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Factors Affecting Maintenance Practises in Iraq's Hospital Buildings

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ABSTRACT

A lack of adequate building maintenance is a significant obstacle faced by governmental hospitals. This paper evaluates factors that negatively impact building-maintenance practices in Iraq. A literature review was conducted to identify factors affecting maintenance. A list of 42 factors affecting hospital-buildings was collected from previous studies and tested using a structured questionnaire distributed to hospital-maintenance experts. During the data analysis, 76 valid questionnaires were used. Based on the respondents' ratings, the relative-importance index (RII) was used to determine the level of importance of each factor. From the results, it was concluded that twelve factors affect maintenance practices in hospital buildings: faulty design (0.889), lack of funding (0.874), inadequate training (0.871), misuse of building facilities (0.866), construction errors (0.863), lack of work experience (0.858), building age (0.826), individual modifications carried out by the hospital staff (0.826), shortage of maintenance staff (0.824), administrative corruption (0.821), selection of unqualified maintenance contractors (0.816) and unavailability of skilled appointed maintenance personnel (0.808). Understanding these factors' effects is essential for maintenance-department managers to develop strategies for maintaining hospital buildings in Iraq by controlling them, as well as identifying problems and finding appropriate solutions to avoid them.

KEYWORDS: Governmental hospitals, Maintenance, Iraq, Building maintenance, Maintenance practices, Factors affecting maintenance.

INTRODUCTION

Hospital buildings are critical for delivering healthcare services and play a crucial role in ensuring patient safety and providing quality care (Pariya et al., 2020). Various facilities and equipment support hospital systems (Abd Rani et al., 2015). Hospitals provide essential services 24 hours a day, 7 days a week, which is greater than any other building (Orooje and Latifi, 2021). Governmental hospitals' effectiveness is affected by several factors, including their maintenance quality (Amir, 2012). Building maintenance is closely related to essential functions guaranteeing the building's planned performance and safety (Chan, 2019). Building maintenance has been regarded as an integral component of a building's life cycle (Kwon et al., 2020), because buildings gradually deteriorate over time for various reasons, including unrepaired defects, neglected damage and environmental causes (Dzulkifli et al., 2021). Buildings undergo maintenance services that optimize their performance and promote user satisfaction (Olanrewaju and Tan, 2022). Maintenance involves delaying buildings' structural deterioration, which is a primary concern for industry professionals (Idrus et al., 2009). Avoiding maintenance reduces asset life, raises operating costs and leads to the wastage of financial and natural resources (Banful, 2004). Maintenance practices include deliberate and organized planning, evaluation, organizing and monitoring of maintenance activities and costs (Bajere et al., 2016). Despite the importance of hospital buildings to the community and the important role of maintenance in such buildings, there is limited research on hospital-

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building maintenance in Iraq. For instance, Reziej and Al-Hilaly (2017) developed a formula for estimating annual maintenance costs. Meanwhile, Alwan and Abbas (2018) determined the best optimal time for preventive maintenance by examining hospital records for the issues that affect medical devices. Further, recently, serious accidents in hospital buildings have resulted in human and material losses. Therefore, this study investigates the factors affecting hospital-maintenance practices and identifies the most influential factors contributing to the declining performance of hospital maintenance, which negatively affects maintenance costs, user safety and medical-service quality. This study is expected to contribute to the field of hospital-building maintenance by allowing stakeholders to improve their awareness and focus on the most important factors affecting maintenance, as well as pay attention to the ongoing challenges to improving the overall maintenance performance of hospital buildings, which will help guide the establishment of appropriate strategies.

METHODOLOGY

This study was conducted in three stages. In the first stage, a review of the relevant literature was conducted to identify factors affecting building maintenance and these factors were included in a survey questionnaire. In the second stage, a field survey was conducted using an open questionnaire, during which experts reviewed the prepared questionnaire form to determine whether the questions were accurate and clear and made any necessary adjustments. Then, the closed questionnaire was distributed to a group of engineers with various educational credentials who specialized in the maintenance of governmental hospital buildings. In the third stage, quantitative data was analyzed using the Statistical Package for Social Sciences (SPSS) and Microsoft Excel. This included determining the reliability of the data, mean, standard deviation and relative-importance index, and then arranging the factors according to their level of importance. Fig. 1 shows the methodology flow chart of the study.

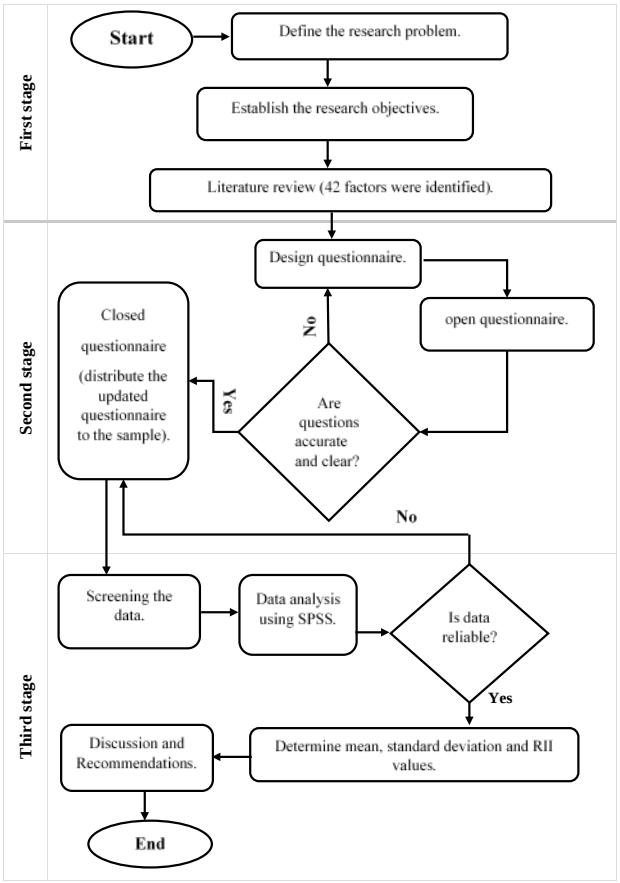

Figure (1): Flowchart of the methodology of the study

LITERATURE REVIEW

This review focused on articles relevant to the topic published between 2013 and 2022 and indexed in Google Scholar, Scopus or Web of Science. Jandali and Sweis (2018) assessed the factors affecting the maintenance management of hospital buildings in Jordan. These factors related to statutory requirements, the design phase, operations conducted by the maintenance group and community perception of the maintenance industry. The findings revealed that several factors affect the maintenance management of hospital buildings, including "the localization of the workforce, the method of awarding maintenance contracts, the lack of feedback from the maintenance group to the design team, the absence of maintainability analysis, the selection and specification of inferior quality materials, the failure to consider life cycle costing analysis, faulty design, design deficiencies affecting building resolution, errors conducted during the design of the project, the complexity of the design, the non-involvement of maintenance experts during the design stage, the use of new materials and components in buildings, the attitude of users, the misuse of facilities, persistent breakdowns due to the indiscipline and ignorance factors of building users and vandalism of facilities by patients and visitors". Jesumoroti and Soo (2021) studied the efficacy of hospital-building maintenance-management systems that were affected by numerous determinants and constraints that significantly influence the performance of hospital buildings in Malaysia throughout their lifespan. The predominant maintenance determinants identified include structural-safety issues such as the walls and floors, the overall safety condition of the buildings, inadequate lighting and ventilation and the inaccessibility of maintenance applications in the occupied building. Ebekozien et al. (2021) evaluated the maintenance practices of public hospital buildings in Nigeria, where the study found that there is inadequate maintenance of public hospital buildings due to "lack of funds for maintenance works, the absence of planned maintenance programs, the lack of successful maintenance programmes by the department, faulty design, inadequately trained personnel, the lack of skilled personnel in the maintenance department, the attitude of users and the misuse of facilities." Talib et al. (2014) assessed the factors affecting the maintenance of public buildings in Penang, Malaysia. Their results showed that lack of preventive maintenance, insufficient funds to maintain the building, lack of building-maintenance standards, non-availability of replacement parts and components and not responding to maintenance requests were the most significant factors affecting maintenance. Salleh et al. (2016) investigated the effect of design failure on maintenance management. Their results indicated that "poor detailing and jointing, insufficient thickness of concrete cover, insufficient jointing between finished faces, incorrect location of conduits and piping at critical locations of the structure and insufficient length of ownership" have significant effects on maintenance. Ofori et al. (2015) examined the factors affecting the decision to carry out building-maintenance practices and found that "faulty design, misuse of buildings after completion, the unavailability of skilled labour to undertake maintenance operations and poor financial support for maintenance work" were the most significant factors influencing the decision to carry out maintenance work. Hassanain et al. (2013) investigated and assessed the factors affecting maintenance cost of public and private hospitals' facilities. They concluded that the most significant factors affecting maintenance cost in public hospitals were: transfer of problems from the construction phase to the maintenance phase for resolution, lack of coordination between the construction group and the maintenance group and lack of quality-control measures during the installation of systems. Moreover, the duration of the maintenance contract, errors conducted during the design of the project, lack of feedback from the maintenance group to the design team and the method of classifying maintenance contractors were the most significant factors affecting maintenance cost in private hospitals. Table 1 shows the factors that will be assessed in this study.

Table 1. Factors affecting building-maintenance practices

Category	Sym.	Factor	Reference
Organization related Factors (ORF)	ORF1	Improper planning and scheduling of maintenance work	(Ebekozien, 2020) and (Bajere et al., 2016)
	ORF2	Selection of unqualified maintenance contractors	(Jandali and Sweis, 2018)
	ORF3	Lack of adoption of planned maintenance and regular inspection	(Aliyu et al., 2016)

	ORF4	Non-response to maintenance requests	(Talib et al., 2014)
	ORF5	Lack of coordination between construction and maintenance groups	(Ofori et al., 2015), (Jandali and Sweis, 2018) and (Hassanain et al., 2013)
	ORF6	Lack of documentation of maintenance work	(Maher and Nemr, 2022)
	ORF7	Non-application of user-satisfaction survey	(Ohaedeghasi et al., 2021)
	ORF8	Administrative corruption	(Dakhil et al., 2017)
	ORF9	Lack of verification and assessment of maintenance-work quality	(Hauashdh et al., 2021)
	ORF10	Low concern for future maintenance	(Waziri and Vanduhe, 2013)
Human Resource-related Factors (HRF)	HRF1	Lack of work experience	(Dzulkifli et al., 2021)
	HRF2	Inadequate training	(El Shorafa, 2013)
	HRF3	Lack of expert building-maintenance professionals	(Hauashdh et al., 2021)
	HRF4	Unavailability of skilled appointed maintenance personnel	(Talib et al., 2014)
	HRF5	Shortage of maintenance staff	(Ohaedeghasi et al., 2021)
Technical-related Factors (TRF)	TRF1	Lack of maintenance planning at the building design stage	(Hauashdh et al., 2021)
	TRF2	Transfer of problems from the construction phase to the maintenance phase for resolution	(Hassanain et al., 2013)
	TRF3	Inaccurate as-built drawings	(Hassanain et al., 2013) and (Ebekozien, 2021)
	TRF4	Lack of advanced technology to detect or evaluate building defects	(Hauashdh et al., 2021)
	TRF5	Faulty design	(Hassanain et al., 2013)
	TRF6	Technological change	(Waziri and Vanduhe, 2013)
	TRF7	Lack of adoption of building information modeling	(Hauashdh et al., 2021)
	TRF8	Construction errors	(Arumsari, Wijayanti and Ramadhan, 2021)
	TRF9	Unavailability of spare parts	(Ohaedeghasi et al., 2021)
Financial-related Factors (FRF)	FRF1	Lack of proper planning for allocation of maintenance budget	(Hauashdh et al., 2021)
	FRF2	Inadequate funds to maintain the building due to running out of maintenance budget before the end of the allotted time	(Hauashdh et al., 2021)
	FRF3	Lack of standards to define the exact cost of work and procurements	(Hauashdh et al., 2021)
	FRF4	Lack of funding	(Jandali and Sweis, 2018)
	FRF5	Failure to forecast the accurate maintenance expenditures	(Hassanain et al., 2013)
Building User-related Factors (BRF)	BRF 1	Misuse of building facilities	(Ofori et al., 2015)
	BRF 2	Lack of signs to guide users to use the facilities	(Hauashdh et al., 2021)
	BRF 3	Delayed report of building defects	(Hauashdh et al., 2021)
	BRF 4	Individual modifications carried out by the hospital staff	(Hassanain et al., 2013)
	BRF 5	Occupant density	(D'Orazio et al., 2022)
Building Characteristics-related Factors (BCF)	BCF1	Building age	(Salleh et al., 2016)
	BCF2	Building size	(Breesam and Jawad, 2021)
	BCF3	Structure case	(Breesam and Jawad, 2021)
	BCF4	Wall conditions	(Breesam and Jawad, 2021)
	BCF5	The state of water and sewage networks	(Breesam and Jawad, 2021)
	BCF6	The condition of the walkways inside the building	(Breesam and Jawad, 2021)
	BCF7	Condition of electrical installations and wiring	(Breesam and Jawad,2021)
	BCF8	Building finishes and materials	(Ofori et al., 2015)

Questionnaire Survey

The questionnaire was divided into two sections. The first section requested demographic data from the respondents. The second section solicits the perceptions of the respondents regarding the level of influence of each of the 42 factors using a 5-point Likert scale (from 1 = very low to 5 = very high). After a pilot test with feedback on the first version of the questionnaire, minor

revisions were undertaken to refine the questionnaire and then it was distributed in the survey to engineers and technicians employed in the maintenance departments in Iraqi hospital buildings.

RESULTS AND DISCUSSION

A screening process was conducted on the survey responses to ensure that only valid data would be analyzed. Missing data, outlier values and suspicious responses were discarded. After screening, 76 responses remained, which were analysed in this study.

Respondents' Demographics

As shown in Fig. 2, regarding the proportion of respondents by level of experience, the majority of survey respondents (35.5%) had between 10 and 15 years of work experience, whereas 23.7% had 5-10 years, 15.8% had over 20 years and 14.5% had 15-20 years. A small percentage (10.5%) had less than five years of experience. These results indicate that the respondents possessed the necessary experience and knowledge to comment on the factors affecting maintenance practices, thereby instilling high levels of confidence in their input and the validity of the findings. Fig. 3 shows that most participants (30%) were mechanical engineers, followed by electrical engineers (22%), civil engineers (21%), biomedical engineers (9%) and computer engineers (9%), while a minority (8%) were technicians (others). Fig. 4 presents the respondents' academic degrees in terms of educational attainment, where 8% of the respondents held diplomas, 80% held bachelor degrees, 12% held master degrees and 0% held PhD degrees.

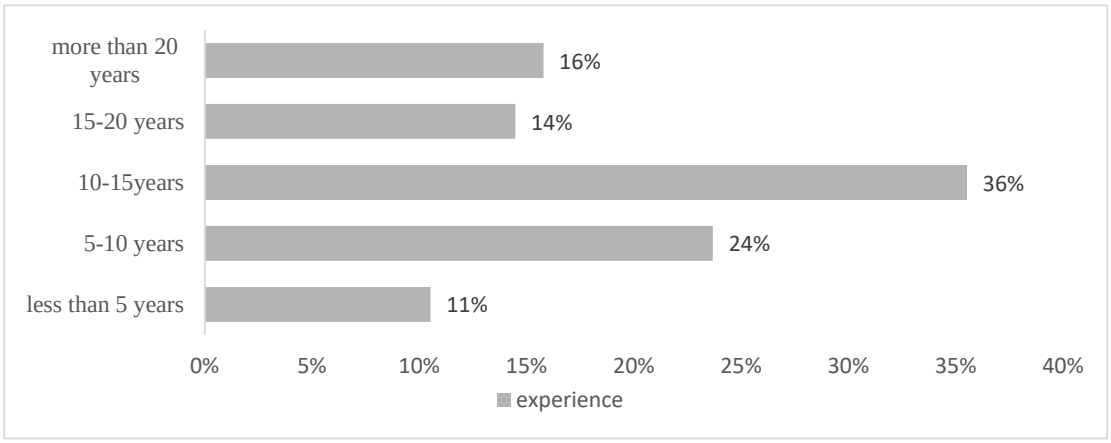

Figure (2): Years of experience of the respondents

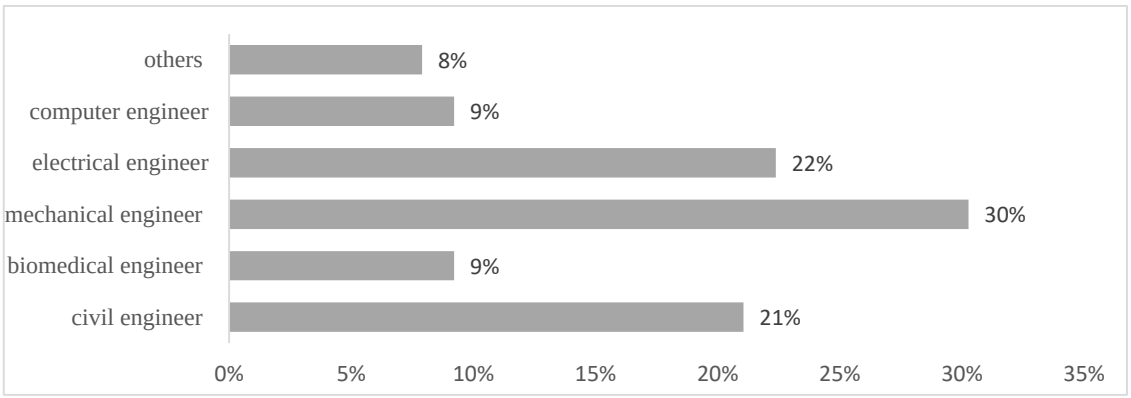

Figure (3): Professions of the respondents

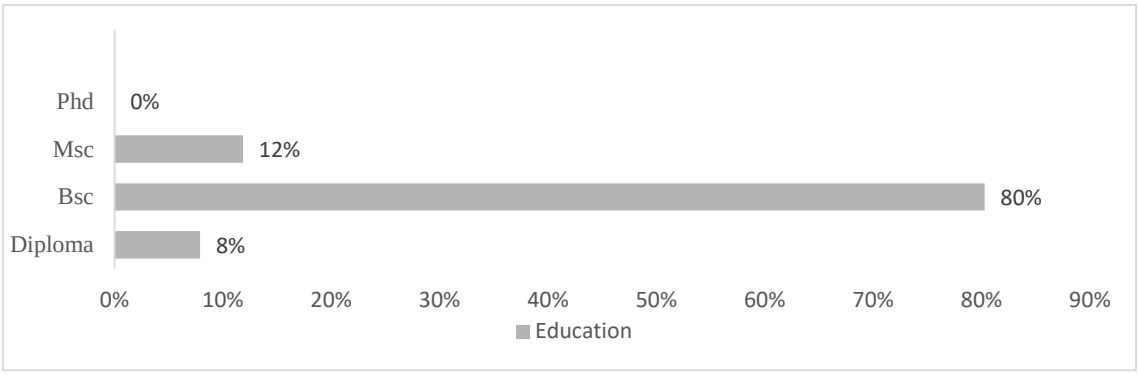

Figure (4): Respondents' academic degrees

Reliability Statistics

The data was analyzed using IBM SPSS-V22 software to determine the reliability of the responses. The Cronbach's alpha coefficient was calculated for each group of factors. This coefficient measures the internal consistency of responses for items being rated. As shown in Table 2, Cronbach's alpha values range from 0.813 to 0.891, which indicates that the responses are reliable, according to Taber (2018). If Cronbach's alpha values range from 0.76 to 0.95, the reliability is fairly high.

Table 2. The values of Cronbach's alpha

Reliability Statistics		
Group	**No. of Items**	**Cronbach's Alpha**
Organization-related factors	10	0.855
Human resource-related factors	5	0.863
Technical-related factors	9	0.881
Financial-related factors	5	0.852
Building user-related factors	5	0.813
Building characteristics-related factors	9	0.891

Factors Affecting Maintenance

The mean and standard deviation were calculated for each factor. Further, the relative-importance index (RII) was calculated. Based on the RII values, the factors were classified according to their importance in light of the Akadiri (2011) criteria set forth in Table 3 to identify the most significant factors negatively affecting maintenance practices in hospital buildings. If two factors have the same value of RII, the factor with the higher mean will be more significant and if two factors have the same values of RII and mean, the factor with the lower standard deviation will be more significant, as shown in Table 4.

Table 3. Importance-level criteria (Akadiri 2011)

RII Values	Importance Level	
$0.8 \leq RII \leq 1$	High	H
$0.6 \leq RII \leq 0.8$	High-medium	H-M
$0.4 \leq RII \leq 0.6$	Medium	M
$0.2 \leq RII \leq 0.4$	Medium – low	M-L
$0 \leq RII \leq 0.2$	Low	L

Table 4. The importance of factors affecting hospital building maintenance practices

Sym.	Factor	Mean	RII	Standard Deviation	Rank
TRF5	Faulty design	4.355	0.889	1.034	H
FRF4	Lack of funding	4.368	0.874	1.008	H
HRF2	Inadequate training	4.447	0.871	1.053	H
BRF 1	Misuse of building facilities	4.329	0.866	1.031	H
TRF8	Construction errors	4.316	0.863	0.962	H
HRF1	Lack of work experience	4.29	0.858	0.992	H
BCF1	Building age	4.132	0.826	0.984	H
BRF 4	Individual modifications carried out by the hospital staff	4.026	0.826	1.170	H
HRF5	Shortage of maintenance staff	4.118	0.824	0.989	H
ORF8	Administrative corruption	4.105	0.821	0.940	H
ORF2	Selection of unqualified maintenance contractors	4.079	0.816	1.020	H
HRF4	Unavailability of skilled appointed maintenance personnel	4.04	0.808	0.932	H
TRF1	Lack of maintenance planning at the building design stage	3.987	0.797	1.201	M-H
BCF3	Structure case	3.963	0.795	1.274	M-H
TRF3	Inaccurate as-built drawings	3.934	0.792	1.185	M-H
BCF4	Wall condition	3.961	0.792	1.273	M-H
ORF1	Improper planning and scheduling of maintenance work	3.947	0.789	1.015	M-H
ORF9	Lack of verification and assessment of maintenance-work quality	3.947	0.789	1.316	M-H
TRF2	Transfer of problems from the construction phase to the maintenance phase for resolution	3.947	0.789	1.188	M-H
ORF3	Lack of adoption of planned maintenance and regular inspection	3.934	0.787	1.011	M-H
FRF2	Inadequate funds to maintain the building due to running out of maintenance budget before the end of the allocated time	4.303	0.783	1.291	M-H
ORF4	Non-response to maintenance requests	3.895	0.779	1.001	M-H
BCF6	The condition of the walkways inside the building	3.882	0.776	1.244	M-H
FRF3	Lack of standards to define the exact cost of work and procurements	3.868	0.774	1.161	M-H
BCF7	Condition of electrical installations and wiring	3.868	0.774	1.239	M-H
BRF 3	Delayed report of building defects	4.132	0.762	1.201	M-H
BRF 5	Occupant density	3.803	0.761	1.106	M-H
BRF 2	Lack of signs to guide users to use the facilities	3.763	0.753	1.094	M-H
TRF4	Lack of advanced technology to detect or evaluate building defects	3.724	0.745	1.121	M-H
ORF5	Lack of coordination between construction and maintenance groups	3.697	0.739	1.184	M-H
BCF2	Building size	3.697	0.739	1.188	M-H
TRF6	Technological change	3.684	0.737	1.109	M-H
BCF8	Building finishes and materials	3.671	0.734	1.180006	M-H
HRF3	Lack of expert building-maintenance professionals	3.658	0.732	1.205	M-H
ORF6	Lack of documentation of maintenance work	3.645	0.729	1.139	M-H
ORF10	Low concern for future maintenance	3.645	0.729	1.215	M-H
TRF9	Unavailability of spare parts	3.645	0.729	1.098	M-H
TRF7	Lack of adoption of building information modeling	3.632	0.726	1.094	M-H
BCF5	The state of the water and sewage networks	3.605	0.721	1.159	M-H
FRF1	Lack of proper planning for allocation of maintenance budget	3.54	0.708	1.062	M-H
FRF5	Failure to forecast the accurate maintenance expenditures	3.007	0.597	1.546	M
ORF7	Non-application of user-satisfaction survey	3	0.542	1.003	M

The results indicate that twelve factors have a high level of importance in affecting hospital-building maintenance practises ($0.8 \leq RII \leq 1$) as follows:

Factor No.1: Faulty Design

The faulty design appears in hospital buildings in different forms, such as the insufficient thickness of the concrete cover, insufficient jointing between finished faces, incorrectly locating conduits and piping at critical structure locations. insufficient provision for thermal movement, insufficient structural design, ignoring maintenance access when designing, not being

concerned with aggressive environments and not considering weather-condition effects. A faulty design negatively impacts maintenance by increasing the time and cost required to repair the defects.

Factor No. 2: Lack of Funding

Inadequate funding is the result of poor financial management. Hospitals may not allocate enough resources for maintenance, leading to a backlog of repairs and deferred maintenance. When outsourcing maintenance services, this factor causes delays in payments to contractors, in turn causing delays in completion.

Factor No. 3: Inadequate Training

Inadequate training renders maintenance personnel incapable of identifying and resolving problems, leading to accelerated equipment and facility deterioration. This can result in costly repairs or replacements and negatively impact the overall health and safety of both patients and staff. Inadequate training can also decrease staff productivity, resulting in maintenance-practice delays and low-quality maintenance works.

Factor No. 4: Misuse of Building Facilities

Misuse of facilities can cause them to wear out more quickly, requiring more frequent repairs and maintenance and creating safety risks, such as electrical or fire risks, that require immediate attention and repair. Misuse of equipment, such as medical equipment or elevators, can cause damage and require costly repairs. The cumulative effect of misuse and neglect can reduce the lifespan of facilities and make it more expensive to maintain and repair them over time.

Factor No.5: Construction Errors

These errors may arise because of a lack of inspection, defects caused by the contractor's administration and his/her staff or the use of sub-standard construction materials. These errors can cause structural issues, such as leaks or weaknesses that can impact the stability and safety of the building. Poor construction can lead to buildings that use more energy or other resources, increasing the costs of operation and maintenance.

Factor No. 6: Lack of Work Experience

It results from inadequate training and development opportunities for the maintenance staff, which can in turn result in a lack of experience and knowledge about building maintenance. Lack of experience can result in poor-quality work, leading to more frequent repairs and maintenance and increased costs.

Factor No. 7: Building Age

As the building ages, it is likely to require more frequent repairs and maintenance, increasing the overall cost of maintaining the building. With the advancing age of building systems, such as plumbing, electrical or HVAC systems, this can result in their deterioration and frequent failures, requiring repairs and maintenance. Over time, buildings can develop structural issues, such as leaks or weaknesses that can impact the stability and safety of the building.

Factor No. 8: Individual Modifications Carried out by the Hospital Staff

Individual modifications, such as installing new equipment or making changes to existing systems, can increase the overall cost of maintenance, as the staff must regularly maintain and repair these modifications. Individual modifications can be incompatible with existing systems, causing problems and requiring frequent repairs and maintenance. This can divert the maintenance staff's attention from other important tasks, leading to a backlog of maintenance and repairs.

Factor No. 9: Shortage of Maintenance Staff

A shortage of maintenance staff can result in the existing staff taking on an increased workload, leading to burnout and reduced efficiency. A shortage of maintenance staff can result in delays in completing maintenance tasks, leading to a backlog of maintenance and repairs. A shortage of maintenance staff can result in poor-quality work, leading to more frequent repairs and maintenance and increased costs.

Factor No. 10: Administrative Corruption

The Oxford English Dictionary defines corruption as a "dishonest or fraudulent conduct by those in power, typically involving bribery." One of the causes of administrative corruption in Iraq is poor organization and administrative instability, weak deterrent procedures and penalties against spoilers, weakness of the internal control systems and lack of quality

standards. Corruption can lead to poor maintenance performance.

Factor No. 11: Selection of Unqualified Contractors

The qualification process for maintenance contractors is important, because it helps ensure that they have the necessary skills, experience and resources to perform maintenance work, reducing the risk of poor-quality work. Selecting unqualified contractors can lead to delays in work completion and cost overruns.

Factor No. 12: Unavailability of Skilled Appointed Maintenance Personnel

It can result from staff turnover, which can lead to a shortage of skilled personnel and budget constraints can prevent hospitals from offering competitive salaries and benefits, making it difficult to attract and retain skilled maintenance personnel. This factor can result in inefficient resource use, increased costs and waste.

CONCLUSIONS

Hospitals are critical infrastructure assets and the maintenance of these buildings is a complex endeavour that may be affected by numerous factors. This study investigated the factors affecting hospital-building maintenance practices in Iraqi public hospitals. This research topic has scarcely been examined in the context of Iraq. Therefore, the researchers reviewed studies on closely related topics and attempted to fill the gap in Iraqi literature in this subject area. A literature review was conducted to identify factors affecting maintenance; 42 factors were identified and categorized into six groups. Staff members from the maintenance department provided the data, which was then analyzed. Based on the results obtained, the following conclusions were drawn: The RII results indicate that the 12 most significant factors affecting maintenance practices in public hospital buildings are faulty design, lack of funding, inadequate training, misuse of building facilities, construction errors, lack of work experience, building age, individual modifications carried out by the hospital staff, shortage of maintenance staff, administrative corruption, selection of unqualified maintenance contractors and unavailability of skilled appointed maintenance personnel.

Recommendations

This study's results can aid in preventing the occurrence of negative factors affecting maintenance practices and enhancing maintenance performance in hospital buildings by identifying appropriate solutions. Further, other countries with similar characteristics as Iraq may benefit from this study's results. Therefore, the researchers propose the following set of recommendations:

1. It is essential to thoroughly review, test and update designs, in addition to involving maintenance personnel in the design process, which can also ensure that maintenance considerations are taken into account.
2. Funding for maintenance must be prioritised; alternative funding sources, such as grants and private-public partnerships, must be considered. Additionally, cost-saving measures, such as preventive maintenance and equipment upgrades, can help reduce long-term maintenance costs.
3. There is an urgent need for routine training of maintenance personnel to improve their abilities.
4. Rules must be established for users to protect the hospital and its facilities.
5. As-built drawings must be provided to facilitate access to damaged elements.
6. An effective compliance programme consisting of routine audits, reviews and investigations must be implemented to detect and prevent administrative corruption in the maintenance department.
7. Contractors need to go through a pre-qualification process that includes a full review of their credentials, experience and references.

This study focused on determining the importance of each identified factor affecting building maintenance by calculating the RII. However, it did not examine the relationship between the dependent variable (maintenance) and the independent variables (factors) by calculating the correlation between the them. So, in the future, researchers can make a hypothetical model to test how these variables are related.

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