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Evaluate the State of Building Maintenance Performance in Construction Projects: A Case Study of Iraq, Diyala

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ABSTRACT

Building maintenance is one of the critical issues that maintenance managers should prioritize. As a result, evaluating the performance status of maintenance is required to understand the reality of maintenance in construction projects and to ensure that maintenance meets the required goals and improves building preservation. Therefore, the aim of this study is to evaluate the state of building maintenance performance in construction projects. The field survey included preparing a list of the questionnaire, conducting a statistical analysis of a Sample Questionnaire, and discussing the results. Note that the research has achieved practical results The results showed that the average value for the axis (encouragement/development) reached (2.31), which is the lowest value in the questionnaire, showing that was an absence of professional development and employee training through a training course, as well lack to carry out follow-up work on the status of performance of the functions of the main building elements, in addition to the scarcity of taking into account the design, construction phase and how to perform maintenance, and therefore the failure to apply these factors will harm the process maintenance and efficiency.

1. Introduction

Building maintenance is becoming increasingly important in the construction industry around the world [1], after the builder has left the site, the building upkeep begins [2]. As a result, structures cannot remain new for the rest of their lives. The instant a building is constructed, it begins to degrade. According to [3], it is impossible to create maintenance-free structures, but good design and proper workmanship are carried out by experienced professionals or competent craftsmen utilizing appropriate installation codes, essential building materials, and methods that can reduce maintenance work. According to [4], disregard of upkeep leads to accumulated outcomes as the fabric and finishing of buildings deteriorate. According to [5], a building's ability to provide the required atmosphere for a specific activity is a measure of its usefulness. As the components of a building begin to deteriorate, it becomes necessary to take steps to ensure that the desired characteristics of that facility, such as safety and convenience, are preserved. Because the ability of a building to provide the required environment for a particular activity is a measure of its function, the deterioration of the building's components necessitates taking steps to preserve the desired building characteristic [6].

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Performance assessment is an important part of any process management, and so the evaluation of a facility's performance is critical for determining future decisions. According to [7], it is important to identify factors that are critical to the organization's success while conducting a performance evaluation. Furthermore, these factors, known as critical success factors (CSFs), indicate a set of concerns that must be addressed in order to attain a specific strategic goal. CSF is critical for building maintenance projects, according to [8], because it can uncover project failure causes and enhance performance. As a result, in order to produce a successful project, these essential components must be adequately prepared. [9], affirms building services assessment and condition monitoring are required to identify the status of services offered to users. [10] Stated the reasons for evaluating performance, which included providing management and employees with feedback on their job. Employee feedback can lead to a variety of positive outcomes, such as increased motivation or the launch of improvement projects, all of which can assist the company in achieving continuous development.

Researchers have recognized the relevance of building maintenance in obtaining cost-saving and enhanced facilities [11]. Maintenance of any building begins with the design stage, but the organization and execution of maintenance work occur only after the structure has been finished as a result of a change in the building's preoccupation circumstance [12]. Preventive maintenance is mentioned by Hauer et al., who emphasize its importance. The following preventative maintenance best practices are recommended: (1) to inventory building components and assess their conditions; (2) to build capacity for ranking maintenance projects and evaluating their costs; (3) to plan strategically for preventive maintenance in the long and short term; (4) to structure a framework for operating a preventive maintenance program; (5) to use tools to optimize the preventive maintenance program; (6) to involve a third party in the preventive maintenance program [13].

Finally, it can be stated that in order to avoid all such construction flaws that can result in high future maintenance costs, the old manner of procurement building construction must be revised by forming a relationship between designers and construction specialists [14]. Building maintenance, such as has numerous long-term advantages [15].

- Improved building performance.
- Extend the useful life of structures.
- Keeping operational costs to a minimum.
- Users and people of the community will have a favorable impression of the building and its owner.

2. Methodology

To achieve the objective of the research, a field study was conducted that included several steps:

2.1 Prepared the questionnaire

According to [16], the use of the questionnaire method is a quick, effective and easy approach to collecting facts, data, and attitudes from maintenance personnel, maintenance contractors, and the designer. In order to obtain more accurate results, a five-point Likert scale technique [17] was adopted in this paper. The questionnaire was divided into two sections, which are as follows:

1. **Section One:** It contains the personal information of the questionnaire sample, such as engineering specialization, educational attainment, Years of experience in the field of engineering, and project management experience.
2. **The Second Section:** This section included three axes for evaluating the status of building maintenance performance in construction projects, which are as follows:

First Axis: Planning

The first axis (6) included questions about the extent to which the basic planning requirements are met. Table 3 displays an analysis of the elements of the first axis, including the frequency, arithmetic mean, and standard deviation for each paragraph.

Questions about the first axis:

1. Is the performance evaluation of the building in which you periodically?
2. Performance evaluation affects the success of building maintenance effectiveness.
3. Is there a pre-defined annual or quarterly plan for maintenance?
4. There is planning to manage the financial resources allocated for maintenance in the building, and are the financial resources for maintenance invested as allocated to them.
5. It is taken into consideration in the design and construction phase how maintenance is carried out.
6. Is there a follow-up to the status of performance of the function of the main building elements?

The Second Axis: Organization

The second axis (8) included questions about evaluating the real state of the organization process for maintenance work, Table 4 displays the analysis of the items of the second axis, as well as the arithmetic mean and standard deviation for each paragraph.

Questions about the second axis:

1. There is a technical team that determines the required maintenance work in advance before transferring it to the maintenance team.
2. Are there approved indicators to evaluate maintenance if it is done?
3. Maintenance managers use financial indicators to evaluate performance.
4. Is the required work fulfilled by the time it is needed?
5. Is there a special maintenance unit with good skills to carry out the planned maintenance work?
6. The higher authorities demand from the building management periodic reports on the condition of the building and its need for maintenance.
7. Do the higher authorities take into consideration when evaluating the lower authorities, the condition of the building, its efficiency, and the extent of its application of maintenance programs.
8. Are there measurement criteria for selecting the maintenance team?

The Third Axis: Encouragement/ Development

The third axis included (6) questions that expressed the reality of the application for the basics (encouragement/development). Table 5 analyzes the elements of the third axis, including the frequency, mean, and standard deviation for each paragraph.

Questions about the third axis:

1- There is the professional development, training, and education of the employees through training courses or field visits to modern, advanced, and specialized projects?
2- Contact is made with highly experienced international companies specialized in the field of maintenance to benefit from global experiences in improving the reality of maintenance in Iraq.
3- Is the principle of motivation used for employees to encourage them to perform incrementally?
4- Building management encourages creativity and innovation at work for self-initiatives to develop performance in building maintenance.
5- Are modern technologies used instead of traditional methods?
6- The development of new electronic and technological software and hardware affects the performance of the building.

2.2 Selecting a research sample

The researcher ensured that the questionnaire sample included engineers with experience in building implementation and maintenance, in addition to university professors in engineering disciplines. Table 1 shows the entities to which the questionnaires were distributed the number of forms distributed (70), and the number of forms received (60).

Table 1: Sample questionnaire

The Entities	Distributed forms	Received forms
Diyala Health Department / Department of Projects, Engineering Services and Maintenance	9	8
Ministry of Higher Education and Scientific Research/ Presidency of Diyala University / Department of construction and projects	19	17
Ministry of Higher Education and Scientific Research / University of Diyala/ College OF Engineering	14	12
Ministry of Construction, Housing / Diyala Building Directorate	5	5
Ministry of Construction, Housing / Directorate of Diyala Municipalities	15	10
Ministry of Higher Education and Scientific Research / Interior Departments / Maintenance Department	8	8
Total	70	60

3. Analysis of a sample questionnaire

Answers to personal information questions on the questionnaire form include the following:

A- Engineering Specialization: The research sample included engineering specializations as shown in Figure 1, which depicts the recurring distribution of engineering specializations. It appeared that (41.70%) of civilian engineers and the highest proportion.

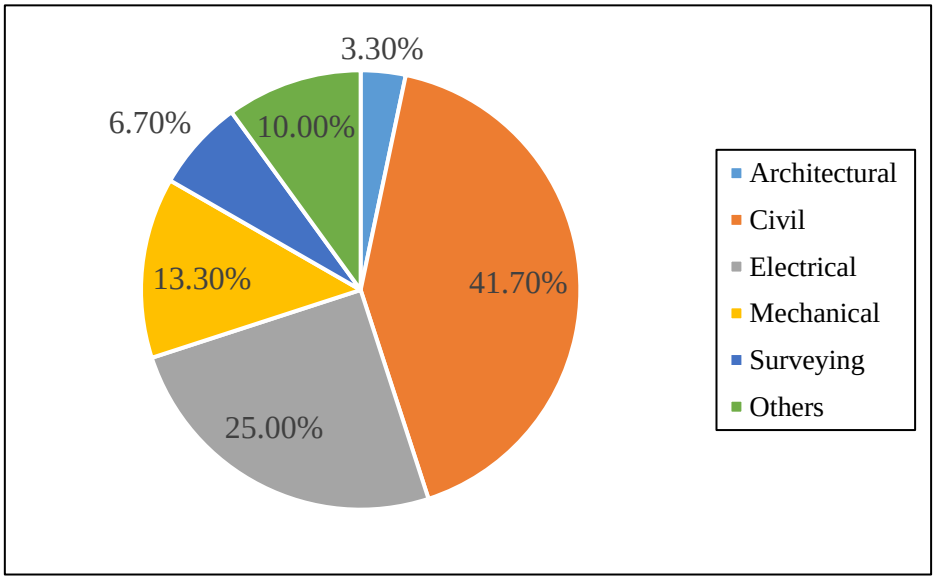

Figure 1. Engineering specialization distribution

B- Educational Attainment: According to Figure 2 which depicts the recurring distribution of educational attainment, it appeared that (68.3%) of the sample members held a bachelor's degree and (16.70%) held a doctorate. While (10.00%) held, a master's degree and (5.00%) held a diploma.

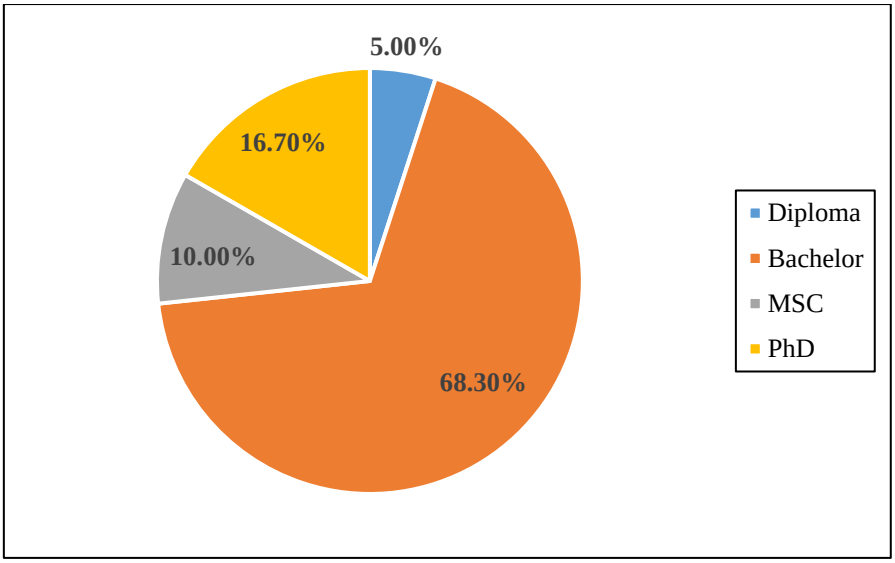

Figure 2. Distribution based on educational attainment

C- Group: The work groups of the sample participant in the questionnaire differed, as seen in Figure 3.

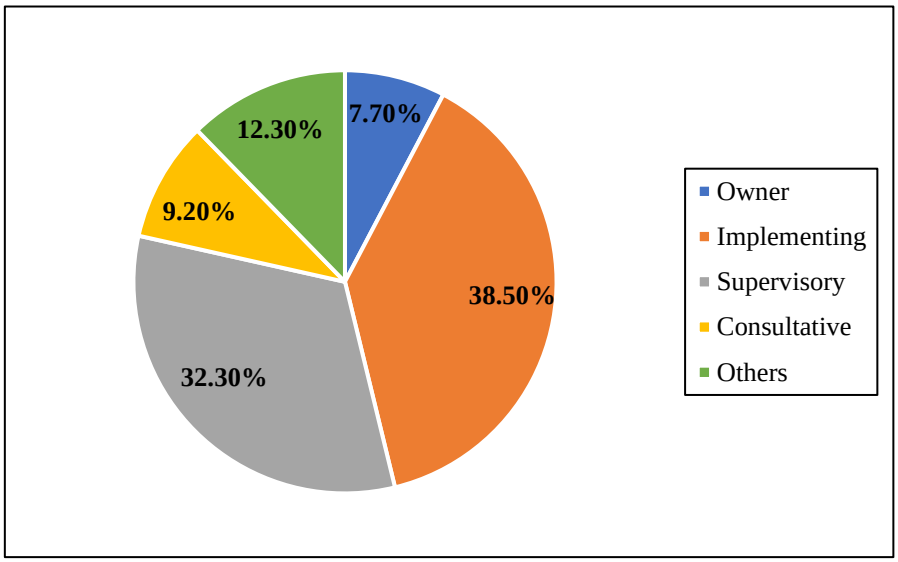

Figure 3. The participant groups

D- Engineering Experience: The research sample is included according to Figure 4 which shows the recurring distribution of the number of years of experience in the engineering field, as the results showed that (28.3%) of the sample member gained experience from (16-20) years and by (25.0%) of those who had the experience of more than 20 years, while the rate of (20.0%) was recorded for the experience gained from (5-10) years, it is worth noting that those with less than 5 years of experience made up (15.0%) of the total, while those with (11-15) years of experience made up (11.7%), which is the smallest percentage.

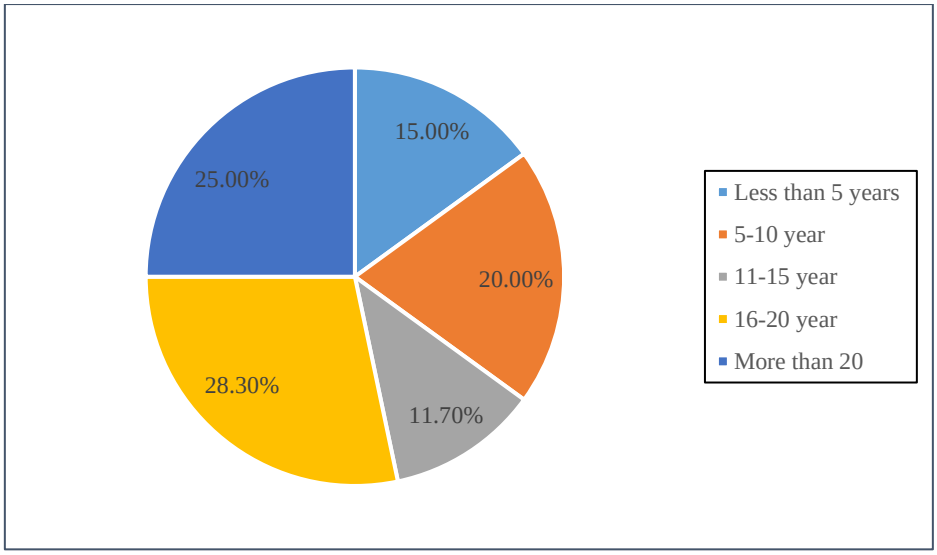

Figure 4. Distribution based on years of engineering experience

E- Experience in Projects Management: According to Figure 5 depicting the frequency distribution of the number of respondents with project management experience, (78.30%) of the respondents have project management experience. While (21.70%) of the respondents do not have experience in project management, they do have experience in other fields.

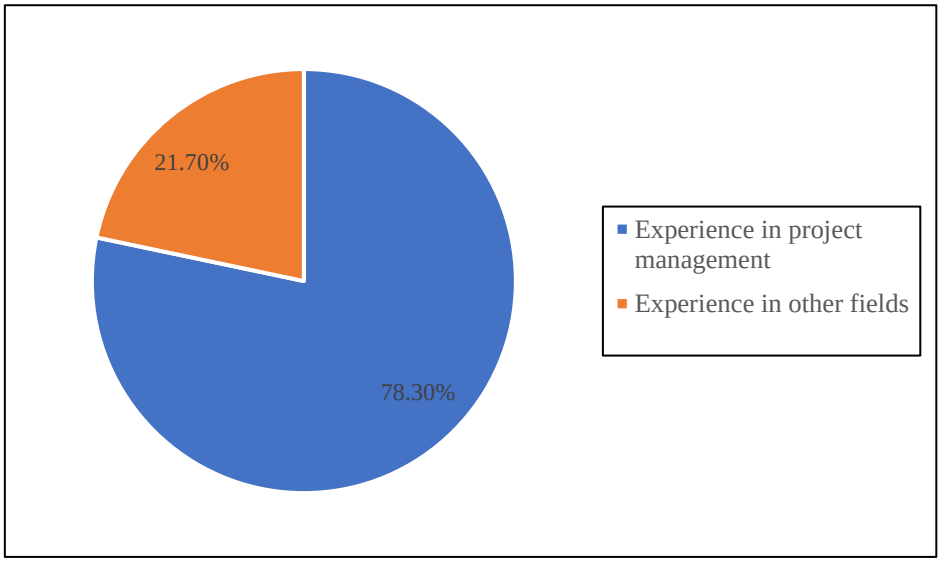

Figure 5. Distribution by experience in projects management

4. Reliability of questionnaire

There are several methods for measuring questionnaire reliability. The Alpha Cronbach method has been used and is the most common method for measuring accuracy. The Alpha Cronbach coefficient has a normal range of (0-1), and the closer the value is to (1), the higher the internal consistency of the questionnaire [18]. The reliability rating based on the Alpha-Cronbach coefficient is shown in Table 2 below.

The reliability of the questionnaire was determined using the Alpha Cronbach method (IBM SPSS V.21) = 0.913

Table 2: Reliability cutoff values [18]

Cronbach's alpha	Degree of Reliability
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq o.6$	Questionable
$o.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Un acceptable

5. Results and discussion

The field study and analysis of the questionnaire results revealed that there are a number of flaws in the management of building maintenance in construction projects, and a delegation of these flaws was classified based on the basic function of management (planning, organization, and encouragement/development). The following is an analysis of the axes' results, which are as follows:

First: Planning

From the results of Table 3: The results showed that the average value of this axis was 3.09, which indicates that it is the highest value among the rest of the axes. According to the results of Table 3, question no. (2) "The performance evaluation affects the success of building maintenance effectiveness." The highest score according to the respondents (mean= 3.833, SD = 1.026). This high value is attributed to the general reliance of construction projects on building performance evaluation.

The results of question no. (4) showed that "there is planning to manage the financial resources allocated for maintenance in the building, namely, the financial resources for maintenance invested as allocated to it." It is the lowest score according to the respondent's viewpoint (mean = 2.767, SD = 0.981). This result is in line with the suffering of construction projects in the absence of accurate planning for the cost of maintenance, as there was no consistency between the provision for maintenance and the costs spent, due to poor planning. Followed by aquestion no. (6) "Is there a follow-up to the status of performance of the function of the main building elements?" It ranked lowest (mean = 2,667, SD = 1,174).

Second: Organization

According to the Table 4:

When analyzing the data for this axis, the average value for this axis was 2.74, which is a low value compared to the planning axis. The results of question no. No. (1) showed that "there is a technical team that determines the required maintenance work in advance before transferring it to the maintenance team" is the highest result according to the respondents' point of view (mean = 3.167, SD = 1.237), followed by question number. (4) That "Is the required work fulfilled by the time it is needed?" with the score (mean = 2.983, SD = 1.142).

The lowest result is the question number. (8) "Are there measurement criteria for selecting the maintenance team" with (mean = 2.333 and SD = 1.099) according to the respondent's point of view.

Third: Encouragement/Development

According to Table 5:

The results showed that the mean value for this axis was 2.31, which is the lowest value. The result of question no. (6) Showed that "The development of new electronic and technological software and hardware affects the performance of the building." It is ranked in the first place from the respondent's point of view (mean =2,450, SD =1.142), and result question no. (4) That "Building management encourages creativity and innovation at work for self-initiatives to develop performance in building maintenance ", in ranked second with (mean =2.217, SD =1.303).

According to the respondents, question no. (2) "Contact is made with highly experienced

international companies specialized in the field of maintenance to benefit from global experiences in improving the reality of maintenance in Iraq." It occupied the lowest rank (mean =1.600, SD =0.886).

Table 3: Statistical analysis of items for the first axis

Item	Frequencies of response level					Mean	S.D
	1	2	3	4	5		
Q1	2	9	24	19	6	3.300	0.962
Q2	2	4	13	24	17	3.833	1.028
Q3	7	12	19	12	10	3.100	1.245
Q4	5	19	24	9	3	2.767	0.981
Q5	10	19	10	9	12	2.900	1.399
Q6	7	26	14	6	7	2.667	1.174
Average Mean							3.09
1= **Never (No)**	**2= Rarely**		**3= Sometime**		**4= Often**	**5= Always**	

Table 4: Statistical analysis of items for the second axis

Item	Frequencies of response level					Mean	S.D
	1	2	3	4	5		
Q1	5	15	16	13	11	3.167	1.237
Q2	14	20	15	7	4	2.450	1.171
Q3	10	17	19	10	4	2.683	1.142
Q4	7	11	25	10	17	2.983	1.142
Q5	6	14	23	12	5	2.933	1.087
Q6	9	12	22	14	3	2.833	1.107
Q7	14	17	17	7	5	2.533	1.214
Q8	15	21	16	5	3	2.333	1.099
Average Mean							2.74
1= Never (No)	**2= Rarely**		**3= Sometime**		**4= Often**	**5= Always**	

Table 5: Statistical analysis of items for the third axis

Item	Frequencies of response level					Mean	S.D
	1	2	3	4	5		
Q1	23	17	10	4	6	2.217	1.303
Q2	34	20	4	0	2	1.600	0.886
Q3	15	22	13	6	4	2.367	1.164
Q4	14	19	16	8	3	2.450	1.142
Q5	17	16	21	6	0	2.267	0.989
Q6	9	14	11	21	5	2.983	1.242
Average Mean							2.31
1= Never (No)	**2= Rarely**		**3= Sometime**		**4= Often**	**5= Always**	

5. Conclusion

After investigating the status of building maintenance performance in construction projects and analysing responses, the researcher came to the following conclusion:

1- Lack of professional development for employees through training courses or field visits to advanced and specialized projects.
2- Poor planning to manage the financial resources allocated for maintenance in some government departments affect the maintenance process and its efficiency.
3- Failure to carry out follow-up work on the status of performance of the functions of the main building elements.
4- Lack of incentive to encourage employees to increase performance or encourage creativity and innovation at work.
5- Lack of communication with international companies with high experience in the field of maintenance in improving the reality of maintenance in Iraq.

Recommendations

- It is necessary to pay attention to the maintenance process in general, allocate the required funds, and invest these amounts for maintenance as they are allocated.
- Using the principle of incentive to attract engineers to the maintenance department and encourage them to increase their performance.
- Using modern technologies and keeping pace with developments in maintenance by communicating with companies with high experience in the field of maintenance in order to improve the reality of maintenance in Iraq.

References

[1] A. Weber and R. Thomas, "Key performance indicators-Measuring and managing the maintenance," *IAVARA Work smart*, pp. 1–16, 2005.

[2] I. Ofori, P. Duodu, and S. Bonney, "Establishing factors influencing building maintenance practices: Ghanaian perspective," *Journal of economics and sustainable development*, vol. 6, no. 24, pp. 184–193, 2015.

[3] R. A. Iyagba, "The Menace of Sick Buildings: A challenge to all for its prevention and treatment. Akoka, Nigeria." University of Lagos Press, 2005.

[4] H. K. Breesam and Z. A. Jawad, "Factors affecting maintenance procedures for public buildings," in *IOP Conference Series: Materials Science and Engineering*, 2021, vol. 1090, no. 1, p. 12120.

[5] S. J. Odediran, O. A. Opatunji, and F. O. Eghenure, "Maintenance of residential buildings: users' practices in Nigeria," *Journal of Emerging Trends in Economics and Management Sciences*, vol. 3, no. 3, pp. 261–265, 2012.

[6] M. Y. L. Chew, N. De Silva, and S. S. Tan, "A neural network approach to assessing building façade maintainability in the tropics," *Construction Management and Economics*, vol. 22, no. 6, pp. 581–594, 2004,

[7] B. Atkin and A. Brooks "Quantification methods of technical building performance" Total Facilities Management, Blackwell Science, Oxford. Augenbroe, G. and Park, C.S. Building Research and Information, Vol. 33 No. 2, pp. 159-172, 2000.

[8] M. F. M. Mukelas, E. M. A. Zawawi, S. N. Kamaruzzaman, Z. Ithnin, and S. H. Zulkarnain, "A review of critical success factors in building maintenance management of local authority in Malaysia," in *2012 IEEE Symposium on Business, Engineering and Industrial Applications*, 2012, pp. 653–657

[9] Ahmad, R. "Role and Approach of Building Surveying in Facilities & Maintenance M anagement." In *National Seminar on Facilities & Maintenance Management In the 21st Century: The Demands & Needs for Growth in Malaysian Building Industry, 12th August*. 2008.

[10] B. Andersen and T. Fagerhaug, *Performance Measurement Explained: designing and implementing your state-of-the-art system*. Asq Press, 2002.

[11] N. de Silva, M. F. Dulaimi, F. Y. Y. Ling, and G. Ofori, "Improving the maintainability of buildings in Singapore," *Build. Environ.*, vol. 39, no. 10, pp. 1243–1251, 2004, doi: https://doi.org/10.1016/j.buildenv.2004.02.011.

[12] E. Geisler, "Trends in Hospital and Healthcare Technologies–The future," *Hospital Engineering and Facilities Management*, pp. 18–22, 2002.

[13] J. Hauer, V. Bombach, C. Mohr, and A. Masse, "Preventive Maintenance for Local Government Buildings: A Best Practices Review.," 2000.

[14] S. N. H. Ishak, A. H. Chohan, and A. Ramly, "Implications of design deficiency on building maintenance at post-occupational stage," *Journal of Building Appraisal*, vol. 3, no. 2, pp. 115–124, 2007, doi: https://doi.org/10.1057/palgrave.jba.2950061.

[15] K. R. Reziej and N. H. Al-Hilaly, "Determine an Equation to Calculate the Annual Maintenance Cost for Public Hospitals (Al Sader City Hospital as a Case Study)," *Journal of Engineering*, vol. 23, no. 2, pp. 1–12, 2017.

[16] K. Al Hallaq and B. Tayeh, "The Effect of Design and Construction's Faults/Errors on Maintenance of UNRWA's School Buildings in Gaza Strip," 2015.

[17] R. Likert, "A technique for the measurement of attitudes.," *Arch. Psychol.*, 1932.

[18] R. D. Yockey, *SPSS demystified: A simple guide and reference*. Routledge, 2016.