# Building Maintenance

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# 1. INTRODUCTION

Buildings that are in a poor state of performance will increase the rate of capital consumption. The prosperity and well-being of a country therefore depend on buildings because national building stock depends on the amount spent to maintain the buildings. Many developed countries not only spend more than half of their total investment in the construction industry to maintain their building stock, but also invest about 10 % of their GDP for maintenance of constructed facilities. Building maintenance both in practice and theory is service oriented, not product focused but it is technical in nature. Maintenance management involves making use of resources for the sustenance of the building performance optimally.

In other words, it makes certain that buildings are in high performance during their operation phase. However, maintenance management can no longer be standalone both as a term or concept due the extent and scope of the inadequacies.

While more recent studies have considered the maintenance of buildings of the most important phases of the project management due to of the long time period represented by the ratio to the period of the project life, it has been found that the number of research and studies written in this area in Iraqi literature is still humble.

## 2. WHAT'S MAINTENANCE

BS 3811: 1984 defines maintenance as:

A combination of any actions carried out to retain an item in, or restore it to another from this definition two key components can be identified:

- Not only actions that relate to the physical execution of maintenance work, but also those concerned with its initiation, financing, and organization.
- The notion of an acceptable condition, which implies an understanding of the requirements for the effective usage of the building and its parts, which in turn compels broader consideration of building performance. acceptable condition.

all the required services and activities provided in order to preserve, protect and care for a building's structure and form after completion or after any repair or replacement to current standards to enable it to serve its intended functions throughout its entire lifespan without upsetting its original features and use". However, the definition contains some key terms and concepts that require looking into. For instance, "to preserve" denotes that maintenance is an active process that never comes to end provided the building remains. Further, when carrying out maintenance, the strategy must take into account current advancement in building regulations, standards and technology.

"Care" implies that the performance of the building requires systemic consideration. "To serves its intended functions" suggests that maintenance aimed at allowing the building to perform the useful roles for which it was built. "Without upsetting its original features and use" denotes maintenance has no effect outside the boundaries created by the initial designs of the building. In another words, it implies that maintenance is caused due to depreciation from wear and tear—use function. Works caused due to changing in users' value systems cannot be associated with maintenance services. "To current standards" suggests that maintenance involves some degree of improvement, even if it is for the sake of accommodating new technology or latest codes, standards and/or regulations.

*Table 1 Maintenance Definitions*

| Author(s) and date | Definitions |
|---|---|
| Pitt (1997) | The task of providing a repair service that will protect the fabric and the use of the building to a standard that represents value for money |
| Christensen (2005) | To preserve in a condition or state of quality equivalent to that which was designed, structured or used in the past |
| Best and De Valence (2002) | All control employed to make sure asset remains functional |
| Lofsten (2006) | Actions undertaken in order to reduce the adverse effects of breakdown and maximise the facility at minimum cost |
| Booty (2006) | All the technical and administrative actions that are required in order to retain a building in a state in which it can serve its required functions efficiently and as expected |
| CICA (1989) | Any intervention to make sure a facility reaches its optimal service life |
| Emmitt and Yeomans (2001, 2008) | The necessary actions that are carried out to prevent building failure and to extend the service life of the buildings |
| Burden (2004) | To provide upkeep, repair and care for the building's integrity and appearance after acquisition or after restoration at an acceptable level to enable it to perform its useful functions |
| Marsh (2003) | Services required so that the building can operate efficiently and effectively while taking into account environmental condition, reliability and economic issues |
| Ashworth (2004) | Works required to preserve building and other items or equipment in a state of fitness for purpose |

## 3. TYPES OF MAINTENANCE

The following definitions are all given in BS 3811 and, for practical purposes, it is clear that the maintenance workload will consist of a mix of all of these (Figure 1 and 2).

(1) Planned maintenance – maintenance organized and carried out with forethought, control and the use of records, to a predetermined plan.

(2) Unplanned maintenance – ad hoc maintenance carried out to no predetermined plan.

(3) Preventive maintenance – maintenance carried out at predetermined intervals, or corresponding to prescribed criteria, and intended to reduce the probability of failure, or the performance degradation of an item.

(4) Corrective maintenance – maintenance carried out after a failure has occurred, and intended to restore an item to a state in which it can perform its required function

(5) Emergency maintenance – maintenance that it is necessary to put in hand immediately to avoid serious consequences

(6) Condition-based maintenance – preventive maintenance initiated as a result of knowledge of the condition of an item from routine or continuous monitoring.

(7) Scheduled maintenance – preventive maintenance carried out to a predetermined interval of time, number of operations, mileage, etc.

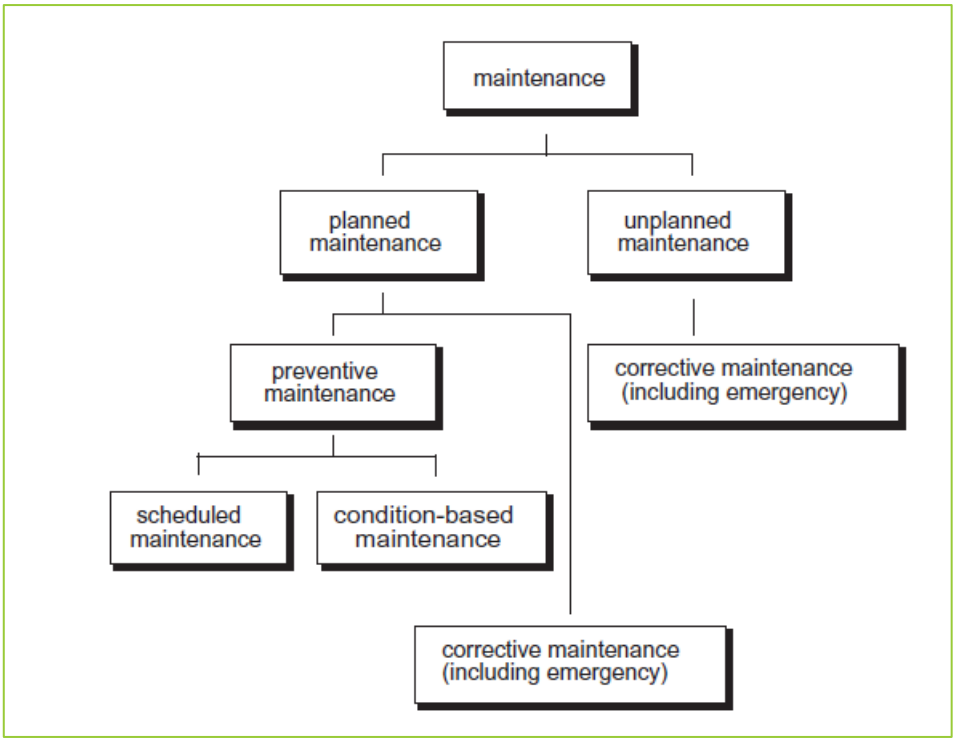


*Figure 1Types of maintenance. BS3811*

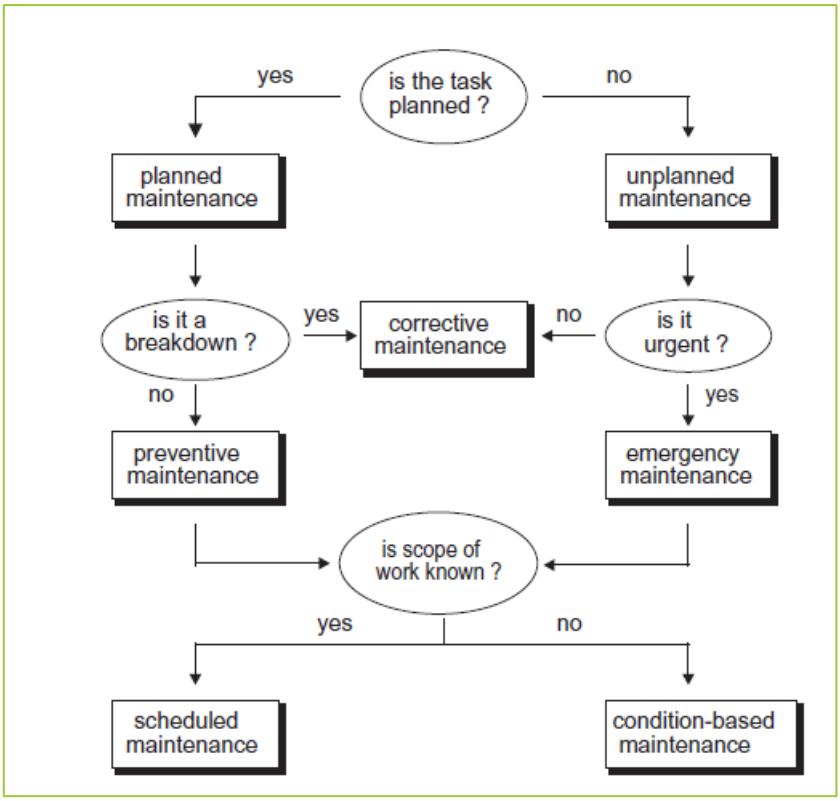


***Figure 2 Decision-based types of maintenance***.

Maintenance can be divided into two broad categories:

The Fig. 3, provides an overview. In unplanned maintenance there is no organized arrangement to follow, and everything is carried out as a reaction to a situation, possibly resulting in prolonged breakdowns. Unplanned maintenance suggests that the building operator takes no responsibility for the failure of the engineering services and the inevitable consequences. It could put building operators at risk of not meeting their statutory requirements and is not recommended as a technique to be adopted. It is, therefore, not considered further.

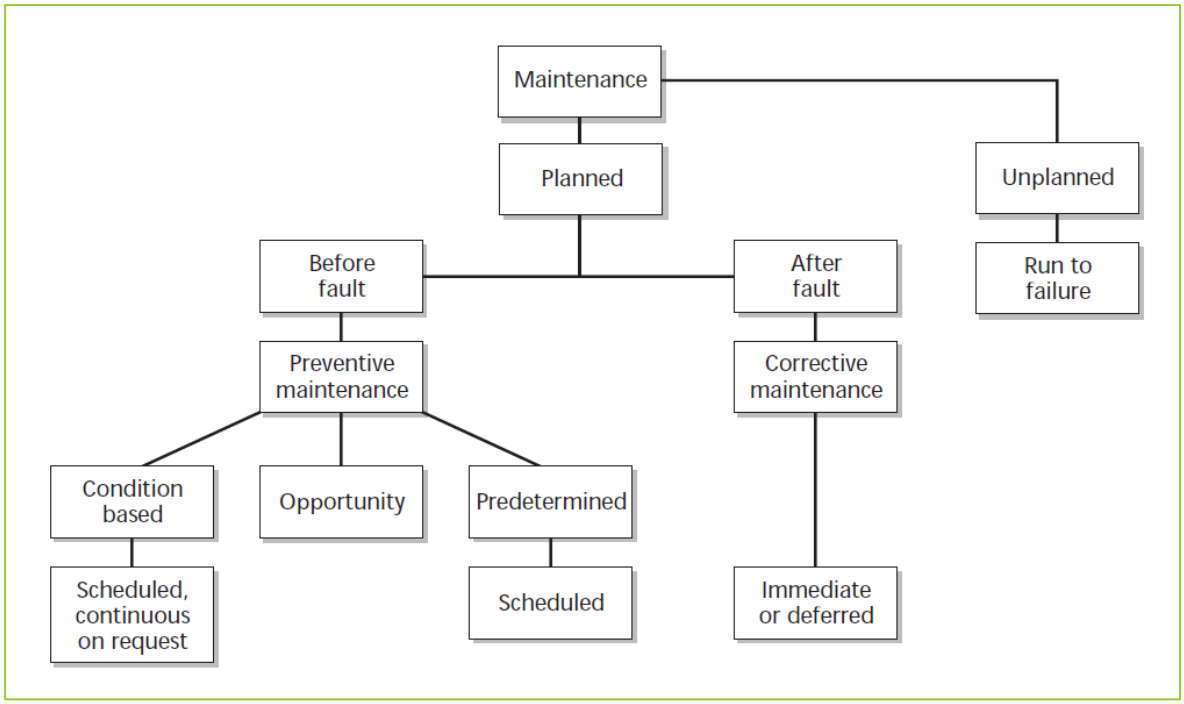


*Figure 3 Types of Maintenance*

Planned maintenance is organized, controlled and follows a recognizable procedure. It can take several forms, such as:

1. Preventive maintenance:
   Carried out at predetermined intervals or corresponding to prescribed criteria and intended to reduce the probability of failure.
2. Corrective (or 'reactive') maintenance:
   Work done once a fault has occurred to restore plant to normal operation; this approach would be subject to prior agreement by the building user that this is an acceptable basis for maintenance.
3. Immediate maintenance:
   Necessitated by unforeseen breakdown or damage and needing to be put in hand immediately.
4. Scheduled maintenance:
   Preventive maintenance carried out to predetermined intervals, number of operations, hours run etc. The HVCA's Standard maintenance specification for building services covers the majority of building services plant and equipment. This

provides a useful source of reference for maintenance requirements and typical frequencies.

5. Opportunity maintenance:
   Work done as and when possible, within the limits of operational demand.
6. Design-out maintenance:
   Other forms of maintenance may be inappropriate, therefore maintenance needs are ‘designed-out’ to achieve the required level of reliability.
7. Condition-based maintenance:
   Work initiated by trends highlighted by routine or continuous monitoring of the condition of plant, such as general performance or specific parameters (e.g. bearing vibration and motor-winding temperature).
8. Reliability-centred maintenance:
   Based on the operational requirements of specific plant in relation to known reliability information.
9. Business-focused (or ‘risk-based’) maintenance:
   Prioritizing maintenance according to the core business activities, taking into account business risk, resilience and performance of the installed plant to ensure the function of the business is optimized.
10. Run to failure:
    The consequences are such that plants can be safely and cost effectively run to destruction without serious loss of service and there is no risk of failing to comply with statutory requirements. This may assume there is a standby unit that will automatically operate on failure of the duty unit.

Whichever overall maintenance plan is adopted, it is likely to consist of a mixture of these methods. It needs to start with an assessment of what is effective followed by a decision as to what is desirable and a consideration of the resources available in terms of labor, materials and facilities; together, these should provide a rational basis for preparing a program of planned maintenance.

Condition-based maintenance is initiated by monitoring the condition of plant. This is becoming more applicable to building services as the techniques gain understanding and credibility, the instruments and equipment become simpler and cheaper, and clients become more demanding in terms of plant reliability. The concept is that a parameter can

be established which gives a good indication of plant condition and also reflects the likely mode of failure. By monitoring this parameter, the required timing and type of maintenance can be determined. Monitoring can be assessed by establishing trends over time to identify marked departures from the normal, or by condition checking where readings are compared with established parameters for the particular item of plant or equipment on a 'go /no go' basis.

Plant that could justify condition monitoring would typically be:

- Expensive to maintain.
- Expensive to replace if run to failure.
- Failure could lead to high consequential costs.
- Failure could lead to an unacceptable situation (creating a safety hazard or causing an essential building function, such as a data processing, to cease to operate)
- Critical to the overall building operation.

'Designing out' may appear an ideal solution but should be considered only where other options are not available.

For example, where health and safety considerations, operational requirements, reliability demands or even building location dictate that other maintenance requirements are not viable. The use of designing-out can put a major responsibility on the design engineer. In most building services applications, it is unlikely to be encountered as the only option, but the client should be aware of it and ensure that this is clearly defined in the brief if considered appropriate.

This requirement may have a significant cost implication but is far more readily addressed at the design stage than during or after installation.

## 4. FACTORS LEADING TO MAINTENANCE

Maintenance could emanate due to different factors, e.g. problems arising from poor design, bad workmanship, substandard materials, and components, as well as the unaccommodating behavior and nature of the users and occupants. Maintenance costs increase with the age of the building. However, older buildings constructed of well-established materials and components and using well-tried and tested techniques (and which in all probability have been updated and improved) may not be subjected to heavy maintenance works or expenditure. The major sources of maintenance are explained next

### 4. 1 Poor Design:

This is a maintainability issue. Building maintainability is a design characteristic. It is concerned with ease, accuracy, safety, and cost of building maintenance. Some buildings are designed without considering the maintainability aspect, thereby making maintenance difficult, expensive, risky, unsafe, and tedious. A building should be designed/constructed so that its maintenance can be performed with minimum cost and time. Effective maintainability is mainly design related. Inadequate consideration of maintainability results in a lot of maintenance problems while the building is in operation. Maintainability entails maintenance time, labor/ frequency of maintenance, maintenance costs and other related issues that facilitate maintenance.

Many maintenances works actually generate from the design stage, as poor design will lead to serious maintenance problems.

The under-listed questions should be addressed while selecting alternative designs:

(a) Are the parts readily available?

(b) Are the parts standardized and simplified?

(c) How expensive would the parts be?

(d) Is there a need for specialized labor?

(e) What is the duration of the likely maintenance works?

(f) What is the nature of the likely failure?

However, the fact that each building is unique makes the matter more complicated. It will greatly assist if the maintenance organizations are consulted before new buildings are commissioned.

## 4. 2 Poor Workmanship

Labor plays a very important factor towards reducing maintenance works. The consequence of labor on the performance of construction projects are multifaceted as the workforce factor starts from the concept and design stage and continues throughout the construction and building operation stages. The design and construction team as well as the maintenance personnel must display a high level of competency and be able to work in sync. It is not difficult to postulate that even with high-quality materials and components, the building will eventually fail if the workforce that put the building together are not good at the job. Poor workmanship could be the result of lack of know-how, know why, know when, know what, training and skill, or just plain negligence.

## 4.3 Defective Materials and Components

Substandard and defective materials and components will lead to maintenance problems, if not at the commissioning stage, then surely later, when the building is operational. In order to reduce the impact of the problem, durable and industryproven materials and components should be given priority.

Materials of good quality can also fail to make the grade if used for the wrong purpose or in an unsuitable environment. Each material has its own special characteristics and qualities that the designer must not ignore. As for the contractor, a maintenance bond should be signed in order for the contractor to rectify all defects owing to the usage of unapproved or second-rate materials. The designers and other consultants should make available to contractors and key maintenance indicators that the contractors must comply with even though this rarely happens in practice.

Usage and Age All built facilities, irrespective of materials, components or workmanship used will with usage and time, encounter structural and systemic deterioration and decay. Maintenance in terms of usage is hinged on, and very much related to, the culture of the occupants. However, a question that must be addressed is who is the design/

building meant for? A suitable answer to the question is very important towards reducing the impact of maintenance due to usage and age of the buildings.

The products are exposed to atmospheric weather condition. Buildings are constantly subjects of sunlight, rain, frost action, humidity, condensation, wind and pollutions of all sorts. Buildings are affected by climatic and environmental factors. This is even if the architects and/or engineers designed the building correctly and the contractors constructed or built correctly. Hence, a major cause of maintenance problems in buildings is exposure to climate and weather conditions.

Different building materials and components react differently to weather. Therefore, to minimize the maintenance expenditure, there must be a proper selection of materials and components, as well as alternative designs for different atmospheric conditions and geographical locations. Once more, a wrongly designed roof, like a flat-roofed feature in a building that might be appropriate in the West, might be more expensive to maintain in the tropical countries such as Malaysia due to high humidity and heavy rainfalls. The effect of the climatic changes is also affecting our buildings.

The materials and components that were suitable in the past are becoming unsuitable due to the effect of climatic changes. While increase in temperature with high humidity is increasing the rate of decay and deterioration, flooding is also making the buildings unreliable. One of the likely measures to improve maintenance activities is through simplifications of designs.

Building materials and components are exposed to different weather conditions for long periods of time, the reason why it is very important to determine the effects of sunlight, heat, humidity and other effects of climate changes in the properties of the materials, color and gloss. Therefore, there is the need to understand these properties in the evaluation of the building performance.

In university buildings, due to the intriguing nature of the users coupled with constant changes of users that could have diverse backgrounds, there seems to be high demand for maintenance or improvement. Furthermore, the increased user loads on the building and lack of awareness of the user are also greatly contributing to maintenance.

## 5. Maintenance vs. Improvement

It is essential to clarify the difference between maintenance and improvements; maintenance is the activities which return back the quality of service and the performance for each deteriorated system or sub system to the designed levels, while the improvement is meeting the new user and technical and regulations requirements Fig.5,Stanford, 2010,sometimes maintenance concept has been referred to by the expression (adaptive concept) while improvement concept has been referred to by the expression (perfective concept).

### 5.1 Adaptive concept

This concept involves adjusting or adapting the service system for changing to a different service delivery. An example of this is changing the maintenance service of residential building to academic building or changing from lecturer's requirements to student's requirements.

### 5.2 Perfective Concept

This concept involves developing or acquiring additional service system or improving the operation capability of the service system. This should not, however, be confused with refurbishment work, as it does not involve changing the physical outlook of the building but only the service provided.

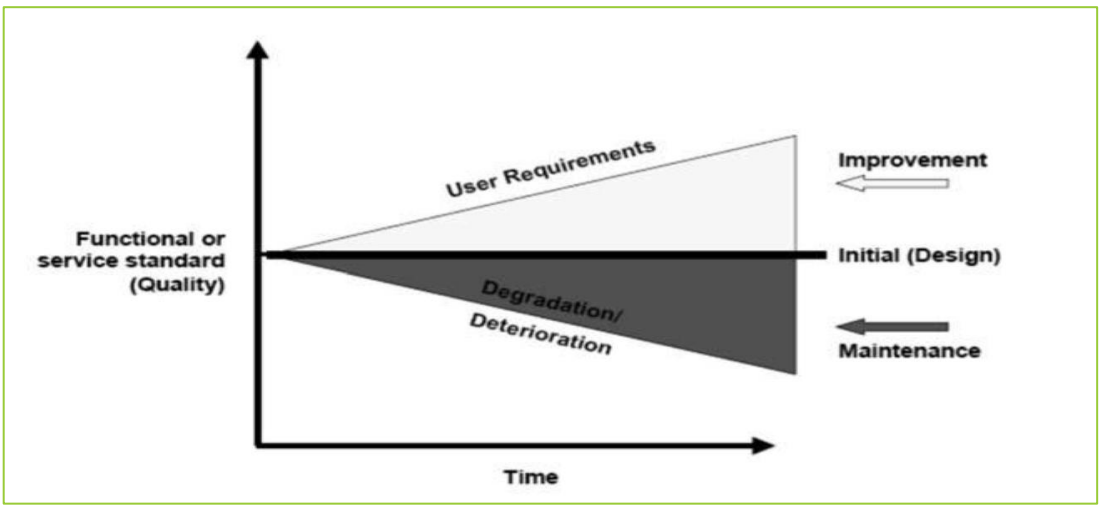


*Figure 4 Different between improvement and maintenance*

## References


1. Chanter B., and Swallow P., 2007, *Building Maintenance Management*, Blackwell Publishing editorial ISBN: 978-1-4051-3506-1, 2nd edition.
2. Olanrewaju A. L., and Abdul-Aziz A.R., 2015, *Building Maintenance Processes and Practices-The Case of a Fast Developing Country*, Library of Congress Control Number: 2014952904, ISBN 978-981-287-262-3, Springer Singapore Heidelberg New York Dordrecht London
3. Stanford H.W., 2010, *Building Maintenance Protection of Capital Assets*, The Fairmont Press, Inc., Indian Trail 700, Lilburn, GA 30047.
4. Doos, Q. M., Al-Saadwi, K. R. and Ibraheem, H. K. (2016) “Evaluation of Maintenance Management in Iraqi Governmental Buildings”, *Journal of Engineering*, 22(9), pp. 55–71. doi: 10.31026/j.eng.2016.09.04.