Factors affecting maintenance procedures for public buildings

Prof. Dr. Hatem K Breesam 1* and Zahraa A Jawad 2

1Professor of Construction Management Engineering, Department of Civil Engineering, University of Baghdad, Baghdad.
2MSc.Student, Department of Civil Engineering, University of Baghdad, Baghdad, Iraq

*Corresponding author: dr.hatem.kh@coeng.uobaghdad.edu.iq

Abstract. Government buildings, like any other building, need to be maintained frequently, to preserve the original and to ensure that they perform their functions. Maintenance depends on a set of procedures, and these measures are affected by several technical and administrative factors. This study aims to know the most important factors affecting maintenance procedures and their time, to enhance the reality of maintenance of government buildings. A survey was conducted for professionals in the field of building maintenance. The analysis of the questionnaire answered by (75) engineers showed that the most influencing factors on maintenance procedures and their time are; Maintenance time (when it started), safety and health measures, work completion time, defective construction, lack of implementation, poor completed maintenance work, design problems, delay in reporting failure, response time for maintenance work, the skill of maintenance personnel, unavailability of skilled workers, services Building materials, material properties, unqualified contractor, poor budget control, insufficient funds, building age, structure condition, and sewage component networks. Therefore, controlling these factors can reflect positively on maintenance procedures and time, and thus enhance the reality of maintenance of government buildings in Iraq.

Keywords: maintenance, maintenance procedure, public buildings, Government buildings, maintenance time.

1. Literature review

Most government institutions suffer from the lack of financial allocations for maintenance work, in addition to the weak maintenance work performed, at a time when we witness the incompleteness of government buildings such as schools, hospitals, etc., where the completed number does not meet the required numbers, so there is great importance for maintenance, as it preserves the existing buildings and extends their life, so the maintenance work must be done carefully and in a way that achieves the required purpose. Also, maintenance work procedures face many administrative obstacles in addition to a timed obstacles. The measure of a building's function is its ability to provide the required environment for a particular activity, and thus the deterioration of the building components makes it necessary to take appropriate measures to maintain the required building characteristics, which provide comfort and safety [1]. Preserving the building in its structural, aesthetic and functional condition is the main goal of the maintenance process [2].
There are several definitions of maintenance in the previous literature. It can be defined as all administrative and technical procedures that ensure that all elements and parts of the building are in an acceptable standard to perform the desired [3]. Maintenance is all administrative and technical procedures, including supervision, to preserve the item or return it to a location that enables it to perform the function for which it was made [4]. Maintenance is a combination of procedures that are carried out either to return an item to an acceptable condition or to preserve it [5]. Reducing all negative impacts of inactivity and maximizing attachment at a lower cost [6]. There are five main factors affecting the maintenance of public buildings: lack of preventive maintenance, insufficient amounts allocated for building maintenance, lack of a standard for building maintenance, lack of spare parts and components, and lack of response to maintenance requests[7]. Residential building users indicated in the survey that the causes of maintenance problems are: faulty workmanship, design accuracy appropriate to user needs, use of inexpensive and low-level materials; the most influential factor in residential building maintenance is the lack of funding for building maintenance[8]. Include critical success factors in building maintenance management for the university sector in (4) perspectives: the customer (customer satisfaction, customer complaints, quality of services, reaction to the customer's need), internal processes (excellence Service, technical capabilities, customer recruitment, process efficiency, efficiency) The financial perspective (management expectations, financial growth, cost reduction, productivity, etc.), the learning and growth perspective (technological leadership, continuous improvement of service, staff efficiency, etc.) and concluded that critical success factors help provide a successful competitive performance for the university sector In terms of maintenance management[9]. Cobbinah identified another type of factor responsible for poor public building maintenance: age of buildings, insufficient funds, lack of maintenance culture, high maintenance costs, pressure from a number of users on the building, and poor construction and maintenance work carried out by maintenance personnel in the organization[10]. The researcher has identified 12 factors affecting building maintenance strength such as design decision, structural strength, strength of specific materials, maintenance manual, safety measures, environmental factors, maintenance stations, quality control factors, usage factors, skill maintenance personnel, protection of strength after construction[2].

Knowing the factors that affect maintenance procedures and determining which are the most influential is important for the purpose of controlling these factors as a first step to improving maintenance procedures. That is, to solve any problem, we must know the main reasons that led to it. Also, to reduce time and resources and not focus on multiple factors, we notice that there are many factors that affect maintenance within the previous studies, some of which are influential in one country and there is a possibility that it will be less influential in another country, so knowing the most influential factors makes us focus on certain factors, influencing In the country, to control it.

2. Methodology
The previous literature was reviewed, and to achieve the research objectives, a questionnaire was conducted, it is one of the methods of collecting non-quantitative information from the community, it was conducted in two stages:

The first stage: an open questionnaire, in which the prepared questionnaire form was discussed with a group of experts to know the accuracy and clarity of the questions asked, with the possibility of amending it for the research service.

The second stage: the closed questionnaire. The questionnaire was distributed to a group of engineers with no less than five years of experience, in different specialties related to the maintenance of government buildings, and various educational certificates, and they work in different departments in Iraq and with different positions of department managers, department heads and others. In line with statistical theories.
(100) copies of the questionnaire were distributed, and only (78) forms were returned, and (75) forms were approved, and 3 forms were ignored due to errors and incomplete information. The questionnaire consists of two axes, the first axis includes personal information (characteristics of the study population), and the second axis includes a question related to the factors affecting the maintenance procedures and time.

3. Results and Discussion

The data of the prepared questionnaire was obtained and distributed. Figures (1), (2) shows the characteristics of the sample of respondents.

After analyzing the data with IBM SPSS-V23 software, the mean was calculated for each factor. Also, the relative importance index (RII) was calculated using the equation below, to determine the weights of the factors affecting the maintenance performance measurement. Also, the level of the relative importance indicators was also calculated.

\[
\text{RII} = \frac{\sum(X_1*Y_1+X_2*Y_2+X_3*Y_3+\ldots+X_n*Y_n)}{(A*N)}
\]

RII: Materiality Index.

Y: the weight is given to the factors according to the scale to be adopted, as the five Likert scale was adopted in the questionnaire (very important = 5, important = 4, medium =3, little =2, scarcely =1)

A: The total number of worker responses.

N: the largest weight (i.e. 5 because the scale used is five)

The Cronbach Alpha Test was calculated to measure the reliability of the questionnaire and the result was equal to (0.943) for the entire questionnaire, which indicates an excellent level of reliability.

![Figure 1. Distribution of the sample on the public and private sectors.](chart.jpg)
Table 1. Factors affecting the maintenance procedure and its time

| Factors                                      | Mean | RII  | RII-Level |
|----------------------------------------------|------|------|-----------|
| 1- Technical defects appear                  |      |      |           |
| A - Maintenance time (when it started)       | 4.61 | 0.92 | H         |
| B - Safety and health measures               | 4.08 | 0.82 | H         |
| C - The time required to complete the work   | 4.2  | 0.84 | H         |
| D - Implementation disadvantages            |      |      |           |
| 1- construction Wrong                        | 4.43 | 0.89 | H         |
| 2- Poorly in implementation                  | 4.19 | 0.84 | H         |
| E - Poor maintenance work performed          | 4.37 | 0.87 | H         |
| F - The need for special devices and tools   | 3.97 | 0.79 | M-H       |
| G - Problems with providing spare parts       | 3.75 | 0.75 | M-H       |
| H - design problems                          | 4.11 | 0.82 | H         |
| I - defects in maintenance                   | 3.79 | 0.76 | M-H       |
| 2- Decreased interest in future maintenance  |      |      |           |
| A - Delayed of failure reporting             | 4.28 | 0.86 | H         |
| B - high humidity                            | 4    | 0.8  | M-H       |
| C - rain                                     | 3.64 | 0.73 | M-H       |
| D - atmospheric gases                        | 2.64 | 0.53 | M         |
| E - solar radiation                          | 2.77 | 0.55 | M         |
| F - Environmental and biological impacts     | 2.93 | 0.59 | M         |
| 3- Administrative problems                   |      |      |           |
| A - Safety and health measures               | 3.87 | 0.77 | M-H       |
| B - The need for a special program           | 3.41 | 0.68 | M-H       |
| Category                                      | Code | Score | Scale | Description                                                                 |
|----------------------------------------------|------|-------|-------|----------------------------------------------------------------------------|
| C - the need for a special experience        |      | 3.28  |       | M-H                                                                        |
| D – response time to maintenance work        |      | 4.19  | 0.84  | H                                                                          |
| E - Project management problems              |      |       |       |                                                                            |
| 1- The skill of maintenance personnel        |      | 4.64  | 0.93  | H                                                                          |
| 2- Lack of skilled workers                   |      | 4.09  | 0.82  | H                                                                          |
| 3- Lack of familiarity with site and local conditions | | 3.72  | 0.74  | M-H                                                                        |
| 4- Quality control factors                   |      | 3.88  | 0.78  | M-H                                                                        |
| F - Maintenance management problems          |      |       |       |                                                                            |
| 1- Provide maintenance manual                |      | 3.81  | 0.76  | M-H                                                                        |
| 2- The need for special standards            |      | 3.24  | 0.65  | M-H                                                                        |
| 3- Not to use preventive maintenance         |      | 3.77  | 0.75  | M-H                                                                        |
| G - Resource management problems             |      |       |       |                                                                            |
| 1- Building services and materials           |      | 4.2   | 0.84  | H                                                                          |
| 2- The materials are inconsistent with the client's activities | | 3.57  | 0.71  | M-H                                                                        |
| 3- Material properties                       |      | 4.07  | 0.81  | H                                                                          |
| 4- Unqualified contractor                    |      | 4.44  | 0.89  | H                                                                          |
| H - Financial management problems            |      |       |       |                                                                            |
| 1- Poor control over the budget              |      | 4.05  | 0.81  | H                                                                          |
| 2- High maintenance costs                    |      | 3.93  | 0.79  | M-H                                                                        |
| 3- Insufficient funds                        |      | 4.13  | 0.83  | H                                                                          |
| 4- Restrictions on the budget                |      | 3.87  | 0.77  | M-H                                                                        |
| I - political problems                       |      | 3.24  | 0.65  | M-H                                                                        |
| J - government restrictions                  |      | 3.71  | 0.74  | M-H                                                                        |
| K - political restrictions                   |      | 3.27  | 0.65  | M-H                                                                        |
| 0 - The lack of institutional and training facilities | | 3.81  | 0.76  | M-H                                                                        |
| P - security aspects                         |      | 3.88  | 0.78  | M-H                                                                        |
| A - the age of the building                  |      | 4.48  | 0.9   | H                                                                          |
| B - the height of the building               |      | 3.67  | 0.73  | M-H                                                                        |
| C - the size of the building                 |      | 3.69  | 0.74  | M-H                                                                        |
We note that the factors within the paragraph of appearance of technical defects, all of them are important, as the RII was as follows: maintenance time (when it started) (0.92), safety and health measures (0.82), The time required for completing the work (0.84), and this thing is self-evident, because whenever we do Maintenance at a faster time reduced the continued deterioration of the building. Also, health and safety measures are important in any construction work, including building maintenance work, and we believe that the appropriate time to complete the work, facilitates the process of maintenance of government buildings, especially since some buildings such as schools, It is required to complete all technical and administrative matters related to maintenance during the fiscal year, and in case of lack of time, its maintenance is postponed for the next year. We notice that the two factors of implementation defects, namely the wrong construction and failure to implement, were also important, where RII have respectively (0.89) (0.84), and we see that any work error requires maintenance in the future, which requires maintenance in the future. The (poor maintenance performance) factor also got high importance, its RII (0.87), We believe any poor work will deteriorate in the future which requires maintenance.

The factor (design problems) also received a high importance, as RII has (0.82), we see that design problems lead to implementation defects, and there is no doubt that they require maintenance for defects in the future. Also (response time to maintenance work), was also an important factor, RII for him (0.84), and we believe that speeding up the response to maintenance work will keep the building from deteriorating further, as slow response may lead to requiring more Maintenance, For example, failure to speed up maintenance of building roofs can lead to deteriorating condition, requiring roof
removal in some cases. (The skill of maintenance personnel) and (the lack of skilled workers) appeared as important factors and the index of relative importance for them was respectively (0.93) and (0.82). We believe that even with the availability of sufficient funds for building maintenance, the skill of maintenance personnel is important to successfully complete maintenance work. Also, there is maintenance work that requires skilled workers specializing in this field, otherwise, the paragraph is not done in the required manner. As for the factors related to the problems of resource management, namely (building services and materials), (materials properties) and (unqualified contractor), they were important factors, as RII have respectively (0.84) (0.81) (0.89), We believe that these factors are important in Any construction work, including maintenance work. The two factors (poor control over the budget; RII 0.81) and (insufficient funds; RII 0.83) were also important, and we find that most government buildings are allocated annual maintenance funds, and most government departments suffer from the lack of allocated sums and the large number of buildings that need To maintenance. The age of the building got (RII 0.9), so it is considered an important factor, and this is self-evident because the aging of the building requires continuous maintenance work.

The condition of the structure (RII 0.84) and the networks of the sewage drainage components (RII 0.88) are also important factors, and we find that many buildings such as schools, for example, due to neglect of maintenance work and the aging of the building, the condition of the structure has become poor, as some buildings are described as ramshackle buildings. Also, we find that most restoration tender for government buildings include maintenance of sewage drainage networks.

Table (2) shows a summary of the factors that appeared at the highest level (H), and the rank of these factors according to the index of relative importance from highest to lowest.

As for the other factors, they were less important than the previous ones, that is, in the second level of importance, located between medium to high (M-H), which is the need for special devices and tools(RII 0.79), the problems of providing spare parts (RII 0.75), as well as some factors that fall within the administrative problems, which are measures for health And safety(RII 0.77), the need for special programs (RII 0.68), the need for a special experience(RII 0.66), and we believe that most of the maintenance work carried out is done with the available equipment and tools, which meet the purpose. Also the factors of high humidity and rain, the RII were respectively (RII 0.80) (RII 0.73), meaning that it is not of high importance, and we see that the weather conditions of rain and humidity do not actually affect maintenance work in Iraq, despite the possibility of its impact in other countries. Other factors also received the second level of importance, (lack of familiarity with the site and local conditions; RII 0.74), quality control factors (RII 0.78), availability of maintenance manual (RII 0.76), the need for special standards (RII 0.65), non- using Preventive maintenance (RII 0.75). The materials are inconsistent with the client's activities (RII 0.71), we believe that most maintenance work is neither complicated nor large and somewhat similar, so these factors appeared in these proportions. High maintenance costs factor (RII 0.79), and we believe that it is Although most government buildings require maintenance, A paragraph of maintenance work on their own, And also one building does not cost much. Budget restrictions (RII 0.77), we find that despite the small budget allocated annually for maintenance work for government buildings, the method of its disbursement is not restricted, it is spent on Paragraphs that maintenance engineers deem necessary. Security aspects (RII 0.78), political problems (RII 0.65), political restrictions (RII 0.65), we find that most political matters in general do not significantly affect maintenance work. Governmental restrictions (RII 0.74), Indeed we think that it appeared at this rate because there were no instructions restricting building maintenance.

The absence of institutional and training facilities (RII 0.76), we believe that this factor appeared at this rate, because most workers in building maintenance have experience gained from their work In other engineering departments, such as supervision, follow-up, and others, which gives them a good experience. The height of the building (RII 0.73), its size (RII 0.74), its area (RII 0.70), the condition of the external walls (RII 0.73), the condition of the internal walls (RII 0.75), The condition of the
walkways inside the building (RII 0.72), the condition of the electrical wires (RII 0.79), these factors appeared on a second level of importance, we believe that this is due to the fact that they do not pose a great danger to the condition of the building, and some of them are maintenance to preserve the aesthetic of the building. As for the social and cultural factors, the relative importance index came, for all the factors mentioned in the questionnaire, which fall within the social and cultural factors, between medium to high (M-H), which are: user defects (RII 0.79), improper use (RII 0.80), intensive use (RII 0.76), human behavior and attitudes (RII 0.71), sabotage of a third party (RII 0.67). Although maintenance work is done due to the misuse of buildings, we believe that it appeared at this level of importance, as most government buildings suffer from a lack of maintenance work for long periods, that is, even with good use, we need maintenance of the buildings for many reasons such as the building's aging. A cultural practice (RII 0.62), the lack of a maintenance culture (RII 0.77). We believe that most of the employees who use government buildings and those concerned are quick to inform the relevant government departments of the needs of the buildings used for maintenance, but due to the lack of financial allocations, most buildings are not maintained. The ability to recycle (RII 0.64), it does not require many materials such as construction work for new buildings, so this percentage came in this way. Comfort and luxury (RII 0.63), most maintenance work is for the paragraphs that preserve the structure and extend the life of the building, that is, the very necessary paragraph. As for the paragraphs that are concerned with matters of comfort and luxury, the focus on them is not high. Other factors obtained a lower index of relative importance, that is, they are located in the medium level (M), which are air gases (RII 0.53), solar radiation (RII 0.55), environmental and biological effects (RII 0.59). We believe that these factors have little impact on maintenance measures in Iraq, despite the possibility of their impact in other countries due to the difference in weather.

**Table 2.** The descending order of the factors most influencing maintenance measures and their time, which are at the highest level (H).

| Factors                                | Group                                | rank |
|----------------------------------------|--------------------------------------|------|
| The skill of maintenance personnel     | Decreased interest in future maintenance | 1    |
| Maintenance time (when it started)     | Technical defects appear             | 2    |
| The age of the building                | The building                         | 3    |
| Construction Wrong                     | Technical defects appear             | 4    |
| Unqualified contractor                 | Decreased interest in future maintenance | 4    |
| The components of the sewage drainage network | The building                     | 5    |
| Poor maintenance work performed        | Technical defects appear             | 6    |
| Delayed of failure reporting           | Decreased interest in future maintenance | 7    |
| The time required to complete the work | Technical defects appear             | 8    |
| Poorly in implementation               | Technical defects appear             | 8    |
| Response time to maintenance work      | Decreased interest in future maintenance | 8    |
| Building services and materials        | Decreased interest in future maintenance | 8    |
We notice in Table (2) that the number of factors that fall at level (H) is 19 factors, and we find that 36.8% of the factors fall within the group of the appearance of technical defects, while 5% of the factors fall within the group of low interest in future maintenance, while the group of administrative problems, the ratio of the high factors was 42.1%, and 15.8% of the factors are within the construction group.

4. Conclusion
Building maintenance procedures and their time are affected by many factors. This study attempted to shed light on the factors affecting maintenance procedures and time, for government buildings, as the factors were divided under five main headings.

This study clarified, through the results of the prepared questionnaire, that the most important factors affecting maintenance procedures and their time are: With regard to factors that fall within the appearance of technical defects; Maintenance time (when it started), safety and health measures, time to complete work, flawed construction, failure to implement, poor maintenance work performed, design problems.

With regard to the factors that fall in, decreased interest in future maintenance, the most important factor; Delayed of failure reporting.

As for the administrative problems, the most important factors are; Response time to maintenance work, the skill of maintenance personnel, unavailability of skilled workers, construction services and materials, material properties, unqualified contractor, poor budget control, insufficient funds,

As for the building, the most important factors are; The age of the building, the condition of the structure, the networks of the sewage drainage components.

We noticed that no factors appeared of great importance, among the factors that fall into, social and cultural factors.
Finally, we can say that the factors related to the emergence of technical defects and administrative problems are the most influential on maintenance procedures and time, so controlling the factors that fall within these names can improve maintenance procedures for government buildings in Iraq.

References
[1] Odediran S J, Opatunji O A and Eghenure F O 2012 Maintenance of residential buildings: users’ practices in Nigeria J. Emerg. Trends Econ. Manag. Sci. 3(3) 261-5
[2] Adejimi A 2005 Poor building maintenance in Nigeria: Are architects free from blames? Proc. ENHR Int. Conf. Hous. New Challenges Innov. Tomorrow’s Cities, Iceland 29 1–16
[3] Ali A S, Keong K C, Zakaria N, Zolkafli U and Akashah F 2013 The effect of design on maintenance for school buildings in Penang, Malaysia Struct. Surv. 31(3)194–201,
[4] Parida A and Kumar U 2006 Maintenance performance measurement (MPM): Issues and challenges J. Qual. Maint. Eng. 12(3) 239–51
[5] Chanter B and Swallow P 2006 Building maintenance management Blackwell Publishing Ltd. UK
[6] Löfsten H 2000 Measuring maintenance performance – in search for a maintenance productivity index Int. J. Prod. Econ. 63(1) 47–58
[7] Talib R, Ahmad G, Zakaria N and Sulieman M Z 2014 Assessment of factors affecting building maintenance and defects of public buildings in Penang, Malaysia Archit. Res. 4(2) 48–53
[8] Waziri B S and Vanduhe B A 2013 Evaluation of factors affecting residential building maintenance in Nigeria: Users’ Perspective Civ. Environ. Res. 3(8)19–25
[9] Zulkarnain S H and Rahman M Y A. 2011 A review of critical success factor in building maintenance management practice for university sector World Academy of Science, Engineering and Technology 5(5) 215–9
[10] Cobbinah P J 2010 Maintenance of buildings of public institutions in Ghana case study of selected institutions in the ashanti region (Doctoral dissertation)