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THE UNIVERSITY OF HONG KONG

PRIORITIZATION OF PLANNED MAINTENANCE WORKS IN PUBLIC HOSPITALS IN HONG KONG

A DISSERTATION SUBMITTED TO
THE FACULTY OF ARCHITECTURE
IN CANDIDACY FOR THE DEGREE OF
BACHELOR OF SCIENCE IN SURVEYING

DEPARTMENT OF REAL ESTATE AND CONSTRUCTION

BY

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HONG KONG

APRIL 2006

DECLARATION

I declare that this dissertation represents my own work, except where due acknowledgment is made, and that it has not been previously included in a thesis, dissertation or report submitted to this University to any other institution for a degree, diploma or other qualification.

Signed: _____

Name: Choi Ka Wing, Janet

Date: 13th April, 2006

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ABSTRACT

Priority setting has always been one of the most difficult issues in maintenance planning due to the multi-criteria decision making involved. The issue becomes even more complicated in the context of healthcare facility management (FM) due to the highly critical nature concerning the performance of hospitals buildings and facilities. As a result, the criteria adopted in maintenance prioritization have to be carefully selected and weighted. This dissertation first aims at identifying the relevant factors affecting criteria setting in maintenance prioritization in public hospitals. The current maintenance prioritization practice adopted by the Hong Kong Hospital Authority will also be investigated. More importantly, views of the facility managers at different levels of hierarchy in the organization structure will also be examined from different perspectives.

Qualitative case study approach is adopted in this dissertation. Findings of the research shows that significant difference was found in terms of resources and financial considerations between the views of the two levels. However, such difference does not create conflicts due to sufficient communication and also similar views in other considerations, including social and technical ones. On the contrary, it is suggested that the fund allocation mechanism can aid better utilization of resources since real needs of cluster hospitals can be better understood and balanced. It is hoped that this study can help the Hospital Authority identify the suitable prioritization criteria and mechanism so as to facilitate planned maintenance management in terms of 'value for money'. Also, it is hoped that it can provide useful insights to facility managers in other property holding organizations concerning the relevant maintenance prioritization systems and factors to be considered.

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Chapter 1 Introduction

1.1 Background of the Study

With increasing population and fast growing demand for medical services in Hong Kong, the demand for healthcare facilities has been rising drastically in recent years. With intensive use and ageing of public hospital buildings, maintenance works and projects have become vital agenda for facility managers in the Hospital Authority due to the high criticality of the hospital buildings performance.

However, faced with the budgetary constraints of the healthcare sector, budgets for building maintenance in public hospitals are unlikely to meet the ever-increasing maintenance need. Although the problem is unlikely to be solved without an input of further resources, a well set maintenance plan may help to improve the situation. As a result, effective and rational allocation of resources is indispensable and of paramount importance.

Priority setting has always been one of the most difficult issues in maintenance planning since various factors have to be taken into considerations during the prioritization process. This multi-criteria decision making involves in maintenance prioritization makes it a subject worth studying.

The issue of maintenance planning becomes even more significant in hospital buildings maintenance management. A hospital is a special facility due to its unique operating condition - operating 24 hours a day, 7 days a week. Also, unlike most

business ventures, hospitals involve much greater stakes than the profit-only vision in the sense that a mistake in a hospital can cost the life of a human being. The performance of hospital buildings becomes a highly critical issue due to its impacts on the quality of medical services provided. Hence, the criteria adopted in maintenance prioritization should be carefully selected and weighted.

Under the establishment of a full scale comprehensive cluster management structure in 2002/03, facility management in the Hospital Authority can be viewed from three levels, i.e. Head Office level (CWD), cluster level and also hospital level. Prioritization of maintenance and improvement works is done by individual hospitals. However, the priorities will then be submitted to cluster for bids. It is the responsibility of the cluster facility management (FM) team to further prioritize all the items submitted by different cluster hospitals to determine the allocation of budgets for the works. Due to the different roles of the teams, it is anticipated that there will be differences between their views in terms of the factors affecting their maintenance prioritization decisions.

1.2 Research Questions

As mentioned above, a properly set maintenance plan is an issue of paramount importance to the Hospital Authority in order to ensure efficient use of resources. In this research, the following questions will be answered:-

(i) What is the current maintenance prioritization practice adopted by the Hong Kong Hospital Authority?

(ii) What are the relevant factors affecting criteria setting in maintenance prioritization in public hospitals?

(iii) What is the relative importance of the factors from the facility managers' perspectives?

(iv) Do the views of the facility managers at different levels of hierarchy in the organization structure differ from one another?

(v) What are the impacts of clustering on maintenance priorities in hospitals?

1.3 Objectives

This dissertation attempts to study the area of maintenance prioritization in public hospitals in Hong Kong. Five objectives are formulated and summarized as follows:-

(i) To investigate the current maintenance prioritization practice adopted by the Hospital Authority;

(ii) To identify the relevant factors affecting criteria setting in maintenance prioritization in public hospitals;

(iii) To examine the relative importance of the factors from the facility managers' perspectives;

(iv) To examine the views of the facility managers at different levels of hierarchy in the organization structure and identify the differences if any; and

(v) To discuss the impacts of clustering on maintenance priorities in hospitals.

1.4 Significance of the Study

Chan (2004) pointed out that the Hospital Authority is facing a big challenge in allocating the maintenance funds due to the budgetary constraints of the healthcare sector. In the Kowloon West Cluster (KWC), one of the seven clusters of the Hospital Authority, the reinstatement value of the maintenance items calculated with reference to several newly established projects, the actual annual maintenance budget barely amounted to two per cent of the reinstatement value.

Previous studies of Spedding et al. (1994) and Shen et al. (1997, 1998, 1998a, 1999, 1999a) revealed that improving planned maintenance management of public buildings in terms of 'value for money' by setting up a viable prioritization model would be one of the ways to tackle the problem of lack of maintenance funds. In fact, Bushell (1984) has also pointed out that setting priorities is vital if maintenance programmes are to be effective and give value for money. These studies concentrate on the factors and issues which managers consider in order to come up to the maintenance prioritization decisions. It is believed that investigating the value of the factors concerned would be crucial since they form the basis for priority modelling which help to ensure the best use of available resources in maintenance management.

By carrying out this study, it can help the Hospital Authority to identify the suitable criteria and achieve better maintenance planning and resources allocation. Also, examining the views of facility managers at different levels of the hierarchy would further facilitate the set up of a comprehensive and systematic prioritization model for maintenance and improvement works in publics hospitals in Hong Kong. In addition,

the study can also help to examine the impacts of setting the cluster FM team on individual hospitals. This will be useful to those clusters in which well-established cluster FM teams are absent.

Although the dissertation focuses on public hospital buildings, the methodology of the study may also be applied to other property holding organizations in identifying the critical factors required for prioritizing maintenance items. Similar to the case in the Hospital Authority, maintenance prioritization and planning would always be essential to property holding organizations owing to limited resources. Facility managers and maintenance managers are always facing the problem of budget constraints in making maintenance plans. Thus, there is always a need to prioritize planned maintenance works. As a result, this study is also applicable to other organizations to help ensure that suitable criteria are chosen and appropriate weightings are assigned in the maintenance plan. This aids better planning and lead to more effective and efficient use of the available funding.

1.5 Outline of the Study

This dissertation consists of six chapters.

Chapter 1 is the introduction. Background information, framework, and objectives of the study are specified.

Chapter 2 is the literature review. In this chapter, literature about maintenance, maintenance management, planned maintenance, facility management (FM) and priority setting in maintenance management will be discussed.

Chapter 3 is the Hong Kong Hospital Authority. Different aspects about the Hospital Authority, including the organization structure, maintenance management strategies and the current maintenance planning practice will be investigated. Details about the Kowloon West Cluster (KWC) will also be given.

Chapter 4 is the hypotheses and research methodology. Hypotheses will be given based on literature search and real-life observations. The research method and data collection adopted in this dissertation will also be introduced.

Chapter 5 is the case study on the Kowloon West Cluster. Findings of the study will be examined with discussions and explanations provided.

Chapter 6 is the concluding chapter of this dissertation. It will summarize the findings in this dissertation. Limitations and areas for further research will also be discussed.

Chapter 2 Literature Review

In this chapter, the definition and classification of various types of maintenance will be introduced. Previous researches on maintenance management and facility management will also be reviewed. Some existing prioritization methods in planned maintenance management will then be studied to identify the factors used in the prioritization process. These methods are important to this study as they provide useful insights into the approaches and factors for constructing the research methodology.

2.1 Definition of Maintenance

British Standard BS 3811: 1964, defined maintenance as 'work undertaken in order to keep or restore every facility, i.e. every part of a site, building and contents to an acceptable standard'.

There are two processes envisaged: 'retaining', i.e. work carried out in anticipation of failure, and 'restoring', i.e. work carried out after failure. There is also the concept of an 'acceptable standard'. Lee (1987) pointed out that this may be construed as acceptability to different parties concerned and there are no absolute standards which would be equally acceptable to everybody.

This definition was also recognized as being too narrow by Allen (1993) who suggested that once restoration or replacement occurs, it often results in an improvement.

It is generally conceded that maintenance should include a reasonable element of improvement, e.g. the replacement of worn-our components with up-to-date versions. Lee (1987) suggested that it is logical to extend the meaning of maintenance to cover localized improvements of this sort. However, where the intention is to increase the efficiency in the use of the building by adding facilities which were not previously present, the work should be classed as improvement.

Chanter and Swallow (1996) also suggested that maintenance and improvement are inseparable to a large extent since in any maintenance operation there will almost always be an element of improvement. However, works having the clear objectives of adapting or increasing the utility of a building, rather than maintaining it at the current level, should be regarded as improvement.

In recognizing the desirability of including a reasonable element of improvement, Allen (1993) quoted the recommended addition in the 'Report of the Committee on Building Maintenance': 'improve any facility, i.e. every part of a building, its services and surround to a currently acceptable standard and to sustain the utility and value of the facility.'

The notion of a 'currently accepted standard' was also introduced, which, from the general tenor of the definition, is assumed to be higher than the initial standard (Lee, 1987). There may, of course, be cases where buildings are put to a less demanding use for which lower standards would be acceptable.

The Chartered Institute of Building (1990) further modified the BS 3811 definition: 'Building maintenance is work undertaken to keep, restore or improve every facility, i.e. every part of a building, its services and surrounds to an agreed standard, determined by the balance between need and available resources.'

Bushell (1984), by quoting BS 3811: 1984, defined maintenance as 'a combination of any actions carried out to retain an item in, or restore it to an acceptable condition', emphasizing actions that relate not only to the physical execution of maintenance work, but also those associated with initiation, organization and implementation etc.

Definition of Maintenance in Hospital Buildings

While the above definitions were envisaged to cover all buildings, Allen (1993) quoted the definition of maintenance in the Woodbine Report which amplified the standards for hospital buildings: 'work undertaken to hospital premises to acceptable standards of safety and efficiency having due regard to the needs of patients and staff within the immediate environment, the requirements of the NHS and the resources available'. However, the additional wording was merely regarded as emphasizing the constraints on the execution of the works.

Such constraints were also recognized by Chanter and Swallow (1996), who suggested that healthcare buildings represent, perhaps, the most difficult group of largely public sector buildings to maintain because of their complex engineering services and their heterogeneous nature.

2.2 Classifications of Various Forms of Maintenance

BS 3811 (1984) defined the different types of maintenance and the relationship of various forms of maintenance (Figure 2.1).

(i) Planned maintenance: Maintenance organized and carried out with forethought, control and the use of records to a predetermined plan.

(ii) Unplanned maintenance: Maintenance carried out to no predetermined plan.

(iii) Preventive maintenance: Maintenance carried out at predetermined intervals or corresponding to prescribed criteria and intended to reduce the probability of failure or the performance degradation or an item.

(iv) Corrective maintenance: Maintenance carried out after a failure has occurred and intended to restore an item to a state in which it can perform its required function.

(v) Condition-base maintenance: Preventive maintenance initiated as a result of knowledge of the condition of an item from routine or continuous monitoring.

(vi) Scheduled maintenance: Preventive maintenance carried out to a predetermined interval of time, number of operation, etc.

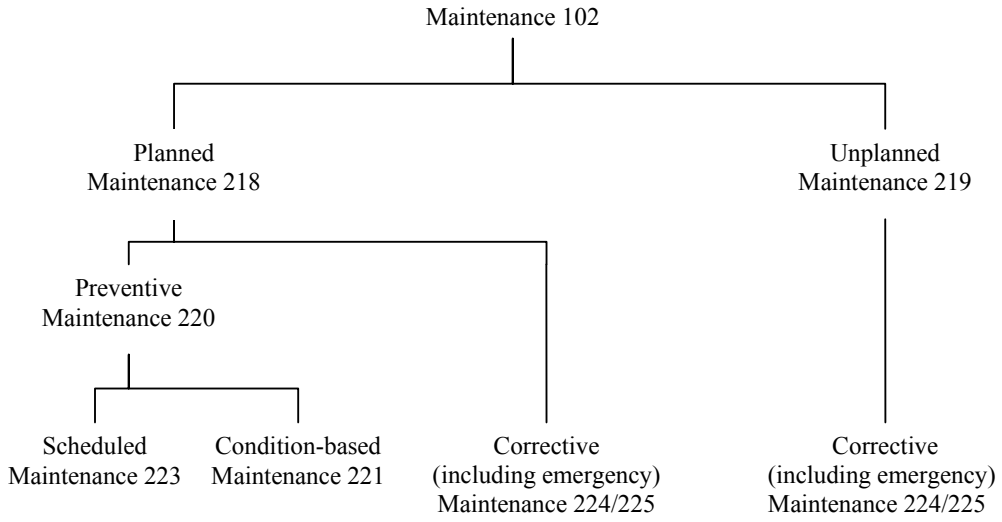

Figure 2.1 Relationship of various forms of maintenance (Source: British Standards Institution (1984). *BS3811: British Standard Glossary of Maintenance Management Terms in Terotechnology*, London: HMSO.)

2.3 Planned versus Unplanned Maintenance

Unplanned maintenance tasks often take places in an *ad hoc* manner in response to breakdowns or user requests (David and Arthur cited in Horner at el., 1997). Thus, it would be extremely expensive for two reasons:

(i) The failure of the item can cause a large amount of consequential damage to other elements in the building. For example, failure of the roof could cause damage to the ceiling and the interior of the building.

(ii) Failure of an item can occur at a time which is inconvenient to both the user and the maintaining authority. This can make manpower and spare parts planning extremely difficult.

On the other hand, planned maintenance tasks are performed in accordance with a predetermined plan at regular, fixed intervals, which may be based for example on operating time. Raymond and Joan (1991) summarized the advantages of planned maintenance over unplanned maintenance:

(i) Maintenance can be planned ahead and performed when it is convenient to the building's user;
(ii) Maintenance costs can be reduced by avoiding the cost of consequential damage;
(iii) Downtime can be minimized so the habitability of the building can be increased; and
(iv) Health and safety of the user can be improved.

Nevertheless, Horner et al. (1997) by quoting El-Haram suggested that preventive maintenance has some disadvantages which must be minimized:

(i) Planned maintenance is performed irrespective of the condition of the building elements. Consequently, a large number of unnecessary tasks will be carried out on elements that could have remained in a safe and acceptable operating condition for much longer time.
(ii) The condition of an element may end up worse than it was before, as a result of human error during the execution of the maintenance task/
(iii) Planned maintenance tasks are usually very demanding in terms of spare parts and labour.

Chanter and Swallow (1996) suggested that there will be planned and unplanned work within any maintenance organization. The balance between the two will vary, depending on the nature of the organization and its attitude to building maintenance.

2.4 Maintenance and Facility Management (FM)

Most of the definitions quoted above regarded maintenance works as that which enables the building to continue to efficiently perform the functions for which it was designed. This may include some upgrading to raise the original standards, where appropriate, to contemporary norms and the rectification of design faults. As buildings may be considered to be a facility (Chanter and Swallow, 1996), it was suggested that building maintenance needs to be seen as a part of a larger property management function and viewed in the context of the emerging discipline of facility management (FM).

2.4.1 Definition of Facility Management (FM)

Although the term facility management (FM) ('Facilities Management', UK) has been widely used throughout the world for more than a decade, different definitions do exist (Chan, 1998). Some of the most popular definitions of FM are quoted below:

'The practice of coordinating the physical workplace with the people and work of an organization: (it) integrates the principles of business administration, architecture, and the behavioural and engineering sciences.' – US Library of Congress (cited in Chan, 1998)

'A profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology.' – International Facility Management Association (IFMA, 2006)

'The process by which an organization exchanges and sustains agreed levels of support service in an operational environment to meet the strategic objectives of an organization. The operational environment includes the physical, social and managerial setting together with all of the support services and systems that support core activities.' – Centre for Facilities Management, University of Strathclyde, Scotland, U.K. (Centre for Facilities Management cited in Chan 1998)

'The integration of multi-disciplinary activities within the built environment and the management of their impact upon people and the workplace.' – British Institute of Facilities Management (BIFM, 2006)

'A business practice that optimises people, process, assets and the work environment to support delivery of the organization business objectives.' – Facility Management Association of Australia Ltd. (FMA , 2006)

'The process by which an organization integrates its people, work process and physical assets to serve its strategic objectives. As a discipline, facility management is the science and art of managing this integrative process from operational to strategic levels for promoting the competitiveness of organizations.' – The Hong Kong Institute of Facility Management (HKIFM, 2006)

All of the above definitions indicate that FM focuses on managing the interaction of three basic elements which are people, place and process as illustrated in Figure 2.2 (Facility Management Institute cited Hubbard, 1992).

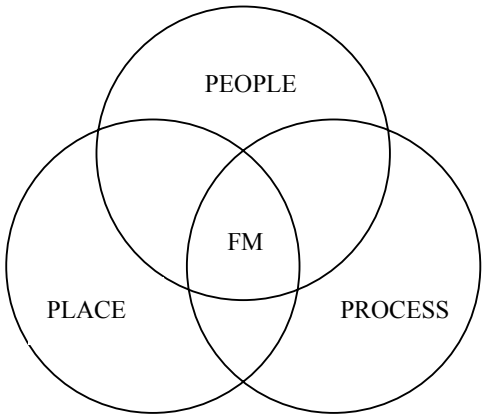

Figure 2.2 People/Place/Process (3Ps) model developed by FMI (Source: Hubbard, G.M. (1993). "Keys to Creating Performance Measures", *Facilities Design and Management*, Vol. 11(5), pp.66-68.)

2.4.2 Scope of Facility Management (FM)

FM encompasses a wide range of facilities involved in the effective management of built assets (Amaratunga et al., 2000). It involves the total management of all services that support the core business of the organization. It focuses on the interaction between the core business, the support functions and the facilities throughout all sectors of industry, commerce and services (RICS, 2006).

The scope of FM is extremely wide and varied. It is suggested that key areas of advice including building management, business operations, business re-location, business support, health and safety, occupiers, outsourcing, property management, services

such as cleaning and catering, strategic planning and advice, support functions and utilities (RICS, 2006).

IFMA (2006) also identifies eight FM core competencies. These include operations and maintenance, real estate, human and environment factors, planning and project management, leadership and management, finance, quality assessment and innovation, communication and technology.

Within such broad spectrum of FM functions, Chan (1998) narrowed down the responsibilities into tasks of the following natures:

Strategic - Long term and policy planning.

Tactical - Medium term planning and intervention projects to restore balance between strategic plans and user needs

Operational - Short term plans and housekeeping

This categorization was also shown (Table 2.1) in the study by McGregor and Then (1999).

	Executive Responsibilities	Management Roles	Project Tasks
Strategic	♦ Mission Statement ♦ Business Plan	♦ Investment Appraisal ♦ Real Estate Decisions ♦ Premises Strategy ♦ Facilities Master Plan ♦ Workplace and IT Strategies	♦ Strategic Studies ♦ Estate Utilization ♦ Corporate Standards ♦ FM Operational Structure ♦ Corporate Brief
Tactical	♦ Corporate Structure ♦ Procurement Policy	♦ Setting Standards ♦ Planning Change ♦ Resource Management ♦ Budget Management ♦ Database Control	♦ Guideline Documents ♦ Project Programme ♦ FM Job Description ♦ Prototypical Budgets ♦ Database Structures
Operational	♦ Service Delivery ♦ Quality Control	♦ Managing Shared Space ♦ Building Operations ♦ Implementation ♦ Audits Emergencies	♦ Maintenance Procurement ♦ Refurbishment / Fit-outs ♦ Inventories ♦ Post-Occupancy

Table 2.1 Matrix of FM tasks (Source: McGregor, W. and Then, D.S.S. (1999). *Facilities management and the Business of Space*, London: Arnold.)

2.4.3 Responsibilities of Facility Managers

The responsibilities of a facility manager are defined by the IFMA (2006) as follows:

- Long range and annual facilities planning;
- Facility financial forecasting;

- Real estate acquisition and/disposal;
- Work specifications, installation and space management;
- Architectural and engineering planning and design;
- New construction and/or renovation;
- Maintenance and operations management;
- Telecommunications integration, security and general administrative services.

Nutt (cited in Mok, 2003) also described the responsibilities of a facility manger in five primary areas: physical, spatial, environmental, human and financial. A clear presentation on different circumstances that involved the effort of the professionals over the life span of a building was also given. The existing premise requires daily maintenance; when time passes, it is necessary to carry out modification and improvement; additions and alterations would be needed while external environment changes; planning and design of new facilities are used for subsequent development and with expansion of portfolio, the facility manger has to deal with strategic decision. These five circumstances are summarized in Figure 2.3.

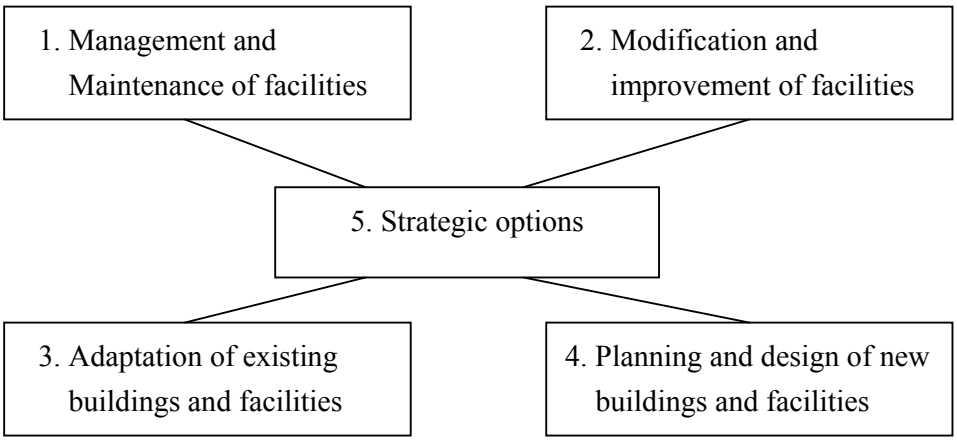

Figure 2.3 Circumstances of FM decisions (Source: Mok, Y.S. (2003). *Facility Management Outsourcing in Hong Kong*, Unpublished B.Sc.(Surveying) Dissertation. Department of Real Estate and Construction, The University of Hong Kong.)

2.5 Maintenance Management and Facility Management (FM)

2.5.1 Maintenance Management

Maintenance management issues play a major role in the performance of constructed facilities (Amaratunga et al., 2000; Hinks cited in Shohet, 2003b).

Allen (1993) suggested that maintenance management encompasses many operations and functions and can be described as: 'the effective and efficient utilization of resources to ensure that the process and its facilities are kept operable to standards required by the users'. Figure 2.4 shows the elements of a maintenance management system.

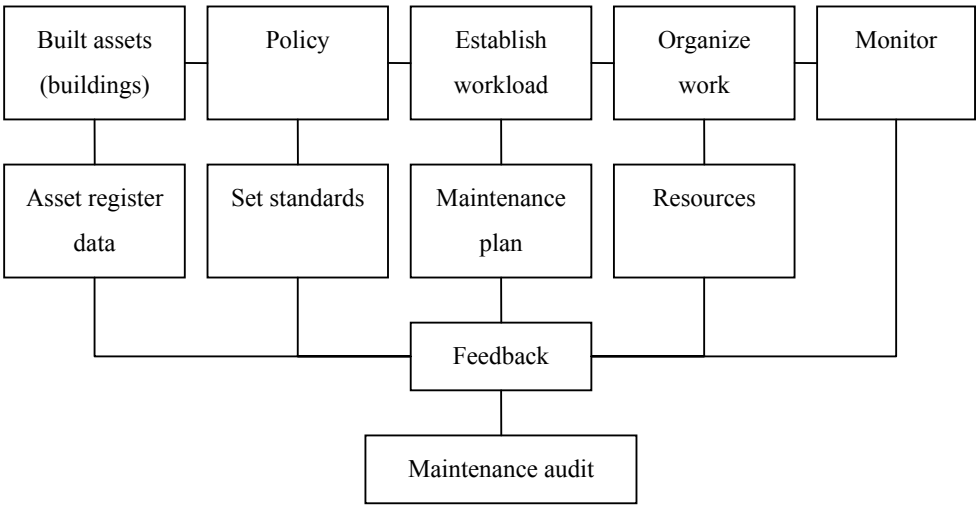

Figure 2.4 Elements of a maintenance management system (Source: Allen, D. (1993). "What is Building Maintenance?", *Facilities,* Vol. 11, pp. 7-12.)

2.5.2 Maintenance Management in Facility Management (FM)

Based on the scopes of FM and also the duties of the facility managers as identified in Chapter 2.4, it is shown that maintenance management is one of the important subsets of FM. It involves in all the three levels of FM from operational (e.g. maintenance procurement) to strategic ones (e.g. the use of key performance indicators in maintenance management).

In fact, Hinks and McNay (1999) have pointed out that maintenance management, together with space management and accommodation standards; project management for new-build and alterations; the general premises management of the building stock of the company; and the administration of associated support services, all fall within the common interpretations of FM.

2.5.3 Maintenance Management in Healthcare Facility Management (FM)

Over the decade, healthcare FM has become the subject of an increasing number of academic research and development efforts.

Alexander (1996) suggested that a hospital is a facilities set-up with effective co-ordination and control of the physical estate, its technical services and equipment, together with the non-clinical servicing activities is required to provide a physically pleasing, technically sound, cost controlled and secure base in which patient care can be practiced. FM in hospitals provides supports to the medical and nursing activities and thus direct patient care. It is important that FM in hospitals can help ensure that all the non-clinical activities are in place and working effectively; buildings and support services are there and working effectively and direct patient care can be effectively practiced.

Shohet (2003b) shared similar views and regarded hospital as a system of connected and interdependent components. Every single task performed in each component affects the critical outcomes of cost; service and clinical quality; physician and patient satisfaction and also the image of the hospital. Due to the interconnectedness of hospital departments and their functions, the issue of FM in hospital management is a complicated one to be investigated.

Shohet and Lavy (2004) described six core domains within the area of healthcare FM: maintenance management, performance management, risk management, supply services management, development, and ICT as an integrator.

Maintenance management hospital buildings has been regarded as one of the more complex subjects in the field of FM due to the great complexity of hospitalization buildings, the high criticality of mechanical and electrical systems, and the shortage of maintenance budgets (Shohet, 2003). Also, performance and operation of hospital buildings are affected by numerous other factors, including actual hospital occupancy relative to planned occupancy, age of buildings, building surroundings, managerial resources invested, and labor sources for implementation of maintenance (in-house provision vs. outsourcing).

2.6 Building Maintenance Strategies

Horner et al. (1997) introduced a maintenance management approach which is based on the failure consequences of each item in a building to select an appropriate and cost-effective maintenance strategy (either planned or unplanned) for each item or group of items in a building. The prime objective is to determine the best combination of maintenance strategies for a building by selecting the optimum maintenance strategy for each individual item, taking into consideration health, safety and satisfaction of the user and the costs of maintenance tasks.

In order to implement the said approach, a comprehensive review of all constituent items in a building should be carried out, and each item within the building should be analyzed form the point of view of failure and its is especially important to identify the consequences of failure. As a result of this analysis, all the constituent items in the building will be divided into two groups depending on the significance of the consequences of failure:

(i) Significant items

Significant items are those whose failure affects health, safety, environment or utility (including cost). Under this group, the items are further divided into two categories: Health, safety and environmentally significant items (HSESIs) and Utility significant items (USIs). HESESIs are those whose failure creates a possibility that the user could be injured or killed, or that environmental standards could be breached. An item is regarded as utility significant if the cost of maintenance if less than the cost of failure. Thus, all items whose failure is like to have an effect on the revenue, direct and indirect maintenance costs, quality, user satisfaction, appearance, serviceability or availability of the building are potentially utility significant.

(ii) Non-significant items

Non-significant items are those items whose failure has no significant effect. This means that the failure does not affect health, safety, environment or utility.

Once significant and non-significant items are identified, the next step is to select an appropriate maintenance strategy for each item in the building. Figure 2.5 illustrates the steps in determining the maintenance strategies.

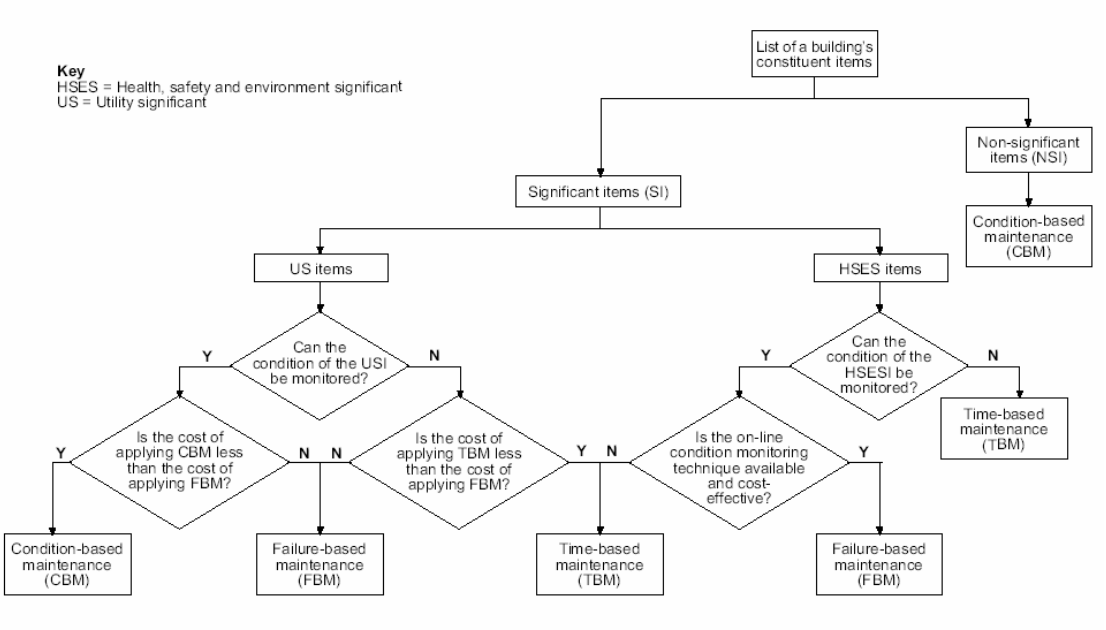

Figure 2.5 Building maintenance decision diagram (Source: Horner, R.M.W., El-Haram, M.A. and Munns, A.K. (1997). "Building Maintenance Strategy: A New Management Approach", *Journal of Quality in Maintenance Engineering*, Vol. 3, pp. 273-280.)

2.7 Prioritization in Planned Maintenance

2.7.1 Some current practices of maintenance priority setting in Hong Kong and UK

The current practice of maintenance priority setting by some of the authorities in Hong Kong and the United Kingdom have been investigated by Shen et al. (1994, 1997, 1998 and 1999)

Architectural Services Department (ArchSD)'s Practice

The Property Services Branch (APB) of the ArchSD which was responsible for the maintenance, refurbishment, and improvement of all government properties in Hong Kong has a condition and priority related maintenance programme. The essence of the programme is to plan for or accept the possibility of restricted maintenance as a result of fiscal stress. The technical needs of the buildings are established through cyclic condition surveys. A priority system reflects stated policy in standards of maintenance for different types and parts of buildings, health, safety and legal requirements. It is employed to assess their condition-related maintenance proposals. Projects are selected according to priorities until the funds allocated are fully committed.

Hong Kong Housing Department's Practice

The Housing Department has a planned maintenance programme called CARE which is the acronym of condition, appraisal, repair and examination. The concept is to deal systematically with the maintenance and improvement of each public housing block by first carrying out a condition survey and then appraising the finding s and arranging for works to be carried out in an intensive repair period of about 2 years. Tenants would be able to enjoy a low breakdown 'quiet' period of 4 years and an improvement in maintenance standards. The quite period is also called the examination period during which building condition data would be collected for the next CARE cycle.

The priorities in the CARE programme are as follows in descending order:

(i) work necessary to maintain the safety or persons;

(ii) work necessary to keep property habitable, e.g. by reasons of hygiene, security, electrical and water supply;

(iii) work necessary to keep buildings operational; and

(iv) work necessary for the appearance of the property, the provision or upkeep of non-essential services or facilities.

Hong Kong Hospital Authority – Kowloon West Cluster's Practice

A Facility Performance Management System (FPMS) was developed to prioritize facilities maintenance needs systematically from various risk perspectives and materialize a process of holistic facility planning for restoration, renovation and improvement to meet the services development (Chan, 2003).

The principles of priority criteria applied are:

(i) Health and safety;

(ii) Risk to patients;

(iii) Statutory requirements;

(iv) Risk to clinical services;

(v) Environmental issues;

(vi) Urgent repair;

(vii) Preventive maintenance;

(viii) Routine maintenance;

(ix) Major maintenance;

(x) Capital renewal;

(xi) Barrier free access; and

(xii) Appearance.

Based on these principles, seven standardized inspection criteria were set:

(i) Physical condition in terms of useful life left and appearance of system,

(ii) Functionality in terms of system performance and service availability,

(iii) Maintainability in terms of routine and planned maintenance with availability of resources,

(iv) Importance (operational impact),

(v) Surroundings impact,

(vi) Environmental consideration and

(vii) Obligatory compliance.

Each of the criteria is assigned with a weighing for implication of relative significance in macroscopic point of view. Summation of the individual score of the seven standards will result in an overall mark, the Facility Performance indicator, which is served as the main indicator of the prioritization purpose. Scoring mechanism set with a view of the type of operations and occupancies characteristics are grouped by services and departments from highest operational risk priority of Operating Theatre, Intensive Care Unit, Neurosurgical High Dependency Unit, Coronary Care Unit, Paediatric and Neonatal Intensive Care Unit to the lowest priority such as hostel and

administrative areas. All the scores captured will be transferred to corresponding grade, e.g. grade A (highest) to grade E (lowest) for easy reference in the facility planning and improvement of 3-year rolling plan.

The FPMS serves as a standardization for assessment to provide decision-making tools which can help management decision making. It allows subjective decisions to be replaced by objective decisions taking into account clearly formulated objective functions and a complex set of constraints.

Maintenance prioritization practice in the UK

It is a common practice that property professionals in the local authorities in Britain assess the priority of each maintenance item for inclusion in their planned maintenance programmes. Shen et al. (1994, 1997, 1998 and 1999), by quoting the report produced by the Architects and Building Group of the former Department of Education and Science (DES, 1985), suggested that although priority ratings may differ in detail between local authorities, the following are regarded as typical:

1st Priority – work needed immediately or in the near future to meet legislative requirements and to ensure the health and safety of building occupants and users; work required to prevent the imminent closure of accommodation or serious dislocation of activities.

2nd Priority – work necessary within one year to prevent serious deterioration of the fabric or services, such as those which are likely to lead to higher future costs of repair or renewal

3rd Priority – work as above which many be deferred beyond one year; work desirable to maintain the environmental quality of buildings and grounds, such as internal decorations, fencing, etc.

The existing methods of prioritizing planned maintenance in four selected local authorities are further investigate. (Shen et al., 1994; 1997; 1998 and 1999)

County A has a simple policy in planned maintenance prioritization, which is to keep premises in a warm, safe and watertight condition, and to keep them "open and trading".

County B has a policy of keeping built assets operational, Maintenance problems are tackled as they arise. Works that may cause health and safety problems or required by relevant legislation are usually given the first priority. The second priority goes to works that are essential to keep buildings operational and safeguard the fabric. The third category is cyclic maintenance such as external painting and flat roof repairs. The fourth and the fifth priorities are given to works which are desirable to prevent further deterioration and works which are required to bring buildings up to current standards.

County C has a detailed policy towards the setting of maintenance priorities. Works are divided into four categories: external building works, engineering, internal building works, and surroundings to buildings. Within each category, guidelines for assigning priorities to maintenance works are given. In general, the priorities were given in the following order:

(i) work essential to the health and safety of occupants;

(ii) work necessary to keep the building operational;

(iii) repairs to the fabric of a building;

(iv) preventative maintenance. E.g. external repainting and rewiring;

(v) internal redecoration, fencing, repairs, resurfacing of roads, etc.

County D uses five priority categories as shown in Table 2.2.

Priority	Work Definitions and Descriptions
A	Work required to meet statutory requirements or requirements of insurance policies, to ensure health and safety of occupant.
B1	Work required before at next financial year to prevent continued progressive deterioration of the fabric or services, leading to significantly higher future cost in repair or renewal, and very inefficient use of the Council's resources (including energy).
B2	Work required to remove health, safety and hygiene risks of a less serious nature.
B3	Work required to remove health and safety risks of a minor nature.
C	Work required to an element which in its present condition is of considerable inconvenience to building users but is not causing a safety hazard or could be deferred for one year.

Table 2.2 Priority rating in County D (extracts) (Source: Spedding A., Holmes R. and Shen Q.P. (1994). "Prioritizing major items of maintenance in large organizations", *RICS Research Conference "A Focus for Building Surveying Research"*, University of Salford, UK, pp.123-131.)

2.7.2 Existing Methods of Building Maintenance Priority Setting

Shen (1997) pointed out that although there were some publications on methods of setting priorities in highway and bridge maintenance, very few can be found in the field of building maintenance.

Bushell's marking system

Bushell (1984) proposed a marking system (Figure 2.6) based on health service experience in which a number of factors to be considered in assessing maintenance priorities were included.

The factors which may be considered to have some degree of priority for rating are as follows in their approximate order or priority: -

(i) Safety

The risk of life or limb is without question a high priority. Structurally dangerous items ought to be dealt with as soon as they arise from the list. However, potential dangerous or hazardous items must also be a first charge on resources as it is a prime duty to provide a safe and healthy environment. Hygiene is also included in this category.

(ii) Essential services

Judgement will be needed in determining whether the component or building element is part of an essential service.

(iii) Statutory requirements

It is vital for maintenance manager to keep themselves fully informed of the law. The requirements of legislation will usually be mandatory and although this is not true for Codes of Practice and British Standards, their recommendations should be followed.

(iv) Security

In some organizations part of all of the premises may have a specific security rating and this will attract a high priority.

(v) Initial cost

Initial cost will have some bearing particularly in relation to pay back.

(vi) Revenue saving

Schemes which will show a good and quick return for the sum invested to obviate waste are given a high priority for any organization.

(vii) Spares availability

Delays in obtaining or the non availability of spares can be significant. For example, if spares are readily obtainable then the replacement of a component can be left possibly until a breakdown occurs.

(viii) Alternative source of supply

Where a service of piece of equipment can be readily hired, borrowed or even dispensed with for a time, then its rating should reflect this.

(ix) Delivery time

If a strict yearly financial accounting system exists, necessitating monies to be spent within a fixed period, then the delivery time of components or materials is a factor affecting priorities.

(x) Manpower

Since some items will attract a low labour content, account must be taken of the time scale of these activities and the possible diversion of skills from prime tasks.

(xi) Public relations or similar factors

Public relations or ‘cosmetic’ maintenance, political expendiency, ‘decibel’ bidding or any other such all embracing item, will appear at some time of another as a factors to get a scheme into a programme. Such factors have a place if for no other reason than acknowledging that technical judgements must sometimes take second place. They should therefore be considered on their merits and given appropriate weighting.

PRIORITY FACTORS

Scheme		Re-floor main entrance	Redecorate main kitchen	Redecorate admin. block	Replace boiler	Re-roof Block A	Rewire nurses home	Laundry calendar		
Cost of scheme		£2,500	£4,000	£20,000	£70,000	£25,000	£50,000	£30,000		
Safety	1	Accidents risk √	Infection risks √		√		√			
Essential service	2	√	√		√			√		
Statutory requisites	3		Hygienic √		Insurance √		√			
Security	4								High	
						√			Low	
Revenue saving	5				£2,000	£300 pa	N/A	£1,000	Cost	
						Call out	N/A	4 years	Time (re-coup)	
Spares	6					N/A	N/A		Good	
					√	N/A	N/A	√	Bad	
Alternative supply	7					N/A	N/A		Yes	
			√		√		N/A	√	No	
Delivery time (months)	8	0.5	1	1	4	2	6			
Manpower (months)	9	0.25	0.5	0.5	1	1	4		Technical Officer time	
		0.25	1	3	5	1	8		Construction time	
Public relations factor	10	√	√		√		√	√	High	
				√		√			Low	
Remarks	11	Need to avoid break up of base	Environmental Health Officer enforcement	Not essential to do all at once phase in smaller units		Patching could continue	Fire risk			

Figure 2.6 Bushell's marking system for maintenance prioritization (Source: Bushell, R.J. (1984). "Assessing Maintenance Priorities--Guidelines Based on Health Service Experience", *Managing Building Maintenance*, Ascot: Chartered Institute of Building.)

Shohet's Building Performance Indicator

Shohet (2003a) developed a building evaluation methodology which uses systematic rating scales for the evaluation of the performance of building components. The condition of the building components is evaluated according to three criteria: (1) actual physical performance of the systems; (2) frequency of failures in building systems; and (3) actual preventive maintenance carried out on the systems.

The condition of the entire building is assessed using the Building Performance Indicator (BPI), which is composed of the weighted average of the scores given to the various building systems. The weight of each system in the BPI is derived from its respective value in the Life Cycle Costs of the particular type of building.

The BPI provides a Key Performance Indicator (KPI) for the assessment of the performance of hospital buildings and serves as benchmarking measure for setting the priority of building-systems in the allocation of resources (financial, labour, and materials). It enables the determination of priorities based upon the performance of the entire building, and on the performance of each system in the building.

Some other most widely-cited methods for maintenance prioritization of buildings were identified and reviewed by Shen et al. (1994, 1997, 1998, 1998a, 1999 and 1999a):

Roué's formula system

Roué (1986) introduced the following formula:

$$Ip = a\,[\,(b*c*d) + 100*e + 10*f\,]$$

Where a, b, c, d, e, f are criteria used, they are as follows:

a – likelihood of failure

b – importance of departments

c – effect of failure

d – ability to response

e – safety

f – long-term effects

The method was implemented in one health authority for two years and was one of the very early models for the prioritization of building maintenance. It identified some critical factors (such as safety and effect of failure) in the priority-setting process and it introduced the concept of a priority index. However, the formula itself seems to be too rigid for maintenance managers to adopt and the coefficients are too subjective and artificial to be accepted by the practitioners.

Priority category matrix

The priority category matrix is used in the PROMIS system – a management information system for property maintenance developed by WPE Systems Ltd in the

UK – to facilitate the setting of maintenance priorities. The priorities of works are expressed in terms of the year and quarter when the maintenance action should be taken. Four factors are taken into consideration in this method, i.e. physical condition, property status, user effect, and fabric effect. A score of 1, 2, or 3 can be allocated to a maintenance item in respect of each factor, to reflect the importance of the item.

The method does not has the flexibility to take other major factors into account. It is also difficult for users to apply since it is not clear how the weightings for the four factors should be assigned. It also seems to be artificial to assign the time for maintenance work to be undertaken, which does not take into account the available resources.

Point Accumulation System

This method was originally used by local authorities in allocation limited council houses to large number of applicants. By setting up a number of criteria and a mechanism for calculating the points an applicant deserves, the position of an applicant in the waiting list can be determined. In theory, a similar method can be used in prioritizing maintenance works. Suppose three criteria are used:

(i) physical condition;

(ii) importance of usage; and

(iii) effects on users.

The range of points given to each item in respect of a criterion will depend on the relative importance of the criterion. The total points of a maintenance work will be the sum of the individual points given to it in respect of each criterion selected. If a job is deferred for a year, a further two points can be given.

There are two potential problems associated with this method. First it is difficult to determine the range of pointes for each criterion to reflect its relative importance. Second, even if the ranges are determined, it will be very difficult for surveyors to distinguish between scale 15 and 16 in a range from 1-20 unless detailed guidelines can be produced which may well prove to be too cumbersome.

The multi-attribute approach

The application of the multi-attribute utility theory in priority setting was introduced by Spedding et al. at the University of West of England in 1993.

According to Spedding *et al*. (1994), building matinenance managers normally consider a number of factors before making priority-related maintenance decisions. Six factors, including technical, political, financial, social, economic and legal were introduced (Figure 2.7).

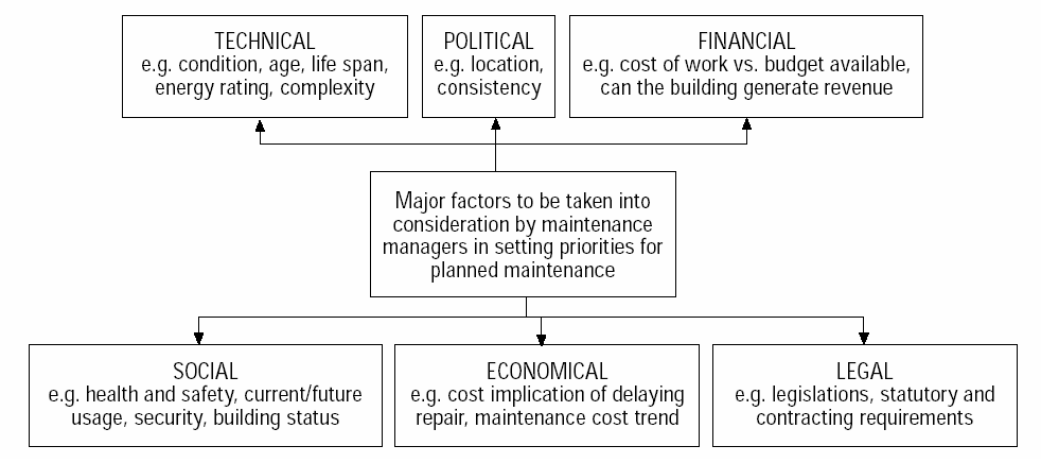

Figure 2.7 Major factors to be considered in planned maintenance prioritization (Source: Spedding A., Holmes R. and Shen Q.P. (1994). "Prioritizing major items of maintenance in large organizations", *RICS Research Conference "A Focus for Building Surveying Research"*, University of Salford, UK, pp.123-131.)

Within this framework, criteria used for priority setting will be ranked according to their relative importance, and weighting will subsequently be assigned to each criterion. All maintenance works identified during condition survey or inspection will be measured and a score will be given in respect of each criterion selected earlier. Suppose n criteria C_1, C_2, …, C_p, …C_n are used in the prioritization process, their relative weights are W_1, W_2, …, W_p, …, W_n and work j was scored S_{j1}, S_{j2}, …, S_{jp}, …, S_{jn} against criteria C_1, C_2, …, C_p, …, C_n. The overall priority index for job j can then be calculated by using the following formula:

$$S_j = S_{j1}*W_1 + S_{j2}*W_2 + \ldots + S_{jp}*W_p + \ldots + S_{jn}*W_n$$

Six major criteria have been identified by Spedding (1994) for evaluation of maintenance tasks. The criteria are:

(i) Building Status (BS): The relative importance of the building (where the defective element is examined) compared with others, in terms of function, current and intended future usage, e.g. an infant school might have a higher status than a leisure building

(ii) Physical Condition (PC): The physical condition of the defective element being examined and its possibility of breakdown or failure, e.g. elements in very bad conditions would be given higher priorities than those in fair conditions.

(iii) Importance of Usage (IU): The importance of the functional unit (in relation to other units within the same building) where the defects are situated, e.g. the reception area would be more important than storage rooms

(iv) Effects on Users (EU): The effects of breakdown or failure of the defective element(s) on the occupants and users of the building (including staff and member of the public), e.g. a problem relating to health and safety would be more important than an aesthetic problem

(v) Cost Implication (CI): The cost implication of breakdown or failure of the defected element(s) on maintaining the overall condition of the building fabric and building services, e.g. a defective roof would be given a high priority because if it is not repaired promptly, the eventual cost will be higher due to possible damages to other building elements

(vi) Effects on Service Provision (ESP): The cost implication of breakdown or failure of the defected element(s) on the provision of services for which the building is designed and used.

In addition to the standard criteria listed above, the method also takes into account some special criteria, such as legal requirements, special maintenance policies, and pressures created from day-to-day maintenance. These special criteria can override the standard criteria.

The above framework was presented to participating organizations, and their comments were taken into consideration in the modification of the framework. For example, to ascertain which factors contribute primarily to the weighting of a criterion in priority setting, discussions were held with chief surveyors and other senior members of staff regarding their views on the weightings. The model has also been tested with real data in the existing maintenance programme and backlog in British local authorities. The test indicated that by using the framework, it was possible to rearrange various maintenance items in descending order of priority and to substantially match the final decisions made by the authority. The validity of the criteria were also supported by maintenance managers in many organizations and the weightings applied during the test reflect the average scores of the corresponding criteria obtained from a survey of more than 40 local authorities.

The multi-attribute method combines the good pointes of the above methods and provides maintenance managers with a powerful, yet flexible, tool in reducing subjectivity and justifying maintenance decisions. It provides a framework that takes

into account major factors commonly used by maintenance managers, and allows them to modify the factors without destroying the reliability of the method. However, one of the major limitations of the method was that there is no appropriate framework for assigning weightings for the selected criteria.

The modified multi-attribute approach using AHP

The modified multi-attribute approach for maintenance prioritization was developed by Shen et al. at the Hong Kong Polytechnic University in 1997. It is based on the above multi-attribute prioritization model. The main addition to the original method is to decide the weightings of each criterion in the multi-attribute prioritization model with a more accurate and quantitative method – the Analytic Hierarchy Process (AHP), which can make the model more scientific and objective.

The AHP was developed by Thomas L. Saaty in the early 1970s to help individuals and groups deal with multi-criteria decision problems. By incorporating both subjective and objective data into a logical hierarchy framework, AHP provides decision makers with an intuitive and common-sense approach to evaluate the importance of every element of a decision through a pair-wise comparison process. AHP is best suited for a multi-criteria problem in which accurate quantification of the impact of the alternatives on the decision-making problem is not possible. Hence, it is ideal for assigning weighting to criteria in the maintenance priority-setting problem.

This modified model for maintenance prioritization has been tested in the real practices of maintenance in one of the major public departments responsible for

building maintenance management in Hong Kong: the ArchSD. It was implemented in the planned maintenance of educational buildings maintained by the Property Services Branch of the ArchSD. The test indicated that by using the framework it was possible to speed up the priority setting process with increased transparency and reduced subjectivity. It also showed that weightings for the selected criteria can be more scientifically assigned.

The modified multi-attribute method using AHP overcomes the problem in the MA method by incorporating AHP into the multi-attribute method, a set of weightings can be more accurately assigned to the selected maintenance criteria, which will greatly affect the accuracy of the priorities for the maintenance items. The approach also improves clients' and/or end-users' satisfaction through improved transparency in the prioritization process and their increasing awareness and participation in the process.

Chapter 3 The Hong Kong Hospital Authority

In this chapter, some general background information and the structure of the Hong Kong Hospital Authority will be provided. The facility management (FM) structure in HA will then be introduced. Current planning and management of maintenance and improvement works will also be reviewed. In addition, details about the Kowloon West Cluster of the Hong Kong Hospital Authority will be given. These are all important as they provide insights in establishing the framework of the study.

3.1 Background

The Hospital Authority (HA) is a statutory body established in 1990 under the Hospital Authority Ordinance with the aim of taking over the management responsibility of all the ex-government hospitals (schedule I hospital) and ex-subvented hospitals (schedule II hospital), to improve the overall operational efficiency. It is an independent organization which is accountable to the Government through the Secretary for Health and Welfare, who is responsible for the formulation of health policies and monitoring the performance of the Authority.

HA is responsible for delivering a comprehensive range of hospital, specialist outpatient and community-based services through its network of healthcare facilities. It currently manages a Head Office, 43 public hospitals / institutions, 45 specialist outpatient clinics and 74 general outpatient clinics (with the transfer of the management of 59 General Outpatient Clinics from Department of Health in 2003). The total GFA occupied amounts to over 2,300,000 sq. meters. As at 31 December

2004, the Authority managed a total of 28,410 hospital beds which represented around 4.0 public hospital beds per 1,000 population. It employs about 52,000 staff (full time equivalents as at 31 December 2004). For 2004/2005, the Authority's recurrent expenditure budget from Government, net of income, is HK$27,801 million.

3.2 The Cluster-based Structure

Services of the Hospital Authority are provided to the public under a cluster-based structure since 1993 with the establishment of eight hospital clusters. In mid 2001, a new cluster management structure was implemented in phases to facilitate the further streamlining and rationalisation of services within a hospital cluster. Together with the adoption of a population-based resource allocation system, such organizational evolution aims to promote inter-hospital cooperation within geographical areas and improve organizational effectiveness through resource sharing. It is believed that benefits will be achieved through sharing of clinical expertise, supporting resources and other related hospital facilities etc.

In 2002/03, a full scale comprehensive cluster management structure to all cluster upon the appointment of Cluster Chief Executives, with the accountability of total resources allocation, entrusted for services rationalization among hospitals (Chan, 2003). Figure 3.1 shows the Executive Structure of the Hospital Authority with the Head Office and the seven mega-clusters.

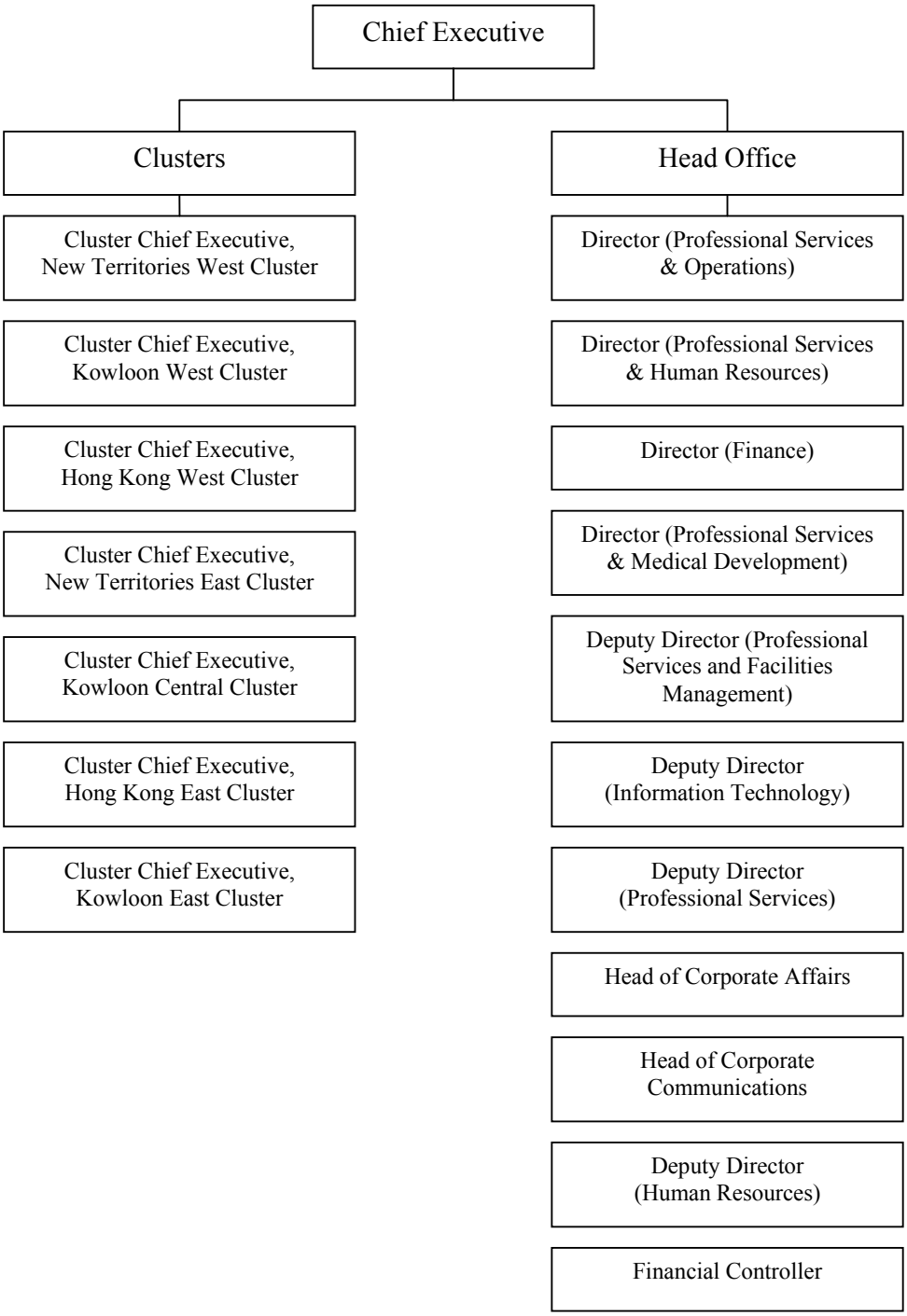

Figure 3.1 Executive Structure of the Hospital Authority 2005 (Source: The Hong Kong Hospital Authority (2005). *HA in focus 2005*, Hong Kong.)

Power is delegated to the seven clusters under the clustering structure. The Cluster Chief Executive (CCE) has the power to make decisions in his/her own cluster. As a result, each cluster can be regarded as a sub-organization within the Hospital Authority.

3.3 Impacts of Clustering on Facility Management (FM)

Similar to other healthcare facilities (as mentioned in Chapter 2.5.3), facility management (FM) plays a very important role in the Hospital Authority. It covers a wide range of areas, including strategic facility planning, maintenance management, performance management, space management, building operation management, procurement etc.

Since the appointment of Cluster Chief Executives (CCEs) in 2002/03, most clusters have started to develop cluster-based management of key functional areas including FM. This has been leading to the devolving of the monitoring and cost control functions previously exercised by Capital Works Department (CWD) under the Professional Services and Facilities Management Division of Head Office to the clusters, and in time to other functions such as tendering and term contracts (Capital Works / Business Support Services Policy Group, 2004). Thus, FM in HA can be viewed from three levels, i.e. Head Office level (CWD), cluster level and also hospital level.

The Head Office level can be regarded as the strategic level. With the gradual transfer of routine project monitoring and financial control functions to the cluster level, CWD

concentrates on developing procedures, setting standards, formulating policies and providing guidance in "toolkit" form to help clusters take up these new responsibilities. It also provides support to Head Office and all clusters in all aspects of project delivery, actively managing major projects and coordinating funds for minor improvement and maintenance works (HA Annual Report 2004/05)

Cluster and hospital levels can be regarded as implementation levels. Apart from the above mentioned monitoring and financial control functions, the cluster level also plays an important role in resources allocation since budgets are allocated from the Head Office on a cluster basis, which are then further distributed to hospitals by clusters.

3.4 Maintenance Planning and Management

3.4.1 Planning of Maintenance and Improvement Works

Owing to limited resources, minor works (include improvement works to all hospitals and planned maintenance works to Schedule I hospitals costing less than HK$15 million) have to be prioritized on a need basis. An obligatory 3-year planning process for minor works requires hospitals to maintain and up-date quarterly a comprehensive 3-year rolling plan for all improvement, maintenance and engineering equipment replacement projects. Year one projects should be high priority bids for current year funding, year two projects are also relatively urgent and year three projects are merely wish-list items.

A system of classifying the minor works in the 3-year plans has been established which comprises 3 categories corresponding to years one to three described above. Category A are projects with feasibility study completed, propose plans available and approval to go ahead. Category B are projects of high priority, approved in principle for detailed planning work and feasibility study to be proceeded before funds earmarked. Category C projects are wish-list items with only conceptual plans available.

For improvement works, item by item approval is required from the Permanent Secretary for Health, Welfare and Food. The indicative funds available (derived from the current commitment and expected amount of the vote) are allocated on a cluster basis proportional to the adjusted population served. For maintenance works, the notional budget for each cluster is based on age-adjusted gross floor area (GFA).

3.4.2 Management of Maintenance and Improvement Works

The Capital Works Department (CWD) develops procedures, standards and strategies for the management of maintenance and improvement works and provides technical support to hospitals in respect of these works. It is not resourced to provide 'hands-on' technical services, but coordinates the works of all works agents including the Architectural Services Department (ArchSD) and Electrical and Mechanical Services Department (EMSD) of the Government, private architects and consulting firms and private works contractors.

ArchSD has gradually withdrawn from providing planned maintenance of Schedule I hospitals and is now only assisting some hospitals with routine (day-to-day) maintenance works. EMSD has been appointed to handle routine maintenance works in three clusters (Hong Kong West, Hong Kong East and Kowloon West) and routine maintenance in other clusters is handled by the HA Term Contract System.

The majority of the maintenance and improvement works in hospitals are executed under the HA Term Contract for Minor Works (HA-TMC) system which comprises a Term Maintenance Surveyor, appointed to undertake design work, statutory submissions and site supervision, a Term Quantity Surveyor for cost estimation, control and certification of payments and a Term Works Contractors for construction services.

For minor works with value up to HK$100,000, hospitals may select their own execution method but they are encouraged to use HA-TMC for reasons of quality control, insurance cover and better management of the works.

3.5 Impacts of Clustering on Maintenance Prioritization

Under the cluster-based structure, power to make decisions relating to maintenance and improvement works within the cluster is fully delegated to individual CCE, who is usually assisted by the cluster FM team in determining the priorities for the cluster and also the allocation of funds. As a result, the priorities of maintenance and improvement items set by individual hospital FM teams will be submitted to cluster

for bids. The cluster team will further prioritize all the items submitted by different cluster hospitals to determine the allocation of budgets for the works.

Under normal circumstances, the Head Office will not intervene the priorities of works in the clusters unless public safety is endangered or the operational requirements cannot be met. The role of the Capital Works Department of the Head Office is mainly to provide technical support to the works.

3.6 The Kowloon West Cluster (KWC)

As FM in the Hospital Authority is carried out on a cluster basis, it is necessary to look into the cluster in order to understand how the system actually works. The Kowloon West Cluster – the largest cluster under the Hospital Authority – is chosen for such illustration purposes.

3.6.1 Background

The Kowloon West Cluster is the largest cluster under the Authority. It comprises seven public hospitals (4 acute hospitals, 2 convalescence hospitals and one psychiatric hospital). Within this cluster, the distribution of schedule I and II hospitals in terms of sizes and resources are basically comparable. Schedule I hospitals are Princess Margaret Hospital and Kwai Chung Hospital. Schedule II hospitals include Kwong Wah Hospital, Caritas Medical Centre, Our Lady of Maryknoll Hospital, Wong Tai Sin Hospital and Yan Chai Hospital. It serves a population of over 1.8 million in Wong Tai Sin, Mona Kok, Shamshuipo, Kwai Chung, Tsing Yi, Tsuen

Wan and Tung Chung districts with over 7900 beds and armed with over 12450 staff of total expenditure over HK$6.7 billion per year (Chan, 2003).

3.6.2 Cluster Facility Management (FM)

In line with the corporate direction of clustering development, Cluster Facility Management office was set up in 2002 at Kwong Wah Hospital to promulgate the standardization of professional services based on a common platform (Chan, 2003). It is one of the departments under the branch of Administrative Services in the Cluster (Figure 5.1). The cluster FM team is composed of a general manager and seven hospital managers from member hospitals under the cluster. Each of the representatives is responsible for an area of work, including project management, safety management, cashflows, maintenance prioritization, facility performance management and environmental protection issues.

While the facility maintenance of schedule I hospital are fully undertaken by maintenance services government agent, EMSD, with a comprehensive service level agreement for planned and corrective works, the schedule II hospitals are largely performed by in-house technical teams with a small percentage of work outsourced to contractors (Chan, 2003).

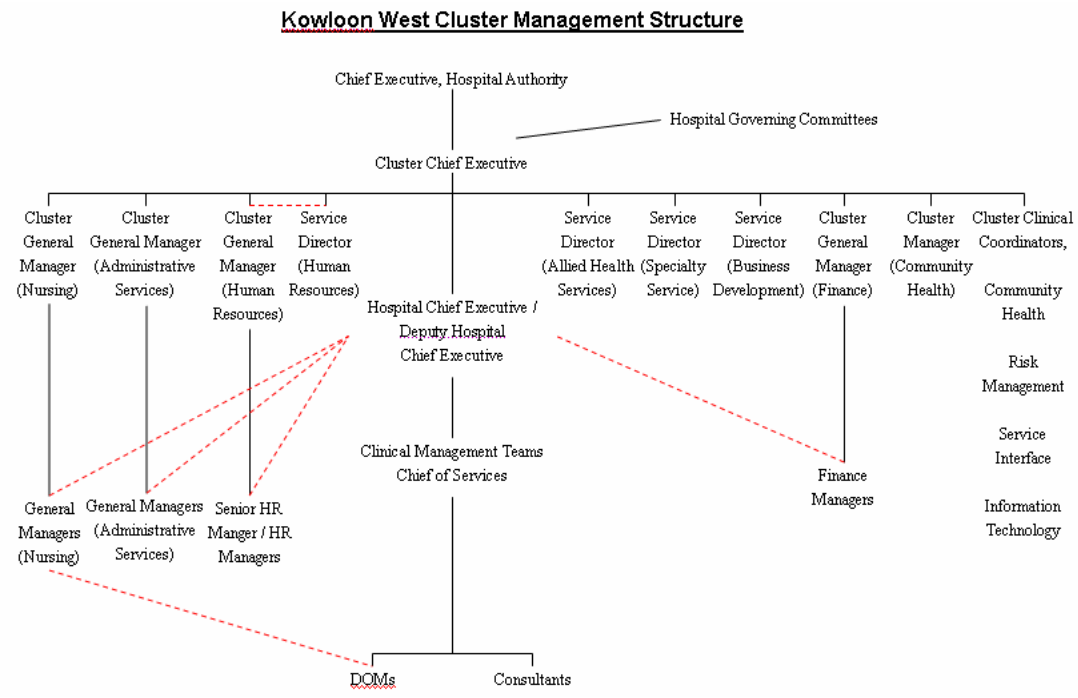

Figure 3.2 Management structure (as at 1st Dec 2005) of the Kowloon West Cluster, Hospital Authority

To ensure the quality FM services delivered to the users, cluster hospitals have implemented the following systematic mechanisms to manage their daily facility planning and maintenance services:

- Quality management systems of ISO 9000, ISO 14001 and OSHAS 18001;
- Computerized Maintenance Management System managed by the Central Helpline at Kwong Wah Hospital and Princess Margaret Hospital as "one-stop-shop" for planned and corrective maintenance for other hospitals within the mega cluster;
- Central Control and Monitoring System with web-based assessment for management of system performance;

- Integrated telecommunication system with DECT phone to capture all real-time information and alert for prompt maintenance services.
- Facility Project Management System for management of cash flow and project progress with the introduction and emphasis on the correlation of the parameters with the ability of sending early alarm for remedy if there is any apparent project delay.
- Energy Performance Contracting for achieving guaranteed energy saving, a well-defined, risk-averse application of integrated heat pumps, heat exchangers and chillers optimization and integration in an innovative features

3.6.3 Facility Maintenance and Improvement

KWC is the cluster serving the largest population size. Apart from being the cluster with the largest built up area (with GFA over 500,000 sq meters), it is also the one with the largest number of old buildings. According to the Cluster Facility Audit carried out in 2003, a total of 65 building blocks were located in the cluster[1], with an average building age of around 28 years. As a result, it is the cluster getting most maintenance and improvement funding allocated under the guiding principle of age adjusted gross floor area and population-based funding respectively.

The total project sum in hand per year within this cluster is over HK$80 millions. However, faced with the budgetary constraints of the health care sector, the reinstatement value calculated with reference to several newly established projects,

[1] Details of the Audit are summarized in Appendix I of this dissertation for reference.

the actual annual maintenance budget barely amounted to 2 per cent of the reinstatement value which is appeared marginally below the norm (Chan, 2003).

3.6.4 Current Prioritization Practice for Maintenance and Improvement Works

Priorities of works are first decided by the FM team of individual hospitals and then submitted to the cluster team for bids.

Prioritization in Schedule I Hospitals

In all Schedule I hospitals under the KWC, EMSD is appointed as the maintenance agent for all the maintenance and improvement works. Based on the records in the FPMS (refer to Chapter 2.7.1 for details); information and advice provided by EMSD and also the professional consultants, priorities of works are set by the Hospital Administrators (Facilities Management) and submitted to the cluster team for bids.

Prioritization in Schedule II Hospitals

Unlike Schedule I hospitals, there are in-house teams in Schedule II hospitals to manage all the hospital facilities. Priorities for maintenance and improvement works are set based on the scores in the FPMS; information from inspections and records done by the technical staff in the team.

Prioritization in the Cluster Team

The cluster team considers all work items from different hospitals as a whole to decide how funds are to be allocated. Through reviewing scores in the FPMS, on-site inspections and discussions with hospital representatives, a ‘cluster priority’ will be determined and funds are allocated to hospitals accordingly.

Chapter 4 Hypothesis and Methodology

In this chapter, hypothesis will be set as basis of testing in this study. A detailed account of the proposition will be given. The method adopted in collecting and analyzing the data will also be specified.

4.1 Recapitulation of Literature Review

The literature review together with the investigation on the Hospital Authority established important theoretical fundamentals for this study. It revealed that maintenance management is an important but complicated issue in the context of healthcare FM and that prioritization in planned maintenance is always indispensable due to the budget constraint Reviews of previous researches on the existing prioritization methods suggested that the factors and weightings adopted in the prioritization would be of paramount importance no matter which method is adopted. This provides a ground for studying the views of the FM managers on the factors before a suitable prioritization model can be proposed. In addition, the implications of the "triple layer" maintenance management structure in the Hospital Authority on the prioritization of works in public hospitals is another important issue from the resources allocation point of view.

4.2 Hypothesis

Based on the literature review, it is found that the maintenance management structure in Hospital Authority is a subject worth examining. In addition, the "central

prioritization" mechanism for maintenance and improvement works on a cluster basis is also an interesting area to be studied.

As decisions related to maintenance and improvement works are solely determined within the cluster, only the views of the cluster teams and the hospital teams are relevant in considering maintenance prioritization issues for hospitals. Views of the Head Office are not included in this study.

The cluster FM team is responsible for the resources allocation for maintenance and improvement works among the cluster hospitals whilst the implementation of the works is left to hospital teams.

Due to the different roles played by the teams in the hierarchy, it is therefore reasonable to deduce that the importance of considerations taken into account for prioritizing maintenance items by the cluster FM team will be different from those considered by hospitals. The cluster team, which is responsible for allocating resources, will try to balance all factors and the interests of all the hospitals of the cluster during the prioritization process. The hospital team, which is responsible for implementation of works in its own hospital, may focus more the aspect of service provision during the prioritization process.

However, the author believed that such differences will exist only in certain areas of considerations. It is anticipated that heavy weightings would be given to some factors, such as "statutory requirements" and "operational impacts", no matter which level the

facility managers come from. As a result, the following hypothesis is proposed in this research:

"There will be significant differences between the views of the cluster FM team and that of the hospital FM teams in terms of resources and financial considerations in the prioritization of maintenance and improvement works."

4.3 Methodology

The research was qualitative, studying in detail the views of the facility mangers at different levels of the hierarchy in the Hospital Authority using a case study approach.

Due to the cluster-based structure of the Hospital Authority, a qualitative case study analysis is considered to be the most suitable approach for this research. It cannot be denied that the most ideal case would be getting the involvement of all the facility managers in the Hospitals Authority to take part in the research so as to get the most representing results by using a quantitative analysis. However, due to the specific background and structure of each cluster, it is simply not possible to gather all the information and carry out a detailed analysis with the limited time and resources available for this research.

Although all the public hospitals are managed by the Hospital Authority, powers are delegated to Chief Cluster Executives to make decisions for their own cluster. As a result, different clusters may have different approaches to make decisions regarding how resources are to be allocated among cluster hospitals. In order to have a detailed

description regarding the background of the cluster for analyzing purposes, one cluster is chosen for investigation for the purpose of this study.

In choosing the cluster for the case study, the facility management structure within the cluster is considered as one of the important criteria as the study aims at examining the views of different levels in the hierarchy. The Kowloon West Cluster – the cluster with a well-established cluster FM team - is therefore chosen as the case study for investigation. Apart from its well-established FM structure, it is also the largest cluster under the Hospital Authority, in terms of both the age adjusted GFA and the serving population size. It is also the cluster getting the largest share of funding for maintenance and improvement works (see Chapter 3.6 for details).

4.3.1 Data Collection

With the purpose of examining the views of the facility managers in the case study chosen, the method of conducting face-to-face interviews is adopted as the principal method to obtain relevant information and data for this dissertation. There are two major reasons for choosing face-to-face interview study instead of a postal questionnaire survey:

(i) Direct contact with interviewees through verbal interactions allows further follow-up questions and explanation of the interview questions. Also, direct responses could be obtained. These allowed more detailed information and in-depth comments be obtained for analysis when compared with a postal survey.

(ii) Face-to-face interview offers a higher degree of flexibility since adjustment of questions according to different situations is allowed. This contributes to a better understanding of the reasons supporting the facility managers' views.

Structure and Content of Interviews

Semi-structured interviews were carried out face-to-face with interviewees. It involves asking and obtaining answers to questions. The interviews consisted of two parts. In the first part, interviewees were asked to rank various factors being considered in the maintenance prioritization process according to their importance.

In choosing the most suitable method to deal with the rankings and weightings of the factors, a number of alternatives have been considered. The process of deriving the ranking of each prioritization criterion can be regarded as a multi-criteria decision-making process. According to Lo et al. (2000), there are numerous methods such as the direct point allocation, paired comparison (e.g. Saaty, 1982), multiple regression model, explicit trade-offs (e.g. Keeney-Raiffa, 1993) and equal/unit weighting to synthesize the prioritization process. A comparison of the methods can be found in the article by Schoemaker and Waid (1982).

The simplest way would be allowing the interviewee to rank all the factors, from 1 to 12, or through direct point allocation. However, as the number of factors was not small, it would be rather difficult for the interviewees to give a consistent weighting to all the factors. Therefore, it was doubtful whether simple ranking was practically reliably sound. For this reason, another alternative is adopted.

For the purpose of this study, the AHP developed by Saaty (1982) is considered to be a suitable method in terms of the level of accuracy and complexity of the method. By in corporating both subjective and objective data into a logical hierarchy framework, AHP provides decision makers with an intuition approach to evaluate the importance of every element on a decision through a pairwise comparison process. It is best suited for a multi-criteria problem in which accurate quantification of the impact of the alternatives on the decision-making problem is not possible. (Lo et al., 2000) and has been used in quite a number of researches related to building maintenance prioritization (Shen et al., 1997; 1998; 1998a; 1999 and 1999a) and also pavement maintenance prioritization (Duffuaa, 1999).

The general approach is to structure the complex problem in the form of a hierarchy in at least three levels; namely, the goal, the criteria and the attributes (the alternatives). The process begins by determining the relative importance of the criteria in meeting the goal. Then pairwise comparisons are made between attributes with respect to each criterion to decide the relative importance of one attribute versus another. High accuracy is achieved through redundant relative judgements and also a measure of the inconsistency of judgements. Finally, the results of the two analyses are synthesized to calculate the relative importance of the attributes in meeting the goal (Lo et al., 2000).

In spite of the above reasons supporting the use of AHP in the study, the approach is not adopted since there are only 3 factors under each category in the hierarchy established in this study (see below for details). Generally, only multi-criteria decision-making processes involving more than 5 factors in the same level in a

hierarchy gets the benefits of using AHP as Miller (1956) indicates that humans only have the capacity to deal with around seven (plus or minus two) variables when processing information. As a result, instead of using the pairwise comparison in AHP, interviewees were asked to carefully assign percentage weightings to indicate the relative importance of the factors and categories.

Although the pairwise comparison in AHP is not adopted, the method of the study is in a similar logic of structuring the problem in the form of a hierarchy. The interviewees were then asked to determine the importance of the attributes by assigning percentages with respect to each criterion to decide the relative importance of one attribute versus the other two. Then comparisons are made between the relative importance of the criteria in meeting the goal. Interviewees were first asked to indicate the relative importance of the attributes under each category so that they can get a better understanding and a more general picture of what is included in the categories. This helps to facilitate the comparison between the categories with respect to the goal. Finally, the results of the two analyses are synthesized to calculate the relative importance of the attributes in meeting the goal.

In setting up the hierarchy, a hierarchy of three or more levels can be established in which similar attributes are grouped. Each group is then analyzed and the result is used for analysis at the next level in the hierarchy. If too many levels and attributes are to be handled, the data manipulation process will be too complicated. The interviewers as well as the interviewees will be exhausted and the quality of the information collected will be affected (Lo et al., 2000). Therefore, a three-layer hierarchy is adopted in this study.

Based on previous researches in the literature review, all the factors which were usually considered during maintenance prioritization were identified. Also, similar factors were grouped under different categories. Table 4.1 summarizes all the factors identified[2].

In the second part, follow-up questions were asked to get further descriptions and explanations regarding their views. This part of the interview helps to increase the comprehensiveness and reliability of the data obtained from interviews. In addition, it may also create opportunities to probe the responses of interviewees by asking supplementary questions so as to obtain more details and pursue new aspects.

[2] A copy of the questionnaire requiring interviewees to assign weightings is compiled in Appendix II of this dissertation for reference.

Goal: Setting maintenance, replacement and improvement priorities

CATEGORY	FACTORS	
1. Social	1.1	Effects on users - health and safety, comfort, security, convenience etc.
	1.2	Environmental issues - impacts on the environment
	1.3	Operational impacts – risks to clinical services and public relations due to defect and in case of failure, e.g. importance of the building (in terms of function and use rate), importance of the functional unit with defects, etc.
2. Regulatory	2.1	Statutory requirements – e.g. Buildings Ordinance, environmental legislations etc.
	2.2	Internal regulations and policies
	2.3	Trade practices - informal 'rules' in practice
3. Technical	3.1	Physical conditions - e.g. age, useful time left, appearance etc.
	3.2	Functionality - e.g. system performance, service availability, possibility of breakdown etc.
	3.3	Resources availability - e.g. spares availability, manpower, delivery time etc.
4. Financial	4.1	Direct cost - cost of work (initial cost) vs budget available
	4.2	Indirect cost - cost implications, e.g. extra costs due to delaying repair and in case of failure etc.
	4.3	Revenue generating capability

Table 4.1 Categories and factors to be considered when setting maintenance, replacement and improvement work priorities in hospital buildings

Interviewees

Face to face interviews were carried out with three facility managers in the Kowloon West Cluster. All the three interviewees are in charge of the maintenance and improvement works prioritization in their teams. Each of the interviewees is the one who involves most in the prioritization process and has the ultimate decision making

power in the team. Also, each of the interviewees from the hospitals has been working on prioritization in the team for over 8 years. They are very experienced and familiar with the prioritization in their teams. As a result, it is believed that they represent the views of the cluster team, a Schedule I (ex-government) hospital and a Schedule II (ex-subvented) hospital in the case study respectively. It was made clear at the beginning of the interview that their views are to represent the views of their teams rather than their personal views so as to ensure that a reliable conclusion can be drawn.

Before the cluster FM team was established in 2002, all the planned maintenance works in Schedule I hospitals were executed by ASD (now EMSD) which was appointed as the maintenance agent. In addition, funding for these works also came from ASD before 2000. Improvement works were executed by external consultants and funding for these works was obtained through a bidding system for the government fund. There were no in-house professionals to deal with the FM matters; only a Hospital Administrator (FM) was appointed in each hospital. On the other side, Schedule II hospitals had its own in-house team to deal with all the maintenance and improvement works. As a result, the personnel responsible for FM matters in the hospitals were usually building professional such as Building Surveyors or Building Services Engineers. The funding for all the works, no matter whether it was maintenance or improvement, had to be obtained through the bidding system for government fund. Although the fund allocation under the present clustering system has been unified for both types of hospitals, the author believes that the differences in their historical backgrounds may constitute to potential differences in views towards

maintenance prioritization. As a result, facility managers in Schedule I and Schedule II hospitals were both interviewed.

Limitations

Although direct interview with facility managers representing the views of teams at different levels of hierarchy is chosen as the method to obtain information for the dissertation, the limitations of this method should be addressed. The number of successful interviews could be done is far less than the number of postal questionnaire survey due to time and resources limitations. Also, only the facility manager in charge of the maintenance prioritization process instead of all those involved in the team was interviewed. Although they were clearly asked to indicate their views on behalf of teams at that hierarchy, there are still chances for potential personal bias to be included, which may lead to a less representing result.

4.3.2 Data Analysis

As it is anticipated that some of the interviewees' opinions will overlap with those of the others, the findings of the research will be analyzed based on factors under different categories so that similar opinions and ideas from different interviewees can be grouped. Differences can also be easily identified to facilitate conclusion drawing.

In fact, the qualitative analysis adopted in the study consists of three con-current flows of activity: data reduction, data display, and conclusion drawing or verification (Miles and Huberman, 1994).

Data Reduction

Data reduction refers to the processes of selection, focusing, simplifying, abstracting and transforming the data that appear in written-up field notes or transcriptions. It is a form of analysis that sharpens, sorts, focus, discards and organizes data in such a way that final conclusion can be drawn and verified (Miles and Huberman, 1994). In this study, qualitative data gathered from different interviewees will be reduced and transformed through selection, summary, paraphrase for further analysis.

Data Display

Data display is an organized, compressed assembly of information that permits conclusion drawing and action. The display may include many types of matrices, graphs, charts and networks. They are designed to assemble organized information into an immediately accessible, compact form so that the analyst can see what is happening and either draw justified conclusion or move on to the next step of analysis the display suggests may be useful (Miles and Huberman, 1994). Processed qualitative data in this study will be displayed mainly in the form texts.

Conclusion Drawing

It is important for the qualitative analyst to decide what things mean, e.g. regularities, causal flows, and propositions (Miles and Huberman, 1994). Conclusion will be drawn from the views of interviewees to test the hypothesis.

Chapter 5 A Case Study of The Kowloon West Cluster

In this chapter, the research findings will then be discussed to test the hypothesis. Also, implications of the findings will be included.

5.1 Views on Factors affecting Maintenance Prioritization[3]

5.1.1 Social Considerations

All the three interviewees regarded "Effects on users" and "Operational impacts" as equally important whilst the remaining factor "Environmental issues" as comparatively less important. Identical weightings were assigned to the factors under this category.

Operational Impacts

All the three interviewees thought that defects affecting service provision in hospitals should be given higher priorities due to the special nature of the services provided by hospitals. Unlike other premises, not only the quality of services provided would be affected, instead, it may be a matter of life and death in cases which prompt services cannot be delivered to patients due to defects in the facilities. An example given by the interviewee from the cluster team was that defects located in the operating theatre which affect the performance of surgeries would be accorded very high priorities.

[3] Weightings assigned to different factors and categories by the interviewees are compiled in Appendix III of this dissertation for reference.

Interviewees from both hospitals emphasized that the role of hospital FM teams is to ensure proper support to clinical services in the hospital in terms of facilities. It is therefore very important to avoid any disturbance to the operation in the hospital. In fact, close connection with clinical staff has to be made so as to gather feedbacks and opinions concerning the operational impacts of the items.

Interviewee from the cluster pointed out that it is the cluster FM team's responsibility to ensure smooth operation in all the cluster hospitals. It was stressed that failure in providing proper services due to facility problems in any one of the hospitals is not acceptable. As a result, the impacts brought about by the items to be prioritized in different hospitals should be carefully assessed and weighted before a decision is made.

Effects on Users

Defects which endanger the health and safety of the users should also be placed on higher positions in the priority list. In fact, all the three interviewees stressed that these issues do not only apply to users, but also to the general public. Interviewee form the cluster team gave an example of the unsafe structure on the external façade of the hospital buildings.

However, interviewees from both hospitals admitted that it is sometimes difficult for them to cater the needs of all users since quite a number of groups of users are involved in hospital buildings, e.g. patients, doctors, nurses and other non-clinical staff. On one hand, different groups have different needs and requirements. On the

other hand, resources available are always limited. As a result, complaints were sometimes found.

Similar to the case in operational impacts, interviewee from the cluster stressed that it is important to ensure safety in all the cluster hospital buildings. As a result, higher priorities will be accorded to items related to health and safety issues when compared to those related to comfort and convenience.

Environmental Impacts

Compared to the impacts on users and service provision, the impacts of the defect on the environment were weighted as a less important factor to be considered during the prioritization process. The interviewees admitted that although environmental issues should be taken into considerations during the prioritization process with increasing concern on environmentally friendly practices, priorities will definitely be given to those which create impacts on services and users in the hospitals.

Summary

Table 5.1 summarizes the views of the interviewees regarding the "social" factors:

	Cluster	Schedule I	Schedule II
Operational impacts	♦ Important to ensure smooth operation in all cluster hospitals	♦ Important to ensure proper support to clinical services in the hospital in terms of facilities	
Effects on users	♦ Essential to ensure safety of both the users and general public in all cluster hospital buildings	♦ Essential to ensure safety ♦ But resources available are limited to satisfy all the needs of different groups	
Environmental issues	♦ Relatively less important		

Table 5.1 Summary of views with regard to "social" factors

5.1.2 Regulatory Considerations

"Statutory requirements" was the most important factor indicated by all the interviewees whilst "internal regulations and policies" were weighted as the second most important factor under this category. "Trade practice" was regarded as the least important factor. Although, the orders given to the importance of the factors were the same for the three interviewees, the differences in the extent of percentage weightings assigned among factors by different interviewees indicate some potential differences in their views.

Statutory Requirements

All the three interviewees made very clear that all relevant statutory requirements must be fulfilled. Relevant legislations, such as the Buildings Ordinance, must be considered in setting maintenance and improvement works priorities. All of them thought that maintenance and/or improvement works for the purpose of fulfilling the statutory requirements should be given highest priorities. It was also pointed out that under normal circumstance, maintenance works for such purpose will usually contain some sort of improvement. In other words, works more than the statutory standards will be carried out.

Internal Regulations and Policies

The interviewees also agreed that internal regulations and policies, though not as important as statutory ones, should be fulfilled under necessary conditions. However, differences seem to exist between the views of the cluster and hospitals in terms of the extent of the difference in weightings assigned regarding the importance of the two factors. The relative weightings of "statutory requirements" to "internal regulations and policies" indicated that interviewees from both hospitals thought that the former was far more important than the latter when compared to the view of the cluster team.

Interviewees from both hospitals thought that the importance of this factor is far lower than that of statutory requirements. They revealed that there were in fact not many very stringent and prescriptive internal controls to follow. The regulations provide them with rooms to make discretion depending on the situations of the cases. As long

as the basic requirements are satisfied, which are usually not difficult to achieve, priorities can be determined based on other more important criteria.

The perspective of the interviewee from the cluster team is somewhat different. It was pointed out that due to the special function of the cluster FM team, internal regulations and policies have to be taken into account during prioritization. The cluster FM team acts as an intermediary between the Capital Works Department of the Head Office and the hospital FM teams (refer to Chapter 3.3 for details). It directly reports to the CWD regarding the situations in all the cluster hospitals and, at the same time, communicates with hospitals concerning the instructions and policies of CWD. In other words, the cluster team is responsible for ensuring that regulations and policies from CWD are properly followed and implemented by hospitals. Apart from that, the cluster team's role in allocating resources further helps to ensure proper implementation of the internal policies. As a result, the factor is in fact quite important from the cluster team's perspective.

Trade Practices

Difference in extent of relative importance was also found in the case of "trade practices" although all three interviewees agreed that it was the least important consideration under this category. The relative weighting of "trade practices" to the other two factors under this category by interviewee from Schedule I hospital was much lower when compared views of the Schedule II hospital and the cluster team.

According to the views of both interviewees from the cluster team and the Schedule II hospital, "trade practices" should be followed if the conditions allow. As building professionals, they thought that those long-established informal "rules" in the industry reflect certain "local standards". Although following these practices may not always fulfill the requirements in all cases, taking those into consideration during the prioritization would still be useful.

Interviewee from the Schedule I hospital admitted that she was not that familiar with the trade practices in the industry since she was not a building professional (refer to Chapter 4.3.1 for details). Therefore, not much consideration has been placed to this factor during prioritization unless she was advised by the maintenance agent, i.e. the EMSD, or the term consultants.

Summary

Table 5.2 summarizes the views of the interviewees regarding the "regulatory" factors:

	Cluster	Schedule I	Schedule II
Statutory requirements	♦ All relevant statutory requirements must be fulfilled		
Internal regulations and policies	♦ Not as important as statutory requirements ♦ But still quite significant ♦ To ensure regulations and policies from CWD are properly followed and implemented by hospitals	♦ Far less important than statutory ones ♦ Not difficult to follow as the rules are not very prescriptive ♦ Discretions allowed	
Trade practices	♦ Least important ♦ But should still be followed if circumstances allow ♦ Long-established informal rules reflecting some 'local standards'	♦ Not much considerations unless advised by maintenance agent and consultants	♦ Similar to the view of the cluster team

Table 5.2 Summary of views with regard to "regulatory" factors

5.1.3 Technical Considerations

"Functionality" was weighted as the most important factor indicated by all the interviewees whilst "physical condition" was weighted as the second most important factor under this category. "Resource availability" was regarded as the least important factor. Similar to the situation under the previously discussed category, even though the orders given to the importance of the factors were the same for the three interviewees, the differences in the extent of percentage weightings assigned among factors indicate some potential differences in their views.

Functionality

All the three interviewees agreed that highest priorities should be accorded to defective elements or facilities which cannot function properly or with a high possibility of breakdown when compared to the other two aspects under this category. The reason given to support their views was that malfunctioning may affect the normal operation in the hospitals, which again may lead to loss in human lives if the defective facility was located in critical areas, e.g. the Accident and Emergency rooms. Poor performance of the defective facilities may also lead to similar consequences.

Physical Conditions

The interviewees also held a unanimous view that attention should also be paid to the physical conditions of the facilities since they may help to identify the risk of

malfunctioning. One of the examples was to consider the age of the facility with its lifespan.

Physical conditions of facilities and buildings in the Schedule I hospital were considered based on the records and reports prepared by the maintenance agent, i.e. EMSD and also the term consultants. The interviewee revealed that opinions and professional advice from the consultants will be taken into account in the prioritization.

Interviewee from the Schedule II hospital also pointed out the importance of keeping records regarding the physical conditions of the facilities and building status. It is suggested that keeping track on how the facilities perform is essential to achieve the aim of preventive maintenance. As a result, regular inspections by in-house technical staff and proper records are both required.

Interviewee from the cluster team relies on records from the FPMS (refer to Chapter 2.7.1 for details) and also site inspections to determine the physical conditions of the facilities. The interviewee stressed that the responsibility of conducting detailed survey goes to the hospital FM teams and the cluster's main role is to determine which hospital has a more urgent and genuine need.

Resources Availability

The relative weighting of "resources availability" to the other two factors by the representative from Schedule I hospital is much lower when compared to that of the other two interviewees.

In the Schedule I Hospital, "resource availability" is not a very important concern in the prioritization process due to the appointment of the maintenance agent, i.e. EMSD and also the term consultants in the hospital. They deal with problems related to resources, such as spares and manpower etc., and ensure works are completed and delivered properly on time. As a result, the interviewee, who is responsible only for administration part of the works, revealed that she does not have to worry much about these problems when setting the priorities of works.

In the case of Schedule II hospital, the interviewee is responsible for prioritization, as well as, most of the execution of the works (except those outsourced to term contractors). He therefore needs to take into account the resource issues, such as manpower, spares availability etc., during prioritization to ensure works are properly done on time.

From the perspective of the cluster FM team, in prioritizing the works of all cluster hospitals, "resources availability" is important in facilitating efficient use of resources in the cluster. Interviewee from the cluster team stressed that it is important to ensure adequate resources are available in the hospitals for proper execution of works before they decide the cluster priority and allocate the funds accordingly.

Summary

Table 5.3 summarizes the views of the interviewees regarding the "technical" factors:

	Cluster	Schedule I	Schedule II
Functionality	♦ Highest priorities should be accorded to defective elements or facilities which cannot function properly or with a high possibility of breakdown ♦ Malfunctioning may affect the normal operation in the hospitals		
Physical conditions	♦ Help to identify the risk of malfunctioning ♦ Responsibility of conducting detailed survey goes to the hospital FM teams	♦ Based on records and reports prepared by the maintenance agent ♦ Opinions and professional advice from the consultants will be taken into account	♦ Require both regular inspections by in-house technical staff and proper records
Resources availability	♦ Important in facilitating efficient use of resources in the cluster	♦ Not an important concern ♦ Problems are handled by maintenance agents	♦ Important ♦ Responsibility of the team for proper execution of the works

Table 5.3 Summary of views with regard to "technical" factors

5.1.4 Financial Considerations

All three interviewees regarded "direct costs" as the most important factors to be considered under this category. The weightings assigned by interviewees from the two

hospitals were identical. Both of them thought that "indirect costs" was less important than "direct costs" whilst "revenue generating capability" was not a relevant factor to be considered during prioritization. However, interviewee from cluster team regarded these two factors as equally important.

Direct Costs

The interviewees were unanimous on the view that costs of the works are the most important consideration under the financial aspect. There was no dispute that budget constraint is the biggest problem faced by maintenance managers. Prioritization is therefore essential as the reinstatement value of the works to be done is always larger than the budget available.

Indirect Costs

In addition, there was no dispute that not only direct costs should be considered, instead, attention should also be paid to the indirect costs. The interviewees agreed that cost implications of delaying repair and improvement is also significant in the financial considerations. One of the examples given was the extra costs incurred due to the poor performance of the facilities. Interviewee from the Schedule II hospital pointed out that works which would lead to greater savings in costs (e.g. energy costs) after repair would be given a higher priority even though the direct costs may be relatively higher. He also added that life-cycle costs are which facility managers should look at when making decisions.

Revenue Generating Capability

Difference in views was found between cluster and hospitals concerning the revenue generating capability issue. Interviewee from cluster regarded that as equally important as "indirect costs" whilst representatives from both hospitals considered that as irrelevant during the prioritization process.

The hospital representatives' perspective was supported by the reason that profit is not the main determinant in making decisions in hospitals, unlike other commercial business organizations. After all, public hospitals are not aiming at profit making. Due to the special nature of hospital services – one which involves human lives, revenue generating capability was not taken into account during prioritization.

Interviewee from the cluster team did not show any disagreement on the argument and emphasize once again that profit making is certainly not the main objective in public hospitals. However, he added that it is still important to attain a balanced account within the cluster - which is in fact, one of the duties of the cluster team. The team is responsible for compromising with other departments at the cluster level to achieve a balanced account. Under the current tight financial situation of the Hospital Authority, revenue generating capability would be a factor which all management level staff in different clusters would have to take into account when they decide how money are to be spent since resources are allocated on a cluster basis (as mentioned in Chapter 3.4.1).

Summary

Table 5.4 summarizes the views of the interviewees regarding the "financial" factors:

	Cluster	Schedule I	Schedule II
Direct costs	♦ The most important consideration under the financial aspect		
Indirect costs	♦ Cost implications of delaying repair and improvement is also significant		
Revenue generating capability	♦ Equally important as "indirect costs" ♦ Important to attain a balanced account within the cluster ♦ A factor which all management level staff would consider	♦ Irrelevant consideration ♦ Unlike other commercial businesses, profit is not the main determinant in making decisions in hospitals	

Table 5.4 Summary of views with regard to "financial" factors

5.1.5 Category Weightings

The weightings assigned by different interviewees to the categories are very similar. In fact, identical weightings were given by cluster and Schedule I hospital representatives. Both of them thought that factors under the categories of "regulatory" and "technical" are equally important and should be weighted more heavily than the factors under "social" and "financial" after considering all the attributes under each category. Interviewee from Schedule II hospital emphasized on the importance of "regulatory" and regarded the remaining three as equally important.

In fact, all the three interviewees pointed out that it is sometimes difficult to assign very rigid weightings to factors in determining the priorities of works. Very often, adjustments have to be made based on the actual situation of the cases. The importance of the factors may vary depending on the items being considered and also the time when the priorities are set. Interviewee from the cluster team further raised that it is also the reason why the FPMS is used only as a benchmark in prioritizing maintenance items. The increasing importance of infection control in according priorities to maintenance and improvement works after the outbreak of SARS and also the current Avian Flu issues was given as an example.

5.2 Hypothesis Testing

Based on the above analysis on the views of the interviewees regarding factors to be considered in maintenance prioritization, differences in certain considerations can be found.

In general, relative importance of the factors taken into account by the cluster team is more similar than those considered by the two hospitals although there is no dispute that some factors like “statutory requirements” and “functionality” should be given heavier weightings. The most significant difference between cluster level and hospital level was found under the “financial” category. Unlike hospital level, in which focuses are placed only on the costs incurred by the hospital, cluster will consider the revenue generating capabilities of different items.

Such results confirm the hypothesis that views of the cluster facility manager differ from those of the hospital facility managers in terms of resources and financial considerations. In addition, the deduction that the cluster team will try to balance all factors and the interests of all the hospitals of the cluster during the maintenance prioritization process; whilst the hospital teams will focus mainly on issues regarding their own hospitals is also confirmed.

5.3 Implications of Differences in Views on Resources Allocation

Under the "central prioritization" mechanism, maintenance and improvement priorities of individual hospitals have submitted to the cluster for bids and funds are then allocated according to the cluster's priorities (refer to Chapter 3.6.4 for details). Since differences in the views between the cluster team and the hospitals on the factors considered in determining priorities are identified, the implications of these differences on resources allocation would be worth looking at.

All the three interviewees agreed that the fund allocation mechanism in accordance with the priorities of the cluster FM team can aid better utilization of resources even though there are some differences in the views concerning the factors considered. They thought that these differences between the two levels would help to achieve better balances in resources allocation since sometimes hospitals may focus too much on their own hospitals and neglect the needs of others when setting their own priorities without the existence of the cluster team.

Before the establishment of the cluster FM team, individual hospitals had to negotiate directly with the Cluster Coordinator (CC), a member of the Head Office, for maintenance and improvement funds. There was no formal basis in determining how funds are to be allocated. The interviewees revealed that sometimes the amount might have been determined merely based on the reputation of hospitals and even the relationship between the Hospital Chief Executives and the CC. Consequently, unfair distribution might sometimes occur.

With the cluster FM team taking up the role of fund allocation in 2002, the real needs of individual hospitals can be better understood since the team will carry out on-site inspections and discussions with all cluster hospitals before it comes up to a final priority list. Both interviewees from the two hospitals thought the existing fund allocation system through the cluster team and the FPMS is able to satisfy most of their needs although there do exist some differences in views. In fact, such view can be reflected from the fact that disputes and appeals from hospitals to the cluster were rare. These suggest that balance between the needs of different hospitals can be better understood through the “central prioritization” mechanism.

Chapter 6 Conclusion

This chapter reviews the research by reiterating its objectives, summarizing its findings and discussions, and stating its limitations. Further research areas are also recommended.

6.1 Review of the Research

The objectives of the research are first, to investigate the current maintenance prioritization practice adopted by the Hospital Authority; secondly, to identify the relevant factors affecting criteria setting in maintenance prioritization in public hospitals; thirdly, to examine the relative importance of the factors from the facility managers' perspectives; fourthly, to examine the views of the facility managers at different levels of hierarchy in the organization structure and identify the differences if any and finally, to discuss the impacts of clustering on maintenance priorities in hospitals.

Previous studies on maintenance and maintenance management were first reviewed to show the importance of prioritization in planned maintenance. Some existing prioritization methods in planned maintenance management were then studied to identify the factors to be considered in the prioritization process. General background information and the structure of the Hong Kong Hospital Authority were also investigated to identify the current planning and management of maintenance and improvement works in the Hospital Authority. These are all important as they provide insights in establishing the theoretical framework of the study.

Interviews were employed in this research to examine the views of the facility managers at different levels of the hierarchy regarding the relative importance of the factors to be considered in the maintenance prioritization process. On one hand, it helped to identify the differences in the concerns of different levels, which fulfilled the major aim of this research. On the other hand, it was able to cater the constraints on time and resources of this research.

Detailed investigation was carried out in the Kowloon West cluster. Views of facility managers from different levels of the hierarchy regarding factors to be considered during maintenance and improvement works prioritization were examined and explained. Several differences were identified with reasons. The implications of such differences in views on resources allocation were also discussed.

6.2 Summary of Findings

It is found that maintenance prioritization is a very important topic in the context of healthcare FM. In addition, a suitable prioritization method would be indispensable under the budget constrains which are always faced by facility managers in all organizations. Moreover, it is revealed that the factors and weightings adopted in the prioritization would be of paramount importance no matter which method is adopted.

With regard to the maintenance prioritization in public hospitals in Hong Kong, the findings of the research showed that differences in views do exist between the facility managers from different levels of the hierarchy in the Hospital Authority regarding the factors to be taken into account in maintenance and improvement work

prioritization. In general, relative importance of the factors taken into account by the cluster team is more similar than those considered by the two hospitals. The most significant difference between cluster level and hospital level was found under the "financial" category. Unlike hospital level, in which focuses are placed only on the costs incurred by the hospital, cluster will consider the revenue generating capabilities of different items.

Such differences further illustrated the main focus of each level in the prioritization for the maintenance and improvement works. The cluster level will try to balance all factors and the interests of all the hospitals of the cluster during the maintenance prioritization process; whilst the hospital level will focus mainly on issues regarding their own hospitals. It is believed that difference in duties and roles of the teams is the major reason leading to such discrepancy.

It is also found that the fund allocation mechanism through the prioritization by the FPMS and the cluster team can aid better utilization of resources even though some differences exist in the views concerning the factors considered when compared with the hospitals' perspective.

6.3 Implications of the Research

Through the identification of all the relevant factors to be considered and also the methods adopted in maintenance prioritization in this research, better maintenance planning in different organizations can be facilitated. Facility managers and maintenance managers in all organizations are always facing the problem of budget

constraints in making maintenance plans. Thus, there is always a need to prioritize planned maintenance works. This study helps facility mangers to identify suitable methods and criteria; and also, set appropriate weightings during maintenance prioritization.

Concerning the context of healthcare FM in public hospitals in Hong Kong, the findings of this study helps the Hospital Authority to achieve better maintenance planning and resources allocation. The findings which shows that the fund allocation mechanism through the prioritization by the FPMS and the cluster team can aid better utilization of resources suggests that setting up such mechanism is beneficial to the hospitals. It is therefore recommended in all other clusters in which well-established cluster FM teams are absent. This would not only help the Hospital Authority to improve planned maintenance management in terms of 'value for money', but also benefit the users of the hospitals and the general public.

In fact, the idea of such mechanism may even be extended to other property holding organizations with buildings and facilities distributed in all parts of the city. Telecommunication companies would be one of the examples. Similar to the case in the Hospital Authority, maintenance prioritization and planning would always be essential owing to limited resources. However, proper prioritization may not always be easy due to the scattered and large volume of facilities and building stock. As a result, a clustering approach together with a facility performance management system may be effective.

6.4 Limitations of the Research

Qualitative case study approach was considered as the most suitable research methodology in this study under the time and resources constraints. However, it may not fully represent a very comprehensive view of all the clusters due to the limited number of interviewees. Moreover, the issue of personal bias as addressed in Chapter 4.3.1 may also reduce the reliability of the results.

Apart from that, it should be noted that the number of hospitals investigated in the case study may also reduce the representative power of this research. There are altogether two Schedule I hospitals and five Schedule II hospitals in the cluster chosen for case study. However, only facility managers of two hospitals, one from each group, were interviewed since some hospitals refused to participate in the research due to the issue of confidentiality according to hospital policies. As a result, the findings obtained from the limited number of interviewees may not be representative enough.

In addition, according to the interviewees, the importance of the weightings may vary from time to time, depending on the situations of the cases and the items. As a result, the weightings, which reflect the importance of the factors, assigned by the interviewees during the interviews may be changed from time to time. This implies that the findings of this research has to be reviewed from time to time.

6.5 Areas for Further Study

In the course of examining the views of facility managers in different levels of the hierarchy in the Hospitals Authority regarding factors affecting maintenance and improvement work prioritization, the author has only demonstrated the case in the Kowloon West Cluster. Views of facility managers in other clusters can also be studied so that the most suitable factors and weightings can be identified for setting up a systematic prioritization model in public hospitals in Hong Kong. Involving all facility managers in the Hospital Authority may be worthwhile. Apart from that, other than facility managers, the views of different groups of users, such as patients, doctors, nurses and non-medical staff, can also be examined since a more comprehensive view which best suit the organization can be obtained

In fact, this area of research can also be extended to other property holding organizations so as to facilitate the set up of more systematic prioritization systems. For example, feasibility of adopting the clustering and 'central prioritization' mechanism may be studied. After all, proper prioritization in planned maintenance management will not only be beneficial to these organizations; instead, it also helps to facilitate the improvement in the conditions of facilities and building stock. This area would be a fertile ground for further studies.

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APPENDIX I

SUMMARY OF FACILITY AUDIT 2003

OF THE KOWLOON WEST CLUSTER, HOSPITAL AUTHORITY

Hospital A

Building Blocks	Floor Levels	Year of Establishment	Site Coverage (m^2)	Gross Floor Area (m^2)
Block 1 (Phase I)	7 (G-6)	1964	N / A	3,336
Block 1 (Phase II)	7 (G-6)	1992	N / A	1,548
Block 2	7 (G-6)	1964	N / A	13,334
Block 3	5 (G-4)	1965	N / A	2,246
Block 4	14 (G-13)	2002	N / A	48,517
Sports Hall	2 (G-1)	1988	N / A	280
Block 5	5 (G-4)	1966	N / A	4,137
Block 6	13 (G-12)	1978	N / A	49,599
Block 7	19 (G-18)	1988	N / A	48,879
Garage	2 (G-1)	1964	N / A	650
Building Services Unit	2 (G-1)	2002	N / A	510

Hospital B

Building Blocks	Floor Levels	Year of Establishment	Site Coverage (m^2)	Gross Floor Area (m^2)
Block 1	4 (LG2-1)	1981	N / A	N / A
Block 2	9 (G-8)	1981	N / A	N / A
Block 3	9 (G-8)	1981	N / A	N / A
Block 4	4 (LG2-1)	1981	N / A	N / A
Block 5	9 (G-8)	1981	N / A	N / A
Block 6	9 (G-8)	1981	N / A	N / A

Hospital C

Building Blocks	Floor Levels	Year of Establishment	Site Coverage (m^2)	Gross Floor Area (m^2)
Block 1	-	-	54.517%	
Wing I	11 (G-10)	1965		18,070
Wing II	11 (G-10)	1964		12,240
Wing III	11 (G-10)	1961		15,256
Central Wing	15(G-14	1961		8,050
Block 2	11 (G-10)	1960		14,600
Block 3	11 (G-10)	1960		5,300
Block 4	11 (B-9)	1981		7,600
Block 5	6 (G-5)	1998		8,340
Block 6	12 (G-11)	1961		5,015

Hospital D

Building Blocks	Floor Levels	Year of Establishment	Site Coverage (m^2)	Gross Floor Area (m^2)
Block 1	6 (LG-4)	1960	5,935	3,949
Block 2	5 (LG-4)	1999	2,437	4,909
Block 3	7 (LG-5)	1962	4,184	6,603

Hospital E

Building Blocks	Floor Levels	Year of Establishment	Site Coverage (m^2)	Gross Floor Area (m^2)
Block 1	10 (LG3-6)	1975	N / A	N / A
Block 2	10 (LG3-6)	1975	N / A	N / A
Block 3	10 (LG3-6)	1975	N / A	N / A
Block 4	10 (LG3-6)	1975	N / A	N / A
Block 5	10 (LG3-6)	1975	N / A	N / A
Block 6	10 (LG3-6)	1975	N / A	N / A
Block 7	14(G-14	1995	N / A	N / A
Block 8	15 (LG2-12)	1975	N / A	N / A
Building Services Unit I	2 (G-1)		N / A	N / A
Block 9	6 (G-5)	2002	N / A	N / A
Block 10	Demolished		N / A	N / A
Block 11	2 (G-1)	1995	N / A	N / A
Block 12	10 (G-9)	1975	N / A	N / A
Block 13	9 (G-8)	2000	N / A	N / A
Block 14	10 (G-9)	1975	N / A	N / A
Block 15	10 (G-9)	1975	N / A	N / A
Block 16	10 (G-9)	1975	N / A	N / A
Block 17	14 (G-14)	1999	N / A	N / A
Building Services Unit II	1		N / A	N / A

Hospital F

Building Blocks	Floor Levels	Year of Establishment	Site Coverage (m^2)	Gross Floor Area (m^2)
Block 1	5 (1-5)	1969	N / A	8,300
Block 2	5 (1-5)	1969	N / A	
Block 3	5 (1-5)	1969	N / A	
Block 4	1 (G)	1975	N / A	120
Block 5	5 (B-4)	1965	N / A	7,300
Block 6	5 (B-4)	1965	N / A	
Block 7	5 (B-4)	1965	N / A	
Block 8	4 (1-4)	1995	N / A	1,2000

Hospital G

Building Blocks	Floor Levels	Year of Establishment	Site Coverage (m^2)	Gross Floor Area (m^2)
Block 1	22 (G-21)	1989	1,230	7,828
Block 2	19 (G-18)	1993	4,400	24,733
Block 3	8 (G-7)	1973	580	2,880
Block 4	13 (G-12)	1999	3,070	
Block 5	4 (G-3)	1973	300	1,050
Block 6	18 (G-17)	1983	Total 1,800	14,130
Block 7	18 (G-17)	1983		
Building Services Unit	3 (G-2)	N / A	235	270

APPENDIX II

QUESTIONNAIRE TO INTERVIEWEES

Assessing the Priorities in setting Maintenance, Replacement and Improvement Works in Public Hospital Buildings in Hong Kong

The objective of this questionnaire is to assess the importance that you place on various categories and factors to be considered when setting maintenance, replacement and improvement works priorities in public hospital buildings in HK

This questionnaire survey consists of two parts. Part A assesses the hierarchic weightings of several factors to be considered during the prioritization process under different categories. Part B assesses the hierarchic weightings of these categories.

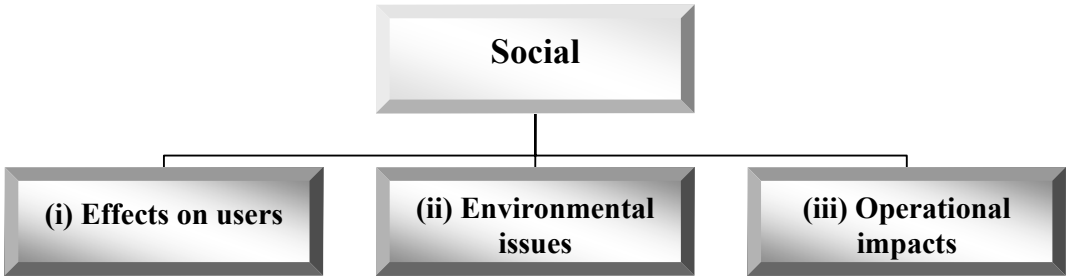
Categories and factors to be considered when setting maintenance, replacement and improvement work priorities in hospital buildings

Goal: Setting maintenance, replacement and improvement priorities

Categories	Factors
Social	1.4 Effects on users 1.5 Environmental issues 1.6 Operational impacts
Regulatory	(i) Statutory requirements (ii) Internal regulations and policies (iii) Trade practices
Technical	(i) Physical conditions (ii) Functionality (iii) Resources availability
Financial	(i) Direct costs (ii) Indirect costs (iii) Revenue generating capability

Part A: Hierarchic Weightings of Factors

With reference to the hierarchy in the figures, please indicate the relative weight that YOU think the following factors should get under the corresponding categories in the tables provided.

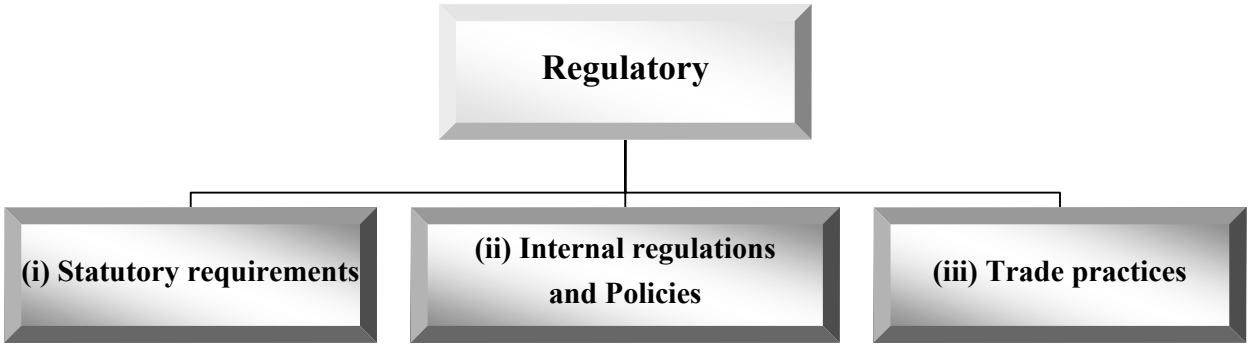


(i) Effects on users - e.g. health and safety, comfort, security, convenience etc.

(ii) Environmental issues - impacts on the environment

(iii) Operational impacts – risks to clinical services and public relations due to defect and in case of failure, e.g. importance of the building (in terms of function and use rate), importance of the functional unit with defects, etc.

Effects on users (%)	Environmental issues (%)	Operational impacts (%)	Total (%)
			100

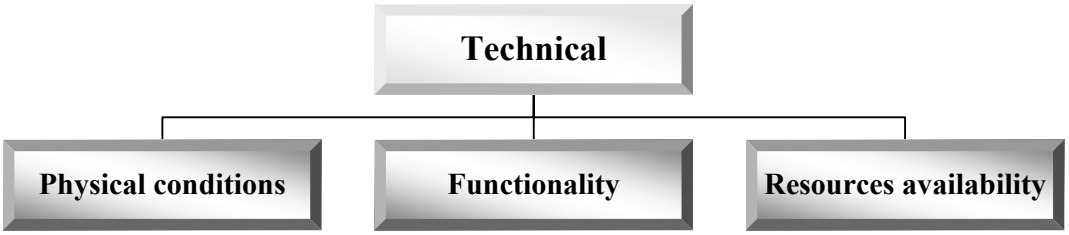


(i) Statutory requirements – e.g. Buildings Ordinance, environmental legislations etc.

(ii) Internal regulations and policies

(iii) Trade practices - informal 'rules' in practice

Statutory requirements (%)	Internal regulations and polices (%)	Trade Practice (%)	Total (%)
			100

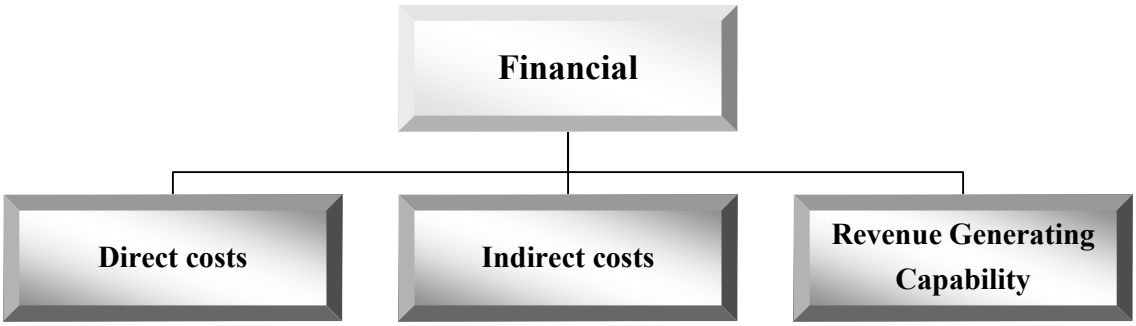


(i) Physical conditions - e.g. age, useful time left, appearance etc.

(ii) Functionality - e.g. system performance, service availability, possibility of breakdown etc.

(iii) Resources availability - e.g. spares availability, manpower, delivery time etc.

Physical condition (%)	Functionality (%)	Resources availability (%)	Total (%)
			100



(i) Direct costs - cost of work (initial cost) vs budget available

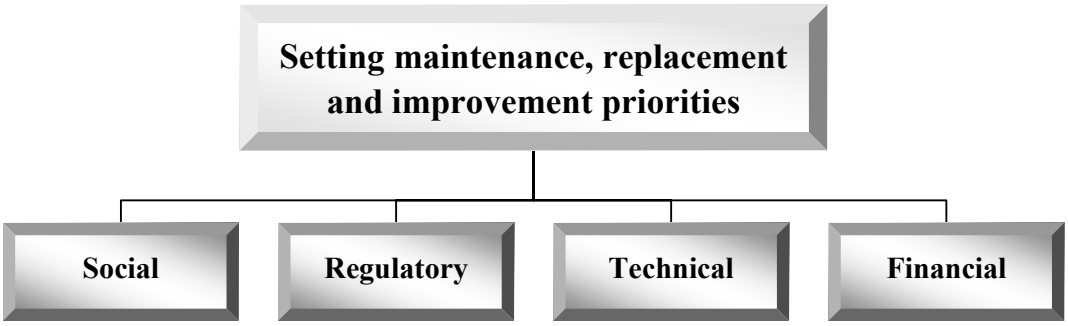
(ii) Indirect costs - cost implications, e.g. extra costs due to delaying repair and in case of failure etc.

(iii) Revenue generating capability

Direct costs (%)	Indirect costs (%)	Revenue generating capability (%)	Total (%)
			100

Part B: Hierarchic Weightings of Categories

With reference to the hierarchy in the figure, please indicate the relative weight that YOU think the following categories should get under the goal in the table provided.



Categories	Factors
Social	(i) Effects on users (ii) Environmental issues (iii) Operational impacts
Regulatory	(i) Statutory requirements (ii) Internal regulations and policies (iii) Trade practices
Technical	(i) Physical conditions (ii) Functionality (iii) Resources availability
Financial	(i) Direct costs (ii) Indirect costs (iii) Revenue generating capability

Social (%)	Regulatory (%)	Technical (%)	Financial (%)	Total (%)
				100

End of Questionnaire

Thank you!

APPENDIX III

WEIGHTINGS OF FACTORS AND CATEGORIES

Social Considerations

Factors	Cluster	Schedule I	Schedule II
Effects on users	40%	40%	40%
Environmental issues	20%	20%	20%
Operational impacts	40%	40%	40%

Regulatory Considerations

Factors	Cluster	Schedule I	Schedule II
Statutory requirements	50%	80%	70%
Internal regulations and policies	30%	15%	20%
Trade practices	20%	5%	10%

Technical Considerations

Factors	Cluster	Schedule I	Schedule II
Physical condition	30%	30%	30%
Functionality	50%	60%	50%
Resources availability	20%	10%	20%

Financial Considerations

Factors	Cluster	Schedule I	Schedule II
Direct costs	40%	60%	60%
Indirect costs	30%	40%	40%
Revenue generating capability	30%	0%	0%

Category Weightings

Categories	Cluster	Schedule I	Schedule II
Social	20%	20%	20%
Regulatory	30%	30%	40%
Technical	30%	30%	20%
Financial	20%	20%	20%