Determining Appropriate Strategy for Building Repair and Maintenance System (Case Study, Karaj, Iran)

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ABSTRACT: Failure to define the indicators and sub-indicators for measuring the performance of Repair and Maintenance (R&M)[1] activities is one of the significant issues in a building to increase its life expectancy. Evaluation of R&M system in a building is one of the key factors in improving the quality of R&M performance steps. Therefore, to implement appropriate strategies, the criteria affecting on R&M system must be identified. Also, choosing the proper net policy is a strategic decision-making problem that effectively reduces the cost and longevity of buildings. In this research, by using the experts' opinion and the Delphi method, the indicators and sub-indicators affecting the R&M system were identified, and those indicators were graded using the decision tool. The existing buildings in Karaj city as a case study were then considered to evaluate the proposed system. Analysis of the results shows that the safety index has the highest grade according to the experts' opinion, but by reviewing the results of the case study, this rank was assigned to the health criterion. Then, by using the SWARA technique, the most critical policies affecting buildings' R&M are identified among Emergency Maintenance (EM), Breakdown Maintenance, Corrective Maintenance (CM), Preventive Maintenance (PM), Predictive Maintenance (PdM), Total Productive Maintenance (TPM), Proactive maintenance. Applying the VIKOR method and the results of both approaches revealed that Corrective Maintenance (CM) and Breakdown Maintenance (BM) policies are the best for buildings, R&M policies.

1 Repairs and Maintenance

1- Introduction

The correct implementation of the maintenance system increases the lifespan of buildings and reduces their costs. The issue of maintenance is less important compared to the other effective sectors in the construction industry, including design, supervision and implementation, especially in Iran, while knowing the factors influencing the maintenance system and knowing its strategies in the building, not only causes There is a significant reduction in buildings during operation, which also brings significant financial effects [1]. The operation of the maintenance system should be carefully and continuously checked, so that the facilities and equipment of a building have a proper performance [2]. Failure to pay attention to those matters will increase maintenance costs, indeed. Choosing the right maintenance strategy with a set of combined decisions, to achieve optimal performance and increase proper utilization, minimizing costs, and providing reliable equipment and system agility is of particular importance [3]. If the right option is chosen, it will be possible to improve the quality of the equipment's performance, and then the maintenance costs will be reduced. If inappropriate strategies are chosen, new problems will be created for the equipment and facilities. This research seeks to determine and prioritize the basic indicators of the maintenance system in buildings and determine its appropriate policy using multi-criteria decision-making methods, to recognize and analyze them to evaluate the building maintenance system, and to compare the results from the experts' point of view and case study. To choose the most suitable maintenance strategy, different indicators and approaches have been used. After determining the maintenance indicators in buildings, the most appropriate maintenance strategy among the effective strategies in this field has been ranked by experts.

2- Methodology

The main purpose of this research work is to identify the criteria and sub-criteria effective on the maintenance system and examine these parameters in the buildings of Karaj city as a case study and compare its results with the results of pairwise comparison of criteria and sub-criteria by experts to choose the most appropriate maintenance policy. Regarding the use of decision-making methods, the

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Table 1. Selected research criteria

Criteria	Criteria
possibility	Proper utilization
Energy saving	Availability
Comfort	Environment
Health	Reliability
safety	Cost
Time	Value Added
	Risk

Fig. 1. Total comparison of building maintenance sub-criteria

experts were selected by non-probability sampling method and using targeted judgment methods [4]. After selecting the panel members, a consensus was reached among the experts regarding the indicators and sub-indicators of the maintenance system using the Delphi method. The main criteria and sub-criteria related to them, which have been most used in the selection of appropriate maintenance policies, according to the background of research and examination of the national building regulations and related by-laws, and according to the opinion of experts, were considered and introduced in Table 1.

After determining the parameters and sub-parameters and setting up the questionnaires, and distributing them among the samples, the condition of the building maintenance parameters was asked based on the Likert scale by the existing condition of the buildings. To evaluate the building maintenance system, the results of a case study (Karaj Ccity) were examined. To determine the number of samples using Cochran's formula method, first, the number of buildings with more than 3 floors that were built in Karaj city from 1977 to 2019 was collected through Iran's statistical system, which represents the total population according to the method. The Cochran's formula, the total number of obtained buildings was 37184 samples, so the statistical population was determined to include 380 sample buildings [5, 6].

To rank the indicators and sub-indices in this section, after the electronic distribution of a paired questionnaire among experts, the priority of sub-indices in each section was determined according to the AHP method. In the following, after distributing the questionnaire resulting from the sub-criteria among the samples, each of the questions was analyzed according to the collected information using SPSS software. To convert the qualitative answers into quantitative ones, the method of weighing the indicators was used. According to the examination of the results obtained from the distribution of questionnaires among the samples and the opinions of the building managers, it was determined, the criterion health is in the better condition, safety is in the second place, and energy saving is in the last place, which indicate that health index is more important than safety in buildings. Also, the quality of cleaning and maintenance of common areas has a greater impact on the health and quality of the building, based on maintenance than the other sub-criteria, and according to its weight, in the range of good to very good effect. Consequently, it can be said that this sub-criterion has
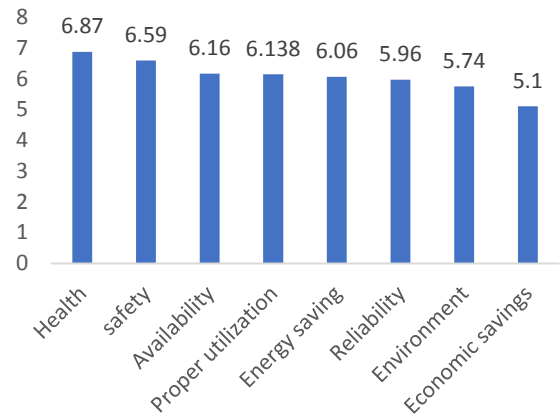
a positive effect. Herein, Figure 1 shows a comparison of all net indices based on the answers.

3- Results and Discussion

The results of the method showed that the safety criterion has the highest priority, and the health criterion is in second place. However, by examining the results of the case study questionnaire, it was found that the status of health criteria is better, and safety is in second place. Also, according to the expert's opinion, the criteria of energy saving, and reliability have the lowest priority respectively, but by the examination of samples, it was found that the criteria of environment and economic saving have the lowest priority respectively, which shows the difference between the opinion of the experts and the results of the case study. Finally, by using Multi-Criteria Optimization and Compromise Solution, the results obtained based on the opinion of experts and a case study were used to rank and choose the appropriate building maintenance strategy. The investigation of the methods used in this research shows the same results of both methods, and based on that, the Corrective Maintenance and Breakdown Maintenance strategies were introduced as suitable options for the building maintenance system.

4- Conclusion

By comparing the criteria and sub-criteria it was determined that the safety criterion has the highest rank according to the experts' opinion, but in the examination of real samples, it was found that the health criterion has the highest priority. Also, the criterion of reliability according to the experts' opinion, and the energy-saving criterion in the case study, have the lowest priority.

Knowing the results of prioritizing the criteria and sub-criteria, to choose the best building maintenance strategy among the seven most used strategies and using the SWARA method, three strategies were selected: Corrective

Maintenance, Breakdown Maintenance, and Reactive/ Emergency Maintenance. Finally, by applying the VIKOR method, it was determined that according to the values of (s), (R), and (Q), the results in both methods used in this research work are the same, and the Corrective Maintenance and Breakdown Maintenance strategy that are the best politics in the building maintenance system.

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