Facilities Management for Building Maintainability: A Research Framework

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Abstract

Building maintenance is a necessary evil in organisations with built assets. It can only be ameliorated, but not eliminated. Even so, more maintenance is anticipated for there is an ageing trend among built facilities. To tackle challenges ahead, building maintainability provides a way out. It is a concept where ease of maintenance is emphasised, however, it is understudied and inadequately considered from Facilities Management (FM) perspectives. The aim of this paper is therefore to review literature to identify research gaps and consult areas in FM to gain insights to improve building maintainability. A research framework of managing for maintainability is proposed in the end.

Literature in building maintenance, building maintainability and FM is systematically reviewed. It has long perceived maintainability of buildings as an inherited characteristic of design and installation and some works have been done to improve it through design. Managerial aspects to achieve building maintainability are, however, generally ignored. The author thereby identifies managing for building maintainability to be the focus in this paper as well as in subsequent studies. Benchmarking, financial management, information management and outsourcing in FM are inquired to see if they offer any opportunities to improve maintainability. Questions are raised in each area that founded the basis of the research framework. They remain unanswered in this paper. As stated in its sister paper, studies in building maintainability are scattered. Managing for maintainability is an area that has not been considered. This paper will fill the research gap in managing for maintainability and contribute to the body of knowledge by considering building maintainability from FM perspectives.

Keywords: Benchmarking, Building Maintainability, Financial Management, Information Management, Outsourcing

1. Introduction

Building maintenance to some extent is a necessary evil for organisations holding built assets can never get rid of it. One may save a dollar from building maintenance today but it is merely false economy and it can build disastrous consequences. Moreover, the ageing trend of built assets becomes more apparent which means there will be greater needs to maintain in the future. Durability and maintainability, in this sense, are the way outs that may help maintenance, however, designing for a hundred per cent maintenance-free (i.e. perfectly durable) facility is technologically and economically inviable. In this regard, planning, designing and managing for maintainability should be studied to see if there is any scope for reducing costs, enhancing efficiency and improving facilities performance in maintenance. This paper will review literature in building maintainability to identify any gaps from earlier works. Meanwhile, novelties in Facilities Management (FM) are consulted to see if they can give a hand to improve building maintainability. A research framework of managing for maintainability in FM will then be developed. It serves a supplement to the framework developed in a sister paper (Lau and Ho, 2010) where building maintenance management and sustainable development are accented.

2. Defining Building Maintenance, Building Maintainability and Facilities Management

2.1 Building Maintenance

What is maintenance? An answer is provided in the *Oxford Dictionary of English*, that is, "the process of keeping something in good condition". Building maintenance, more specifically, is defined as "a combination of any actions carried out to retain an item in, or restore it to an acceptable condition" (BS3811:1984). Distinct from the BSI's definition, the one by the Committee on Building Maintenance included improvement works (DoE, 1972) and CIOB (1990) further explained what constituted "an agreed standard". Wood (2009) proposed a simpler but more inclusive definition that founded on antecedent definitions. In sum, building maintenance in a broad sense includes daily and routine cleaning, renovation, refurbishment, etc. Along with building maintainability, definitions of the two are provided in Figure 1.

2.2 Building Maintainability

In engineering, maintainability is defined as "a characteristic of equipment design and installation expressed in terms of ease and economy of maintenance, availability of the equipment, safety and accuracy in the performance of maintenance actions" (Blanchard and Lowery, 1969; pp1). Maintainability as inherited design characteristic is a deep-rooted thought, and this has been further reiterated in later studies (e.g. Dhillon, 1999). Maintainability may

also be expressed as a probability that an item will be retained in or restored to a specific condition within a given period of time (BS3811:1993; US Department of Defence, 1981), or maintenance will not exceed certain times or maintenance cost will not exceed certain dollars in a given period (Blanchard, Verma and Peterson, 1995), given prescribed procedures are followed.

Contrary to the gradual development in engineering, building maintainability has attracted little attention and a generic definition is absent. Feldman (1975, pp1), who contributed the first study in building design for maintainability, defined it as "the condition of an item or a surface that permits its repair, adjustment or cleaning with reasonable effort and cost". Not until 25 years later did the subject catch eyes of researchers in Singapore who then defined it as "achieving the optimum performance through the building life span within a minimum life cycle cost" (Chew and De Silva, 2003). In a recent study by Ikpo (2009) who sought to analyse maintainability of public buildings in Nigeria, Smith (1981)'s definition was adopted, that is, "the probability that a failed item will be restored to operational effectiveness with a given period of time when the repair action is performed in accordance with prescribed procedures" (pp19).

With the deep-seated view of maintainability as an inherited design and installation characteristic, the significance of managerial devices towards maintainability is not appreciated. The author thereby defines building maintainability as "features and/or measures that expedite maintenance, leading to improved maintenance efficiency, augmented building performance and best value outcomes." In a maintainable building, on one hand, fewer resources (i.e. the input) are required to maintain it to an agreed standard, leading to reduced maintenance costs, less required manpower, etc. On the other hand, augmented building performance such as shorter downtime can be achieved (i.e. the output). For the sake of filling the research gap, managing for building maintainability will be focused in this paper.

2.3 Facilities Management (FM)

As a novel discipline that has been developed quickly in recent years, FM is "a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, processes and technology" (IFMA, 2010). FM is evolved from conventional estates and property management and now is a comprehensive management approach that comprised of three aspects, viz FM for business management, FM for management and control and FM for operation and daily works (JFMA, 2006). In other words, a qualified facility manager should be competent in areas such as Corporate Real Estate, Project and Contract Management, Maintenance and Operations, etc (HKIFM, 2010) (Fig 2).

Charged with missions to provide competitive advantage to an organisation's core business and to achieve best value, FM as a means to better management of facilities reduces costs, improves flexibility, enables delivery of effective and responsive services and creates a better environment (Keith, 1996; Atkin and Brooks, 2009). With FM, shortcomings in current

management can be identified and subsequently rectified to improve efficiency. FM and building maintainability in this sense share similar philosophy – building maintainability is achieved through reformed processes where efficiency is improved, that is, fewer inputs are required to give an even better outcome. So there is no ground not to learn from FM and apply FM principles and processes to improve building maintainability.

3. Literature Review

3.1 Building Maintainability – An Overview

The story of Cinderella and the "Little Match Girl" probably represented the respective fate of building maintenance and building maintainability. When Cinderella married the Prince and lived happily ever – "All's well that ends well", the "Little Match Girl" finally saw her grandmother and passed away on New Year's Day. Almost like the "Little Match Girl", so far building maintainability has been disregarded in its short life.

Building maintainability was born to tackle maintenance problems stemmed from design, and the provision of adequate access was an essential contributor to maintainable building design (Feldman, 1975). Subsequent research in the subject has, however, experienced two decades of glacial period until its importance to attain greater productivity was realised in Singapore (Construction 21 Steering Committee, 1999). Gaining knowledge and benchmarking maintainability were identified as prioritised issues (De Silva et al., 2004). Defects in wet areas and façade were analysed afterwards, with design, materials, construction and maintenance identified as maintainability significant factors (Chew and De Silva, 2003; Chew and Tan, 2004; Chew, Tan and Kang, 2005). Underpinned by research findings, grading systems were developed to predict maintainability and thus assist decision-making (Chew, De Silva and Tan, 2004a; 2004b). Not only Singapore but building maintainability has also attracted attention in Nigeria where maintainability analysis of public buildings at the design phase may make mandatory (Ikpo, 2009). When achieving optimum performance and minimum life cycle cost are targeted at in the Singaporean researches, repair time is concerned in Nigeria. Accessibility, maintenance manuals, available technology, economic index and reliability are five identified facets that may affect Mean Time to Repair (MTTR) in the proposed maintainability evaluation framework. Apart from building design and benchmarking, the planning and design processes should be reviewed for they largely influence building design and hence maintainability. When buildings were designed, maintenance related factors were inadequately considered (Arditi and Nawakorwit, 1999). With a view to learn from past successful projects to reduce total project cost, Dunston and Williamson (1999) proposed to integrate maintainability into Constructability Review Process (CRP). Similar work was done by Meier and Russell (2000) who developed a model process to implement maintainability with corporate-level programme as the start. Regardless of previous works on building maintainability, managerial aspects in maintainability have not been investigated.

3.2 Maintenance Management and Building Maintainability

In one of his famous quotes, Thomas Edison (1847-1931) said, "Genius is one percent inspiration, ninety-nine percent perspiration." By the same token, buildings can hardly be maintainable unless they are managed and maintained in a maintainable way. To quest for more effective maintenance management for maintainability, issues including maintenance standard, maintenance resources and maintenance strategies should be examined and some works have been done in a sister paper (Lau and Ho, 2010). In summary, setting maintenance standard involves multi-criteria decision making and it suffers from the inability to justify. Although a framework was proposed by Then (1996) to help describing the standards, maintainability was not addressed in his model. What we need is a model that can expedite and justify the setting such that an optimal standard is specified. Much the same problem of unjustifiable decision does occur in planning and assigning resources to maintenance activities (Then, 1996; Van Winden and Dekker, 1998), where complains against inadequate maintenance resources are constantly made (DES, 1985; SCALA, 1993; Shen, 1997). Such misallocation may also be caused by the discrepancies in maintenance between strategic and operational level (Lee and Scott, 2009), or alternatively, between employers and consultants. What we need is a mechanism that enables timely acquisition as well as optimal allocation of resources. Notwithstanding various maintenance strategies are available and innovations such as planned preventive maintenance (PPM) and Just-in-time (JIT) maintenance are seen, little knowledge is in what strategy suits which maintenance works most. What we need to know is the appropriate strategy for a particular type of tasks that results in a maintainable outcome. Further to effective maintenance management, it is believed that novelties in FM can greatly facilitate maintenance and achieve maintainability. These novelties will be examined in the following paragraphs.

4. Facilities Management and Building Maintainability

4.1 Benchmarking

As a tool to identify and gain insight from industry best practices, benchmarking is a continuous, systematic process of measuring and comparing against external organisations (i.e. competitors) that leads to improvements or even superior performance (Atkin and Brooks, 2009; Camp, 1989; Langston and Lauge-Kristensen, 2002). It is in general a simple process that comprises of following steps which roughly follow Deming's PDCA process – (1) identify subject (2) plan study – what and who to measure (3) collect information (4) analyse findings and determine gap (5) set goals for improvement (6) implement new order (7) monitor the process for improvement (Atkin and Brooks, 2009; Watson, 2007). Having said that the benchmarking process is uncomplicated, it has to be objective and some expressed concerns about the confidentiality and secrecy between competitors in benchmarking (Park, 1998; Rondeau, 2001). If benchmarking is absent, performance monitoring and then improved efficiency, quality and economic return will otherwise become impossible.

With benchmarking, building maintainability can be ameliorated for it exams and unearths facts about present maintenance processes. On one hand, it assists facility managers who may make reference to findings from benchmarking in planning maintenance. On the other hand, the current best practices in maintenance can be recognised. Thorough examination in the grounds leading to superior performance is however needed before learning and adapting. Because former works in Singapore and Nigeria centred on building designs and pre-occupancy stages when they appraise maintainability, the effects of management are not reflected in their models. In this regard, the author seeks to use benchmark to compare and identify measures in management that will lead to the most maintainable outcomes.

4.2 Financial Management

Getting the job done is purely a fantasy if organisational activities are not supported by necessary financial resources. In FM, financial management plays a vital role not only in supporting but also in achieving outcomes that are best value for money. It is regarded by Langston (2003) as a critical ingredient in the effective deployment and operation of facilities for it plans, forecasts, budgets and controls financial resources to ensure they are used wisely. As one of the business units, facility managers in the FM department nowadays may need to prepare budget for new initiatives and routine activities for approval. When managing for building maintainability is concerned, a closer look at financial management of operational budgets is needed.

In literature, insufficient funds for maintenance have been well documented. In addition to the inability to justify the budget and the existence of strategic-operational gap, budget cuts are other problems facing facility managers. Built asset and organisational performance will definitely be affected unless the inadequacy problem is alleviated. Meanwhile, building maintainability can hardly be improved if this problem persists. At the strategic level, changes in mindset that maintenance is an unwelcome cost burden to a value adding process are essential (Jones and Sharp, 2007). Whilst at the operational level, historical data, together with financial and ICT tools, should be better utilised to budget maintenance. Through benchmarking, financial implications of maintenance decisions can be monitored and compared. As a result of these moves, senior management can make certain of the financial position of maintenance and their implications in organisational performance. Further to planning, budgeting and benchmarking, new initiatives in finance should be introduced, for instance, provision of contingencies and sinking funds to set aside respective financial resources for unexpected events and anticipated spending in long-run. All in all, a mechanism that allows timely acquisition and prudent management of financial resources for maintenance is needed.

4.3 Information Management

Thanks to the rapid development of Information Technology (IT) in recent years, excellent opportunities are now offered to organisations to better manage information and create knowledge. As "knowledge is power", effective use of information merits maximised profit, improved quality, reduced cost and minimised uncertainty when an organisation works towards identified goals (Langston and Lauge-Kristensen, 2002). For information management to thrive, information gathered must be relevant, up-to-date and detailed enough. They have to be monitored, interpreted and updated to support decisions and operations to yield optimised performance. While at the same time, computer-based system should be used to facilitate the process. Exchange of information among different applications and between specific facilities is essential, and the Internet provides a perfect communication channel that makes centralised control possible. Underpinned by technological breakthroughs, the next question is how they can help maintenance. Quoting Smith (2003, pp105)'s word, it is about "how, why, where and when technology augments the function or actions of FM to create knowledge." In the following, several ways in information management that may help achieving maintainability are suggested for discussion.

To begin with, Building Information Modelling (BIM) which is a process that models building life cycle may ease maintenance planning. As BIM builds on historical data and both physical and operational attributes, maintenance information in different stages such as maintenance and repair cycles can be simulated, given maintenance-related information is incorporated in the model. Next, Computer-aided Facilities Management (CAFM) may enhance diagnosability of facilities. In conjunction with sensors connecting to building management systems, real-time monitoring of facility performance becomes possible, and hence faults are easier to detect. It greatly helps facility managers to identify and diagnose failures so as to take proper remedial actions promptly. In the meantime, CAFM tools manage maintenance works schedules, prioritise activities and resolve budget reconciliation (Smith, 2003). In the course of these processes, information generated may serve as reference to later maintenance and future improvements. Building maintenance as a result is better managed and maintenance processes are expedited. In other respect, advances in telecommunication technology also contribute to improve building maintainability. For example, users in an organisation may place maintenance orders over the Internet and maintenance operations may be facilitated through the use of RFID.

4.4 Outsourcing; Issues in Procurement

Outsourcing, as defined by Domberger (2002), is "the process whereby activities traditionally carried out internally are contracted out to external providers" (pp12). It is a hot topic in both management and FM where organisations "outsource" non-core services and concentrate on their core business. By outsourcing non-core services, organisations may reap fruit in specialisation, market discipline, flexibility and cost savings, however, costs in transaction, monitoring and control are incurred (Domberger, 2002). Organisations must be aware of the drawbacks when they decide to outsource services for outsourcing may not always result in a

better outcome. As far as achieving building maintainability is concerned, it is not about choosing between retaining maintenance services in-house or outsourcing them but how the decision affects maintenance performance and thus maintainability.

If an organisation chooses to outsource certain activities, procuring services from external service providers will be the next step. In the process of procurement, tender documentations and tendering processes are the two key activities involved. For the sake of achieving maintainability, here comes a few issues. First, what type of contract should be used for a particular maintenance activity? Second, comparing with traditional procurement how does partnering and alliance affect maintainability? Apart from procurement, Service Level Agreement (SLA) which is a statement of intentions set out by the customer is often in place to specify the level of service to be provided (Atkin and Brooks, 2009). In setting SLA, nevertheless, it may encounter similar problems that happen in describing maintenance standard. With regard to building maintainability, we need the SLA to be self-justifiable and reflect the interests of stakeholders to make sure an appropriate level of service is maintained.

Other than the earlier mentioned fields in FM, areas such as Conflict Management, Contingency Planning and Disaster Recovery, Human Resource Management and Space Management may be essential to building maintainability. Notwithstanding that they are not addressed in this paper, it is hoped that later studies will cover these areas.

5. The Research Framework

As a matter of fact, building maintenance is mostly undertaken when buildings have been occupied. In other words, advance planning for future maintenance is generally absent. As for building maintainability where ease of maintenance is emphasised, there is a deep-rooted thought of building maintainability as an inherited characteristic of design and installation. As a result, endeavours throughout the years were to design for maintainability whilst managerial aspects for improving maintainability have left unattended. In this connection, building maintainability is redefined as “features and/or measures that expedite maintenance, leading to improved maintenance efficiency, augmented building performance and best value outcome”, and managing for building maintainability will be highlighted to fill the current research gap.

As a novel discipline that has developed rapidly in recent years, the philosophy of FM is somehow similar to building maintainability. By integrating 3Ps to provide competitive advantage and achieve best value outcome, FM pursues cost reduction, efficiency and a better environment. That is exactly the target of building maintainability and therefore experience is gained from some aspects in FM.

Benchmarking, which is a systematic process to measure and compare performance against competitors, is fundamental to achieve building maintainability. With benchmarking, performance of maintenance processes can be evaluated objectively to identify any shortcomings in current arrangement. What we need to know is (1) what are the key

maintainability indicators? (2) how can they be measured? (3) why they behave like that? and (4) what are the good practices in maintenance that leads to enhanced maintainability?

Financial management, which is a process to plan, forecast, budget and control financial resources to achieve best value outcomes, is of vital importance to the effective deployment and operation of facilities. In managing financial resources for maintenance, insufficient funds for maintenance, inability to justify the budget proposal, existence of strategic-operational gap and budget cuts are the challenges that have been well documented. What we need to know is (1) how do those best-of-breed arrange finance for maintenance? (2) how do new initiatives in finance (e.g. sinking fund) influence building maintainability? and (3) how to devise a method that enables timely acquisition and prudent management of financial resources for maintenance?

Information management, which facilities the use, process and management of information, can reduce cost, improve quality and reduce uncertainty through the use of computer-based systems. Breakthroughs in telecommunication have also promoted exchange of information and control at distance. What we need to know is (1) how BIM may help in planning maintenance for better maintainability? (2) what are the benefits of maintenance in CAFM and how they are reflected in maintainability benchmarks? and (3) how do maintenance profiles and maintenance manuals help maintainability?

Outsourcing, which is a process to contract out non-core services to external service providers, allows organisations to focus on their core business and reap fruits from services provided by third parties who have comparative advantages in their service. We would like to know the difference in maintainability if similar maintenance works are undertaken separately by in-house staffs and contractors. Procurement is the next step if an organisation decides to outsource certain services. In respect of building maintainability, we need to know (1) what type of contract should be used for better maintainability? and (2) what are the effects of partnering and alliance upon maintainability? In Figure 3, a diagram summarising the proposed research framework of managing for building maintainability is provided.

6. Conclusion

Building maintenance is no longer a necessary evil if organisations make use of it to improve facility performance and add value – building maintenance is indeed an angel. What is more, facility managers have to get ready for the growing maintenance demand associated with the ageing trend among built assets. Improving building maintainability for these reasons is of critical importance. In the old days, the maintainability concept has long been regarded as an inherited design characteristic and hence managerial aspects in maintainability are neglected. In connection with that, building maintainability is redefined and managing for maintainability is scrutinised.

On account of the philosophy behind managing for building maintainability and FM, four areas in FM are consulted. Benchmarking is an essential tool to improve building maintainability as it measures maintenance performance. More specifically, it serves as the foundation to compare and identify measures in management that result in more maintainable outcomes, and vice versa. Financial management is at the heart of achieving outcomes that are best value for money. Effective maintenance is sometimes, however, restrained by insufficient funds and even budget cuts. We need to figure out a method that enables timely acquisition and prudent management of financial resources for maintenance. Information management is an innovation that management and exchange of information are made easy. Use of computer-based systems in maintenance processes nowadays is more common. We need to go further to see how certain applications in information management may help achieving building maintainability. Outsourcing is the procuring of non-core activities such as maintenance services from contractors, while at the same time organisations can focus on their core business. We need to know how the outsourcing decision affects building maintainability. In the research framework provided, question raised in this paper are consolidated. Answers to these questions are believed to be the clues to manage for maintainability. They will be addressed shortly in subsequent studies.

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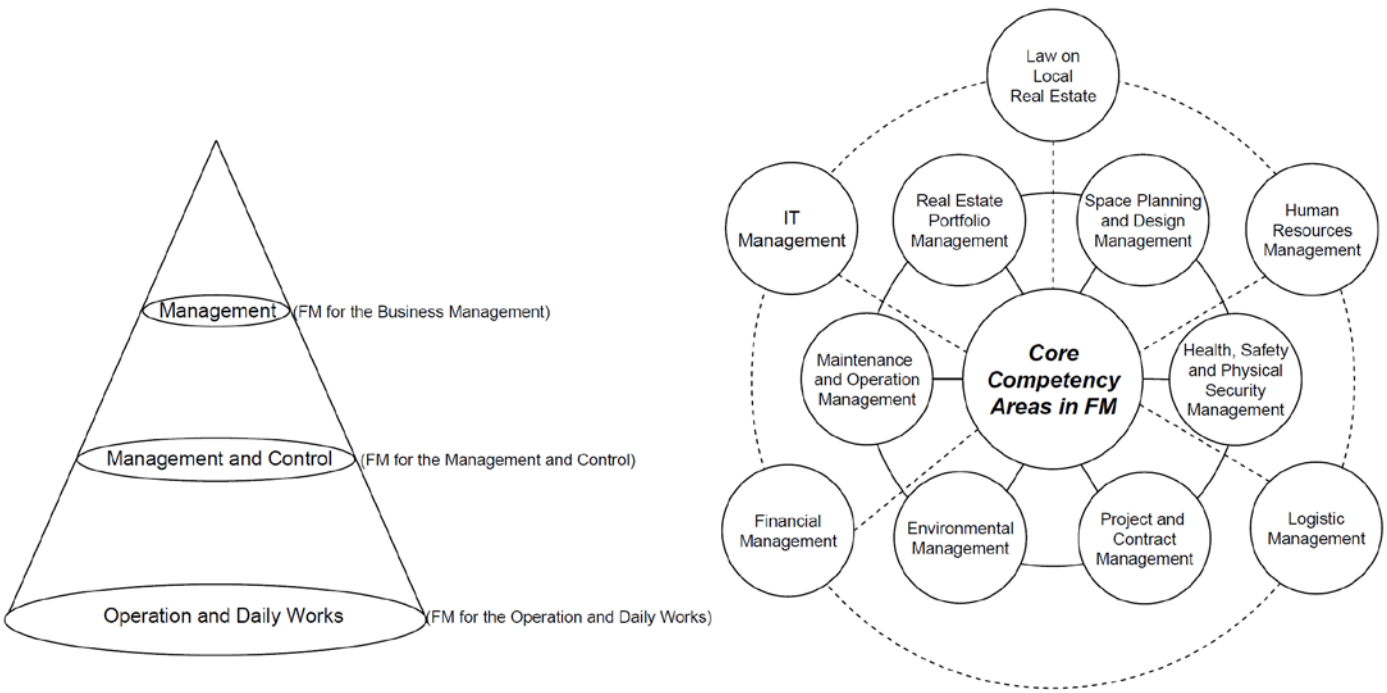

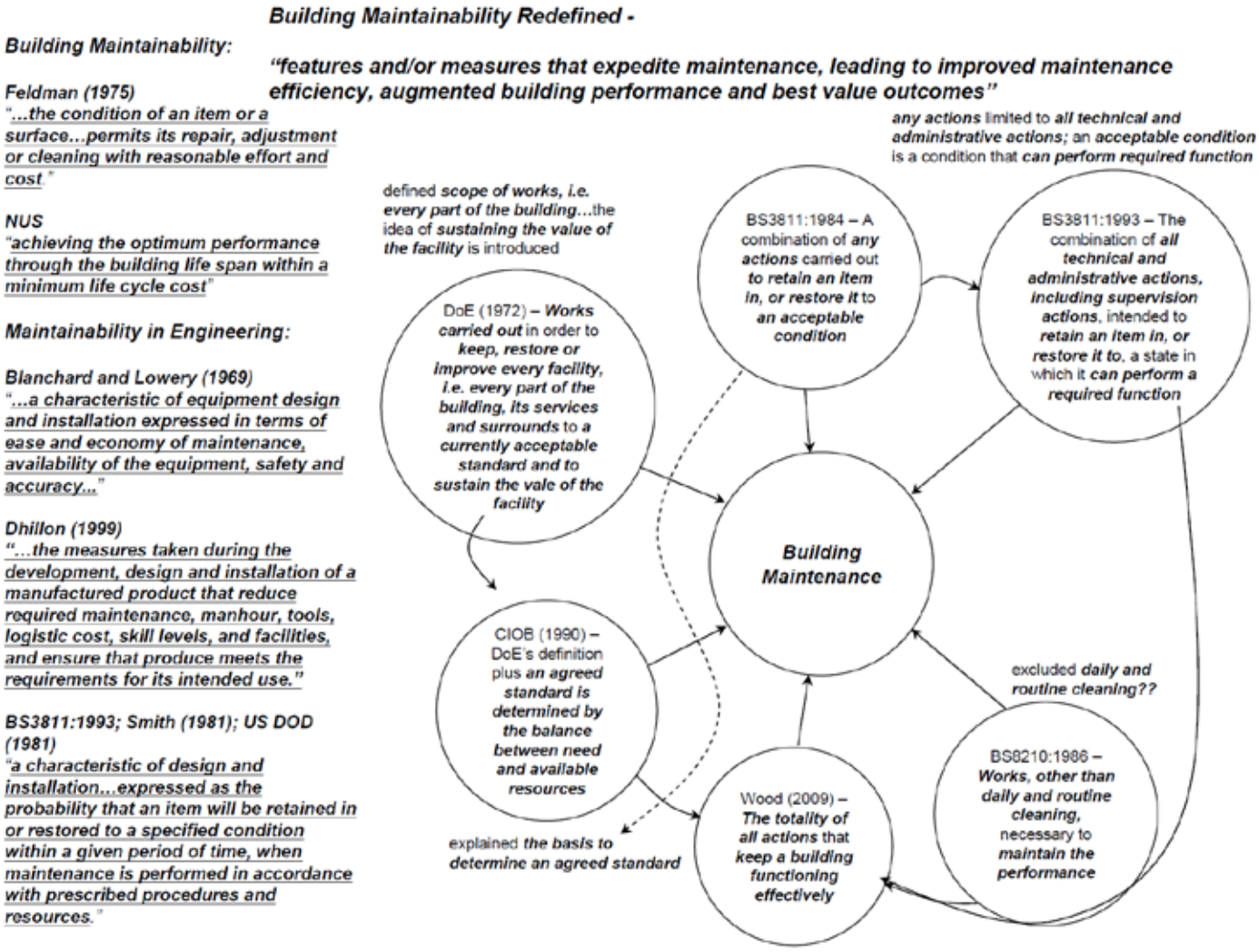

Figure 1: Definitions of building maintenance and building maintainability

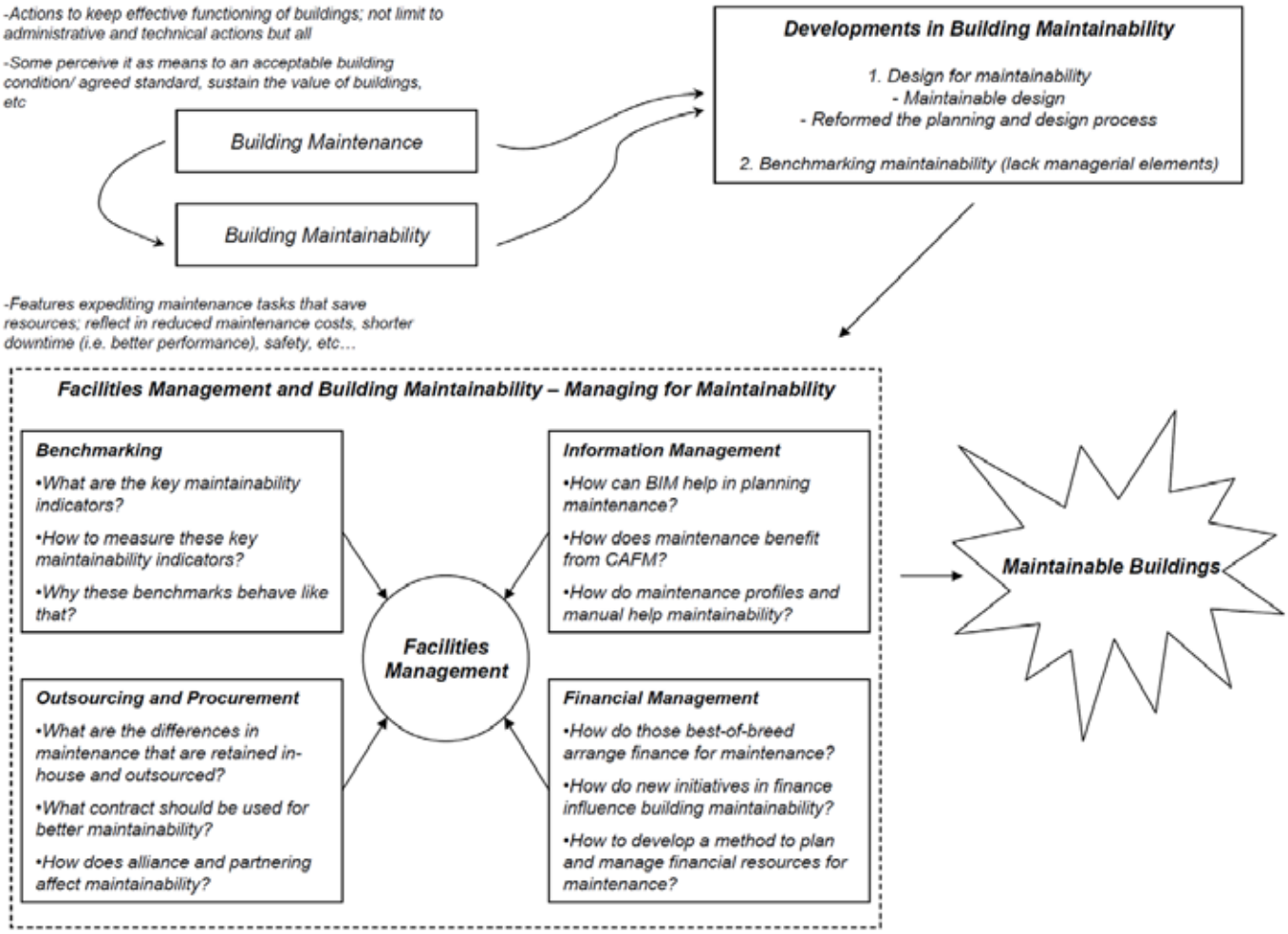

Figure 3: Proposed research framework for managing for maintainability

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