Planning and Implementation of Building Maintenance Strategies

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Abstract: This book is an exploration of the intricate process of planning and implementing effective building maintenance strategies. In the realm of construction and property management, building maintenance plays a vital role in ensuring the longevity, functionality, and value of our built environment. The purpose of this book is to serve as a comprehensive guide, offering insights, knowledge, and practical tools for professionals and enthusiasts alike who are involved in building maintenance Whether you are a facility manager, maintenance technician, property owner, or aspiring expert in the field, this book aims to equip you with the necessary understanding and strategies to make informed decisions and optimize maintenance efforts.

Throughout the pages of this book, we delve into the fundamental concepts and principles of building maintenance strategies, exploring the importance of proactive planning, effective execution, and continuous evaluation. We delve into topics such as building maintenance strategies, characteristics of planned maintenance, participative mechanisms in planned maintenance and the maintenance of building facilities and services all of which contribute to the development of robust maintenance strategies.

It is our hope that the knowledge imparted within these pages will empower you to enhance the efficiency, functionality, and lifespan of the buildings under your care.

Keywords: Building, maintenance, skilled, outsourcing, services

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PREFACE

This book is an exploration of the intricate process of planning and implementing effective building maintenance strategies. In the realm of construction and property management, building maintenance plays a vital role in ensuring the longevity, functionality, and value of our built environment. The purpose of this book is to serve as a comprehensive guide, offering insights, knowledge, and practical tools for professionals and enthusiasts alike who are involved in building maintenance. Whether you are a facility manager, maintenance technician, property owner, or aspiring expert in the field, this book aims to equip you with the necessary understanding and strategies to make informed decisions and optimize maintenance efforts.

Throughout the pages of this book, we delve into the fundamental concepts and principles of building maintenance strategies, exploring the importance of proactive planning, effective execution, and continuous evaluation. We delve into topics such as building maintenance strategies, characteristics of planned maintenance, participative mechanisms in planned maintenance and the maintenance of building facilities and services all of which contribute to the development of robust maintenance strategies.

It is our hope that the knowledge imparted within these pages will empower you to enhance the efficiency, functionality, and lifespan of the buildings under your care. We would like to express our gratitude to the countless professionals and researchers who have contributed to the field of building maintenance. Their dedication and expertise have laid the foundation for this book, and we are honoured to build upon their work.

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Lastly, we extend our deepest appreciation to the readers of this book. Your curiosity, commitment to continuous learning, and passion for maintaining our built environment are what drive us to share our knowledge and insights. We hope that this book serves as a valuable resource on your journey towards developing and implementing effective building maintenance strategies.

Together, let us embark on this enlightening exploration of building maintenance strategies, shaping a future where our built environment stands strong, functional, and sustainable.

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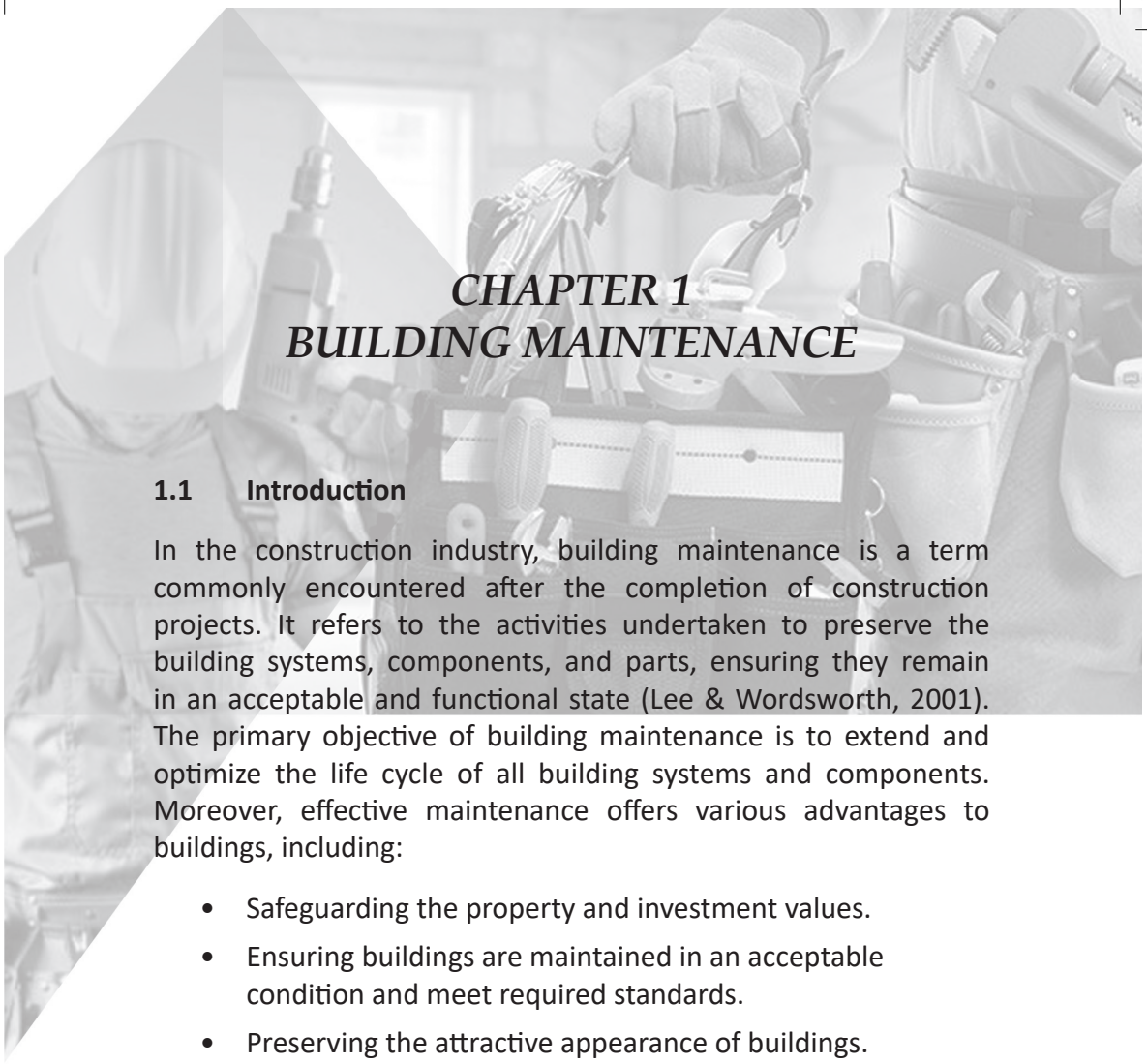

CHAPTER 1
BUILDING MAINTENANCE

1.1 Introduction

In the construction industry, building maintenance is a term commonly encountered after the completion of construction projects. It refers to the activities undertaken to preserve the building systems, components, and parts, ensuring they remain in an acceptable and functional state (Lee & Wordsworth, 2001). The primary objective of building maintenance is to extend and optimize the life cycle of all building systems and components. Moreover, effective maintenance offers various advantages to buildings, including:

- Safeguarding the property and investment values.
- Ensuring buildings are maintained in an acceptable condition and meet required standards.
- Preserving the attractive appearance of buildings.
- Generating income for building owners and surrounding activities.
- Conserving the historical and architectural values of buildings.

In the present day, achieving sustainability in buildings has become a significant concern in the construction industry. Building maintenance plays a vital role in attaining building sustainability, leading to an inevitable rise in maintenance costs within the construction sector. Consequently, the significance of building maintenance is now widely acknowledged. Building maintenance is a long-term program that requires meticulous planning and implementation. While the construction phase of a building

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CHAPTER 2
BUILDING MAINTENANCE STRATEGIES

2.1 Introduction

Traditionally, building maintenance has been divided into two main categories: planned maintenance and unplanned maintenance (Seeley, 1987). With an increasing recognition of the importance of efficient building maintenance, the building industry now primarily emphasizes the adoption of planned maintenance. In this approach, unplanned maintenance only addresses the repair or replacement of parts and components after they have been damaged, lacking a structured maintenance program with allocated resources. A comparison between planned and unplanned maintenance is outlined in Table 2.1. This book focuses its discussions on planned maintenance, which is further subdivided into several strategies, as illustrated in Figure 2.1.

Table 2.1: Comparisons between planned maintenance and unplanned maintenance

Planned Maintenance	**Unplanned Maintenance**
Higher initial cost	Reduced initial cost
Effective maintenance planning and management	Absence of planning and management, often reliant on ad-hoc approaches
Limited uncertainties	Heightened uncertainties
Minimal occurrences of building and system failures	Frequent building and system failures
Lower risks	Higher risk
Extended lifespan	Shortened lifespan
Lower life cycle cost	Increased life cycle cost

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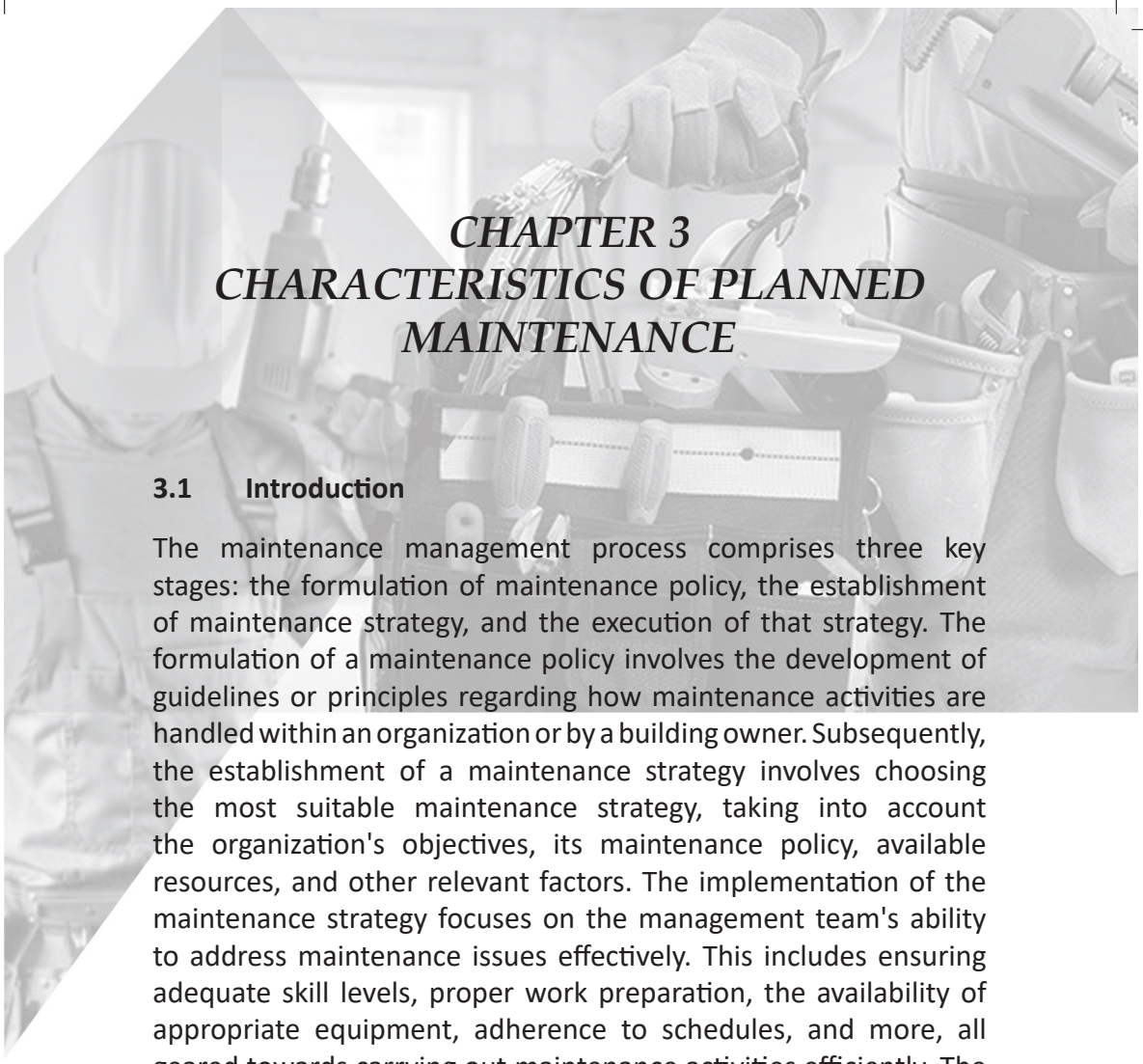

CHAPTER 3
CHARACTERISTICS OF PLANNED MAINTENANCE

3.1 Introduction

The maintenance management process comprises three key stages: the formulation of maintenance policy, the establishment of maintenance strategy, and the execution of that strategy. The formulation of a maintenance policy involves the development of guidelines or principles regarding how maintenance activities are handled within an organization or by a building owner. Subsequently, the establishment of a maintenance strategy involves choosing the most suitable maintenance strategy, taking into account the organization's objectives, its maintenance policy, available resources, and other relevant factors. The implementation of the maintenance strategy focuses on the management team's ability to address maintenance issues effectively. This includes ensuring adequate skill levels, proper work preparation, the availability of appropriate equipment, adherence to schedules, and more, all geared towards carrying out maintenance activities efficiently. The effectiveness of maintenance implementation can be evaluated by its ability to minimize waste, expenses, downtime, failures, and user complaints.

Given the greater effectiveness of planned maintenance over unplanned maintenance, it is advisable to introduce and implement planned maintenance practices. In general, there are two primary categories of planned maintenance: preventive maintenance and corrective maintenance. Preventive maintenance encompasses a range of tasks, including inspections, monitoring, cleaning, lubrication, adjustments, alignments, repairs, replacements, and the upkeep of building and system components, all carried out proactively to prevent failures or system breakdowns. Preventive

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CHAPTER 4
PARTICIPATIVE MECHANISMS IN PLANNED MAINTENANCE

4.1 Introduction

The concept of participation theory finds broad acceptance across various domains, proving its utility in information systems development, management science, planning, and evaluation practices (Gregory, 2000). Flynn (1992) further highlighted four pivotal aspects that endorse the incorporation of participation theory in decision-making, design, and planning:

i. Ethics: All individuals engaged in a project or activity possess the right to voice their own perspectives and demands.

ii. Expediency: Those excluded from decision-making could potentially critique or undermine decisions made by others.

iii. Expert knowledge: Certain decisions necessitate specialized expertise, and involving pertinent experts in the decision-making process ensures that decisions align with this knowledge.

iv. Motivating force: Participation in the decision-making process ensures that individuals comprehend the rationale behind decisions, thereby promoting efficient and effective implementation of the associated tasks.

The theory of participation has led to in-depth discussions about participative management in the management domain. Successful participative management necessitates the sharing of information, effective communication, fair distribution of rewards, and investment in employee training. Participative management is essentially characterized by delegating increased decision-making authority and responsibility to frontline employees. This approach

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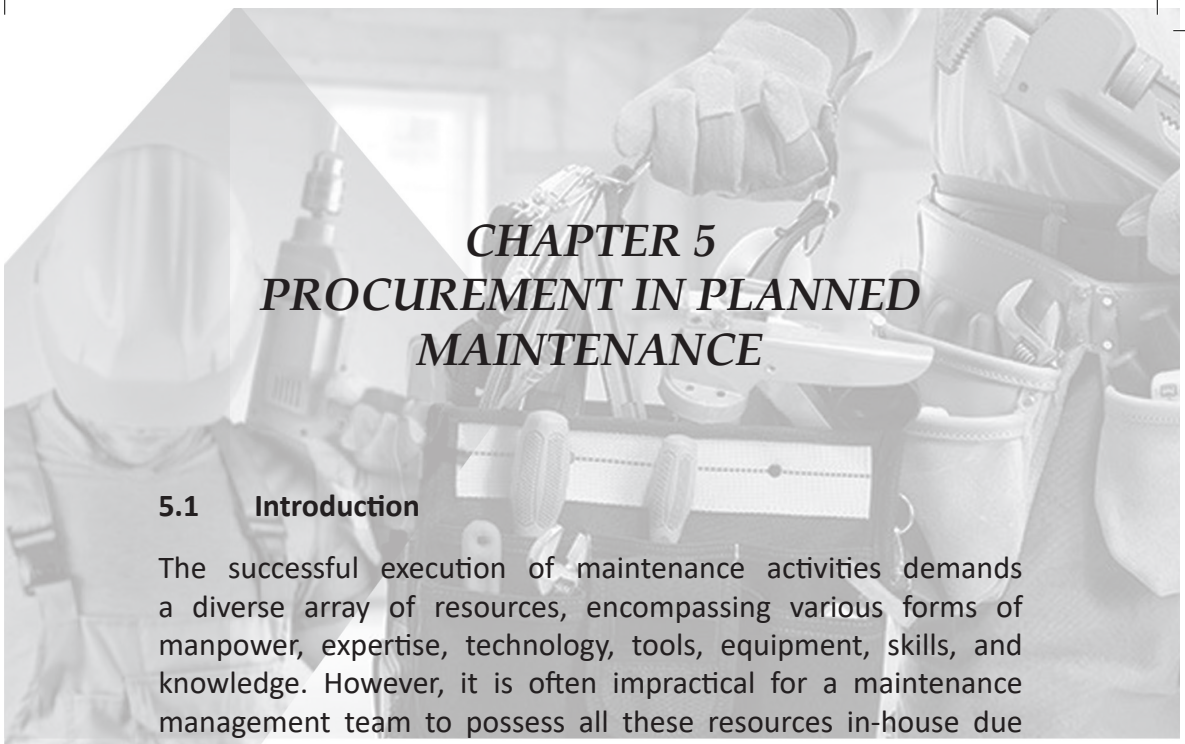

CHAPTER 5
PROCUREMENT IN PLANNED MAINTENANCE

5.1 Introduction

The successful execution of maintenance activities demands a diverse array of resources, encompassing various forms of manpower, expertise, technology, tools, equipment, skills, and knowledge. However, it is often impractical for a maintenance management team to possess all these resources in-house due to cost considerations. Consequently, an efficient maintenance management approach is achieved through a strategic blend of in-house and outsourced resources. In light of this, the procurement process becomes a necessity in the realm of maintenance management, serving as the means to effectively acquire and manage these essential resources.

Procurement is defined as an organizational framework that designates specific roles and responsibilities to individuals and entities (Adekunle, Michael, & Malik, 2009; Love, Irani, Cheng, & LI, 2002). Within a project, the procurement system plays a pivotal role in influencing overall satisfaction and the eventual success of maintenance work. The procurement system establishes the main structure of authorities and responsibilities among project participants, ultimately emerging as a crucial determinant of project success. Given its significance, the careful selection of an appropriate procurement strategy holds paramount importance in maintenance management.

The procurement approach outlines the interconnections of various components within a project that outlines the systematic execution of design, funding, maintenance, and operational aspects of a project. Additionally, it highlights the specific duties

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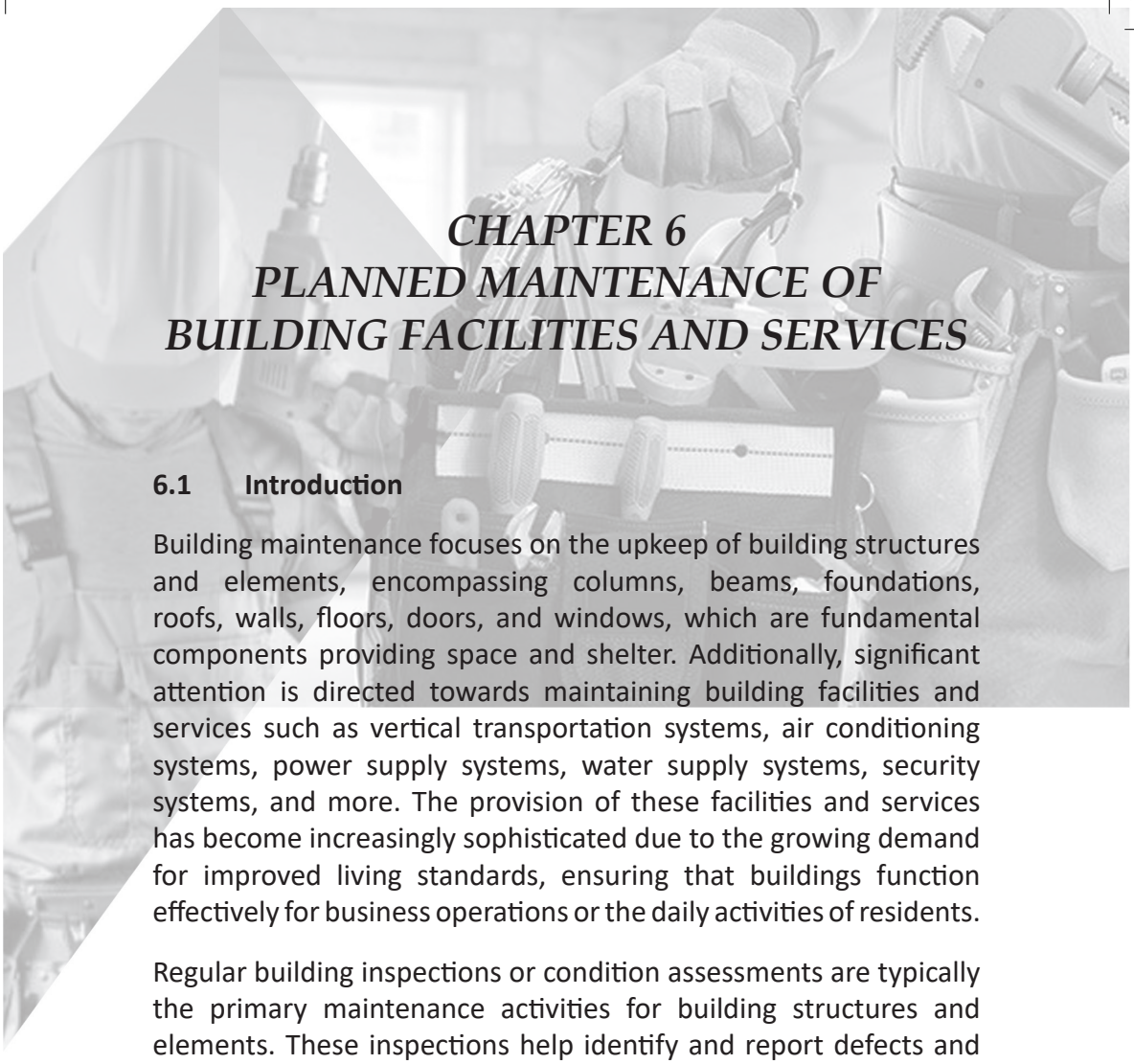

CHAPTER 6
PLANNED MAINTENANCE OF BUILDING FACILITIES AND SERVICES

6.1 Introduction

Building maintenance focuses on the upkeep of building structures and elements, encompassing columns, beams, foundations, roofs, walls, floors, doors, and windows, which are fundamental components providing space and shelter. Additionally, significant attention is directed towards maintaining building facilities and services such as vertical transportation systems, air conditioning systems, power supply systems, water supply systems, security systems, and more. The provision of these facilities and services has become increasingly sophisticated due to the growing demand for improved living standards, ensuring that buildings function effectively for business operations or the daily activities of residents.

Regular building inspections or condition assessments are typically the primary maintenance activities for building structures and elements. These inspections help identify and report defects and deterioration in the building's components. Subsequently, work orders are issued to implement appropriate remedial actions aimed at restoring the structures and elements to acceptable condition standards. Therefore, the identification, diagnosis, and prognosis of defects play a vital role in the maintenance of building structures and elements.

In this chapter however, the focus shifts towards the maintenance of building facilities and services, which often involve mechanical and electrical components. Each facility or service may adopt different maintenance strategies, such as scheduled maintenance, condition-based maintenance, or corrective maintenance, within their maintenance programs. Sometimes, specific regulations or

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BIBLIOGRAPHY

Adekunle, S. O., Michael, D., & Malik, M. A. K. (2009). Construction project procurement routes: an in-depth critique. International Journal of Managing Projects in Business, 2(3), 3338-3354. doi:10.1108/17538370910971018

Ancarani, A., & Capaldo, G. (2005). Supporting decision-making process in facilities management services procurement: A methodological approach. Journal of Purchasing and Supply Management, 11(5-6), 232-241. doi:10.1016/j.pursup.2005.12.004

Atkin, B., & Brooks, A. (2005). Total Facilities Management (2nd ed.). Oxford: Blackwell Publishing Ltd.

Barringer, H. P. (2003). A Life Cycle Cost Summary. Paper presented at the International Conference of Maintenance Societies, 20-23 May, 2003.

Bassioni, H. A., Price, A. D. F., & Hassan, T. M. (2005). Building a Conceptual Framework for Measuring Business Performance in Construction: An Empirical Evaluation. Construction Management and Economics, 23(5), 495-507.

Bon, R., McMahan, J. F., & Carder, P. (1998). Property Performance Measurement: From Theory to Management Practice. Facilities, 16(7/8), 208-214.

Chanter, B., & Swallow, P. (2007). Building Maintenance Management (2nd ed.). Oxford: Blackwell Science Ltd.

Planning and Implementation.indd 179 10-Jan-24 11:17:50 AM

Dainty, A. R. J., Cheng, M. I., & Moore, D. R. (2003). Redefining Performance Measures for Construction Project Managers: An Empirical Evaluation. Construction Management and Economics, 21(2), 209-218.

Espling, U., & Olsson, U. (2004). Part II. Partnering in a railway infrastructure maintenance contract: a case study. Journal of Quality in Maintenance Engineering, 10(4), 248-253. doi:10.1108/13552510410564864

Flanagan, R., & Norman, O. (1983). Life Cycle Costing for Construction. London: Royal institution of Chartered Surveyors.

Flynn, D. J. (1992). Information Systems Requirements: Determination and Analysis. London: McGraw-Hill.

Gregory, A. (2000). Problematizing Participation: A Critical Review of Approaches to Participation in Evaluation Theory. Evaluation, 6(2), 179-199.

Hui, E. Y. Y., & Tsang, A. H. C. (2004). Sourcing Strategies of Facilities Management. Journal of Quality in Maintenance Engineering, 10(2), 85-92.

Kleeman, W. B. (1994). Out-tasking: More Widespread than Outsourcing in the USA. Facilities, 12(2), 24-26. doi:10.1108/02632779410051742

Lee, R., & Wordsworth, P. (2001). Lee's Building Maintenance Management (4th ed.). Oxford: Blackwell Science Ltd.

Li, Z., Yao, W., Lee, S., Lee, C., & Yang, Z. (2000). Application of Infrared Thermography Technique in Building Finish Evaluation. Journal of Nondestructive Evaluation, 19(1), 11-19. doi:Doi 10.1023/A:1006612023656

Love, P. E. D., Irani, Z., Cheng, E., & LI, H. (2002). A model for supporting inter-organizational relations in the supply

Planning and Implementation.indd 180 10-Jan-24 11:17:50 AM

chain. Engineering Construction and Architectural Management, 9(1), 2-15.

Moreno-Muñoz, A., Dolores Redel, M., Oterino, D., & De la Rosa, J. J. G. (2007). Quality standards for "clean" electrical supplies. Facilities, 25(1/2), 61-77. doi:10.1108/02632770710716948 RICS. (2009). Building maintenance: strategy, planning and procurement. In RICS guidance note 2nd edition. UK: Royal Institution of Chartered Surveyors (RICS).

Seeley, I. H. (1987). Building Maintenance (2nd ed.). New York: Palgrave.

Shen, Q. (1997). A comparative study of priority setting methods for planned maintenance of public buildings. Facilities, 15(12/13), 331-339. doi:10.1108/02632779710188324

Sherwin, D. (2000). A Review of Overall Models for Maintenance Management. Journal of Quality in Maintenance Engineering, 6(3), 138-164.

Suruhanjaya Tenaga. (1994). Electricity Regulations 1994. In P.U. (A) 38/94. Putrajaya: Suruhanjaya Tenaga.

The Chartered Institute of Building. (1990). A Good Guide to Good Practice: Maintenance Management. Berkshire: The Chartered Institute of Building.

Tsang, A. H. C. (1995). Condition-Based Maintenance: Tools and Decision Making Journal of Quality in Maintenance Engineering, 1(3), 3-17.

Venkatesh, J. (2007). An Introduction to Total Productive Maintenance (TPM). Retrieved from http://www.plant-maintenance.com/articles/tpm_intro.shtml

Planning and Implementation.indd 181 10-Jan-24 11:17:50 AM

Wu, S., & Clements-Croome, D. (2007). Ratio of Operating and Maintenance Costs to Initial Costs of Building Services System. Cost Engineering, 49(12), 30-33.

Yang, H., Yeung, J. F. Y., Chan, A. P. C., Chiang, Y. H., & Chan, D. W. M. (2010). A Critical Review of Performance Measurement in Construction. Journal of Facilities Management, 8(4), 269-284.

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