
Original Article

Overview of maintenance strategy, acceptable maintenance standard and resources from a building maintenance operation perspective

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ABSTRACT This paper is part of a research study focusing on building maintenance operation processes. The fundamental investigation is to review building maintenance policy with respect to maintenance strategy, acceptable standard and resources. The arguments and problems arising in maintenance operation processes are discussed. Following the overall discussions, the types of challenges, problems as well as arguments from the organisational and operational perspectives are summarised. The preliminary conceptual framework highlights the importance for maintenance personnel to justify the building maintenance objectives by matching with organisational goals and objectives. It helps to improve the gaps between the top management at the strategic level and maintenance personnel at the operation level in performing building maintenance as well as maintenance operation efficiency.

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INTRODUCTION

Building maintenance policy is a written document, and provides a management framework to the maintenance personnel to determine appropriate maintenance strategy

and standard. Building maintenance policy and strategy is one of the main aspects in management of building maintenance operation processes (Lee, 2008; Lee and Scott, 2008). The three essential elements for formulating the maintenance policy are the choice of maintenance strategy, defining maintenance standard and allocation of maintenance resources. Maintenance activities could not be planned and implemented successfully without the understanding of these elements.

Maintenance strategy in general includes corrective, preventive or condition-based maintenance. However, there are different views on choosing appropriate maintenance strategy. Among various maintenance strategies, the effectiveness of planned preventive maintenance (PPM) is more challenged by the top management (Spedding, 1987; Horner *et al*, 1997; Wood, 1999, 2003a; Loosemore and Hsin, 2001). Moreover, maintenance standard is difficult to agree with top management (Then, 1996; Zavadskas *et al*, 1998; Wood, 2003a). Acceptable maintenance standard depends very much on available maintenance resources with consideration of common factors such as characteristics related to building, tenant, technical, administration and political factors (El-Haram and Horner, 2002). Maintenance personnel at operational level argue that the maintenance budget is always below the needs (Pitt, 1997; Shen and Lo, 1999; Lam, 2000; Lo *et al*, 2000; Tse, 2002). On the contrary, top management at the strategic level criticises inefficiency of the maintenance organisation. It is becoming more difficult to get more resources (Pitt, 1997; Shen and Lo, 1999; Lam, 2000; Lo *et al*, 2000; Tse, 2002). Technology becomes a tool for assisting maintenance personnel to improve building maintenance operation efficiency. It is recommended using intelligent equipment and automatic maintenance scheduler to enhance maintenance quality and efficiency (Tse, 2002).

BUILDING MAINTENANCE POLICY

Maintenance is defined as work undertaken in order to restore every facility, that is, in every part of site or building to an acceptable standard (BSI, 1964). According to Seeley (1976), maintenance is defined as 'work undertaken in order to keep, restore or improve every part of a building, its services and surrounds, to a currently acceptable standard, and to sustain the utility and value of the building. Maintenance is defined as the combination of all technical and administration actions, including supervision actions, intended to retain an item in, or restore it to a state in which it can perform a required function' (BSI, 1991). Maintenance is defined as the effort in connection with different technical and administration actions to keep a physical asset in, or restore it to a condition where it can perform a required function (BSI, 1993). Development of the maintenance definition has also been shifting from solely technical responsibility into the importance of the balance of both technical and management responsibility with time elapse.

Maintenance policy is a tool for maintenance personnel to plan their appropriate maintenance strategies. However, before a maintenance programme is prepared, maintenance personnel and top management are required to agree on maintenance policy because it requires strategic directions, as well as resources. The maintenance policy consists of five major components, and different maintenance strategies are developed from these components. Without defining this policy, maintenance operation processes will be in a haphazard order. The five major components (CEM, 1994; RICS, 1990; Chanter and Swallow, 1996; Lee and Wordsworth, 2001) are as follows:

- The length of time for maintaining for their present use.
- The life requirements of the buildings and their fittings and services.
- The standard to which the building and its services are to be maintained.

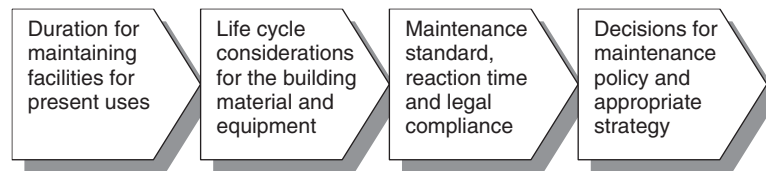


Figure 1: Sequences for formulating building maintenance policy and strategy.

- The reaction time required between a defect occurring and a repair being carried out.
- The legal and statutory requirements shall also be considered.

Following with these five major components in maintenance policy, the sequences for formulating maintenance policy and strategy is summarised in Figure 1.

CHALLENGES OF EFFECTIVENESS OF MAINTENANCE STRATEGIES

Three considerations for developing maintenance policy are building maintenance objectives, benefits and policies (Armstrong, 1987). The main purpose is to obtain benefits with integration of adequate maintenance policies. It concerns with proper procedures for planning building maintenance activities. Alner and Fellows (1990) summarise that safety is the primary concern for the planning of maintenance strategy to ensure building and associated services are in safe condition, fit for use and comply with the law and all statutory requirements. Maintenance work is carried out to maintain the value of the physical assets of the building stocks and quality. Thus, these factors are considered important for development of maintenance policy. However, apart from the value consideration, Burns (1997) argues that there should be ground rules for the allocation of maintenance resources available to management. Maintenance policies are beneficial to the organisation as a whole, it must relate to the cost involved for getting maintenance funding.

Maintenance strategy is adopted in order to extend the life cycle of buildings and its fittings services. Maintenance personnel choose different maintenance strategies depending on allocation maintenance resources. The maintenance policy is the integration of different strategic approaches, which include corrective, preventive and condition-based maintenance (Horner *et al*, 1997). Ollila and Malmipuro (1999) identify that the main types of categories of maintenance consisted of reactive, preventive, predictive and proactive maintenance. However, Coetzee (1999) argues that the maintenance strategies should be based on the detailed design of the maintenance cycle for different types of organisations. Chan *et al* (2001) split this into five types of maintenance strategy, including time-based, performance-based, breakdown-based, renovation-based and integration-based. Furthermore, Tse (2002) is of the opinion that most of the maintenance practices are failure-driven, time-based, condition-based, reliability-centered and predictive.

The basic maintenance strategies include preventive, corrective and condition-based maintenance. According to Chan *et al* (2001), the time-based, performance-based, breakdown-based, renovation-based and integration-based are also developed from the three basic maintenance strategies. PPM has been described as the most effective maintenance strategy against the frequency of breakdown (Seeley, 1976; Wood, 2003b). However, PPM is considered an ineffective solution because it makes too early and unnecessary replacement (Spedding, 1987). The argument of this maintenance strategy is becoming the focus of economic downturn, resulting in cutting operation cost to

Table 1: Summary of problems associated with planned preventive maintenance

<i>Maintenance strategy</i>	<i>Arguments and problems</i>
Planned preventive maintenance (PPM)	<ul style="list-style-type: none"> • It makes too early and unnecessary replacement. • It lacks empirical data to support its efficiency and effectiveness. • The relationships between PPM and the organisational objectives are not known. • There are suggestions to better use of the PPM in order to optimise maintenance resources. • Maintenance practices in Hong Kong concentrate on time-based and failure-driven strategies but without adopting a comprehensive maintenance approach.

organisations. Moreover, the study about the effectiveness of PPM with empirical data to support its efficiency is limited (Horner *et al*, 1997; Wood, 2003a).

Wood (1999) introduces just-in-time theory developed from the production industry applying to building maintenance. From the strategic perspective, there is little understanding about the relationships of PPM with the core business objectives (Loosemore and Hsin, 2001). On the contrary, it is recommended for the better use of the PPM in order to optimise maintenance resources (Shen and Lo, 1999). Tse (2002) argues that maintenance practices in Hong Kong concentrate on time-based and failure-driven strategies, but without adopting a comprehensive maintenance approach, and that maintenance is still in a primitive stage. From the technological perspective, most of the studies focus on the study of technology application to condition-based maintenance and performance-based maintenance with centered reliability maintenance, and forward maintenance and predictive maintenance are all based on the condition surveys (Pitt, 1997; Lam, 2000). Table 1 summarises the problems associated with the strategy of PPM.

ARGUMENT OF ACCEPTABLE MAINTENANCE STANDARD

There are different interpretations among organisations about the acceptable maintenance standard, which may be higher or lower than the original standard, but it depends on how much the maintenance resources is approved. Although this standard is influenced very much by the available resources, maintenance personnel have to define maintenance standard by looking at the balancing between the facility cost and maintenance resources. The baseline is to comply with statutory requirements. However, there is argument about what the acceptable standard should be (Then, 1996; Zavadskas *et al*, 1998; Wood, 2003a). The argument is due to the maintenance policies, and the allocation of maintenance resources is different among organisations. Organisations with adequate maintenance resources have a higher maintenance standard as compared with the original standard. On the contrary, organisations with limited or even inadequate maintenance resources encounter difficulties for bringing a building facility to original standard, but just meeting with statutory requirements. This has impacts not only on the organisational image, but also minimises its competitive strength in business environment.

Although there are different approaches to interpret the acceptable standard, it is important because maintenance strategies cannot be properly planned and organised without defining the maintenance standard. Then (1996) is of a similar opinion that the maintenance standard is a fundamental element to maintenance process and it is influenced by the building regulations, health, safety and uses. However, the maintenance standard is difficult to manage, as it is based on the users' perception and expectation. The major influences on acceptable maintenance standard are summarised in Figure 2.

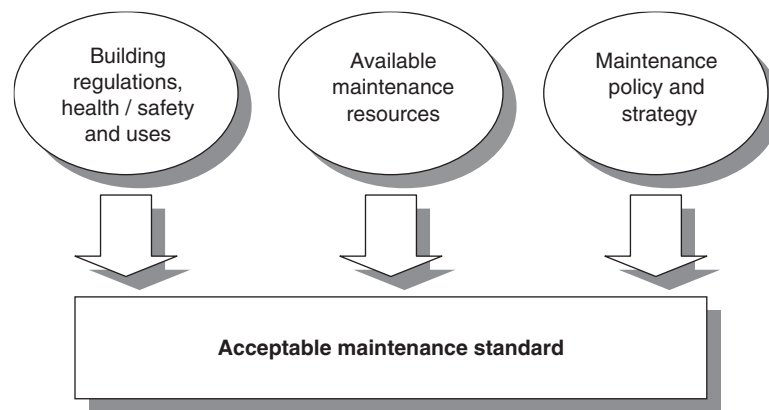


Figure 2: Major influences on acceptable maintenance standard.

Moreover, the interpretations of acceptable standard from the maintenance personnel at the operational levels and top management at the strategic level are different. Wood (2003a) is of similar opinion that it is hard to agree on acceptable maintenance standard because of the different interpretation, and lack of understanding the actual requirements from the building users. Zavadskas *et al* (1998) suggest that understanding more about the organisational policy and management perspectives could raise the maintenance standard. This implies to consider supporting the operational levels from the top management. The management inputs from the top management at the strategic level and the maintenance personnel at the operational level help to improve setting up agreed maintenance standards.

ARGUMENT OF MAINTENANCE RESOURCES

Owing to economic downturn, organisations have pressure to reduce operation cost and the staff level of the sub units of organisations. The main purpose of these exercises is to optimise the available constraint resources. The same impacts are on the building maintenance operation. As a result, top management at the strategic level is keen to understand about how the building maintenance operation is best performed. They also look for possible ways to minimise maintenance operation cost with consideration of downsizing in-house maintenance organisation. It is believed that outsourcing provides a flexible strategy for the organisations. Moreover, maintenance represents a high proportion of the total operation cost (Chanter and Swallow, 1996; Oberg, 2002). Top management also challenges maintenance as wastage of maintenance resources (Shen and Lo, 1999; Lam, 2000; Lo *et al*, 2000; Tse, 2002).

On the contrary, although maintenance works identified exceeds budgets, maintenance personnel at the operational level are difficult to obtain adequate maintenance resources for planning maintenance activities (Pitt, 1997). This is a dilemma for maintenance personnel at the operation level because top management is finding gaps to improve facility services to satisfy their customers with constraint budget. As a result, there are studies arguing about approved maintenance resources cannot meet with the maintenance requirements (Shen and Lo, 1999; Lam, 2000; Lo *et al*, 2000; Tse, 2002). Shen (1997) is of the same opinion that maintenance budget for public housing cannot meet maintenance needs. Risks associated with this disorganised maintenance resources have impacts on the health and safety issues. Moreover, allocation of maintenance resources is often chaotic (Then, 1996; Coetzee, 1999). Then (1996) also emphasises that maintenance personnel

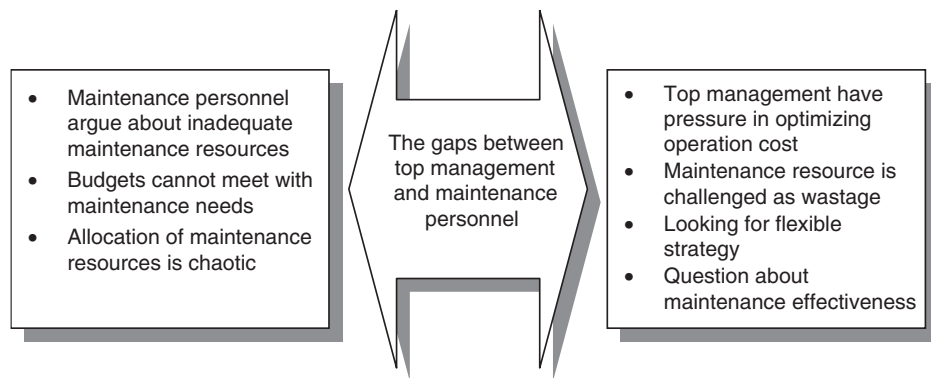


Figure 3: Summary of arguments of maintenance resources.

could get more resources only with an ability to justify on their maintenance objectives. According to Horner *et al* (1997), it is suggested to plan an optimal approach to reduce financial expenditures. Zavadskas *et al* (1998) recommends to develop an effective management of resources from the maintenance personnel is required. Figure 3 summarises the arguments of maintenance resources from top management and maintenance personnel.

FOCUSING ON TECHNOLOGY AND TECHNICAL KNOWLEDGE

Technology assists to improve and speed up construction process and also building maintenance operation processes (Pitt, 1997). In the context of building maintenance, it helps detecting building defects more effectively with technology application in non-destructive testing. Examples include infrared scanning for identification of de-bonding external wall tiles, computerised maintenance management system (CMMS) for improving building maintenance operation processes in terms of saving in labour and material. Majority of building maintenance data information could be retrieved, controlled and monitored immediately. Moreover, building management system is a common system to assist the maintenance personnel to tackle the problem/defects related to controlling and monitoring of building services systems. Advanced technology has now enabled maintenance personnel to care for building facilities in a more efficient and effective way.

Wood (1999) agrees that technology helps to intelligently care for buildings. With the fast development of latest technology, maintenance personnel will be equipped with knowledge in order to adapt different approaches to respond to external business environment. Madu (2000) is of similar opinion, and suggests maintenance personnel to survive and help organisations to increase their competitive advantages with application of technology in improving maintenance management processes. Further development with more investment and more money by using advanced technology in building maintenance (Jones and Collis, 1996) and for maintenance reliability (Tse, 2002). However, asking for more resources to invest for technology applying to building maintenance is contradictive to reducing maintenance cost.

Wood (1999) argues that maintenance personnel are too reliant on using technology, but just lack understanding of management and operational context. Moreover, there are arguments about maintenance personnel, who are too reliant on their technical knowledge and experience and are not concerned with organisational goals and objectives (Amaratunga *et al*, 2000; Lo *et al*, 2000; Chan *et al*, 2001; Alani *et al*, 2002). This may lead to overlook the importance related to the human dimensions. It also contributes to the

lack of maintaining an attitude for caring the relationships between buildings and their users.

DISCUSSIONS ON THE ARGUMENTS AND PROBLEMS ASSOCIATED WITH MAINTENANCE STRATEGY, STANDARD AND RESOURCES

Maintenance policy is concerned with maintenance strategy, maintenance standard and maintenance resources, which is categorised as the major components for formulating maintenance policy. It has to be agreed before implementation and is a management tool for both maintenance personnel and top management. Maintenance strategy is based on corrective, preventive and condition approaches. Different types of buildings, services and fittings require different types of maintenance approaches. However, the common factors influencing maintenance strategy are health and safety, and are fit for use, law, value and quality. PPM is more challenged among various maintenance strategies. Moreover, the relationships between PPM and core business objectives are not known.

Maintenance personnel experience difficulties in determining the maintenance standard because of the constraint maintenance resources. Although maintenance strategy could not be standardised, this could be overcome by understanding more about the problems and arguments between top management at the strategic level and maintenance personnel at the operational level. Maintenance personnel always argue inadequate of maintenance resources. In order to manage resources efficiently and effectively, studying about justification of the maintenance objectives could improve the misunderstanding between top management and maintenance personnel. Moreover, maintenance personnel are too reliant on using technology and do not understand management and operational contexts, as well as the relationships between buildings and their users.

Maintenance policy requires combination of different approaches for formulating, but the choice of maintenance strategy is arguable. PPM is more challenged by top management on its effectiveness among different types of maintenance strategy. One of the reasons is lack of understanding the relationships between PPM and business objectives. On the contrary, there are studies recommended to better use of PPM for optimising maintenance resources. Understanding more about organisational objectives helps to compromise a solution for improving allocation of maintenance resources.

The main challenges of PPM, maintenance standard and maintenance resources come from misalignment of management strategy between top management and maintenance personnel. The inadequate information about how the maintenance personnel plan, develop and justify building maintenance objectives is also necessary to justify on the effectiveness of using technology in building maintenance. Building maintenance has connections with the organisational objectives, thus understanding the development of building maintenance objectives helps to improve disordered maintenance resources. Thus, the diagrammatic conceptual framework for the study of building maintenance operation processes is developed in Figure 4.

CONCLUSIONS AND RECOMMENDATION

The maintenance objectives will be considered in connection with the organisational objectives. However, there are limited studies of how building maintenance objectives match with the organisational objectives in an organisation. In addition, types and characteristics of managerial inputs from the operational level are not known. This creates barriers in agreeing on the maintenance resources, and has impacts on the efficiency and effectiveness of the organisation. From the financial perspective, most of the previous arguments of maintenance works identified are always without sufficient resources. Thus,

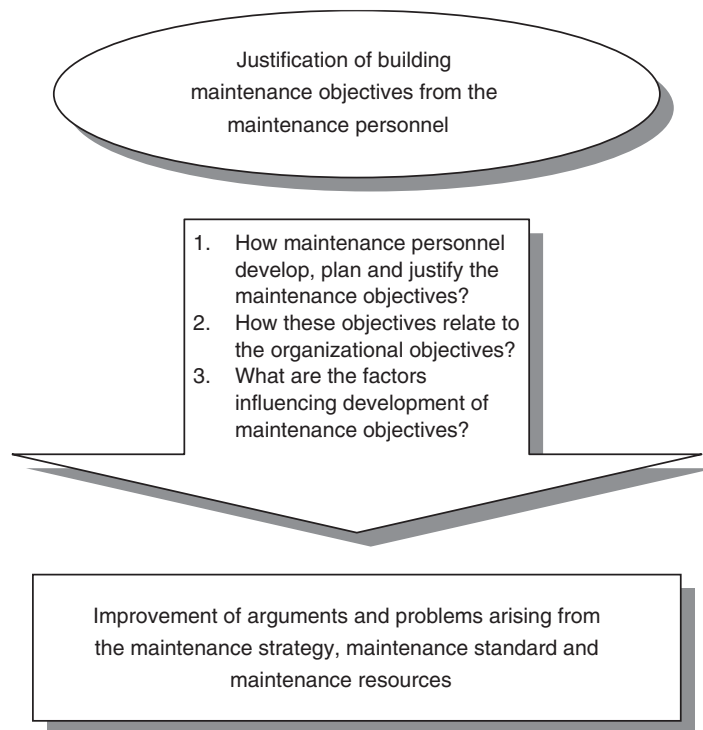


Figure 4: Conceptual framework developed for the study of building maintenance operation processes from the building maintenance objectives.

it is suggested shifting to focus on the study of organisational needs, and how these needs reflect in the building maintenance objectives.

Previous studies seldom investigate the reasons why maintenance resources are allocated. Types of criteria for maintenance management decisions are also outstanding. It is important to investigate how the maintenance personnel justify their maintenance objectives. Moreover, studying about how PPM is connected with organisational objectives is limited. It is suggested addressing how maintenance objectives are related to maintenance strategy, which have influences on the building maintenance operation processes.

Maintenance objective is one of the organisational sub-business objectives, and is dominated by the organisation strategy. Planning of maintenance objectives have impacts on the facility management operation in terms of using different maintenance strategies, which are influenced by the cost, quality and process directly and indirectly. On the contrary, whether the top management is concerned with the maintenance strategies are not known. Building maintenance objectives are the fundamental element to describe the scopes, purposes and aims of the maintenance activities, as well as the relationships with the organisational objectives. However, maintenance personnel are criticised for narrowly focusing on the technical issues. The links between building maintenance operation and organisation is an important issue and was recognised by most of the researchers for achieving organisational goals effectiveness.

Investigations about how the maintenance objectives are established, and the relationships between building maintenance and the business objectives are limited. It is also important to know how the relationships between the strategic level and the operational level are established. Studying alignment map between these two levels is to

achieve a better planning of maintenance activities and resources allocation. However, mismatching between the two levels still exists when the basic of the links and the maintenance objectives are not known, or not clearly defined. Some organisations have not clearly defined their maintenance objectives, and are even without maintenance objectives.

It is concluded that arguments of maintenance strategy, standard and resources are due to the lack of justification of building maintenance objectives. Thus, the preliminary investigation of research question can be focused on the investigation of 'How do maintenance personnel at the operational level develop building maintenance objectives?' Following with this main question, it is recommended to collect the data and information about how maintenance personnel develop building maintenance objectives, and the following data and information is recommended:-

- What are the generic building maintenance objectives?
- What are the factors influencing planning of building maintenance objectives?
- What are the reasons for the prioritisation of building maintenance objectives?
- What are the challenges from the top management and the gaps between building maintenance objectives and organisational objectives?

Understanding the relationships between the top management at the strategic level and maintenance personnel at the operational level are considered important for better management of building maintenance operation processes.

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