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WEB BASED INFORMATION MODEL TO SUPPORT
MAINTENANCE AND OPERATIONS MANAGEMENT

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A thesis submitted in fulfillment of the
requirements for the award of the degree of
Master of Engineering (Civil)

Faculty of Civil and Environmental Engineering
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SEPTEMBER 2007

I declare that this thesis entitled “*WEB BASED INFORMATION MODEL TO SUPPORT MAINTENANCE AND OPERATIONS MANAGEMENT*” is the result of my own research except cited in the references. The thesis has not been accepted for any degree and is not currently submitted in candidature of any other degree.

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*“For my beloved father, Haji Zakaria Bin Haji Abd Aziz; mother, Hajjah Siti
Sa’adah Bt Hj Ahmad; wife, Syaizura Hani Bt Abd Samat; and
sons, Muhammad Amir Danish & Muhammad Danish Iskandar; sister,
Norzalida and brothers, Zahriladha & Zahrulhazmi and my fellow friends
...Alhamdulillah ”*

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ABSTRACT

Facilities Management (FM) has been considered as facilities maintenance and operation and has a broad range of functions. Because of its nature, information can be lost during maintenance operations and it will affect decision making. Information Technology (IT) may be used as a tool to make an effective decision-making and productivity of the organisation can be further improved through the use of IT. Therefore the use of a Computerised Maintenance Management System (CMMS) as an operational and maintenance management tool can be used. The purpose of a CMMS is to manage, capture, and track inspection, maintenance and repair activities of an organisation, because in a world of increasing information flows, data retrieval becomes more and more important. Therefore, the purpose of this study is to identify the requirement of electronic management for the maintenance department to support their maintenance operations. This research is also aimed to develop and gauge the effectiveness of the proposed framework for an information model called *electronic Maintenance Online System* (eMOST) to support maintenance and operations at the Office of Development and Asset Management or Pejabat Pembangunan dan Pengurusan Harta (PPPH), Kolej Universiti Kejuruteraan dan Teknologi Malaysia (KUKTEM) as a facility management tool. In this research, Cold Fusion Markup Language and MS Access as a database were used to develop the proposed information model. It starts with developing the process model using IDEFØ notation before transform it into programming language.. Prior to the development of eMOST, quantitative studies had been conducted by using three different sets of questionnaires which were designed to meet the objectives of the study. The first set of questionnaire tackled the issues of maintenance management at higher institutions in Malaysia and the second set of questionnaire is to investigate the customer satisfaction index on the performance of maintenance activities done by PPPH, KUKTEM. The third questionnaire was meant to evaluate the proposed information model i.e eMOST from users' perspective and perceptions. The results from analysis of the survey data showed that, none of the higher learning institutions in Malaysia used any facility management software or CMMS to assist their maintenance activities as the majority of them were using out-sourcing method to carry out their maintenance activities and therefore the use of eMOST has expedited the response time taken by PPPH.

ABSTRAK

Pengurusan Fasiliti mempunyai skop pengurusan yang luas. Antaranya ialah pengurusan penyelenggaraan dan juga pengurusan operasi. Dalam mengurus fasiliti, maklumat yang betul dan tepat amat penting dalam membantu membuat keputusan semasa mengurus fasiliti. Namun, disebabkan mempunyai skop yang luas, kehilangan maklumat boleh berlaku dan mempengaruhi dalam membuat sesuatu keputusan. Di dalam arus kementerian, Teknologi Maklumat (TM) boleh digunakan sebagai alat dalam membantu untuk mengumpulkan maklumat sekaligus dapat membantu Pengurus Fasiliti membuat sebarang keputusan dengan lebih cepat. Maka, penggunaan Sistem Pengurusan Penyelenggaraan Berbantu komputer (SPPB) boleh dijadikan sebagai alat kepada Pengurus Fasiliti dalam mengurus kerja-kerja penyelenggaraan dan operasinya. Tujuan utama SPPB ini ialah untuk mengumpul, mengurus dan mengesan kerja-kerja penyelenggaraan didalam sesebuah organisasi. Oleh itu, tujuan kajian ini dilakukan ialah untuk mengenal pasti elemen-elemen yang perlu ada pada sesebuah SPPB. Selain itu, kajian ini dilakukan ialah untuk membina dan menguji keberkesanan SPPB yang dibangunkan dan disamping membuktikan bahawa TM berupaya untuk membantu Pengurus Fasiliti di Pejabat Pembangunan dan Pengurusan Harta (PPPH), Kolej Universiti Kejuruteraan dan Teknologi Malaysia (KUKTEM) dalam mengurus kerja-kerja penyelenggaraan dan operasi. SPPB yang dibangunkan diberi nama *electronic Maintenance Online System (eMOST)*. Dalam membangunkan SPPB ini, bahasa yang digunakan ialah *Cold Fusion Markup Language (CFML)* bersama *MS Access* sebagai pengkalan data. Ianya bermula dengan membuat proses carta aliran dengan mengguna simbol IDEF0 kemudian ianya akan ditukar menjadi sistem dengan menggunakan bahasa pengaturcaraan. Sebelum pembinaan *eMOST* dilakukan, kajian kuantitatif dilakukan dengan membuat tiga set borang kaji selidik yang mempunyai objektifnya yang tersendiri. Set borang kaji selidik yang pertama bertujuan untuk mengetahui isu-isu kerja-kerja penyelenggaraan yang timbul di Institusi Pengajian Tinggi Awam (IPTA). Set borang kaji selidik yang kedua bertujuan untuk menilai prestasi kerja-kerja penyelenggaraan yang dilakukan oleh PPPH dari kaca mata pelanggannya. Manakala, set borang kaji selidik yang ketiga ialah untuk menilai keberkesanan *eMOST* dalam membantu menguruskan kerja-kerja penyelenggaraan dari kaca mata pelanggan PPPH. Hasilnya didapati, tiada satu IPTA yang menggunakan SPPB dalam mengurus kerja-kerja penyelenggaraan, majoriti kerja-kerja penyelenggaraan yang dilakukan di IPTA ialah menggunakan kontraktor luar dan didapati *eMOST* sebagai SPPB dapat membantu dalam menguruskan kerja-kerja penyelenggaraan dan mempercepatkan masa tindakbalas aduan oleh PPPH, KUKTEM.

TABLE OF CONTENTS

CHAPTER	TITLE	PAGE
	TOPIC	i
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	TABLE OF CONTENTS	vii
	LIST OF TABLES	xii
	LIST OF FIGURES	xiii
	LIST OF APPENDICES	xv
1	INTRODUCTION	
	1.1 Background	1
	1.2 Background of the problem	2
	1.2.1 Pejabat Pembangunan dan Pengurusan Harta (PPPH), Kolej Universiti Kejuruteraan dan Teknologi Malaysia as a case study	3
	1.3 Problem Statement	8
	1.4 Objective	8
	1.5 Scope	8
	1.6 Importance of the study	9
	1.7 The Methodology	10
	1.8 Summary	12

2	LITERATURE REVIEW	
2.1	Introduction	13
2.2	An Overview of Facilities Management (FM)	13
2.3	Function of Facilities Management (FM)	15
2.4	An Overview of Operation and Maintenance (O&M)	19
2.4.1	Classification of Operations and Maintenance (O&M)	20
2.5	An Overview of Maintenance Procurement	21
2.5.1	Direct Purchase	23
2.5.2	Quotation	23
2.5.3	Tender	23
2.6	An Overview of Resourcing	24
2.7	An Overview of Maintenance Contract	24
2.7.1	Contract based on Drawing and Specification	25
2.7.2	Contract based on Bill of Quantities	25
2.7.3	Cost Reimbursement Contract	26
2.7.4	Term Contract	26
2.7.4.1	Measure Term Contract	27
2.7.4.2	Day Work Term Contract	27
2.8	Project Information Life Cycle	28
2.8.1	Information Technology in Operation and Maintenance (O&M)	30
2.9	Reviews on Previous Research on Conceptual Operations and Maintenance Management Model	32
2.9.1	Facility Management Information System (FMIS)	33
2.9.2	Integrated Facility Management Information System (IFMIS)	34
2.9.3	Facilities Management (FM) Models Findings	35

3	RESEARCH METHODOLOGY	
3.1	Introduction	36
3.2	Information Gathering	36
3.3	The Instruments	37
3.3.1	Questionnaire on Issues of Maintenance Management at Higher Learning Institutions in Malaysia	39
3.3.2	Questionnaire on Assessment of Implementation of Maintenance Works at Pejabat Pembangunan dan Pengurusan Harta (PPPH), Kolej Universiti Kejuruteraan dan Teknologi Malaysia (KUKTEM)	47
3.3.3	Questionnaire on the Evaluating of the Proposed Information Model	51
3.4	Sample of the Study	53
3.5	Reliability Test	54
3.6	Building the Process Model	54
3.7	Development of Information Model	56
3.7.1	Data Flow Diagram (DFD) – Definitions and Symbols	58
3.7.2	Selection of Hardware and Software	60
3.8	Summary	61
 4	 PROPOSED INFORMATION MODEL	
4.1	Introduction	62
4.2	Proposed Maintenance Management Process Model	62
4.2.1	Manage Asset	65
4.2.2	Maintain Asset	66
4.3	Building the Information Model	68
4.3.1	Data Flow Diagram (DFD)	68
4.3.2	Application Menu Design	71

4.3.3	Main Menu Interface	72
4.3.4	Work Order System	75
4.3.5	Preventive Maintenance (PM) Task System	77
4.3.6	Reporting System	79
4.4	Summary	82
5	DATA ANALYSIS	
5.1	Introduction	83
5.2	Issues of Maintenance Management at Higher Learning Institutions in Malaysia	84
5.2.1	Computerised Maintenance Management System (CMMS)	85
5.2.2	Most Needed Functions in Computerised Maintenance Management System (CMMS) Software	85
5.2.3	Source of Services	87
5.2.4	Maintenance Related Problem	91
5.2.5	Discussion on Issues of Maintenance Management at Higher Learning Institutions in Malaysia	93
5.3	Assessments of Implementation of Maintenance Work at Kolej Universiti Kejuruteraan dan Teknologi Malaysia (KUKTEM)	94
5.3.1	Questionnaire Distributions	95
5.3.2	Managing the Maintenance Works	97
5.3.3	Providing Safety and Health Precautions	99
5.3.4	Complaint Management System	100
5.3.5	Discussion on Assessment of Implementation of Maintenance Works at Kolej Universiti Kejuruteraan dan Teknologi Malaysia (KUKTEM)	103

5.4	Evaluation of Proposed Information Model	104
5.4.1	Questionnaire Distribution	104
5.4.2	System Functions	106
5.4.3	Monitoring and Controlling the Contractors	108
5.4.4	Discussion on Evaluation of Proposed Information Model	110
6	CONCLUSION	
6.1	Introduction	111
6.2	Constraint of Research	112
6.3	Conclusion	113
6.4	Future Research	114
	REFERENCES	116
	APPENDICES	123

LIST OF TABLES

TABLE NO.	TITLE	PAGE
Table 3.1	Summary of opinion related to most needed functions in Computerised Maintenance Management System	40
Table 3.2	Summary of opinion related to measuring the maintenance department performance.	48
Table 3.3	Size of Populations and Samples	53
Table 3.3	Results of Reliability Test	54
Table 3.4	Life span of the components of an information system	56
Table 5.1	Questionnaire distribution and response rate by Organisations	84
Table 5.2	Questionnaire distribution and response rate by Positions	84
Table 5.3	Most Needed Maintenance Functions	87
Table 5.4	Distribution of Type of Maintenance by Source of Service	88
Table 5.5	Distribution of Maintenance Components by Source of Service	89
Table 5.6	Reason using Outsourcing	90
Table 5.7	Reason using In House	90
Table 5.8	Common problems experienced by the maintenance department	92
Table 5.9	Questionnaire distribution and response rate	95
Table 5.10	Satisfaction level for all respondents	96
Table 5.11	Mean score for Management of Maintenances Works Criteria	98

Table 5.12	Mean Score Customer Satisfaction for staffs and students	98
Table 5.13	ANOVA overall standing	99
Table 5.14	Mean score for Providing Safety and Health Precautions Criteria	100
Table 5.15	Mean score for Complaint Management system Criteria	100
Table 5.16	Questionnaire distribution and response rate	105
Table 5.17	Respond for all respondents	106
Table 5.18	Mean score for System Functions	107
Table 5.19	Mean score for Monitoring and Controlling Criteria	109

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
Figure 1.1	Organization Chart for PPPH	5
Figure 1.2	User using memo to lodge complain	6
Figure 1.3	Work done report form	7
Figure 1.4	The Methodology	11
Figure 2.1	FM Components	14
Figure 2.2	An Overview the scope of FM activities, (Quah,1999)	15
Figure 2.3	Functions of general planning and control (Yu et al., 2000)	16
Figure 2.4	Identifiable FM Functions (Yu et al., 2000)	18
Figure 2.5	Flowchart for Procurement Process for maintenance work	22
Figure 2.6	Project Information Life Cycle (Yu et al. 1999)	28
Figure 2.7	Project's Life Cycle (CIDB News, Issue 3, 2003)	29
Figure 2.8	Current utilization of computer applications and data exchange in FM (Teicholz and Takehiko, 1995)	31
Figure 2.9	FMIS system architecture (Boss, 1995)	33
Figure 2.10	IFMIS system architecture (Cheng et al.,1996)	34
Figure 3.1	Process flow gathering information	38
Figure 3.2	IDEFØ notation Legend	56
Figure 3.3	System Architecture for proposed Information Model	58
Figure 3.4	Comparison of sets of DFD Symbols	59
Figure 3.5	Show How a web server and web application server work together	60
Figure 4.1	General Maintenance Management Process Model	64

Figure 4.2	Node A0 – Decomposition diagram for <i>Manage Asset</i> process	65
Figure 4.3	Node M0 - Decomposition diagram for <i>Maintain Asset</i> process	66
Figure 4.4	Node M1 - Decomposition diagram for <i>Maintenance Option</i> process	67
Figure 4.5	Information Structured in the proposed Information model	69
Figure 4.6	A Context Diagram of proposed Information Model	70
Figure 4.7	Overview for the proposed Information model menu and sub menu	73
Figure 4.8	Main interface for the Head of Department	74
Figure 4.9	Main interface for the staff of maintenance department	75
Figure 4.10	The Interface of Corrective Work Order	76
Figure 4.11	The Interface of Preventive Work Order	77
Figure 4.12	The Interface for Preventive Maintenance Task	78
Figure 4.13	The Interface for completed work done report for corrective maintenance	80
Figure 4.14	The Interface for completed work done report for preventive maintenance	81
Figure 5.1	The most preferred method to lodge complaints	101
Figure 5.2	Response from the respondents for upgrading the current complaint system	102
Figure 5.3	Respondents rate for level of user friendliness for Proposed Information Model	108

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Questionnaires Set One	123
B	Questionnaires Set Two	133
C	Questionnaires Set Three	137
D1	SPSS Analysis : Reliability Test for Questionnaire Set Number 1	141
D2	SPSS Analysis : Reliability Test for Questionnaire Set Number 2	144
D3	SPSS Analysis : Reliability Test for Questionnaire Set Number 3	145
E	Detail of Data Flow Diagram for Proposed Information Model	146
F	Proposed Information Model Snapshot	152
G1	SPSS Analysis : Analysis Questionnaire Set Number 1 (Question Number 7)	157
G2	SPSS Analysis : Analysis Questionnaire Set Number 1 (Question Number 8)	158
G3	SPSS Analysis : Analysis Questionnaire Set Number 1 (Question Number 9)	159
G4	SPSS Analysis : Analysis Questionnaire Set Number 1 (Question Number 10)	160
G5	SPSS Analysis : Analysis Questionnaire Set Number 1 (Question Number 11)	160
G6	SPSS Analysis : Analysis Questionnaire Set Number 1 (Question Number 15)	161

H	SPSS Analysis : Analysis Questionnaire	
	Set Number 2	163
I	SPSS Analysis : Analysis Questionnaire	
	Set Number 3	165

CHAPTER 1

INTRODUCTION

1.1 Background

Today construction is too complex with lots of information shown in the form of drawings, contracts, reports, charts and worksheets. It involves with hundreds of participants, decisions and data which is started from the idea followed by feasibility study, design, construction and end up with the Operation and Maintenance works. Christian and Pandeya (1997), found that, the longest portion of the facility's life is Operations and Maintenance phase which is covered almost 80% of the total life-cycle cost. Maintenance and Operation management which have the responsibility to keep the assets to be in good working condition is one of the Facilities Management (FM) functions. Majahalme (1995), believed that FM not only concerned with facilities used and maintenance but also to add value to the enterprise by continually improving the quality of the operating environment.

World economics and global changes seem to play a significant role in the evolution of FM and, due to these facilities managers are under pressure to operate at low cost. In FM, accurate information, data and time are critical to the decision maker, this means that the facilities manager must access a broad range of facilities data in order to achieve cost effective decision (Teicholz and Takehiko, 1995).

Information Technology (IT) can be used as a tool to capture the accurate information and data for the facilities manager but, the use of IT in FM seemly not very efficient. This is because using standalone systems to solve all the problems in FM will increase the errors and reduce the efficiency of the system due to the numerous data input from one computer application to another and the lack of information integration (Teicholz and Takehiko, 1995; Kyle et al., 2000).

1.2 Background of the problem

Building can be considered as an asset, to ensure its optimal value over its life cycle, proper maintenance is a must. Building system such as electrical or mechanical require regular maintenance to ensure that they can function properly. But the behaviour of the owners who are not aware of the importance of building maintenance contributes to the failure of the system, whom they feel that maintenance works are only wasting their budget. Neglecting the maintenance works can cause the enormous bills in the future. Arditi et al. (1999), believed that many of the owners let their buildings deteriorate into a state of which it is very difficult and costly to fix.

Some top management allocate little yearly budget for maintenance works since they believed that the department of maintenance is a non-profitable department, and some of the department of maintenance have forced to find new and innovative ways to maximize their limited resources and increase the revenue (Buys and Nkado, 2000). In maintenance organisation, these conflicts and constraints will affect the workers productivity and the efficiency of the maintenance. At the same time the maintenance cost may increase.

From the literature, top management who are aware of these matters will allocate some amount of budget to improve the maintenance system that can achieve the organisation's goal. But in the view of Mason (1993), some systems rarely met anyone's expectation; some of it is fail to adopt a new technology, end user misperception and the designer misconceptions. Wayenbergh and Pintelon (2002)

believed that the decision on the required maintenance concept are crucial and the most important feature of the framework is that it allows to incorporate all information available in the company, ranging from experience of maintenance workers to data capture by modern information technology. The other factor that contributes lacking of facilities information is difficulty to share and maintain all these information throughout a project's life-cycle among the multiple disciplines. Consequently, some valuable information to the FM are lost during the project's life-cycle.

1.2.1 Office of Development and Asset Management, Kolej Universiti Kejuruteraan dan Teknologi Malaysia as a Case Study

Kolej Universiti Kejuruteraan & Teknologi Malaysia (KUKTEM) was established on 16 February 2002 under the University and University College Act 1971. The KUKTEM commenced operation in February 2002. It stemmed from the Malaysian government decision to set up a public technology and competency-based technical university in the state of Pahang. Base on projection, KUKTEM will have 380 academic staff and 190 non-academic staff by 2005. Ultimately, KUKTEM will be staffed by a total of 1,860 personnel by the year 2010 to cater to the 10,000 students projected (KUKTEM's 2002 Annual Report).

Office of Development and Asset Management or Pejabat Pembangunan dan Pengurusan Harta (PPPH), has a big role to deliver KUKTEM's strategic planning by providing a conducive environment and better facilities. Currently, PPPH which only has 29 staffs has a major role to full fill almost about 2500 students and 485 staff members need (Figure 1.1 shown the organization chart for PPPH). The unit has responsibility to ensure KUKTEM's assets are functioning and in good condition. However, PPPH cannot run from receiving complaint from staff members and students, such as the work quality and inefficiency of PPPH members as well as inefficiency of management system. In 2002, PPPH had received an allocation about RM 341,724.00 and the allocation had increased to RM 1,246,537.00 in 2003 while in 2004 the allocation had been increased to RM

3,866,781.00 (KUKTEM's 2002, 2003 & 2004 Annual Report). An increase in allocation is to give PPPH space to improve their management system subsequently the services has been given could fulfill KUKTEM's members and can reach optimum level.

In the era of information system, KUKTEM has implemented electronic management (e-management) to eliminate unnecessary bureaucracy, works, and reduce unnecessary controls. Besides that, e-management tries to provide the information which is needed to the member of KUKTEM systematically. The e management system can also empower the staff member of PPPH minimizing and streamlining handoffs that occurs in the department and the most important is enhancing the working system from paper oriented to virtual oriented (KUKTEM ICT Master Plan, 2002 and Wan Maseri, 2004).

To achieve this philosophy, KUKTEM has used e-management system which is called Integrated Management System (IMS). The IMS integrates all the managerial and technical aspects from strategic level to operational level. Currently, PPPH does not have any systematic process to deliver every maintenance job. Insufficient information has made maintenance task facing difficulties, such as lack of information had been collected during the construction phase, resulted in improper maintenance work system had been done.

From the observations, most of the users use the memo system of the IMS to lodge complaint as shown in Figure 1.2. Maintenance records are recorded manually by the staff at PPPH, this is difficult for Head of Department or somebody to retrieve the previous maintenance record for evaluation and analysis. On the other hand, PPPH has not aligned its operations with KUKTEM's ICT philosophy.

CADANGAN CARTA ORGANISASI PPPH

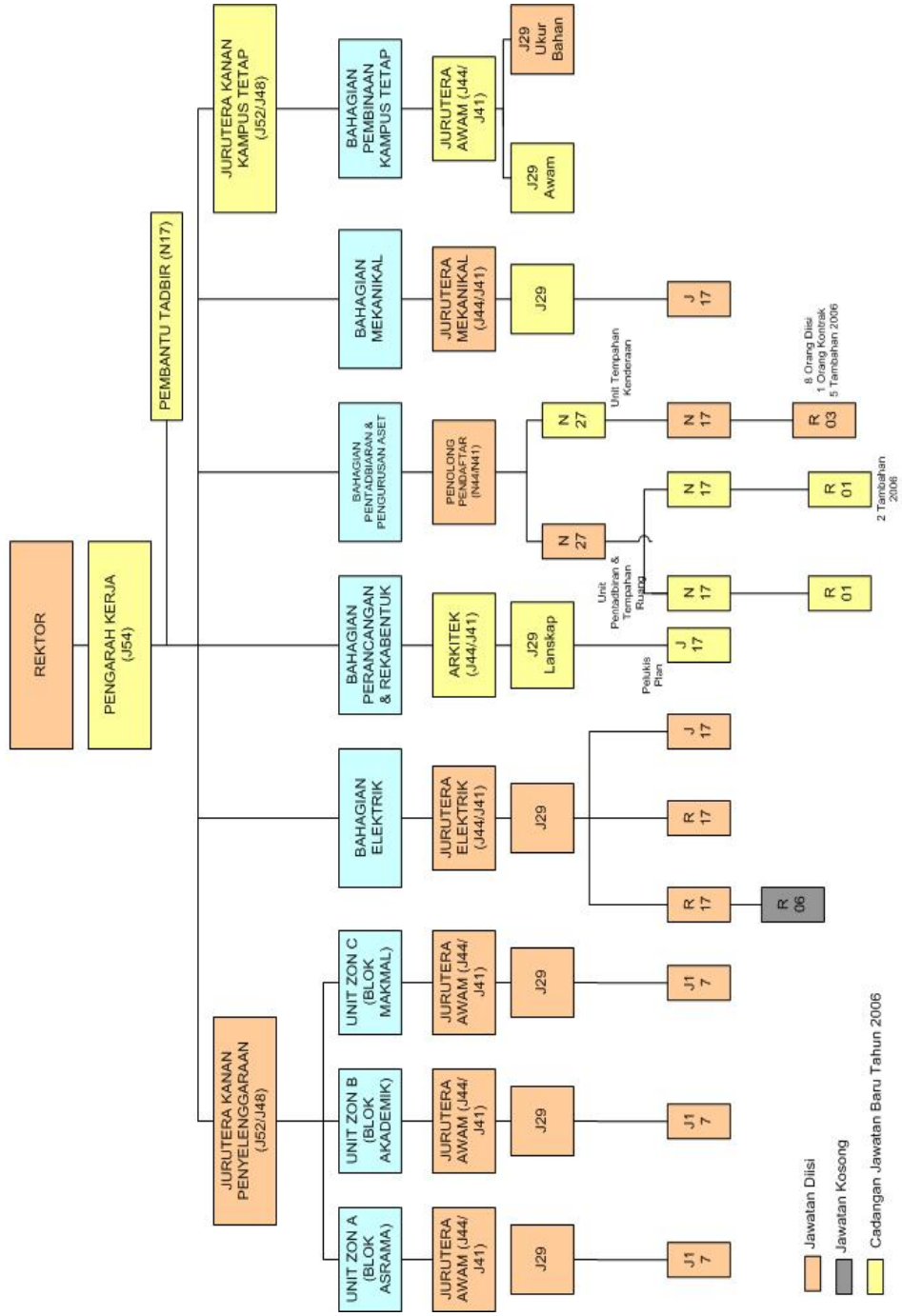


Figure 1.1 : Organisation Chart for PPPH

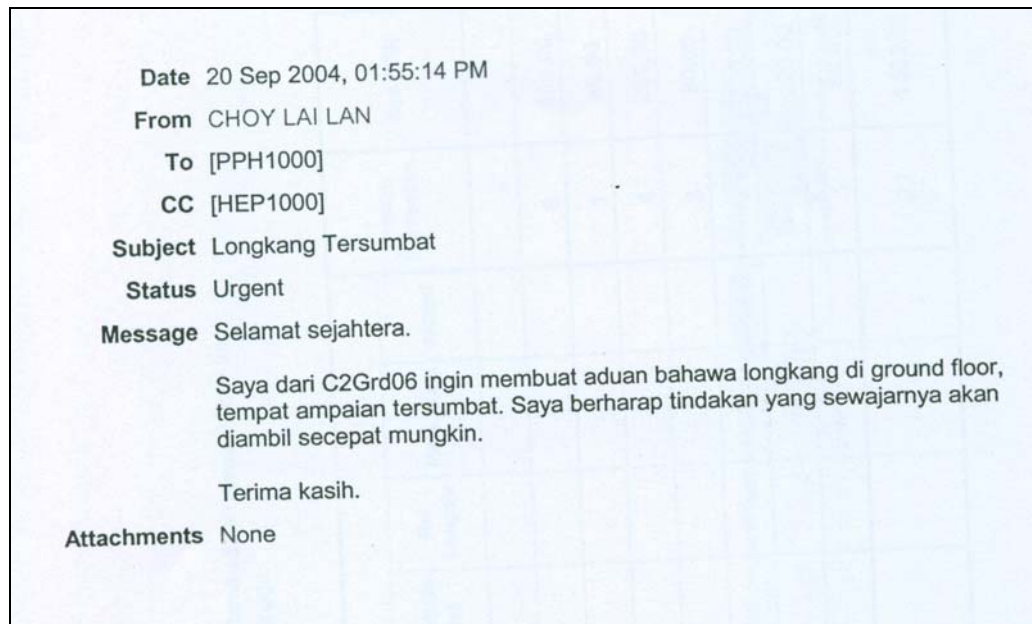


Figure 1.2 : User using memo to lodge complain

Furthermore, the information from the work done report is very insufficient to do evaluation or analysis to measure the effectiveness of contractor (Figure 1.3 show the sample of maintenance record at PPPH). In managerial level, right and accurate information in the maintenance records are very crucial; it is because from these records the Head of Department can predict the next yearly budget, the performance of their staff, contractor and facilities itself.

For instance, from previous maintenance records, majority complains lodged by the students is about clogged floor trap. By having a good report, filing system or maintenance records, the Head of Department can review the numbers of complaints and costs associated with the failure of floor trap system. From this information the Head of Department can decide the best decision or action to reduce or prevent it from happening again such as by putting cleaning the floor trap into one of the item or activities in Preventive Maintenance.

From the observation, there is no specific method to analyse or to evaluate the performance of the contractor whether in the form of response time, quality or based on number of call-backs.

[illegible]

Figure 1.3 : Work done report form

By having a systematic maintenance record such as a good filing system and accurate information, will help or assist the supervisor or the Head of Department to monitor, plan and control the maintenance works. The suggested information framework and model also will help the supervisor or Head of Department monitor the performance of their staff, contractors or assets in terms of durations of completing the tasks. This information will support the facilities manager to do a planning and controlling strategy which will assist in identifying the necessary information required to support maintenance management functions and to categories each activities, such as corrective or preventive maintenance.

1.3 Problem Statement

Irregular maintenance would contribute to the increasing expenditure and poor services in the community; there is no specific system to monitor the effectiveness of maintenance and operations management. This is supported by Spedding (1994), said that by continued neglect of the importance of the maintenance in higher institution not only increased the cost to repair it but it also seriously affected the quality of work and achievement of many students because of having a grim environment for them and their lecturers. Grimshaw et al. (1986), added, an effective planned maintenance management system for educational institutions will ensure that they will always be aware of the consequences of ineffective maintenance management system. They will also be in the position to prepare accurate budgets that will include sufficient funds for future major works.

1.4 Objective

The main objectives of this study are:

- a) To identify the requirements of electronic management for maintenance department to overcome current problem and approach.
- b) To develop a framework for information process and model which to support Maintenance and Operations Management.
- c) To gauge the effectiveness of the developed information process and model which to support Maintenance and Operations Management

1.5 Scope

The scope of this research is to develop an information process and model to support Maintenance and Operations Management as of the FM functions at the Office of Development and Asset Management (PPPH), Kolej Universiti Kejuruteraan dan Teknologi Malaysia, Pahang. The information model will be generic and the application development will be limited to allowing the exchanges, organize, store, manage and retrieve the information to support the Maintenance and Operations.

1.6 Importance of the Study

Simpson (1996) and Housley (1997), agreed that the existing of Facilities Management (FM) is to support the core business in the organizations including universities. The existing of FM will increase competitiveness and effectiveness of the service but Armartunga and Baldry (1999), believed that the understanding of FM in higher institution still remains undeveloped and to date little data is available to access how FM has been applied at higher institutions and overall organisational performance. Wood et al. (1996), added that, building performance measure especially for maintenance activities not so common in higher education compare to public hospital or private sector office. In addition the expansion in student intake combine with the limited funding worsens the current situation (Armartunga and Baldry, 1999).

Thus to this, the beneficiaries of this research is to the Office of Development and Asset Management (PPPH), Kolej Universiti Kejuruteraan dan Teknologi Malayisa (KUKTEM) which is the suggested framework can be an alternative technique for improving the existing Maintenance Management System, and to the building investors and building occupants due to the more thorough and efficient use of information, knowledge and data.

1.7 The Methodology

To achieve the objectives, there are four phases to be followed in this research as shown in Figure 1.4.

Phase 1, literature search will be conducted, where the main activities are to investigate and knowledge acquisition about Facilities Management (FM), maintenance management and research work on existing FM systems and model, to gain a full understanding of the FM especially on Maintenance and Operations Management and the needed electronics function that must have in Computerised Maintenance Management System (CMMS).

Phase 2, industrial visits to the Office of Development and Asset Management at local universities including KUKTEM will be conducted to gain / investigate the current maintenance management approach. The critical interview and questionnaire survey on how they perform their maintenance activities, the process, the most needed function in CMMS and the obstacle will be included in this phase. At this phase, the investigation using questionnaire survey of the level of user satisfaction at KUKTEM will also be done. This information will be used to guide the research to develop the information framework.

Phase 3, the researcher will develop the conceptual information framework and transform into prototype information mode. To build an information model, the detail data regarding the maintenance processes needs to be collected. To acquire this data, an information gathering strategy has been established, which included interviews, existing document sampling, and observations of the work environment.

Phase 4, the researcher will demonstrate the proposed model at Office of Development and Asset Management (PPPH), KUKTEM, in order to determine the effectiveness of the system.

The detail of this methodology will be discussed at *Chapter Three – Research Methodology*.

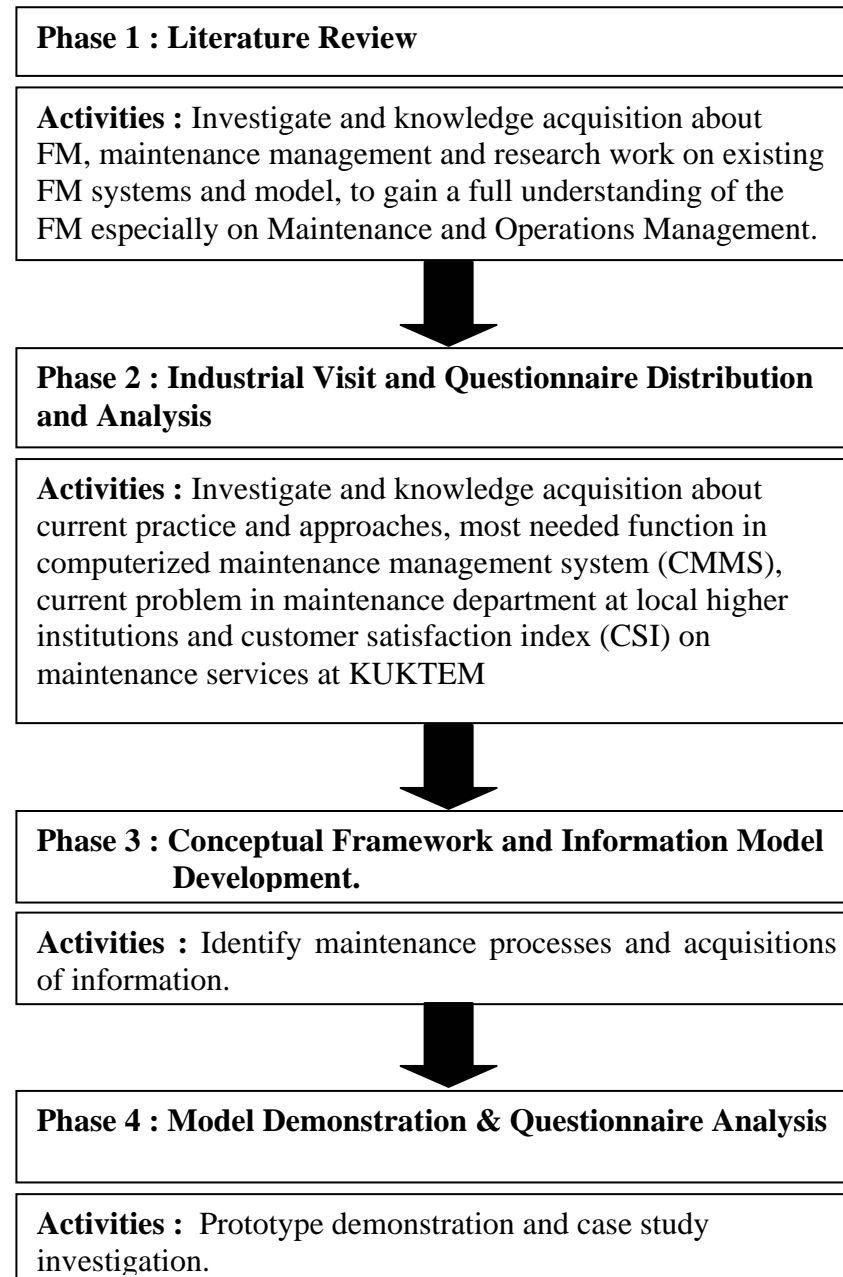


Figure 1.4 : The Methodology

1.8 Summary

Information Technology can be an enabler of changes such as changes in maintenance organisation, in communications, in attitude and in the working environment. It also helps to improve maintenance practice and creates better competitiveness. Managing the maintenance operations has been made easy by having a good integrated information and communication system. It makes maintenance operations more organised and easy to handle and control and provides an updated information that is easy to analyse maintenance operations and aiding maintenance manager in the decision making process. This suggested framework can be a starting point to the Maintenance and Operations Management at Office of Development and Asset Management (PPPH), which can be implemented and run smoothly in dynamic changes environment and able to give an optimal solution to the previous problems.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Facilities Management (FM) has been considered as facilities maintenance and operation traditionally. In the early 90's due to changes in the business environment likes, globalization and downsizing and increasing in facilities maintenance and operations cost has changed the role of FM into business area. FM has been recognized as to add value to a business by continually improving the quality of the operating environment (Teicholz and Takehiko, 1995).

2.2 An Overview of Facilities Management (FM)

Facilities Management (FM) has been successfully developed and established in developed countries. In Malaysia, FM seems to be new for certain organisation. Some organisation use FM to support their strategic planning (Hamilton, 2003). According to Teicholz (2001), FM plays a role in integrating employee, work process and work place into a coherent productive and holistic system.

As shown in Figure 2.1, FM touches on elements of human resources, process engineering, ergonomic, architecture and interior design.

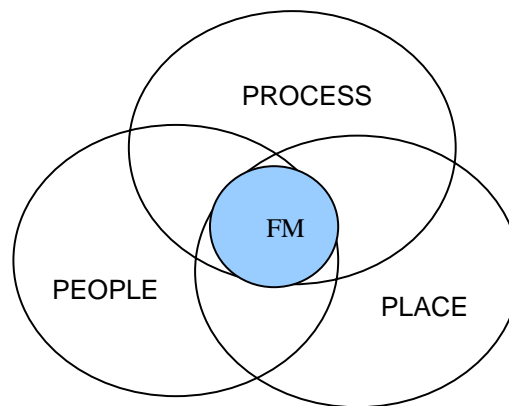


Figure 2.1: FM Components (Teicholz, 2001)

US Library of Congress, 1983, defined FM as “The practice of coordinating the physical workplace with the people and work of the organisation, integrating the principles of administration, architecture, and the behavioural and engineering science”. In general, FM includes planning, maintaining and providing the assets, both large and small, that support the endeavours of people at work. Kincaid (1994), had identified the three main types of activity of FM i.e.:

- a) Property management activities.
- b) Property operations and maintenance for building system and elements to sustain it.
- c) Office administration.

2.3 Functions of Facilities Management (FM)

Quah (1992), reported that Facilities Management (FM) work can be grouped under four main areas of management which consist of Financial, Space, Characteristics and Operational Management. Figure 2.2 shows an overview of the scope of FM activities in Quah's perspective.

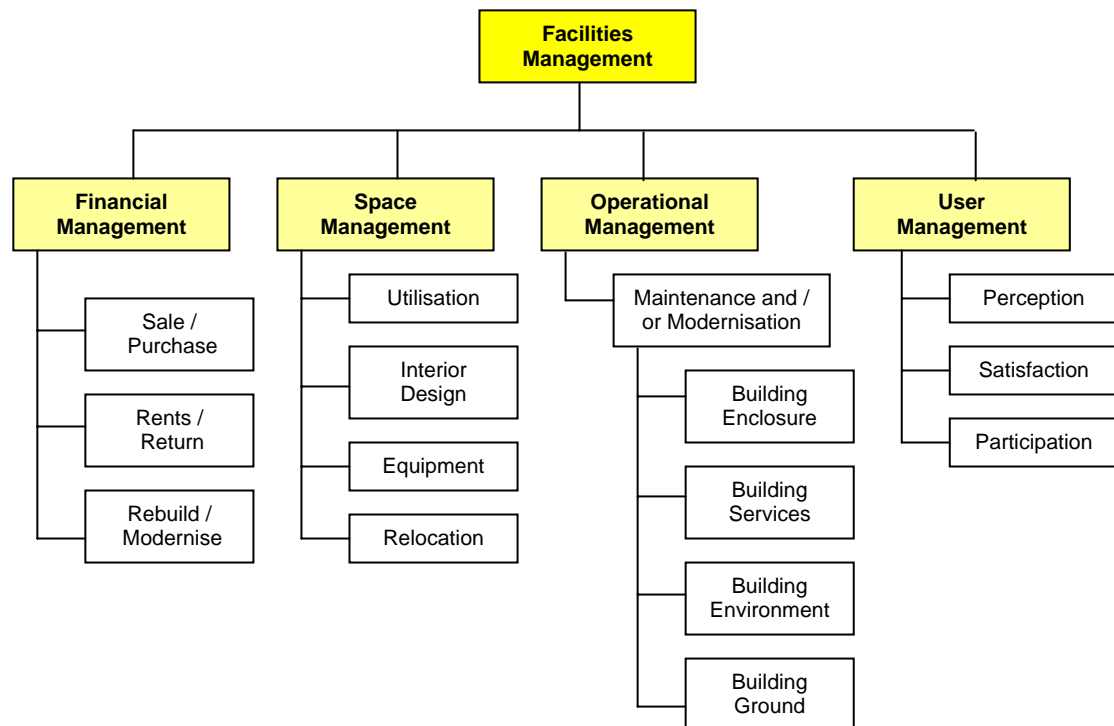


Figure 2.2: An Overview of the scope of FM activities (Quah,1999)

Operational management involves in Maintenance and Modernisation of Building Enclosure, Building Services, Building Environment and Building Ground. Quah (1992), indicates that differential emphasis is expected to be placed in these four areas of management and would be largely dependent on building type. However, the operational management would normally be receiving the highest level of attention as it directly contributes to efficient functioning of the building.

To make the scope of FM much clearer and have their own direction, North American Facilities Management Domain Committee as member of the International Alliance for Interoperability (IAI) had developed general FM hierarchy as a guideline for developing IAI-FM projects (Yu et al., 2000). The IAI is a global

consortium of architecture, engineering, construction and facilities management (AEC/FM) company and software developers which their mission is to enable interoperability among the industry processes of all different professional roles in AEC/FM. From this hierarchy, FM functions and their processes are considered into two main aspects:

- a) A general management planning and control functions.
- b) A specific or identifiable FM functions.

General management planning and control functions as shown in Figure 2.3, are divided into scope, cost, time, work and risk management functions.

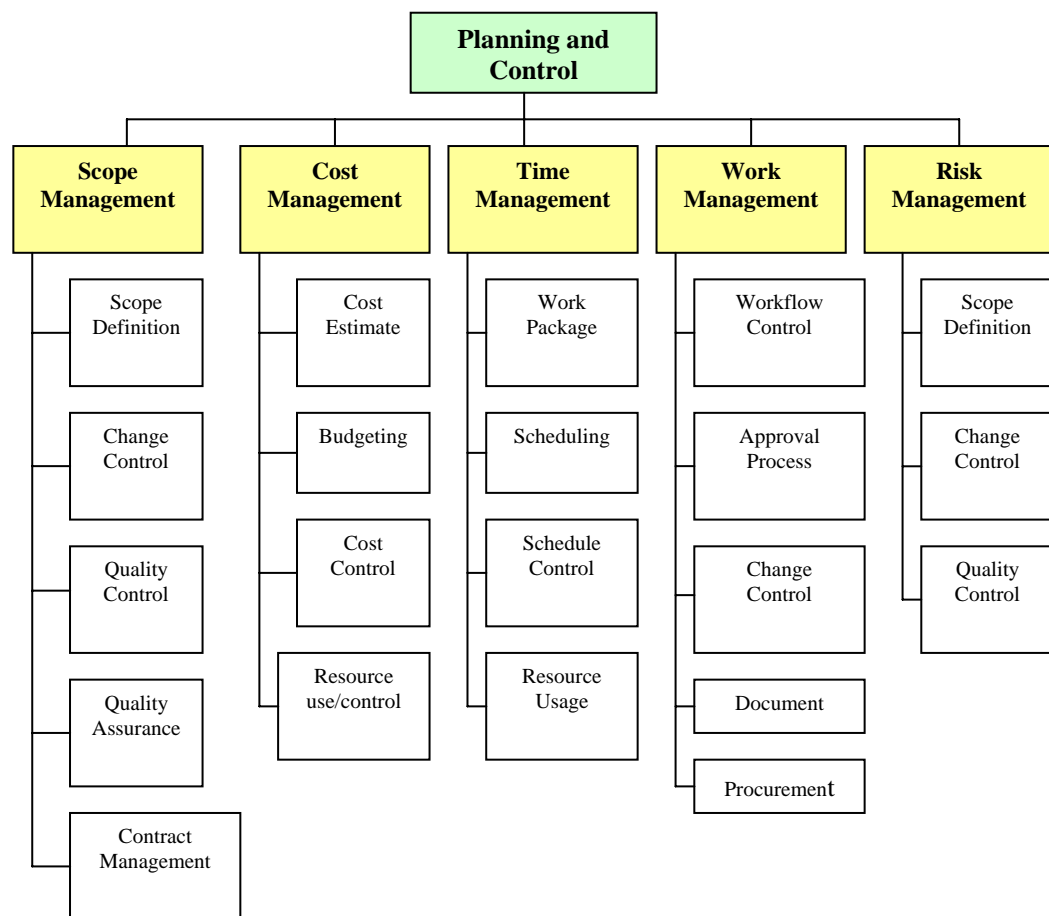


Figure 2.3: Functions of general planning and control (Yu et al., 2000)

Meanwhile, identifiable FM functions in Figure 2.4 are divided into 3 primary functions:

- a) Maintenance and Operation Management
- b) Property Management
- c) Services.

Each category is decomposed into sub-functions. For instance, the Maintenance and Operations Management function is decomposed into sub functions; Monitoring/Tracking Assets, Maintenance/Alteration/Repair and Space Management.

Teichoiz and Takehiko (1995), based on result survey conducted in the USA, conclude that the Maintenance and Operations Management function is the most critical and strategic in FM. In this research, the Maintenance and Operations Management group of function is established as the problem domain.

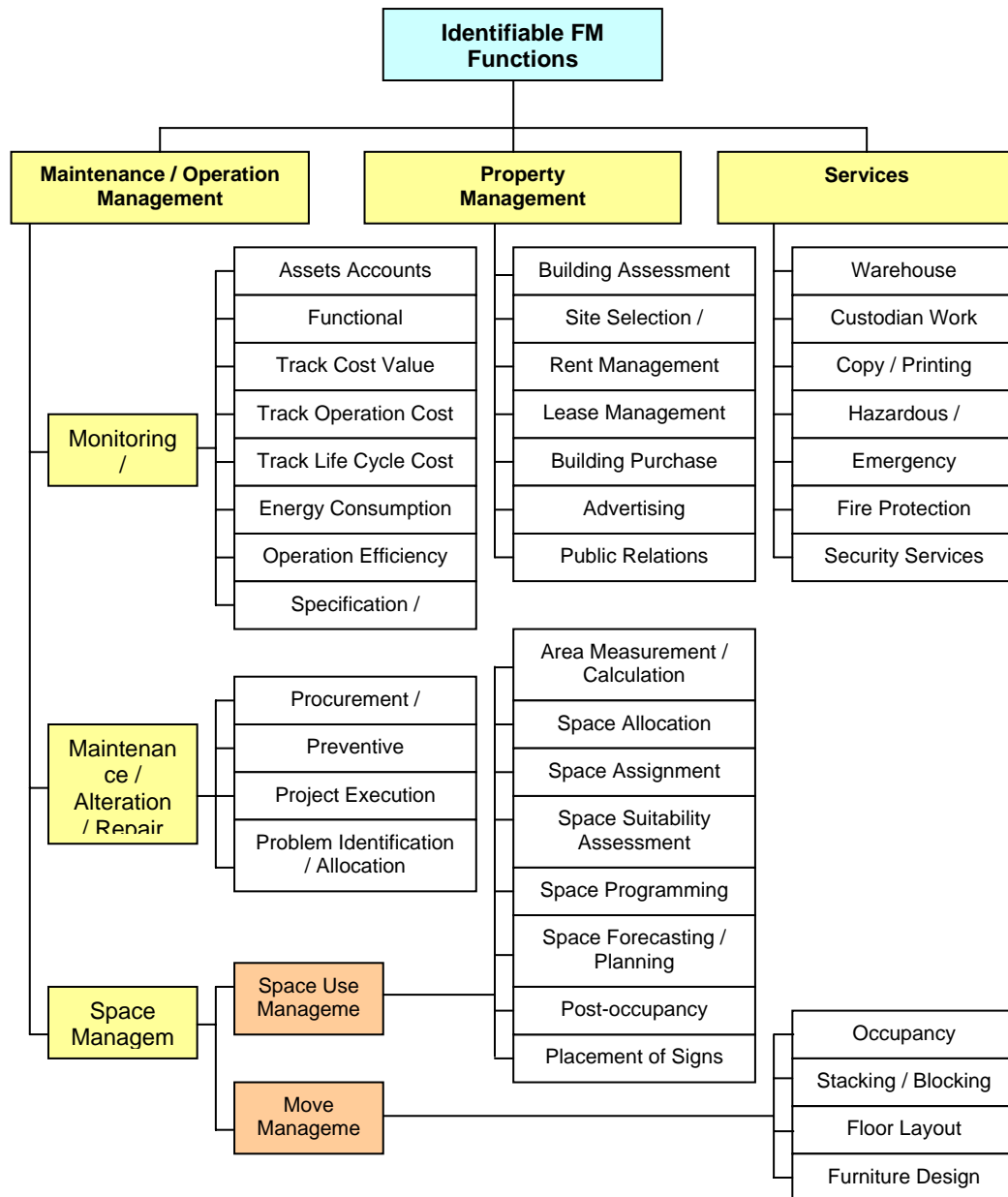


Figure 2.4: Identifiable FM Functions (Yu et al., 2000)

2.4 An Overview of Operation and Maintenance (O&M)

Maintenance can be defined as the preservation of a building so that it can serve its intended purpose. According to British Standard 3811, building maintenance defined as “a combination of any actions carried out to retain an item in, or restore it to, an acceptable condition” (“Glossary” 1984). In general, Maintenance and Operation not only do repairing and replacing the building's various system and components, but also cleaning and inspection can be categorised as parts of Maintenance and Operation works.

As one of the group of Facilities Management (FM) functions, Maintenance and Operation Management is responsible for providing a management structure to do any maintenance activities such as preventive maintenance for equipment or scheduling maintenance, because the main objective for Maintenance and Operation Management is to keep facilities at the best condition with the lowest cost. To achieve this, Hammer (1988), suggested that, the facilities manager must tackle the following issues in their daily activities.

- a) In order to keep low or reduce downtime equipment and operations interrupts, the facilities manager should estimate the appropriate timing for maintenance operations to be performed.
- b) To reduce the operating costs, the facilities manager should forecast the future of replacement and maintenance.
- c) To estimate the amount to spend on maintenance within a given budget.
- d) To implement schedule or preventive maintenance to reduce the unscheduled maintenance in order to eliminate the costly equipment failure.

2.4.1 Classification of Operations and Maintenance (O&M)

As to maintain or preserve the building, proper maintenance is needed to keep the life cycle cost down and ensures proper and smooth operations. The right type of maintenance is required to avoid any extra cost. There are many types of maintenance such as preventive maintenance, routine maintenance etc. According to Ahmad (2002) and King et al. (1984), types of maintenance are as the following:

- a) *Service Maintenance*: It includes maintenance items requested by the occupants. Also includes emergency items.
- b) *Routine Maintenance*: It includes general maintenance to the common areas. These items are not tenant requested, but are necessary to keep the building in good condition.
- c) *Preventive Maintenance*: The professional property manager is trained to understand that major breakdowns can be prevented. Preventive maintenance keeps a building operating at peak efficiency through regular inspection and repair. The aim is to catch small problems before they become big and expensive.
- d) *Corrective Maintenance*: It consists of repairing the building and equipment due to natural wear and tear or faulty preventive maintenance. With equipment problems, there may be a question asked to ensure whether the particular item should be repaired or replaced.
- e) *Differed Maintenance*: Occasionally, the necessary maintenance is put off until a later date; this is called differed maintenance. Contributing to the delay might be budget limitations, owner preference, and the availability of parts or inclement weather.
- f) *Extraordinary Maintenance*: This task involves major rehabilitation, replacement or refurbishment of units, buildings or grounds.

2.5 An Overview of Maintenance Procurement

According to BS 4884 procurement can be defined as “all managerial, technical, contractual, administrative and physical actions by or on behalf of an organization requiring goods, materials or services in obtaining the requirement”. A maintenance contract is a multifaceted document that is used to manage the work. In Malaysia, The Ministry of Finance is the responsible body to supervise and standardize the government procurement. In order to carry out this responsibility, the Treasury Department issued the Treasury Circulars and Instructions to all the government departments including the Semi Government bodies. The Treasury Department is empowered to control, enforce, supervise and standardise the procurement on behalf of the Federal Government.

In Malaysia there are numerous procurement methods for maintenance activities widely used, all these methods is subjected to the financial limits that has been fixed by the Treasury Department. The procurement method that had been practiced at Kolej Universiti Kejuruteraan dan Teknologi Malaysia (KUKTEM) is as follows;

1. Direct Purchase
2. Quotation
3. Tender

Figure 2.5 shows the flowchart for procurement process that had been practiced at Kolej Universiti Kejuruteraan dan Teknologi Malaysia (KUKTEM).

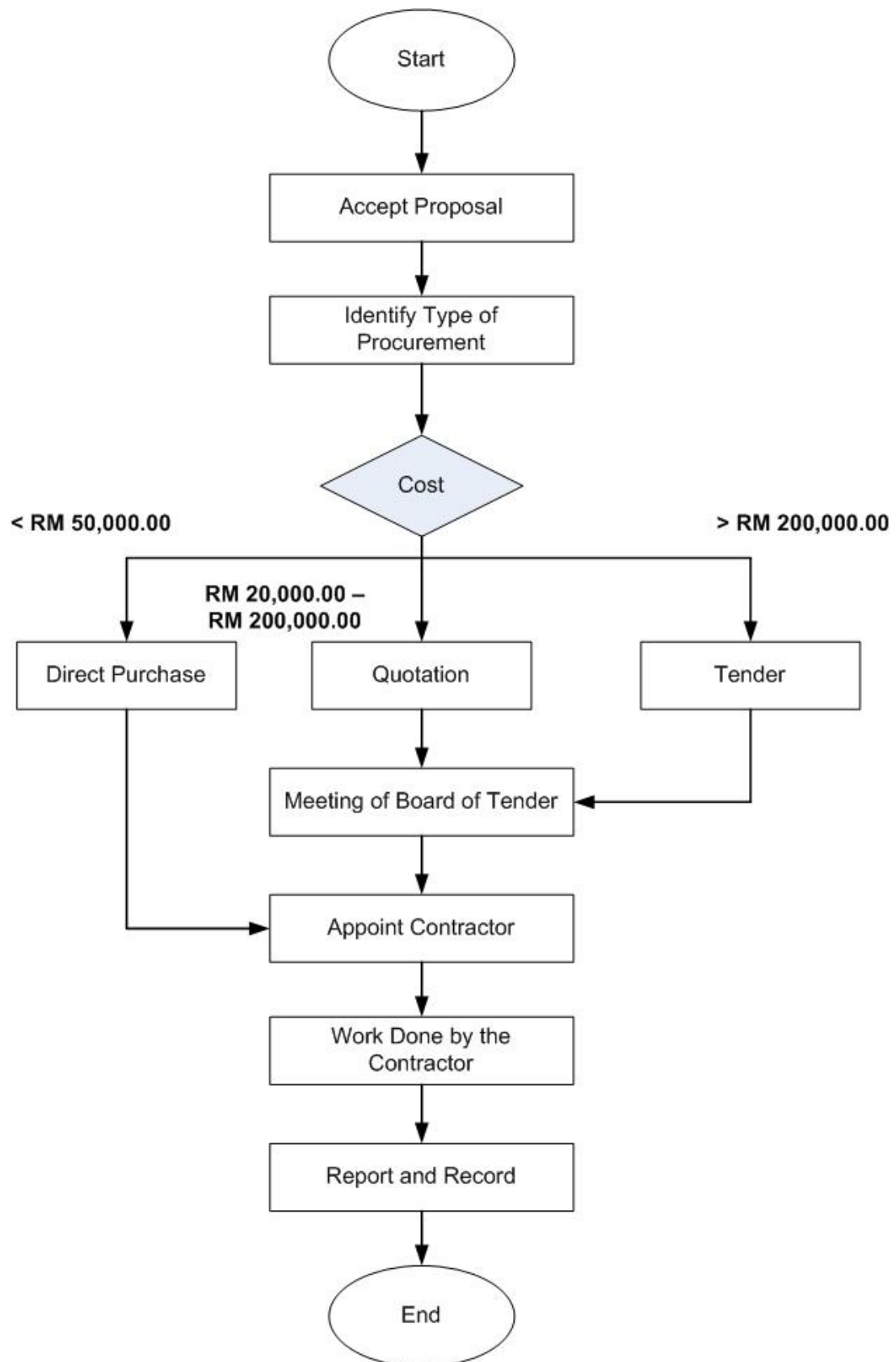


Figure 2.5 : Flowchart for Procurement Process for maintenance work

2.5.1 Direct Purchase

Treasury Instruction 173.1 and Treasury Circular No 2 year 2001 describe, under this method, any government agency is allowed to carryout the direct purchase for the supply and services not exceeding RM50,000.00 for an item. The suppliers can be registered or unregistered with the government as long as the item supplied is reasonable and fair (Lembaga Penyelidik Undang-Undang, 2005).

2.5.2 Quotation

According to Treasury Instruction 180.2, 170, 173 and Treasury Circular No 2 year 2001, works that are not categorized as requisition works and values from RM20,000.00 to RM200,000.00 and not using schedule of rate, quotation are required to be called. Under this instruction, any work involving the building structure, any non technical department must refer to the technical department to get advice while for work that does not involve any structural work, and any non technical department can call the quotation on their own (Lembaga Penyelidik Undang-Undang, 2005).

2.5.3 Tender

Procurement that exceeds RM200,000.00 has to be tendered as per describe by Treasury Instruction 181, 172 and new Treasury Circular No 2 year 2001 (Lembaga Penyelidik Undang-Undang, 2005).

2.6 An Overview of Resourcing

Traditionally facilities manager has two options in resourcing either in house or outsource. In House sourcing means all the maintenance activities will use the organization's own staff, while outsource means all the maintenance activities will be done by third party which the maintenance department will monitor the progress. Both have their own strengths and weaknesses; it is up to the facilities manager to evaluate which option is suitable with their organisation goal and mission. Kennedy (1993), advice that, the organisation has an authority to choose the right contractor based on the needs of organisation's business, goal and management style.

Alexander (1992), suggested seven principles to guide the facilities manager in determining the most suitable resourcing strategy for their organization.

- a) Accountability for the service provision
- b) The structure for delegation of responsibility
- c) The allocation of authority
- d) Level of control at operational, tactical and strategic level
- e) The scope and level of integration
- f) The level of user involvement
- g) Availability of service from the market

2.7 An Overview of Maintenance Contract

All construction projects involve risk, and contract has been used to transfer all the risk. A contract is made whereby agreements by parties have been reached or where they are deemed to have reached agreement and the law recognizes rights and obligations arising from the agreement. The overall success of the maintenance strategy will be determined by the skill with which the maintenance contract has been written. To be successful contracts must be specifically written to ensure the desired performance level achieved. Because there are different types of maintenance, the contract must reflect to this and provide a method to ensure that requirement is explicit. The contracts arrangements in Malaysia are similar to that