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Research paper

Assessment of Health Buildings in Hilla City According to the international Standard LEEDV4

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Abstract

The sustainability and functional performance of healthcare facilities are paramount for patient well-being and environmental stewardship. This study presents a pioneering assessment of five major public hospitals in Hilla City, Iraq, against the Leadership in Energy and Environmental Design (LEED) v4 for Building Design and Construction (BD+C) framework. Data was collected through comprehensive on-site audits, document analysis, and direct observation. The results reveal a significant performance disparity: the newly constructed Imam Al-Sadiq Teaching Hospital achieved a Gold rating with a score of 67 out of 110 points, demonstrating strong performance in Water Efficiency and Indoor Environmental Quality. In stark contrast, the four older hospitals (Babylon Teaching, Al-Hilla Teaching, Al Noor Children's, and Marjan Medical City) all scored below the 40-point threshold, rendering them Uncertified. This failure is primarily attributed to aging infrastructure, defunct energy systems, and a lack of sustainable operational policies. The study diagnoses these critical dysfunctions and underscores the urgent need for systematic rehabilitation. We conclude by recommending the enactment of municipal legislation requiring that all new hospital constructions and major renovations in the region adhere to LEED v4 standards to ensure a higher, more sustainable quality of healthcare infrastructure for the future.[1]

Keywords: *-Health Buildings, Green Rating Systems, LEED Certification, LEEDV4, sustainability*

1. Introduction

Globally, the healthcare sector is a significant consumer of energy and resources, with hospital buildings operating 24/7 and possessing complex functional requirements. Consequently, the push towards green and sustainable healthcare facilities has become a global priority. Green Building Rating Systems (GBRS) such as BREEAM, Green Globes, and the widely adopted Leadership in Energy and Environmental Design (LEED) provide frameworks to mitigate the environmental impact of buildings. Studies have shown that LEED-certified hospitals can reduce energy consumption by up to 30% and improve indoor air quality, which is directly linked to better patient recovery rates and staff productivity [2]. Furthermore, research by Bernardi et al. (2017) highlights that such rating systems are instrumental in guiding project managers toward more sustainable decision-making throughout a building's lifecycle.

However, in many developing regions and post-conflict areas like Iraq, public infrastructure, including hospitals, often predates modern sustainability concepts. These facilities frequently suffer from deferred maintenance, inefficient systems, and poor environmental performance, directly impacting public health and operational budgets [3]. While there is a growing body of literature on sustainable buildings, a significant research gap exists in the systematic evaluation of existing hospital infrastructure in Iraq against these international benchmarks.

This study addresses this gap by providing the first comprehensive assessment of the major public hospitals in Hilla City using the rigorous **LEED v4 framework**. The novelty of this research lies in its application of a world-class standard to diagnose specific points of failure in aging healthcare infrastructure within a regional Iraqi context. By quantifying the performance of these buildings, this research provides an evidence-based foundation for targeted rehabilitation and policymaking. The objective is to identify critical dysfunctions and propose a strategic roadmap for improving the safety, efficiency, and environmental performance of these vital community assets.[4]

2. LEED V4

In 2014, the latest version of LEED V.4 was released, which will be mandatory on all green buildings from October 31, 2016. During the development stages of the LEED V4 as a building appraisal system, it has been applied in more than 135 countries worldwide due to the continuous development of the LEED V.4 systems to include all conditions and projects, where for example in LEED V.4, 21 different modifications in the market sectors in Various new and constructed projects, warehouses, hospitals, and schools, as well as segmented buildings [5]LEED v4 allows the opportunity for LEED to fit the unique aspects of different projects, which were summarized in Figure (1) [8].

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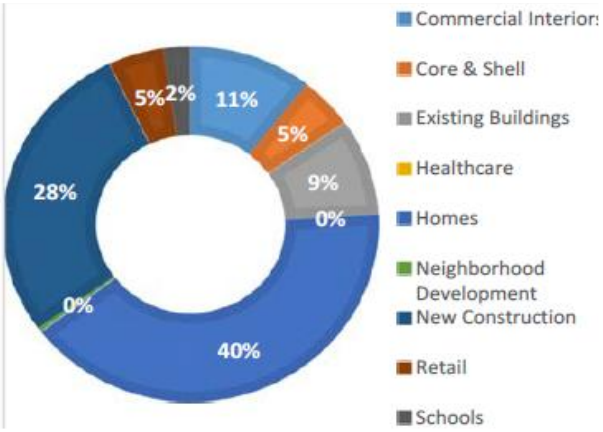


Fig. 1: LEED V4 -Certified Buildings as of December 2014 [8].

2.1. The main pillars of the LEED V4

There are four main pillars and categories of projects in the LEED V4 [5]:
1) Building Design and Construction
2) Interior Design
3) Maintenance and operation
4) Neighborhood Development

The goal of the LEED system is that the building accommodates climate change and is healthy internally and externally in terms of materials, resources, and energy so that the individual can live and practice their business [6]. Figure 2 shows LEED V4 Certification Credit Categories [9].

2.2. Basic requirements

The grades that the building obtains through the LEED V4 according to the number of points that the building was able to collect according to the requirements and points of each classification [9].
Possible Points: 110
Building is Certified Rating: 40-49 points,
Building is Silver Rating: 50-59 points,
Building is Gold Rating: 60-79 points,
Building is Platinum Rating: 80+ points (more than 80 points till 110 points, get the highest rating) [15]

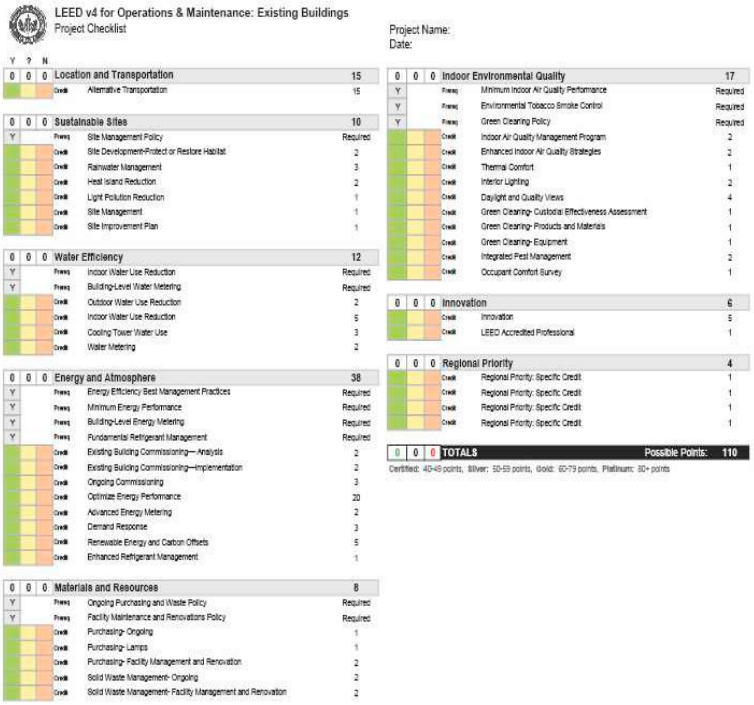
2.3. LEED V4 certification credit categories

According to the certificate LEED V4 in Figure (2) and based on it, the evaluation form for the five hospitals was designed according to the figures (3, 4, 5) as follows [9], [10]:

3. The objective, case study, and research methodology

The goal is to evaluate some of the major hospitals in the City using the classification of the LEED V4 system [9] in the field of environmental design, with field visits and collecting documented information with photos and data as in the pictures. (Fig. 9-29). And the locations of hospitals in Hilla City are according to Figure 6.
To ensure a systematic assessment, the researchers developed a structured site visit checklist based on the LEED V4 rating system categories. The process included the following steps for each hospital:

- Field visits were conducted by the research team to observe hospital conditions and collect data.
- Visual inspections of building structures, materials, mechanical systems, water systems, and energy installations were carried out.
- Specific evidence was collected through photographs, measurements, and notes.
- The research team used LEED V4 categories as a direct checklist, evaluating each hospital against criteria for:
- Location and Transportation
- Sustainable Sites



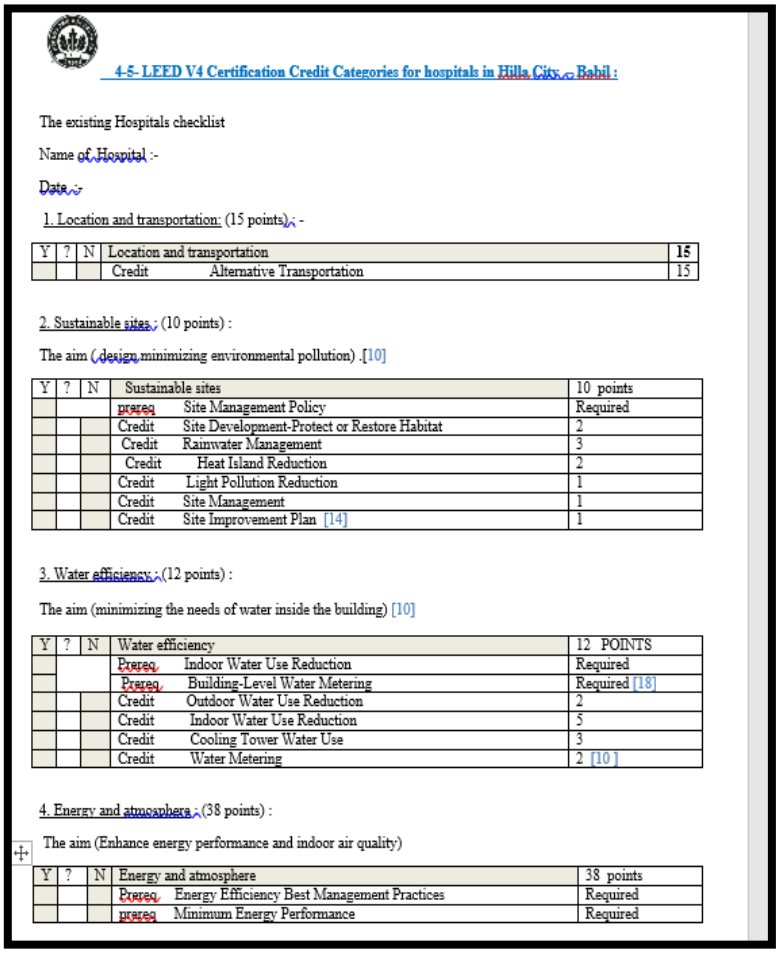
LEED v4 for Operations & Maintenance: Existing Buildings
Project Checklist

Project Name:
Date:

Y	?	N				
0	0	0	Location and Transportation			15
			Credit	Alternative Transportation		15
0	0	0	Sustainable Sites			10
Y			Prereq	Site Management Policy		Required
			Credit	Site Development-Protect or Restore Habitat		2
			Credit	Rainwater Management		3
			Credit	Heat Island Reduction		2
			Credit	Light Pollution Reduction		1
			Credit	Site Management		1
			Credit	Site Improvement Plan		1
0	0	0	Water Efficiency			12
Y			Prereq	Indoor Water Use Reduction		Required
Y			Prereq	Building-Level Water Metering		Required
			Credit	Outdoor Water Use Reduction		2
			Credit	Indoor Water Use Reduction		6
			Credit	Cooling Tower Water Use		3
			Credit	Water Metering		2
0	0	0	Energy and Atmosphere			38
Y			Prereq	Energy Efficiency Best Management Practices		Required
Y			Prereq	Minimum Energy Performance		Required
Y			Prereq	Building-Level Energy Metering		Required
Y			Prereq	Fundamental Refrigerant Management		Required
			Credit	Existing Building Commissioning—Analysis		2
			Credit	Existing Building Commissioning—Implementation		2
			Credit	Ongoing Commissioning		3
			Credit	Optimize Energy Performance		20
			Credit	Advanced Energy Metering		2
			Credit	Demand Response		3
			Credit	Renewable Energy and Carbon Offsets		5
			Credit	Enhanced Refrigerant Management		1
0	0	0	Materials and Resources			8
Y			Prereq	Ongoing Purchasing and Waste Policy		Required
Y			Prereq	Facility Maintenance and Renovations Policy		Required
			Credit	Purchasing- Ongoing		1
			Credit	Purchasing- Lamps		1
			Credit	Purchasing- Facility Management and Renovation		2
			Credit	Solid Waste Management- Ongoing		2
			Credit	Solid Waste Management- Facility Management and Renovation		2
0	0	0	Indoor Environmental Quality			17
Y			Prereq	Minimum Indoor Air Quality Performance		Required
Y			Prereq	Environmental Tobacco Smoke Control		Required
Y			Prereq	Green Cleaning Policy		Required
			Credit	Indoor Air Quality Management Program		2
			Credit	Enhanced Indoor Air Quality Strategies		2
			Credit	Thermal Comfort		1
			Credit	Interior Lighting		2
			Credit	Daylight and Quality Views		4
			Credit	Green Cleaning- Custodial Effectiveness Assessment		1
			Credit	Green Cleaning- Products and Materials		1
			Credit	Green Cleaning- Equipment		1
			Credit	Integrated Pest Management		2
			Credit	Occupant Comfort Survey		1
0	0	0	Innovation			6
			Credit	Innovation		5
			Credit	LEED Accredited Professional		1
0	0	0	Regional Priority			4
			Credit	Regional Priority: Specific Credit		1
			Credit	Regional Priority: Specific Credit		1
			Credit	Regional Priority: Specific Credit		1
			Credit	Regional Priority: Specific Credit		1
0	0	0	TOTALS		Possible Points:	110

Certified: 40-49 points, Silver: 50-59 points, Gold: 60-79 points, Platinum: 80+ points

Fig. 2: LEED V4 Certification Credit Categories [9].



4-5- LEED V4 Certification Credit Categories for hospitals in Hilla City, Babil :

The existing Hospitals checklist

Name of Hospital :-

Date :-

1. Location and transportation: (15 points) :-

Y	?	N	Location and transportation	15
			Credit Alternative Transportation	15

2. Sustainable sites : (10 points) :

The aim (design minimizing environmental pollution) .[10]

Y	?	N	Sustainable sites	10 points
			prereq Site Management Policy	Required
			Credit Site Development-Protect or Restore Habitat	2
			Credit Rainwater Management	3
			Credit Heat Island Reduction	2
			Credit Light Pollution Reduction	1
			Credit Site Management	1
			Credit Site Improvement Plan [14]	1

3. Water efficiency : (12 points) :

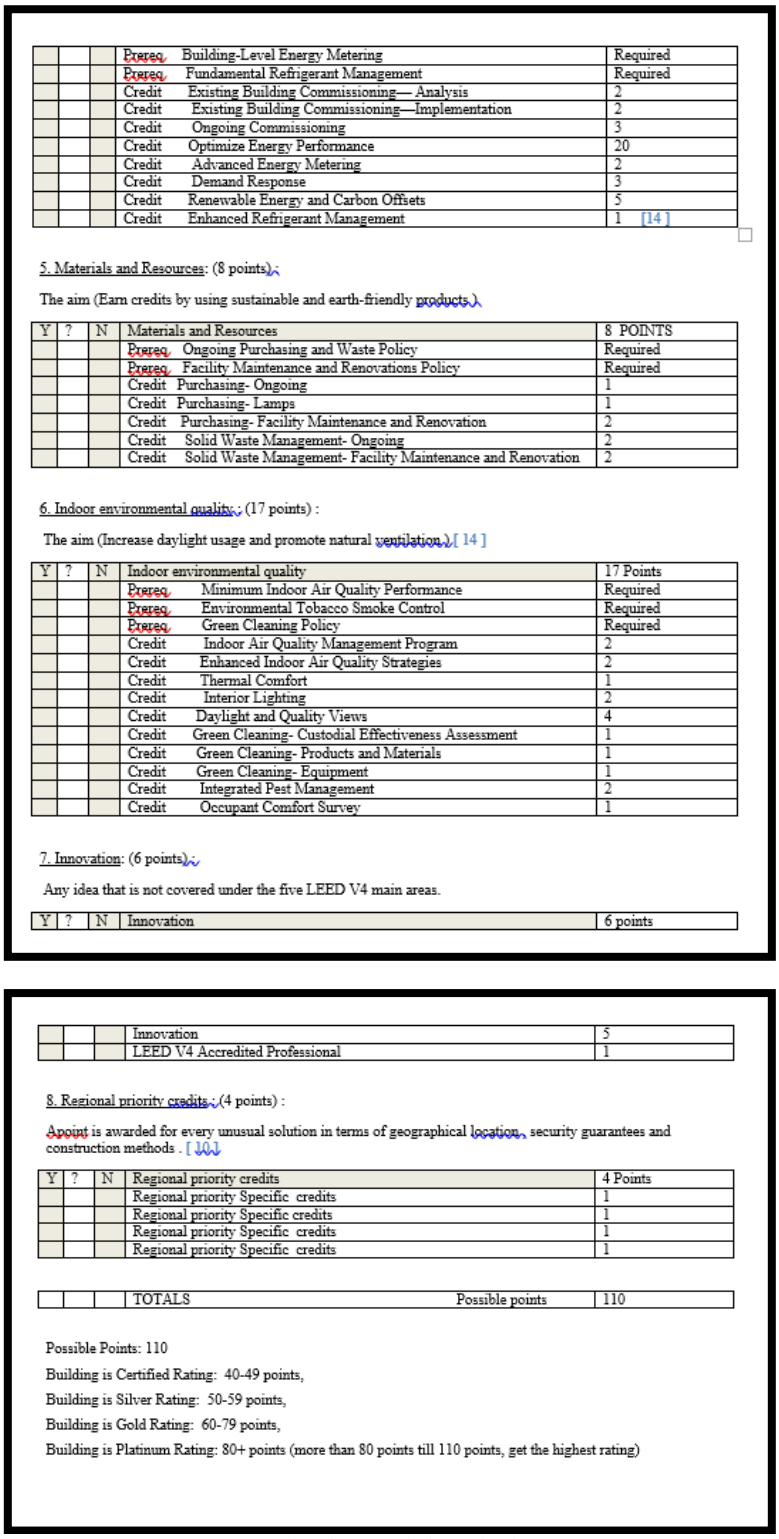
The aim (minimizing the needs of water inside the building) [10]

Y	?	N	Water efficiency	12 POINTS
			Prereq Indoor Water Use Reduction	Required
			Prereq Building-Level Water Metering	Required [18]
			Credit Outdoor Water Use Reduction	2
			Credit Indoor Water Use Reduction	5
			Credit Cooling Tower Water Use	3
			Credit Water Metering	2 [10]

4. Energy and atmosphere : (38 points) :

The aim (Enhance energy performance and indoor air quality)

Y	?	N	Energy and atmosphere	38 points
			Prereq Energy Efficiency Best Management Practices	Required
			prereq Minimum Energy Performance	Required



			Prereq Building-Level Energy Metering	Required
			Prereq Fundamental Refrigerant Management	Required
			Credit Existing Building Commissioning— Analysis	2
			Credit Existing Building Commissioning—Implementation	2
			Credit Ongoing Commissioning	3
			Credit Optimize Energy Performance	20
			Credit Advanced Energy Metering	2
			Credit Demand Response	3
			Credit Renewable Energy and Carbon Offsets	5
			Credit Enhanced Refrigerant Management	1 [14]

5. Materials and Resources: (8 points):

The aim (Earn credits by using sustainable and earth-friendly products.)

Y	?	N	Materials and Resources	8 POINTS
			Prereq Ongoing Purchasing and Waste Policy	Required
			Prereq Facility Maintenance and Renovations Policy	Required
			Credit Purchasing- Ongoing	1
			Credit Purchasing- Lamps	1
			Credit Purchasing- Facility Maintenance and Renovation	2
			Credit Solid Waste Management- Ongoing	2
			Credit Solid Waste Management- Facility Maintenance and Renovation	2

6. Indoor environmental quality: (17 points) :

The aim (Increase daylight usage and promote natural ventilation.)[14]

Y	?	N	Indoor environmental quality	17 Points
			Prereq Minimum Indoor Air Quality Performance	Required
			Prereq Environmental Tobacco Smoke Control	Required
			Prereq Green Cleaning Policy	Required
			Credit Indoor Air Quality Management Program	2
			Credit Enhanced Indoor Air Quality Strategies	2
			Credit Thermal Comfort	1
			Credit Interior Lighting	2
			Credit Daylight and Quality Views	4
			Credit Green Cleaning- Custodial Effectiveness Assessment	1
			Credit Green Cleaning- Products and Materials	1
			Credit Green Cleaning- Equipment	1
			Credit Integrated Pest Management	2
			Credit Occupant Comfort Survey	1

7. Innovation: (6 points):

Any idea that is not covered under the five LEED V4 main areas.

Y	?	N	Innovation	6 points

			Innovation	5
			LEED V4 Accredited Professional	1

8. Regional priority credits : (4 points) :

Apoint is awarded for every unusual solution in terms of geographical location, security guarantees and construction methods . [10]

Y	?	N	Regional priority credits	4 Points
			Regional priority Specific credits	1
			Regional priority Specific credits	1
			Regional priority Specific credits	1
			Regional priority Specific credits	1

			TOTALS Possible points	110

Possible Points: 110

Building is Certified Rating: 40-49 points,

Building is Silver Rating: 50-59 points,

Building is Gold Rating: 60-79 points,

Building is Platinum Rating: 80+ points (more than 80 points till 110 points, get the highest rating)

Fig. 3,4,5: The Five Hospitals Evaluation Form.

- Water Efficiency
- Energy and Atmosphere
- Materials and Resources
- Indoor Environmental Quality
- Innovation
- Regional Priority

For every category, points were assigned according to the LEED V4 scoring guidelines based on the actual conditions observed on-site. Points were awarded only if clear evidence supported compliance with LEED criteria.

Each hospital was scored independently by the research team to maintain objectivity and accuracy. The total scores for each hospital were then compiled to produce the assessment results.

The names of hospitals are:

First: Babylon Teaching Hospital for Women and Children

Second: Al-Hilla Teaching Hospital

Third: Al Noor Hospital for Children

Fourth: Imam Al-Sadiq Teaching Hospital:
Fifth: Marjan Medical City.

Fig. 6: Shows Locations of Some of the Major Hospitals in Hilla [12].

Map showing the locations of five major hospitals in Hilla City, illustrating accessibility and transportation conditions based on urban layout.

4. Description of the case study

First: - Babylon Teaching Hospital for Women and Children (Founded in 1984):

1) Location and Transportation: - The hospital is in Hilla city center is a crowded area that is difficult to each easily, although it does not have a green space that surrounds it and isolates it from neighboring areas [21].
2) Site and Area: - The area of the placement is approximately (150 * 125) m². The site consists of four buildings: the main building, the two homes for the doctors' house, the fever building, the caravans, the drinking water tanks, and some services. The largest dimension of the external site borders is equal to 15 m, behind the buildings that were used as parking lots, while the western part of the site was used as a dump for different waste and scrap, and Figure 7)illustrates this. [20] and [the researcher is on a site visit]
3) Buildings and their architectural and construction condition:

The main building consists of two floors, and some parts of it consist of only one. Its construction condition follows the typical dimensions (from 1.2m - 7.2m for halls) and consists of concrete columns covered with metal and outer walls are two layers of external and internal metal plate and the space between the sheets is stuffed with heat insulation wool and now it does not perform the required purpose of the building's feet and exposes it to damage, moisture and the growth of fungi and insects in it.

As for the interior walls, the construction condition of the building is a modular division divider, the main is brick walls, and inside, the structure is divided by gypsum board partitions with a metal

The structure to install the cutters and the cutouts is double, while the main brick walls are covered with gypsum board as well, and these walls are stained with a cellulose plastic dye, a friend of the environment.

As for the ceilings, they con

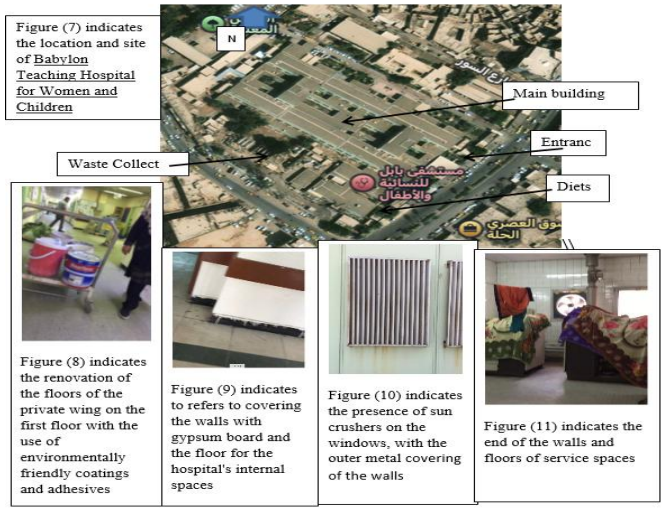


Fig (7, 8, 9, 10, 11): explain the details of the building of the Babylon teaching hospital for women and children

sist of two main roofs, which are an armed concrete cast, and the secondary ones are square units of Gibson board with dimensions of each of them (60 * 60) cm2 and the distance between the two roofs is equal to (1.5 m) and is dedicated to hospital services of water pipes (hot and cold), heating and cooling ducts, are now idle and suspended from work because they need a comprehensive replacement except for smoke sensors, and they have been replaced by individual heating, cooling, ventilation, vacuum and heaters (contouring, fan, heater, and vacuum) and its environmental damage.[23]

As for finishing floors, all sections of the general hospital were tiled with porcelain tiles. As for laboratories, their walls are covered with ceramics and their floors are tiled with granite. As for the radiation sections, they are tiled with granite tiles, and their walls are concrete

walls coated from the inside with lead boards and doors to prevent the transmission of radiation to the rest of the hospital spaces. As for the corridors of patients, their dimensions are (* 7.2m7 7.2 m), with a capacity of (8) beds and another (7.2mX4.8m) and a capacity of (4) beds, bearing in mind that the international standard for the area allocated to the patient is equal to (8m²) for corridors. As for finishing its floors, it is with a (Roll plastic anti-bacteria) in the form of a roll that is brushed and fixed to the floor with adhesive, and figures (8, 9) illustrate this. For operating halls, floor finishing is also a type (Roll plastic anti-bacteria) with an internal copper mesh for discharging ga. [The researcher is on a site visit]

As for the special wards for women and children located on the first floor, they have been renovated, paving the floor with marble, finishing the walls with ceramic to the center, with the construction of new sanitary installations and attaching them to these sections, and converting the old into warehouses because of its oldness and failure to do its job. As for the direction of the corridors, it is the western direction, and this direction is not suitable for these spaces, as it causes an increase in the heat burden imposed on them, despite the presence of sun blockers on the windows, which are good in terms of type and material, and figure (10) illustrates this. As for the flattening of the building, there are no flat surfaces. It is covered by gravel itself, which is difficult to clean. Noting the foot and damage in the doors, windows, ladders, and electrical appliances, as the repairs were in a patchwork and not a systematic manner according to a specific approach.

5. Water, sewage, energy, others

The hospital obtains water from the municipality of Hilla city, and after entering the water to it, it is divided into parts, part goes to other treatment (filtering and filtering), so that water becomes RO water used for drinking, in the kitchen and figure (11) illustrates this, operations halls, and laboratories, and the second part goes to laundry clothes or washing, to bathrooms, health facilities, the kitchen, and irrigation of crops, and there is no rain water collection tank. As for sewage discharged from the hospital, it is collected in basins, then sent to a diving well, and then taken to a treatment station before it goes to the city sewers because of its epidemic contamination. [The researcher is on a site visit]

Second: - Al-Hilla Teaching Hospital(Founded in 1972):

1) Location and Transportation

The hospital is located within the scope of a dedicated building for healthy buildings, bordered by the northern, southern and western sides, internal streets that lead to residential neighborhoods of Iskan and Nasige on the one hand, and to Nader General Street on the other side, which are broad and open streets in general, there are few times of crowding, and the main hospital entrances are open to north direction from the site and fiure (12)illustrates this. [24]

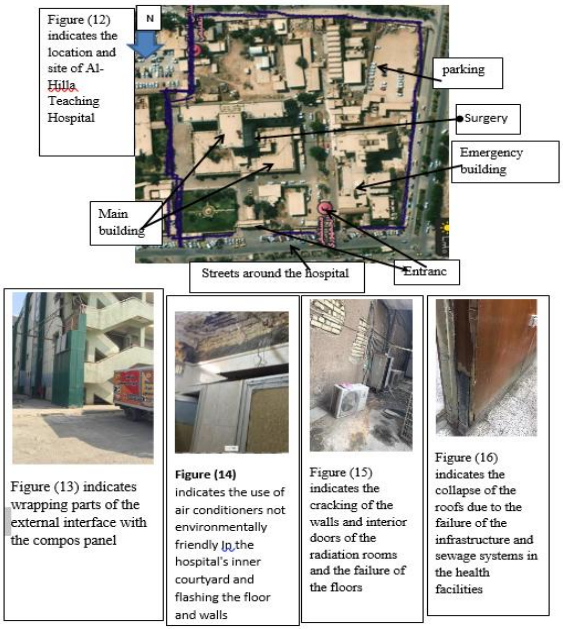


Fig (12, 13, 14, 15, 16): explain the details of the building of Al-Hilla teaching hospital

2) Site and area

The area of the hospital is approximately (150 * 200) = 300,000 square meters and possesses a large area that surrounds it and isolates it from the areas surrounding it. The hospital buildings consist of several buildings, which are the emergency, the main building consisting of four floors, the private wing and the crematorium, the residence of doctors, the crematorium, maintenance buildings and the cafeteria, The surrounding area does not have enough green areas and rest areas except for the area near the private wing that contains a simple and small green area with simple rest areas. As for the car parks, they took the back space from the hospital, and Figure 12 illustrates this. [28]

3) Buildings and their architectural and construction condition

The old main buildings include the emergency building, consisting of one floor, and the main hospital, which includes the departments of administration, surgery, laboratories, radiology, magnetic resonance, consulting clinic, kitchen, laundry, pharmacies that took the ground and first floors, and patients' lobbies that took the upper floors [17]. The construction condition is bad and not good mentioned in characteristics of building exterior and internal building and termination materials in building materials and is the above. Babylon Teaching Hospital for Women and Children. [19]

,radiation, scan, and resonance spaces, there is a lead insulator of radiation, but he suffers from damage to his feet. [17] and figures (13, 14, 16) illustrate this

limited to cooling, heating, hot water, vacuum, and electrical ... Etc. It is unemployed, out of service, and replaced by non-environmentally friendly electrical appliances, and figure (15) illustrates this, and this has resulted in the closure of

4) Water, sewage, energy, and others

It has the same characteristics and disadvantages mentioned in the Water, sewage, energy, vertebra in the Babylon maternity and children's hospital above. [16]
Third: - Al Noor Hospital for Children (Founded in 1920):

1) Location and transportation
Al-Noor Hospital for Children is located in the Babel neighborhood near the old entrance to Hilla City, bordered to the northwest, west, and southwest by major streets near it, which caused very high noise and congestion, making it difficult to move from and to it, especially during peak times, and figure (17) illustrates this. The rest of the directions are bounded by residential areas. [21].
2) Site and area
The area of the site is 1700 m². Its shape is close to the square and is considered a very small area for the establishment of a hospital because the site requires several considerations and criteria for achieving the best performance desired and fiure (7) illustrates this and its need for annual taboos to avoid infection and pollution, in addition to that, the hospital site lacks green spaces and sufficient cars parking, with caravans filled to the site due to hospital expansion. With no incinerator there, the waste is sent to Al-Hilla Teaching Hospital, and Figure 17 illustrates this. As for the site lighting, large lights are used, directed to the ground [12]
.
3) Buildings and their architectural and construction condition
The architectural and structural details of the building are the same as the architectural and structural details of the Babylon Teaching Hospital for women and children, and figures (18, 19, 20) illustrate this.[The researcher is on a site visit]
4) Water, sewage, energy, and others
It has the same characteristics and disadvantages mentioned in the Water, sewage, energy, vertebra in the Babylon maternity and children hospital above, and figure (21) illustrates this. [The researcher is on a site visit.]

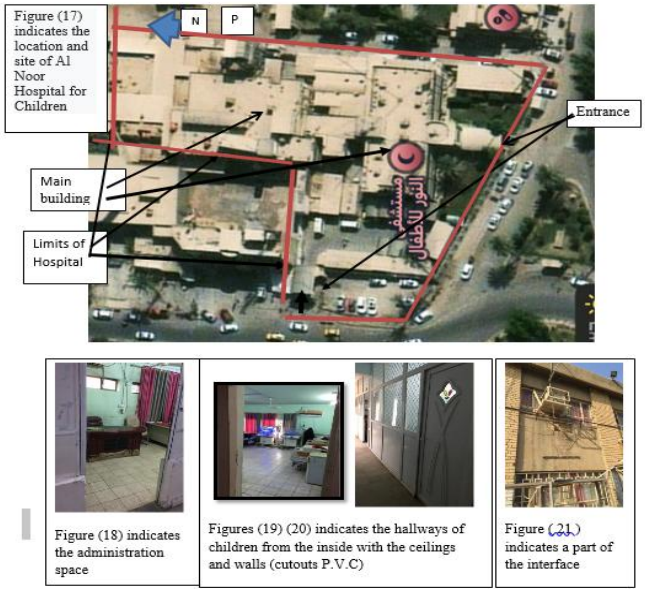


Fig (17, 18, 19, 20, 21): explain the details of the building of AL–Noor hospital for children

Fourth: - Imam Al-Sadiq Teaching Hospital(Founded in 2017):
1) Location and transportation
The hospital is located near public streets, so it is bordered to the east by street (60), to the north by Tahmazia street and the west and south by a residential area and accessed via these streets, but these streets are crowded in peak times (beginning and end of official working hours), so it is preferable to complete the construction of the support streets to reduce hustle. [24] And the researcher is on a site visit.
2) Site and area
The area of the site is approximately 68000 m 2, and the hospital is in the center of the site, so it has good and forbidden distances for its neighbors, and Figure 22 illustrates this. Most of the hospital's main entrances are in the northern direction on Tahmazia Street, due to the congestion of Street 60 and the narrowness of its prohibitions. The eastern side, adjacent to street 60, contains primitive gardens. As for Tahmazia Street and the southern direction, it contains internal streets leading to hospital sections and parking lots.
As for the western direction of the hospital, it is semi-abandoned and contains the basic services buildings, fuel depots, and a shredding system for the disposal of medical waste, but it was not operated, with a note that the various hospital waste collected in this direction. It is noticeable that there are no rest areas or shaded areas to sit under. As for the site lighting, large lights are used, directed to the ground. [24] And the researcher is on a site visit. And figures (22, 23) illustrate this.
3) Buildings and their architectural and construction condition
The construction condition consists of a concrete structure system of hidden columns and bridges, as the concrete ceiling system is a way ribbed slab. And this system is used for large concrete spaces. As for the main walls that follow the basic structure, they are either brick walls that are terminated with the material (gypsum board) or concrete walls also covered with (gypsum board) insulating between thm are heat insulating fibers and figures (25, 26) illustrates this, while the outer walls are internal parts of the bricks and the outer part of the metal (composites) and stuffed with heat insulating fibers and figure (24) illustrates this
There is a secondary roof in the hospital that extends in all hospital spaces a distance (1.5 m) from the main ceiling and between the two roofs passes the hospital services from electrical lines, cooling, central heating, fire sensor lines, alerting patients, etc,(they are types including metal or plastic panels or gypsum board or epoxy and some of them are treatment for thermal insulation, moisture or fire. In addition to the foregoing, there are other types of packaging and building walls, such as plastic dye and glass partitions for some spaces,

and ceramic material for bathrooms and sanitation, kitchens, and laundry, and the use of lead panels in the packaging of walls and doors of radiation rooms

As for the tiling of the floor, it is the same in all hospitals. As for the doors, they are made of either wood, glass, iron, or aluminum, according to the space function. As for the windows, they are of double glazing, and their frames are made of aluminum or iron. [The researcher is on a site visit]

4) Water, sewage, energy, and others

The hospital obtains water from the municipality of Hilla city, and upon entering the hospital it is divided into two parts, one of which goes for filtering and sterilization and is used for drinking and surgery spaces and the other goes to boilers, galleries, pushers, cooling and heating devices, bathrooms, sanitary facilities, laundry and watering crops where there are no rainwater tanks for watering .. As for the energy used, it is not environmentally friendly, and its source is from the city's electricity, which comes from fossil fuels. As for sewage water, it is collected in basins, then sent to a diving well, then to the treatment plant, and then to the city sewers. [The researcher is on a site visit]

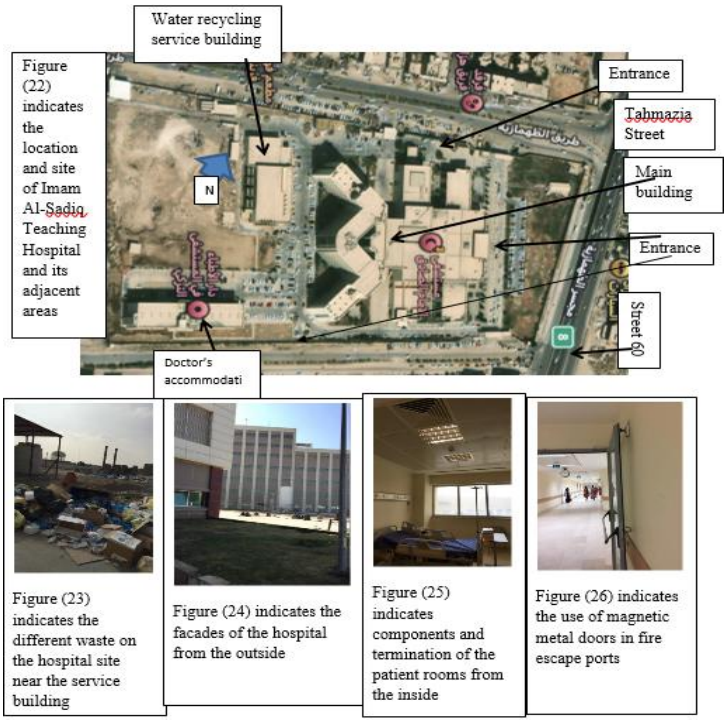


Fig (22, 23, 24, 25, 26) :explain the details of the building of AL–Imam Al Sadiq hospital

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Fifth:- Marjan Medical City(Founded in 1957):

1) Location and transportation

The medical city is located near the old entrance of Hilla city of Baghdad- Hilla street, it is bordered on the eastern side and the west by the Shatt al-Hilla border and on the north is a residential area and the building of the Courts Complex and on the south by the college of administration and economy of the University of Babylon and can be reached via Baghdad- Hilla street only by public and private transport and there is no other way to reach it. [26]

2) Site and area

The area of the site is about 100000 m², and it consists of several buildings and separate caravans, and each building is for a specialized medical department. Some of them are affiliated with the old hospital administration, and the other is affiliated with the Babylon Health Department. The hospital's departments include the old building, emergency and consulting, private wing, medical rehabilitation unit, joint diseases, the center for industrial kidney, and the house of doctors, with service caravans:

information, incinerator, agricultural division, statistics, engineering division, and petrol station.

The site contains large green areas and high trees that contribute to providing shade, and because the site is near the river, it is watered directly from it through the wells connected to it. [24]

As for parking lots, there are few and they do not fulfill the purpose, and Figure 27 illustrates this.

3) Buildings and their architectural and construction condition

The architectural and structural details of the buildings are similer in terms of architectural, structural, functional details of the Babylon Teaching Hospital for women and children with the very old main buildings and their out of service and the figures (28, 29, 30, 31) illustrate this [13] and. [the researcher is a site visit]

4) Water, sewage, energy, and others

Water, sewage, and energy in Margan Hospital are similar of details of of the Babylon Teaching Hospital for women and children, and Figure 32 illustrates the type of energy. [The researcher is on a site visit.]

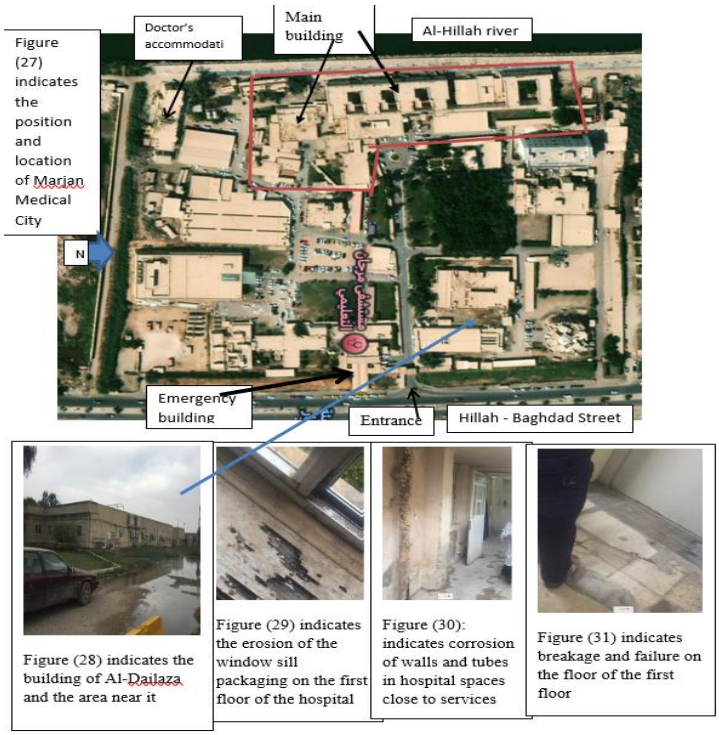

Fig (27 , 28 , 29 , 30 , 31) :explain the details of the building of Marjan Medical City

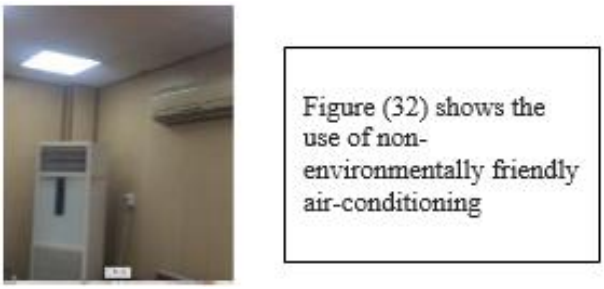

Fig 32

6. The criteria – specific results and discussion

First: - The criterion (Location and Transportation):
Hospitals obtained the same degree of evaluation = (7.5 / 15) for this paragraph for its location within the city, with transportation moving with fuel that is not environmentally friendly.
Second: - The Standard (Sustainable Sites): -
The five hospitals receive the same degree of assessment and table no. (1) shows this. [The researchers are on a site visit.]

Table. 1 shows the values of Sustainable Sites of hospitals [the researchers]

No.	The value of Sustainable Sites	10 M	The reasons
1	Babylon Teaching Hospital for Women and Children	3/10	
2	AL-Hilla Teaching Hospital	(2.5 / 10	
3	Al Noor Hospital for Children	3/10	to the use of electrical energy and pollution from the west, and radiation.
4	Imam Al-Sadiq Teaching Hospital	3.5 / 10	
5	Marjan Medical City	3/10	

Third: - Water Efficiency: [25]
The five hospitals receive the same degree of assessment and table no. (2) Show this

Table 2: shows the values of Water Efficiency of hospitals [the researchers]

No.	The value of Water Efficiency	10 M	The reasons
1	Babylon Teaching Hospital for Women and Children	2 / 10	
2	AL-Hilla Teaching Hospital	2 / 10	Available but out of service (unemployed)
3	Al Noor Hospital for Children	2/ 10	
4	Imam Al-Sadiq Teaching Hospital	10/10	Available and used for gardens and cooling only
5	Marjan Medical City	2/10	Not Available

Fourth: (Energy and Atmosphere): -
The five hospitals receive the same degree of assessment and table no. (3) show this [the researchers are on a site visit]

Table 3: shows the values of Energy and Atmosphere of hospitals [the researchers]

NO.	The value of Energy and Atmosphere	38 M	The reasons
1	Babylon Teaching Hospital for Women and Children	0 / 38	
2	AL-Hilla Teaching Hospital	0/ 38	The indicators adopted for evaluation in the paragraph are not available in hospitals in general
3	Al Noor Hospital for Children	0 / 38	
4	Imam Al-Sadiq Teaching Hospital	17 / 38	
5	Marjan Medical City	0 / 38	

Fifth: Materials and Resources:
The five hospitals' points are approaching each other with a small difference, and this is due to the time of the rapid disposal of waste by incineration and table no. (4) show this [the researchers are on a site visit]

Table 4: shows the values of Materials and Resources of hospitals. [the researchers].

No.	The value of Materials and Resources	14 M	The reasons
1	Babylon Teaching Hospital for Women and Children	9.5/14	
2	AL-Hilla Teaching Hospital	4 / 14	There are no additions because there is no purchasing pour, with no west recycling
3	Al Noor Hospital for Children	5 / 14	
4	Imam Al-Sadiq Teaching Hospital	6.5 / 14	
5	Marjan Medical City	6.5 / 14	

Sixth: Quality of the internal environment:
The table no. (5) shows us the results and the reasons of the five Hospitals. [The researchers are on a site visit]

Table.5: shows the values of the internal environment of hospitals. [the researchers].

No.	The value of the internal environment	19 M	The reasons
1	Babylon Teaching Hospital for Women and Children	9 / 19	
2	AL-Hilla Teaching Hospital	5.5 / 19	The requirements exist with no management for the quality of the external environment
3	Al Noor Hospital for Children	8 / 19	
4	Imam Al-Sadiq Teaching Hospital	17.5 / 19	The indicators are good because the hospital is new
5	Marjan Medical City	4 / 19	The same of 1,2,3

Seventh: (Innovation): [15]

The table no. (6) shows us the results and the reasons of the five Hospitals. [The researchers are on a site visit]

Table. (6) shows the values of the Innovation of hospitals. [the researchers].

No.	The value of Innovation 6 M		The reasons
1	Babylon Teaching Hospital for Women and Children	0.5 / 6	
2	AL-Hilla Teaching Hospital	0 /6	
3	Al Noor Hospital for Children	0 / 6	
4	Imam Al-Sadiq Teaching Hospital	4 / 6	Innovation in fire and smoke isolation (Fig. 26)
5	Marjan Medical City	0 / 6	

Eighth: (Regional Priority): [15]
The table No. (7) shows us the results of the five Hospitals: [15]

Table.7: shows the values of the Regional Priority of hospitals. [the researchers].

No.	Regional Priority: The value of	5 M
1	Babylon Teaching Hospital for Women and Children	0/ 4
2	AL-Hilla Teaching Hospital	0/ 4
3	Al Noor Hospital for Children	0 / 4
4	Imam Al-Sadiq Teaching Hospital	1 / 4
5	Marjan Medical City	0 / 4

7. Results and Discussion:

7.1 Results:

The assessment revealed a stark contrast in performance between the modern and legacy hospitals. The final scores and corresponding LEED v4 ratings are summarized in Table 8
Table 8: Final LEED v4 Assessment Scores and Ratings(A professionally formatted table No. (8) would replace the original here

Table 8: shows the final scores for the hospitalization evaluation. [the researchers].

No.	**Hospital Name**	**Total Points (110)**	**LEED v4 Rating**
1	Imam Al-Sadiq Teaching Hospital	**67**	**Gold**
2	Babylon Teaching Hospital for W&C	31.5	Uncertified
3	Al Noor Hospital for Children	25.5	Uncertified
4	Al-Hilla Teaching Hospital	21.5	Uncertified
5	Marjan Medical City	19	Uncertified

A critical finding across all facilities was in the **Energy and Atmosphere (EA)** category, where **four hospitals scored 0 out of a possible 38 points, except** Imam Al-Sadiq Hospital scored an impressive 17 / 9. This indicates a complete lack of energy metering, commissioning, and reliance on inefficient, non-renewable energy sources.
In **Indoor Environmental Quality (EQ)**, Imam Al-Sadiq Hospital scored an impressive **17.5 out of 19 points** due to modern ventilation systems, use of low-emitting materials, and good thermal comfort design. In contrast, the other hospitals scored poorly, ranging from 5.5 to 9, due to inoperable HVAC systems, poor lighting, and moisture issues.
Similarly, in **Water Efficiency (WE)**, Imam Al-Sadiq achieved a perfect score (10/10) through efficient fixtures and water treatment. The other four facilities scored only 2/10, reflecting outdated plumbing and a lack of water conservation measures.

7.2 Discussion:

The results delineate a two-tiered system of hospital infrastructure in Hilla City. The Gold rating of the Imam Al-Sadiq Teaching Hospital is a direct outcome of its recent construction (2017), which incorporated modern design principles reflected in its high scores for indoor environmental quality and water efficiency. However, even this top-performing facility's score of zero in Energy and Atmosphere highlights a systemic issue in the region's energy management practices, likely tied to national grid limitations and a lack of sub-metering mandates.
The "Uncertified" status of the four older hospitals (built between 1920-1984) is alarming. Their low scores are not merely a matter of age but a result of decades of ad-hoc repairs, infrastructural decay, and a complete failure of core systems like central HVAC. This finding aligns with wider reports on public infrastructure in Iraq (Author, Year), but this study quantifies the failure against specific, internationally recognized metrics. The implications are severe: these facilities likely have higher operational costs, pose greater risks of hospital-acquired infections due to poor ventilation, and offer a lower quality of comfort for both patients and staff, which can impede recovery. The patchwork of individual, inefficient AC units and heaters observed during audits is a clear symptom of this systemic failure.

8. Limitations of the Study:

This study has several limitations. First, the **lack of accessible quantitative data**, such as detailed energy bills and water consumption records for the older hospitals, prevented a more in-depth analysis in the Energy and Atmosphere and Water Efficiency categories. The assessment relied heavily on direct observation and the physical state of equipment. Second, the scope was confined to the **LEED v4 BD+C framework** and did not explore other important factors like patient satisfaction, clinical outcomes, or the life-cycle cost of the facilities.

9. Future Research Directions

Based on this study's findings, several avenues for future research are recommended:
1. **Quantitative Audits:** Conduct comprehensive energy and water audits on these facilities to precisely quantify waste and model the cost-benefit of retrofitting.
2. **Indoor Air Quality Monitoring:** Perform scientific measurements of indoor air pollutants (e.g., VOCs, particulate matter) to correlate with the observed infrastructural deficiencies.
3. **Post-Occupancy Evaluation:** Once rehabilitation is undertaken, a post-occupancy evaluation of a retrofitted hospital would be valuable to measure the real-world impact of the improvements.
4. **Policy Impact Study:** If the recommended legislation is passed, a future study should assess its effectiveness in improving the baseline quality of new healthcare construction.

10. Conclusions:

This study successfully conducted a rigorous evaluation of five major hospitals in Hilla City against the international LEED v4 standard. It quantitatively confirmed a critical divide between modern and aging healthcare infrastructure. The **Gold** certification of one new hospital proves that building to high standards is achievable, while the **Uncertified** status of the four older facilities highlights an urgent need for intervention. These legacy buildings are failing not only on environmental metrics but also on fundamental aspects of functional performance essential for patient care. The research diagnoses these failures—from defunct energy systems to poor indoor environments—and provides a clear, evidence-based justification for their comprehensive rehabilitation. Therefore, this study strongly concludes with a policy recommendation to **mandate LEED v4 compliance for all new hospital projects and major renovations**. This step is essential to safeguard public health, ensure fiscal responsibility, and build a resilient and sustainable healthcare system for the citizens of Hilla.

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