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Greening Conservation Buildings in Light of Contemporary Technology: The Iraqi Conservation Experience

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ABSTRACT

The research focuses on the concept of green conservation, which means integrating advanced technological capabilities within conservation buildings in accordance with both conservation standards and green architecture standards, with the aim of revitalizing and upgrading buildings of value. Upon review of the Iraqi Green Code, it was found that it excludes conservation buildings, which identified the problem of the research in the absence of a trend towards greening local conservation buildings. The goal of the research was determined by the necessity of presenting a theoretical framework for greening conservation buildings in light of the specificity of the local context, which could serve as an approach for specialists on the one hand and to activate the Iraqi Code on the other hand. The research adopted the descriptive approach, which included a set of steps in order to reach a theoretical framework that includes major and secondary vocabulary through (clarifying green technological techniques - analyzing studies and specialized literature - analyzing the practices of the concept within the Arab context - analyzing the indicators of the Iraqi Green Code) so that the research moves to the next step. The following is represented by applying the vocabulary of the framework to the Baghdadi Museum building (where the Baghdad Municipality completed maintenance and preservation operations in a way that preserves its value and prevents its deterioration) to apply the vocabulary of the theoretical framework to reach the conclusions that confirmed the power of technological capabilities in upgrading the Baghdadi Museum building and raising its efficiency without compromising its original features.

1. INTRODUCTION

Iraq is full of buildings of historical and heritage value, and preservation experiments were adopted to reduce the impact of their obsolescence due to time and to preserve and continue them for the longest possible period, but these experiments were not able to activate or revitalize the preservation buildings and raise their quality to be part of sustainable development. With the emergence of the concept of green conservation, it focused on activating conservation buildings based on the integration of advanced technological capabilities within conservation buildings in accordance with conservation standards and green architecture standards, and after examining the Iraqi Green Code, it was found that it excluded conservation buildings, which identified the research problem with the absence of an approach to greening local conservation buildings, and the research goal was determined by the necessity proposing a local vision for applying the concept of green conservation. The potential of technology depends on the conservation and greening indicators in the local context to serve as a theoretical framework for an approach that designers can adopt to upgrade local conservation buildings and activate them in a way that achieves sustainable development, while at the same time activating the green code to apply it to all local buildings. The research adopted a descriptive approach that included a set of steps represented by clarifying the concept of green conservation, its principles, and the technological techniques that achieved it, and analyzing the most prominent studies that dealt with it, as well as analyzing the practice of the concept in the Arab context, since the local context is an extension of it, which confirms the extraction of the most prominent local conservation indicators, as well as clarifying the indicators of the Municipality of Baghdad approved in conservation. Conservation buildings, then analyzing the indicators of the Iraqi Green Code to reveal the indicators of greening and the goals resulting from their application, in order to reach a theoretical framework with major and secondary vocabulary and values.

For the purpose of application, the research adopted its final step of selecting the Baghdadi Museum building (where the Baghdad Municipality completed maintenance and preservation operations in a way that preserves its value and prevents its deterioration) so that the research completes the steps of greening it according to the theoretical framework and proposes a plan to integrate technological techniques into it without compromising its original features and in accordance with the indicators of the Iraqi Green Code, which confirms Upgrading the building to be more efficient and contribute to achieving sustainable development.

2. THE CONCEPT OF GREEN PRESERVATION

Conserver Verde explained that the concept of green conservation is one that integrates the values of responsibility and sustainability, as well as the management of its mandated heritage [1], Victoria's Heritage Council is defined as a method that reduces the use of energy associated with demolition and waste disposal. It provides a basic understanding of how to improve sustainability and reduce energy and water consumption in historic buildings, maximize sustainability practices in performance [2]. It is also defined as a renovated heritage building and modified as a green building without harming its heritage features or losing its values, or leading to de-listing, if listed by the national authority, where the sustainability of the heritage building will be achieved when conservation and operational performance strategies take into account the three pillars of sustainability and the environment system and do not deplete environmental resources in addition to achieving high functional value to serve the community and generate more income for its owners and the national economy [3].

The above proposition shows that the concept of green conservation balances the conservation values of historical and heritage architecture with the values of green architecture that aims to achieve sustainable architecture.

3. PRINCIPLES OF GREEN PRESERVATION

a. Principle of Waste Minimization for Historic Preservation: Preservation maximizes the use of existing materials and infrastructure, reduces waste and preserves the old historic character.

b. The Historic Safety Principle: Existing buildings reduce the climate impact of newly built buildings. Findings indicate that even sustainably constructed new built structures do not recover energy expenditures for nearly 30 years when measured against a renovated existing building.

c. The principle of adapting to the climate using the technology of the era: Historic buildings were traditionally designed with many sustainable features that respond to climate and location. When these features are effectively restored and reused, they can lead to significant energy savings, taking into account the original climate adaptations. For historic buildings, sustainable technology today can complement the inherent sustainable features without compromising the unique historical character.

d. Principle Considering the Social Values and Environmental Benefits of Preservation Values – The current version of LEED® has been modified to take into account the social values and environmental benefits of preserving historic structures.

e. The principle of preservation with the Green Goals and the possibility of reconciling them with conservation standards, provided that both parties strive to be as creative and flexible as possible.

f. Development of the International Green Building Code (IgCC) by the International Code Council (ICC) into a new overlay standard to encourage the incorporation of sustainable design into historic building [2].

Following up on the principles of green conservation has shown that it combines the principles of green architecture with the principles of conservation building together to revitalize the building instead of keeping it an abstract symbol or a rigid object, relying on the power and capabilities of advanced technology that has proven its efficiency in achieving the aspects of sustainability of green architecture, which made it excel in performance and win competitive awards, and for this reason. In the following paragraph, we will focus on clarifying the technological factor in detail.

4. TECHNOLOGIES FOR GREEN PRESERVATION

Technological progress in our time has shed light on many technologies in which the potential for improvement, quality and efficiency is exploited in order to transform into environmental preservation, so that preservation buildings are adapted through these technologies so that they are compatible with the principles of preservation and respect the original features, so that these technologies are acceptable and not extraneous. While Some of these technologies are basically integrated, being part of the old and locally known operational plan, but some still need a business plan in terms of smart technologies.

4.1 Intelligent technologies

Smart technologies include both software as well as smart materials. As for software, it is represented by the "Energy Simulation Program," which is used to analyze and simulate energy consumption in buildings and helps understand how design and technologies affect energy efficiency and improve the building's performance in terms of ventilation and heat. "Light simulation" programs, which are used to evaluate the impact of lighting on buildings and how to improve the use of natural and artificial light inside the building. "Thermal insulation" programs are used to determine the optimal thermal insulation of buildings, which contributes to reducing heat loss and improving energy efficiency [4].

The materials include "HBIM-IOT sensors," which are used to control and maintain building operations, and provide live data about the building's performance and the technology used. And "3D digital printing" devices are used to restore missing parts of historical buildings, which contributes to their comprehensive and effective restoration [5], as well as "smart building materials" including advanced materials such as phase change materials (PCM) which are used to insulate roofs and walls and correct thermal bridging. It also includes materials such as airgel and silica, which are used for thermal insulation and improving air quality [6].

4.2 Energy conservation techniques and the use of renewable energies

These technologies include green composite building materials such as glass assemblies, insulating materials, facade systems, air-spray foam, spray, etc. They are used to improve building insulation and reduce operating costs, as well as provide natural lighting and control conduction and thermal load. These technologies work in an integrated manner to enhance energy efficiency and reduce resource consumption in buildings. Historically, Glass fibers, natural fibers, and carbon fibers can be integrated into the original building materials to improve efficiency [7, 8] or renewable energy technologies are used to be integrated with glass or tile materials to convert the sun's energy into electrical energy to reduce energy consumption, in addition to using thermal systems technologies. Such as geothermal heat pumps and geothermal wells to take advantage of the thermal energy available in the earth. As well as wind energy technologies such as turbines to generate electricity [9].

4.3 Active passive technologies

These techniques are applied to the elements of conservation architecture to increase their efficiency after they have become obsolete due to time and have become ineffective in light of developments, in order to regulate the distribution of air inside the building, reduce the porosity of the outer shell, collect thermal energy, and improve natural lighting. "Active ventilation techniques", which are integrated with air shutters (pedicures), domes, chimneys, and movable glass panels, rely on improving the buildings' air quality effectively and achieving energy savings, which contributes to enhancing environmental preservation in historical buildings. As for "active shading techniques," they rely on sun breakers and double DSF facades, they are used to control lighting and temperature adjustment, which contributes to reducing the effect of direct sunlight on the building. As for "activated light technologies", they include adding light sensors to interior courtyards or adopting light-sensing curtains and ultraviolet filters with the aim of adjusting the distribution of light inside the building, adjusting visibility levels, and treating glare and brightness [4].

5. STUDIES DEALING WITH GREEN PRESERVATION

Four studies specialized in green conservation were chosen because they are considered the most recent and present indicators of the application of the concept by adopting various technological techniques within conservation buildings at the global and Arab levels, in addition to presenting the aspects achieved from the application, which confirms the extraction of vocabulary related to the actual reality of conservation buildings.

5.1 Study by Elabd et al. [5], 2021

The study identified shortcomings in the traditional preservation process, and focused on the role of innovative technologies in effective preservation represented by HBIM and IOT technologies to shift from traditional preservation to flexible effective preservation. Designing and seeing changes in the building before it is actually done to make the building work as a living organism through the use of innovative technologies to be able to understand and deal with change, to turn the rigid heritage into a living organism to understand it and then adapt to the surrounding environment and provide flexibility to interact with unpredictable events through sensors to detect movement and partial climate measurement, overcoming many conservation problems related to human errors, as well as smart and automatic monitoring of heritage buildings, as smart digital software that transmits smart digital data and detects natural conditions and temperature changes that affect the integrity of the building's preservation structure, and tracks the behavior of materials and the extent of durability to preserve on the building in the long term, and the study reflected the extent of the positive effects of technology in maintaining green on the performance of the environmental community, as flexibility has a number of positive effects on the performance of the environmental community, social and economic value, and sustainability. Environmental performance is improved by adapting the building to the surrounding community to be resilient to unexpected risks through safety measures and monitoring features, and to reduce energy consumption and carbon dioxide emissions [5].

The study proposed mechanisms for adapting technological techniques (represented by smart preservation software techniques and sensors for automatic monitoring of conservation building indicators) to the heritage building in a way that preserves its original features and characteristics, especially (color, texture, angle, lines, dimensions, fastening elements, shape of connections, surface textures) so that it conforms to restoration standards and achieves aspects of upgrading to achieve sustainability .

5.2 Study by De Medici [8], 2021

The study focused on the role of advanced technology (represented by photovoltaic systems) in heritage preservation at the level of repair + reduction of gas emissions (improving and efficiency + generating green jobs), as these systems strengthen heritage buildings by creating job opportunities and improving life, doubling the annual energy renewal over the next ten years, reducing greenhouse gas emissions in Europe (GHG), and generating green jobs in the construction industry. costs, as well as its ability to integrate with renewable energies, remove carbon, and offer aesthetics within high health and environmental standards to produce forms and designs that are both renewable and traditional.

The study described the modified technological capabilities of the architectural heritage according to the requirements of energy production from renewable sources, where solar energy technologies allow the capture and accumulation of solar energy and use it to produce electrical or thermal energy through the concentration of solar energy, which uses thermal energy from the sun to drive electric turbines, as well as the possibility of benefiting, including solar heating and cooling systems that harvest thermal energy from the sun to heat or cool the air and provide hot water. The study identified some problems related to the integration of photovoltaic cells with the image of the heritage building, which requires modification of the formal characteristics represented by materials and surface characteristics (color, texture, etc.) and adapting photovoltaic modules to the inclination and roof, roof lines, ridges and cornices, dimensions, covering up pipes, cables and fixing elements, carefully designing joints, choosing colors and surface textures that are compatible with old roofs so as not to affect the ability to integrate with buildings or historical contexts, and consideration into the acceptability of installing asset control system technologies in heritage buildings [8].

The study presented important aspects to hide the contemporary form of new technology within the conservation buildings in order to avoid compromising and distorting the original features of the conservation building.

5.3 Study by Foda [4], 2016

The study dealt with heritage buildings of high values in

Egypt and what they suffer from deterioration, neglect, non-investment and non-periodic maintenance by presenting "green building" practices and applying green principles to produce a classification system for green heritage buildings that can evaluate green heritage buildings. In Egypt, this tool aims to integrate the principles of green building practices into strategies for preserving heritage buildings to achieve sustainable development of heritage building and meet current and future needs by preserving and maintaining the building and applying green practices without harming or losing heritage value. GPRS and the installation of mechanical or mixed systems to reach the Green Pyramid classification system and compare it with other international classification systems such as LEED and BREEAM schemes. The outdoors, enhancing interior quality and achieving safety through the use of high-efficiency devices, LED lighting systems, and highly efficient water fixtures, and making some amendments to the appropriations of the new GPRS building scheme to be compatible with heritage buildings, and added new appropriations to the green heritage building scheme of GPRS [4].

The study focused on technologies related to mechanical services with the aim of facing the challenges of adapting American and British international methodologies in a manner that takes into account Arab specificity. It also presented the most prominent sustainability goals achieved when applying photovoltaic technologies in one of the heritage buildings in Egypt.

5.4 Study by Lansing [10], 2009

The study focused on the necessity of balancing the sustainable aspects of upgrades to increase energy efficiency, reduce carbon impact, and preserve the unique architectural features of conservative buildings, as many of the old buildings have withstood because they were built with durable materials that stand the test of time. It is a quality that is sustainable in nature, and the most prominent techniques referred in the study were the integration of green updates such as geothermal energy, occupancy sensors, and the use of salvaged materials with the features of facade restoration and accessibility to achieve the historical integration of the structure in line with the needs of the twenty-first century as well as systems. Modern features in the original structure of the historic building such as control devices, lighting, life safety systems, elevator, audio and video systems, which can be hidden inside the service structure and are compliant with LEED standards [10].

The study presented some of the technological technologies that were installed within the structure of the historic building and some details of their integration in accordance with the value of the building, as well as the study presented the most prominent aspects of the upgrade achieved.

6. ANALYZING THE APPLIED PRACTICE OF GREEN CONSERVATION

Some of the vocabulary that can be organized to form the vocabulary of the theoretical framework, which is represented by (conservation indicators - greening indicators - technological techniques - achieved goals). In order to ensure the effectiveness of these vocabulary and enrich the values of the theoretical framework within the local context, as some of them are linked to the local context, this will be discussed in the paragraph. The following is an analysis of Arab green conservation experiences in (Egypt & Lebanon).

6.1 Greening the Municipal Council (Mansoura Opera House)-Egypt

The historical background of the building - is the first and oldest theatre in Mansoura. It opened on December 18, 1889, and was called "Tahrir Teatro", which means the theatre of joy for more than thirty years (1920-1988), changed its name to the Municipal Council Theatre, and its last job became the Mansoura Municipal Council which is a cubic building with a rectangular floor plan showing four free facades in a classic style and style [11]. The greening indicators included the following:

Preservation indicators include: Preservation of the original architectural character of the building and restoration and restoration of old architectural elements and degraded and dilapidated parts of the building with the same value, Save architectural details and do not replace the glazing of heritage windows, adopt the original building material and its original relationships as the use of the original stones of the destroyed building in the new building [9], as well as the preservation of the original material, the use of tiles of the original material, the use of new materials that complement the original material and enhance its strength and sustainability and the compilation of the original elements of the reconstruction projects [11].

Greening indicators include: Rationalizing water use by installing water saving technology taps and shower heads to reduce water flow and consumption. Using a system to collect and sweeten rainwater or wastewater for use in irrigation, rationalizing materials and resources through the use of building materials made of environmentally friendly local resources [9], as well as achieving internal environmental quality by reducing CO_2 emissions using environmentally friendly and low carbon building materials and using efficient lighting systems such as LED.

Rationalize energy by exploiting daylight by expanding the inner courtyard and adding a new courtyard to the last two floors of the building to increase natural lighting, Reduce cooling and heating loads, reduce solar heat acquisition, allow existing air current to naturally cool indoor spaces, use solar panels and solar heating system, improve public building performance and turn it into a more environmentally friendly version using occupancy sensors to automatically turn on and off lights with less electricity consumption and less heat generation, as well as waste management by separating flammable and toxic materials into external containers and preventing soil pollution [11].

Technological indicators include: Installation of fire detection and alarm system for all minors' spaces and use of 3D graphics software to identify suitable places to use original stones, air and water pollution monitoring devices, HVAC system for windows and doors [9], application of photovoltaic and photovoltaic cells on the surface, solar heating system, insulation stabilization and installation of sealant materials, reinforcement of air parking (Badacare) with lighting and ventilation control devices [11].

To summarize the results of green preservation: Classification of the building under the Golden Pyramid Certification Level in the Green Pyramid Classification System, saving 34% of electrical power, 3.5 times more performance and attraction of visitors [11].

6.2 The green preservation of Al-Shennawi Palace-Egypt

Preserving the Baroque style in the facades of the palace, as the construction dates back to 1927 to 1930, and emphasizing the style of its tiles, Italian furniture and wooden stairs as indicators of preservation, as well as restoring its service system in the bathrooms by adopting heritage installations to rehabilitate broken and damaged elements and using insulating materials. In the roof and walls to prevent leakage of old pipes as indicators of greening. To achieve the quality of the indoor environment, and as technological indicators, heating, ventilation and air conditioning systems were installed in the windows to ensure adequate ventilation and thermal comfort without damaging or losing the values of the heritage palace. Air purification carbon dioxide sensors are installed at all points of the HVAC system.

The green conservation application also focused on waste management and reducing pollution by separating flammable materials. In order to verify the performance efficiency of the building in light of the adopted technological techniques, the “Revit” program and the simulation program were used to determine the amount of energy expended, which confirmed the increased efficiency of the building thanks to the technological techniques [4].

6.3 The casa Batroun building-Lebanon

An old 100-mm heritage apartment building located in the northern Lebanese port of Batroun, it was established in 1930 and was preserved as a model of an environmentally friendly heritage building [12].

Preservation indicators: Include work to restore the heritage building shape by the population's sense and relevance to the heritage place.

Restored and preserved the architectural character of the heritage building while improving the vital characteristics of the building and increasing its space in environmentally friendly ways. The character of the building was restored by lifting the outer layer that enveloped sandstone and the windows were reopened [13].

Greening indicators: include collecting rainwater for reuse and employing green roofs planted with drought-resistant plants to reduce water consumption. To rationalize the use of resources and materials, it is important to choose high-quality materials that emit low levels of VOCs, thus improving indoor air quality. In addition to achieving the quality of the indoor environment by maintaining natural ventilation and reducing dependence on energy-intensive systems, carrying out a careful study of the placement of windows and shading, as well as using traditional insulating materials and adapting them by mixing local clay with sand, lime and straw to enhance its structural integrity and prevent its collapse on the one hand, as well as increasing efficiency. Insulation with additives to conserve energy on the other hand [12].

Technological indicators: Include the use of cold roof systems and insulating materials such as sheep wool and wood fiber, which have been used for wall insulation. They also incorporate composite green material techniques and enhance the indoor patio with effective LED lighting [12].

To summarize the results of green preservation: The building received the silver level within the British BREEM system in 2014, achieving operational efficiency in terms of thermal analysis with a 50% reduction in energy consumption, the number of hours of exhaustion was reduced by 55%. Achieving economic efficiency by reducing cost and rationalizing the use of resources through the application of traditional techniques. Achieve quality and increase the efficiency of the building by reusing the building as a residence which is the main function, Achieving environmental efficiency by reducing 41% of CO_2 emissions [13].

The analysis of the applied practice of the concept of green conservation in the three approved Arab samples highlighted the extraction of key vocabulary for the green conservation approach that reinforces what was extracted from the analysis of the literature in the previous paragraph and was represented by (the vocabulary of conservation indicators, the vocabulary of green indicators, the vocabulary of technological techniques, and the vocabulary of achieved results), as it was extracting secondary and secondary values within the Arab specificity, as the analysis showed that there is a great similarity in the conservation indicators that specialize in confirming the original features of the conservation buildings that confirm their original features and identity by preserving the architectural elements, their characteristics and details in terms of form and material as conservation indicators, as well as the diversity in greening indicators. It focused on rehabilitating the service aspects by relying on various technological techniques commensurate with the sustainability goals required to be achieved in the conservation building.

In preparation for the next step, which is the possibility of extracting the specificity of green conservation in the Iraqi experience, the Iraqi conservation indicators and the Iraqi greening indicators will be highlighted in the following two paragraphs, in a way that ensures the modification of the terms of the theoretical framework.

As a first step, Iraqi conservation indicators will be presented, then we will move on to presenting Iraqi greening indicators.

7. IRAQI CONSERVATION INDICATORS

The Heritage Division of the Baghdad Municipality Department was visited as it is responsible for protecting heritage buildings and preservation, and possesses all original documents proving Iraqi conservation indicators. It has been shown that Iraqi conservation indicators are classified into three levels (structural preservation, architectural preservation, service preservation) as follows:

- Indicators related to the durability and structural preservation of the conservation building structure and focus on the structural safety of all parts and supports of the structural structure and its structural connections. These include fortifying the cross-section of the structure, installing steel beams, using strong materials and protecting them from vibrations and humidity, installing vibration protection supports, using salt-resistant cement, and strengthening damaged elements. By adding internal columns and strengthening foundations, strengthening fragile materials using fibers and adhesives to strengthen them, preserving the structural character by adopting original construction materials and elements, protecting and preserving materials, removing calcifications, and implementing protective mortar layers [13].
- Indicators related to the features and architectural mass of the conservation building and focus on the architectural style and architectural identity of the conservation building and

include - respecting the original shape of the building through proportion and architectural proportions, color, texture, scale, lines and decorative details, adopting the original material in the building's facades, finishes and interior details, and adopting the implementation method and original construction techniques. To ensure original characteristics, while respecting architectural details such as columns, balconies, decorations, doors, windows, trims and finishes [14].

- Service indicators for the conservation building focus on the functional performance aspects of the conservation building and emphasize the renewal and repair of all components of the service system, modernizing the system and adopting local standards, improving the service structure, addressing the effects of humidity, modernizing electrical systems and providing electronic communications, using insulating materials to enhance thermal insulation, introducing a monitoring system to evaluate the performance of the system such as a BMS system, increasing the performance capacity by introducing new services to enhance the performance capacity, activating the system by making the system interact better with spaces and linking the axes of movement [15].

8. THE IRAQI GREEN BLOG (THE GREEN RIVERS BLOG)

In 2019, the Iraqi Green Code was launched by specialists in green architecture within the Iraqi context. The Code aimed to define the principles, concepts, and applications of green architecture exclusively appropriate to the local environmental aspects of Iraq's climate. The importance of the Iraqi Green Code lies in its confirmation of the technical and artistic standards of the Iraqi environment with the aim of enhancing aspects of environmental sustainability, especially as it emphasizes the use of environmentally friendly and recyclable materials, and encourages the adoption of renewable energy systems for generating electricity and heating water, especially solar energy, given that Iraq's climate is hot and dry most of the year, as well as it confirmed the activation of the water saving and water recycling system to reduce the consumption of resources and energy. The code covers all stages of planning, design, operation, construction, use, works, site study, maintenance, rehabilitation and recycling of green building components, addressing performance improvement strategies.

However, what is criticized about the Code is its exclusion of heritage and historical conservation buildings, and this is what makes it ineffective in applying it to conservation buildings and limiting its effectiveness to newly constructed and implemented buildings, as the Iraqi context for greening buildings and achieving green architecture depends on what the Code proposed, and accordingly, the vocabulary of greening was extracted based on what the Code proposed, which confirms the traditional goals and standards to develop (Table 1) to extract the values of the main and secondary vocabulary of the code as shown below [16].

Table 1. Greening indicators in the Iraqi green architecture code, at the disposal of the researcher

Key Indicators	Subitem	Values
Indicators of water rationalization	Rationalization of potable water consumption in buildings	Use efficient plumbing fixtures
	Rationalization of water consumption in watering crops	Grey water system for the use of grey water in irrigation or domestic operations
Internal environment quality indicators	The most appropriate exploitation Natural ventilation	Orientation of the building Air Parking Window Guidance
	Treatment of pollutants for chemicals and noise	Treatment of volatile organic chemicals (low emission) Application of acceptable noise standards in the indoor environment Application of acceptable noise standards of mechanical systems
	The most suitable use of lighting	Control of natural and artificial lighting in the building
Location selection indicators	Dealing with the topography of the site	Empowering people with special needs Afforestation and reduction of the impact of urban thermal islands Shading sidewalks and ceilings noise pollution
	Easy access to the site	Bicycle Encouragement + Public Transport Certification of electric vehicles
Energy rationalization indicators	Thermal insulation	Shading the building's facades The use of insulation materials in the building envelope / walls / ceilings
	Control the ratio of window openings to the façade	Type and shape of windows, type and shape of glazing How to install the nets
	Accreditation of renewable energies	Solar & Wind Cells Solar Heater
	Rationalization of energy required for the production of building materials	Use of local building materials Use materials made from recycled resources No use of hazardous materials
Indicators of effective management	Creativity	Management in integrating the principles of sustainability and environmental protection
	Decision making in organizations	Empowering human resources, assisting government agencies and community awareness
	Continuous improvement in	Promoting environmental innovation

	environmental performance	Use efficient technology that reduces environmental impact
	Develop indicators and benchmarks to measure environmental performance and assess progress	Compliance with environmental standards and certifications Obtaining environmental certificates such as LEED
Waste management indicators	Reuse and recycling of construction waste Integration of equivalent materials into manufacturing processes to produce a new material Safe disposal of toxic waste and waste Conversion of waste into electrical thermal energy Adoption of clean technology for waste treatment	

9. THE THEORETICAL FRAMEWORK FOR GREEN CONSERVATION IN THE IRAQI CONTEXT

As shown in Table 2, which includes indicators of the theoretical framework for greening local conservation buildings in preparation for its application to a selected sample, represented by the Baghdadi Museum building.

10. APPLYING THE IRAQI GREEN CONSERVATION APPROACH TO THE BAGHDADI MUSEUM MINI

The election of the Baghdadi Museum building came, and by the year 2022, the Baghdad Municipality decided to carry out restoration and maintenance work on the building with the aim of making it permanent and preserving it for the longest possible period as shown in (Figure 1), as it is the most valuable architectural masterpiece in Baghdad, as it dates back to the year 1869 during the era of the Ottoman Empire.

The building reflects the architectural heritage value, as it documents an important period of time in the history of the capital, Baghdad, politically, architecturally, and socially, as it displays the ancient Baghdad lifestyle in a building in which every architectural detail embodies a value in the life of the ancient Iraqi person, and embodies the ingenuity of the builder and craftsman who excelled in creating all the Baghdad heritage elements. The old items were carefully and qualitatively examined, including (floors, walls, vaulted ceilings, walls, environmental vocabulary such as pedicure, fine architectural details of the doors and windows, which are distinguished by their small and multiple openings, and the use of hanging wood in the balconies, internal and external canopies, etc.).

The preservation plan of the Heritage Department in the Baghdad Municipality Department focused on indicators related to the structural structure, represented by (Using concrete with high compressive strength, adding supporting iron parts, adopting ductile reinforcement steel as a concrete cover, removing demolished parts that negatively affect the structure as a whole, adopting rubber materials to cover the surfaces, adopting salt-based cement, adopting paint with flancote.) and the team carrying out the maintenance work was keen to implement them. Regarding the architectural indicators, this study focused on rehabilitating the damaged parts of the building due to time, especially the openings, frames, finishes, or interior elements, by restoring their original form, using the same material, and with the same formal and appearance characteristics, in a way that ensures respect for the building's identity.

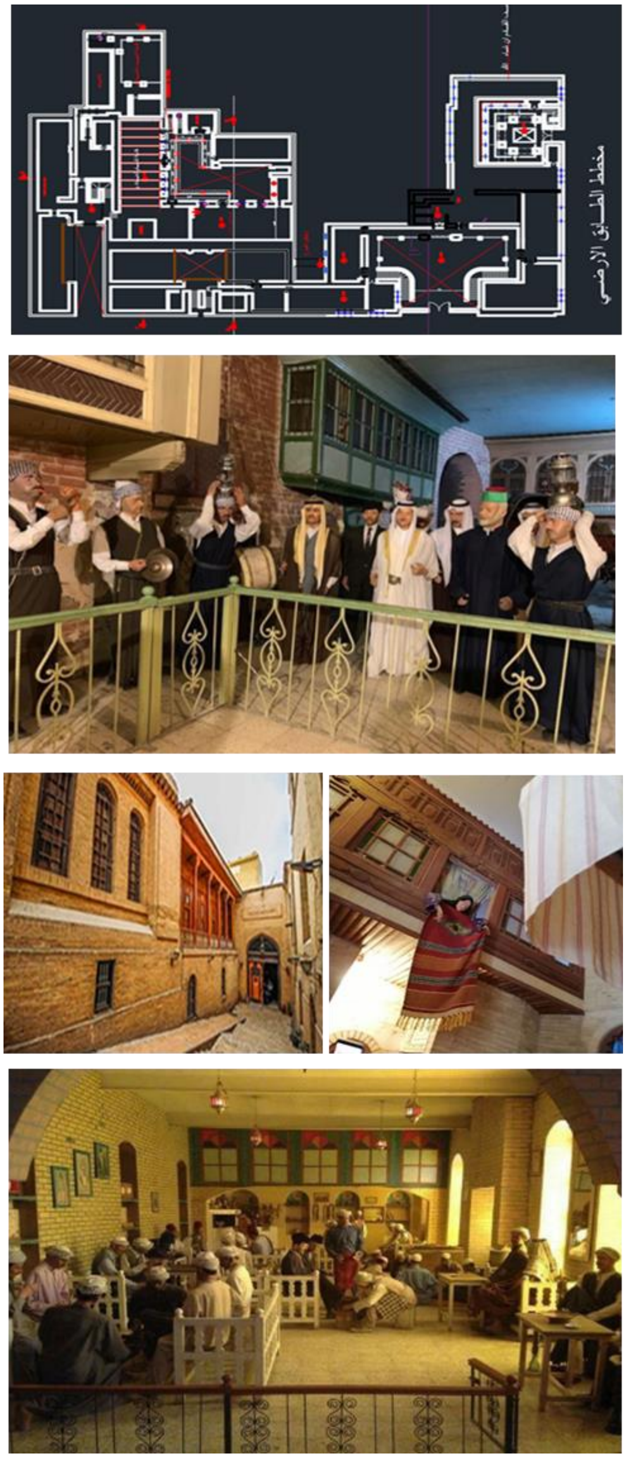

Figure 1. The Baghdadi Museum mini
by researcher

The plan for greening the Baghdadi Museum building will be amended and completed in light of the theoretical framework drawn for applying the indicators of Iraqi green preservation that were extracted in the previous paragraph, and as Table 3 shows, which can be considered an action plan aimed at upgrading the building and raising its efficiency and not just maintaining it as an architectural witness by integrating technological techniques. Possible and contributes to the application of green conservation principles.

11. CONCLUSIONS

Green preservation is a new plan that aims to expand the goals of traditional preservation in order to achieve sustainable development, as it emphasizes the aspects of preserving the building (heritage and history) on the one hand, as well as its role in activating the building by incorporating green building standards without negatively affecting the basic features of these buildings through the introduction of technologies. Greening in accordance with green building codes, which contributes to their advancement and economic improvement at the level of operational costs, water, resources and energy. As well as environmental improvement at the level of reducing the consumption of electrical energy, resources, building materials, water, recycling waste, providing a higher presence in the internal environment, in addition to attracting tourists and the general public to the building to be functionally, environmentally and socially effective.

The practice of green conservation depends on integrating advanced technological techniques within the conservation building while avoiding harming the basic features of the conservation building and its original identity. Thus, the green conservation plan ensures a balance between conservation indicators and greening indicators together.

The strategy for preserving the green environment includes a set of terms, including diapers, preparatory indicators, technological techniques, and achieved results. Each of these items consists of a set of secondary indicators with a set of possible values.

The application of green conservation in the Iraqi context was based on the activation of the Iraqi Green Code, which presented indicators for greening the conservation building within the Iraqi specificity within multiple levels represented by (rationalization of water consumption, environmental quality, site selection, energy conservation, and waste management that confirm Sustainability aspects (environmentally, economically, socially).

The technological mechanisms for greening conservation buildings are numerous and diverse, include (energy conservation techniques, sustainable green techniques, and smart technologies). In the context of the Iraqi experience, composite materials techniques are considered the most prominent as they rely on local and recycled materials.

- The technological dimension of green preservation in the local context emphasized the continuity of the historical appearance of the conservation buildings, such as commitment to the original brick color, the soft and rough exterior texture of the building and the traditional parts of its architectural structure, which emphasize the unique characteristics of the place and its unique aesthetics.

- The technological dimension of green preservation enables to improve the comfort and safety aspects of conservation buildings through the integration of modern technologies for electronic monitoring and improving lighting and ventilation to enhance the performance of the building.

The activation of the indicators of the Iraqi Green Code within the plan to preserve local buildings of heritage value achieves aspects of innovation and conservation creativity by achieving environmental sustainability aspects by converting original construction waste and recyclable materials and converting them into sustainable technical and engineering elements and the use of environmentally friendly building materials, as well as economic aspects, especially those that reduce energy consumption, especially the application of renewable energy technologies within the internal courtyard element as the most prominent heritage item, which contributed to improving the quality of the internal environment. The building in terms of ventilation and natural lighting to upgrade the inner courtyard (and the building as a whole) to the refineries of active elements after there were environmental developments that reduced its original environmental role.

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APPENDIX

Table 2. Terms of the theoretical framework for greening the buildings of the Iraqi reserve (researcher)

Vocabulary	Secondary Indicators	Values			
Preservation indicators	Architectural style	Mass Level		Architectural Composition	Aperture ratio Number of floors Existence of architectural elements (contracts - brackets - basements - domes)
				Constructive Material	Floors Wood Stone Plaster
				Original Decorative Elements	Related to doors Attached to windows Associated with the Brackets Related to Doors
				Slots	Distribution pattern (recurrent - non-recurrent) Area and dimensions Presence of schnachels and beverages Shape of slots
		At the Scheme Level			Functional distribution pattern (longitudinal, centralized, random) The presence of the central courtyard Movement corridor pattern Coverage ratio (planned openness) Angles
	Architectural construction (Structural structure)	Construction Structure Elements (columns, ceilings, floors, walls) Constructive Method Foundations of Structure Construction Elements Linking Details Construction Element Relationships			
	Service System	Ventilation System Refrigeration System Heating System Communications System			
Greening indicators	Water Index	Watering System		Plumbing System	Use foundry systems from environmentally friendly and recyclable materials, such as high-density polyethylene (HDPE) or copper. The use of water-efficient faucets and showers
				Low Water Consumption Plants	Wild Olive Rosemary Cactus
		Grey Water System			
	Resource and Material Index	Efficient Construction System			Speed of completion Moisture and vibration resistance Adjustable and changing
		Efficient building materials			Eco-friendly Resistant to conditions Rot-resistant
	Internal Environmental Quality Index	Ventilation System		Natural ventilation	Offender windows and openings Ceiling openings
				Industrial Ventilation	Air conditioning, ventilation and heating system (HVAC) Mechanical suction fan
		Lighting System	Natural Lighting	Glazing System	Single layer glazing Double-layer glazing Multi-layered glazing
				Slot Type	Offender windows and openings Ceiling openings
				Insulate Windows	Enhanced storm windows Dielectric material-foam Window insulation tyres
			Industrial Lighting		LED system Programmed lighting

			Mixed Lighting	Combining natural lighting and artificial lighting
		Pollutants	Chemical Toxic Substances	Avoid toxic substances Avoid the use of volatile substances
			Noise	Insulating materials such as fiberglass, rock wool or fiberglass Breakers, barriers and acoustic panels
	Energy Indicator and Casing	Thermal Insulation	At the cover level	Walls Ceilings Flooring
			At the level of the service system	At the level of the water pipe system Heating and cooling system
		Renewable Energy		Generate electrical power to operate the building Generating thermal energy to heat and heat water
	Waste Index	Recycling Waste Management		
technologies	Smart Technologies	Software	Power Simulation Software	Energy plus Design builder
			Information modeling	Laser scanning HBIM IOT Digital 3D printing
		Smart Building Materials	Smart Insulation Material	Acrylic micro emulsion Acrylic polymer primary
			Innovative nanomaterial's	Airgel Amorphous silica gel
			Phase Change Material	PCM
	Energy Conservation Techniques and the Use of Renewable Energies	Green Composite Building Materials	Fibers (glass, natural, carbon) - polymer matrix	
		Renewable Energy Technologies	PV systems	Photovoltaic cells embedded in glass or in every tile.
			Water Energy, Groundwater	Geothermal wells
			Wind Energy	Turbine
		Building Casing Techniques	Insulating Material	Moisture resistant concrete, silicone polymers
			Cold Ceiling Technology	Insulating cladding on the outside
	Passive Techniques Activated	Active Ventilation Techniques		Air Catcher (Padcare) Effective techniques for upgrading domes Chimneys
		Activated Shading and Light Technologies		Sun breakers Dual DSF interfaces Light-sensing inner courtyard Curtains & light sensors UV filters
results achieved	Conservation Results	Original Features of the Building	Formal and Aesthetic Features	Shape Colors Texture
			Features of the Structural Structure	Structural load-bearing Structural design
			Service Features	Sewage system Telecommunications infrastructure and other Internet and telecommunication services.
	Precautionary Results	Environmental	Best ventilation Best lighting and natural lighting Thermal comfort Less pollution Less noise Best Isolation	
		Economic	Lowest operating cost Less constructive cost Lowest energy consumption Lowest water consumption	
		Social	Interaction - belonging - security Communication - functional activity	

Table 3. Applying the theoretical framework to the Baghdadi Museum building

Vocabulary	Secondary Indicators		Associated Values
Preservation indicators	Architectural style	Mass Level	Preserving the original architectural composition in terms of the architectural elements that make up the facades and plans, which is represented by preserving the details of the main façade of the building, including architectural decorations and inscriptions if they exist. Retain the details of the building block, while committing to the restoration and maintenance of any blocks that suffer from damage. Maintain original interiors, such as wall panels or decorative ceilings if any. Keep the details of the columns and arches inside and outside, while working to restore any damage to them. Keep window details including trims and kits and do not replace them with modern glass if unnecessary. Keep the details of the main and secondary doors, and restore in case of damage. Maintain details of the building's exterior, such as decorations and geometric details. Keep the details of the internal and external stairs, and repair any damage that could affect safety and

					aesthetics. Preserve any archaeological elements that may be part of the original design. Keep any inscriptions or decorations that reflect art and history, and carry out the necessary maintenance. Because these details indicate a total commitment to preserving the architectural composition and aesthetic elements
					Commitment to the original building material represented by (Jifqim bricks, beech wood material, tinted, granular and transparent glass)
					Preserving the original decorative elements such as the elements associated with the doors (the distinctive decorative wooden doors of the museum) and associated with the windows (decorative stained glass), associated with the arches
					Save the openings in terms of the distribution pattern (repeated - non-frequent), area and dimensions, the presence of shanasheel and mashrabiyat, the shape of the openings
	Architectural construction (structural structure)	At the Scheme Level			Preserving the pattern of the central functional distribution of the building, the presence of the central courtyard, the pattern of movement corridors, the corners, increasing its planned openness by reopening the original pedicure that was closed, as well as the presence of the half-basement
					Reinforcement of structural elements, treatment of water leakage, filling wall cavities or mixing it in cement and internal or external insulating plaster in the form of rolls or FRP boards, cork boards, gypsum or gypsum fibers
					Correction of thermal bridges, to improve its physical and thermal properties, adding reinforced fibers or special additions to the matrix, structural method and foundations of the structure, As well as strengthening the details of connecting structural elements and relationships of structural elements
	Service System				Strengthening the old ventilation systems in the museum building, such as the air catcher (bad care), reopening it, introducing mirrors to its sides to collect natural lighting and heliostats to collect thermal energy to the dump, using the "suction fan", especially in kitchens, bathrooms and other closed places for its ability to withdraw old and polluted air from inside the building, ventilate it, renew the air and provide appropriate ventilation. Modernization of heating and cooling systems by introducing low-energy consumption HAVC systems Modernization of communication systems by introducing performance systems for the service system such as BMS
	Water Index	Plumbing System			The use of foundry systems from environmentally friendly and recyclable materials, such as high-density polyethylene (HDPE) or copper, and by adopting specifications to increase efficiency, especially the choice of pipe diameter (1-0.5, 0.75 ang) made of reinforced plastic.
		Watering System			The use of low-water absorbing plants, such as bulbs, cacti, acacia bushes, oleanders (for decoration), palm trees and perennial Sidr trees (Greywater System)
					Grey Water System
	Resource and Material Index	Efficient Construction System			Achieving speed in completion and making the building system efficient in terms of moisture and vibration resistance and adjustable and changeable
		Efficient Building Materials			Adopting low-emission local building materials that are environmentally friendly and contribute to reducing negative environmental impacts, represented by local building materials (clay bricks, lime bricks, plaster, treated wood, natural wood), resistant to conditions and resistant to rot
	Internal Environmental Quality Index	Ventilation System		Natural Ventilation	Improving the internal environment by organizing horizontal and vertical ventilation channels in the facades using smart energy management systems, represented by the use of smart grid technologies with automatic control in lighting, air conditioning and ventilation systems, as well as installing sensors to monitor and analyze energy consumption in the building and improve its efficiency
				Industrial Ventilation	The use of central air conditioning systems and air heating systems that sense ozone levels in the treated air before distributing it in the building, the main entrances and exits of the building to detect any change in the levels of ozone circulating in the outside air, mechanical suction fans
		Lighting System	Natural Lighting	Glazing System	Single-layer glazing, avoiding double-layer and multi-layer glazing
				Slot Type	Windows and side openings, sunroof openings
Greening indicators				Insulate Windows	Insulating materials-foam, insulating frames for windows, dispensing and storm windows
			Industrial Lighting		LED System
					Programmed Lighting
			Mixed Lighting Chemical		Combining Natural Lighting and Artificial Lighting
		pollutants	Toxic Substances		Avoid toxic substances
					Avoid the use of volatile substances
			Noise		Use insulating materials such as fiberglass, rock wool or fiberglass, avoid crushers as they may damage heritage facades
	Energy indicator and casing	Thermal insulation	At the Cover Level		Walls - heritage walls built with thick (Jifqim) bricks
					Ceilings - adding insulating coatings to the roof (cold roof technology)
					The use of mosaic Kashi from natural quarries for paving floors
			At the Level of the Service System		Pipes made of reinforced plastic at the level of the water system
					Smart grids with automatic control of lighting, air conditioning and ventilation, sensors to monitor and analyze energy consumption in the building
		Renewable Energy			Generating electrical energy to power the building using solar cells on the roof to generate electricity
					Thermal power generation by installing thermal power systems to use thermal energy from sunlight to heat water or a building
	Waste Index				The use of recycling and modification of construction waste - In Iraq, there are many materials that can be exploited and recycled creatively in achieving the concept of green conservation within the museum. Among these materials: - The use of recycled glass in the production of many items such as display carts or display containers. Recycled paper in making posters, illustrations or even in artwork. The use of recycled plastic in some cases to produce accessories for display or small parts in projects. Utilize recycled metals to make frames or structures for display. The use of recycled wood in the creation of furniture that can be used inside the museum. The use of recycled rubber in some cases for the manufacture of carpets or other accessories. Redesign recycled clothing for use in art projects or casual fashion renovation. Recycling old electronic devices and using some parts in display technology projects. Converting damaged building materials into a mixture that can be used in maintenance work later
		Software			Energy Plus

Technologies	Smart Technologies		Power Simulation Software	Design Builder	Can be adopted in subsequent research to determine real percentages of results achieved
				Laser Scanning Digital Printing	(Excluded) because of the lack and absence of local experts in their use and high prices
			Information Modeling	HBIM	Building Management System - BMS, Water Mist Fire Detection System, Wireless Security Cameras
				IOT	Smart grids with automatic control of lighting, air conditioning and ventilation, sensors to monitor and analyze energy consumption in the building
		Smart Building Materials	Smart Insulation Material		Use fine emulsion acrylic and acrylic polymer primer paint the damaged surface for recovery
			Innovative Nanomaterial's	Airgel Amorphous Silica Gel	(Excluded) because it is not available locally and its high prices, and there are no local experts in its use
			Phase Change Material	PCM	
	Energy Conservation Techniques and the Use of Renewable Energies	Green Composite Building Materials			Local clay bricks available in the area to reduce costs, recycled sand, cement and aggregate), adding fly ash and recycled concrete to enhance sustainability properties, use of treated sustainable wood in wooden structures, floors, doors and windows
		Renewable Energy Technologies			Photovoltaic panels+solar heater Water and wind energy (excluded) because of its availability on the site, high prices, and lack of local experts in its use
		Building Casing Techniques	Insulating Material		Materials designed to whisk water away (excluded because not available locally)
			Cold Ceiling Technology		Insulating cladding on the outside (coating reinforced with insulating silicon polymers)
	Passive Techniques Activated	Active Ventilation Techniques			The use of natural ventilation, represented by the pedicure and the internal yard system, in addition to the windows and the mechanical ventilation system, represented by the low-energy Inverter air conditioning system supported by the ventilation system (VAV) to ventilate the interior spaces and protect them from moisture
				Effective techniques for Upgrading Domes Chimneys	(Excluded) because these items are not available within the building
		Activated Shading and Light Technologies		Sun Breakers Dual DSF Interfaces	(Excluded) because the project dispenses with it due to the presence of Shanashil and internal monsters and Alkhsafat and sorties in the details of the facades, and its impact on windows of heritage value
				Light-sensing Inner Courtyard Curtains & Light Sensors	Can be added in parts that are rich in heritage collectibles and artifacts to avoid the effect of bright and irreversible light in the long run
Results achieved	Conservation Results	Original Features of the Building	Formal and Aesthetic Features		Features that must be retained to contribute to the preservation of the historic character of the place include - moving away from modifying the shape of the building so that the original geometric shape of the museum remains undistorted. This includes the preservation of doors, windows and key geometric details. Retaining the original brick color of the building, as this color reflects the history and traditional character of the museum. Stay away from changing the external texture of the building. For example, maintaining roughness in areas with this property, and maintaining soft places in other areas
			Features of the Structural Structure		Increasing structural load-bearing and strengthening structural design and modernization of the sewage system
			Service Features		Modernizing the telecommunications infrastructure and other internet and communication services and adding modern services to the museum, to achieve many improvements and expected benefits: the addition of services such as an improved ventilation system and natural lighting can contribute to improving the comfort of visitors and making their experience more enjoyable. Increased energy efficiency: by using energy conservation and renewable energy technologies, energy consumption can be reduced and thus the museum's environmental impact can be reduced. Improving HVAC systems can lead to better thermal comfort and humidity control inside a building. Infrastructure improvement can include the use of environmentally friendly and recyclable building materials, contributing to durability and sustainability. The addition of modern security systems can improve the level of protection for the museum and cultural objects on display
	Precautionary Results	Environmental			The best ventilation as a result of opening the pedicure and the use of ozone sensors and the VAV system, the best lighting to use a system that provides LED lighting and glare control with sensors, natural lighting, thermal comfort, and the best insulation at the level of the building (walls - floors - surfaces) using insulating materials as well as cold roof technology Less pollution to avoid toxic and volatile substances and less noise because the heritage fish walls provide sound insulation
		Economic			Less operational cost but more construction cost (the cost of the greening process is higher than the cost of normal maintenance, but it lasts longer and provides operational capacity). Lowest energy consumption for PV panels+solar heater, energy-saving HAVC devices and LED lighting Lowest water consumption for plumbing systems and low water absorption plants and gray water system

Social	Interaction – The building's spaces have been further activated by taking advantage of interactive technology, diversifying events and programs, and continuous interaction with the local community. Belonging - The sense of belonging to the building has been increased by enhancing the original features and features as well as the adoption of a digital display of traditional Iraqi social life in the interior surfaces of the rehabilitated halls safety - Increasing the level of safety in the building through the introduction of an electronic monitoring system Communication – Communication has been improved by using social media to interact with the public and launch awareness campaigns and invitation to events. Organizing joint events with the community, providing platforms for expressing opinions and observations, launching a website that provides various information and services, and using modern communication technologies and applications. Functional activity - enhancing activities and events in the halls and building spaces through the introduction and control of digital technologies in the surfaces of the indoor and outdoor spaces