintenance by the contractors where the service contracts for the particular contractors were within one to two years duration which is more than needed. Besides, the less skilled technician in the works of inspection affected the maintenance identification for the building facility and infrastructure. The technicians took long time to investigate the defect causes for the facilities at the Polytechnic.

(b) Approaches to Address Problems

The assistant engineer had issued notice for controlling the verbal complaint in reporting the defect that involved a minor building defect. The training courses also were carried out for the technicians in improving their competencies in the maintenance assessment of building facility.

(c) ICT Implementation

This Polytechnic provided ICT tools to the support maintenance management. These include: (a) mySPATA; (b) mySPA. The ‘mySPATA’ and ‘mySPA’ to record the data inventory and location of defect in detail.

(d) Maintenance Management System

The conventional method such as paper-based form was adopted in the maintenance management being conducted under the main contractor due to the DLP till year 2014.

Case H: Nilai Polytechnic (PNS)

Case H involved the Nilai Polytechnic with the area of 101.5 acres on its development of building facility. This campus consisted of 37 administration building blocks, academic, hostel and staff residential. The Maintenance and Development Unit (UPS) led by the assistant engineer was organised to manage the maintenance for the building facility. The assistant engineer was interviewed to collect the data for the maintenance management problem, approaches to address problems, ICT implementation and maintenance management system at the Polytechnic.

(a) Maintenance Management Problems

The maintenance management was executed manually using paper-based form. The assistant engineer identified the particular problems as follow:

- *Lack of motivation for reporting defect:* Mostly, the paper-based form had delayed for a few days due to no motivation to report defect in the actual time. The delivery delay of the defect complaint was also because of report unhanding. Therefore, the abandoned defect increased the costing on repairs for the facilities to restore its standard condition.

- *Nonspecific complaint:* The maintenance management staff had to contact the complainer to gather the data such as the facility type and location of defect in detail because the information was not specific to the site location. Consequently, this had caused increased duration to conduct the maintenance planning for the facilities at the Polytechnic.
- *Defect repetition:* The poor quality of the main contractor was among of the reasons on the defect repetition problems due to the delay in managing the maintenance in the particular duration. In addition, the quality of material used in maintaining the facilities was also the other reason for the defects repetition at this Polytechnic.

(b) Approaches to Address Problems

The technician conducted the investigation to improve the maintenance assessment for the building maintenance works did by the main contractor.

(c) ICT Implementation

Generally, this Polytechnic was supported by ‘mySPATA’ and ‘mySPA’ to manage the data inventory for the building facility.

(d) Maintenance Management System

This Polytechnic was supported by the conventional process in the maintenance management had been conducted under the main contractor until July 2013.

V. SYNTHESIS OF GOOD PRACTICES

Table 1.3 below represents the suggested solution from the case studies to improve their current practices on the maintenance management by ICT implementation at the Polytechnic. Case A, C and H, they have been suggested to improve the particular defect of information in the complaint by combining with the related software technology. The customers will use the electronic form to report the defect complete with the data facilities and more detail of the defect explanation to gather accuracy of the inspection works. The other suggestion from the assistant engineer is to provide the information on the particular defect to diagnose the facility at the Polytechnic (Case A, B, C, D, F and G).

Table 1.3: Suggested Solutions from Case Studies

CASE STUDY	SUGGESTED SOLUTIONS
Case A	<ul style="list-style-type: none"> • Improve the specific defect information in complaint • Provide more specific information on inspection • Decrease the defect repetition

	<p>through assessment for material quality used</p> <ul style="list-style-type: none"> Control the budget allocated for maintenance planning
Case B	<ul style="list-style-type: none"> Provide more specific information on inspection Decrease the defect repetition through assessment for material quality used Control the budget allocated for maintenance planning
Case C	<ul style="list-style-type: none"> Improve the specific defect information in complaint Provide more specific information on inspection Decrease the defect repetition through assessment for material quality used Control the budget allocated for maintenance planning
Case D	<ul style="list-style-type: none"> Provide more specific information on inspection Decrease the defect repetition through assessment for material quality used
Case E	<ul style="list-style-type: none"> Decrease the defect repetition through assessment for material quality used Control the budget allocated for maintenance planning
Case F	<ul style="list-style-type: none"> Provide more specific information on inspection Decrease the defect repetition through assessment for material quality used Control the budget allocated for maintenance planning
Case G	<ul style="list-style-type: none"> Provide more specific information on inspection Decrease the defect repetition through assessment for material quality used Control the budget allocated for maintenance planning
Case H	<ul style="list-style-type: none"> Improve the specific defect information in complaint Decrease the defect repetition through assessment for material quality used Control the budget allocated for maintenance planning

The assistant engineer also suggested improving the maintenance assessment for the material used in the building facility and infrastructure in regard with the repetition of defect at the Polytechnic. The case studies recommended

providing more sustainable facilities in order to control the budget expense for the entire facilities at the Polytechnic.

Case A, B, C, E, F, G and H have been suggested to prevent the limited budgets through efficient maintenance planning on the ad hoc maintenance. There were many departments and units considered for the maintenance management processes at the Polytechnic. The mishandling of defect report caused inadequate budget in maintaining the facilities. Therefore, the systematic database with the current ICT technology and decision making process should be developed to improve the building facility and infrastructure performance by conducting regularly time schedule on the maintenance repairs.

VI. CONCLUSION

There is a total of eight case studies have been used to analyse the key problems, approach to address problems, ICT implementation and maintenance management system at polytechnic. The factor of nonspecific complaint, defect repetition, limited budgets, time gap of building repairs and less competent manpower are the main problems on the case studies findings. In order to improve information adequacy in the complaint, the new system will be developed which provides building attributes, for instance, the facility type, defect and location in detail. Other than that, the new system can manage budgets on ad hoc and preventive maintenance effectively.

Regarding the above findings, this research will concentrate on the development of a new system to integrate the maintenance identification, assessment and planning processes to improve the decision making process and maintenance management at Polytechnic.

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