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APPLICATION OF INTEGRATED ENVIRONMENTAL MANAGEMENT MODEL ON ONE OF EGYPTIAN HOSPITALS

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ABSTRACT

Recently, with significant advances in management expertise, interest in health system performance assessment has evolved exponentially; the presence of an efficient evaluation system seems inevitable. One of the organization's serious issues is known to be the lack of assessment in different areas of the building, including the evaluation of building components and facilities.

In enhancing and maintaining the health and welfare of the Egyptian people, the Egyptian health system faces many challenges. The framework is faced not only with the burden of battling poverty-related diseases and the lack of education, but also with numerous economic difficulties in hospital management, in order to ensure the provision of optimal organizational and medical services. [1]

Whereas, many environmental issues have been observed during operation of healthcare facilities. Therefore, the need to implement an integrated hospital management system has arisen to improve the efficiency of the building from an environmental aspect and an engineering aspect as well.

KEYWORDS: Integrated Environmental Model – Egyptian Hospital management – Environmental management for healthcare facilities - Healthcare facilities management – Integrated hospital management – Hospital buildings improvement.

INTRODUCTION

Hospital buildings are important for any community as those facilities are energy and resource-intensive enterprise and considered a major consumer of resources, as they open 24 hours a day, 365 days a year, also function as offices, laboratories, commercial laundries, lodging establishments, food service providers. [1]

Therefore, the way of design, construction and operation have significant impact on health and environment, accordingly, maintaining an Integrated Environmental Management in hospital buildings is crucial to ensure health and safety for both the patient and medical team. Improvements in hospital performance are important for advancing towards healthcare.

The medical units represent a challenge for the building services engineers who are often put in difficulty to ensure the indoor optimal conditions, as when health facilities perform well, the general performance of the health system improves.

An integrated model has been designed to evaluate the performance of the building technically and environmentally and based on this evaluation a scoring will be resulted in each criteria which are covering the most important issues with regard to building properties considering the following criteria; Structure, Architecture/ Interiors, Architecture/ Exteriors and landscape then with regard to Infrastructure considering the following criteria; Water, Electricity, HVAC, Sewer, Medical Gases, Fire fighting and Solid Wastes, such model will be used to evaluate an operated hospital. [2]

The resulted score will help us to focus on the weakness points of the building, and by listing such issues we will be able to propose solutions based on relevant international and local codes, guidelines, and manuals. The final stage for the model will be relatively economically, whereas certain solutions will be selected only based on their cost and weight in the scoring process taking into consideration that such selected solutions will not hinder the operation of the building. [2]

Finally, apply the selective solutions to the building and by this action we will enhance the overall performance of the building, subsequently, we will be capable of achieving the optimal integrated environmental management in Egyptian hospitals.

The environmental integrated model shown in figure (1) is mainly considering low to moderate cost options, this is in addition that such solutions ensure the continuity of hospital's operations. [2]

The aim is to study the factors affecting integrated healthcare facilities management including maintenance this is in order to help to control the operation of hospital building efficiently in Egypt to improve hospitals performance.

Accordingly, inspection has been performed on one of governmental hospitals which has opened partially year 2008 then completed on 2013 and it has 300 beds with an overall built-up area exceeding 28,000 m2 comprising 11 floors.

Earlier studies have been observed and one of the most important related ones was Healthcare Building Sustainability Assessment (HBSA) methods which are based on criteria organized into different levels, such as categories and indicators which highlight aspects of significant importance while designing and operating a sustainable healthcare building.

This is in order to bring more objectivity to the sustainability assessments, so the standardization bodies proposed core indicators that should be used in the evaluation of the environmental, societal and economic performances of buildings. [3]

To present a proposal for the incorporation of Sustainable-Effective Design criteria in a new HBSA method to assess the sustainability of construction works whereas, the proposed method is composed of fifty-two sustainability indicators that cover the different dimensions of the sustainability concept to advise during the design of a new healthcare building in urban areas. [3]

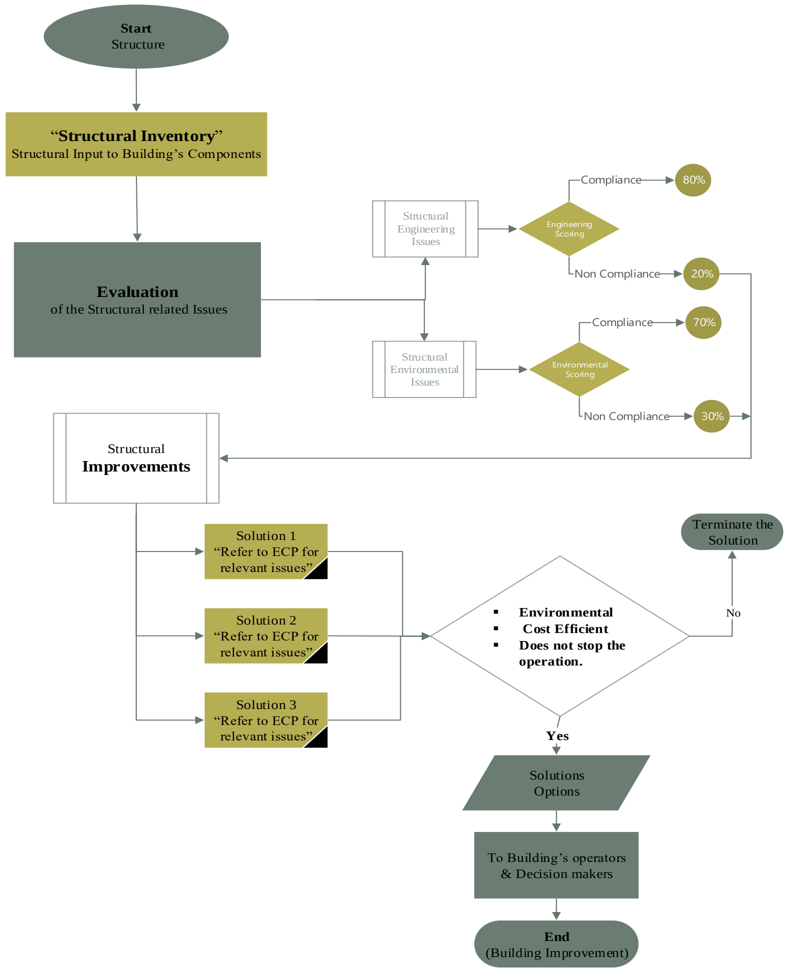

Figure 1: Integrated model application on Building's "Structure"

LITERATURE REVIEW

A greater number of different factors need to be addressed in healthcare design projects than in other styles of buildings, such as the feelings of patients, comfort needs and the introduction of the latest technology. Sustainable healthcare construction activities should be properly addressed in the design and use process in order to design these structures, taking into consideration a sustainable approach. Therefore, there is a lack of shared understanding in the field of various constructed, natural and social systems. The purpose of the study is to contribute to a better understanding in this context by providing a proposal for the structure and weight framework of the sustainability criteria of the HBSAtool-PT method of healthcare building sustainability assessment. The methodological approach adopted is revolutionary as it considers the views of the key stakeholders of healthcare buildings, the current health evaluation methods and the standardization work of ISO and CEN in the field of methods for evaluating the sustainability of construction works in the production of the list of sustainability criteria. Furthermore, in the Portuguese context, a technique for designing the weighting system to be used in the aggregation of the various indicators is proposed and implemented. As a result, the proposed Healthcare Building Sustainability Evaluation Framework (HBSAtool-PT) provides fifty-two sustainability measures that cover the various aspects of the concept of sustainability to guide decision-making during the construction of a new or retrofitted urban healthcare building. The proposed HBSAtool-PT framework offers a more balanced structure between the dimensions of sustainable development and incorporates more holistic social and economic issues as opposed to other current approaches. [3]

HBSAtool-structure PT's can help to create major advantages that are not visible in traditional architecture and building management practises. In addition, relative to other current approaches, it allows for more common social and economic issues to be incorporated rather than concentrating on minimising environmental impacts. When decisions are taken at the early stage of design, whether in new building or renovation operations, sustainability standards may be incorporated, with a higher likelihood of performance and reduced costs.

This is only possible by using detailed and structured methods that can be used by the design teams in decision-making. It should also be emphasised that the approach used must be aligned with the environmental, societal and economic contexts of the country/region in which it will be applied in order to be effective. [3]

In this regard, HBSAtool-PT provides a standardized list of overall sustainability metrics with the corresponding weights and aims to encourage the development of more sustainable healthcare facilities in Portugal. Furthermore, since the global sustainability assessment does not have a common international understanding of the weight of each indicator, this research also aims to present a methodology for developing the weight system of the HBSA method. [3]

With regard to the methodology used, since no international understanding of the weight of each measure is standard, it is focused on the results of a questionnaire involving the key stakeholders in the Portuguese healthcare sector.

This approach is very important because it allows for: I considering the expertise and experience of various stakeholders in the process of planning, using and sustaining a healthcare building; ii) validating the list of sustainability indicators and the suggested structure for the method; (iii) understanding the relative importance to global sustainability of and sustainability sector, category and indicator; and taking account of particular environmental, economic and societal contexts. [3]

Finally, this study provides an approach aimed at improving current approaches to measuring the viability of healthcare buildings. The proposed framework is based on the limitations of current approaches that have been accepted and on continuing standardization.

Such research and programs can be of great benefit in trying to enhance the efficiency of healthcare facilities. Some findings that may be important to the debate on the efficacy of investments in healthcare buildings from this study are:

First, the following methods of assessment can be used: to raise awareness and encourage sustainable practices in healthcare buildings; to minimize use and costs and, ultimately, the environmental and economic impacts of these buildings; and to help the decision-making process of designing and running sustainable healthcare buildings by both design teams and building managers;

Secondly, by taking into account the opinions of the key stakeholders, both the list of metrics and the weight framework are more consistent with their preferences, thereby increasing their possible efficacy.

Third, it helps hospital administrators to equate the operational performance of their buildings with traditional and best practices on the national scene by proving a list of sustainability metrics and the associated evaluation methods and benchmarks. [3]

MATERIALS AND METHODS

It includes application of integrated environmental designed schematic model and applies it on one of Egyptian University hospitals. The following are main criteria that selected to evaluate the hospital based on; the first is the “Building Properties” and the second is the “Infra-structure”, this is in addition to preparing a questionnaire, and inspection filed visits.

Then the "RUN" model programme on the mentioned hospital and assess the current status and recommend cost-effective environmental solutions for any created problems in order to achieve integrated environmental management on the hospital building.

The building will then be scored on the basis of two perspectives: engineering or technological and environmental, then the findings will highlight all non-compliance problems in all components of the building (Structure, Design, Landscape, Electrical, Mechanical, Water, Sanitation, Fire Fighting, Medical Gases and Solid Waste) using manuals, local codes and applicable international codes.

Therefore, and by highlighting the environmental concerns related to non-compliance, we will suggest all possible solutions as per figure (1) that will boost the environmental performance of the building and, consequently, the earlier scoring, such solutions will be proposed by a committee of engineers, specialized consultants, technicians and experts.

MODELLING

This study illustrates the results of running the integrated environmental model on our sample hospital this is in order to evaluate the current status and to propose cost efficient solutions for any generated issues to enhance the building performance considering the environmental aspects.

The hospital’s inventory stage is the first gate for the model that directing the model to enter all inputs in the hospital; starting from the built up area, the number of beds, the number of floors and else which is a kind of surveying to the overall building.

Then the model will be directed to the next stage which will focus on evaluating the existing conditions reflecting all the negativity found, thus, in order to resolve such issues in the final stage which is improvement; The aim of this research is to evaluate an operated hospital based on the generated model to help to control the operation of hospital building efficiently in Egypt to improve hospitals performance.

Accordingly, inspection has been performed on a hospital under the authority of “Ain Shams University”. The following are main criteria that selected to evaluate the hospital based on; the first is the “Building Properties” and the second is the “Infra-structure” as illustrated below in figures (2) and (3).

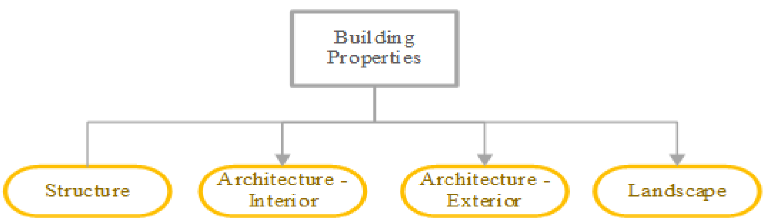

Figure (2) Building Properties – Stage I

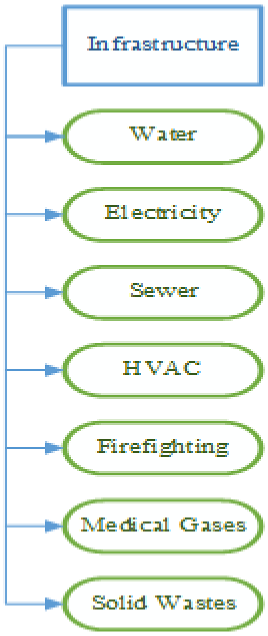

Figure (3) Infrastructure – Stage II

Table 1: Running the Integrated Management Model on the Case Study Hospital

Main Criteria	Sub- Criteria	% Engineering Compliance	% Env. Compliance	% Stage Compliance Engineering	% Stage Compliance Env.
Building Properties	Structure	80%	70%	65%	53%
	Architecture - Interiors	70%	60%		
	Architecture - Exteriors	60%	53%		
	Landscape	50%	30%		
Infrastructure	Water	70%	40%	66%	51%
	Electricity	65%	55%		
	Sewage	60%	45%		
	HVAC	65%	60%		
	Firefighting	70%	40%		
	Medical Gases	75%	70%		
	Solid Wastes	60%	50%		
Overall Score (% Compliance)		**66%**	**52%**		

(A) EVALUATION OF STAGE I - BUILDING PROPERTIES

As illustrated above in table (1) the percentage of compliance in the Architecture –Interiors related issues is 70% and 60% in related environmental issues which is reflecting a medium value that can be briefly illustrated as below issues;

The following figures are showing the existing ceiling condition;

Fix loose false ceiling tiles.

Figure 4: Existed Ceiling System

Replace broken gypsum false ceiling tiles as appeared below in figure (4).

For exposed ceiling rooms with cracks in the cement plaster.

Figure 5: Damped Ceiling Spots

In ceilings with damp or wet spots – in wet areas – as shown in figure (5).

Figure 6: Existed Ceiling tiles

Some of gypsum ceiling tiles as appeared damaged below in figure (6) noting that acoustic performance is required to comply with noise levels especially in patient rooms as per the World Health Organization guidelines of 35 dB during the day and 30 dB at night.

Use ceiling materials with low VOC or zero emissions; such acrylic paint, plastic, metal, and mineral or glass fibres.

Light fittings should be recessed, flush fitting and designed to prevent dust build up on the surfaces of the fitting, and to prevent ingress of dust.

The following are the flooring main issues;

- Lack of coved skirting to avoid creating corners that provides ease of cleaning and infection control.
- For Vinyl flooring finished rooms self-coved skirting is installed which are formed by turning the floor sheet up the wall over a 20mm radius cove fillet at the base of the wall, providing a smooth and continuous transition between the horizontal and vertical surfaces.
- Sheet vinyl and rubber skirting are welded to matching floor material.

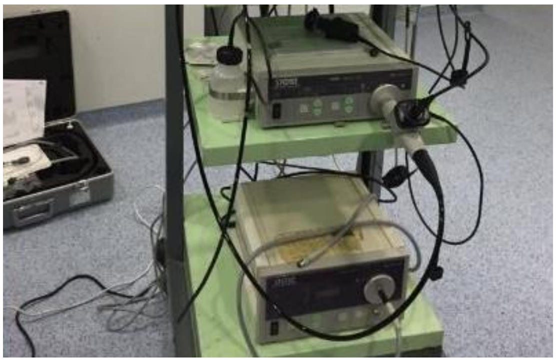

Figure 7: Vinyl Flooring

The vinyl flooring generally is in a good condition as appearing in figure (7) and only some localized areas are requiring repair, Vinyl' is a durable, resilient and impervious sheet material providing an economic ‘polish free’ low maintenance and hygienic solution.

Figure 8: Stone Flooring in Patient Rooms

Figure 9: Stone Flooring in Public Areas

Generally, stone flooring is requiring filling joints as shown in figure (8) and figure (9) with grout and preferable to be epoxy based grout to provide more durability and higher sealing properties.

Figure 10: Kitchen flooring

Heavy duty Sornaga tiles in kitchen areas as shown in figure (10) are broken and their joints are mostly free from grout.

For patients' rooms, the main colour selection was pale as appeared in figure (11) and depends on white, grey or beige colours and such colours will affect the psychological status, thus, the colour selections should reconsider this important issue.

Figure 11: Patients' Rooms

The use of colour is used to serve as a wayfinding device for general use or for specific user profiles.

For architecture –exteriors, the percentage of compliance in the Architecture –Exteriors related issues is 60% and environmentally 53% which is illustrated in Figure (12) reflecting a medium value that is due to the following;

Orientation of the building resulting in one of the longer sides being subject to sun heat (South- West).

Large areas are cladded with structural glazing system which allows large amount of heat to transfer inside the building.

Few sun shading elements are used.

Heavy elements such as precast concrete panels are used.

No energy generating panels are used such as photovoltaic panels.

Some cracks require attention.

No green roofs are allocated.

Figure 12: Architecture-Exterior.

No acoustic materials are used to lower the noise from the surroundings.

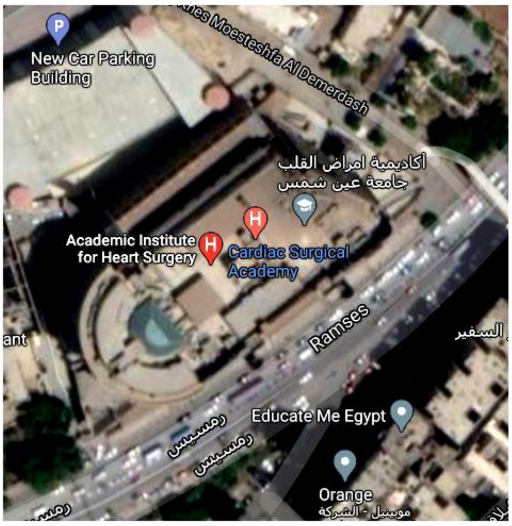

Figure 13: Satellite Map for the Hospital's location

For landscape, the percentage of compliance is 50% and 30% which are reflecting a low value; as the softscape of green areas are only limited to few trees distributed randomly on the perimeter of the building as shown on the below satellite map in figure (13) and the majority of the landscape area is allocated for hardscape comprising in roads and pedestrian walkways; this low value requires redesign to allow for extensions of green areas to create as possible a buffer zone around the building and to reduce the pollution and noise as possible in order to enhance the in-door air quality.

(B) EVALUATION OF STAGE II – INFRASTRUCTURE

The evaluation process herein will focus generally on the infra-structure related issues as will be explained below as observed in the hospital's roof;

- There is no water supply and drainage works on the roof as it is fully loaded with central air conditioning units which should have water supply pipes and sewage for washing these units.
- Some cracks had been noticed in water supply pipes as some of them are temporary repaired by adhesive tapes (more than 12 cases have been observed on the surface).
- Drainage gutters which are allocated for water results from washing air conditioning units were coverless and clogged with grass and some weedy plantings.
- Roof tiles joints were free from grout which allows water to leak to the below eighth floor ceiling.
- Drainage water results from washing air conditioning units are not directed to the allocated drainage pipes and dumped on the roof top which caused additional damage to the eighth floor ceiling and appeared clearly at the doors of the operating theatres and some ceilings in the intensive care rooms.
- A polyethylene water tank with a capacity of one cubic meter were leaking from some joints and this tank was additionally located on the roof while it was not originally considered in the main design of roof and used to feed some sterilization and intensive care area.
- For the 8_th Floor and in bathrooms the following issues observed;
- Water leaks from ceiling on operating theatres doors which caused by the roof issues listed above.
- Floor siphons in patient rooms and intensive care toilets were having blockage problems due to improper dumping of solid wastes throw them as well as some leaking from air conditioning pipes and again treated temporary with adhesive tapes.
- Some suspended ceiling tiles were damaged due to improper dismantling.
- Unavailability of proper maintenance equipment for feeding and drainage pipes which lead to breakage of those pipes.
- For Catheters building's roof the following issues observed;
- Drainage water results from washing air conditioning units are not directed to the allocated drainage pipes and dumped on the roof top which caused additional damage to below corridors and rooms.
- For sterilization area the following issues observed;
- Additional medical equipment's were supplied with the required feeding pipelines which were not properly installed and caused leakage flowed below granite floor tiling and reached the ground and the basement floors creating vertical trenches.
- Newly installed basins in more than floor used to drain blood directly on sewer pipelines that are not designed to deal with this type of liquids especially without dilution which resulted in a blockage the drainage pipes.

- For the basement floor the following issues observed;
- Subsequently to upper floors issues the basement floor collect and accumulate the problems and blockages occurred in manholes which requires regular maintenance work.
- Flooring gutters and drains are damaged as not being regularly maintained.
- Inaccessibility to lifting station as construction materials were stored above it and hindered the maintenance works from being executed regularly.
- For the service building the following issues observed;
- Some pumps are broke-down and only two pumps are operating.
- Water and fire pump room flooring are damaged and requires maintenance specially to fill grout to flooring tiles.
- Carbon Dioxide cylinders must not have located directly on floors but at least must be put on a concrete pad not less than 150 mm.
- Additional bathroom in the upper floor which did not exist in the original design drawings and has no door, and all its piping lines and connections require to be checked, this bathroom is happened to be on the same floor with the electricity units below the offices.
- The roof contains cooling towers for central air conditioning and is missing float control in the entry levels. There is a leak from all exit pipes at the connecting points of the valves and all the surrounding drainage pipes are not sanitized and have no covers, this is contributed to the leakage occurred in the offices floor.

RESULTS & DISCUSSIONS

The current status has been observed and evaluated within the mentioned hospital, which is generally reflects severe need to proper maintenance, whether for feeding pipelines or sewer pipelines or the air conditioning, or some modifications to the original designs, accordingly and in order to prevent their recurrence in the future to maintain the integrity of the origin and the quality of its operation and provide a high level of service, the following cost efficient solutions are recommended;

Repair the source of leakage on the mentioned several floors starting from roof reaching to the basement.

Carry out the work of solving the current technical problems by a qualified contractor starting from the top to the bottom as follows: -

- Inspecting each role and writing a report within a day for the works needed for it and suggesting the parts and equipment that need to be supplied, the estimated cost of these works and the time period for them, approved by the consultant
- Implementation begins upon approval under the supervision of the consultant and the engineering department
- It is possible to work in more than one floor at the same time, and the same procedure is followed for the services building
- These works are received by a technical committee headed by the consultant and the membership of the director of the engineering department and an engineer in each specialty of the engineering department.

- Providing an engineer for each of the utilities and equipment specializations, with a minimum of one mechanical, one electrical, one sanitary and networks, one structural and one architectural.
- Providing technicians with a minimum number of 4 in each specialty. It is preferable to have more than one mechanical technician, one for air conditioning, one for medical devices, one for utility pumps (water, fire and sanitation) and one for the incinerator as well as the situation for electricity communication technicians and technicians for electric power.
- The engineering department is equipped with the equipment necessary for maintenance in each specialty, with work to train them to use them, along with the provision of spare parts in warehouses that are used for emergencies, as well as spare parts for each equipment according to its catalogue.
- The recommended permanent and integrated solution: -
- A periodic program for preventive maintenance for all hospital networks and equipment is set up for each specialty, and it is the responsibility of the Director of the Engineering Department to follow up the implementation of this program on a daily basis.
- We see the necessity of having business drawings as implemented for all roles as well as a page or more for each equipment or device indicating the date of its installation, dates of maintenance work on it and the quality of maintenance, and in which the next maintenance dates are also specified according to the catalogue of this device or equipment and a copy of all this is placed on the manager's device The engineering administration and the specialist engineer according to his specialty and for the hospital director.
- A therapeutic maintenance program shall be put in place in which the method for dealing with any complaint is determined, so that any problem is resolved within two hours at most.
- Until the necessary adjustments are made for the engineering department, a company specialized in the field of electro-mechanical is dealt with to carry out all maintenance work in the building, including air conditioning, sanitary, fire, electricity and medical gases, i.e. what is called the arteries of the building, and the specialized consultants in cooperation with the engineering administration prepare a brochure for a contract with a company Maintenance.
- Coordination must be made with the engineering administration so that no modifications are made to the utility networks after returning to the consultants to ensure the efficiency and safety of the building.
- The above proposed solutions have been estimated to cost approximately less than one million EGP (US$ 60,000) and such value is considered very low when it compared to the building cost which was 250 million EGP. Finally, the proposed solutions will contribute to increase and enhance the overall score of the building from 66% to 85% and environmentally it will reach at least 70% instead of the 52%.

CONCLUSIONS

Optimal environmental management of hospital buildings has been applied on one of the Egyptian hospitals through an integrated model has been designed based on earlier research, this application has contributed to the building's overall efficiency, whereas by using the proposed cost efficient solution we were able to enhance the building performance significantly. The mentioned solutions were considering the cost efficient or economical ones taking into considerations continuing the operation of building.

Thus, many recommendations are required in order to accomplish the required results such as; Design software which is capable of converting the integrated environmental management model this is in order to expedite the process and to obtain more accurate results. Link the local Egyptian environmental codes and standards to the software which will efficiently propose environmental safe solutions. Encourage the specialists to contribute to the software as they will propose the most cost efficient and practical environmental solutions. Create a mobile application which will be an easier accessible tool to improve the integrated environmental management, also will be able to receive inputs from users that can improve the resultants.

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