THE DEVELOPMENT OF GUIDELINES FOR THE MANAGEMENT OF BUILDING MAINTENANCE IN MALAYSIA

A thesis submitted to The University of Manchester for the degree of Doctor of Philosophy in the Faculty Engineering and Physical Sciences

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EMMA MARINIE AHMAD ZAWAWI
School of Mechanical, Aerospace and Civil Engineering

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ABSTRACT

The principle aim of this thesis was to derive of generic maintenance guideline for the maintenance department in Malaysia. This is due to the lack of research and information about maintenance technology in Malaysia. The research works identifies types of maintenance, maintenance strategies, rules and regulation and some experience of maintenance works both in UK and Malaysia.

The study focuses on the management of maintenance including setting up organisation, policies and quality standards. The research method used was a quantitative analysis involving questionnaires and surveys. Surveys covers all aspect of maintenance management in Malaysia including, occupants satisfaction, number of staff members, and the strategies of maintenance.

The guideline was then developed based of the surveys outcome. Several elements were identified including factors affecting the performance of maintenance. The guideline covers all major aspect such as management, staffing, training and regulation that expected to be useful in managing the maintenance department. Discussion, future trend and some recommendation were also brief as it summarised this thesis content.

The finding of this thesis is hopefully to be one of the important sources especially to maintenance department in Malaysia as guide to run a better maintenance system.

DECLARATION

No portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or any other institute of learning.

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CHAPTER 1 INTRODUCTION

1.0 Background

Maintenance management in the private and the public sector has been rapidly changing through out the years. This is due to several factors. The enhancement of sophisticated technology, globalisation and change of economy are of the main causes. There are many explanations have been made to express the definition of maintenance. But generally the main purpose of maintenance is to ensure that equipment remain in good working condition. The best way to achieve excellent maintenance is to have a good maintenance management that match as closely as possible the expected requirements of the user.

There are also other aspects that have a great impact on the quality of maintenance productivity, including organisation, training and motivation, maintenance control, supervision, maintenance operation, maintenance scheduling, and work order system. All those factors need serious attention as it have an important influence on the performance of the building's systems.

This thesis provides a framework of building maintenance management guidelines that are appropriate for the requirements for building maintenance department in Malaysia. Many studies have been done in order to fulfil as many as possible procedures and

guidelines as a framework for the best practice of maintenance management in Malaysia.

Current situation of building maintenance in Malaysia

Malaysia boasts one of south-east Asia's most vibrant economies, the fruit of decades of industrial growth and political stability. It has a population of almost 25.3 million (US, 2005) and its capital city is Kuala Lumpur. As far as Malaysia is concerned, real estate management and its technologies is not a highly developed subject area. Not many sources of development in this area was found. In February 2001 during the opening of the Kuala Lumpur 21 Convection and Exposition, the then Deputy Prime Minister of Malaysia, Datuk Seri Abdullah Ahmad Badawi made a statement (Moore and Finch, 2004) (The Star, 2001):

> *'Unless Malaysia changes their mentality to become more aware of the need to provide good services and improve the upkeep of buildings, we will forever be a Third World country with First World infrastructure.'*

This statement seems does not bring any improvement to the building maintenance technology in Malaysia when the latest annual budget is seems not much different from the previous. Referring to the Malaysian Budget 2006, the Malaysian Prime Minister (who also act as Malaysia Finance Minister) reported to the parliament that the government would provide a special allocation of RM1 billion for the maintenance of public facilities for next year and this is to

supplement the allocation of RM4.3 billion provided to agencies for maintenance .In 2005, the government has provided RM500 million, enabling nearly 9000 maintenance works to be undertaken by class F contractors (the lowest level of contractor class in Malaysia with work project below than RM70 000 – more details at Appendix 2), in addition to the allocation to government agencies amounting to RM4.1 billion (Malaysia Annual Budget, 2005).

The Prime Minister of Malaysia says that it is very common to see that most government buildings were not regularly maintained because most faults cannot be distinguished at their early stage. Based on this, he has suggested that the Public Work Department needs to prepare building maintenance guidelines in order to identify any damage from the early stage (Utusan Malaysia, 2006). This could also avoiding government to spent more money on maintenance and it could make things stay last longer. This guideline is very important to recognised damages and failures hence preventive and predictive strategy can be applied.

However Malaysia government has never stopped working to enhance its quality to a better level, it is also foremost to have a good manner people that could help government protect all equipment to be always in good working condition. This is reflecting as vandalism is one of the major causes of faulty items.

Economic significant of building maintenance in Malaysia

In understanding the need for building maintenance management, it would be relevant to look at Malaysian economic indicators and the place of property in its economy. In April 2001, the government released a new plan, the "National Vision Policy," to guide development over the period 2001-10 (Department of State US, 2005). The National Vision Policy targets education for budget increases and seeks to refocus the economy toward higher-technology production. In 2004, the government announced plans to revamp the government-linked corporations (GLCs) with the intention of improving performance and gradually reducing the state's stakes in them (Department of State US, 2005).

Before the out break of the Asian financial crisis in mid-1997, Malaysia experiences rapid economic growth and property sector plays a significant role in this growth. Table 1 blow indicates that the Malaysian economy has performed above 7.0% with the exception for 1998. Referring to Zailan (2001), Malaysia has moved from an agro-based economy before the 1980's to one based upon manufacturing and services orientated in the 1990's (Table 1).

Table 1a: GDP Growth and Selected Domestic Products by Industries - Share Of GDP (Zailan,2001)

Types/year	1980 %	1990 %	1994 %	1995 %	1996 %	1997 %	1998 %	1999 %	2000 %
GDP GROWTH	7.8	9.7	8.6	9.6	8.6	7.5	-7.5	5.8	7.5
Agriculture	23.0	8.7	14.9	9.6	12.7	9.1	9.4	9.4	8.8
Construction	5.0	3.6	4.1	4.6	4.1	4.8	4.0	3.6	3.4
Manufacturing	20.0	27.0	31.4	28.6	34.2	29.9	27.9	30.0	32.6
Finance insurance & real estate	8.0	9.8	10.9	10.8	11.3	10.2	12.6	12.1	11.9

Table 2b: GDP Growth and Selected Domestic Products by Industries (EPU-Malaysia, 2006)

Types/year	2002 %	2003 %	2004 %	2005 %	2006 %
GDP GROWTH	4.4	5.4	7.1	5.3	6.0
Agriculture	2.8	5.6	5.0	2.1	2.0
Construction	4.3	5.8	3.9	0.8	5.0
Manufacturing	4.3	8.4	9.8	4.9	7.0
Finance insurance & real estate	6.5	4.5	6.8	6.5	6.0

Apart from that, manufacturing, finance and insurance made up 30% of the economy and real estate 12.1% compared to 20.0% and 8.0% respectively, in 1980 (Zailan, 2001). The latest indicators taken from Economic Planning Unit Malaysia (EPU, 2006) presents that from 2002 the GDP Growth have slightly decrease till 2003 and made up 7.1% in 2004. These economic indicators reveal an expanding and growth oriented economy which should give rise to employment, service industries, as well as office and retail space (Zailan, 2001). Accordingly the numbers of operational property assets such as buildings offices, industrial premises, shopping complexes and residential have increased tremendously.

1.1 Aims and Objective

The aims of this thesis are to analyse how building maintenance management is implemented the United Kingdom, and to construct a framework of best practice that could be applied in Malaysia.

In order to fulfil the aims of this research the author has taken a closer look to the objective of the thesis and they are as follows:

1. To study and explain the important requirement of successful building maintenance.
2. To examine the building maintenance practice in UK and understand the standards, policies and strategies applied.
3. To study the different practices of building maintenance between UK and Malaysia and identifies the key issues within the Malaysian context.
4. To identify the rules and regulation and codes of practice for the control of maintenance work.
5. To propose procedures and guidelines for effective building maintenance management in Malaysia.

1.2 The methodology of study

The study includes a literature review and the collection and analysis of field data. The primary review was taken from both international journal and local Malaysia journal, conference proceeding, previous theses, and newspapers. The literature review

was organised into few main sections including the philosophy of maintenance, legislation, regulation and code of practice in building maintenance, the maintenance strategy and policy and building maintenance in Malaysia. All sections have been discussed in details and critical manner where some experience of building maintenance management of other countries was also included in it.

The collect field includes data gathered from three questionnaires administered within buildings and some data gathered from short interviews with the building maintenance staff conducted by the author during the period of collecting data in Malaysia. The questionnaires are described in detail in Chapter 4 in this thesis.

1.3 Thesis arrangement

The structure of the thesis consists of 8 chapters (Figure 1). Chapter 1 gave an introduction to the thesis by describing its general contents. It contains an explanation of the thesis aims and objectives. The scope of the thesis was also discussed in this chapter.

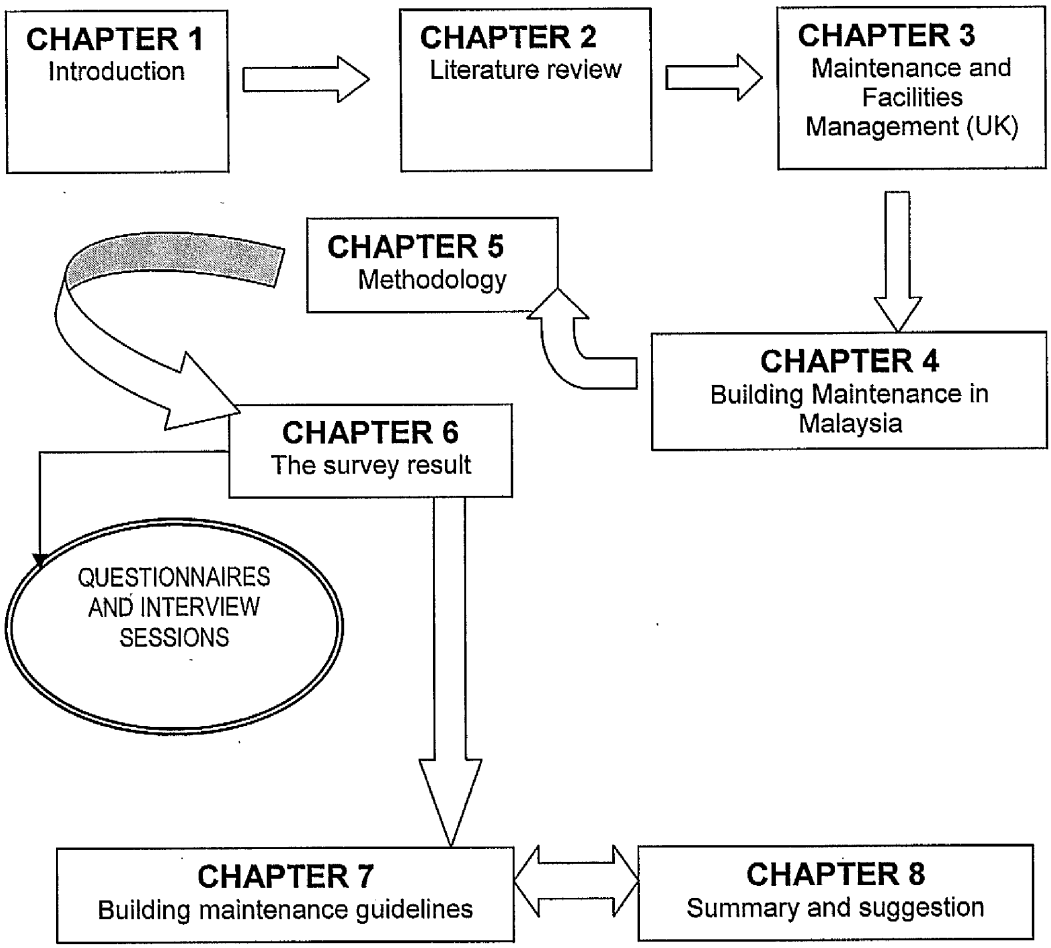


Figure 1: Overview and content of the thesis

Chapter 2 was an overview of the maintenance concepts that has been taken from journals, newspapers, proceeding and many other primary sources. Basic knowledge to the sophisticated technology was review in this chapter. It also comprise the literature study of the maintenance from all over the world including its definition, the new finding, building performance and many other current issues in building maintenance technology.

Chapter 3 contains the methodology of the research where and how the questionnaire was conducted. In this chapter, the designed questionnaires are also discussed.

In Chapter 4 current status of building maintenance management in Malaysia is discussed. This discussion also based on the reading and evaluation of journals and articles or newspapers from previous researchers. In practice, not many references were found in the wider Asian but other relevant references were discuss the issue of maintenance in around South East Asia context.

In Chapter 5 the role of maintenance in facilities management is explained. As maintenance is a part of facilities management, it is believed that maintenance should give a big impact on the success of facilities management in terms of advancing productivity and the increasing the company's profits. There is also some briefing on its philosophy and their implementation.

Chapter 6 presents the result of the surveys and relevant analyses performed by using statistical software package. Charts and tables are presented and interpreted. There is also some discussion based on the data gathered and some conclusions are made concerning finding of the surveys.

Chapter 7 further evaluates the results based from Chapter 6 and adapts them to develop indicators that can be used to evaluate the building maintenance organisation.

Using these results, together with the analysis describes in Chapter2 to 5, guidelines are developed for the organisation and management of maintenance within Malaysian building that is presented in Chapter 8.

In Chapter 9 the research findings are summarised and suggestion for the future research are made.

CHAPTER 2 THEORY AND LITERATURE RIVIEW

2.0 Introduction

This chapter is about background theory and the literature that is related to this research. The chapter covers four important topics that reflect the research objective, namely, maintenance management, building performance measurement, maintenance and education and computerized maintenance.

2.1 Maintenance and its definition

As from the beginning, it is very important to understand the meaning of building maintenance. Maintenance is defined in BS 3811:1993 as *'a combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function'* (BS 3811:1993).

In detail, the word "retain", implies that defects are prevented from developing by carrying out work in anticipation of failure and "restore" means that minor defects are allowed to occur before they are corrected (BS 3811:1993). In order that the item or facility can perform its required function, some degree of improvement is needed, over the life of the building, expected standards of comfort and amenity rise.

The BS3811 again explains that, where there are statutory requirements for maintenance, what it terms the 'acceptable standard' to be reached must be no less than that necessary to meet such requirements; and 'maintained' is defined in the Factories Act 1961 as *'maintained in an efficient state, in efficient working order and in good repair'* (Factories Act 1961,UK). Most buildings have long life expectancies, and acceptable standards of amenity and performance will rise substantially over their lifetime. Therefore the following definition should be accepted as reflecting the main objective of building maintenance as *'Building Maintenance is work undertaken in order to keep, restore or improve every facility, such as every part of a building, its services and surrounds, to a currently accepted standard and to sustain the utility and value of the facility'* (BS3811:1984)).

2.2 Maintenance strategies

Building and their services inevitably become obsolete resulting from factors relating to the use of the building (functional, economic, location, social, statutory or physical), and changes in the needs and aspirations of the building user. The aging and obsolescence of buildings, together with a corresponding depreciation in value, is therefore a continuous process (figure 1), but can be slowed or reversed by appropriate 'repair' and 'maintenance' (David, 1999).

'Repair' however is defined as a 'restoration of an item to an acceptable condition by the renewal, replacement or mending of worn, damaged or decayed parts (highlight the breadth or work that may be undertaken to deal with defects, damage and decay as they affect building elements, components or individual materials) (David, 1999). The principles of repair, which by necessity are closely allied to those of building maintenance, are typically based on some or all of the following (David, 1999):

i. complying with specific requirements (example: statutory, health and safety, lease or covenant obligation)
ii. satisfying functional, performance, statutory and/ or user requirements
iii. removing or treating defects
iv. slowing rates of deterioration and decay
v. Safe guarding value and utility of building and facilities achieving desired or expected standards.

Maintenance may be undertaken either in anticipation of failure (preventive maintenance) or carried out to restore the building to an acceptable standard after failure (corrective maintenance) (David, 1999). What is considered to be an 'acceptable standard' will be determined in relation to the importance of the building, the building user and the use to which the building is put. An approach to a programme of planned maintenance, which is typically both

preventive and corrective in nature, brings many benefits (David, 1999) including

i. retaining the value of the property
ii. achieving optimum usage by minimising indirect maintenance costs
iii. a good appearance
iv. maximising the life of materials and components
v. ensuring best use of materials and components
vi. maintaining user satisfaction
vii. ensuring suitable standards of health, safety and security
viii. decreasing insurance risks
ix. ensuring compliance risks
x. ensuring compliance with regulations and other legislation.

If overall maintenance is planned, preventive maintenance will reduce the costs of attending to emergencies and defects.

2.2.1 Categories of maintenance

In maintaining a building, there are usually several strategic options available to management, and many alternative decisions to be considered. There is, for example, the possibility of reducing the demand for maintenance by addressing the actual cause of failure

and identifying its consequences. For instance, it may be necessary to decide whether to repair or replace an item, and whether to carry out periodic maintenance at fixed intervals or simply to respond to the requests of the users. Thus, building maintenance can be divided into forms, such as:

2.2.1.1 Preventive maintenance

It is daily maintenance (cleaning, inspection, oiling and re-tightening), design to retain the healthy condition of equipment and prevent failure through the monitoring of deterioration, periodic inspection and equipment condition diagnosis, to measure deterioration. It is further divided into periodic maintenance and predictive maintenance. Just like human life is extended by preventive medicine, the equipment service life can be prolonged by doing preventive maintenance.

2.2.1.2 Corrective maintenance

Corrective Maintenance is a maintenance activity which is required to correct a failure that has occurred or is in the process of occurring. This activity may consist of repair, restoration or replacement of components. Corrective Maintenance has to be distinguished from preventive maintenance or condition based maintenance.

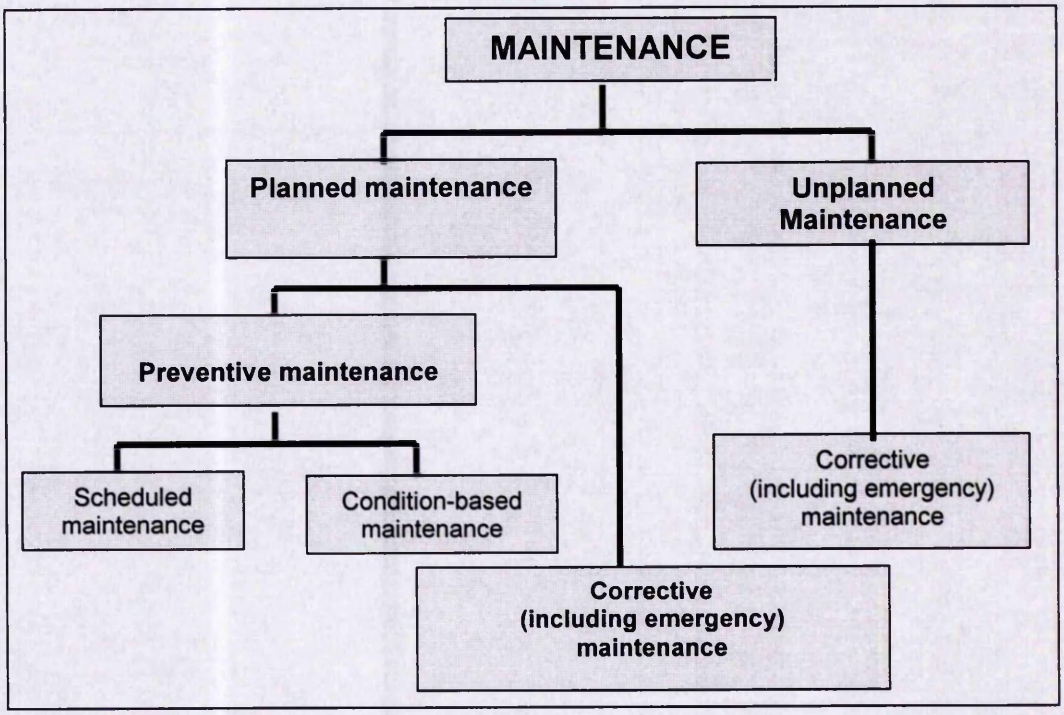


Figure 2 : Types of maintenance (Armstrong 1987)

2.2.1.3 Predictive maintenance

This is a method in which the service life of important part is predicted based on inspection, in order to use the parts to the limit of their service life. Predictive maintenance can be defined as measurements that detect the onset of a degradation mechanism, thereby allowing casual stressors to be eliminated or controlled prior to any significant deterioration in the component's physical state. Results indicate current and future functional capability: basically, predictive maintenance differs from preventive maintenance by basing maintenance need on the actual condition of the machine rather than on a preset schedule.

Pitt (1997) discussed about the data requirements for the prioritisation of predictive building maintenance. His discussion covered the traditional approach to condition survey, changing landscape, multifactor condition survey and prioritisation. He concluded that forecasting predictive maintenance can be subdivided into the identification and assessment of maintenance needs, prioritisation of these needs, and the formulation of a predictive maintenance programme. The power of hardware and the potential of modern software enable new approaches, ignoring the constraints of the old manual systems, to be developed. The new approach can be developed by going back to the aims and objectives in undertaking a condition survey. These aims and objectives lead to a multifactor approach including condition data, management data and risk data.

2.2.1.4 Emergency maintenance

This is a necessitated by unforeseen breakdown or damage.

2.2.1.5 Design out

This can prove to be a very effective method of solving a recurring problem. However it can easily be inappropriately used. Putting in a more powerful motor due to frequent tripping may be an ill-thought reaction to malpractice by an operator, when simple instruction may solve the same problem. Before considering the designing out of a problem, it is important to identify exactly what

the root cause of the problem is. Having identified this is it possible to monitor the condition of this problem area. It may be cost effective to monitor this and take action as necessary. The advantages of design out are that minor projects can be inexpensive and guaranteed to work, thus solving a recurring problem. The disadvantages are that the root cause may be omitted in the process, and larger design out projects can prove to be very expensive, production can be disrupted for a considerable period of time and with larger projects, the expected result may not occur and unexpected problems may occur as a result of a major project. Solving a problem in one area may simply create one somewhere else.

2.2.1.6 Breakdown maintenance (operate to failure, run to fail)

Breakdown or on failure maintenance can be effective if applied correctly. For example, non-critical low cost equipment, or where no other strategy is possible. The advantages are low cost if correctly applied and require no advanced planning other than ensuring spare parts is available. Disadvantages include the lack of a warning of failure, risk to safety, uncontrolled plant outage, production losses. This method can also require a large standby maintenance team, secondary damage can be caused. There can also be a longer repair time, greater need for a large stock of spares, and the need for a standby plant.

2.2.1.7 Fixed time (planned) maintenance.

Planned maintenance is the most widely used type of maintenance. It is most effective if implemented as equipment begins to wear out and probability of failure increases. Planned maintenance tasks are often grouped together into maintenance downtimes or windows to minimize the total number of planned maintenance stoppages per year. This strategy is seriously flawed because the majority of industrial failure modes are random in nature and so maintenance tasks based on time will have limited affected in improving equipment performance (Smith and Tate,1998). Planned maintenance brings a few advantages such as failure reduced, labour used cost effectively, and maintenance well in advance (provision for labour and material) (CIBSE, 2000). However there are significant disadvantages unnecessary and invasive maintenance may carried out, applicable only to age related deterioration and maintenance in itself sometimes induces failures.

2.2.1.8 Condition based maintenance (CBM)

CBM relies on the fact that the majority of failures do not occur instantaneously but develop over a period of time. CBM involves recording some measurement that gives an indication of machine condition (temperature increase on an insulation surface, vibration increase on a bearing housing). Condition monitoring is not purely a *'high tech'* tool to be used by highly skilled engineers. Operators who

work with equipment every day can listen to equipment and identify changes in noise levels and vibrations. Temperature changes can be felt and these give warnings that something is 'not right'. An investigation can then be carried out to identify the exact problem. The advantages of CBM include maximization of equipment availability, some forms of inspection involving human senses can be inexpensive, allows a shutdown before severe damage occurs, production can be modified to extend unit life, cause of failure can be analyzed, maintenance can be planned, labour can be organized and spares can be assembled. However the disadvantages of CBM mean that a company must carefully choose the correct technique and period of time will be required for trends to develop and then machine condition can be assessed.

Starr and Wynne (1994), discussed typical building services failure, and described where and how to apply Condition Based Maintenance (CBM) (Starr and Wynne, 1994). Condition Based Maintenance (CBM) is a philosophy that has been widely applied in manufacturing, offshore, and process industries. There are many techniques used in CBM as vibration analysis, thermal analysis, lubricant analysis, visual, aural and tactile inspection and also BEMS monitoring. CBM can achieve significant cost reductions by avoiding unnecessary maintenance, reducing the number of failures, and limiting consequential damage.

2.2.1.9 Opportunity maintenance (window)

This is not actually a maintenance strategy but a combination of fixed time (planned maintenance) and breakdown maintenance. It can be useful when a forced stoppage gives maintenance unexpected access to machinery to carry out inspections and/or maintenance. Inspections during routine down times can identify unexpected tasks that need to be carried out but time does not allow it to happen. These tasks can be recorded on a maintenance management system and scheduled into the first available down time.

2.3 The needs for maintenance

In the context of a building, after it is completed, it has to meet various requirements, withstand the rigours of the climate and it is expected to last for many years, preferably with minimal maintenance. Many reasons can be put forward to justify maintenance being carried out, such as (Armstrong 1987):

i. to protect a property and its engineering services

ii. to increase utilization and reduce non-availability time

iii. to ensure safety requirements are complied with.

However there are a few factors causing maintenance for buildings. Figure 3 is described the causes and agents of deterioration.

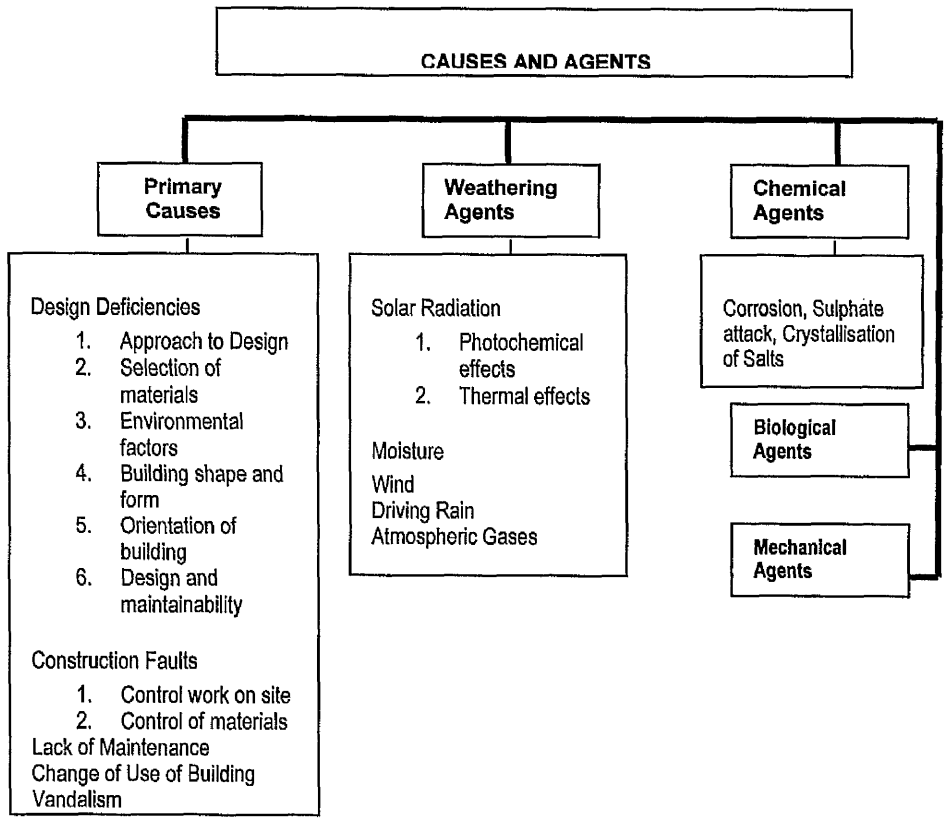


Figure 3 : Causes and agents of deterioration (Son and Yuen 1993)

The objective of maintenance can be summarised as minimising both the cost of non-availability of an engineering service through an adequate maintenance facility, and the resource costs associated with supplying that facility (Son and Yuen 1993). It should also be recognised that in addition to enabling the engineering services to be available when required, maintenance is also vital to ensure they retain their value as assets within the building. Besides that, there are few factors explained the needs of maintenance such as (Son and Yuen 1993):

1. *Ageing Stock of Building*

- The most direct determinant in developed countries is the increasing stock of buildings which will have to be maintained or retrofitted.

2. *Obsolescence*

- Regardless of the state of the property market, commercial developments face increasingly keen competition to attract new tenants and retain existing ones. Property owners will want to upgrade their buildings to prevent their obsolescence. In addition, easier access to private financing and less regulatory requirements may make retrofitting a better proposition than redevelopment.

3. *Advent of New Technologies*

- With the advent of new technologies, changes and modifications to existing buildings are required to meet new demands. For examples, the introduction of computer-aided manufacturing (CAM) in factories inevitably initiates demand to change factory layouts and storage facilities. Such changes are likely to be carried out by the renovation and retrofitting of existing buildings.

4. *Rising Social Expectations and Aspiration*

- The natural increase in aspirations and purchasing power will expand the market for higher standards in both maintenance and retrofitting work, already particularly evident in residential premises.

At the same time, rising social affluence will also generate demand for restorative retrofitting of archaic buildings and structures.

5. *New Legal Development*

- New legal development point particularly in the law of occupier's liability and the tort of negligence, continue to impose an increasingly heavier burden on building owners to maintain and keep their premises safe. These developments will push for higher standards and a greater degree of professionalism and thoroughness in the execution of maintenance and retrofitting work.

6. *Environmental Issues*

- From the environmental point of view, it may not be acceptable to demolish buildings. This means that, in some cases, maintenance and modernisation may be a better alternative than large-scale demolition, because of the high costs involved to take protective measures against pollution. Apart from the effects of building on the environment there is the additional problem of 'sick building syndrome' inside buildings which may result from inadequate maintenance.

7. *Impact of construction defects*

- Construction defects are substantial source of maintenance expenditure. Faulty construction is one of the most common causes of early deterioration. A few studies have been conducted to discover the faults in design and construction that affect maintenance. A

report that was developed to the Building Maintenance Committee (in the UK) suggest that about 20% of the average annual expenditure on repairs in a large number of buildings was abnormal and, in most cases, could be described as arising from defects. An analysis of the investigations into defects in buildings by the new Building Research Advisory Service, says that most defects come to light in the first 3-4 years of the lives of buildings.

In general those seven factors applied to the needs of maintenance as it gives an impact to the decreasing or increasing of the cost or budget for maintenance. Having understood the content of these factors, people would be more critical thinking about the important of building maintenance. Equipment and property will last longer and it also ensured those safety requirements are well followed.

2.4 Maintenance Management

Maintenance management requires a combination of different skills, including the technical knowledge and experience necessary to identify maintenance needs and specify remedies. Like any other form of management, the basic concepts are (Armstrong 1987):

1. Setting aims and objective
2. Providing the means of attaining those aims and objectives
3. Decision making.

The function of maintenance may be defined as the proper use of resources to ensure plant is repaired, replaced, adjusted or modified to enable it to operate at a specified availability and performance. The basic element of maintenance management is shown in the Figure 13.

Basically, there is no universally ideal structure for maintenance. Every organisation needs to develop its own structure to suit the complexity of its maintenance work, to meet its particular requirement and to match its resources. Figure 4 shows a sample of structure for maintenance department taken from the Building Department of Damansara Specialist Hospital in Malaysia (1997).

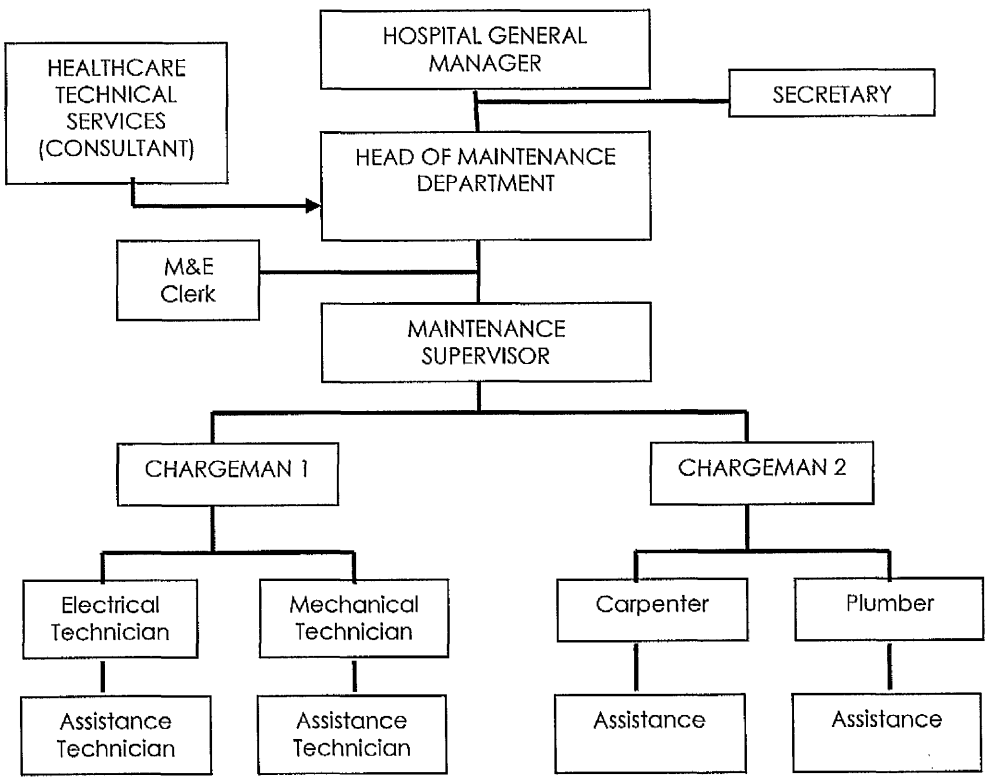


Figure 4 : Basic maintenance structure
(Source: Damansara Specialist Hospital, Kuala Lumpur, Malaysia)

Lo, Lam and Yuen (2000), investigated the attitudes of maintenance professional of different backgrounds on a priority setting of various fire safety attributes (Lo, Lam and Yuen, 2000). A two stage of systematic survey has been carried out to identify the fire safety attributes and to evaluate their important. Building surveyors are considered to possess specialist knowledge on building maintenance and structural survey and building services engineers are considered the expert in building services installation. The investigation has indicated that the professional backgrounds of professionals do have some influence on their judgement on the importance of individual fire safety attributes. The building surveyors who are considered to possess specialist knowledge on building technology believe that the passive means of fire protection, such as travel distance, is comparatively more important whereas the building services engineers who are considered on building services believe that the active fire protection components, such as emergency lighting are more important.

Chau and Leung (2003) carried out an analysis on the HVAC maintenance contractor selection process (Chau and Leung, 2003). The objective of this study is to test how different managers actually choose maintenance contractors, in particular the heat ventilation and air conditioning (HVAC) contractors. The research involves an

identification of attributes and levels and presentations of questions which comprises property, facility and building maintenance managers, who have experience in managing more than five offices building in the past.

Among the 120 survey conducted, 20 were rejected on the basis that respondents refusal in providing information that would impeach their company policies. Overall, a satisfactory 83% response rate was obtained. Their finding reveals that both maintenance and property managers have their similar rank for selecting the HVAC contractors: type of maintenance, quality assurance, reputation, network location and price or service orientation.

Horner, El-Haram and Munns (1997) proposed a new approach to maintenance management (Horner, El-Haram and Munns, 1997). They have broken the building down into the physical elements and items of each functional system and subsystem. As a result of their analysis, all the constituent items in the building are divided into two groups depending on the significance of the consequences of failure. Introduction of this approach is expected both to reduce building maintenance costs and to improve the health, safety and satisfaction of the user.

Both of them then describe the objectives of building maintenance and the principal elements of housing maintenance cost (El-Haram and Horner, 2002). A questionnaire was designed to

examine the factors that could have a significant impact on housing maintenance cost. The questionnaires were sent to 50 local authorities and housing associations throughout Scotland. They found that factors such as high tenant expectations, budget constraint, and improper use of the property, energy costs, in case of income support tenants, and the right to buy policy were the most significant.

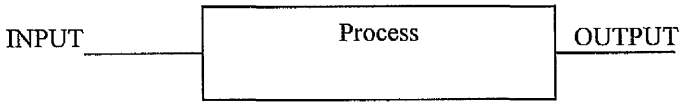
Another approach was then presented by Shabha (2003), This researcher evaluated the approach to low-cost maintenance and refurbishment of high rise buildings in parts of Birmingham, UK (Shabha, 2003). Many technical and environmental problems are attributable to the use of concrete in high rise buildings, together with the designs faults which will be further examined, along with a critique of their impacts on the occupants of the high rise. Most of the technical problems are related to roofs, walls and windows, and have been identified. These problems have resulted in the present-day need for the refurbishment of the housing stock of the city. The decision was solely based on two main factors; which are to cater for new users' requirement and to improve the performance spatially and environmentally in order to meet the building regulation requirement. The second is to accommodate current user's requirements and match their expectations.

He found that many of the buildings constructed have proven to be short-lived and the designs short-sighted. What was considered to be modern, low cost and low-tech public sector housing in the early 1960's has proven to be deficient and highly inadequate for 1990s users' expectation and aspirations. His studies demonstrate that the major problems areas with concrete high-rise buildings are poor quality materials and bad specification of the external envelope, encompassing roofs, walls and windows.

2.5 Building Performance Measurement

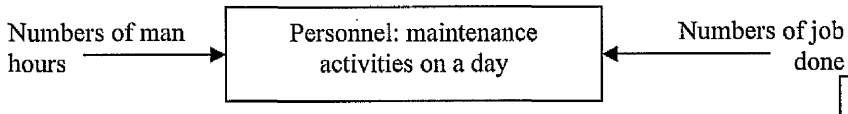
In simple terms 'building performance' has been defined in BS 5241 as behaviour of a product in use. Building performance is important both in an inter-building and in an intra-building sense (Douglas, 1996).

Three models below shows the indicators can be applied to the measurement of building maintenance performance. It was developed by Liliane and Frank (1997).



MODEL 1

Efficiency = theoretical input / actual input
Effectiveness = actual output/ theoretical output
Productivity = output/input



MODEL 2

Theoretical	10 workers	50jobs	8h/day
Actual	8 workers	45jobs	8h/day
	+		
	2 workers	10hr/day	

$$\text{Efficiency} = \frac{10\text{workers} * 8\text{hr/day}}{8\text{ workers} * 8\text{hr/day} + 2\text{workers} * 10\text{hr/day}} * 100\% = 95\%$$

$$\text{effectiveness} = \frac{50\text{ jobs}}{45\text{ jobs}} * 100\% = 90\%$$

MODEL 3

$$\text{Productivity}^{\text{theoretical}} = \frac{50\text{ jobs}}{8\text{ workers} * 8\text{hr/day}} = 0.625$$

$$\text{Productivity}^{\text{actual}} = \frac{45\text{ jobs}}{8\text{ workers} * 8\text{hr/day}} = 0.536$$

$$\text{productivity index} = 0.536/0.625 * 100\% = 86\%$$

Groote (1995) introduced a practical approach of maintenance performance analysis. He has listed four stages in auditing the quality of maintenance such as:

- The maintenance survey of the prevailing situation of influencing parameters.
- The analysis of information and the formulation of conclusions and recommendations.
- The definition and setting of priorities and plan of action
- Cost-benefit analysis to justify the proposed actions

Having identified the audit methodology, Groote (1995) then proposed the principles in maintenance quality auditing that comprise the maintenance survey, analysis of the assessed data, quality audit conclusion/recommendation, definition of priorities, plan of action and cost benefit analysis. He then realised that developing building performance indicators is not easy work.

Chan, Lee and Burnet (2001) identified the general practices, maintenance workload, maintenance and repair costs, failure modes and failure occurrence rate in hotel building. They concluded that for the success of a hotel business, apart from good room services to the guests, it is equally important to provide comfortable indoor conditions and satisfactory performance of the building and the engineering systems. Proper maintenance of the building and the engineering systems is essential for support of the business activities (Chan, Lee and Burnet, 2001). Several performance indicators and their assessment have been compiled by them and the equations is as shows below.

EQUATION 1

- Manpower utilisation index

MUI = Maintenance hours spent on maintenance works in a period/ Total maintenance hours available for maintenance in the same period.

EQUATION 2

- Urgent repair request index (URI)

$$URI = \frac{UR}{UR + GR}$$

UR = number of urgent repair requests arising from guest and in-house staff

GR = number of general requests for repair of the building facilities.

Sarel Lavy-Leibovich and Igal M.Shohet (1997), carried out research to ascertain the various efficiencies of maintenance under different policies, levels of resources and sources of manpower (Sarel Lavy-Leibovich and Igal M.Shohet, 1997). Their research focuses on the maintenance of hospital buildings as a model for multi-system facilities. They have described the preliminary development of maintenance indices for examining the efficiency of work patterns of maintenance departments. These indices are based, to a large degree, on field survey findings on hospital campuses, but can be implemented in other multi-system buildings, such as office buildings, educational facilities and industrial plants.

Three indices of quantitative management tools were developed as *building performance index* for monitoring the performance of the building system, the *manpower sources diagram* for improving the effectiveness of both internal and external labour resources and *maintenance input index* for evaluating the efficiency of both internal

and external labour resources. The hospital was analysed by using the three indices that were developed. They found that facility management professionals are expected to find new ways to improve the comfort, security, safety, energy efficiency and cost effectiveness of the building's management and operation. A higher efficiency level may be achieved by employing a maintenance executive manager. This will reduce the principal engineer's span of control and as a result will decrease the maintenance team's dependence on the principal engineer.

Similar to the above approach, Al Zubaidi (1997) presented a case study which identifies and quantifies both the major problem areas in terms of cost and frequency of maintenance activities and the nature and cause of the demand for maintenance in Withington Hospital (Al Zubaidi, 1997). Even though they have the same idea about analysing a building indicators, Al Zubaidi (1197) has discussed in detail the priorities and categories of maintenance work, and attempts for forecast the demand for maintenance by collecting general statistics, discussing factors affecting the demand for maintenance, and building a forecasting model which estimates the arrival rates of maintenance jobs per trade. His research can be categorised as a part of building performance measurement that relates more to the modelling and estimating works.

In 1998, Bejder and Kaklausas have carried out an analysis to determine an efficient version of a lifetime process of building, with emphasis on its maintenance (Bejder and Kaklausas, 1998). They have followed five principles which are complex analysis, functional considerations, cost-benefit ratio optimisations, the application of the results of various interrelated sciences and simulation (modelling) of a lifetime process of a building. These five principles seems to be useful to be apply in building maintenance management as its principle might help companies reducing necessaries budget during maintaining a building.

Besides having indicators to measure the building performance there are also other method to ascertain the building condition. For example, Nanayakkara (1999), condition survey to examine the fitness of building services. The condition survey establishes whether the plants and installations are capable of continually supporting business needs and legal requirements in the short and medium term and to establish the priorities of a programme of remedial action (such as modifications, refurbishment and replacements); and to plan for the provision of the necessary financial resources.

A common purpose of carrying out a condition survey is to collect data about the nature and condition of the building stock and also to identify the financial commitments required to maintain the assets, usually for a five year period. The asset details, nature of use

and importance of the assets and the required maintenance standard and asset condition are among the assembled information during condition surveys while the main outcomes are as a future maintenance programme and a budgetary plan for future maintenance. The main benefit of condition surveys is the development of a future maintenance plan that can be a starting point of future maintenance strategies, the development of asset condition database and the production of information that can be used to benchmark the operation and maintenance regime (Nanayakkara, 1999).

2.6 Application of Computers and Information Technology in Maintenance

Manually controlled maintenance systems generate instruction forms, historical records, cost details and stock information. The vast quantity of data produced can, however, lead to it not being used because of the time and effort necessary to analyse it.

Computer aided maintenance management has introduced new possibilities for gathering, analysis, interpretation and projection of information. This can improve control of the maintenance function, identify quickly the areas needing attention, permit detailed operating budgets, show exactly the stores and stock control situation and account for expenditure with a greater degree of confidence.

2.6.1 Computer Aided Maintenance Management

Computers have been used to assist the maintenance management process since the early 1970s, and by mid 1980s substantial number of maintenance organisations were using software developed for large mainframe computer systems (Petit, R, 1983; Jones and Collis, 1996). A range of powerful and sophisticated microcomputers were being developed during the late 1980 (Jones and Collis, 1996).

Computer aided maintenance management is therefore a means of using more effectively the data generated by a maintenance system (Armstrong 1985). It offers the opportunity to gather, analyse, and process information on a much greater scale and in more detail than a manual system. It can operate more selectively, enabling it to be a decision support tool by improving the quality of the data on which decisions will be made.

Jones and Collis (1996) conducted a survey which purposes to examine the use of computers in maintenance management. 50 public sectors organisation (local authorities) and 50 private practice organisations involve in their survey that covers the percentage of the organisation using computer for maintenance activities, the types of computer maintenance management being used, and the level of user satisfaction when using computerised maintenance

management systems. Their findings showed that the majority who used computers for aspects of their maintenance management work, and that a wide range of maintenance activities have been computerised and seventy nine per cent of respondents believed that their systems were beneficial to efficiency.

Then Danny (1995) pointed out the use of computers aided building condition surveys. He listed the building condition survey process as surveys objectives; scope and coverage of surveys; survey design and method of data capture; organisation and management of the physical survey on site, data handling and data analysis; reporting the results of the survey, relationship of condition database to other property-related files, and updating the condition database. The use of this information technology is to improve the accuracy of maintenance demand assessment so that the outcome of the budgetary evaluation represents a realistic budget proposal based on assessment of real needs and clearly identified priorities. The availability of cheap database software, the falling prices of hardware, and the ease with which condition data of buildings can be captured and analysed have presented the maintenance manager with a powerful tool to justify the case for the preservation of the value of built assets. In summary, effective maintenance management requires a clear understanding of the nature of the business and the demands of the business operation. Investment in building condition surveys is a first step in acquiring a knowledge base of the assets

being managed, so that scarce resources can be prioritised and targeted as a range of maintenance actions over a specific time period.

2.6.2 Building (Energy) Management System (B(E)MS)

The BMS can be use to provide information on the total run time and condition of HVAC components, which can be integrated into maintenance operations. Ideally, a maintenance policy should be decided for each component of the HVAC system, taking into account risk, technical and cost issues. Five maintenance categories may be classified as run to fail, install redundant units, preventive maintenance program, condition-based maintenance, and redesign to reduce maintenance (Bengtsson, 2003).

Preventive maintenance tasks are carried out either at regular calendar intervals or at intervals based on equipment run time. Preventive maintenance ranges from simple lubrication to complete tear down and rebuild of equipment. Selection of the maintenance period is of great economic significance and is usually based on manufacturers' recommendations. Planned maintenance software is available which use to catalogue maintenance tasks for various plant items, generate and manage work orders, manage inventory for spare parts, store maintenance history, and generate management reports.

The BMS is used to provide information on equipment runtime, which is fed directly to the planned maintenance program.

2.7 Education in Maintenance

The growing importance of the maintenance industries renews the interest of both practitioners and academia working in the maintenance field. The increase in complexities and advanced technology increase the demand for good maintenance services. Meanwhile, the growing concern on the health, safety and environment on building owners encourages them to maintain or upgrade their buildings to the required standards.

A study by the Polytechnic of Central London identified three main roles and eight sub-roles for which adequate professional education in maintenance is needed (UK Dept of Environment, 1972) the maintenance-specific roles included both the higher level supervision and the management of maintenance. The general practitioner role included construction economists and quantity surveyors in economic fields; architects, civil and structural engineers, surveyors, building inspectors, resident site architects and the engineers in the building fabric area; and mechanical, electrical, heating and ventilation and public health engineers in building services. The client role includes the property or estate manager and, in manufacturing industry, the engineering or plant manager

responsible for the buildings, as well as the specialist advisers retained or employed by the client. People without any professional qualification may be and often are found in all these roles but at this level their educational needs in maintenance approach those of the professional, and professional skills will increasingly be called for in the future (UK Dept of Environment, 1972).

There are many already working in industry whose knowledge of maintenance-related subjects is inadequate and there are also a very great number of people responsible for building maintenance at a professional or managerial level who has had no previous experience or training in the subject. The report of the committee of Department of the Environment (UK Dept of Environment, 1972) recommended that those responsible for supervising maintenance work should have a minimum relevant education to Higher National Certificate or Higher National Diploma level and also recommended the content of syllabuses required for people in maintenance fields; the latter is shown in the diagram below.

Table 3: Professional Education in Maintenance *(Source: R&B Bulletin, Building Maintenance, 1972)*

<table>
<tr><td rowspan="2">Maintenance Specialist</td><td colspan="2">Building Fabric</td></tr>
<tr><td colspan="2">Building Services</td></tr>
<tr><td rowspan="5">General Practioner Construction</td><td colspan="2">Economics</td></tr>
<tr><td rowspan="3">Building Fabric</td><td>Design</td></tr>
<tr><td>Inspector</td></tr>
<tr><td>Builder</td></tr>
<tr><td colspan="2">Building Services Design and Installation</td></tr>
<tr><td>Client</td><td colspan="2">Client</td></tr>
</table>

2.8 Conclusion

To conclude, it is worth emphasising that maintenance is now much more sophisticated than previously. Much research has been carried out into the development of appropriate and well managed building maintenance. The improvement of maintenance management can be expected to become more critical as operations become more automated and inventory levels are reduced. As maintenance becomes a critical issue in terms of a company's productivity, advances in the area of maintenance management will contribute a great deal to the overall productivity of the firm and to its ultimate success or failure.

CHAPTER 3 RESEARCH METHODOLOGY

3.0 Introduction

As mentioned above, the study consists of a literature review of building maintenance management in Malaysia and the UK (journal articles, internet sources, newspapers), and examples of actual collected data. It is also important to understand all the terms commonly used in building maintenance, as illustrated in Chapter 2.

According to Phillips and Pugh (1994) there are four elements to a PhD:

1. The *background theory* reviews the literature in the field of study.
2. The *focal theory* describes what the research is about and why it is done.
3. The *data theory* justifies the relevance and validity of the proposed solution of the research.
4. The *contribution* evaluates the importance of the contribution made to the discipline by the research.

This thesis has tried to apply the above guidelines.

3.1 Qualitative and Quantitative Data Analysis

There are two research methodologies, known as qualitative and quantitative methods. Quantitative research uses methods adopted from the physical sciences that are designed to ensure objectivity, generalisation and reliability (Weinreich, 1996). These techniques cover the ways research participants are selected

randomly from the study population in an unbiased manner, the standardised questionnaire or intervention they receive, and the statistical methods used to test predetermined hypotheses regarding the relationships between specific variables. The researcher is considered external to the actual research, and results are expected to be replicable no matter who conducts the research.

Qualitative research methodologies are designed to provide the researcher with the perspective of target audience members through immersion in a culture or situation and direct interaction with the people under study. Hypotheses are generated during data collection and analysis, and measurement tends to be subjective. In the qualitative paradigm, the researcher becomes the instrument of data collection, and results may vary greatly depending upon who conducts the research (Weinreich, 1996).

3.2 Research methodology

This thesis is considering using the quantitative approach whereby questionnaires were involved for collecting of the data. Apart from that there were also interviews and observation applies as the methods of research in this thesis.

This thesis uses the quantitative approach, with questionnaires for collecting data. In addition, interviews and observation were used.

3.2.1 The survey approach

Sets of questionnaires were distributed in Malaysia to obtain data about building maintenance there. They were used to gain data from

three types of respondent: the buildings' occupants, maintenance staff, and the person in charge in the maintenance department. Fifteen buildings were involved in this survey, comprising hospitals, offices and hotels. Details about questionnaire design are introduced in Chapter 6 of this thesis.

Questionnaires are more objective than interviews, as responses are gathered in a standardised way, and generally they are a relatively quick of collecting information. However, in some situations they can take a long time not only to design but also to apply and analyse. Potentially information can be collected from a large portion of a group, but this potential is not often realised, as returns from questionnaires are often low. However, return rates can be dramatically improved if the questionnaire is delivered and responded in time.

3.2.2 Interviews and observation

Only a small amount of data was contributed from interview and observation sessions. This method is considered hard to manage because it needs pre-arranged appointments, and not all respondents are available. It was only used for those in charge of maintenance departments, and people in this position are always busy. Some who agreed to be interviewed and cooperate in this research were unable to at the last minute because their work took priority and they had to attend a meeting or attend to an emergency task. This predicted problem made the author rely less on acquiring data from interview

and observation, and it is only used as a backup in certain circumstances.

3.2.3 The analysis approach

In this part, the researcher decided to use the SPSS software package as a medium to analyse the surveyed data. Some of the data were also analysed using Microsoft Excel, which is very useful as it can represent the data in interesting graphical form that improves the presentation. Analysis of data is described in detail in Chapter 6. All data were allocated to suitable categories based on the research hypothesis, and divided into three major sections as follows:

Section 1: Occupants' Satisfaction Level

In this section, the important of analysing occupants' satisfaction levels reveals what aspects occupants most dislike. The results were then compared with other variables that were hypothesised to be the reason for the outcomes. In this case, the Pearson Correlation test was used to find out variables with significant effects on the others. The outcome was then summarised as the factors that affect satisfaction levels towards maintenance services in the buildings.

Section 2: Capability of maintenance staff

This section contains details about the maintenance staff, including academic qualification, work experience, and number of staff. This is

to find out whether the staff members are capable of doing their jobs. A comparison analysis for the three types of building was done and.

Section 3: Building maintenance management

In this part, discussion was based largely on data from interviews, visits and observation. This relates to the strategy used to manage the maintenance department, the organisation of the department, staff training and job specification.

3.3 The research findings

The research findings in this thesis are described under development of guidelines and the research evaluation.

3.3.1 Research evaluation

This term actually refers to an assessment of the research, the problem solving and its further development. It comprises suggestions and discussion of the finding and its contribution to knowledge. The research evaluation is given in the conclusion of the last chapter.

3.3.2 Developing the guidelines

Developing the guidelines was based on the results of the analysis. The results were classified in several categories, to be reviewed as guidelines for use in Malaysia.

CHAPTER 4 THE STATE OF BUILDING MAINTENANCE IN MALAYSIA

4.0 Introduction

Not many references are available on building maintenance in Malaysia. However, research has shown that it is still a critical issue and that more study in this field could improve its quality. The object of this chapter is to highlight for the reader the current state of building maintenance in Malaysia. It is discusses the previous and current conditions as well as problems that commonly occur in maintaining buildings in Malaysia.

4.1 Current issues surrounding building maintenance in Malaysia

Kayan and Ali (1997) have identified factors which influence the issue of maintenance in Malaysia; they include illegal renovation, vandalism, use of poor quality materials, unacceptable interpretations of regulations and guidelines, and poor management. Hakim (2002) said that it is impossible for a building to be built maintenance free. Most buildings in Malaysia have a problem with the building fabric, because of the hot, humid climate. The most common problem is the need to constantly repaint walls.

Referring to the latest statement by the Prime Minister, Dato' Seri Abdullah Ahmad Badawi, a huge amount of money is spent maintaining buildings in Malaysia because of inadequate maintenance in the past (*Utusan Malaysia*, 2006b). The main reason

was that early identification of damage was not carried out, resulting in worse damage later on.

In 2001 the *New Straits Times* (2001b) reported that the Petaling Jaya Municipal Council had decided to relinquish managing the Lembah Subang low-cost flats as it did not have sufficient manpower to supervise and manage services. It subsequently called for tenders to privatise the management services, including maintaining the cleanliness of the premises and also ensuring that facilities are not vandalised. Vandalism, such as damage to the public toilets and lifts, was among the many problems which had prompted the council to decide to appoint a company to manage the premises. To prevent this vandalism, they placed four council personnel at the Lembah Subang flats to monitor the situation there. Additionally, prompt action should be taken to reorganise the structure of the maintenance schedule which might help the flats remain safe and in good condition.

A resident from Taman Kepong, Kuala Lumpur complained that Alam Flora did not carry out their work properly (*New States Times*, 2001a). Alam Flora Sdn. Bhd is a single purpose company formed by the HICOM-led Consortium for privatisation of the Solid Waste Management (SWM) for Central and Eastern Regions of Malaysia, covering the states of Selangor, Pahang, Terengganu, Kelantan and Federal Territory of Kuala Lumpur. Alam Flora handles about five thousand two hundred tons of waste per day using rear

loader compactors, open tippers, side loaders and Arm Roll. Besides household waste, Alam Flora offers to collect of garden waste, bulky waste and construction or renovation wastes.

According to this resident of Taman Kepong, the drains were clogged up with rubbish for nearly six month. Only after residents complained did Alam Flora decide to send special trucks and teams of workers to clean up the area. This shows that the company did not meet residents' expectations. Maintenance of sewerage and drainage in housing estates was their main job. Complaints from the residents exposed the need for proper schedules in order to clean the estate's drains; the schedules should be revised from time to time in order to fulfil the customers' requirements. Planned preventive maintenance might help them to produce a better service.

4.2 Privatisation

Public Work Department or Jabatan Kerja Raya (JKR) (JKR, 2004), which is under the Ministry of Public Work Malaysia, is responsible for providing the necessary infrastructure and public facilities, especially roads, bridges, buildings, airports and ports, to meet the needs of national development. However, since 1998 all building maintenance works, especially for government buildings, have been privatised. This privatisation is divided into zones: North, East and South.

In 1996, the government of Malaysia and the three companies signed the concession agreement for the privatisation of hospital support services. This project involved the expenditure of about RM500 million per annum for a concession period extending over 15 years, for the management and provision of clinical waste management services, cleansing services, linen and laundering services, facility engineering maintenance services and biomedical maintenance services in 123 hospitals and 4 institutions (Malaysia Ministry of Health, 1997). A Regulatory Unit was formed in March 1998, consisting of seven senior engineers and a deputy director responsible for managing the concession agreements and developing the technical policies, standards, guidelines, procedures and circulars necessary for the implementation of the hospital support services.

As a result of privatisation, the budget available for the Hospital Support Services was significantly increased from about RM170 million in 1996 to an assured budget of almost RM500 million a year which significantly supported and improved the standard and level of the Hospital Support Services in all one hundred and twenty seven government hospitals and health institutions (Malaysia Ministry of Health, 1997).

More job opportunities are now available and the total number of manpower directly involved with the services is about 10,000, comprising various expertise and trades. New private investments in the health sector have also emerged specifically in the setup of the

highly sophisticated clinical waste incineration and laundering plants that also provide services to the private hospitals and clinics. The privatisation project also encourages the development of new industries related to the Hospital Support Services, such as production and supply of consumables, chemicals, and expertise in the country. Various standards, guidelines and procedures have been developed to improve the quality and level of services to reach new heights and to meet new targets.

KPJSB is one of the largest healthcare groups in the region, offering a diverse and integrated range of healthcare services with high professionalism, caring and quality services to consumers supported by advanced state-of-the-art technology. KPJ Healthcare owns and manages the most comprehensive network of private specialist hospitals in Malaysia and Indonesia, and a range of healthcare support services such as pharmaceuticals, a medical supply distribution network, pathology laboratory, nursing college, institute of healthcare management with international affiliation, and healthcare technical services including hospital development, commissioning, maintenance and bio-medical engineering services (KPJ, 2004)

Healthcare Technical Services Sdn Bhd (HTSSB) was formerly known as TPM Healthcare Services Sdn Bhd, wholly owned by Johor Corporation. By 2000, Healthcare Technical Services Sdn Bhd had been divided into three main divisions: Project Management,

Engineering & Maintenance Service Centre (EMSC), and Hospital Commissioning. EMSC is a consultancy service in technical matters, formed in 1998. Currently there are six hospitals under KPJSB which have signed the agreement to appoint HTSSB as the consultancy to manage and advise on engineering and maintenance. They have strategies and objectives to increase the standard of maintenance service, including the formalisation and standardisation of policies and procedures, to implement, monitor, evaluate and review the effectiveness of policies and procedures, to conduct training and quality assurance activities, to provide sufficient manpower and relevant tools, to establish a central data bank for continuous improvement, and to attain the acceptable standards in complying the statutory requirements (KPJ, 2004)

4.3 Factors influencing the failing in building maintenance

Based on several sources found in this topic, there are three main reasons that contribute to a problem the maintenance system in Malaysia.

4.3.1 Vandalism

As mentioned above, vandalism does contribute to the failures of building maintenance. Vandalism occurs everywhere, not only in buildings but also at other places such as public recreation areas and in buses. As far as building maintenance is concerned, common vandalism problems can be found in low-cost residential areas such

as flats and low-cost housing. Some can be seen in schools and other academic institutions such as colleges and universities, although less vandalism is found in elite areas such as condominiums and government offices. There is no way to avoid vandalism except by hiring a person to monitor the area all the time, and this seems neither practical nor cost effective.

4.3.2 Lack of experts

The term "lack of experts" means that not enough people with sufficient knowledge have been hired to work as maintenance staff. Having people without any background in maintenance is not an easy way to manage. Staff members need to be trained and briefed about their tasks in maintaining a building. From rough observation, no training has been given, most people without experience or knowledge start from below and a friend or supervisor acts as a reference along the way. In this case, most of the buildings will have a lot of complaints regarding their maintenance services. Besides the lack of experts, most maintenance departments do not have enough people to maintain the building. This will cause an inadequate maintenance service, and some jobs cannot be done in the time available.

4.3.3 Guidelines

Malaysia's Prime Minister, Dato. Seri. Abdullah Ahmad Badawi has emphasised that the Public Work Department should provide

guidelines in maintaining buildings in Malaysia (*Utusan Malaysia*, 2006b). He also said that the skill of managing and maintaining buildings must be upgraded by the building owner, of both government and private buildings. He stressed that there is no point in having a beautiful looking building if the interior is not properly maintained. In this case, it is necessary for Malaysian researchers to look at maintenance and its guidelines. Having well organised guidelines might help everyone manage and maintain their assets more effectively.

4.4 Conclusion

It is now clear that building maintenance in Malaysia needs to be reviewed intensively. This includes both the system and its management. It is not easy to maintain a building without a good knowledge in this area and to have a good maintenance system requires good maintenance skills. Thus it becomes a responsibility to the author and other related Malaysian researchers in this field to examine how to improve its quality. Developing maintenance guidelines is one option, but many other ways can be used in order to improve maintenance work.

CHAPTER 5 FACILTIES MANAGEMENT, PHILOSOPHY, IMPLEMENTATION AND ROLE OF MAINTENANCE PRACTICE IN UK.

5.0 Introduction

Facilities management (FM) is the integration of multi-disciplinary activities within the built environment and the management of their impact upon people and the workplace (BIFM, 2006).

Effective FM, combining both resources and activities, is vital to the success of any organisation. At a corporate level, it contributes to the delivery of strategic and operational objectives. On a day-to-day level, effective FM provides a safe and efficient working environment, which is essential to the performance of any business, whatever its size and scope (BIFM, 2006).

5.1 The Philosophy of Facilities Management

Within this fast growing professional discipline, facilities managers have extensive responsibilities for providing, maintaining and developing a myriad of services. These range from property strategy, space management and communications infrastructure to building maintenance, administration and contract management (BIFM, 2006).

The British Institute of Facilities Management (BIFM) defines facilities management as the practice of co-ordinating the physical workplace with the people and work of an organisation.

Atkin and Brooks (2005) summarise facilities management as creating an environment that contributes to carrying out the organisation's primary operation, taking an integrated view of the services infrastructure and using this to deliver customer satisfaction and value for money through support for and improvement of the core business.

Barrett (1995) identifies facilities management as an integrated approach to operating, maintaining, improving and adapting the building and infrastructure of an organisation in order to create an environment that strongly supports the primary objectives of the organisation.

Thomson (1991) suggests that "*if you ask five facilities managers to describe facilities management, you will probably not get two descriptions the same*". He then describes a generic FM department which he considers as having four primary functions:

(1) real estate and building construction (landlord activities in large organisations);

(2) building operations and maintenance;

(3) facility planning;

(4) general/office services (sub-let activities in large organisations).

In the field of higher education, FM is defined as the support services and physical resources of the institution that are inputs to its business success. This definition recognises that FM arrangements may include a broad range of academic support,

administration, and technical services; and that these arrangements can differ widely for individual higher education institutions. The UK Dept of Higher and Further Education, Training and Employment for Northern Ireland (2000) defines FM as supporting the institution's core activities by managing the services and physical resources that are key to its business success, in an integrated and co-ordinated way. Core activities are defined as those relating to research, teaching and learning, and working with business and the community. The facilities of the institution include a range of services, functions and activities, as well as buildings and equipment.

Nordic FM (2003), however, defines facilities management by dividing it into five main categories, as shown in Figure 5. This definition can be seen as an integrated method of operating, maintaining, improving and adapting the buildings and infrastructure of an organisation.

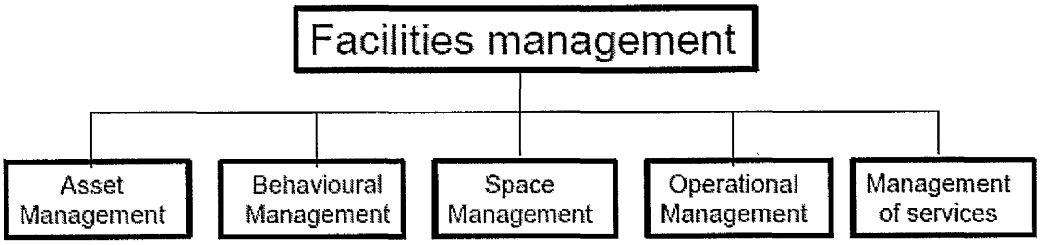


Figure 5: Definition of Facilities Management (Nordic FM, 2003)

Table 4: Sample of facilities management definition (Lindholm,2005)

Author	Definition of Facilities Management
Becker (1990)	FM is responsible for co-ordinating all efforts related to planning, designing and managing buildings and their systems, equipment and furniture to enhance the organisation's ability to compete successfully in a rapidly changing world.
Nourse (1990)	FM unit is seldom aware of the overall corporate strategic planning, and does not have a bottom-line emphasis.
Cotts & Lee (1992)	The practice of co-ordinating the physical workplace with the people and work of an organisation; integrates the principles of business administration, architecture, and the behavioural an engineering science.
Park (1994)	Facilities Management is the structuring of building plant and contents to enhance the creation of the end product. As with all systems it is the generated benefit to the business or activity that matters, not the system itself.
Barrett (1995)	FM is an integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organisation in order to create an environment that strongly supports the primary objectives of that organisation.
Alexander & Spon (1996)	The process by which an organisation delivers and sustains support services in a quality environment to meet strategic needs.
Then (1999)	The practice of FM is concerned with the delivery of the enabling workplace environment -the optimum functional space that supports the business processes and human resources.
Hinks & McNay (1999)	...common interpretations of the FM remit: maintenance management; space management and accommodation standards; project management for new-built and alterations; the general premises management of the building stock; and the administration of the associated support services. Varcoe (2000) ...a focus on the management and delivery of the business
Varcoe (2000)	...a focus on the management and delivery of the business "outputs" of the both these entitles (the real estate and construction industry); namely the productive use of building assets as workplaces.
Nutt (2000)	The primary function of FM is resource management, at strategic and operational levels of support. Generic types of resource management central to the FM function are the management of financial resources, physical resources, human resources, and the management of resources of information and knowledge.
Atkin (2003)	Facilities Management is a practice of coordinating the physical workplace with the people and work of the organisation. It integrates the principles of business administration, architecture and the behavioural and engineering sciences.
Nordic FM (2003)	FM is also seen as an integrated approach to operating maintaining, improving and adapting buildings and infrastructure of an organisation in order to create an environment that strongly supports the primary objectives of organisation.

The definition and scope of FM remains a controversial issue and depend on the local culture, organisations' interests and people's personal interests. Despite the controversial differences in definitions, the conclusive meanings are becoming more essential through internationalisation (Lindholm, 2005). Table 4 lists more

definitions of FM from researchers all over the world. However, the definitions have prevented the development of the common platform that is so crucial to the cohesive theoretical development of FM (Lindholm, 2005).

Although the definitions given by all researchers in this field may seem different, in general FM focuses on the workplace. It emphasises enhancing the performance of organisations, and this makes the definition of facilities management a combination of management of the workplace to enhance the performance of the organisation.

5.2 Facilities Management Function

Generally, facilities management core functions consist of maintaining and improving the value of capital assets and reducing the backlog of maintenance and statutory compliance; operating the installed building services thus enabling the buildings to perform their intended function; and ensuring that assets, used for the delivery of service, are safe and compliant with applicable regulations consistent with assessment of risk and available resources. They also include developing existing assets so that they are functionally suitable for the delivery of service; rationalising the property holdings to the minimum needed for the delivery of the health and social care service; and providing professional advice on all estate related matters (Low, 1996).

Facilities management involves a number of disciplines and services, and is perhaps confusingly often used to describe one specific area of FM, such as maintenance management (Moore & Finch, 2004). It involves the development, co-ordination and management of all of the non-core specialist services of an organisation, together with the buildings and their systems, plant, IT equipment, fittings and furnishings, with the overall aim of assisting any given organisation in achieving its strategic objectives.

Low (1996) clarifies that facilities management contains four main areas:

1. the continuous co-ordination of all efforts, namely planning, designing, construction and management of facilities towards enhancing the working environment of the people and the organisation's ability to meet its business objectives
2. the total integration of a diverse field of disciplines on business, architecture, behavioural and engineering science, under one entity in an organisation to oversee all facilities functions previously controlled by independent departments
3. the management of activities proactively rather than the management of facilities reactively
4. a business concept where facilities management policies and procedure are guided by organisational goals and objectives as well as available resources.

In other words, FM is a multidisciplinary but integrative function that generally involves more than one department in large organisations.

According to Barrett (1995), FM services can be divided into three areas: premises services, office services and central services, as shown in Table 5.

Table 5 : Different Facilities Services (Barrett, 1995)

PREMISES	OFFICE SERVICES	CENTRAL SERVICES
Building maintenance	Mailing	Catering
Decoration work	Stationary	Room booking
Sub-contractor	Photocopying	Insurance
Telecommunication	Vehicles	Archival
Security	Printing	
Safety		
cleaning		

Facilities Management places the non-core business at the service of the core business in such a way as to protect an organisation's capital investment in real estate and helps turn a cost item into one of added value. It can therefore be summarised as creating the optimal environment for the organisation's primary functions, taking an integrated view of the business infrastructure, and using this to deliver customer satisfaction and best value through support for and enhancement of the core business (Lindholm, 2005). Atkin adds that people can develop this definition to describe FM as something that will deliver effective and responsive services; enable changes in the use of space in the future; "sweat" the assets, that is make them highly cost effective; create competitive

advantage for the organisation's core business; and enhance the organisation's culture and image.

According to Lindholm (2005), in many organisations FM is a new function that provides a connection between the core activities and the facility activities (Lindholm, 2005). She indicates that facility activities can also be named facility production. The core business gives the facilities management function a budget to ensure that the organisation gets the facility services it wants. The FM function pays the producer(s) of the facility services for the provided services Lindholm.

5.3 The Implementation of Facilities Management

Effective facilities management, combining resources and activities, is vital to the success of any organisation. At a corporate level, it contributes to the delivery of strategic and operational objectives. On a day-to-day level, it provides a safe and efficient working environment, which is essential to the performance of any business, whatever the size and nature of its operation.

Every organisation has someone responsible for the FM function. They may not actually be called "facilities manager", but there will be someone who will deal with these areas. The smartest of front offices will have people behind the scenes to make sure the lavatories work, the photocopier has paper and that the Internet server is up and running (Questonline, 2004).

Many sources state that FM is becoming an increasingly important function in every organisation. However, unlike new construction, FM, if it is to be taken within the context of not only property maintenance and management, but also retro-fitting, refurbishment and renovation works, will involve more risk because of the higher level of uncertainties during the inception, design, and construction stages. For this reason, Low (1996) believes that total quality management (TQM) can help to rationalise and enhance effective facilities management. Successful implementation of TQM on facilities projects can be achieved through persistence positive, hands-on leadership; upfront preparation and continuous maintenance of a sensible plan.

In facilities management, the broadening process must be further developed to influence management efficiency positively. Some of the factors which need to be considered before TQM can be operated for facilities management are the customer, audits and contracts (Low, 1996).

Strong and enlightened leadership is needed for implementation of successful FM. Careful thought needs to be given to the design of an open profession for the twenty-first century (Alexander, 1994), and to take advantage of modern communications to create a network that reflects the virtual corporation. These are among the strategies that can be put into effect during the implementation of FM. Three emerging managerial roles in FM organisation are those of

managing customers, managing services, and managing assets. These management roles concentrate on three important challenges facing FM (Alexander, 1994):

1. Empowerment of people in the organisation so that they at their most effective
2. Organisation of the service to meet business and user needs and promote the corporate identity
3. The harnessing the potential of new technologies.

According to Atkin and Brooks (2000), whichever course of action has been taken, the primary concern is the basis for the decision: has the chosen approach has been arrived at for appropriate reasons, such as demonstrating better value for money? Two principles should be followed: an informed client function and the relationship with suppliers. In other words, organisations need to act as informed or intelligent clients if they are to be sure of delivering customer satisfaction and achieving best value for money. The best contribution that organisations can make to the enhancement of the competitiveness of suppliers is to manage their own procurement intelligently. An important element of this will combine competition and cooperation to optimal effect. Additionally a great deal of interest in FM will follow as it is likely to bring greater benefit than other approaches in certain circumstances, for example where there is a poorly developed or highly specialised market or

where the requirements of the purchaser are complex and continuously developing.

5.4 Building Maintenance and its significance for Facilities Management

The role of building maintenance is not only to make sure that all plant and equipment are operating at maximum efficiency, but also to meet the performance requirements of the building's occupants. To do this, the maintenance engineer has to consider the needs of the occupants with regard to environmental conditions (heating, cooling, lighting, sanitation, etc.), and to data communications and electrical power, all of which must be provided within the statutory health and safety regulations, together with the capability of the building services plant to meet those requirements (Thompson, 1994).

Maintenance of buildings is one of the more complex subjects in the field of FM (Shohet, 2003). In addition to improving core maintenance services, facilities management needs to be more efficient; organisation becomes the most important thing. Sekula (2003) outlines the issues one should address and the initial steps to take as head of facilities. These include the function of maintenance and operation, which should be investigated both proactively and reactively. He also clarifies that other issues to be borne in mind are financial planning and budgeting, lease review, service contract, referred provider, workspace, and technology infrastructure.

Attention is also given to policies and procedures, management systems, departmental organisation and staffing.

Sekula's study is supported by Shaw and Haynes (2004), who conducted a survey to evaluate the customer perception of FM service delivery. They suggest that facilities managers may use service quality concepts, originally developed for the external consumer market, as one means to support existing performance management methods and better match service delivery with specific customer requirements. In order to implement these models, however, service dimensions, essential to providing a basic framework for service quality management, must be defined for FM services.

Narayan (1998) says that the role of a manager is to identify, evaluate, and minimise the risks faced by his organisation. There is a vital role to be played by maintenance managers in this context. The technical integrity of an organisation affects its long term profitability. Breakdowns, trips and other unplanned shutdowns or slowdowns affect short term profitability. Good maintenance planning can help in both areas, and do so at minimum total cost.

The points which emerge from the above review focus on the importance of the manager of the facilities department; he or she is responsible for making the buildings systems successful and satisfying the occupants. Facilities managers are found in large corporations, banks, the manufacturing industries and consultancies; in fact, almost everywhere where there are plants,

buildings and services to be provided in support of the main core business (Low, 1996).

Consequently, FM covers every aspect of building performance and maintenance. It directly affects building running costs, in both the long and short term, by upholding staff health and morale, and will help keep down the capital and operational costs which can escalate as a result of poor maintenance.

5.5 Conclusion

Research into facilities management is increasing, and the subject now has its own dedicated academic journal. Comments, suggestions and advice all point to the provision of a high quality service and better performance of facilities management in all organisations. The challenge to secure the future of FM as a credible discipline, vocation and business service is enormous (Alexander, 1994); FM needs to be more closely aligned to be a management discipline to enable it to differentiate itself as it develops within the service sector. As has been found by (Low, 1996), many organisations involved with FM do not yet have quality management systems incorporated into their procedures.

Strategy might become the first priority point for facilities management to run efficiently and effectively (Atkin & Brooks, 2000). This should involve formulating and communicating a facilities policy, planning and designing for continuous improvement of service

quality, identifying business needs and user requirements, negotiating service level agreement and establishing effective purchasing and contract strategies (Alexander, 1994). In this way, the organisation will have a much improved ability to determine and specify their FM requirements and will be able to get the best out of the industries they served.

In the context of building maintenance, facilities management focuses on the method of managing and scheduling the maintenance organisation, work planning and strategy and policies and legislation. If this looks similar to other organisational approaches, it is because maintenance is actually the main part of facilities management. Successful implementation of facilities management and maintenance management can enhance a company's profit and may bring substantially improved overall building performance.

CHAPTER 6 COLLECTION AND ANALYSIS OF DATA

6.0 Introduction

This chapter discusses the research survey beginning with the collection of data, through to its analysis and evaluation against the research objectives.

6.1 Collection of data about maintenance

As little information about building maintenance was found in Malaysia, most of the literature is collected from earlier and current situations in the United Kingdom, the United States and other developed countries. There are also articles that discuss maintenance in South East Asia which are relevant to this research. In general, initial data are mostly taken from international journals such as the *Journal of Quality in Maintenance Engineering*, the *Journal of Facilities*, and the *Facilities Management Journal.*

The main objective of this research was briefly explained in an earlier chapter, and the research objectives to be met by use of questionnaires were then covered in depth to provide the rationale for the survey:

1. to identify the occupants' satisfaction level in all selected buildings in Malaysia. As describe in Chapter 4, there are too many complaints received regarding the lack of maintenance in

Malaysia, this criteria reflects the fact that a major objective of the maintenance is to meet the occupants needs.

2. to identify any relationships that influences the performance of maintenance systems in the building. Review in section 4.3 agreed that two factors has failing in building maintenance in Malaysia (vandalism and lack of expertise). It might be other reason contributes to this problem.
3. to gather data about maintenance staff details and to find out if any factor affects the maintenance systems in the building. These criteria needed to ensure that staff members are sufficiently competent to run the system.
4. to find out which request produces the biggest demand and identify any action that has been taken to reduce the number of demands. By conducting this analysis it was possible to examine the fitness of building services in that particular building (Nanayakkara, 1999).

As this research is intended to produce findings for building maintenance in Malaysia the author decided to conduct a survey using a questionnaire related to the selected buildings in Malaysia. The questionnaire was chosen because it is the easiest method to use by all levels of participants, and because many of the possible subjects move around the building during the course of their work, which makes interviewing problematic. Individuals can fill in a questionnaire at a time which is convenient to them.

The author also interviewed managers of maintenance departments where this was possible, and although not all managers co-operated, sufficient relevant data was still collected.

6.2 Designing a questionnaire

Questionnaires offer a feasible way of involving enough participants to allow statistical analysis of the results. Burgess (2001) found that a well designed questionnaire, if used effectively, can gather information on both the overall performance of the test system and on specific components of the system. He also believes that it would be useful to correlate performance and satisfaction with the test system among different groups of users.

There are many way of distributing a questionnaire during data collection: by mail, personal distribution or via the internet. Those options have their own advantages and disadvantages. Jobber and O'Reilly (1996) prefer to distribute questionnaires by mail, as a great deal of information can be collected from widely scattered populations at low cost. However, they admit that a mail survey does have limitations, and is best used where the scheme of questions is not over-elaborate and the questions require straightforward and concise answers. The Internet is becoming an increasingly useful medium for collecting data, with the potential to reach an incredibly large number of respondents. LoPresti & Fischer (2006) agree that this method can also cut costs by eliminating copy fees and interviewer personnel.

As a printed list of questions, a questionnaire is used to obtain information on what people think or feel about an issue, product or service. Oppenheim (1992) confirms that participants can fill in the questionnaire away from the researcher in the form of self-administered, group-administered or postal questionnaires. His term "questionnaire interview" is also used to describe a set of questions administered face-to-face or by telephone in a structured form.

Burgess (2001) believes that the questionnaire should be viewed thoroughly, as a multi-stage process, beginning with a definition of the aspects to be examined and ending with an interpretation of the results. Every step of preparation needs to be designed carefully because the final results are only as good as the weakest link in the questionnaire process. Although questionnaires may be cheap to administer compared to other data collection methods, they are every bit as expensive in terms of design time and interpretation. Burgess lists the steps required to design and administers a questionnaire as:

1. Defining the Objectives of the Survey
2. Determining the Sampling Group
3. Writing the Questionnaire
4. Administering the Questionnaire
5. Interpretation of the Results

Leung (2006) and White (1998) also agree that the objective of the questionnaire must be the highest priority in designing a

questionnaire; it should be specific, clear-cut and as unambiguous as possible, especially as it becomes very significant in the testing method of the hypothesis of the research subject at the later stage. Synodinos (2003), demonstrated that research objectives head the overall process, as shown in Figure 6. From the other point of view, it is very important to know what kind of evidence is needed to meet the purpose of the study and to know how the information is to be used (Marshall, 2006).

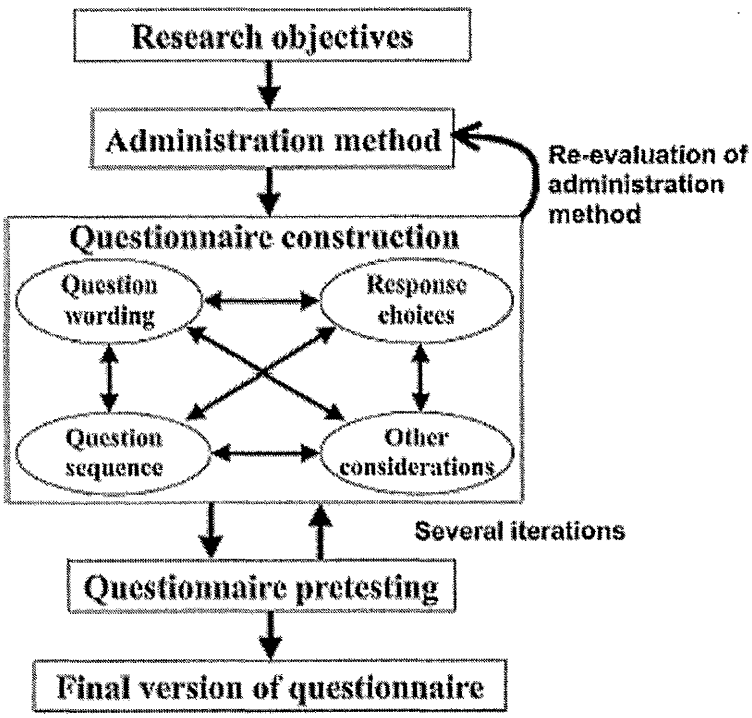


Figure 6 : Questionnaire Construction Process (Synodinos, 2003),

However, some researchers suggest that a pre-test step should be added before the questionnaire is administered (Noël & Prizeman,

2005; Synodinos, 2003). The data obtained from the pre-test should then be evaluated and improvements made (Marshal, 2006; Reynolds & Diamantopoulos, 1996). This process is also known as piloting, and it assists researchers in refining the instrument and field procedures. Pre-testing of the questionnaire is discussed in detail in section 6.4.3 of this chapter.

Questions may be designed to gather either qualitative or quantitative data. By their very nature, quantitative questions are more exact than qualitative questions. According to Burgess (2001), the words "easy" and "difficult" can mean radically different things to different people. Writing questions and constructing a questionnaire takes time and attention (Marshall, 2006) and each question must be carefully crafted, but in particular questions that assess a qualitative measure must be phrased to avoid ambiguity.

6.3 Principles of the questionnaire

In designing a questionnaire, the author needs to know the principles of gathering data. Foddy (1993) states that he believes that the use of verbal data has come to dominate the social sciences; asking questions is widely accepted as a cost-efficient way of gathering information about past behaviour and experiences private actions and motives, and beliefs, values and attitudes.

The questionnaires in this research are designed to gather information about building maintenance management and systems.

Two sets of questionnaires were prepared, the first eliciting beliefs and experiences and the second satisfaction data. Likert-scales response options are used; they are easy to explain and produce straightforward data (Oppenheim, 1992).

6.3.1 Likert Summated Rating Methods

This method is also known as Likert Scales, and is a widely used measuring instrument among researchers. The format consists of a series of positive and negative opinion statements concerning a construct, each accompanied by a five or seven point response scale (see Figure 7). According to Sinodynos (2003), this type of closed-end question should provide response alternatives that are exhaustive and mutually exclusive. He noted that when using this format, the researcher should be careful to make sure that all possible responses do not overlap. It is also important to ensure that the respondent is not overwhelmed by too many alternatives.

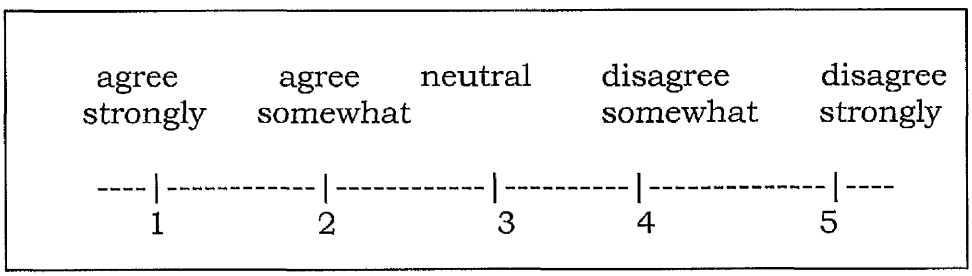


Figure 7: The Likert-Scales (Source: Oppenheim, 1992)

Generally, respondents were asked to rate the extent of their agreement or disagreement with each statement on a scale ranging

from strongly disagree to strongly agree. Thus, Likert scales are force-choice instruments, requiring respondents to select one response from a fixed set of options provided by the researchers. Table 6 shows the rating scales that are commonly used in a questionnaire survey.

Table 6: Likert rating scale statement
(Source: www.uscg.mil/hq/rtc/downloads/survey%20jobaid.pdf)

Type of Scale	Points of Continuum				
	1	2	3	4	5
Agreement	Strongly Agree	Agree	Neither Agree or Disagree	Disagree	Strongly Disagree
Frequency	Always	Often	About half the time	Seldom	Never
Satisfaction	Very Satisfied	Satisfied	Neither Satisfied nor dissatisfied	Dissatisfied	Very dissatisfied
Effectiveness	Very effective	Effective	Neither effective nor ineffective	ineffective	Very ineffective
Quality	Very good	Good	average	Poor	Very poor
Expectancy	Much better than expected	Better than expected	As expected	Worse than expected	Much worse than expected
Extent	To a very great extent	To a great extend	somewhat	To a small extent	To a very small extent

6.3.2 Open-Ended

In an open-ended question the researcher does not provide the respondent with set answers from which to choose. Rather, the respondent is asked to answer "in their own words". This produces mainly qualitative data. Peterson (2000) notes that open-ended questions are necessary in five situations: in instances when the answers are not readily foreseeable, responses can be influenced by

the presented choices; variable measures impose the use of the open-ended format; as in the case of unaided recall, potential for unanticipated events demands flexibility; and initial responses necessitate asking follow-up questions. Otherwise it is suggested that this format be used sparingly because it requires substantial respondent effort (Sinodynos, 2003).

6.4 The questionnaire

This section provides further discussion of the questionnaires that have been prepared by the author. Based on work by the American Statistical Association (1999), the place to start in designing a questionnaire is with the data collection goals. Once these objectives have been clearly identified, the next step is to decide what pieces of specific information are needed to satisfy this objective.

The main reason for a survey is to collect data about the condition and performance of building maintenance and its management in the selected building types in Malaysia. The buildings were chosen because of their diverse functions. It will be recalled that these are hospitals, hotels and offices.

A hospital is a building that operates 24 hours a day with sophisticated biomedical equipment that requires a host of utilities, air conditioning and refrigeration, stabilised power supply systems and medical equipment that plays a very significant role in the healthcare delivery system.

As dynamic, complex and costly buildings to operate and maintain (Chan et al., 2001), hotels' diverse use of space is an impact feature. Guestrooms, restaurants, health clubs, function rooms, retail stores, laundries and swimming pools are likely to exist in the same hotel. In most hotels the engineering department is responsible for maintaining both the building and the building services system. Chan et al. noted that the cost of operating and maintaining the engineering system, in particular the in-house manpower, outsource contractors, energy consumption and equipment deterioration, must be properly monitored and controlled.

EMPORIS (2006) defines a high-rise building as "a tower consisting of a multi storied building of offices or apartments. High rise building is distinguished from other tall man-made structure by the following guideline; it must be divided into multiple level of at least 2 metres height; if it has fewer than 12 such internal level undivided portion must not exceed 50% of the total height; indistinct divisions of levels such as stairways shall not be considered floors to purposes of eligibility in this definition".

In this research high-rise buildings focus on offices which, unlike hotels and hospitals, are in use only 8 to 9 hours a day.

6.4.1 Questionnaire context

In many cases decisions about the collection mode will be driven by financial constraints or other resource limitations (Oppenheim, 1992). Nevertheless, considerations such as overall questionnaire length, question complexity and question sensitivity must be weighed in determining the mode of collection (American Statistical Association, 1999). For example a long questionnaire may not work well on the telephone, complex questions may require an interviewer to be sure that they are understood, and sensitive questions may be best done in a self-administered format (Sinodynos, 2003). Based on these statements, the author has decided that the questionnaire would be both self-administered and interviewer-administered.

The questionnaires were delivered in person. This is because the questionnaire is considered as simple and easy to understand. Since the survey was conducted in Malaysia, both the Malay and English languages were used.

6.4.2 Structure of questionnaire

An introduction to the objective of the survey was given on the first page (Sinodynos, 2003), informing subjects of its purpose. The questions were mostly formatted as close-ended responses, only one question expecting an open-ended response. Three sets of questionnaires were designed.

Questionnaire 1

Set I is for the building maintenance manager to fill in some data about the building. Some of these were interviewer-administered. Questions include:

1. Building usage.
2. Building age.
3. Approximate gross floor area.
4. Number of floors.
5. Number of workers in maintenance.
6. Number of occupants in building.

The other questions were designed to elicit information about maintenance management, including questions on the maintenance strategy, policy and standard. There were also some questions about maintenance staffing to discover whether they had enough equipment, tools and so on for staff to do repairs.

Questionnaire 2

The Set 2 questionnaire was designed to give an opportunity to the occupants of the building to express their satisfaction with the maintenance service in the buildings. Occupants were asked to choose a method for making requests, in order to discover which method is the best and most effective. Occupants were also asked to rate their level of satisfaction towards the maintenance service, such as:

- Did they respond promptly to any request made?
- Was the requested work completed by the time it was needed?

- If it was necessary for the job to be delayed was this communicated to you?
- Were interruptions kept to a minimum?
- Was the worksite left neat and orderly?

Questionnaire 3

Set 3 was designed for the maintenance staff to fill in their details. It includes data about academic qualifications, work experience, age, and gender and so on. Most of the data will be used to assess whether they are qualified to work in the maintenance department and what should be done if they do not have enough knowledge about maintenance jobs.

6.4.3 Pre-testing the questionnaire

The last step in the questionnaire design is to test a questionnaire with a small number of interviewees before conducting main interviews. Ideally, the survey should be tested on the same kind of people that will be included in the main study. This kind of test run can reveal unanticipated problems with question wording, instructions to skip questions and so on (Sinodynos, 2003; Marshall, 2006). It can indicate if the interviewees understand the questions and are giving useful answers.

In this survey, the author sent out 20 draft questionnaires by e-mail and mail and there were 16 replies from the proposed respondents. All their comments have been noted. Three significant

comments were received from the respondents during this pre-test stage:

1. About half of the respondents recommended that the questionnaire should be in both Malay and English.
2. Three respondents suggested that the font size should be larger.
3. Closed format questions were preferred to the open-ended format.

The pre-testing procedure showed that all respondents understood the purpose of the survey. Not many refused to answer the questions. All the comments mentioned above were incorporated into the final version of the questionnaire used in the real survey. The three questionnaires are reproduced in full in the Appendix.

6.5 Conducting the survey

During June and July 2004, the author distributed questionnaires to 15 buildings, consisting of the three types of building being studied – office buildings, hospitals and hotels in Malaysia.

A few building managers did not fully cooperate in completing the questionnaires as some of them were too busy, needing more time to answer the questionnaire. In any event, at least five responses were obtained for each building type.

The author also conducted interviews with the people in charge of the maintenance departments. As most of these people were extremely busy, the interview sessions lasted only a few minutes. Mesiniaga Tower (Yeang, 1996) cooperated most both during the interview and in completing the questionnaire.

Two months were needed to get more detailed data. This survey took time because, as most of the buildings serve commercial purposes, appointments had to be made. Securing an appointment could be difficult because the people in charge of the maintenance departments are often not available. Furthermore, these appointments sometimes had to be cancelled because an emergency or breakdown had occurred. However, the author had expected to encounter these difficulties.

6.6 Statistical Software Package

There are a number of statistical software packages available nowadays, such as *SPSS®*, *Excel®*, *SAS®*, *Minitab®*, *Stata®*, *Access®*, *dBase®* and many more. For the purpose of this research, the author decided to use SPSS® software to analyse data (SPSS, 2000a, 2000b). SPSS®, which stands for Statistical Package for the Social Sciences, is one of the most popular statistical packages, as it can perform highly complex data manipulation and analysis with simple instructions. It is designed for both interactive and non-interactive (batch) use.

SPSS® has scores of statistical and mathematical functions and statistical procedures, and a very flexible data handling capability. It can read data in almost any format (for example numeric, alphanumeric, binary, dollar, date, time formats), and version 6 onwards can read files created using spreadsheet/database software. It also has excellent data manipulation utilities.

6.7 Analysis of Data

This section discusses how data was managed. All data gathered was grouped into categories. The main objective is to get the actual condition of building maintenance performance in various buildings in Malaysia relative to occupants' satisfaction, staff details and some other management variables.

After all data has been managed and grouped it is important to identify the test to be used. There are a few important things to be understood before the test could be proceeding and there are including the terms and type of test in statistical analysis.

The idea of correlation is one of the most important and basic in the elaboration of bivariate relationships. Unlike chi-square measures of correlation indicates both the strength and the direction of the relationships between a pair of variables. There are many formulas that can be used to calculate *r* (Pearson Correlation) (http://www.childrens -mercy. org/ stats/ definitions/correlation. html), and the most detailed formula is given below.

EQUATION 3

Pearson Correlation (r)

$$r = \frac{N\sum - (\sum x)\ (\sum y)}{\sqrt{[N\sum x^2-(\sum x^2)^2]\ [N\sum y^2\ -\ (\sum y)^2]}}$$

N = number of pairs of scores
$\sum xy$ = sum of the products of paired scores
$\sum x$ = sum of x scores
$\sum y$ = sum of y scores
$\sum x^2$ = sum of squared x scores
$\sum y^2$ = sum of squared y scores

Symbol r is stand for the correlation. Through the magic of mathematics it turns out that r will always be between -1.0 and +1.0. if the correlation is negative, we have a negative relationship; if it's positive, the relationship is positive

In statistics, "significant" means probably true (not due to chance). A research finding may be true without being important. When statisticians say a result is "highly significant" they mean it is very probably true. The statistical significance of a result is the probability that the observed relationship (e.g., between variables) or a difference (e.g., between means) in a sample occurred by pure chance ("luck of the draw"), and that in the population from which the sample was drawn, no such relationship or differences exist.

Using less technical terms, one could say that the statistical significance of a result tells us something about the degree to which

the result is "true" (in the sense of being "representative of the population"). More technically, the value of the p-value represents a decreasing index of the reliability of a result. The higher the p-value, the less we can believe that the observed relation between variables in the sample is a reliable indicator of the relation between the respective variables in the population. Specifically, the p-value represents the probability of error that is involved in accepting our observed result as valid, that is, as "representative of the population.

In a scientific study, a theory is proposed, and then data is collected and analyzed. The statistical analysis of the data will produce a number that is statistically significant if it falls below 5%, which is called the confidence level. In other words, if the likelihood of an event is statistically significant, the researcher can be 95% confident that the result did not happen by chance.

EQUATION 4

Statistical significance between two statistics

The difference between any two estimates given in the detailed tables may or may not be statistically significant. Statistical significance for the difference between two independent variables is computed as:

$$S_{x_1-x_2} = \sqrt{[S_{x_1}]^2 + [S_{x_2}]^2}$$

Where S is the standard error, x_1 is the first estimate and x_2 is the second estimate. The result of this computation is to be multiplied by

1.96, and if this result is less than the difference between the two estimates, the difference is statistically significant.

The normal distribution has two parameters, the mean and the standard deviation sigma. Once the parameters are known, the distribution is completely specified. It can be shown, although we will not do so (yet) that a good guess or estimate for the mean of the observed values. An estimate for sigma is the standard deviation. Although the standard deviation is a positive number, the mean can assume any value. The normal distribution is one which appears in a variety of statistical applications. One reason for this is the central limit theorem. This theorem tells us that sums of random variables are approximately normally distributed if the number of observations is large. The normal distribution function is determined by the following formula:

$$f(x) = 1/[(2*\pi)^{1/2}*\sigma] * e^{**}\{-1/2*[(x-\mu)/\sigma]^2\}$$

where:

μ	is the mean
σ	is the standard deviation
e	is the base of the natural logarithm, sometimes called Euler's e (2.71...)
π	is the constant Pi (3.14...)

In a normal distribution, approximately 68% of the values lie within one standard deviation of the mean and approximately 95% of the

data lies within two standard deviations of the mean. (http://www.statsoft.com/textbook/stdisfit.html#normal)

If there are extreme values towards the positive end of a distribution, the distribution is said to be positively skewed. In a positively skewed distribution, the mean is greater than the mode (http://www.mathsrevision.net/alevel/pages.php?page=55). For example:

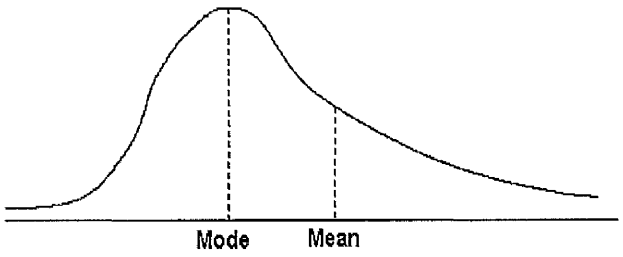


Figure 8 : Skew in data distribution
(http://www.mathsrevision.net/alevel/pages.php?page=55)

A negatively skewed distribution, on the other hand, has a mean which is less than the mode because of the presence of extreme values at the negative end of the distribution.

Skewness is a parameter that describes asymmetry in a random variable's probability distribution. Both probability density functions have the same mean and standard deviation. A positively skewed distribution has a longer tail to the right and a negatively skewed distribution has a longer tail to the left (http://www.mathsrevision.net/alevel/pages.php?page=55).

EQUATION 5

Skew

$$skewness = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^3 / n}{\left[\sum_{i=1}^{n}(x_i - \bar{x})^2 / n\right]^{1.5}}$$

Where x_i is a sample observation, x bar is the sample mean and n is the sample size. Skewed distributions can sometimes be "normalized" by transformation.

6.7.1 Occupants satisfaction level

As far as building maintenance is concerned, occupants' satisfaction level is very important as it can be used to measure the performance of the buildings. The satisfaction level test has been chosen as the first test in this thesis because the main objective of this research is to discover the building maintenance performance. This section presents the extent to which occupants are satisfied with the maintenance services and the building system performance in buildings in Malaysia. 259 replies from respondents from the three types of buildings were analysed in this section. The level of satisfaction expressed by a building's occupants was calculated combining all types of building. With the Likert scale rating, the average of satisfaction was assessed as: the higher the score the

better the satisfaction (1= completely unsatisfied, 5=very satisfied). Figure 9 indicated the five scales of satisfaction level rated by occupants. The purposed of descriptive statistic is to get the mean of each variable as this can be used to identify level of satisfaction. In some cases descriptive analysis was used to quantify data through ratings of perceived intensities on scales and to have a prediction of consumer acceptance (SPSS, 2000).

Figure 9: Satisfaction level scale

1.0 - 1.9	2.0 - 2.9	3.0 - 3.9	4.0 -4.9	5.0
Completely unsatisfied	Not Satisfied	Fairly satisfied	Satisfied	Very satisfied

There were 79 replies from occupants in the hospital type of building. These people worked permanently in these buildings, and included nurses, clerks, hospital attendants and receptionists. There were no patients involved in this survey. Survey analysis comprises five variables to rate their satisfaction towards maintenance service in hospitals.

Table 7: Descriptive Statistics for hospitals

	N	Minimum	Maximum	Mean	Std. Deviation
QUESTION 1 (Q1)	79	2.00	5.00	3.3165	.99414
QUESTION 2 (Q2)	79	2.00	5.00	2.8354	.66853
QUESTION 3 (Q3)	79	2.00	5.00	3.3291	.69285
QUESTION 4 (Q4)	79	2.00	4.00	2.6962	.60668
QUESTION 5 (Q5)	79	2.00	4.00	3.0380	.64932
SATMEAN	79	2.33	3.83	3.0738	.29927
Valid N	79				

Notes :
Q1 = respond promptly to any request made
Q2 = requested work completed by the time it was needed.
Q3 = staff will communicated if jobs delayed
Q4 = interruption kept to minimum
Q5 = worksite left neat and orderly
SATMEAN = Overall Mean of satisfaction

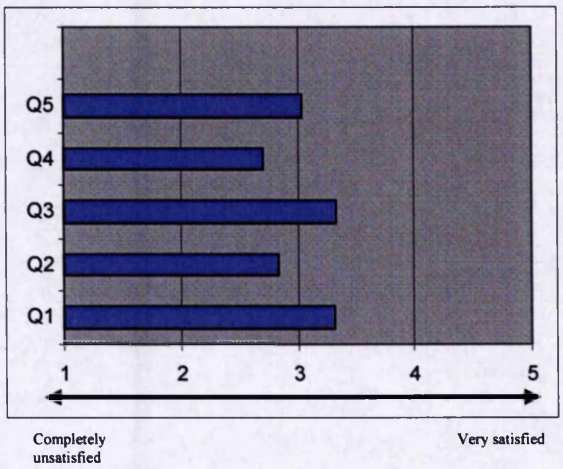


Figure 10: Occupant's satisfaction level in hospitals

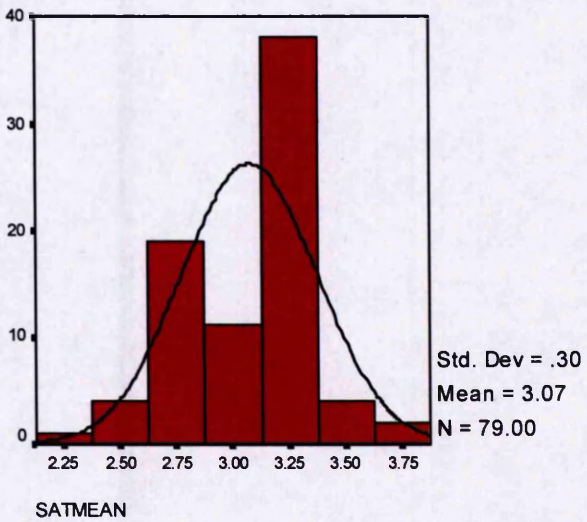


Figure 11: Histogram of satisfaction level in hospitals

Descriptive analysis in Table 7 shows the mean of variables for the satisfaction level of the occupants in hospital buildings. The first column indicates the identification of the question from the questionnaires. The bar chart in Figure 11 illustrates that there are two variables falling between 2 and 2.9 and this means that those variables are rated as 'not satisfied' by the respondents. Q4 with the mean score 2.6 represents whether the interruption of

maintenance works are kept to a minimum, while Q2 with mean score 2.8 represents whether the requested work was completed by the time it was needed. This requires more analysis to find out any factor that influences the result. However, the overall mean of satisfaction in Figure 11 shows that the test had a mean of 3.07 which indicates that occupants were fairly satisfied with the maintenance service provided in the building. The histogram curve illustrates that the satisfaction level is normally distributed and the standard deviation (Garson, 2006) is 0.32, indicating there is a fair amount of variation among respondents toward satisfaction with the maintenance services in the buildings.

Occupants' satisfaction level in hotels involved 80 respondents. They are among the hotel's staff and include housekeeping staff, clerks, receptionists and administration staff. The same methods were applied to obtain occupants' satisfaction level in these hotel buildings. Table 8 show the descriptive statistic for hotels that comprises of 5 variables.

Table 8: Descriptive Statistics for hotels

	N	Minimum	Maximum	Mean	Std. Deviation
QUESTION 1 (Q1)	80	1.00	5.00	3.2125	.74109
QUESTION 2 (Q2)	80	2.00	5.00	3.3875	.60575
QUESTION 3 (Q3)	80	1.00	5.00	3.0875	.84485
QUESTION 4 (Q4)	80	2.00	4.00	3.2125	.74109
QUESTION 5 (Q5)	80	2.00	5.00	2.8625	.79147
SATMEAN	80	2.20	4.80	3.0675	.38967
Valid N	80				

Notes :
Q1 = respond promptly to any request made
Q2 = requested work completed by the time it was needed.
Q3 = staff will communicated if jobs delayed
Q4 = interruption kept to minimum
Q5 = worksite left neat and orderly
SATMEAN = Overall Mean of satisfaction

Referring to Table 8 the mean score from Q5 was identified as 'not satisfied'. This refers to whether the worksite is left neat and orderly once repair work is completed. However, the overall mean of satisfaction in Figure 12 indicates that respondents are fairly satisfied with the maintenance service in hotel buildings with a mean score of 3.07. The histogram curve in Figure 13 illustrates that the satisfaction level is normally distributed and the standard deviation (Garson, 2006) is 0.39, indicating there is a fair amount of variation among respondents toward satisfaction with the maintenance services in the buildings.

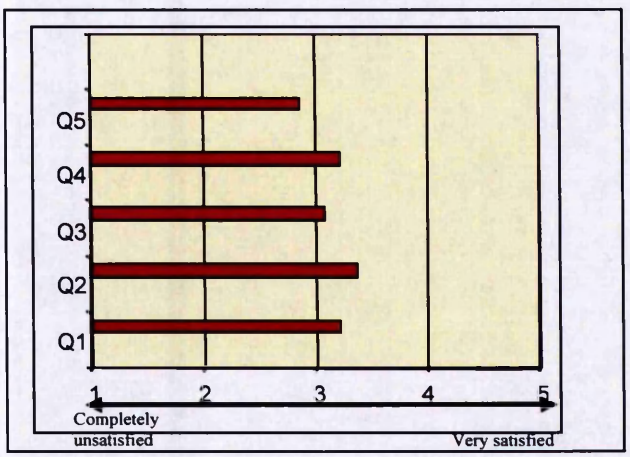


Figure 12: Occupants' satisfaction level in hotel

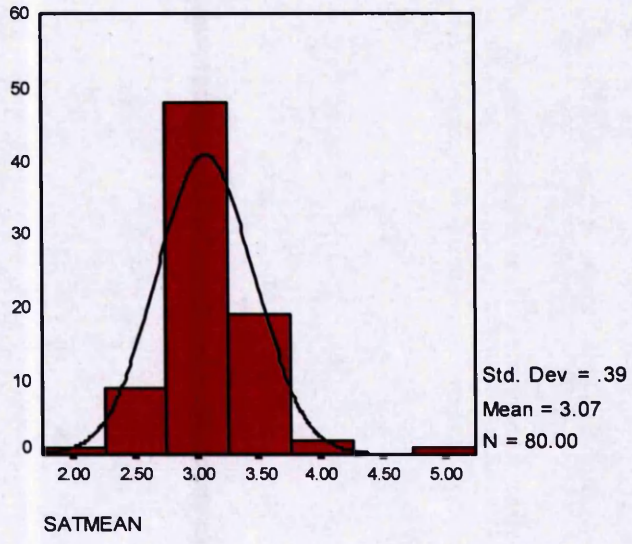


Figure 13: Histogram of satisfaction level in hotels

There were 100 replies from occupants in office buildings and their descriptive statistics are shown in Table 9. All respondents are among the people that permanently work in the selected buildings including cleaners and security guards. The result in this survey shows that occupants are almost satisfied with the maintenance services provided except for variables Q3 and Q4. These represent whether staff will communicate if jobs are delayed (Q3) and whether interruptions are kept to a minimum (Q4).

Table 9: Descriptive Statistics high-rise offices

	N	Minimum	Maximum	Mean	Std. Deviation
QUESTION 1 (Q1)	100	2.00	5.00	3.5900	.69769
QUESTION 2 (Q2)	100	1.00	5.00	3.0500	.75712
QUESTION 3 (Q3)	100	1.00	5.00	2.8900	.80271
QUESTION 4 (Q4)	100	1.00	4.00	2.5700	.62369
QUESTION 5 (Q5)	100	2.00	5.00	3.6000	.68165
SATMEAN	100	2.83	4.00	3.2133	.24967
Valid N	100				

Notes :
Q1 = respond promptly to any request made
Q2 = requested work completed by the time it was needed.
Q3 = staff will communicated if jobs delayed
Q4 = interruption kept to minimum
Q5 = worksite left neat and orderly
SATMEAN = Overall Mean of satisfaction

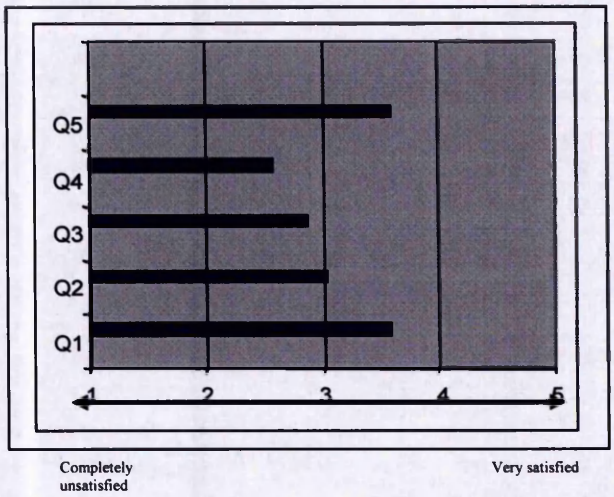


Figure 14: Occupants' satisfaction level in high-rise office building

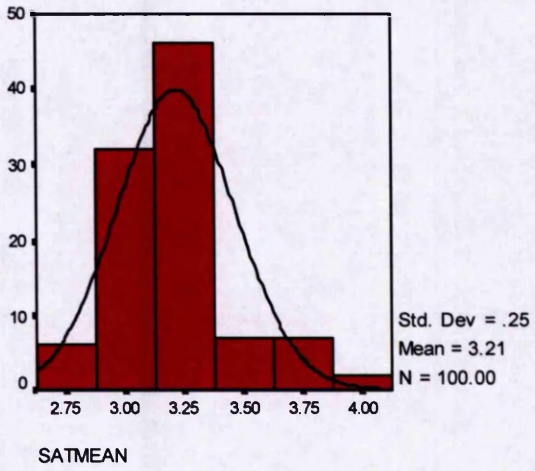


Figure 15: Histogram of satisfaction level in high-rise office building

The histogram curve of this survey illustrates that the satisfaction level is normally distributed. The overall satisfaction mean fell into 3.21, which indicates that occupants are fairly satisfied. The standard deviation (Garson, 2006) is 0.25, indicating there is a fair amount of variation among respondents toward satisfaction with the maintenance services in the buildings.

6.7.2 Cross comparison analysis for occupant satisfaction level

Referring to all satisfaction surveys from occupants, it is found that they are almost satisfied with the maintenance services provided. The bar chart in Figure 16 shows that the occupants' satisfaction level has a similar pattern for the three types of building. The cross comparison analysis below compares all three types of building.

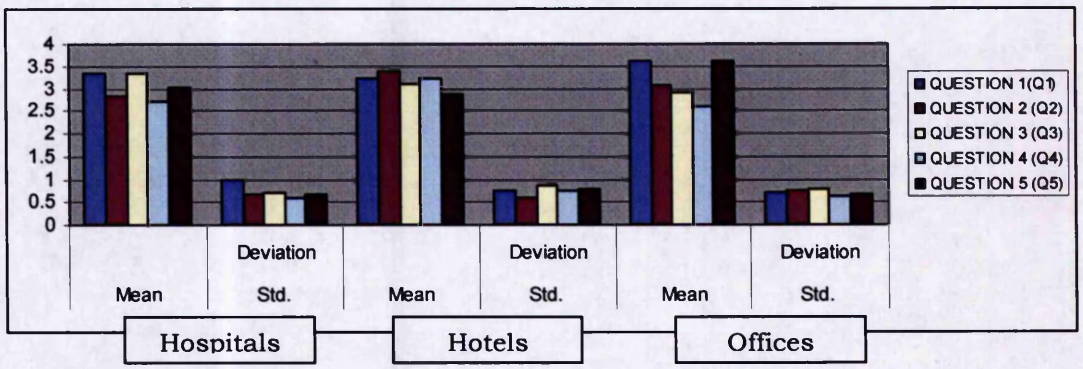


Figure 16: Cross comparison analysis for satisfaction level of the surveyed of buildings

Table 10: Cross comparison of the occupants' satisfaction level.

	HOSPITAL			HOTEL			HIGH-RISE OFFICE		
	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation
QUESTION 1 (Q1)	79	3.3165	.99414	80	3.2125	.74109	100	3.5900	.69769
QUESTION 2 (Q2)	79	***2.8354***	.66853	80	3.3875	.60575	100	3.0500	.75712
QUESTION 3 (Q3)	79	3.3291	.69285	80	3.0875	.84485	100	***2.8900***	.80271
QUESTION 4 (Q4)	79	***2.6962***	.60668	80	3.2125	.74109	100	***2.5700***	.62369
QUESTION 5 (Q5)	79	3.0380	.64932	80	***2.8625***	.79147	100	3.6000	.68165
SATMEAN	79	3.0738	.29927	80	3.0675	.38967	100	3.2133	.24967
Valid N	79			80			100		

Table 10 shows 4 variables have been rated as "not satisfied" with ratings from the minimum mean of 2.5 up to the maximum of 2.8 which are shown in italic bold font. These variables are Questions

2, 3, 4 and 5. Those variables represent whether requested work is completed by the time it is needed (Q2), whether staff will communicate if jobs are delayed (Q3), whether all interruptions are kept to a minimum, and (Q4) and whether the worksite is left neat and orderly (Q5). Question 1, which represents whether staff responds promptly to each request made, was rated as "satisfied" by all respondents. This means that staff did not take too long to attend a job but perhaps they needed a longer time to fix the failure, as this might be related to Questions 2 and 4. This requires more analysis to find out any considerable matters that affect the results.

From the other point of view, data from a short interview with one of the hospital building's managers argued that they have a problem with occupants' satisfaction regarding the maintenance services; in fact, there is one variable with the result of "not satisfied" (Q5). Respondents in these buildings were found not satisfied with the worksite being left neat and orderly. With reference to health and safety regulations, (http://www.hse.gov.uk/PUBNS/regindex.htm) all organisations must be aware of this as it can cause accidents or may harm users of the buildings. The mean score of satisfaction level for Q5 (2.86) in hospital buildings is actually nearly as high as the satisfaction level (3.0). This means that only a few respondents were not satisfied, so managers should be aware of this and ensure that the worksite must be always in a clean, neat and orderly condition.

In this situation, the Pearson Correlation test was found very significant in finding out if those unsatisfied variables have a

relationship with the others. In SPSS, correlation can be easily obtained along with an accompanying significance test. Pearson's correlation is used to find a correlation between at least two continuous variables. The value can fall between 0.00 (no correlation) and 1.00 (perfect correlation). Other factors such as group size will determine if the correlation is significant. Generally, correlations above 0.80 are considered high. In statistic analysis, when a statistic is significant, it simply means that it is very sure that the statistic is reliable. Significant relationships can be strong or weak. Significant differences can be large or small and it is depends on the sample size.

In this analysis it is hypothesised that those unsatisfied variables was influenced by the variables of age of the maintenance staff, their job experience and their academic qualification. Table 11 below shows the results of correlation significant between Questions 2 and 4 towards those three variables.

Table 11: Correlation Matrix for Hospital

		Age	Job experience	Academic qualification
Q2	Pearson Correlation	.059	.059	.098
	Sig.(2 tailed)	.687	.687	.505
	N	49	49	49
Q4	Pearson Correlation	.111	.111	.026
	Sig.(2 tailed)	.449	.446	.859
	N	49	49	49

In table 11, the data provides evidence that every pair of variables is uncorrelated. All correlations value are very small (Pearson Correlation or r value of 0.059, 0.98, 0.111 and 0.026) and too far from 1 (maximum correlation value). The results shown that the significance value is greater than 0.05 (level of significance for 2

tailed significance tests), then it is fail to reject the null hypothesis. This mean that age, job experience and academic qualification does not give any influence to the Q2 and Q4.

Table 12: Correlation Matrix for Hotel

		Age	Job experience	Academic qualification
Q5	Pearson Correlation	.098	.352(*)	.089
	Sig.(2 tailed)	.163	.011	.535
	N	51	51	51

*correlation is significant at the 0.05 level (2 tailed)

In Table 12, it is surprising to note that the significant value of Q5 and Job experience is 0.011 (less than 0.05). Then there is enough evidence to reject the null hypothesis. In the other word there is evidence that the satisfaction level of worksite neat, clean and orderly dependent on the job experience of the staff. The Pearson Correlation is positive and not that strong, r value of 0.352 between job experience and Q5 indicated that the more staff experienced in this area tends to receive the less complaint with respect to worksite neat, clean and orderly.

Table 13: Correlation Matrix for Office Buildings

		Age	Job experience	Academic qualification
Q3	Pearson Correlation	-.121	.303	-.298
	Sig.(2 tailed)	.470	.065	.069
	N	38	38	38
Q4	Pearson Correlation	.074	.368(*)	-.013
	Sig.(2 tailed)	.659	.023	.940
	N	38	38	38

*correlation is significant at the 0.05 level (2 tailed)

Again in Table 13, significance value rounded to three decimal, 0.023 (thus less than 0.05). This data provides evidence to reject the null hypothesis. In the other word the interruption will kept

minimum dependent on the staff job experience. Correlation matrix in this case indicates that the observed relationships were not strong. The Pearson Correlation, r value of 0.303 indicating that the more experienced the staff tends to receive less complaints of staff not would not communicated if job delayed. The r value of -0.298 indicates that the less experienced staff tend to received more complaint of staff would not communicated if job delayed.

Returning to the hypothesis posed at the beginning of this section, it is now possible to state that job experience of the maintenance staff affects two of the variables from the occupants' satisfaction survey. These are Question 4 in the office building and Question 5 in hotels. Moreover, the author predicts that the number of staff members would also is one the reasons affecting the result of occupants' satisfaction level. Less maintenance staff working in the building could result in the job performed not meeting the expected quality, but this again depends on the gross floor area of that building. A larger gross floor area demands adequate numbers of maintenance workers to ensure that the maintenance task is carried out optimally. Bigger buildings with fewer maintenance staff will overwhelm the staff in carrying out the task assigned, while smaller buildings with a larger number of staff will create less work for the staff. Consequently, this will result in a disproportion of work compared to the size of the manpower.

6.7.3 Capabilities of maintenance staff

It has been recognised that the factors affecting the occupants' satisfaction level are not complete if the proportion of work toward manpower size is not analysed. As mentioned in the above section, this would also influence the satisfaction level; thus, detailed analysis of capabilities of maintenance staff is given. Table 14 shows the data concerning buildings details and the proportion of manpower. The first column lists the name of the surveyed building. The second shows the building gross floor area, followed by the number of patient or customer rooms in the third column. The fourth and fifth columns are the total of maintenance requests per month. The last two columns calculate the ratio of gross floor area to the number of staff and the total maintenance requests to the number of staff.

Table 14: Request demand for high rise offices, hotels and hospitals in one month.

Building	Building Gross Floor Area (m^2) (GFA)	Patients/customers Rooms	No. of Maintenance Staff (N)	Total Maintenance Request (N1) per month	GFA/N	N1/N
Hotel A	106548	643	46	208	2316:1	5:1
Hotel B	13128.25	145	12	119	1094:1	10:1
Hotel C	15020	154	23	145	653:1	6:1
Hotel D	102831	260	10	101	10283:1	10:1
Hotel E	100350	231	20	172	5017:1	9:1
Hospital A	10340	139	10	52	1034:1	5:1
Hospital B	16320	272	8	105	2040:1	13:1
Hospital C	61300	800	42	75	1459:1	2:1
Hospital D	150120	2502	53	60	2832:1	1:1
Hospital E	13560	226	12	36	1130:1	3:1
Building A	18100	n/a	40	424	452:1	11:1
Building B	10934	n/a	5	80	2186:1	16:1
Building C	6530	n/a	4	41	1632:1	10:1
Building D	12300	n/a	6	83	2050:1	14.1
Building E	14000	n/a	21	115	66:1	5:1

The results show that buildings are almost facing the problem of not having enough manpower in their department. Occupants satisfaction survey in this research does not present any relationship to the number of staff or efficiency of staff per gross area but from the interview session, the maintenance manager of one of the hospital buildings said, they need another 20 maintenance staff in addition to the 42 staff they have now. Data in Table 14 clearly shows that all staff members are able to access the entire job, but they may be overwhelmed in having to maintain quite a large area. Besides fixing and repairing all the failure requested by the occupants, maintenance staff also needs to do inspection to the given area as their day or weekly routine. They were also need to check if any of the equipment needs to be replaced of service cause of damage or need to be retrofitted. In some cases maintenance staffs were also need to do some paper works such as preparing meeting minutes and some other administrative work. Even though the ratio in table 13 shows that the proportion of staff to do repairs in one month is very small but they are actually need to cover some other works at describe above. It is suggested that every building's maintenance manager need to use standard performance measurement to ensure that they have enough people to maintain the building. Detailed discussion about performance measurement is presented in Chapter 7 of this thesis.

6.7.4 Request demand

Request demand in this chapter is defined as the total numbers of request for maintenance such as repairing, fixing, and replacing equipment in the building. Data for this survey was gathered from the occupants in the building and it is counted only for a month. This section also provides a discussion of the differences and similarities of the buildings, including methods of making requests, staffing, and system performance and so on. Table 15 below shows the statistics for numbers of requests for maintenance in the three types of buildings in one month. The purpose of this data is to identify systems that generate multiple requests for maintenance in one month. Common requests for repair are also provided in this part.

Table 15: Request demands for high rise offices, hotels and hospitals in one month.

(a) High rise office buildings

	BUILDING A	BUILDING B	BUILDING C	BUILDING D	BUILDING E	Total
Sanitary	96	24	2	23	9	**154**
Fire fighting	13	1	0	0	0	**14**
HVAC	12	10	7	9	1	**39**
Lift & Escalator	46	3	9	4	0	**62**
Telecommunication	5	2	11	15	0	**33**
Lighting	249	38	12	32	105	**436**
Electrical	3	2	0	0	0	**5**
Security	2	0	0	0	0	**2**
Total	**426**	**80**	**41**	**83**	**115**	**745**

(a) Hotel Buildings

	Hotel A	Hotel B	Hotel C	Hotel D	Hotel E	Total
Sanitary	80	26	55	18	52	**231**
Fire	0	0	0	0	11	**11**
HVAC	3	4	0	3	45	**55**
Lift	0	3	1	5	8	**17**
Telecommunication	2	23	5	38	22	**90**
Lighting	120	48	83	28	17	**296**
Electrical	1	15	1	5	12	**34**
Security	2	0	0	4	5	**11**
Total	**208**	**119**	**145**	**101**	**172**	**745**

(a) Hospital Buildings

	HOSPITAL A	HOSPITAL B	HOSPITAL C	HOSPITAL D	HOSPITAL E	Total
Sanitary	15	33	33	10	6	**97**
Fire fighting	0	0	0	0	0	**0**
HVAC	8	9	8	12	6	**43**
Lift & Escalator	0	1	0	0	0	**1**
Telecommunication	2	3	3	3	2	**13**
Lighting	11	48	23	28	20	**130**
Electrical	3	4	4	3	2	**16**
Nurse call	6	4	2	4	0	**16**
Bio-medical equipment	2	3	0	0	0	**5**
Medical gas	3	0	2	0	0	**5**
Security	2	0	0	0	0	**2**
Total	**52**	**105**	**75**	**60**	**36**	**328**

In general, all buildings are completed with standard building services systems. Hospital buildings have a further three systems, being nurse call, medical gas and biomedical equipment. These are particular to the hospital buildings as they are all for services and medical treatment in the hospital. The statistics show that the three building types have similar patterns of demand for maintenance. Lighting and sanitary systems produce the highest number of requests for maintenance in a one-month period. Observations and discussions with the building maintenance managers during the surveys highlighted that the common calls for repairs can be divided

into a few items as shown in Table 16.

During the observations and discussions with the building maintenance manager of one of the surveyed buildings, it was discovered that occupants were very particular about the condition of the building, especially those who dealt a lot with customers. It would be a real problem for them if the telecommunication system was always breaking down when they expected to have more customers to deal with by telephone.

Table 16: Common complaints from the occupants of the buildings (source: occupants' satisfaction survey)

Lighting	**Sanitary**
- Flickering - Dusty - Bulb failure	- WC blockage - Water cistern not functioning - Water tap loose - Leakage - Water trap blockage
HVAC	**Telecommunication**
- too cold/too warm - leakage - noisy - Air filter dusty	- Telephone not functioning - No ringing tone

The survey has found that in many buildings in Malaysia, contractors maintain the telecommunications system. Monthly check-ups are usually done and full reports will be submitted to the building maintenance manager. This shows that in-house maintenance staff only repairs very minor faults rather than inspecting the whole system. Faults such as no ringing tone or no pulse were the most common breakdowns reported by the occupants

throughout the month. This is probably caused either by the low quality of telephone units or connection errors. No instances of vandalism were reported. As far as day-to-day works are concerned, maintenance staff only needs to replace the telephone unit with a new one and check the connection. If they cannot fix the problem themselves, they call the contractors.

The sanitary system was found to create the second highest demand for maintenance in one month. It is to be expected that buildings with more toilets received more calls for sanitary repairs. Hospital buildings and hotels have more toilets than high rise offices. However, the survey has proved that hospital buildings do not in fact have as many complaints about this system as the others. This may be because their maintenance systems run well. In addition, where maintenance staff can fix the fault on the day that it is reported, the complaint is categorised as day-to-day work. Blockages, loose taps and leakages are among the faults occurring in sanitary systems. Some of the equipment needs to be replaced and some of it needs to be inspected and tested for wear and tear.

6.7.5 The methods of request

Most occupants prefer to use the telephone to make a request for maintenance. Figure 17 backs up this statement. Occupants feel that it is easy to talk directly via telephone instead of using other methods of making requests. It might be faster than having to fill in a

work order form. However, the effectiveness of making a request is the most important thing as it can affect the performance of the maintenance service.

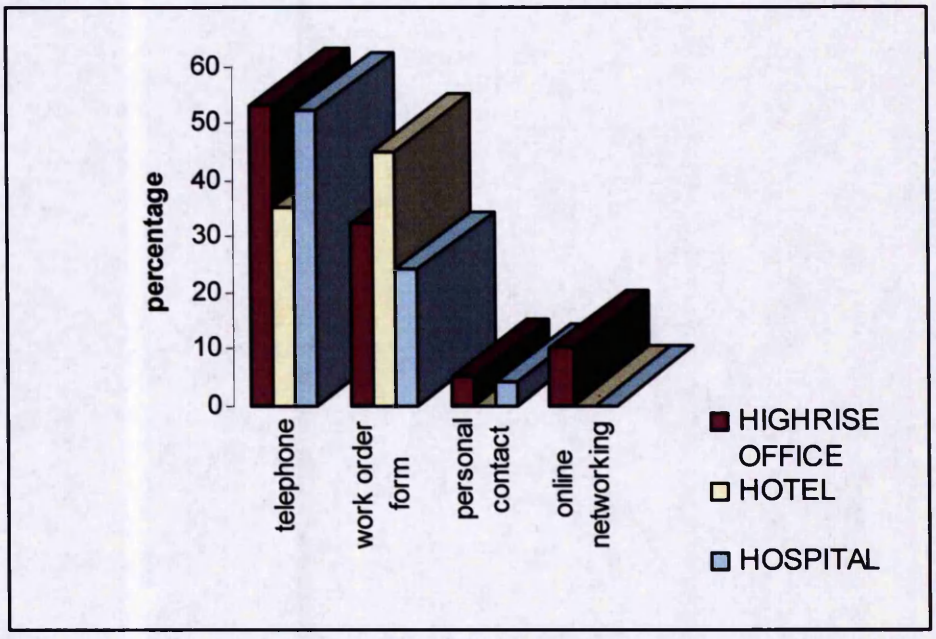


Figure 17: Method of request for high rise offices, hotels and hospitals in Malaysia

In addition, maintenance people must be bear in mind that every request received must be properly recorded. The information gathered could be used in the future for any purpose, such as for setting monthly or annual budgets and weekly or monthly work schedules.

6.7.6 Maintenance staff qualification

Figure 18 shows the numbers of staff with educational qualifications in the three types of building in Malaysia. The proportions show that the number of staff with only school leaver qualifications is still very

high, especially in hotel buildings where almost 35% of staff members are school leavers (SRP and SPM).

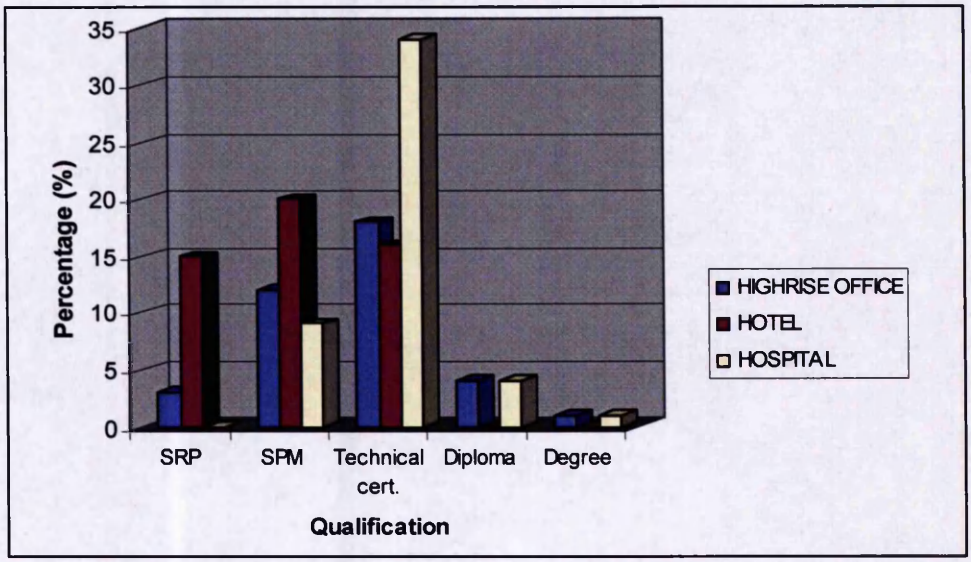


Figure 18 : Academic qualifications of maintenance personnel

Based on discussions with one of the building managers, all staff members are supposed to hold at least a technical certificate. This is to ensure that they have at least a basic technical knowledge to allow them to working in a building systems environment. Besides that, management of the building can save more of their budgets if they do not need to arrange basic technical training for them.

6.7.7 The cross comparison study of the capability of maintenance staff in the surveyed buildings

Based on Table 17, many buildings face the problem of not having enough maintenance staff in their department. As the maintenance manager of one of the hospital buildings said, they need another 20 maintenance staff in addition to the 42 people they have now.

Table 17: Request demand for high rise offices, hotels and hospitals in one month.

(a) High rise office buildings

Building	Building Gross Floor Area (m^2) (GFA)	No. of Maintenance Staff (N)	Total Maintenance Request (N1) per month	GFA/N	N1/N
Building A	18100	40	424	452:1	11:1
Building B	10934	5	80	2186:1	16:1
Building C	6530	4	41	1632:1	10:1
Building D	12300	6	83	2050:1	141
Building E	14000	21	115	66:1	5:1

(b) Hotels

Building	Building Gross Floor Area (m^2) (GFA)	Rooms	No. of Maintenance Staff (N)	Total Maintenance Request (N1) per month	GFA/N	N1/N
Hotel A	106548	643	46	208	2316:1	5:1
Hotel B	13128.25	145	12	119	1094:1	10:1
Hotel C	15020	154	23	145	653:1	6:1
Hotel D	102831	260	10	101	10283:1	10:1
Hotel E	100350	231	20	172	5017:1	9:1

(c) Hospitals

Building	Building Gross Floor Area (m^2) (GFA)	Bed	No. of Maintenance Staff (N)	Total Maintenance Request (N1) per month	GFA/N	N1/N
Hospital A	10340	139	10	52	1034:1	5:1
Hospital B	16320	272	8	105	2040:1	13:1
Hospital C	61300	800	42	75	1459:1	2:1
Hospital D	150120	2502	53	60	2832:1	1:1
Hospital E	13560	226	12	36	1130;1	3:1

Data in Table 17 clearly shows that all staff members are able to undertake the entire job, but they may be overwhelmed in having to maintain quite a large area. Based on this result, it is suggested that every building maintenance department manager needs to use standard indicators to ensure that they have enough people to maintain the building.

6.7.8 Data from the interview session

These types of data were gathered from a short interview with the buildings maintenance manager. Even though not many information was gathered but some of them give a views of how the system is look like. In this case, respondents were asking to answer in three different session including management information, planning and scheduling and future plan. There are only 7 replies out of 15. The result is shown in Table 18.

The results in Table 18 show that most of the respondents possess all the required records. These documents are a compulsory item which must be kept properly in every maintenance department. They might be very important during an emergency, and must be well organised and easy to access.

All respondents replied that work order forms were used in their department. The work order's form record the request for repairs, and is signed by the maintenance staff repairing or fixing the failure. In many cases, the form is prepared for all departments in the building and will be sent to the maintenance department if a breakdown occurs. With this method, the history of all requests will be kept, analysed and summarised for the improvement of the system.

Table 18: Results from a short interviews with the building maintenance manager.

Questions		Number of respondent	
Section 1		**Yes**	**No**
1	Do you posses the following information		
	As built drawing	7	0
	Maintenance manual	7	0
	Maintenance policy	6	1
	Maintenance standard	5	2
2	Does your organisation use work orders for any failure occurs?	7	0
3	Do you split responsibility for maintenance between building fabric and M&E services?	5	2
4	Does your organisation use a computerised system for maintenance activities?	1	6
Section 2			
1	Does your organisation use maintenance planners to plan and prepare schedules maintenance work such as major repairs and shutdown?	5	2
2	Is maintenance staffs assigned to job tasks based on their specialized knowledge and abilities?	5	2
3	Does your organisation use contractors to handles excessive workload and specialised skill application?	7	0
Section 3			
	Future plan	5. To expand their specialities among the staff 6. To employ more staff to cover the demand request. 7. To apply computerised system for maintenance activities.	

The importance of splitting responsibility between building fabric and M&E services is to simplify the job specification. This will involve prioritisation of work requests, some of which may need to be fixed urgently and some later. Each of the staff members has their own specialisation, and to prevent their being asked to do job beyond their scope of work, the manager needs to divide staff into two categories, the building fabric and M&E services. One reason is to easily assign people for the request for repairs, and another is to simplify plans for preventive and predictive maintenance.

In section 2, respondents were asked whether they use maintenance planners to plan and prepare scheduled maintenance work such as major repairs and shutdown. The maintenance planner is very important in assisting maintenance staff and the management in scheduling the works. It might be a daily, weekly or monthly plan. Five of them said yes and the other two said no. One of them agreed that the planner is a practical guide to assist staff members to run the system. They only have to refer to it to see what types of work need to be done at a certain time and when should they inspect other equipment that need maintenance. Some of the respondents said that this planner is just creating unnecessary work, but overall they agreed that maintenance planning has a role in guiding maintenance staff during their day duty, and managers needing to monitor and assist staff when required.

Respondents were also asked whether maintenance staff were assigned to tasks based on their specialised knowledge and abilities, and generally this is compulsory. However, two of the respondents said no to this because of the lack of maintenance staff. In this case, each member of staff is required to have at least a basic knowledge of every single item for maintenance. They said that it is impossible to assign staff based on specialised knowledge, especially when several specialised tasks need to be done at the same time. Managers need to be careful as staff could harm themselves when doing work without enough knowledge for the given task. When this happens, it is the

responsibility either of the manager or the company to respond to the authority regarding the incident.

The last question in this section concerns the use of contractors to handle excessive workloads and specialised skill application. All respondents said yes to this. Most of them said that systems such as lifts and escalators, and fire fighting need maintenance at least once a month and it would be done by a nominated contractor. In one case, air conditioning equipment such as condensers, compressors or boilers might also need maintenance from a specialised manufacturer.

In section 3, respondents were asked to discuss their future plan to improve the system. Three main points emerged: first, they wanted to apply a computerised system for maintenance activities, which would be very reliable, practical and could assist management in many ways to monitor the whole maintenance works. The second plan is to expand staff specialisation by sending them to attend courses or organising in-house training. Thirdly, some of them plan to employ more maintenance staff to cover the higher number of requests for maintenance.

6.4 CONCLUSION

In conclusion, data from the survey has shown the condition of maintenance management and performance in three types of building in Malaysia. Most buildings face similar problems in terms of

breakdowns and other weaknesses that have an effect on the quality of the system. Lighting, HVAC, telecommunications and sanitation are considered to need most maintenance attention. Scheduling and prevention planning would be good solutions to improve this situation. Most occupants prefer to use the telephone to request maintenance, and males are more likely to be employed in maintenance departments. The study has also found that most organisations need to be careful when hiring people to work in the maintenance department. It may be that some technical competency will be needed in their routine job, and if they do not have this, management would need to organise training for them. Indicators of maintenance needs might be very usefully employed in maintenance departments to ensure that there are enough people to cater for all the maintenance needs.

CHAPTER 7 RESULTS AND DISCUSSION

7.0 INTRODUCTION

After analysis of data, it now remains to evaluate all the results and start developing the guidelines for building maintenance management for Malaysia. Factors influencing the performance of building maintenance are discussed in this chapter in the light of the results obtained.

7.1 Factors Influence the performance of building maintenance

It emerge from Chapter 6 that two major factors affect the performance of building maintenance: lack of maintenance skills and lack of maintenance staff. Other factors that contribute to this problem are related more to the management process, including the method of making requests, staff experience, training schemes and most importantly, the lack of information about maintenance management and the absence of guidelines or rules to follow.

7.1.1 Lack of maintenance skills

In Chapter 6, the results show that the proportion of maintenance staff with only school leaver qualifications is quite high (SRP and SPM). This shows that most companies have not really voiced concern about this matter. From the interview session, the author found that some companies *had* organised training for these particular staff, covering all necessary knowledge including, scope of work, handling tools, communication and some technical knowledge.

This training is not specifically for those without the required qualifications, but includes other staff members to ensure that all of them are alert to the current issues in their field.

The author is of the opinion that, to be on the safe side, every employer should be more specific when hiring people for a certain task. It is important to have people with good technical knowledge working in the maintenance department, in order to avoid delay and to reduce unexpected incidents that could occur during their time on duty.

7.1.2 Lack of manpower

There are many pieces of published research discussing manpower planning. Subjects including manpower model, manpower planning and manpower simulation are those related to the important of manpower management but up till now there has been no appropriate method for the determination of the optimum staffing on the maintenance department. This is due to the fact that the work load in the maintenance department is characterized by high fluctuation in demand for maintenance personnel (Mjema, 2002). In the case of maintenance management in Malaysia the low pay in this sector would be on of the impact of the lack of manpower. This is basis from the author's observation and short discussion with the head of the department. It is strongly recommended that management should do a research to solve this problem such as

review a reasonable pay or bonus for people in this field. Gerald and Milind (1998) believed that the main objective of the developing this model is to reduce the cost resources used in the maintenance department. Ideally, maintenance should be optimised relative to the true costs of maintenance including lost production, cost of storages required due to breakdowns, insurance costs/liability expenses as a results of maintenance failure. Referring to the results in Chapter 6 (section 6.12.4) it is clearly shows that lack of manpower is one of the factors influencing the performance of maintenance in the building. The surveyed has identified that most of the staff members are able to cater to the entire task but not able to maintain quite a large area. In this case it is important to empathise that each of the maintenance uncharged person should realise that it is necessary to analyse personnel capacity requirement for their maintenance department. A good example of manpower planning was presented by Hambleton (1982) He developed a manpower model for maintenance personnel considering different maintenance areas for forecasting the maintenance crews. He measured service level as the response time to breakdown call.

Regarding this research it is found that elements that should be concerned in evaluating capacity requirement of maintenance manpower are as follows:

1. the building's gross floor area
2. number of repair requests (request demand)
3. working hours

With basis from these three elements, it is possible to predict whether or not staff members are sufficient and able to do their works.

The method of request has a minor influence on the performance of maintenance systems, as was seen in Chapter 6. The surveys indicated that occupants prefer to use a telephone to make a request for repair, as it is quicker than filling in a request form. In general there are no effects on performance as long as every request made is recorded. Using the telephone, filling in work order forms, personal contact or online networking are just options representing different levels of technology in the maintenance system. Today, many organisations implement online networking as a way to connect people in the building. This is not the quickest method but it is very practical as it will record the entire request made and at the end of the month it will summarise statistical data that could be used to monitor maintenance management closely.

7.1.3 Staff job experience

Experience is related to the maintenance staff's skill levels. Relatively little data was collected in this area from the surveys, but the interview sessions revealed that most managers agreed that people with experience are more able to run the system and handle problems by themselves.

CHAPTER 8 THE MAINTENANCE MANAGEMENT GUIDELINE IN MALAYSIA

These guidelines are drawn up specifically for Malaysia, as it is the intention of the author to contribute knowledge to her own country. The author is sure that the guidelines will provide a good, practical foundation for most maintenance departments in Malaysia. The availability of organised guidelines is important as a framework for individual departments to follow, and the procedures and rules will contribute to better management. The discussions and recommendations are based on the results in Chapter 6 including data collected from the interview sessions with the building maintenance manager.

8.0 Management

The word *management* may be defined as the "process of getting activities completed efficiently and effectively with and through other people" (Gullick and Urwick, 1937). It comprises planning, organising, staffing, directing, coordinating, reporting and budgeting. Even though it covers a wide range of functions, the most important thing to be borne in mind is leadership. In order for the maintenance organisation to be effective, certain roles and responsibilities must be defined and assigned.

8.1 Employment of manpower

The CIBSE's (2000) *Guide to Ownership, Operation and Maintenance of Building Services* emphasises that the competency requirements for designers, engineers, technicians and tradesmen are increasing and that they have to be able to demonstrate and prove competence. This is also mentioned by the Construction (Design and Management) Regulations (1994) (CDM, 1994). The requirement is intended to ensure that chosen staff members are competent to perform the required tasks safely. These statements are equally applicable to Malaysia. In Malaysia, most companies are aware of the importance of having competent maintenance staff, not only because of the regulations but also to make sure that all equipment is kept safety by the staff. Staff with a competency certificate should be aware of the health and safety regulations at work, which should help reduce the number of accident in the workplace. It is strongly recommended that each maintenance department keep relevant documents safely, for regular review.

Besides that it is also important to ensure that all maintenance staff gets a well supervision. According to Wireman (2005) supervision or coaching staffing ratio could monitors the span of control for a front line maintenance supervisor. In a traditional organisation, the proper ratio is 1 supervisor for every 8 – 12 maintenance technicians. The indicator is as below:

$$\frac{\text{Number of maintenance employee of full time equivalents}}{\text{Number of supervisors or coaches}}$$

Notes:

Any ratio over 12 – results in effective supervision

Any ratio less than 8 – there is not sufficient work to justify the supervisor. The maintenance supervisor may still be required

8.2 Staff training

Training, and in some cases retraining, is essential if the skills required to operate and maintain the high-tech equipment now being installed in plants and facilities are to be developed (Wiremen, 2005). CIBSE (2000, section 19.1) recommends that the organisation should begin by identifying the most important operation requirements or problems to highlight training needs. They must then plan and initiate the training, which may be either from in-house resources or given by a specialist training provider. The author would suggest that maintenance management in Malaysia should organise a training scheme for their staff, especially those without enough experience to work in the building maintenance field. Managers should be aware of their staff's capabilities and knowledge in maintenance before they start work in the building maintenance department. The author believes that most companies in Malaysia have an organisation that provides training for the staff, and that training is normally offered to all new staff. In addition, the maintenance manager should be aware of training schemes normally organised by specialist contractors and

should send staff to learn about maintaining new equipment. Performance indicators that are applicable for this subject are (Wireman, 2005):

$$\frac{\text{Total Technical Training Hours}}{\text{Total Numbers of Employee}}$$

$$\frac{\text{Total Interpersonal Training Hours}}{\text{Total Numbers of Employee}}$$

Notes: the technical training and the interpersonal training should be almost even 50-50 split.

This indicator examine the actual average training hours being allocated per employee per year. This indicator can be calculated on a monthly basis and trended over time to insure that proper attention is being given to the training needs of the organisation.

8.3 Inspection reports and planning of works

Inspection in this context is the regular work that staff members should do. As part of the planned maintenance programmes, equipment such as boilers, lifts and escalators, air conditioning, and fire fighting systems have their own inspection schedules. During inspection, items that need to be replaced can be identified. This could make it easy for maintenance staff to plan, and direct costs that are involved during their inspection work. The author would suggest that it is necessary for all maintenance departments to make sure that all inspected items are recorded and this report would give good guidance for the person in charge of monitoring, estimating and summarising budgets. The overall Equipment Effectiveness

indicators proposed by Wireman (2005) are found to be very practical and are recommended for the Malaysia context. It is to measure the condition of the equipment and the asset.

Availability = Scheduled Time – All Downtime
*(should be at least 90%)

Performance Efficiency = $\frac{\text{Actual output for Scheduled Time}}{\text{Design Output for Scheduled Time}}$

*(should be at least 95%)

Quality rate = $\frac{\text{Defect or Rework}}{\text{Total Reduction}}$

*(should be at least 99%)

90% x 95% x 99% = 85%

These are the goals for the overall equipment effectiveness indicator. It is flexible that can be used for daily, weekly and even monthly time periods for the calculation.

8.4 Building records and general

Good records can save owners and occupiers much unnecessary expense and reduce potential hazards in exploration work when faults arise (BSI, 1986: section 3.3.1). These records include those which need to be kept during the life of a building, such as details of defects, maintenance, alterations and painting carried out, and costs (BSI,1986: section 3.3.3). In addition, other items such as architectural drawings, monthly or annually budgets, lists of tools,

and all other data pertaining to the building should be kept properly. Daily records of requests for repairs and numbers of failures should also be in an organised database. Legal information such as statutory and insurance inspections, rules and regulations during work, and job specification should also be methodically filed. BSI (1986: BS8210, section 3.3.1.5) states that:

> *"When no records exist, information should be slowly built up as it becomes available during the course of maintenance works. Alternatively consideration should be given to initiating surveys or investigation to obtain faster result."*

It is important to keep data in an appropriate and organised manner. This is not only for the purpose of emergencies but also to help all existing and new staff members to easily understand and access the required information during their work. For example, providing accurate equipment maintenance records enables a company to accurately track equipment in such engineering terms as mean time between failures or mean time to repair (Wiremen, 2005). All changes to the equipment's details, such as the user manual, should be noted from time to time. A schedule visit by the authority regarding this could remain the efficiency of data keeping in the department.

8.5 Form of records

There are many methods of records management. BSI (1986: BS8210, section 3.3.5) suggests that all records can be kept in the form of one of the following:

1. paper or plastic film
2. microfilm
3. computer storage

Whatever method is used, the purpose is obviously to keep all records safely and easily accessible. Security backup is also important to ensure that those important and private statements are not available to unauthorised people. In this case the author suggests that a security code is applied in accessing these documents. For the quality and efficiency of the implementation, it needs to be check in scheduled by the authority.

8.6 Maintenance policy

Not only the maintenance department, but also other organisations or companies should have their own policy. CIBSE (2000, section 3.4) lists questions that are intended to help in the formulation of a policy, as follows:

(a) What are the implications of failure?

(b) How is this plant likely to fail?

(c) What is the probability of failure?

(d) Are standby facilities available?

(e) Will spares be available on site?

(f) Can equipment be purchased or rented locally?

(g) Can a standard of maintenance be stated?

(h) Will all necessary documentation be provided?

Based on these questions, a policy structure could be designed; the answers are likely to affect how subsequent maintenance decisions are taken (CIBSE, 2000). These questions could form the basis of guidelines in designing a policy for maintenance departments in Malaysia.

8.7 Planning and Scheduling

In general, planning and scheduling are the responsibility of management. They include strategies for how maintenance work is carried out, both for planned and unplanned maintenance and day-to-day work. This will ensure that all jobs are carried out and not delayed, unless they require the presence of experts from an equipment manufacturer. Also, having a work schedule makes it easier for staff members to manage their time, and unexpected or emergency breakdowns can be dealt with by those who are on standby duty. The author suggests that planning and scheduling is the first priory when assigning staff members to daily work. Managers should summarise the progress of the maintenance system at least once a week. With its implementation, all staff members will be more alert to the tasks they have been given. The author suggested that the indicator's below to be used to ensure that the proper levels of maintenance activities are being planned.

$$\frac{\text{Maintenance Work Order Planned}}{\text{Total Work Orders Received}} \times 100\%$$

This indicator is derived by dividing the total numbers of work orders planned by the total numbers of work orders received. It will provide a manager with opportunities for improvement in the overall planning programme.

8.8 Maintenance works programme

This topic refers to the maintenance schedule, where and how staff members are assigned to tasks. They should note which items are to be maintained daily, when the item in question is to be inspected and how frequently the work is to be done. It is the responsibility of the maintenance manager to prepare this maintenance work programme and display it in the maintenance department to allow all maintenance staff to see and understand the range of their duties.

The author believes that most companies already possess such a work programme and recognise it as an important part of the maintenance system, with staff responsibilities clearly identified. Table 18 below shows examples and guidance on how work can be scheduled.

Table 19 : Example of work schedule in maintenance department

No	Task		Assigned member
1	Daily	Routine inspection and maintains of engineering plant Planned lamp replacing	Technicians technicians
2	Weekly	Inspection and operation of high-voltage electric installation Planned lamp replacing Monitoring of plumbing and water services operation	Charge-maintenance(staff with competency requirement in this area) Technicians technicians
3	Monthly	Ensuring compliance with statutory requirements for services installation Inspection, compliance testing and monitoring of fire systems and equipment Purchased of engineering plants and equipments (spares and materials) as required. Portable appliance testing	Manager In-house technicians and nominated contractor Manager
4	Yearly	Scheduling staff training Supervision and control of specialist contractors Five- yearly electrical inspection	Manager Manager manager

A performance indicator that is applicable in this subject is (Wireman, 2005):

$$\frac{\text{Number of Maintenance Employee or Full Time Equivalents}}{\text{Numbers of Planners}}$$

This indicator use to monitor the span of control for a maintenance planner. In a traditional organisation, a proper ratio is 1 planner for every 15 – 20 maintenance technicians (Wireman, 2005).

8.9 Operating and maintenance manual

The operating and maintenance manual covers all aspects of managing and handling maintenance. It is very important as it can raise maintenance into sharper focus by helping workers to become more aware of their responsibilities and duties. It also helps service designers to appreciate their role in providing installations that are safe, economical and give satisfactory performance over their full life-span (CIBSE, 2000). The author would suggest that all maintenance departments in Malaysia should have documented operating and maintenance manuals; the documents must be filed methodically. This documentation is an important reference tool for existing staff members, and a useful guide in helping new staff to understand the operation of equipment.

8.10 Contract maintenance

It should be emphasised here that not every item can be maintained and repaired by in-house maintenance. Services such as lifts and escalators, air conditioning condensers or compressors, medical gases and other sophisticated equipment still require experts to maintain and inspect them. It is suggested that maintenance departments in Malaysia should have a list of nominated contractors for each particular service, together with the manufacturer's instructions available for regular inspection, showing the maintenance that normally takes place yearly under the terms of the

contract. All their contact details must be clearly recorded to make it easier for reference as and when they are needed.

8.11 Health and Safety Regulation

The basis of British health and safety law is the *Health and Safety at Work Act, 1974* (UK Government, 1974). This Act sets out the general duties which employers have towards employees and members of the public, and which employees have to themselves and to each other. *The Management of Health and Safety at Work Regulations 1999* (UK Government, 1999) *(the Management Regulations)* generally make more explicit what employers are required to do to manage health and safety under the Health and Safety at Work Act.

8.12 Occupational safety and Health Act 1994 (Malaysia)

The *Occupational Safety and Health Act, 1994* (OSHA) (Malaysia Government, 1994) provides the legislative framework to promote, stimulate and encourage high standards of safety and health at work. The aim is to promote safety and health awareness, and establish effective safety organisation and performance through self-regulation schemes designed to suit the particular industry or organisation. The long-term goal of the Act is to create a healthy and safe working culture among all Malaysian employees and employers. The Department of Occupational Safety and Health (DOSH) is responsible for enforcing compliance with OSHA 1994. DOSH also enforces compliance with the Factories and Machinery Act 1967.

OSHA 1994 defines the general duties of employers, employees, the self-employed, designers, manufacturers, importers and suppliers of plant or substances (Malaysia Government, 1994). Although these duties are of a general character, they carry a wide ranging set of responsibilities. The Act provides a comprehensive and integrated system of laws to deal with the safety and health of virtually everyone at work and the protection of the public where they may be affected by the activities of people at work. Employers must safeguard, as far as is practicable, the health, safety and welfare of the people who work for them. This applies in particular to the provision and maintenance of a safe plant and system of work. Arrangements must also be made to ensure safety and health in the use, handling, storage and transport of plant and substances (MIDA, 2006).

The operation, installation, maintenance and dismantling of equipment and processes need competent persons. Thus, during the installation of machinery and equipment such as cranes, lifts and local exhaust ventilation systems, competent persons are compulsory to ensure safe erection, whilst a boiler man and a steam engineer are required to operate high-risk equipment such as boilers. Processes that use hazardous chemicals require competent persons to conduct the air quality and personnel monitoring, and a safety and health officer and an occupational health doctor are required to ensure the proper surveillance of the workplace (MIDA, 2006).

There are seven regulations under OSHA 1994 that are enforced by DOSH:

1. Employers' Safety and Health General Policy Statements (Exception) Regulations, 1995.
2. Control of Industrial Major Accident Hazards Regulations, 1996.
3. Classification, Packaging and Labelling of Hazardous Chemicals Regulations, 1997
4. Safety and Health Committee Regulations, 1996
5. Safety and Health Officer Regulations, 1997
6. Use and Standards of Exposure of Chemicals Hazardous to Health Regulations, 2000
7. Notification of Accident, Dangerous Occurrence, Occupational Poisoning and Occupational Disease Regulations, 2004

8.13 Statutory or Legal Liabilities in Malaysia

Here are the regulations relevant to people in the maintenance field which must be kept in the department for the reference of the workers:

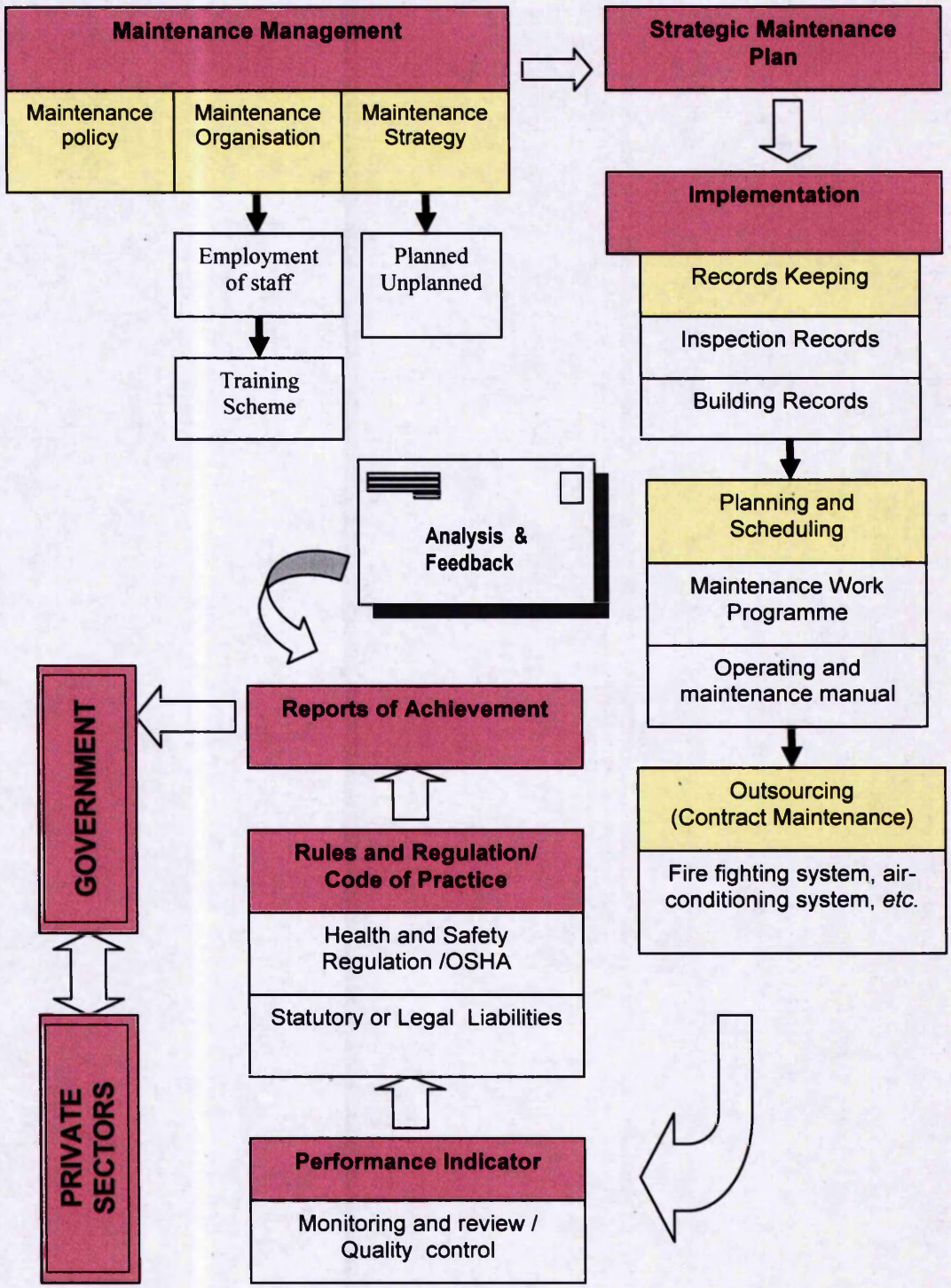
1. Electric Passenger and Goods Lift Regulations, 1970
2. Fencing of Machinery and Safety Regulations, 1970
3. Notification, Certificate of Fitness and Inspection Regulations, 1970
4. Persons-In-Charge Regulations, 1970
5. Safety, Health and Welfare Regulations, 1970

6. Steam Boilers and Unfired Pressure Vessel Regulations, 1970
7. Certificates of Competency-Examinations Regulations, 1970
8. Administration Regulations, 19709.
9. Compounding of Offences Rules, 1978
10. Compoundable Offences Regulations, 1978
11. Lead Regulations, 1984
12. Asbestos Regulations, 1986
13. Building Operations and Works of Engineering Construction (Safety) Regulations, 1986
14. Mineral Dust Regulations, 1989
15. Noise Exposure Regulations, 1989
16. Notification, Certificate of Fitness and Inspection (Amendment) Regulations, 2004.
17. Uniform Building By-Laws 1984.

When running a system, especially for those who are dealing with technical equipment such as those working in maintenance, all the regulations are very important. For example, Safety, Health and Welfare Regulations, 1970, should be referred to in the case of any accident that might occur during their duty at the workplace. This kind of regulation could also be a guide to all staff in preventing accidents in the workplace. When dealing with maintenance, the author suggests that maintenance managers in Malaysia should be aware of these regulations. It is not only for the safety of the maintenance staff but it would involve the whole organisation including the building's assets and the building's occupants. The

author has noted that these regulations should be clearly emphasised during training programmes organised by the companies.

Figure 19 : Guideline for the management of building maintenance in Malaysia



CHAPTER 9 CONCLUSION AND RECOMMENDATION

9.0 Introduction

In the context of managing maintenance, one of the functions is to support the main operation of the organisation, ensuring that all sources are always productive. To attain this objective, the maintenance function should be clearly understood, and it can be defined as retaining or repairing all physical resources and components together with ensuring that they are always in good and safe working condition. The management team should also ensure that all staff members know and understand the building maintenance functions and its strategies, including corrective and preventive maintenance.

9.1 The important requirement of successful building maintenance

The author has found several important requirements of successful building maintenance. These including a good understanding of the needs for maintenance where property and its engineering services could be protected, utilisation could be increased, non availability time could be reduce, and safety requirement are ensured to be complied with. Apart from that, the main objective of maintenance is also important where it could meet all user satisfaction and requirement. Peoples working in building maintenance should also know their role in conducting and running the building system.

Having good indicators to measures the building system performance might be a good approach of successful building maintenance.

9.2 Building maintenance practice in UK, the standards, policies and strategies applied.

There are many statutory, regulation and code of practice applied for maintenance in UK. British Standard, BSRIA and CIBCE are the most popular one. All regulation is found very comprehensive to be used as a guide in maintenance field. Beside the used of OSHA, the *Health and Safety at Work Act, 1974* (UK Government, 1974) is very command used for the health and safety at workplace.

9.3 Practices of building maintenance between UK and Malaysia and identifies the key issues within the Malaysian context.

In the UK, FM represents a relatively mature market, with service providers seeking the opportunity to diversify elsewhere internationally (Mike and Edwards, 2004). Research has found that, there would appear to be a general lack of FM skill and knowledge in South East Asia including Malaysia at this present time. Hence it is to recommend that those countries need to open up to change, particularly with respect to parity in issues of global competition in FM standard, and greater promotion and awareness of facilities management is required in order to gain wider industry recognition, overcome cultural barriers and the general lack of understanding and appreciation of what FM is actually constitutes and comprises (Mike and Edwards, 2004).

This study of building maintenance in Malaysia has unveiled its real condition. Even though not many sources were found discussing this, there were enough to show that Malaysia needs significant improvement in its building maintenance systems. Several articles in Malaysian newspapers reported complaints from users regarding breakdown and long-term failure to carry out repairs. Vandalism seems to be very common and councils say that they have insufficient manpower to control it (*New Straits Times*, 2001b). In the worse cases facilities are left abandoned and buildings are not maintained.

9.4 Rules and regulation and codes of practice for the control of maintenance work.

Research has found that Malaysia has referred much on the rules and regulation from UK. This including the British Standard, CIBSE and BSRIA which is very familiar for the control of maintenance work. Apart from that, Malaysia has also had regulations but not specifically for the maintenance work. The one that is was proposed in section 8.13 is apart of the regulation used in Malaysia. The Uniform Building by Law 1994 identified to be more reliable for the building and maintenance works beside and OSHA has been found very useful in term of the health and safety in building's work.

9.5 Propose of procedures and guidelines for effective building maintenance management in Malaysia.

A propose guideline for the management of building maintenance in Malaysia is presented in Chapter 8. This guideline focusing on the management of the organisation including employment of manpower, the training scheme, rules and regulation, maintenance policy and the maintenance planning that believe to be very important to be implemented in most companies in Malaysia. There were also key performance indicators suggested in this guideline in order to give a better guide to the management team to evaluate building performance system.

9.6 Recommendation for the improvement of building maintenance management in Malaysia

The author recommends that every agency in Malaysia should have a systematic maintenance system. For this there are five steps to be followed. The first one is to appoint an officer to be responsible for all aspects of maintenance of assets in the building.

The second is to prepare and keep up to date the Maintenance Asset Records. These records list all assets that need maintenance to make sure that they are in good working condition. Assets should be in different categories such as electrical, mechanical, structural or environmental. All assets should be coded to easily identify their priority for maintenance or service.

The third step is to list the maintenance schedule for assets. This comprises the frequency for and all details of maintenance for

each asset. The fourth step is to plan the maintenance operation, identifying maintenance activities for all items in the records.

The last step is to evaluate and review the maintenance programme that has been implemented. This assessment is very important to establish whether the target has been achieved and to find out what could be done to solve remaining problems.

Maintenance work in Malaysia is described as a service industry. Hence, as with other service industries, maintenance work in this new era is moving towards privatisation, which has been introduced in government agencies, and is expected to present further challenges in the future. It needs good professional skills to meet consumers' requirements for a proactive and high quality service. The appearance of high technology and sophisticated buildings, known as intelligent buildings, entails the need for good maintenance services. This requires a better trained maintenance organisation from a variety of disciplines, ready to implement the technology expected to be installed in the new buildings.

For all the people involved in this critical industry, the challenge is to have good self-motivation and start promoting a "maintenance culture", such as encouraging people to love and care for the environment.

In implementing the proposed guidelines for a maintenance management system in Malaysia, there several benefits have been identified. The author believes that by introducing these guidelines, people involved in this service will be more concerned about how

important it is to have a well managed maintenance system. When this happens, more people will be aware of the regulations to be followed. A safer environment will be created when all people are concerned about safety. The proposed guidelines will also help people in the maintenance field to develop a well structured organisation. In addition, more training and courses will be arranged to enable people to become more reliable working in this field. On the companies' side, the implementation of these guidelines might help to reduce their maintenance budgets, because more and more failures can be avoided; they will also help to reduce energy consumption in the building, again increasing the companies' profits.

However, before these proposed guidelines can be successful, several obstacles must be overcome. The government need to play their role in promoting environmentally friendly strategies to encourage people to love their environment (e.g. in reducing vandalism). A huge amount of money is needed for the training and courses that might involve international connections. At first, a few staff may be sent abroad to attend courses by specialist manufacturers. This would be followed by organising more economical local in-house training.

It is hoped that the proposed guidelines will be a very useful document for maintenance departments in Malaysia, helping them to improve both the status and the standard of the maintenance system.

9.7 Discussion and future trend

The maintenance system will be better if it is well managed and organised. However, the factors discussed above are only a part of the major contribution of a good maintenance system. In addition, it is essential to maintain standards. There are two categories: the standard of quality and the standard of service (Norasmadi, 2006), with different criteria. The standard of quality involves physical maintenance activities including the cleanliness of the workspace, and it must achieve a level that is satisfactory to the occupants overall. To reach these standards, six criteria are identified: policies and objectives, quality control, products, completion of work, cleanliness of working space, and repair work.

1. Policies and objectives

   The standard of quality must be set out in the policy and objectives of the organisation. The building's owner must set out the required level to be achieved, and this must be standardised to cover all the companies in Malaysia. All maintenance staff must have a clear view and good knowledge in order to achieve this quality standard.

2. Quality control

   The quality level must be always controlled, strengthened and protected by all technical staff and the management team. Close supervision should be established to supervise and evaluate the achievement of this quality at all times.

3. The products

This standard of quality is measured by the number of complaints. It is necessary for all staff and management teams to study and anticipate strategies to reduce the number of complaints.

4. Completion of work

All work done will be assessed and labelled as of high quality only if it is completed satisfactorily. Work which cannot be fixed in a short time must be completed within a specified time. All sites must be left clean, tidy and organised to show that the work has followed the rules and regulations.

5. Cleanliness

Again, all work must be carried out in an organised, clean and tidy manner. The workplace must have a sign to show that repairs are in progress, to remind other people to be aware.

6. Repair work

Work will not reach the quality standard if it has not been done properly. Managers must ensure that all requests are completed on time. If not, the occupants must be informed, with good reasons for the delay. Again, notices of work in progress must be clearly displayed to avoid accidents.

The standard of service, however, is more closely related to the character and behaviour of the maintenance staff during the servicing. This includes response, flexibility, good manners and

communication. For example, some of the failures might interrupt occupants and make them angry. With a good response and polite communication these problems can be solved and any unexpected incident avoided; this is considered as a good service standard. There are five important criteria in this standard: policy and objectives, occupants' satisfaction, time constraints, standard assessment and acknowledgment.

1. Policy and objectives

   Managers or owners of the building must establish the policies and objectives of the organisations in order to give a clear view to all staff members about the service they are expected to give.

2. Occupant satisfaction

   The occupants' satisfaction is the main target to reach in the quality standard. The better the service the more cooperation will be gained from the user.

3. Time constraints

   Service standard is also viewed from the aspect of time constraints. It does not necessarily mean that they need to work fast, but they need to manage their time efficiently.

4. Standard assessment

   It is important to monitor the maintenance staff's performance, either by reports from the users or occupants, or by close supervision. Whatever the methods, the purpose is to achieve the standard of quality.

5. Acknowledgement

Users or occupants of the building must be informed early and clearly before the maintenance works start. This is to ensure that all people know about and are aware at all times of the interruption.

The author suggests that there are three major sets of guidelines to be followed in order to comply with the Health and Safety regulations:

1. The Management is fully committed to:

- Integrate safety and health issues in all aspects of the workplace.
- Take effective action to provide and maintain a safe and healthy work environment.
- Disseminate information and promote communication on safety and health.
- Plan, develop, implement, and monitor the safety and health program.

2. The Employee is expected to:

- Work in a safe and healthy manner.
- Encourage others to work in a safe and healthy manner.
- Discourage others from working in an unsafe manner.
- Co-operate to support and promote safety and health in the workplace.
- Report any unsafe conditions that come to attention at work.

3. The Safety and Health Committee operates to:

- Reach consensus through the process of joint consultation between employees and management.
- Be responsible for managing the safety and health standards in the department.

Based on all the author's recommendations, it is believed that those people involved in maintenance must understand the importance of having good maintenance management. The objective is not only business profit but, most importantly, to ensure the wellbeing of staff members.

9.8 Recommendation for the future research

This is only a small part of the guideline proposed by the author, they would be other factors need to be done for future research to make this guideline complete to be used in all area in maintenance field in Malaysia. It is to suggest to other researchers to focus on the subject of:

1. Building performance indicator.
2. Education in maintenance that should be offer by local university to produce people with good maintenance skill.
3. Facilities management in general including managing their organisation from the top level to the lowest level.
4. Strategy in maintenance to meet the building maintenance need in Malaysia.

5. Research in computerise maintenance management.

It is believed that these subjects would be valuable to be study for the improvement of this research and for the improvement of building maintenance management in Malaysia as a whole.

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APPENDIX - 1

SET 1

The purpose of this survey is to determine the maintenance management system and the performance of building in a range of building types. This is a part of researcher PhD programme. This questionnaire comprises four sections such as general information, management information, planning and scheduling and open ended question in the last section. All data gather are confidential and only use for the purpose of study.

As it is appreciated that your time is valuable, the questionnaire has been designed to enable completion with the minimum effort. All information forwarded will be treated in the strictest confidence.

Questionnaire to be return to:
Emma Marinie Ahmad Zawawi
Lot.573, Jln, Sungai Udang, 41250,
Klang,Selangor.
03-33740446
Or:
Building Engineering Department, Centre for Civil and Construction Engineering, UMIST, M60 1QD, Manchester, UK

SURVEY ON MAINTENANCE IN PRACTICE

Notes:

(1) always
(2) often
(3) usually
(4) seldom
(5) never

Please circle as appropriate

SECTION 1 : GENERAL INFORMATION

Please tick as appropriate

4. Please indicate the type of building usage

Office	
Hotel	
Healthcare	

5. Building age_____

a. below 5 years
b. 5 – 10 years
c. 10-15 years
d. 15-20 years
e. 20 years and above

6. Approximate gross floor area : _____

4. Number of floor : _____

7. No of worker in maintenance department _____

8. No of occupants in building _____

SECTION 2 : MANAGEMENT INFORMATION

1	Do you posses the following information: a. As built drawings b. Maintenance manuals c. Maintenance policy d. Maintenance standard
2.	Does your organisation use work orders for any failure occurs?

3.	Do you split responsibility for maintenance between building fabric and M&E services?
4.	Does your organisation use a computerised system for maintenance activities?

SECTION 3 : PLANNING AND SCHEDULING

3.	Does your organisation use maintenance planners to plan and prepare schedules maintenance work such as major repairs and shutdown?	
4	If you have planners, do they prepare a job plan before a job is scheduled to begin?	
5	Are maintenance staffs assigned to job tasks based on their specialized knowledge and abilities?	
6	Does your organisation use contractors to handles excessive workload and specialised skill application?	
7	Which maintenance is handled by contractors?	

Air-conditioning	☐	drainage & sewerage	☐
Lift and escalator	☐	sanitary system	☐
Security system	☐	medical gas system	☐
Lighting	☐	telecommunication	☐
Fire fighting	☐	Electrical	☐

SECTION 4 :

1	What is your future plan to improve maintenance system in this building

Thank you very much for your cooperation in completing this questionnaire.

SET 2

The purpose of this study is to evaluate the building maintenance system and the performance of building in a range of building types. This is a part of researcher PhD programme. All data gathered will be useful for the researcher to design and proposed a guideline of the maintenance management system for the uses of Malaysian.

This questionnaire is designed to give the opportunity to the occupants to express their satisfactory toward the maintenance system in the building. The questionnaire has 2 sections. Section 1 is for general information while section 2 is for the occupants satisfactory.

As it is appreciated that your time is valuable, the questionnaire has been designed to enable completion with the minimum effort. All information forwarded will be treated in the strictest confidence.

Questionnaire to be return to:
Emma Marinie Ahmad Zawawi
Lot.573, Jln, Sungai Udang, 41250,
Klang,Selangor.
03-33740446
Or:
Building Engineering Department, Centre for Civil and Construction Engineering, UMIST, M60 1QD, Manchester, UK

SURVEY ON OCCUPANTS SATISFACTION WITH MAINTENANCE

Notes:

(1) Excellent
(2) Good
(3) Acceptable
(4) Unacceptable
(5) Completely unacceptable

SECTION 1: GENERAL INFORMATION

Building usage :

Office	
Hotel	
Healthcare	

Department : _____

SECTION 2: SATISFACTORY SURVEY

1	In which way you make the request a. telephone b. work order form c. personal contact					
2.	Did they respond promptly for any request made?	1	2	3	4	5
3.	Was the requested work completes by the time it was needed	1	2	3	4	5
5	If it was necessary for the job to be delayed was this communicated to you	1	2	3	4	5
6	Were interruption kept minimal	1	2	3	4	5
7	Was the worksite left neat and orderly	1	2	3	4	5
4.	Are you satisfied with the quality of work completed	1	2	3	4	5
8	Which of this are the most frequent failures you have requested for repair? (Please state number of request per week) Sanitary services ..... Fire fighting services ..... HVAC					

	Lift and escalator	.....
	Drainage and Sewerage	.....
	Medical Gases	.....
	Telecommunication	.....
	Lighting	.....
	Electrical	.....
	Security services	.....
	Biomedical Equipment	.....
	Nurse Call System	.....

Please rate the following into your individual satisfaction for the maintenance of the building services listed below:

1	Lighting	1	2	3	4	5
2	Sanitary Services	1	2	3	4	5
3	Lift and Escalator	1	2	3	4	5
4	Electrical	1	2	3	4	5
5	HVAC (Heating, Ventilation & Air Conditioning)	1	2	3	4	5
6	Fire fighting	1	2	3	4	5
7	Medical Gas System	1	2	3	4	5
8	Security System	1	2	3	4	5
9	Nurse Call System	1	2	3	4	5
10	Telecommunication	1	2	3	4	5
11	Sewerage and Drainage	1	2	3	4	5
12	Biomedical Equipment	1	2	3	4	5

Your comments about the effectiveness of the maintenance system in this building:

Thank you very much for your cooperation in completing this questionnaire.

SET 3

The purpose of this study is to evaluate the building maintenance system and the performance of building in a range of building types. This is a part of researcher PhD programme. All data gathered will be useful for the researcher to design and proposed a guideline of the maintenance management system for the uses of Malaysian.

This questionnaire is designed to give the opportunity to the maintenance staff to express their opinion toward the maintenance system in the building. The questionnaire has 2 sections. Section 1 is for general information while section 2 is for the worksite concern.

As it is appreciated that your time is valuable, the questionnaire has been designed to enable completion with the minimum effort. All information forwarded will be treated in the strictest confidence.

Questionnaire to be return to:
Emma Marinie Ahmad Zawawi
Lot.573, Jln, Sungai Udang, 41250,
Klang,Selangor.
03-33740446
Or:
Building Engineering Department, Centre for Civil and Construction Engineering, UMIST, M60 1QD, Manchester, UK

SURVEY ON MAINTENANCE STAFF

SECTION 1: GENERAL INFORMATION

1	What is your position in this department? a. supervisor b. carpenter c. charge man d. handyman e. plumber d. electrician f. _____
2.	Gender? a. Male b. Female
3.	Group of age? a. under 20 b. 20-30 c. 31-40 d. 41-50 e. 50 and above
4	How many years' experience do you have as a maintenance staff? a. less than 2 years b. 2 years – 4 years c. 4 years – 6 years d. 6 years – 8 years e. 8 years and above
5.	What is your highest academic qualification a. SRP b. SPM c. Technical Cert d. diploma e. degree f. _____
6	Working hours : a. full time (8.00 – 5.00) b. shift c. part time

SECTION 2: WORKSITE CONCERN (EXTRA DATA)

1.	Do you maintain the HVAC system?	
2.	Is maintenance staff received training to help them do their job?	1 2 3 4 5
3	Do maintenance staffs follow safety policies and procedures?	1 2 3 4 5

4	Are you provided with any personal protection equipment (PPE) such as ear plugs, gloves, goggles, etc?	1	2	3	4	5
5	Does management follow-up and review housekeeping with maintenance staff?	1	2	3	4	5
7	Does management explained the rules and regulation regarding your work task?	1	2	3	4	5
8	How often in a month this building had a breakdown?	1	2	3	4	5
9	Are you provided a complete set of tool for job repairs?	1	2	3	4	5
10	Does management explained the maintenance department policies and standards?	1	2	3	4	5
11	Does management explained to you about your duty, responsibility and your scope of work in maintenance department?	1	2	3	4	5
12	Do you kept all record of maintenance request and work done in a proper folder/file?	1	2	3	4	5
13	Do you had a problem communicating with the occupants demands due to maintenance repair?	1	2	3	4	5

Your comments about the effectiveness of the maintenance system in this building:

_____

_____

_____

_____

_____

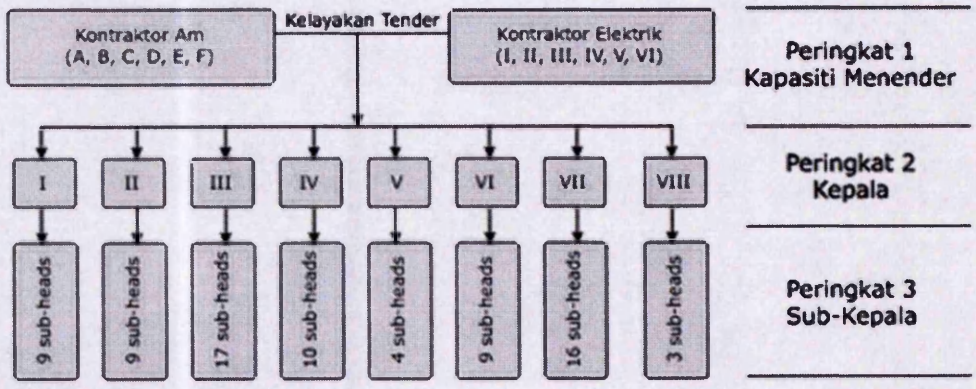
_____

Thank you very much for your cooperation in completing this questionnaire.

APPENDIX - 2

Criteria System of grading Contractors in Malaysia

PKK is the first government agency who has authorization over Malaysian contractor's services. The agency classifies the contractor registration into 3 levels. First level goes to 2 categories of tender capacity, next level is 7 divisions of heads, and the third level is sub-heads.



Sources http://pkk.mecd.gov.my

Classification of Contractors

(source http://pkk.mecd.gov.my/rujukan/Bil_6_Tahun1984.pdf)

Class A1 for work contract of RM750, 000 and above (unlimited)
Class A for work contract of RM500, 001 to RM10, 000, 000
Class B for work contract of RM250, 001 to RM 4, 000, 000
Class BX for work contract of RM100, 001 to RM 2, 000, 000
Class C for work contract of RM100, 001to RM 1, 000, 000
Class D for work contract of RM75, 001 to RM 500, 000
Class E for work contract of RM70, 001 to RM 500, 000
Class EX for work contract of RM35, 000 to RM 100, 000
Class F for work contract of below than RM70, 000

APPENDIX - 3

International Conference on Energy, Environment and Disasters – INCEED2005, Charlotte, NC, USA – July 24-30, 2005

EVALUATION OF PERSONNEL REQUIREMENT IN BUILDING MAINTENANCE DEPARTMENT: A CASE STUDY OF MALAYSIA

E M Ahmad Zawawi, S N Kamaruzzaman, R E Edwards

Building Division, School of Mechanical, Aerospace & Civil Engineering, University of Manchester, PO Box 88, Manchester, M60 1QD, England; Email: E.Zawawi@postgrad.manchester.ac.uk, Email: S.Nizam@postgrad.manchester.ac.uk, Email: Rodger.Edwards@manchester.ac.uk

The condition of a working space is said to have significant effects on the health and comfort of the occupants. In view of this, this study aims to describe some of the important factors that are highly influential in constructing a well-designed building maintenance system. Two factors have been identified; the management of the building and the organizational structure of the maintenance department. The data obtained is gathered through surveys and observations, in which 200 questionnaires were distributed to relevant parties, mostly occupants of selected buildings in Kuala Lumpur, the commercial city of Malaysia. These questionnaires carry questions concerning the building's maintenance system, such as the maintenance management team, the training provided to maintenance personnel, the staff's academic qualifications and the tools provided for repairing and maintenance purposes. A problem that stood out was that most maintenance departments do not have enough personnel to cater for the needs of the whole building. Contractors were hired to cover for the insufficiency of personnel, which would later contribute to higher expenditure for the company. Company were also have a problem with unskilled maintenance staff that they need more budget for training purposes. Hiring qualified or skilled maintenance staffs are quite a major problem faced by most building maintenance manager in Malaysia. Besides that, this study also elaborates on factors influencing the quality of maintenance. It is expected that this study would contribute to the development of building maintenance guidelines and would hopefully be a good reference for all maintenance managers in Malaysia.

Keywords: Building Maintenance, organization, personnel, survey, management, Malaysia.

EVALUATION OF PERSONNEL REQUIREMENT IN BUILDING MAINTENANCE DEPARTMENT: A CASE STUDY OF MALAYSIA

E M Ahmad Zawawi, R E Edwards
Building Division,
School of Mechanical, Aerospace & Civil Engineering,
University of Manchester
PO Box 88, Manchester, M60 1QD, England
Email: E.Zawawi@postgrad.machester.ac.uk
Email: Rodger.Edwards@manchester.ac.uk

Abstract:
The condition of a working space is said to have significant effects on the health and comfort of the occupants. In view of this, this study aims to the describe some of the important factors that are very influential in constructing a well-designed building maintenance system. Two factors have been identified; the management of the building and the organization structure of the maintenance department. The data obtained is gathered through surveys and observations, in which 200 questionnaires were distributed to relevant parties, mostly occupants of selected buildings in Malaysia. These questionnaires carry questions concerning the building's maintenance system, such as the maintenance management team, the training provided to maintenance personnel, the staff's academic qualifications and the tools provided for repairing and maintenance purposes. A stand-out problem found was that most maintenance departments do not have enough personnel to cater for the need of the whole building. Contractors were hired to cover for the insufficiency of personnel which would later contribute to a higher expenditure of the company. Besides that, this study also elaborates on factors influencing the quality of maintenance. It is expected that this study would contribute to the developing of the building maintenance guidelines and would hopefully be a good reference to all maintenance managers in Malaysia.

Keywords: Building Maintenance, organisation, personnel, survey, management, Malaysia,

Introduction

Most people do not realize that a building maintenance system contributes to the income of the company owning or renting the building. It has become a part of a total performance approach, together with other factors such as productivity, quality, safety, and environment (Groote, 1995). Maintenance performance is generally hard to measure, as one should not only consider quantifiable parameters but also the quality of the performed maintenance and its organization. This paper is aimed to evaluate and identify the maintenance personal requirement in Malaysia. In Malaysia the building maintenance technology is still in investigation stage thus not many source was found in this field. As building in Malaysia is concerned, buildings are almost maintained by their own staff instead of hire other contractors. Buildings

such as hotels, hospitals and high rise offices are normally have their own maintenance department that managed by the maintenance manager. Building satisfaction survey was found that most occupants considers that the maintenance serviced they received was not in the satisfied point. This might be caused of many circumstances issue such as lack of maintenance staff, un-skill staff, lack of tools and much more. This paper is aimed to evaluate and identify the maintenance personnel requirement in buildings department in Malaysia. Maintenance personnel are also mention as maintenance staff or peoples that are working and responsible for all maintenance job in the buildings.

Academic Qualification

Based on the survey data, most companies do not have fully skilled maintenance personnel. This was proving by the chart in Figure 20 shows the percentage of academic qualification of maintenance people in office buildings. Some of them are high-school leavers that do not posses the necessary skill to do maintenance job. A large number of them are backed up only with technical certificates as their education level. Only one-fourth of them have degrees or diplomas. Degree holders are normally the managers and those at the upper level. They are not involved in technical at all. That staffs with technical certificate is among the technician and supervisors. They are considers as skill staff that fulfil the building maintenance requirements. SRP, SPM and STPM were those that only school's passer and they have no basic technical knowledge and considers as un-skills staff. Only a few of them have some working experience in this field. These are among the problems that are faced by most maintenance organisations in Malaysia. Hiring skilled maintenance personnel is really difficult.

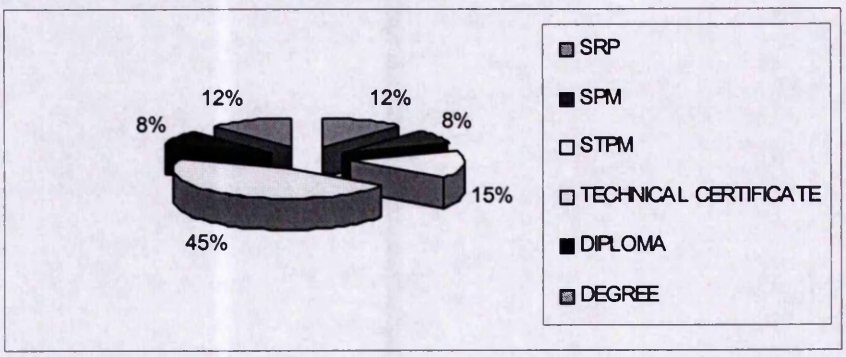


Figure 20 : Percentage of academic qualification of maintenance people in office buildings

In order to resolve this problem the Building Management Team should provide skill training to those staff without required academic certificate. The Construction (Design and Management) Regulation 1992 has stated that it is the duty of an employer to ensure that his personnel have the necessary competency to do maintenance work. It is also the responsibility of the employer to provide his employees with appropriate training if they are not competent enough. Much emphasis is put on competency because a maintenance department works closely with the building's control system, and this would create disaster if it is handled by incompetent workers. Besides that, unskilled staff could cause enormous damage to machines and equipment especially in a manufacturing plant, and therefore represent

a high risk to the building. In view of this, staff must be carefully selected for their knowledge and ability so that they are able to handle matters pertaining to plant equipment and other maintenance matters. Staff evaluation systems, staff motivation programmes and staff trainings are effective ways to improve employees' maintenance skill and should be practiced more often to bring out the best out of them.

On the other side, research has found that there is no specific course for maintenance technology or engineering in most universities in Malaysia. At university level, only basic maintenance knowledge is exposed to students. Faculty of Civil and Construction of University of Technology MARA offers building service courses which provide civil engineering students with knowledge and understanding on the principle of electrical and mechanical engineering. The syllabus emphasizes on the supervision of electrical system and different types of mechanical equipments that are commonly used in building. The operation and maintenance of the equipments are also taught to the students. Students will also learn the electrical wiring regulations and building service systems. Similar courses are also offered by two polytechnics in Malaysia but only at diploma levels. Some of the syllabuses are included in one or two subjects under architecture, building or real estate courses. Besides that, the National Vocational Training Council (NVTC) of Malaysia also provides and coordinates skill training strategies and programmes to keep up with Malaysia's technological and economic development needs. The objectives are to establish a coordinated skill training system attuned to Malaysia's development goals and needs, to promote the development of skill training; and to certify skill competence. These facts clearly show that the standard of technical and skill training must be upgraded to fulfil the required standard. The Ministry of Education and related parties should consider ways to improve this situation. Introducing a technical skill programme or short term course on technical skills is one of the possible solutions

Flexibility of the Personnel

Besides not having enough skilled maintenance staff most company also have lack number of maintenance staff. Table 1 listed numbers of staffs in the maintenance department in Malaysia. The table shows that staffs are able to fix and repairs the entire maintenance request but will be over worked to maintain quite a large area. It is also important for every maintenance manager to study the minimum number of staff they should have. This is to avoid overworked staff which might affect the quality of the system.

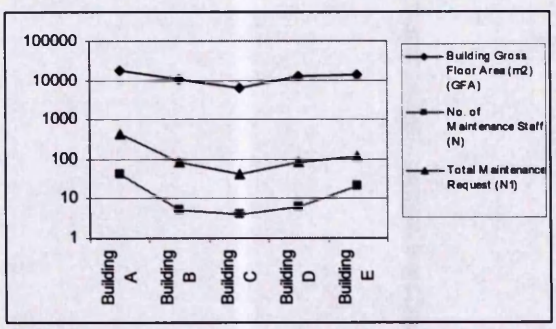


Figure 2 : Building size, number of staff and requests demand

Table 1: Building's size, number of staff and requests demand

Building	Building Gross Floor Area (m^2) (GFA)	No. of Maintenance Staff (N)	Total Maintenance Request (N1)
Building A	18100	40	424
Building B	10934	5	80
Building C	6530	4	41
Building D	12300	6	83
Building E	14000	21	115

Chan, Lee, etc (2001) proposed the Manpower Utilisation Index to be used as an indicator to reflect how well the maintenance workforce has been utilised. This is useful in identifying whether the maintenance workforces is over, fully or under utilised, and for assessing the general productivity of the maintenance personnel. The size of building and the number of staff available are important factors that should be studied deeply. Small simple buildings and large complex buildings might require different amount of maintenance work. The ratio of average request for repair daily or weekly to the number of maintenance manpower would help management to predict whether the maintenance team is able to run the maintenance system effectively or not. The business function will dictate the maintenance needs. To ensure that an organisation achieves its business function with maximum efficiency, a clear understanding of maintenance need is required (Smith and Tate, 1998).

Organization Structure

Evaluation on maintenance personnel also including the way they communicate in the department. This would affect the efficiency of the maintenance system in the building. A good arrangement of organisation structure will help the maintenance department to manage the building without too much hassle. Most buildings in Malaysia have their organization structure but the problem is some of them do not display it for everybody to see. It is important for staff to know their organization structure because it tells more about their responsibilities and provide them with the knowledge of to whom they should report a problem if they cannot fix it by themselves. An observation in most buildings in Malaysia found that most staff is confused with their position in the department. They get hard to find the correct person to report. At last many unresolved request and complaint has been store up without a person in charge. Maintenance staff should be clearly brief they position and jobs and responsibilities before they can start doing their job.

Each person in a maintenance department should know his or her responsibility in the department. Documented description of the job responsibility will help each person to do their work better. A responsible job is one which the value of job outcomes is highly sensitive to the worker's input. A responsible worker is not closely monitored during the production process, but after the outcome of his work is evaluated, he will get credits for a well done job or blames if the job is not good enough. The degree of responsibility may be measured by the variation in the value of job outcomes over the feasible range of worker's effort.

Management should prepare and explain the responsibilities of the staff due to their position in the department. This is to avoid any disputes between the employees over the jobs they are assigned to. Therefore, when there is a request for maintenance work at a certain area, the person in-charge of that area will immediately take up the job.

Management of maintenance can also comprise more than the control activities associated with each item of equipment and can be addressed broadly under the headings of 'technical' and 'control' (CIBSE). Effective maintenance management minimized the cost associated with the non-availability of an engineering service (CIBSE, 2000). Maintenance manager must be able to manage the team. He must be well known with the health and safety regulation and other requirements that are necessary to the departments. It is the responsibility to the manager to bring a

satisfaction condition on only for the occupants but also to his men for not burden on overworked.

CONCLUSIONS

Effective building maintenance can be achieved through a well-organized management, skilled maintenance personnel and a good organization structure. In this paper the maintenance personnel requirement in Malaysia has been evaluated and the finding shows that many parties should involve resolving the condition. The building Management Team as well as the Ministry of Education Malaysia and the Ministry of Human Resource should take note that prompt action really need to build up the level of maintenance technology in Malaysia. The key factors described in this paper is hopefully can be used to draft the guidelines for building maintenance management system for Malaysia.

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FACTORS INFLUENCING THE PERFORMANCE OF BUILDING MAINTENANCE MANAGEMENT IN HIGH RISE OFFICE BUILDINGS IN MALAYSIA

Emma Marinie Ahmad Zawawi, Syahrul Nizam Kamaruzzaman
Building Division,
School of Mechanical, Aerospace & Civil Engineering,
University of Manchester
PO Box 88, Manchester, M60 1QD, England
Email: E.Zawawi@postgrad.manchester.ac.uk
Email: S.Nizam@postgrad.manchester.ac.uk

Abstract:
The role of building maintenance in new manufacturing is becoming ever more critical, with companies adopting maintenance as a profit-generating business element. The maintenance of built environment affects everyone continually, for it is on the state of office, homes and factories that are depend not only for the comfort but also for the economic survival. As buildings in Malaysia are concern, building maintenance system is still in the investigation stage and not many sources of building maintenance were found. The objective of this study is to describe the important factors involved in producing an excellent and quality of building maintenance system. A pilot survey in Malaysia was carried out around June and July 2004. About 200 questionnaires were distributed to people occupying high-rise buildings in Malaysia. The aim is to gather data which are related to the management of building maintenance. The survey also contains data to identify the satisfaction level of building maintenance system in Malaysia. Many issues have been discovered including those related to the management team, training course, academic qualification, repairing tools and so on. Thus factors influencing the quality of maintenance have been identified. It is anticipated that this study would contribute to be a good practical tool to all maintenance managers.

Keywords: Building maintenance, organisation, maintenance personnel, Malaysia.

Introduction

Maintenance is defined in BS 3811:1993 as 'a combination of all technical and administrative actions, including supervision actions, intended to retain an item in, or restore it to, a state in which it can perform a required function' (BS3811:1993). In two notes, the British Standard explains that, where there are statutory requirements for maintenance, the 'acceptable standard' to be reached must be no less than that necessary to meet such requirements; and 'maintained is defined in the Factories Act 1961 as : 'maintained in an efficient state, in efficient working order and in good repair.

Most buildings have long life expectancies, and acceptable standards of amenity and performance will rise substantially over their lifetime. As buildings in

Malaysia are concern, the building maintenance field is still under investigation and not many sources were found. This study is attempted to identify the factors that influence the quality of building maintenance system.

Research Methodology

A survey was carried out in Malaysia during June and July 2004. Sets of questionnaire were distributed to the selected high-rise buildings in Malaysia. The questionnaires were delivered personally to the managers of maintenance departments of the selected buildings. This was further followed-up with telephone calls and personal contacts to ensure a reasonable response rate. Five buildings were chosen for this study and all these buildings are located in Kuala Lumpur, the commercial city of Malaysia. Additional organisations from the service sector were selected and added to the list as this would form the initial target sample population.

There are 3 sets of questionnaire. Set one is for the head of maintenance department. This questionnaire contains data such as building size, number of maintenance staff, building function and some data related to the management of the maintenance system. Set two is answered by the building's occupant. They need to stress their satisfaction towards all building services and building maintenance performance in the building besides completing number of requests they have made for maintenance. Set three is answered by the maintenance staff (supervisor, technician, plumber and others) where they need to fill the data about their personal details including, age, gender, working experience, academic qualification and so on that is expected to help authors analyses the status of maintenance staffing in high-rise office building. Table 1 summarised the replies of the questionnaires.

Table 20 : Response to survey

	No. of Questionnaire sent out			No. of Replies received			Response (%)		
	SET 1	SET 2	SET 3	SET 1	SET 2	SET 3	SET 1	SET 2	SET 3
Building A	1	30	4	1	19	4	100%	63%	100%
Building B	1	30	4	1	26	4	100%	86%	100%
Building C	1	30	6	1	19	6	100%	63%	100%
Building D	1	30	13	1	22	13	100%	73%	100%
Building E	1	30	21	1	14	12	100%	46%	57%

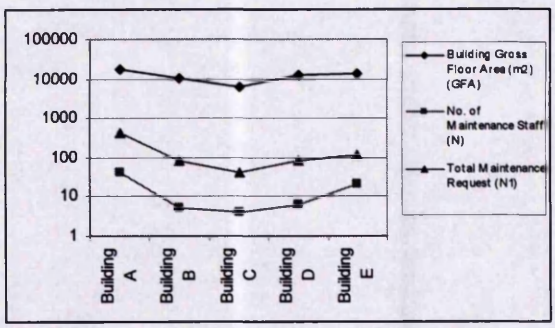
Data Analysis

All data gathered was analysed using statistical package software. Data was first grouping into certain particular category such as satisfactory level, request demand and maintenance personnel staffing. These analysing stage uses some statistical testing to check if the variable has statistically significant each other and also to check if the data is valid or not for the analysing process. This was result many graph and tables that is clear and easy to interpret. Hence the factors influencing the performance of the maintenance system in high-rise office buildings in Malaysia was found.

Request Demand

Figure 1 and Table 2 below shows that most high-rise office buildings in Malaysia do not have enough maintenance staff to cater all need. Some of them might be able to fix and repairs item on time but have not enough time to cover quite a large area. Having a skilled maintenance staff does not entail that maintenance system would run smoothly. The number of staff available to manage the building is also important. Each company or department is supposed to have enough maintenance staff for this purpose. Most high-rise office buildings in Malaysia faced this problem for years. Chan, Lee, etc (2001) proposed the Manpower Utilisation Index to be used as an indicator to reflect how well the maintenance workforce has been utilised. This is useful for identifying whether the maintenance workforces is over, fully or under utilised, and for assessing the general productivity of the maintenance personnel.

The size of building and the number of staff available are important factors that should be studied deeply. Small simple buildings and large complex buildings might require different amount of maintenance work. The ratio of average request for repair daily or weekly to the number of maintenance manpower would help management to identify the capability of their team to run the maintenance system.



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Building D	12300	6	83
Building E	14000	21	115

Maintenance Staffing

Besides not having enough staff in maintenance department, most companies face a problem in finding skilled and knowledgeable maintenance employees. The bar chart in figure 2 shows the numbers of maintenance staff with only a school's leavers is still high, that is 15 out of 38 respondents (SRP & SPM). The survey also shown that most of the maintenance staff has not much experience in this area where there is only 23.7 percent from the 38 respondents considers experiencing 8 years and above in this field. This might results poor maintenance because they are expected as unskilled workers. One solution would be to request top management to create a work environment that is conducive to senior employees, so that they are able to share their skills and knowledge or conduct a training program to establish the new employees in maintenance field. It is also important for every maintenance manager to study the minimum number of staff they should have. This is to avoid overworked staff which might affect the quality of the system.

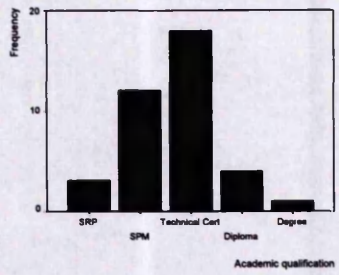

Figure 2: academic qualification of the Maintenance staff in high-rise office buildings in Malaysia

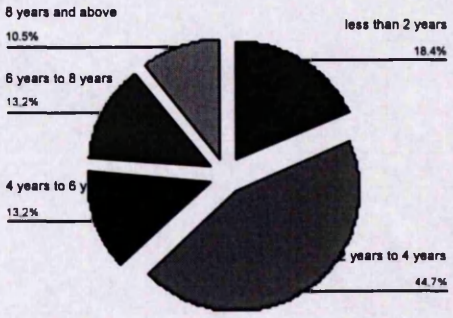

Figure 2: Percentages of maintenance staff's with academic qualification

Organization Structure

A good arrangement of organisation structure might help the department to manage the building without difficulties. Most building maintenance departments in Malaysia have this structure but a few of them keep the printed copy in files, and do not bother to provide detailed explanation of the structure to their staff. It is important for staff to know the organization structure because it tells more about their responsibilities and provide them with the knowledge of to whom they should report a problem if they cannot fix it by themselves.

Planning and Scheduling

Planning and scheduling in management in very important in order to develop a good organisation structure (Smith, 1992). Strategies and policies of the department must be strong enough and well organised. This will come in handy when breakdown occurs since it is easier to determine the appropriate procedure to handle the breakdown. A survey has found that most maintenance departments in Malaysia have the strategies but not the policies. The strategy may closely follow the original maintenance policy as described in the Guide to ownership, operation and maintenance of building services (CIBSE, 2000). Building records are usually comprised of documents related to the building such as as-built drawings, history of equipment, list of nominated contractors and others. These references will be needed usually in emergency cases especially during breakdowns of important and complex equipment such as life-supporting machines in hospitals.

Besides that, maintenance manual is also important to be prepared for the use of maintenance staff (Armstrong, 1987). It will enable staff to organise the repair and maintenance of the buildings, its services and surrounds effectively and economically. These manuals also enable them to clean the building and operate it services efficiently and reduce losses of time and production. The person in-charge of maintenance department must make sure that these data is updated from time to time and is always well-organised.

Tools and equipment

Survey has shown that some departments do not provide a complete set of tools and equipment for the use of building maintenance personnel. This is proven when most of them consider 'usually' and 'seldom' when asked if they are provided with a complete set of tools for repairing work. It is the manager's responsibility to provide a complete set of tools for their staff including personal protection equipment such as

gloves, ear plugs and goggles. Having not enough tools to do repairs might delay the job and this would also create unsatisfied condition among the occupants.

Conclusion

Based on this study, several factors affecting the performance of building maintenance management in high-rise office in Malaysia were found. There are lack of maintenance personnel to cater all the maintenance needs, not enough skilled and knowledgeable people in maintenance department, organisation structure is not fully used, unorganised maintenance strategies and policies and not enough tools provided. Those factors were identified to be affected both performance and profit to the company. It is to propose that top management need to organise training for those that are not enough knowledge in maintenance and to improve the maintenance strategies and policies such as adapting the preventive and predictive maintenance (Lee, 1987) to a better standard. Management of maintenance can be comprised of more than the control activities associated with each equipment and can be addressed broadly under the headings of 'technical' and 'control' (CIBSE, 2002). Effective maintenance management minimized the cost associated with the unavailability of engineering services (CIBSE, 2002). A maintenance manager must be able to manage his team well. He must be well-versed with the health and safety regulations and other requirements necessary to the department. It is the responsibility of the manager to bring a satisfactory condition not only for the occupants but also for his service team so that they are not overworked. This study is anticipated to be a good guidance to every building maintenance manager in high-rise office buildings in Malaysia.

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