Survey of Maintenance Management Implementation: A Case Study of Office Buildings in Indonesia

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Abstract

Building maintenance is a process that's carried out to maintain the function of a building. This procedure involves planning and implementing various maintenance measures during the construction phase. Having a well-planned system can help provide a sense of comfort to the users of the building. This can increase their productivity. This study aims to find out how the building maintenance factor influences the comfort of office workers. Random sampling method is used in this study to collect the data. The primary data of this study was obtained by distributing questionnaires to office workers in 3 different office buildings with a total of 45 people using the random sampling method with each respondent receiving 15 questions. The secondary data and other supporting data are obtained from literature studies, regulations, and scientific journals. The results show that building maintenance affects the comfort of office workers 83.20%, 80%, and 86,10% in buildings A, B, and C respectively. Meanwhile, the percentage of building maintenance variables that are the most dominant on the comfort of office workers is the room cleanliness maintenance variable in Building A, B, and C with a value of 82.40%, 83.04%, and 85.17%. Building maintenance affects the room cleanliness the most.Its impact is 82.80%, 81.62%, and 85.60% in Buildings A, B, and C, respectively.

Keywords
Maintenance Management, Preventive Maintenance, Total Productive Maintenance, Survey, Office Building.

1. Introduction

Building maintenance refers to the process of maintaining the function of a building. It involves the management of various maintenance programs and procedures. Building maintenance is a method of preserving the function of a structure in the construction industry. Its implementation necessitates maintenance management and associated costs. Building maintenance results can provide security and comfort to building users. According to the Minister of Public Works No.24/2008 concerning guidelines for building maintenance, a building is a physical form of the result of construction work that is integrated with its domicile, partially or wholly located above and/or in the ground and/or water, that functions as a place for humans to carry out their activities, whether for housing or residence, religious activities, business activities, culture or special activities.

Building performance refers to the design and construction of a facility that provides a comfortable and healthy environment for users (Bakens et al., 2005; Ibem et al., 2013). Therefore, an analysis of maintenance demand that reflects the perception of the functionality of the services provided by the building can help evaluate the performance of the building system.

Buildings require excellent management during the maintenance and operation phase due to the high costs associated

with this phase (F. Rodrigues, et al., 2018). When building maintenance is not achieved at the highest level, this could affect the building users' satisfaction and performance of the building (Heracleous, C., & Michael, A., 2019). However, to take the advantages and disadvantages of maintenance, this paper is aimed to identify the characteristics of preventive maintenance, as well as the measures to improve the efficiency of the characteristics that influence maintenance performance in office buildings.

1.1 Objectives

The main objectives of this research are as follows:

1. To understand the maintenance characteristics at the office building sector
2. To understand the relationship between maintenance management, environmental building, and occupation satisfaction.

2. Literature Review

2. 1 Building Maintenance

Maintenance planning for facilities including the office buildings has been one of the important things that need to be strategically arranged by the managers. Nurcahyo et al. (2018) stated that the capability in maintenance planning gives guidelines to the organization to achieve excellence in the maintenance process. In addition, the selection of maintenance policies is a very important task for the company. This work is often done on the basis of qualitative and subjective choices that rely solely on human factors (Nurcahyo, et al., 2017).

The building has a huge role in the operations of a company. It has to be considered as one of the factors that the management needs to be concerned with. (Au-Yong et al., 2019). Maintenance plays a huge role in maintaining the condition of buildings. It is important to maintain the building's longevity in an acceptable manner (Hui, 2005) to maintain property value and maximize return on investment (Tiun, 2009).

2.2 Maintenance Management

There are various interpretations about maintenance management according to previous studies. Management is a process utilized to lead and manage various parts of an organization. It involves the deployment and manipulation of various resources. (Marquez 2006). According to Al-Turki (2014) maintenance program is carried out to maintain an asset's worth. It involves various actions designed to prevent or minimize its wear and tear. Maintenance is a combination of technical and managerial actions that are carried out during the life cycle of an item (BSI Standards Limited 2017). The maintenance goals of a company are to improve its efficiency and satisfaction of the users.

Maintenance management is a process utilized for identifying, planning, and controlling the maintenance activities of a facility. This process involves carrying out strategies and procedures that are designed to improve the efficiency and profitability of the maintenance program (BSI Standards Limited 2017). A maintenance program is a process utilized to maintain operations. It involves planning and controlling the various tasks and activities related to maintaining the facility's ability to operate efficiently. A maintenance planning process involves three phases which are planned for various reasons (Nurcahyo et al. 2018). These phases are: strategic, medium, and short-term (Al-Turki 2014). A maintenance strategy is a set of procedures and processes that are designed to support the continuous improvement of an organization (Al-Turki 2014).

In Indonesia, according to the Regulation of the Minister of Public Works Number: 24/PRT/M/2008 concerning Guidelines for Building maintenance is a process that involves keeping the building's various components and systems working properly. It's also carried out to maintain the building's reliability. Based on the regulation, this research would like to explore the following points:

1. Types of Building Maintenance
   Hestin Mulyandari et al (2011) stated that the types of maintenance activities consist of:

a. Scheduled Maintenance
   1) Preventive maintenance is carried out to prevent unexpected damage that can occur when production facilities are used.
   2) Predictive maintenance is a process that involves identifying and replacing spare parts that are not working properly.
   3) Corrective Maintenance is carried out when a facility or structure gets damaged or has an issue. They require attention to the costs associated with maintaining the facility.

b. Unscheduled Maintenance
   Breakdown maintenance is a type of maintenance that occurs suddenly and is usually not predicted or scheduled. It is highly avoided to avoid the impact that it has on all parties.

2. Maintenance Characteristics:
   a. Preventive maintenance (PM) maintenance is carried to aims reducing failure possibility or function decline of an item and carried on a chosen interval, PM that has been determined (predetermined), or in accordance with the specified conditions (Condition Based Maintenance). According to Wardani (2018), maintenance and management often are viewed differently depending on one's field, each definition will always cover the processes of discovery, capturing, information exchange, and application.
   b. Scheduled preventive maintenance, routine maintenance is performed on equipment to keep it running and prevent downtime and expensive repair. (Joshi, et., 2014). (Xiao et al, 2015) preventive maintenance can be effective for machine maintenance at a high level of reliability. However, the implementation of scheduled maintenance activities can result in machine downtime while PM is being performed. There is also spare part management, which is important due to spare parts accounting for a significant portion of maintenance costs (Al-Turki et al., 2014). Direct materials (spare parts) are all materials and component parts that can be economically traced directly to planned maintenance work (Mohammed Ben-Daya et al., 2009) (Umar M. Al-Turki et al., 2014).
   c. Characteristics of condition-based maintenance that affect maintenance performance include skilled managers, monitoring equipment and techniques, data and information acquisition, and the frequency of monitoring and inspections (Au-Yong, 2014).
   d. The concept of comfort is complex to describe because it is more of an individual responsive judgment. Convenience is defined as the state of having met basic human needs that are both individual and holistic. The fulfillment of comfort can lead to an individual sense of well-being. A pleasant working environment is influenced by both physical and non-physical factors.

3. Methods

The data collection method was conducted by using a questionnaire given in three office building locations as shown in below Table 1. To analyze the results of data collection, references from the collected papers were used.

Table 1. Method mapping table based on 4 maintenance survey reference papers

No.	Paper Title	Data Collection	Methods
1	Significant Characteristics of Scheduled and Condition-Based Maintenance in Office Buildings	Literature review, questionnaire survey, and semi structured interviews	Ranking of Characteristics, reliability analysis
2	Improving Occupants' Satisfaction with Effective Maintenance Management of HVAC System in Office Buildings	Questionnaire Survey	Correlation Analysis & Regression Analysis

3	Benchmarking facilities operation and maintenance management using CAFM database: Data analysis and new results	Benchmarking workflow, Questionnaire Survey, Gathering data from CAFM system	Regression Analysis, Artificial Neural Network (ANN), Life Cycle Cost Analysis (LCC)
4	Structural equation model for assessing factors affecting building maintenance success	literature review, Questionnaire The the survey, Structural equation modeling	Reliability testing, Validity testing

Based on the mapping of 4 maintenance characteristic survey papers, our group will use data collection techniques and methods according to the paper entitled "Significant Characteristics of Scheduled and Condition-Based Maintenance in Office Buildings" as the reference of this paper.

The survey method is used in the study to gather information about employee satisfaction in office buildings. The survey uses the Likert scale to assign ratings to each criterion. The definition of each scale is explained in table 2.

Table 2. 5 Point Likert Scale

Scale	Description
1	Very Good
2	Good
3	Less Good
4	Not Good
5	Not Very Good

The questionnaire of employees consists of a set of questions exploring more about the working environment, maintenance management, and employee satisfaction of the office buildings.

4. Data Collection

The data collection for this paper was obtained from interviews and surveys that were responded to by the management officers of building facilities in three different office buildings in Indonesia. The analysis of the collected data was conducted by using the literature sources from books and papers as the theoretical basis.

Table 3. Characteristics of the office buildings surveyed

Building	Purpose	Area [m^2]	Number of Floors	Year	Type Management
A	Electrical Service	2.271,5	4	2018	Direct/ Outsourcing
B	Oil & Gas Company	1452	17	1998	Direct

C	Public Service	39.629	16	2012	Outsourcing

The survey looked into three buildings in Indonesia, general information about the three buildings is provided in Table 4.

Facility check can be performed on a regular or periodical basis through observation, regular monitoring and the use of specialized equipment when necessary to evaluate the actual status and quickly detect signs of degradation, damage, and equipment failure

Table 4. Maintenance Period by Facility of each buildings

No	Description	Maintenance		
		Electrical Service	Oil & Gas Company	Public Service
1	Air Conditioner	Every 3 month	Every 2 month	Every 2 month
2	Generator Set	6 month	3 Month	3 Month
3	Fire Prevention	A month	A month	A month
4	Elevator	A month	A month	A month

The maintenance frequency of facilities such as air conditioning, generator set, fire prevention, and an elevator is shown in table 3. It should be noted, however, that the design may change the maintenance frequency with explanation, taking into account interest in the facility's function.

5. Results and Discussion

The interviews were conducted in the office building of electrical service, oil & gas company, and public service that specifically runs its building. Among the questions asked was about how the maintenance management is conducted to maintain the condition of the office building. The scheduled maintenance was planned and run accordingly by the facility management officers.

This research involved cooperation from a management company and the company to conduct interviews and surveys of their workers. The survey was conducted by giving questionnaires to workers from 3 selected buildings in offices in Indonesia to compare building maintenance management and occupant satisfaction levels. The set of questions explore more about characteristics of maintenance, preventive maintenance, and corrective maintenance that had been implemented in the office buildings where the respondents work. The number of respondents who submit the response to the questionnaire is 45 respondents in total. Table 5 shows the respondents from each building. The survey was conducted via electronic message and email from October 21 to October 28, 2021.

Table 5. Respond number by building

Office	A	B	C	Total
Answer	15	15	15	45

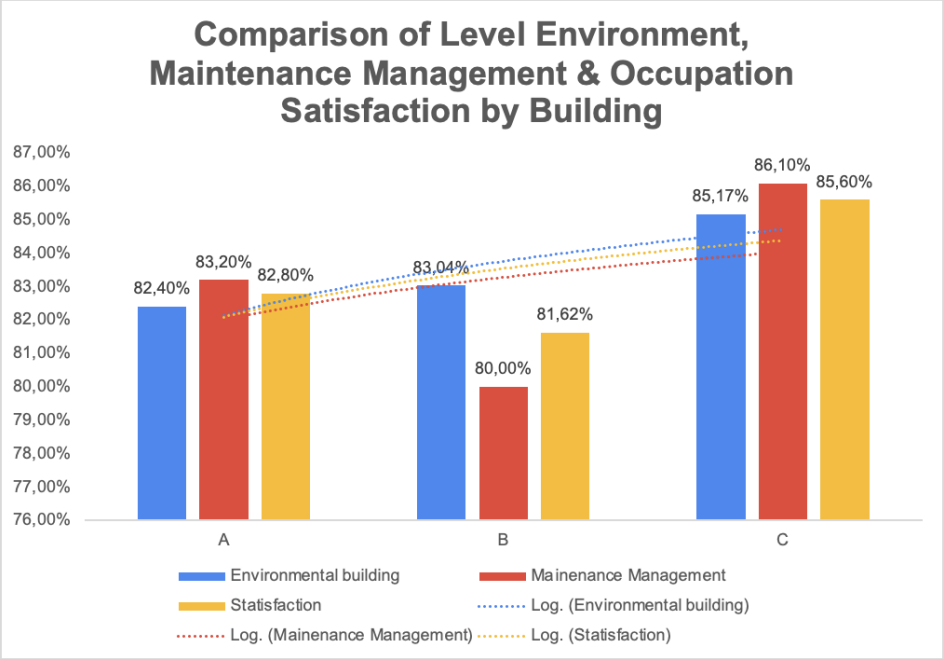

Figure 1. Comparison of Level Environment, Maintenance Management & Occupation Satisfaction by Building

The elements of Environmental Building in this research consist of the cleanliness of the building and security. Meanwhile, the elements of Maintenance Management consist of the condition of facilities and buildings, and also how effective the maintenance activities contribute to the current condition (see Figure 1). The result of this research shows that the maintenance activities in each building contribute positively to the condition of facilities and buildings.

Occupation Satisfaction was measured using a five-point Likert scale ranging from very satisfied to very dissatisfied. The results showed that building A (83,2%), B (80%) and C (86,1%).

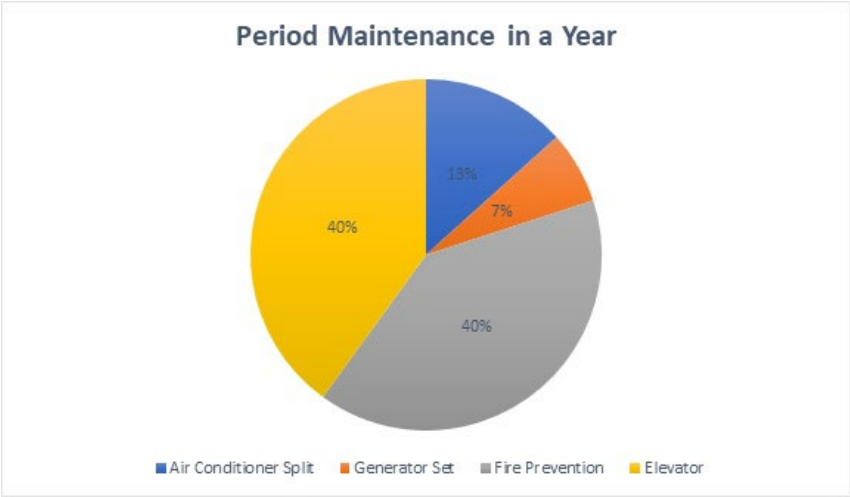

Figure 2. Periodic Maintenance in a Year

This research analyzed four kinds of facilities' periods of maintenance in a year as shown in the above figure 2. The maintenance period of those facilities was always conducted according to the schedule that had been planned by the management due to their nature as the essential facilities for the users to work and also for the preparedness in the emergency condition.

Elevator and fire prevention are the facilities that are most concerned about among all of the others. The elevator was maintained every once a month due to the amount of its usage that is very high. Meanwhile, fire prevention was also maintained every once a month as a preparation for emergency conditions that might happen unpredictably.

6. Conclusion

Based on our research above, we examine the relationship between the level of maintenance management to building quality and the level of occupant satisfaction in office buildings, as well as to determine the building factors, environment condition, maintenance management, and occupant satisfaction.

By analyzing the questionnaire responses exploring the characteristics of maintenance, the results show that the condition of the office environment and maintenance management positively affects the satisfaction of the users of the office buildings. The results showed that Building A, B, and C have satisfactory percentages of 83,2%, 80%, and 86,1%. Overall the Building C has the most satisfactory percentages among the three research subject buildings. The results of management maintenance show that the equipment in the buildings is basically maintained regularly. The results of user satisfaction in office buildings show that the value of environmental conditions and maintenance services has a positive relationship with satisfaction for current office building users.

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Biography

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