SIGNIFICANCE OF BUILDING MAINTENANCE MANAGEMENT SYSTEM TOWARDS SUSTAINABLE DEVELOPMENT: A REVIEW

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Abstract: The notion of building maintenance is separated into two elements specifically building maintenance management and building maintenance technology. Building maintenance management should accurately be considered as unfolding how a system of maintenance endeavor might be prearranged to deal with a problem of building maintenance. It distinguishes that, aside from locating and remedying the building deficiency an effective programme to restrain overall cost of maintenance but also in an effort to maximize the gain and benefits of the savings. There are a few factors that influence the decision to accomplish the maintenance work. There are the maintenance needs that is the principal aspire of maintenance is to protect a building in its early stage and some major rationale for maintaining building are retaining its significance and value of investments, maintaining the building in a condition that it persists to accomplish its purpose and presenting a good outer shell. Besides that, the efficient maintenance management system embraces many skills and efforts that include identifying maintenance needs and the accurate and spot on remedies. In general, there have four types of maintenance which are breakdown or corrective maintenance, scheduled maintenance, preventive maintenance and also predictive maintenance. This paper will review and discuss some of the major elements of building maintenance towards achieving sustainable building.

Keywords: building maintenance, maintenance management, maintenance technology, sustainable building, repair, building defects, progressive decay

1. INTRODUCTION

Building owners consider the planned maintenance as a matter of serious apprehension, and yet building owner cannot afford to tolerate their buildings to perish over a period of time. As it is undoubtedly unfeasible, and even detrimental to restore all the older buildings, everybody apprehensive with those buildings, whether as the owners, builders or the end users, ought to take a serious attention in this infinite dilemma of building. Now and then, they have a certain amount of budget to handle or cover this problem and only waiting for the liable person [1]. Building maintenance progression was on reservation and restoration commotion for the building of structural and components. Building maintenance envelops every part of buildings, for example, rooms, toilet windows, wall and their furniture. Building maintenance is a worldwide problem and extremely measured for the untimely route of construction that the superiority of the building can be guaranteed [1].

Maintenance also can be referred as an operation that being done on a continuous basis to maintain the building in a safe and the best form for the everyday use. Maintenance activities cover all the building like from the top to
the bottom of particular building. This commotion will identify all part of it in order to ensure that it could be used either on the structural, components and the materials holistically [1, 2].

There are numerous definitions that define maintenance work. For example, British Standard BS3811, define maintenance as special task embarked on in sequence to remain or reinstate each amenity such as, each part of a site, building and contents to a satisfactory benchmark. While, the Chartered Institute of Building defines, building maintenance as work done to maintain, restore or perk up every facility for instant, every parts of the building, the services and surrounded to an contracted criterion determined by the equilibrium between necessitate and obtainable resources. Another definition for maintenance is a work done to control certain condition of a building so that the outline lies within specific regions [3].

The word ‘control’ suggests an optimistic action that is premeditated so as to attain a definite outcome. On the other hand, the term specified regions apparently has a meaning related to ‘satisfactory standards’ and would be strong-minded in a parallel way.

In contrast, Lateef and Khamidi defined maintenance as the necessary processes and services commenced protecting, shield, improve and care for the building’s fabrics and services to dish up its projected function all through their whole life span devoid of radically disconcerting of their basic features and functions [2, 3].

In addition, building maintenance is defined as the mishmash of all technological and management actions, including administration action, planned to engaged an item in, or restore it to a state in which it can perform a required function [3] and defined as the effort in connection with diverse technical and administrations in order to keep its physical asset in, or reinstate it to a condition where it can execute a necessary purpose [4].

There are two major factors that could influence it; maintenance needs and effectual maintenance management system. In terms of maintenance needs, the primary endeavors are to maintenance and preserve that building from its preliminary stage such as feasible and efficient serves on its purposes. As been mentioned earlier, the core principles of building maintenance are to retain the value of the investment, to maintain the building in a circumstance where it can fulfill its function and presenting the excellent appearances. While for the efficient building maintenance management system embraces several skills included in identifying maintenance needs and in order to indicate the accurate remedial work and their sympathetic of the modern management technique. Every building, through abandon and worsening faces certain decrease from progressive crumble and encompass an appropriate maintenance can be cheaper, faster and easier than main repairs on the building itself.

According to the global objective of a maintenance system are repair and replacement done when necessary maintenance budget allocated to a basic need. While objective from Social Organization is to capitalize on the overall building life and to achieve maximum contentment. Maintenance also a procedure that is carried out within certain allocated budget. Objectives for a commercial organization are to warrant that their building functions at an acceptable level and at the same time it could increase the building life entirely. In addition, this organization also wants to balance between the maintenance spending and building effectiveness.

The objectives of building maintenance are to make certain that the buildings and their related services are in a secure and protected condition, to guarantee the building are fit to be occupied, to ensure that the condition of the building meets all legislative standards and requirements, to perform the maintenance work indispensable to uphold the value of the physical assets of the building stock and also to accomplish the work essential to maintain the superiority of the building holistically [5].

Besides, other specific maintenance objectives are to execute every day housekeeping and cleaning to sustain a appropriately well turned-out facility, swiftly react and repair minor discrepancies in the facility, expand and perform a system of frequently scheduled maintenance actions to avoid untimely failure of the facility and its systems and the components as well, to complete the major repairs based on the least possible life-cycle cost [6], recognize and make out the design and complete enhancement projects to diminish and curtail entirety building operating and building maintenance costs, to operate the facility utilities in the most cost-effective mode while providing required dependability, offer an trouble-free and complete reporting and recognition of essential repair and maintenance work, to perform precise cost estimating to guarantee smallest possible cost solutions to maintenance problems, to preserve an appropriate level of material and spare parts to hold opportune repairs and perfectly track the costs of all the maintenance works done [6].
2. TYPES OF MAINTENANCE

As been presented earlier, maintenance can be categorized into two groups: unplanned and planned maintenance. For planned maintenance that work that have a scheduled and carried out, i.e. daily cleaning of floor, weekly for cleaning the window and a year to check the painting of the building facade. Whereas for the unplanned maintenance where the work is carried out on emergency basis or when having problem in that building, for example, when lift is having problems, so maintenance needs at that particular time. There are three types of maintenance which are; corrective maintenance, preventive maintenance, and condition-based maintenance.

The types of maintenance include the service maintenance that maintenance items demanded by the renter or the occupant. It also includes some emergency items. Next is what we called as a routine maintenance that includes broad or general types of maintenance to the common areas. These particular aspects are not requested by the tenant, but it is necessary in order to keep the building in excellent state [7].

2.1. Corrective Maintenance

Corrective maintenance is the maintenance carried out subsequent to the breakdown that has occurred and projected to reinstate an item to a state in which it can execute its necessitated purpose. Whereas, preventive maintenance is maintenance that carried at prearranged period of time and anticipated to diminish the possibility of malfunction or the performance dilapidation of any particular item. Condition-based maintenance is defined as preventive maintenance commenced as a result of knowledge of the condition of an item from the schedule or incessant monitoring [7].

It should be pointed out that corrective maintenance is the simplest types of maintenance approach, where building components are utilized until its breakdown. It covers all actions, which include repair of an element that has failed to a point at which it cannot execute its essential purpose. Hence, corrective maintenance can be tremendously costly because the breakdown or failure of a particular item can cause a great amount of significant damage to other elements in the building. For examples, failure of the roof might cause harm to the ceiling and the interior part of the building and the failure of an item can take place at a time which is not convenient to equally the user and the maintenance personnel. This could formulate manpower and spare parts planning exceptionally complicated. Figure 1 show the system life cycle.

Fig. 1. System life cycle [7].
Nevertheless, corrective maintenance is still a significant part of any maintenance management strategy [8]. Corrective maintenance related to correction of unforeseen variances and is almost constantly an emergency modus operandi, leading to inescapable extra cost and it is also imperative to homogenize technical procedures that permit the minimization of the negative aspects of this type of maintenance [6]. Its also consists of revamp to the building and paraphernalia owing to natural wear and tear or defective preventive maintenance. With equipment problems, there may be a question as to whether the meticulous items have to be replaced [5].

Corrective maintenance has a lawful role to play in the entire maintenance program, although a limited one. The advantages of corrective maintenance can be viewed as a double-edged weapon, and thus skill and care is necessary when determining which assets should be authorized to run to breakdown. Corrective maintenance is most accepted to be the suitable maintenance approach for non-significant items and utility significant items whose condition cannot be monitored and for which the cost of applying time-based preventive maintenance is less than the cost of pertaining the corrective maintenance procedure [6].

2.2. Preventive Maintenance

On the other hand, the preventive maintenance is established to surmount the disadvantages of corrective maintenance, by reducing the likelihood of the incidence of malfunction and avoiding unexpected failure. Preventive maintenance task is done in agreement with a prearranged plan at regular, fixed intervals, which may be based for example on an operating time. There are some advantages of preventive maintenance in excess of corrective maintenance such as the maintenance could be intended in advance and executed when it is expedient to the building’s user, the cost could be diminished by avoiding the cost of significant damage, the point in time that a component of the building or the entire building is out of service, can be diminished, the health and safety of the user can be improve and the planned maintenance task are frequently very challenging in terms of spare parts and the labour cost.

In the category of preventive maintenance are included the ones programmed for predefined, customary intervals, to make for certain components sustained good routine; this type of maintenance can reduce non-planed work and allows the inference of overall costs [6, 9]. Other than that, the professional property manager is trained to comprehend that foremost breakdowns can be prohibited. Preventive maintenance keeps a building operating at pinnacle competence during regular scrutiny and repair. The intention is to determine minute problems before they turn out to be big and costly according to their cost of maintenance [4, 6, 8]. Preventive maintenance approach is most suitable when assets that are subject to expected wear-out unpreserved surrogate, assets breakdown patterns are recognized and be able to be modelled effectively, assets that are extremely synchronized for the health and safety reasons and also assets that can be in actual fact captures under the service contract. Figure 2 show the total cost broadens with the meeting point of corrective and the preventative costs that indicated the total cost required low point.

![Inspection versus Total Cost](image)

**Fig. 2.** Total Cost broadens with the meeting point of corrective and the preventative costs indicating the total cost desired low point [8].
2.3. Condition-Based Maintenance

Last of all, for the condition-based maintenance, maintenance carried out in reaction to an important worsening in a unit as designated by a change in monitored limitation of the unit condition or performance [9]. This maintenance notion distinguishes that an alteration in condition and routine of an item is the primary grounds for carrying out the maintenance. As a result, an optimal time is required in order to execute the maintenance to establish the real state of each component item in any particular building. For the purpose of gaining the full benefit of using this type of maintenance. It should be pointed out that the condition of an item have to be observed carefully in order to spot whether there is any proof of alteration from the normal state of an abnormal form [9]. Figure 3 represents the ‘typical’ degradation process experienced by any types of equipment. In a certain period of normal operation time, where the item has been running smoothly, a change might happens which will affect the overall performance.

![Figure 3. Typical degradation process took place by any types of equipment [9].](image)

2.4. Relationship between Preventive and Corrective Maintenance

There are two types of maintenance that are preventive maintenance and corrective maintenance. Preventive maintenance is a routine, regularly scheduled maintenance of a piece of equipment that ensures its continued use and maximize the life expectancy. Meanwhile, corrective maintenance is an emergency work orders that maintenance activity work after damage or problems occur.

Nevertheless, preventive maintenance is suggested to diminish equipment breakdown owing the time program and the cost aspect connected with the schedule servicing of any particular equipment is small in comparison to the cost of coping with unforeseen and disastrous breakdown which entail not only main repairs but even the replacement of pretentious components and the system as well [2]. Figure 4 show the different between the preventive and corrective maintenance.

According to Figure 4, it show that preventive maintenance were better compare to the corrective maintenance because we do some precautions on that building to prevent it became more worst compare we do some renovation after it damage. The cost of corrective maintenance also more expensive compared to the preventive maintenance because we do something like having little damage before it became worst.

Preventive maintenance has quite many advantages over that of a corrective maintenance program. The advantages of preventive maintenance are can increased the component lifecycle and can reduce asset failure. Other than that are having some possible energy savings and can estimate 12-18% cost savings in contrast to the corrective maintenance. While the advantages of corrective maintenance are lesser short-term cost and can require fewer staff since less work is being done [10].
As a disadvantage, the corrective maintenance could increase long-term costs due to unplanned equipment downtime and probable derivative equipment or procedure damage. Preventive maintenance also have some disadvantages on it, which are can be labor intensive and having some breakdown are still likely to occur despite preventive maintenance work being carried out and it may include the performance of needless maintenance requisite by the predetermined maintenance schedule [10].

Although, each type of maintenance has their importance that need to be applied according to the problems that occur on the structural on that building. When the building needs to have maintenance procedure, firstly need to categorize that problems in each type of maintenance that can be apply according to the problems. Building inspection also, cannot do the work of preventive maintenance when the problems need have in corrective maintenance because it may effect on that structural itself.

3. BUILDING MAINTENANCE PERFORMANCE

Maintenance performance indicators are utilized to assess the efficiency of maintenance performed. Maintenance performance indicators could be used for financial reports, for monitoring the performance of employees, customer contentment, the health safety environment rating and overall equipment efficiency, as well as many other applications. If maintenance performance indicators are recognized correctly then maintenance performance can offer or recognize resource portion and control, problem areas, the maintenance contribution, benchmarking, personnel performance and the contribution to maintenance and overall business objectives [11].

It should be noted that all the parameters set the edge of extent that to be calculated in the maintenance management system for example it utilize the building evaluation notion in for the post-occupation to the public office buildings in Malaysia which focuses on particular building components, services and also the noise contamination and shuddering [7 - 9].

4. MAINTENANCE WORK

Generally, three types of maintenance work were involved; there are normal work, urgent work, and emergency work. This types of work were been apply according to the types of failure and their action time. One to three weeks were taken for ordinary work, whilst for jobs right away, the action taken in less than one week. Instant action must be taken for emergency work in one to two days. Among the activities maintenance involved in the type of work such as the following:-

4.1. Work Service

Cleaning services were involved in work service for their facilities and equipment. These services require scheduling and should be conducted in accordance with priorities and frequency of the equipment or facilities need to maintenance. Quantity of services is dependent on size range and number of devices in a building. More
and more large size and equipment coverage, more service jobs required and vice versa. Among the examples of the works such as machines, windows, floors and others [12].

4.2. Repair Work
Repairs carried out to address failures and defects of the facility and equipment building covering incompatibility methods and materials used in construction. Thus, appropriate services focused on the early stages after construction is completed. Urgent repairs can reduce maintenance requirement more frequent in the future. Repair work implemented based on the complaints and consumer reports or the owner damage building components pump, tiles, lighting, air conditioning and so on affect the comfort of many [13].

4.3. Replacement Work
All materials, components and equipment for a building have levels and different rates of damage influenced by the quality, the environment, and frequency its use [14]. Thus, the replacement used for ensuring that each of these items that are at a critical point replaced as corrective action cannot be made. Scheduled inspection should be done continuously for each recorded items intended to identify failures and damage. Replacement can prevent adverse effects on performance and function of the building. Among the items that must be observed consists of the structural, mechanical, system electrical and water system are the main lifeline buildings [15].

4.4. Work Protection
Protection involves work aimed at controlling functions, including the appearance of a building performance. Protection should be given during the life of the building involved as the building is vulnerable to damage and defects caused by factors such as weather, frequency of use and others. Protection can avoid any defect and more serious damage in the future. It can guarantee resistance of each component during use. For example, the action is to paint on exterior surfaces of buildings for reaction control weather and fungal attack or function [15].

5. CONCLUSIONS
This paper has explained the theories of maintenance comprehensively. It will help future researchers to be acquainted with maintenance issues. It should be pointed out that building maintenance management should appropriately be regarded as describing how a system of maintenance effort could be organized to deal with a problem of building maintenance. It shows that, apart from locating and remedying the imperfection of an effective program to restrain maintenance cost, but it also to enhance the advantage of the investment. There are many factors that influence the verdict whether to perform maintenance procedure for a building. It includes the maintenance needs, the major intention of maintenance is to protect a building in its preliminary stage and some main purpose of maintaining building are retaining the value of investments, maintaining the building in a condition that it continues to fulfil its purpose and presenting a good exterior and façade or building envelope. Besides that, the effectual maintenance management clinches many skills that includes identifying maintenance needs and to identify the correct remedies. Every building through disregard and worsening faces certain death from progressive decompose and appropriate maintenance is cheaper, faster and easier than major repair.

REFERENCES