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Sustainable Functional Adaptation as an Integrated Preservation Strategy Approach for Heritage Buildings - Case Study: The Contemporary Museum in Babylon

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ABSTRACT

The functional adaptation of heritage buildings represents a pivotal strategy for preserving architectural heritage, and one of its most prominent applications is converting these buildings into museums. This study examines the challenge of striking a balance between heritage preservation and meeting the functional needs of contemporary museums. To address this problem, the study adopted a qualitative research methodology with a descriptive-analytical design, with three integrated stages: (1) analyzing the literature and international experiences to extract basic principles; (2) developing a multi-criteria evaluation framework (matrix) as a validated primary research tool; and (3) systematically applying this matrix to a specific case study (the contemporary museum in Babylon). The project achieved high ratings in the "Preservation of Physical Authenticity" and "Social and Cultural Integration" axes. It revealed significant functional deficiencies and low ratings in the "Efficiency of Visitor Movement" and "Flexibility of Exhibition Spaces" axes. The main contribution of this research is to provide two practical outcomes: a developed and validated assessment framework as a useful methodological tool for evaluating future projects, and a set of design strategies aimed at improving functional performance in functional adaptation projects with minimal impact on heritage values, providing practitioners and decision-makers with practical tools to make more informed and balanced design decisions.

1. INTRODUCTION

Heritage buildings, as living testaments to past eras, lifestyles, and cultures, are gaining increasing importance, necessitating their preservation and sustainability through reuse. Functional adaptation is a pivotal strategy in this context, as it provides these buildings with new functions commensurate with their potential and location, ensuring their continuity and contributing to their understanding by future generations, while ensuring that the new use does not conflict with their authenticity and architectural character.

International agreements, such as the Athens Charter [1], affirm the global responsibility to protect human heritage. However, these sites remain vulnerable to multiple threats, prompting specialists to seek policies that make their preservation economically and culturally viable. Functional adaptation stands out as one of these effective policies, as it contributes to transforming heritage buildings into vital and usable spaces, supports sustainable development by reducing the environmental and economic costs of urban expansion, and enhances their self-preservation potential [2].

Despite its benefits, functional adaptation, particularly when converting heritage buildings into museums, remains a complex and delicate process. These complexities stem from the fundamental problem of achieving a delicate balance between the need to preserve the building's inherent heritage values (physical, architectural, historical, aesthetic, and social) and the necessity of meeting the stringent functional and technical requirements of a contemporary museum. Failure to achieve this delicate balance can either distort the heritage building's identity and harm its value or result in a functionally impaired museum that fails to achieve its objectives effectively.

This problem is exacerbated by the urgent need for clear methodological frameworks and objective evaluation tools to comprehensively measure the success of such projects, as well as the need for proven design strategies that practitioners can leverage, particularly in local contexts that lack such tools. Therefore, this research seeks to address this problem, with the primary objectives of:

1) Evaluating the effectiveness and appropriateness of functional adaptation processes for heritage buildings converted into museums, focusing on the case of the contemporary museum as an applied study.
2) Developing a methodological framework for evaluating these processes.
3) Deriving and formulating effective design strategies that help achieve the desired balance between preservation and function.

2. THEORETICAL FRAMEWORK

2.1 Functional adaptation of heritage buildings as a sustainable strategy

Feilden [3] defined a heritage building as any structure that inspires a sense of wonder and prompts us to learn more about the people and culture that created it. It encompasses archaeological, architectural, historical, aesthetic, social, economic, and even spiritual, as well as political and symbolic values. It is also a symbol of cultural identity. Feilden [3] also set a 100-year designation period for a building to be considered historic. The great importance of heritage buildings stems from the collective values they hold, which collectively represent cultural identity.

They are living, tangible testaments to the region's history, reflecting the architectural styles, materials, and construction techniques of the era in which they were constructed. They also have economic value in stimulating tourism and attracting investment. They also represent an essential focus for community activities and promoting cultural exchange through cultural events, educational programs, exhibitions, and other activities [3-7].

All sustainable development models and proposals emphasize the importance of a balanced interaction between the site, residents, and visitors.

To meet the needs of all, a comprehensive approach is necessary, with maintenance, rehabilitation, and preservation efforts at its core (Figure 1) [8].

Figure 1. The main parties for interaction in the cultural tourism approach to historical areas [8]

Functional adaptation is the most sought-after measure in the management of architectural heritage. It is defined as the process of transforming an abandoned, old, or ineffective building into a new one that can be used for a different purpose [9]. This transformation can occur through conversion, adaptation, restoration, rehabilitation, or other means [10]. The ICOMOS Burra Charter also refers to "repurposing" as adapting a place to a new use [11].

It involves reusing a building with its existing structure to extend its lifespan while adapting it for a new function. It is the optimal solution that preserves the functional life of a historic building and prevents its deterioration [12]. Although repurposing old structures is not a new concept, it emerged in the twenty-first century, referring to the transformation of the function and use of these structures. Therefore, many of its definitions revolve around performance [13]. The approach to addressing additions, adaptations, and new construction has evolved from a cautious approach focused on respecting the historical character of the place to one that seeks to achieve harmony between design and modern materials without compromising the overall cohesion.

The focus has shifted from preserving the original function as much as possible. In the event of change, the new function must be compatible and, with minimal modification, contribute to the sustainable development of the area [14].

Preserving and reusing heritage buildings is often more sustainable than new construction, as it saves materials and energy. Reuse also contributes to the preservation of these buildings, thereby supporting environmental conservation [15]. The challenge in repurposing a building lies in adapting the function within the historic building structure, which has been prepared for another function. This new use must ensure economic efficiency and the building's integration with its environment and community aspirations. Community participation in heritage conservation takes multiple forms and levels, depending directly on their organizational structure, resources, the nature of the heritage project, and the legal frameworks regulating it [16].

Consequently, it becomes a strategy for ensuring the sustainability, revitalization, and continued effectiveness of historic buildings [12]. While adaptive repurposing recycles a building to achieve sustainability, it requires the flexibility to adapt sustainably to alter and reuse buildings [10].

Adaptation can only be sustainable if it meets all sustainability criteria. These criteria are not static and require continuous evaluation to improve the building reuse project. Djebbour and Biara's [12] study demonstrated a set of criteria, including the physical character of the building (form), the new use (function), the project's interaction with the community (society), its impact on the economic aspect (economy), its integration into its environment (environment), and the management of public decision-making to change the building's function as shown in Figure 2.

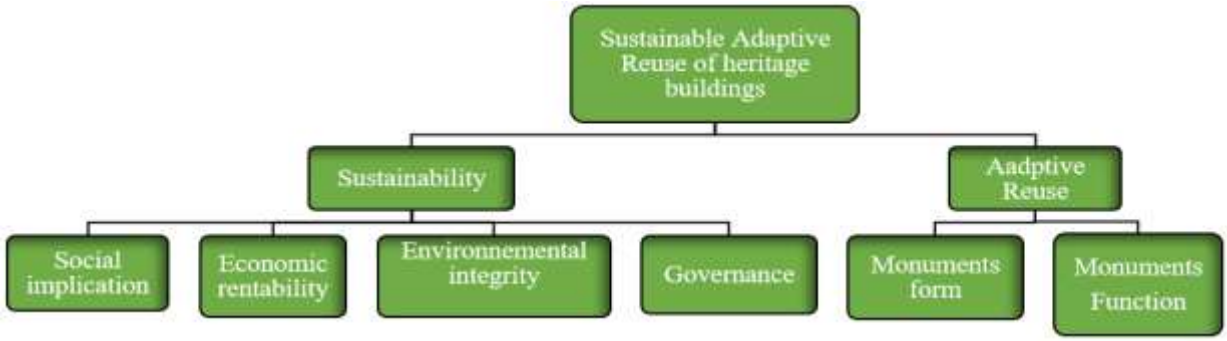

Figure 2. Concepts and dimensions of sustainable adaptive reuse of heritage buildings [12]

2.2 Principles of functional adaptation of historic buildings

Continued use is the best way to preserve heritage sites. The decision to repurpose a historic building is influenced by several key factors that must be evaluated [17].

Significance and value: Assessing the building's cultural and heritage significance and its value to the local community.

Sustainability and impact: The extent to which sustainable development criteria (economic, environmental, and social), life cycle assessment, and impact on the local economy are met.

Adaptability: Assessing the building's physical and structural capacity to accommodate new functions.

Stakeholders: Considering the views and perspectives of various stakeholders.

To achieve efficient and effective functional adaptation, the following principles can be guided [18]:

Significance: Carefully analyzing the heritage values and fabric of the building to identify essential elements.

Function: Selecting a new use that is consistent with the site's significance and requires minimal change.

Limitations of change: Determining the level and type of acceptable modifications that do not harm the values of the place.

Sustainability: Ensuring the building's resilience to potential future changes and its long-term preservation.

Relationship contextualization: Preserving the building's connection to its surrounding environment and protecting essential views.

Effective management: Ensuring sustainable management and sufficient resources for the site's ongoing conservation.

Interpretation: Demonstrating and interpreting the significance of heritage as an integral part of the adaptation project to connect the past with the present.

2.3 Methods for dealing with heritage buildings to restore their functional adaptation

Methods for adapting heritage buildings to their functional environment vary depending on the nature of the building and the proposed new function. In general, these methods can be classified according to the level of intervention they involve [19] into three main approaches, as shown in Figure 3.

Preservation with minimal intervention: This approach focuses on preserving the building in its original condition without significant modifications or additions, and is limited to restoration and reinforcement. It is appropriate in cases where:

- The original function continues (such as a place of worship).
- The building is used for a similar function that does not require spatial changes.
- The building is considered a tourist attraction of artistic or historical value, displayed as is.

Directed interior modification: This approach involves introducing deliberate changes, often concentrated within the building, to accommodate different functions. It includes:

- Reconfiguring the interior spaces (by adding or removing elements or re-dividing them) to suit the new functional requirements.
- Redesigning the interior space with a new vision, even if the original function remains or is similar to it.

Comprehensive development and continuous adaptation: This approach views the building as a cultural heritage that requires preservation while responding to developments and addressing its problems. It adopts a comprehensive approach to developing and adapting the building to ensure its continuity and vitality, and may include larger, planned interventions to ensure its continued vibrancy.

Figure 3. Dealing with heritage buildings to restore their functional adaptation [19]

2.4 Factors influencing the decision to adapt heritage buildings functionally

The success of the decision to repurpose a heritage building depends on a comprehensive analysis of several interrelated factors, as shown in Table 1 [20].

2.5 Museum design standards

The International Council of Museums (ICOM) stated that: "A museum is a permanent, non-profit institution in the service of society and its development, open to the public, which acquires, preserves, researches, transmits, and exhibits the tangible and intangible heritage of humanity and its environment for education, study, and enjoyment" [21].

Museum design primarily depends on the type of museum, the collection it houses, and its budget. Design treatments typically relate to a set of criteria that must be addressed, including visitor movement, space division, display style, and lighting [22], as in Table 2.

Table 1. Factors influencing function adaptation decisions [20]

Impact Factor	Interpretation of Factors
Actors	The role of stakeholders (users, producers, investors, and regulators).
Building and context characteristics	Understanding the Original function of the building. Understanding the Physical Character. Comprehensive assessment of building values. Needs of the district: Determine the extent to which the proposed new function aligns with the local context's needs to ensure project sustainability.
Conservation actions	Assessing the level and quality of necessary conservation and restoration interventions (from emergency measures to comprehensive restoration or even additions and modifications).
Adaptive reuse potentials	Analyzing the building's ability to accommodate new functions from multiple aspects (physical, economic, functional, environmental, social, cultural, political).
Proposed functional changes	Identify and evaluate new function alternatives, and select the most appropriate one for the nature and values of the building, ensuring its protection and sustainability.

Table 2. Museum design requirements, authors

Criteria	Design Processing
Visitor movement	Design clear, logical paths that prevent users from getting lost and allow for flexibility in viewing and navigating sequences.
Interior Design	Prefer large, flexible spaces that can be divided as needed, using dimensions, colors, and materials to stimulate the visitor experience.
Display Style	Place exhibits at appropriate levels and with suitable lighting, provide visual context for them, and focus the design on the most important pieces.
Lighting	Use a combination of ambient and focused lighting to accurately and attractively present exhibits, while achieving appropriate lighting balance and effective control (especially of artificial lighting).

3. INTERNATIONAL CASE STUDIES

3.1 Bayt al-Kritliya (Gayer-Anderson Museum)

Bayt al-Kritliya is considered one of the most important historical houses in Egypt. It consists of two houses dating back to the Ottoman era, specifically during the sixteenth and seventeenth centuries AD were combined into one. It is considered a unique example of Egyptian houses during the Ottoman era. The two houses suffered from the passage of time, and their condition deteriorated. During the expansion project around the Mosque of Ahmad Ibn Tulun in the 1930s, the two houses were nearly demolished due to their condition. However, the Committee for the Preservation of Arab Monuments restored and repaired the two houses, connecting them with a corridor. After that, the house became a standing example of Ottoman-era architecture. In 1942, the Egyptian government named the house the Jabir Anerson Museum, which is considered one of the most important museums and Islamic houses built during the Mamluk era.

Figure 4. Bayt al-Kritliya (Anderson Museum) – Cairo, the architectural elements of the building, the nature of the interior spaces, and the museum display style [19]

It is unique in its architectural distinction, as it contains features rarely found in Islamic architecture at that time, including the presence of a fountain inside the house, rather than inside a mosque or Islamic building, as was customary in Islamic architecture (Figure 4) [23].

3.1.1 Conservation strategies

After the completion of conservation work, the building was rehabilitated and converted into a museum and tourist attraction. The adaptation process focused on enhancing the building's efficiency and improving its functionality, with an emphasis on maximizing the efficient use of space and optimizing natural light. It is worth noting that the palace maintained its original design without any modifications or additions of new materials, while some essential services were provided in its annex buildings [24].

3.2 Castelvecchio Museum, Verona

This museum is a military stronghold of the Scaliger dynasty. The castle features Gothic architecture, built of red brick with distinctive M-shaped balconies. Despite its simple decoration, its square size gives it a powerful presence. Italian architect Carlo Scarpa oversaw a meticulous restoration and design process to transform the castle into a museum, which lasted from 1959 to 1973. An understanding of the material and compositional features of his intervention in the Castelvecchio Museum can be derived from visual analyses available from Huynh and Claire [25]. According to this descriptive documentation, Scarpa's unique style and meticulous attention to detail are evident throughout the museum, including the design of the artwork display units. The museum houses a rich and diverse collection, including paintings, sculptures, ancient weapons, ceramics, gold artifacts, and antique bells [25].

3.2.1 Preservation strategies

Carlo Scarpa's design concept/ Scarpa sought to create a

design dialogue that bridged the new with the old, based on a profound respect for the historical and artistic meanings of the existing structure. His passion for water was reflected in his thoughtful use of polished concrete and specific types of plaster on the ground floor, which mimicked its presence. A subtle rejection of repetition characterized his approach; every detail, from the window treatments to the carvings in the concrete forms, the wood panels, and the juxtaposed display of artworks, was unique and carefully considered (Figure 5) [26].

Key Strategies and Interventions/ Scarpa's interventions included convincing the museum administration to demolish Napoleonic-era additions (such as stairs and barracks), which led to the discovery of the castle's original moat. He carried out a comprehensive redesign of the central courtyard, including landscaping, pavements, and fountains, and added a new bridge. He completely reconfigured the ground floor to serve as a central exhibition space, integrating new elements such as display screens, windows, and doors within the historical fabric (Figure 6).

Figure 5. Castelvecchio Museum: The display method and the natural and artificial lighting system

Figure 6. Musée d'Orsay. The station's interior space and how it has been adapted to be a museum

Scarpa balances three approaches in redesigning the castle: his interpretation of the castle's history, highlighting the architectural value of its original components, and meeting the new requirements of the museum. This reflects his critical view that the new design offers a reinterpretation of the monument's value.

Three axes can be distinguished in Scarpa's approach to re-adapting the castle into a museum [26]:

First, there is the concept of balance and unity between the museum's new function and the type of existing building in which it is located.

Second, the idea of the uniqueness of each object requires individual thought and careful placement in a sequence.

Third, he ensured that the visit was a lively and stimulating experience for the visitor, dramatizing the connection between the object and the viewer.

Material Strategies/ Much of the castle's original materials were preserved, including Roman ruins dating back 600 years. Scarpa added thoughtful layers of stone, steel, and wood to the existing structures and facades, paying careful attention to the interconnections and details of the old and new materials and structures.

•Lighting and Environmental Strategies/ Environmental control strategies focused on protecting the artworks.

•Adjustable cotton curtains are used to block direct sunlight. Some works are also displayed outdoors. Natural ventilation was utilized throughout the museum, and the gallery layout and arrangement of objects facilitated air circulation.

3.3 Musée d'Orsay, Paris

The Musée d'Orsay is situated in the former Gare d'Orsay railway station in Paris (Figure 6). The station closed in 1939 due to its unsuitability for modern trains. After facing demolition in the 1970s and being temporarily used for art exhibitions, the decision was made to convert it into a museum due to its outstanding architectural value, large size, and Central location in Paris. These factors formed essential criteria for its preservation [27]. The building's importance lies in its status as an early example of buildings with exposed iron structures (although clad in Stone facades in the Parisian style of the time, in addition to its value as an important industrial and railway heritage.

The design team, architects Renaud Bardon, Pierre Colboc and Jean-Paul Phillipon, founders of the ACT Architecture office in 1972, followed a new philosophical approach to heritage called "Metamorphose de l'Objet Architectural" (Atelier Jean Paul Philippon), based on the concept of the continuous transformation of architecture, the legitimacy of reuse, and the creative dialogue between old and new.

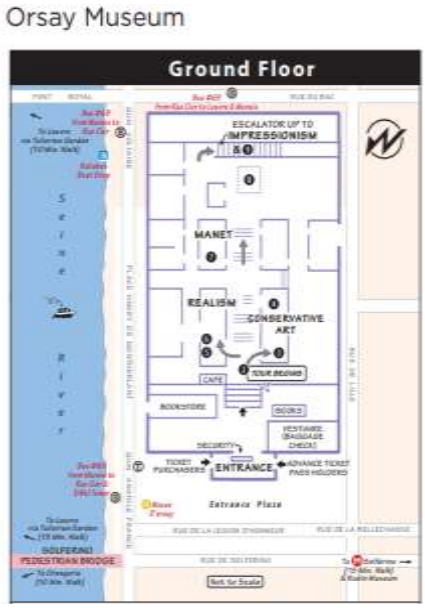

Figure 7. Musée d'Orsay - ground plan of the museum - shows the adaptation of the interior spaces for display

During the conversion, completed in 1986, the station's distinctive exterior facades and domed metal roof structure were preserved. The massive interior space was radically reconfigured, with three levels of galleries along the sides of the building. These levels open onto the vast central nave (137 m long and 40 m wide), which served as the central axis of circulation and display for large-scale sculptures.

A central ramp was designed to facilitate visitor movement between levels (Figure 7). Subsequent renovations (such as in 2011) reinforced the museum's role as a leading museum of 19th-century art. The project is a prime example of the successful adaptive reuse of industrial and heritage infrastructure, a trend also reflected in other projects in Paris, such as the conversion of a disused Railway bridge into the Promenade Plantée [27].

4. METHODOLOGY

The study adopts a qualitative research approach with a descriptive and analytical design. It is implemented through an integrated methodological process that aims first to develop a scientific evaluation tool and then apply it analytically to a specific local case study. The methodological procedures are summarized below:

To develop the evaluation tool, a comprehensive review of specialized academic literature was conducted, along with an analysis of the content of international documents and agreements, and reports issued by relevant organizations (such as UNESCO and ICCROM). A purposive sample was then selected from three leading international experiences in converting heritage buildings into museums. The selection was based on criteria related to the significance of the heritage building and the success of the experience, to extract effective performance indicators that form the basis of the evaluation matrix.

To evaluate the case study (the contemporary museum in Baylon), organized field visits, interviews with stakeholders (museum management, conservation experts in the museum, and the local community contributing to the museum), and analysis of project documents and plans were used to collect detailed data.

The matrix is applied to the case study through a quantitative assessment of each indicator. This assessment is supported by an in-depth qualitative analysis, based on evidence gathered from various research tools, to objectively interpret performance and identify strengths and challenges.

5. COMPARATIVE DISCUSSION OF INTERNATIONAL CASES

The three selected experiences present diverse and contrasting models in their approach to the functional adaptation of heritage buildings and their conversion into museums. Despite the differences in the historical, cultural, and architectural contexts of these buildings, common strategies and recurring challenges are revealed through their analysis. It also highlights different intervention philosophies in addressing the challenge of balancing preservation and functionality. The three international experiences demonstrate a diversity of methods for the functional adaptation of heritage buildings as museums.

Intervention philosophies range from a minimal-intervention conservation approach with a focus on restoration and visual authenticity to a critical dialogue between the old and the new through distinctive architectural interventions that add a new layer (Castelvecchio, led by Scarpa), to radical adaptation by introducing a new, independent functional structure within the historical shell (Orsay). Regarding space and function, two approaches stand out: the first prioritizes the preservation of original divisions, which may limit the flexibility of display and visitor flow as seen in Bayt al-Kritliya. The second approach takes more radical decisions to reconfigure the interior space to serve the museum's function more efficiently (Castelvecchio and Orsay), demonstrating a greater willingness to modify the original structure.

The integration of materials and technologies demonstrates a careful attention to the details of the confluence of new and old materials (Scarpa), or the pursuit of matching new materials to the original to maintain visual continuity. Sensitively integrating modern services remains a common challenge. Experiences also confirm the positive urban, social, and economic impact of these projects (area revitalization, identity enhancement, tourist attraction). In short, there is no single optimal strategy; the most appropriate approach depends on multiple factors (the nature of the building, the museum's requirements, the context, and the conservation philosophy). Approaches range from conservative preservation to bold interventions. The perennial challenge remains understanding the building's values, assessing its potential, making informed and justified intervention decisions, and striking a balance between preserving memory and meeting the demands of present and future use.

6. FUNCTION ADAPTATION STRATEGIES AS A MUSEUM

Based on the findings of previous models for adapting heritage buildings as museums, and to ensure the success of the functional adaptation process of heritage buildings as museums without compromising their original identity, effective design strategies can be adopted that strike a balance between the need to preserve historical and architectural values and fulfill the design requirements of museums, as shown in Table 3.

Table 3. Functional adaptation strategies for heritage buildings as museums (authors)

Strategy	Mechanisms
Conservation of Core Heritage Values	- Identify and understand the tangible and intangible elements of high value (architectural, historical, aesthetic, social) and prioritize their preservation. - Avoid substantial modification of the building's massing, facades, and distinctive architectural elements that constitute the building's identity. - Rehabilitate original materials and use compatible and reliable restoration techniques.

Considered Intervention & Legibility	- Adopt the principle of "minimal intervention" whenever possible. - Clearly distinguish new additions or modifications from the original fabric (without sharp visual conflict), using contemporary, compatible, and harmonious designs and materials (not imitations). - Ensure reversibility of interventions whenever possible, especially concerning interior fittings and display system.
Museum Functional Adaptation	- Achieving high efficiency in visitor circulation and flow, taking into account safety and accessibility requirements, and avoiding any negative impact on the original layout as much as possible. - Providing spatial flexibility in the design of internal exhibition spaces, using adjustable or removable display and partition systems to meet the changing needs of exhibitions. - Providing a suitable display environment in terms of lighting (precise control of natural and artificial lighting to protect exhibits and provide good visibility) and climatic conditions (temperature and humidity control). - Integrating necessary modern services (such as air conditioning, electricity, security systems, and communications) in an invisible manner or with the least possible visual impact on the historical fabric. - Utilizing the environmental advantages of the original building (such as natural lighting and ventilation) and enhancing them with sustainable technologies.
Sustainability & Context	- Ensuring the long-term economic viability of the project through efficient operation and visitor attraction. - Strengthening the relationship between the museum, its urban setting, and the local community (socio-cultural integration), so that the museum becomes a vital part of the social and cultural fabric. - Responding to and enhancing the urban or natural context surrounding the building.

7. DEVELOPING A FUNCTIONAL ADAPTATION ASSESSMENT MATRIX

Based on a theoretical framework derived from the literature and an analysis of international experiences, the primary tool for the study was developed: The "Functional Adaptation Assessment Matrix for Heritage Buildings." on two integrated tracks to ensure the content's validity and applicability: The first is theoretical grounding from the literature and approved international conventions, and the second is practical analysis of leading international experiences that transformed principles into observable strategies.

This matrix was designed as a multi-criteria assessment framework aimed at providing a scientific structure for analyzing and evaluating the performance of a local case study (the contemporary museum).

This matrix was presented to a panel of expert reviewers (an architect specializing in restoration, an academic in architectural conservation, and an expert in museum management).

Interviews were conducted with the experts, who were then given a detailed explanation of the matrix to assess its clarity, comprehensiveness, and relevance. Based on their feedback, the matrix was modified to reach its final form, which will be used in the case study evaluation.

To cover all dimensions of the functional adaptation process, the matrix was organized around five principal evaluation axes as shown in Table 4:

1) The heritage and architectural axis, which assesses the extent to which the building's original value is respected.

2) The functional and museum axis, which focuses on the building's efficiency in fulfilling its new role as a museum.

3) The environmental and technical sustainability axis, which addresses energy efficiency and material use.

4) The social and cultural axis, which measures the project's relationship with the local community and cultural identity.

5) The economic and administrative feasibility axis, which analyzes the project's long-term sustainability. Each of these axes comprises a set of measurable sub-indicators that enable a detailed and accurate evaluation.

Table 4. Matrix for evaluating the effectiveness and success of the functional adaptation process of heritage buildings as museums (authors)

Main Criteria	Secondary Criteria	Measurement Method
Architectural criteria	Preserving historical elements	Plan Analysis
	Balancing the original identity and the new modifications	Analysis of Visual Integration Between Old and New
	Continued use of original materials	Verification of the Use of Original and Replacement Materials
Functional criteria	Design compatibility with its surroundings	Analysis of Building Compatibility with Neighboring Buildings
	Efficient movement within the building	Visitor Flow Analysis
	Quality of internal exhibition spaces	Efficiency of Lighting, Acoustics, and Ventilation Distribution Within Spaces
	Design flexibility to meet museum requirements	The extent to Which Spaces Can Be Modified Without Damaging the Building
Cultural and social criteria	Visitor interaction with the museum	Accessibility of Audiences
	Project contribution to enhancing cultural identity	Analysis of Exhibit Content and Its Relevance to the Local Context
	Integrating the local community into the project	Percentage of Resident Participation in Events and Activities
Economic standards and sustainability	Economic viability through project revenues	Number of Visitors, Activities
	Use of sustainable materials and technologies	Percentage of Sustainable Material Use

8. APPLICATION: THE CONTEMPORARY MUSEUM IN BAYLON

8.1 Case study selection criteria

The contemporary museum project was selected as the main case study for this research based on a set of criteria, summarized as follows:

1) Heritage and tourism significance.

2) Embodying the research problem, as the project represents a vivid embodiment of the main research problem.

3) Significance as a local case study, as it is a pioneering project in the field of functional adaptation within the local context, allowing for the provision of applicable recommendations directly relevant to the local cultural and legislative context.

4) Field accessibility of the project, allowing for direct observation and documentation of the current situation, along with access to primary and secondary data, and conducting interviews with some of the project's stakeholders.

5) Richness of the case study: The adaptation project involved interaction between multiple entities (governmental, advisory, and local community), making it data-rich and multidimensional, thus serving as a suitable local model for applying the evaluation matrix developed in this research.

8.2 Characteristics of the contemporary museum

The Museum is located within the historical center of the city. It is surrounded by a group of administrative buildings (Figure 8). The building was constructed in 1926. It was inaugurated in 1935 as the administrative center during the royal era. It included the offices of the governorate, post office, tax office, police, treasury, and court. The building is characterized by its modern style, which contrasts with its urban context in the historical center, both in terms of its mass formation and layout, as well as the architectural elements used in its facades. The building is located on two floors and opens to the outside through rows of windows surrounded by horseshoe-shaped arches, distributed on both sides of the entrance. The designer employed the principle of symmetry for the two building sections around the axis of the entrance, which is within a prominent block on the building's facade. A horseshoe arch also centers it, but on a larger scale than the arches surrounding the windows.

Figure 8. The contemporary museum building in Babylon within the urban context

Two prominent shoulders are distributed on both sides to emphasize the centrality and definition of the entrance. Rectangular windows are interspersed between the shoulders, distributed over two floors. Despite the symmetrical repetition of the horseshoe arches, the design also features rectangular windows distributed across both floors. The facade is also interspersed with symmetrical shoulders, which also contain arches and windows in the same architectural style. This applies to the facade overlooking the Hilla River.

As for the facade overlooking the market, the architect adopted the same design principles, which include symmetry, repetition, shoulders, and arches, except that he also used pointed arches. As for the plan level, although the building contains an open internal courtyard, its design differs from the idea of the internal courtyard adopted in traditional buildings, and its function is limited only to providing lighting and ventilation for the internal facilities, as the rooms and halls of the building do not open onto this courtyard. It is only accessible from a secondary entrance located under the stairs, as shown in Figure 9.

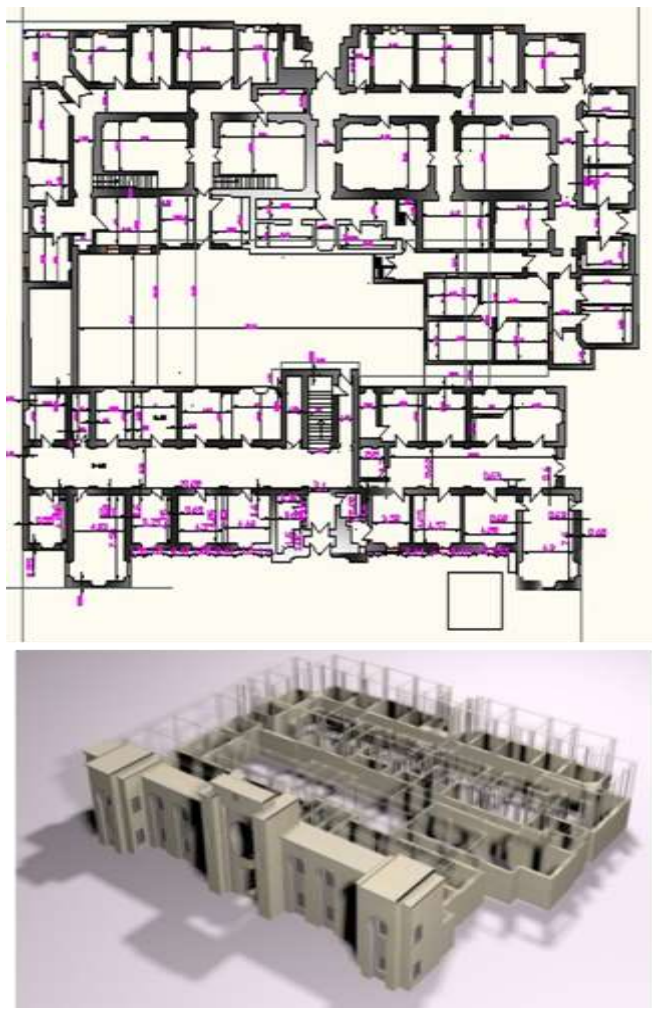

Figure 9. The contemporary museum in Babylon. The original plan of the building, with no modifications made to adapt it to the function of the museum

8.3 Declaring the building a national heritage site

Attention has been drawn to the destruction and multiple threats to Iraq's heritage. ICOMOS has emphasized the need to focus on rebuilding museums in Iraq and similar countries that have been subjected to deliberate vandalism and looting of their cultural heritage, to protect this heritage. It also calls for the repatriation of looted, stolen, and illegally exported

cultural property [21]. As part of national efforts to restore Iraq's cultural heritage to its former glory, following the wars and internal unrest that have ravaged its contemporary history, the building was designated a national heritage site, as stated in Statement No. 10 of 2010. This was followed by a letter from the General Secretariat of the Council of Ministers in the same year, transforming the Babylonian Treasury Building (the building's function at the time) into the contemporary museum. The statement above indicates that the building should be dedicated to Babylonian heritage in a manner consistent with its history and cultural heritage, and that its heritage status was declared in the Iraqi Gazette.

8.4 Functional adaptation

The building's original function included the departments of the Governorate, Post Office, Tax Authority, Police, Treasury, and the court. The building has undergone several transformations throughout its history, from its inception to the present day, occupying the following positions: Hilla District, Governorate, Babil Governorate, Hillah Court of First Instance, Babil Treasury Department, Babil Tax Department, National Insurance Company, Central District Governorate, Popular Medical Clinics Department, and the Contemporary Museum.

8.5 Sections of the museum

The museum contains a diverse collection of tangible and intangible heritage. It is divided into several sections, all dedicated to showcasing the local heritage of the city and its people. It features a display of handicrafts, the works of its scholars, and its creative individuals in various fields, including sports, arts, and other diverse disciplines. Some of the halls are named after scholars and thinkers, such as the Hall of Muhammad Mahdi al-Basir, the thinker, writer, and poet. This hall showcases his heritage, including clothing, books, poetry, and tools. Other halls also include the heritage of intellectuals from the city, as shown in Figure 8.

A wing is also dedicated to the martyrs of Hillah, who rose to defend the country from the evils of terrorism, which wreaked havoc and destroyed much of the national culture. It includes libraries containing various classifications of thinkers and writers from the city, who either donated them themselves or had their families donate them to the museum for public display, with an interest in scientific research (Figure 10).

Figure 10. Museum sections and collections, authors

8.6 Institutional performance and public engagement

The museum operates within a centralized governance structure affiliated with the local executive authority, as mandated by Iraqi Antiquities and Heritage Law No. 55 of 2002 and ratified international agreements. While public data show a seasonal and unstable pattern of attendance, this fluctuation, which is concentrated during academic activity seasons and subsides in the summer, reflects the extent to which climate or holidays impact attendance (Figure 11).

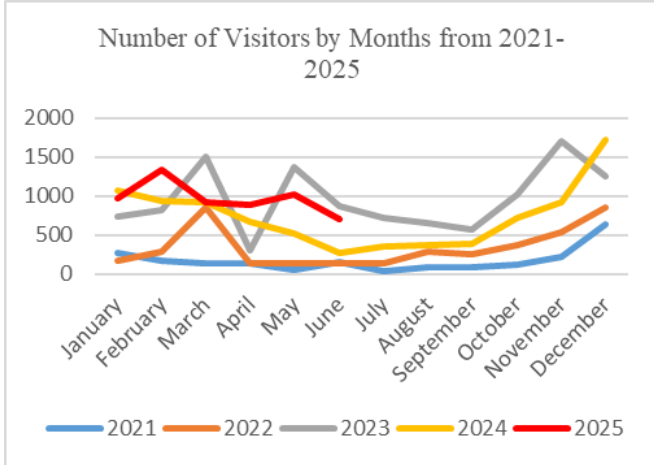

Figure 11. Visitors' numbers to the museum from 2021-2025

8.7 Community participation

The growing interest in the local community's role led UNESCO in 2007 to adopt the local community as a fifth strategic principle of the Convention for the Safeguarding of the Intangible Cultural Heritage [16]. The museum presents an innovative and pioneering model for participatory collection management, relying primarily on the initiatives of the Museum's Supporters and Friends.

The entrusted property mechanism, which enables private collections to be displayed while preserving their ownership by their owners, represents a practical economic solution for developing museum collections without financial burdens and strengthens ties with the local community.

8.8 Environmental performance

The building demonstrates inherent environmental efficiency stemming from its original design characteristics, utilizing traditional techniques (thick walls with high thermal inertia, high volumes, and small openings) to achieve an acceptable thermal comfort range, passively, for most of the year. However, its new function as a museum imposed modern technical requirements, creating a tension between the passive.

Environmental performance of the original building and the active needs of the new function. This tension is manifested in two points: the first is the inevitable need for mechanical air conditioning during the harsh summer months, and the second is the precise artificial lighting requirements for the museum's display, which resulted in visible electrical wiring that distorted the aesthetic value of the interior spaces.

9. APPLYING THE EVALUATION MATRIX TO THE CASE STUDY

The evaluation matrix will be applied to the case of the contemporary museum. Each indicator will be given a quantitative evaluation score organized on a three-tiered scale (high, medium, low), based on its consistency with evidence derived from field and documentary analysis. This will identify the project's strengths and weaknesses. The detailed results of this evaluation are presented in Table 5.

Table 5. Applying the evaluation matrix to the contemporary museum in Babylon (authors)

Main Criteria	Secondary Criteria	Measurement Method	Check Indicators	Evaluation	Feedback
Architectural criteria (Conservation of Core Heritage Values / Considered Intervention	Preserving historical elements	Plans analysis	The physical structure, facades, arches, and symmetry were preserved.	high	The building's original architectural identity and materials have been largely preserved, indicating a strong emphasis on physical preservation.
	Balancing the original identity and the new modifications	Analysis of Visual Integration Between Old and New	No significant changes or modifications were made.	high	
	Continued use of original materials	Verify the use of original materials with substitute materials	The original materials, such as brick, were continued to be used.	high	
	Design compatibility with its surroundings	On-site verification	Compatible	high	
Functional criteria (Functional suitability)	Efficient movement within the building	plans analysis, site verification	Narrow aisles can confuse and limit the viewing sequence	low	The original plan restrictions (narrow corridors) negatively impact the museum's function in terms of visitor movement and were not effectively addressed according to the assessment.
	Quality of internal exhibition spaces	On-site verification of the suitability of the lighting, acoustics, and ventilation distribution system within the spaces, according to the opinions of museum officials.	Conventional artificial lighting systems were used for the shows, and air conditioning was employed to maintain thermal comfort.	low	Electrical wires can distort ceilings and walls, which requires treating electrical supplies in a way that does not compromise the aesthetics of the interior space.
	Design flexibility to meet museum requirements	On-site verification of the presentation style and the possibility of modifying the distribution of spaces without damaging the building.	Limited flexibility	low	Relying on the original room division limits the flexibility of the display compared to open spaces, although it allows for thematic allocation of rooms.
	Integrating modern services with minimal visual impact	Check the service methods followed in the museum	Many services create a visual barrier with the display function.	low	The secondary ceilings that house mechanical and electrical services were treated in a visually disturbing manner.
Sustainability & Context (Cultural and social criteria)	Visitors' interaction with the museum	Audience attraction	Increasing influx annually	high	Local community interest in promoting and sustaining heritage.
	The project's contribution to strengthening cultural identity	Verify the content of the exhibits and their relevance to the local context.	The exhibits focused on local tangible and intangible heritage.	high	The museum has received wide support from the community and a participatory approach to displaying its heritage collections and properties.
	Integrating the local community into the project	Population participation rate in events and activities	Community participation through the Friends of the Museum concept.	high	Holding ongoing events, lectures, meetings, and seminars.
Economic criteria	Economic feasibility through project revenues	Number of visitors, checking community events and activities	The presence of indirect revenues (donations, events) and audience attraction.	medium	growing economic feasibility.
Environmental performance	Environmental benefits of the original building	plans analysis with on-site verification	Using local materials with low thermal conductivity, minimizing openings to the outside, increasing the ceiling height of interior	high	Relying on the original traditional treatments of the building to achieve the thermal comfort range.

			spaces, and increasing the wall thickness.		
	urban context	on-site inspection	The building overlooks the river and the market and is in harmony with its surroundings. The building is part of a former historic administrative center.	high	The building has a prime location overlooking the river and within an important historical context.

10. DISCUSSION OF THE RESULTS

The results of this study confirm that the success of functional adaptation projects for heritage buildings depends on managing a pivotal dialectic between authentic preservation and contemporary functional needs. The case study of the contemporary museum embodied this dilemma. The evaluation demonstrated remarkable success in preserving the building's material values and achieving effective social and cultural integration. However, it revealed significant functional shortcomings in the efficiency of visitor movement and the flexibility of exhibition spaces, indicating that the project's philosophy prioritized physical preservation over operational efficiency.

The ability to detect this subtle discrepancy between the remarkable success in preserving heritage values and the significant shortcomings in functional performance highlights the effectiveness of the multi-criteria evaluation framework developed. The matrix has proven to be an effective analytical tool capable of breaking down a complex project into its measurable components. Therefore, the usefulness of this tool extends beyond diagnosing the case of Babylon; it also serves as a practical validation of the proposed methodological framework, which is one of the primary research outcomes.

This provides a model that can be applied to objectively and comprehensively evaluate future projects. Consequently, this in-depth analysis directly leads to identifying two categories of strategies: the first, which has proven successful in the studied context, most notably "socio-cultural Integration" as a key factor in enhancing the overall value of the project.

The second category, driven by the recognized shortcomings, consists of "functional performance enhancement strategies," which involve drawing inspiration from innovative design solutions (such as the independent paths in the Castelvecchio experience) to incorporate modern requirements while minimizing disruption to authenticity.

11. CONCLUSIONS

The study provided an in-depth analysis of the process of functional adaptation of heritage buildings and their conversion into museums. This process lies at the intersection of architectural conservation, museum design, and urban sustainability. Based on a review of specialized literature, an analysis of diverse international experiences, and an applied evaluation of the case of the contemporary museum in Babylon, the following main conclusions can be drawn:

First: The imperative to balance preservation and function: The research results conclusively confirm that the essence of the success of functional adaptation projects for museums lies in the ability to achieve a delicate and thoughtful balance between two essentials, often conflicting, requirements: preserving the authenticity and intrinsic values of the heritage building, on the one hand, and meeting the functional, technical, and artistic needs of the contemporary museum, on the other. Neglecting either of these aspects inevitably leads to the project's failure, either through the loss of the building's identity and heritage value or the inability of the museum to perform its functions effectively and efficiently.

Second: The effectiveness of guided design strategies: The analysis demonstrated that adopting conscious and guided design strategies is a crucial factor in achieving the desired balance. A set of practical strategies has been identified and replicated in successful experiments.

Third: The importance of a comprehensive evaluation methodology: The development and application of a multi-criteria evaluation matrix represents a key contribution of this research, providing a systematic and scientific tool for comprehensively assessing the success of functional adaptation projects beyond purely aesthetic or functional aspects. Applying this matrix to the contemporary museum in Baylon case study demonstrated its usefulness in objectively and systematically identifying strengths (such as physical preservation and social integration) and weaknesses or challenges (such as efficient movement and space flexibility).

Fourth: Lessons learned from the case study (Contemporary Museum in Baylon): The Babylon Museum experience provides a realistic model that embodies the complexities of functional adaptation. While the project is recognized for its success in preserving the architectural character of the building and enhancing its social and cultural role in the city, it also highlights how the constraints imposed by the original historic structure can pose an ongoing challenge to the museum's function, particularly in terms of modern standards of operational efficiency and visitor experience. This highlights the importance of assessing a building's potential and functional limitations early on, before deciding to repurpose it.

Fifth: Emphasizing the sociocultural dimension: The study, both through the literature and the case study, demonstrated that the ultimate value of a functional adaptation project extends beyond its technical and architectural aspects. The ability of a repurposed building to integrate into community life, enhance cultural identity, and provide a space for interaction and learning is a vital dimension of long-term success and sustainability.

In conclusion, the research suggests that the functional adaptation of heritage buildings as museums is a viable and vital endeavor for sustaining built heritage and enriching urban life. However, it requires careful planning, a sensitive design vision, and a comprehensive assessment methodology. Future studies could apply the proposed assessment framework to a broader range of repurposed heritage buildings in Iraq to validate and develop its validity, and to explore innovative technical and design solutions that reconcile conservation with the increasing functional requirements of contemporary museums.

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