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Introducing a Conceptual Model for Assessing the Present State of Preservation in Heritage Buildings: Utilizing Building Adaptation as an Approach

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Abstract: Building adaptation comprises a variety of construction actions that enhance current condition and extend the life span of buildings. Architectural adaptation involves refurbishing, retrofitting, restoration, renovation, rehabilitation, adaptive reuse, material reuse, conservation, and preservation, as well as other activities to improve building conditions. In this study, the most relevant definitions, implementations, and ranges of the specified terminologies are examined; on the basis of this classification, a conceptual model is constructed to facilitate accurate categorization of building adaptations and its application in various case studies. The current state of heritage buildings in Erbil (the Erbil Citadel as a World Heritage Site and the buffer zone as cultural heritage) is evaluated. We aimed to investigate their current conservation status and determine whether the Erbil Citadel's heritage building adaptation has addressed the issue of energy retrofitting to realize green and passive construction. The results indicate that the framework model is an effective assessment tool in the field of conserving heritage buildings. The majority of Erbil's heritage buildings have been restored and rehabilitated for public interaction; nevertheless, additional interventions are required to improve the buildings' energy efficiency and conservation for this to be recognized as sustainable heritage development. In the future, academics and practitioners may use the suggested framework to clearly and consistently describe the scope of the work in their building adaptation, thereby eliminating the high costs of correcting code and specification requirements that were not met.

Keywords: adaptive reuse; building adaptation; building refurbishment; energy retrofitting; heritage building adaptation; sustainability

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1. Introduction

Sustainable development necessitates that the construction industry discovers a greener, resilient, and ecologically responsible alternative to the current state. Thus, there is an urgent need to explore and execute a sustainable growth strategy in this sector to change the current paradigm, which is characterized by high environmental degradation and resource consumption [1]. Sustainable development encompasses not only environmental but also economic, social, and cultural factors. Several studies have indicated that the protection of cultural heritage improves environmental, social, cultural, and economic sustainability [2].

A heritage building is a historically significant building that is legally protected by local legislations and international bodies such ICOMOS in association with UNESCO [3]. Heritage buildings are a valuable economic resource; thus, any adaptation effort must pay careful attention to the local context and community participation to ensure the sustainability of the buildings [4]. Preservation of historic structures contributes to sustainability by reducing the use of the material, decreasing waste disposal, and consuming less energy than demolition and reconstruction. Preserving and valuing the cultural heritage of buildings and monuments are social responsibilities that seek to preserve our ecology and natural resources for future generations [5].

Heritage buildings may provide feasible solutions toward sustainability for the building environment in the context of being compatible with the natural environment [6].

Heritage sites must be preserved to ensure that future generations can appreciate not only their structural and unique form but also their intrinsic value and that of the modifications or additions that have been made over time, thereby recognizing the profound stratified value of a society's historical identity and cultural development [7]. In recent years, abandoned historic buildings have been adapted for private or public purposes. Many cathedrals, old factories, and other antique structures in European city centers are being converted into museums, boutiques, and showrooms to promote public interaction in these buildings [8]. Erbil Citadel and its buffer zone are examples of heritage sites undergoing revitalization as a result of their inclusion in the UNESCO World Heritage List in July 2014. The inclusion of the Erbil Citadel on this list was preceded by several preservation and planning initiatives aiming to revitalize the citadel [9].

The architectural practices for historical buildings, which were designed and built several years ago, are likely to have limitations, particularly in terms of services and customer expectations that have changed and evolved over the last century. Nevertheless, historical buildings do not allow typical retrofitting interventions, owing to their special construction and architectural characteristics. Moreover, any interventions changes to these buildings may not improve the environmental impact or may cause the overall failure of the system [10]. Therefore, there is a need to assess the types of intervention standards and strategies that can be applied to historical and heritage structures to preserve their integrity while boosting their energy performance and environmental sustainability. Various safeguarding techniques, such as preservation, rehabilitation, retrofitting, restoration, or adaptation, can be used for buildings that have outlived their original purpose, depending on their historical significance, physical condition, projected uses, and required code standards.

World heritage sites face comprehensive and intricate conservation and administration challenges [6]. Many factors of deterioration impact the building's performance and quality after its life span, such as reduced environmental, social, operational, and economical performance [11]. An obsolescent building is frequently economically inefficient and inadequate for occupant satisfaction, provides poor living conditions, and increases energy and water consumption [12]. Building adaptations must be responsive, suitable, and timely to extend the effective life span of a building. Thus, building adaptation is a viable alternative to demolition and new construction due to its potential to provide major environmental, social, and economic benefits [13]. Compared to demolition and new construction, building adaptation can help reduce waste materials and carbon emissions, protect natural resources, improve energy usage, and preserve embodied energy. Moreover, adaptation projects may improve quality of life and thermal comfort, resulting in the occupant satisfaction and preserving the social and cultural characteristics of historical buildings [14]. The scope of building adaptation initiatives can be expansive and differs between projects. The variations in scope result from a number of factors, including building size and type, current conditions and adaptation demands, construction work carried out on these projects, and their intended future use and functions [15]. In the literature, several expressions are used to describe the extent of building adaptation projects such as adaptive reuse, energy retrofitting, refurbishment, reconstruction, material reuse, conservation, rehabilitation, and remodeling. Due to their overlapping scopes and a lack of clarity regarding their applications, these terms are frequently used interchangeably [14].

Architectural heritage is the most vital aspect of a nation's memory. Governments, particularly in developing countries, have understood this, and are compelled to act quickly to safeguard these buildings before they are permanently lost. They began to examine future plans and promote conservation efforts in their nations. In developing countries, decisions need to be made after thorough and efficient evaluations of the materials and technology employed to determine their influence on the building's value and safety.

UNESCO, along with the High Commission for the Revitalization of the Erbil Citadel (HCECR), has engaged in the process of revitalizing the Erbil Citadel and adapting it for public use and interaction under the framework of a European Union-funded initiative [16]. According to the World Heritage Convention, state parties need to regularly report the status of World Heritage sites that they are responsible for safeguarding [17]. Thus, this study can be utilized by the HCECR to report and indicate the current status and level of work of these heritage buildings. There is an important rationale for selecting the Erbil Citadel and its buffer zone, which is incorporated within the research implications. As part of the citadel's rehabilitation and revitalization, several historical buildings have undergone various forms of adaptation. We need a deeper understanding of the role of adaptation in the long-term sustainability of urban areas. Costs, resource usage, and carbon emissions may be decreased through the adaptive reuse of buildings, not to mention the social and economic advantages. The precise adaptation of heritage sites may improve community wellbeing by fostering a sense of belonging and social cohesion [18].

Therefore, this study provides an in-depth assessment of the type and level of adaptation procedures utilized for the Erbil Citadel and what is still needed, as well as comprehensive discussion of each form of intervention with its objectives; this is important because this is the first assessment of the Erbil Citadel and its buffer zone. Moreover, the study investigates whether the retrofitting strategies implemented to improve the energy efficiency of the building allow the building to be more compatible with its new functions and environmental conditions. The framework developed in this study can help academics and practitioners precisely and consistently describe building adaptation projects, thus eliminating the high expenses of confusing codes, specifications, and project descriptions by defining the terms clearly and consistently.

This study chooses the most frequently used phrases in adaptation projects and examines their meanings and classifies their benefits. After performing a literature review, the frequently used and applicable terms linked to building adaptation are selected. Each term is defined, and examples of typical approaches and their applications are provided. Using the Erbil Citadel as an example, we show the current status of building adaptation in Kurdistan by defining the meaning and extent of the interventions made in heritage buildings. Thus, this study establishes the form of adaptation that is most prevalent in adaption, followed by a determination of the building's extent of retrofitting. The objectives of this research are, first, to produce a conceptual model that will be used to determine the current status of the conservation of a heritage and historical building or site, as well as the level of interventions. Thus, we determine the new types of heritage building conservation based on their level and type of intervention. Second, the study investigates the current state of conservation of the buildings of Erbil Citadel as a world heritage site and proposes types of intervention that are required for such buildings to increase the adaptability and life span of the buildings. This study contributes to the literature because it uses historic building adaptation procedures to assess the current condition of a heritage building or site and determine what work remains for these constructions to meet modern public needs and be sustainable. There have been a number of publications that evaluate historic buildings; however, this study uses a World Heritage Site as a case study and introduces a novel assessment technique.

1.1. Literature

The Burra Charter states that adaptation may entail the addition of new services, usage, or changes to protect the area [19]. As per Douglas, adaptation includes any work on a building that exceeds routine maintenance to alter the building's capacity, function, or performance [14].

The scope of building adaption projects is extensive and varies according to the nature of the project and a variety of variables, including the type and size of the building, its existing condition and adaption needs, and all construction activities undertaken throughout these projects. According to a study [20], building adaptation initiatives are classified into two classes: refurbishment and adaptive reuse. Each category is further divided into renovation, rehabilitation, conversion, retrofitting, and material reuse, identified by their structural and nonstructural characteristics.

Douglas (2006) demonstrated that building adoption ranges from basic preservation to relatively complete reconstruction. Interventions such as refurbishment, rehabilitation, remodeling, renovation, retrofitting, and restoration are situated between these two extremes, roughly in ascending order [14]. Furthermore, the scales at which the extent of adaptation can be carried out vary among small-, medium-, and large-scale adaptations.

Another classification for building adaptation initiatives was introduced in the study by Shahi et al., (2020), derived from an extended literature review. The two categories established were refurbishment and adaptive reuse [20]. Each of these categories was divided into subcategories, which include several terminologies; refurbishment was divided into retrofitting, renovation, rehabilitation, restoration, and revitalization, whereas adaptive reuse included material reuse, conversion, transformation, modernization, and reconstruction. Furthermore, all subcategories were divided into two types according to their characteristics, as structural and nonstructural [20]. The term "building refurbishment" refers to enhancing the present status of a structure and improving it for its existing uses [21]. Retrofitting, renovation, and rehabilitation are subcategories of refurbishment. Meanwhile, adaptive reuse refers to the process of converting the function of a building into a new one, which includes reusing an existing structure and utilizing salvaged components from a building for a new function (i.e., reusing materials).

Adaptation of a building can be described as the process of altering its capacity, function, or performance, or making adjustments, reusing, or upgrading a building to accommodate new conditions or demands. [22].

Building adaptation was classified into three types according to the degree of intervention: small-scale, medium-scale, and large-scale adaptation. These categories depend on the scale of intervention, such as involved surface improvement, extensions in minor or major areas, or structural work. Large-scale adaptation includes reconstructing new buildings behind the existing external facades or walls. A further classification for the interventions included external interventions (e.g., new faces, edges, and building bridges) and internal interventions (e.g., consolidation, gate, plaza, and infill); each type of intervention has several functions applicable for heritage buildings [22].

Another study classified and sorted adaption terminology and classified the intervention in two categories [23]: maintenance and adaptation. Adaptation involves changes in the capacity, performance, or function of the building.

1.2. Definitions of Historical Building Adaptation Terminology from Literatures

This section examines the definition of each term, which can help to comprehend their nature and scope.

Conservation can be defined according to the Nara document as efforts aimed at comprehending cultural heritage, knowing its history and significance, protecting it physically, and, if necessary, presenting, restoring, and enhancing it [24,25].

Heritage building refurbishment is a complicated process that requires listing the main reasons and benefits for refurbishing the building and the problems that need to be solved. The building's risk assessment level must be conducted to find this. Changes in building physics, such as variations in air penetration rate, moisture load, and moisture content over the year, may increase the risk of the decomposition of organic materials and a few architectural features [26]. A review of the literature on refurbishment revealed that most of the research has focused on structural and physical changes to buildings while the buildings retain their previous function. Refurbishment is generally combined with structural retrofitting and energy retrofitting interventions; its goal is to elevate the building for better environmental performance while maintaining and preserving its distinct character [27,28].

According to Article 9 of the Venice Charter, restoration is an exceptionally specialized process. Its purpose is to maintain and highlight the aesthetic and historical significance of the monument, and it is founded on a respect for original materials and accurate records. Any further work that is essential must be separate from the architectural composition and exhibit a modern influence. Archaeological and historical research must be performed before and after the monument is repaired [29]. Several studies have investigated the scope and types of interventions in the restoration process [30].

Adaptive reuse prolongs the life span of historic, abandoned structures. It considers modern usage needs, sociocultural requirements, and environmental restrictions. Hence, adaptive reuse attempts to retain and make use of as many of the building's existing material and structure as possible while improving its economic, environmental, and social performance [31,32].

Adaptive reuse may restore historic structures to accessible and usable spaces while contributing to the sustainable regeneration of a region [33]. Numerous communities have recognized that repurposing historic structures is a critical component of regeneration efforts. However, several property developers and owners continue to view the reuse of historic structures as unfeasible due to the risk of planning and construction laws restricting their utilization [34]. Buildings with inadequate indoor environments may endanger not only the building's sustainability but also the wellbeing of the visitors and occupants. There has been extensive research on the microclimates within historic buildings and their effects on occupant health and possible interventions to enhance the energy efficiency and indoor air quality of these buildings [35].

2. Methodology

The first step was to create a definition framework based on an intensive literature study and a categorization to construct terminologies that aid in recognizing the different types of terms used in adaptation projects. The second step involved evaluating the selection criteria and deciding on the community and case study. Using the framework, the present state of conservation of the case studies was analyzed to develop new typologies depending on the level and degree of intervention. In-depth analysis and investigation of the current state of the Erbil Citadel was conducted using the framework model and using SPSS to find the correlation between the building's grade and architectural significance, as well as the level and extent of adaptation. Thus, a qualitative approach via the literature review was conducted while a quantitative approach was conducted using the framework as a checklist and then evaluating it using SPSS Figure 1.

The study relied on a search and evaluation of related journal articles, publications, and research conducted between 2010 and 2023. The following electronic databases were searched: Google Scholar, Elsevier, Emerald, Taylor & Francis, Sage, MDPI, IOP, and IEEE. Between the search phrases, logical Boolean operators were utilized to relate them to the topic. To ensure that the published materials and literature covered the issue of interest, they were evaluated for relevancy. They were then subjected to a comparison to determine the key differences among them, and the most noticeable patterns were identified (Table 1).

Table 1. Summary of literature reviews for the heritage building adaptation process and its initiatives.

Terms	Definitions	References	Scope
Conservation	Conservation usually aims to delay degradation, retaining a place's cultural significance. In some cases, conservation may not necessitate any action (article 14) [19,36]. This makes them useful for social purposes (article 5) [37].	[24,25,38–42]	Retention of function Retention of values and meanings Maintenance Interpretations Protection and management
Preservation	Preservation is appropriate when the building envelop, material, and its conditions have cultural value and they are insufficient (Article 17) [19]. This allows safeguarding the building in its current condition and preventing degradation.	[43–48]	Protection of the building fabric Not obscuring the history of the building through its construction techniques and original function

Table 1. *Cont.*

Terms	**Definitions**	**References**	**Scope**
Renovation	Renovation makes the heritage building operational by upgrading the building's mechanical systems, conducting minor repairs, and renovating the building's interior and exterior envelope.	[49–60]	Using new material
Restoration	Restoration is a highly skilled procedure aimed at preserving and exposing the historical and aesthetical relevance of a building (article 9) [37]. This must be respectful of the original materials and documentation. Any additions must differ from the existing architectural layout and have a modern character [37].	[30,61–71]	Restoration must precede and follow a historical and archaeological investigation of the building
Refurbishment	Refurbishment retains a comprehensive variety of historical evidence and safeguards the structures' current appearance and identity.	[27,28,72–83]	Includes the work for both interior and exterior Keeps the original function
Rehabilitation	Rehabilitation of a historic building recognizes the need for alterations or additions while conserving the site's historical integrity to support ongoing or changing functions. A property can be put to a compatible use through repairs, additions, and renovations as long as the areas or elements that communicate the property's historical, cultural, or aesthetic significance are preserved.	[78,84–89]	Usually combines energy retrofitting approaches and physical modifications to maintain and prepare the structure for usage
Energy retrofitting	Retrofitting is a procedure that entails the addition or updating of features or capabilities to an existing construction to increase the building energy usage and efficiency.	[50,90–98]	Includes improvement of envelop and systems, as well as the inclusion of renewable energy
Material reuse	Reusing and recycling materials is applicable to both building demolition and building adaption initiatives because they both result in waste production [99]. Reuse is defined as the partial repair or refurbishment of recovered materials in order to reuse them for multiple purposes [100].	[101–105]	The restored materials can be utilized for new uses if their condition is sufficient
Reconstruction	Reconstruction involves returning a building to a previously recognized state [19].	[106–108]	Adding new materials Replacing building envelop with new fabric [19] Only if appropriate evidence is available to recreate a previous state of the building
Maintenance	Maintenance includes continued preservation of a building and its setting, which essential for maintaining the structure, envelope, and moving components, such as equipment, fabric, landscapes, or any other objects, in excellent condition [19,109].	[110–113]	Constant building system maintenance to ensure the building's entire operation
Demolition	In some cases, limited destruction may be appropriate for conservation purposes. Significant material that has been removed should be restored where possible [19].	[114–116]	Its elimination improves the building's values and increases the safety
Adaptive reuse	Adaptive reuse involves adding new functions to existing heritage buildings to enable occupants of these buildings to adjust their expectations of contemporary living standards and to fit new uses and activities within the old structures [19,36].	[31–33,117–121]	Safeguarding the viability of a historic structure Addition of new spaces
Revitalization	Revitalization conveys new life into the heritage building context and improves the essential systems of the building such as sanitary systems, electrical systems, and structural reinforcement	[81,108,122,123]	
Transformation	Transformation inserts a contemporary function into the old building context.	[124,125]	Conveying interior changes
Conversion	If the existing use of a building does not fit the demands of its occupants or has been abandoned, the property may be appropriate for conversion.	[122,126–131]	Reducing wasteful consumption of resources Reducing the emissions of greenhouse gases Improving the living standard

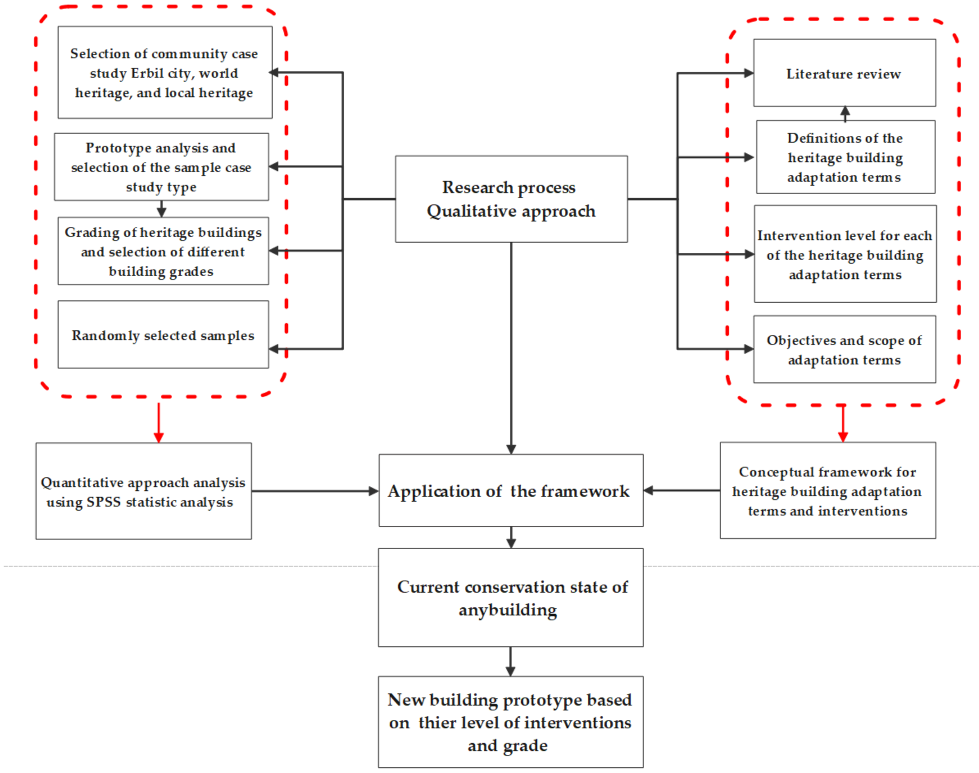

Figure 1. Workflow procedure of the study.

2.1. Conceptual Model

The findings of the literature review analysis and the classification of adaptation terminology were used to establish a framework to determine the current state of interventions in Kurdistan, Iraq.

This framework was used to assist in the identification of the types of terminologies engaged in adaption programs for the selected case studies in the Kurdistan area. This study classified building adaptation into four major categories: conservation, refurbishment, adaptive reuse, and demolition. Each of these could be subdivided into subcategories according to the scope of each procedure included and its interventions.

According to the nature of the intervention, building adaptation could be grouped into two main categories: physical and functional.

Physical adaptation. This applies to the building's physical condition without considering its function. Maintaining the physical condition of a structure with historical or architectural significance involves the consideration of criteria such as style, authenticity, and techniques used. Physical adaptation of the building refers to building refurbishment, which aims to maintain, repair, and upgrade the building. Revitalization, rehabilitation, renovation, restoration, and retrofitting may also belong to this category Figure 2.

Functional adaptation involves changing or modifying the building's uses or functions to comply with adaptability solutions; it can be expanded to include the entire structure and its components. Functional changes are labeled as adaptive reuse, which comprises the following terminology based on the scope and types of interventions involved: transformation, modernization, material reuse, conversion, and reconstruction.

The main aim of adaptive reuse is to fit historical buildings into new functions to be compatible with modern usage and their occupants' comfort; therefore, retrofitting strategies can be categorized into structural and energy retrofitting strategies.

Adaptive reuse is the practice of upgrading an old structure using environment-friendly technologies while retaining the structure's resources and historical significance. Retrofitting or adaptive reuse is a common strategy that contributes to the development of a contemporary, sustainable paradigm. A refit or adaptive reuse project involves adapting a building's architecture such that it may be utilized for an entirely different function.

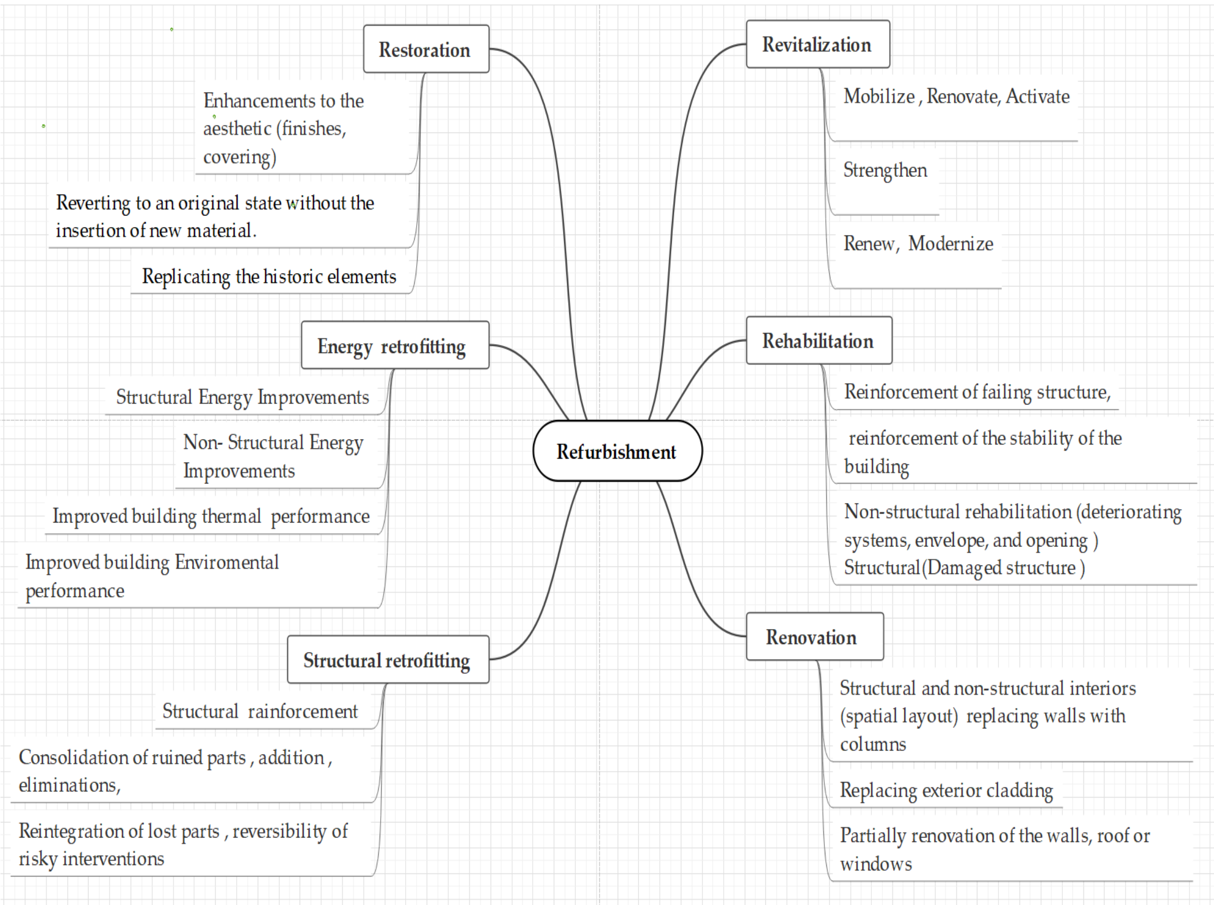

Figure 2. Building physical adaptation terminologies related to refurbishment.

Adaptive reuse must be seen through the lens of environmental sustainability if energy and structural retrofit initiatives are to fulfill the restoration criteria for historic buildings. Using the phrase "adaptive retrofit" emphasizes the objective of incorporating contemporary reuse and restoration innovations in architectural technology. Thus, adaptive retrofit interventions ensure that all interventions are reversible, that historical and architectural values are protected and preserved, that the buildings can be utilized in a variety of ways, and that the onsite performance of the structures is quantifiably updated [132].

Figure 3 shows a diagram of the functional change terminologies within the adaptive reuse topic and the subcategories within this type with their intervention character.

Previous research generally dealt with buildings physically or both physically and functionally, without considering buildings that have been refurbished without being structurally modified or that have not been under any type of adaptation intervention. As a result, two types of typologies were added to the framework, falling under buildings that have not been refurbished recently. As a result, these interventions could be divided into two types according to the current state of the building (preserved or demolished), and then further subcategorized, as shown in Figure 4.

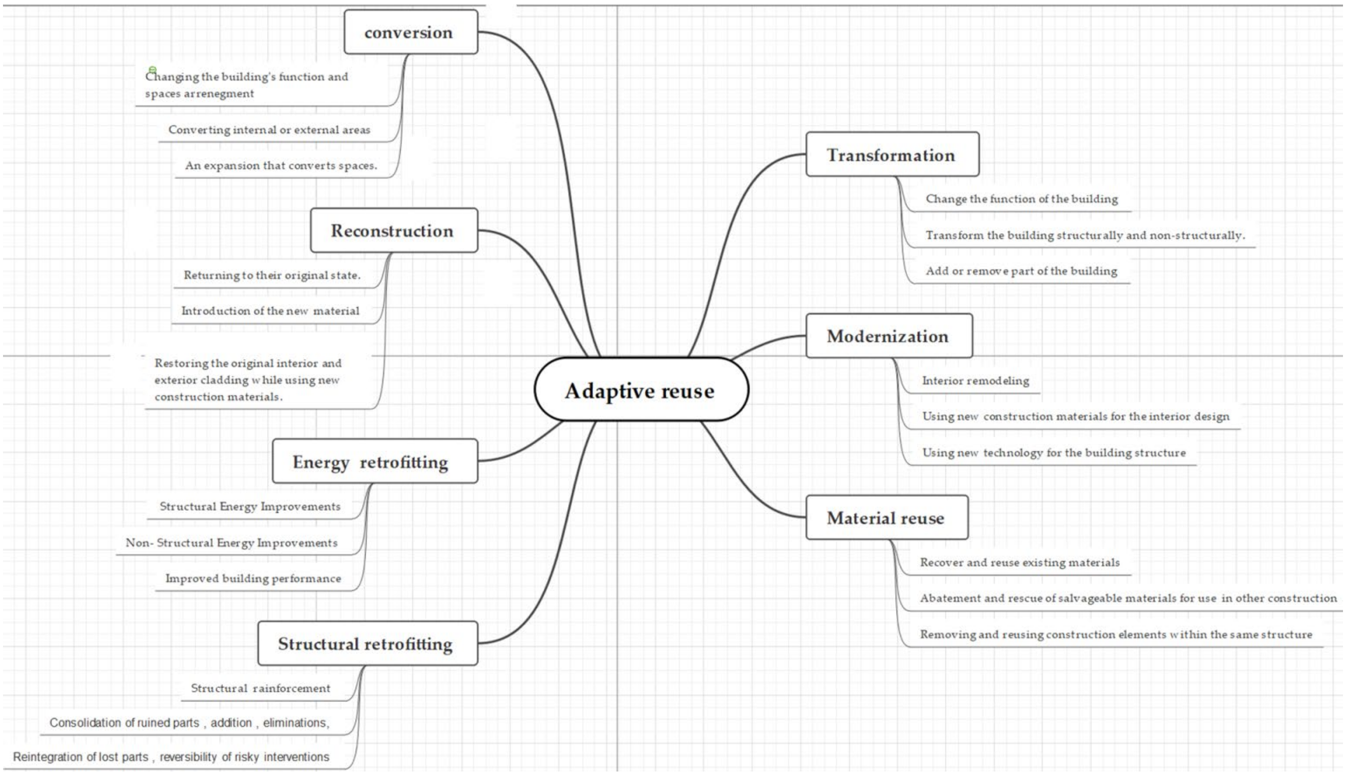

Figure 3. Functional adaptation terminologies related to adaptive reuse.

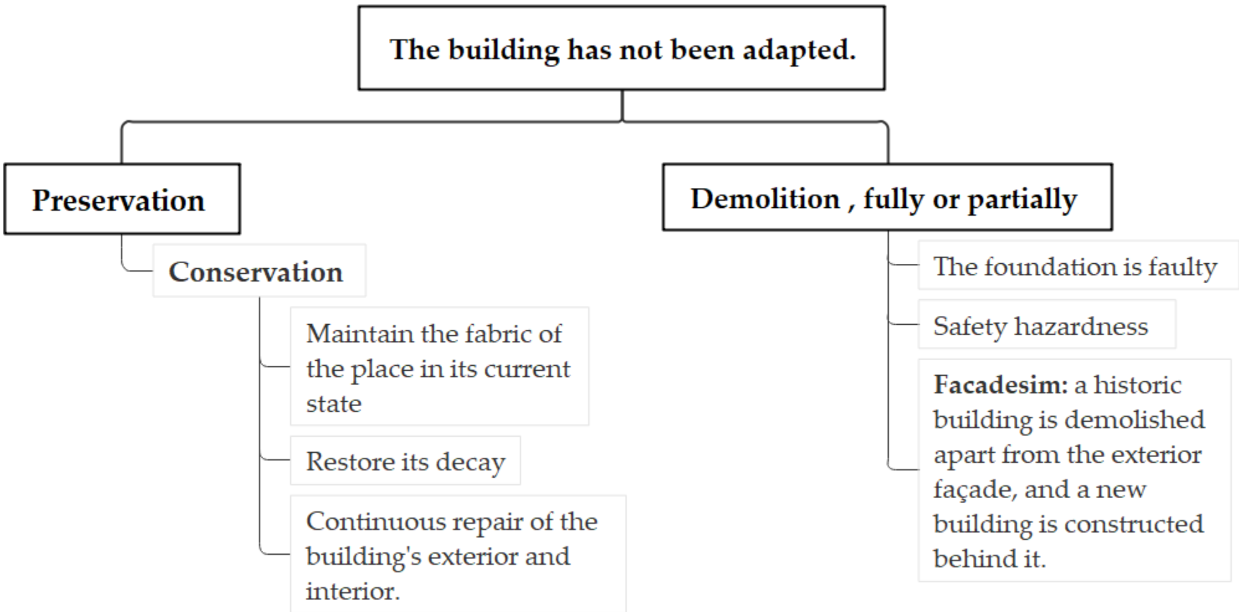

Figure 4. Breakdown of the building adaptation terminologies for a building that has not been recently refurbished.

Thus, the framework for the building adaptation categories was developed. The first concern was whether historical buildings had received any improvements (architectural, structural, or spatial). If not, the structure would be either preserved or demolished on the basis of its current condition and historical significance. Developed buildings were evaluated to determine any types of interventions, allowing for classification as adaptive reuse or building refurbishment. Each of these phrases could be further categorized according to the type and number of interventions. The steps needed to implement the framework are outlined in Figure 5.

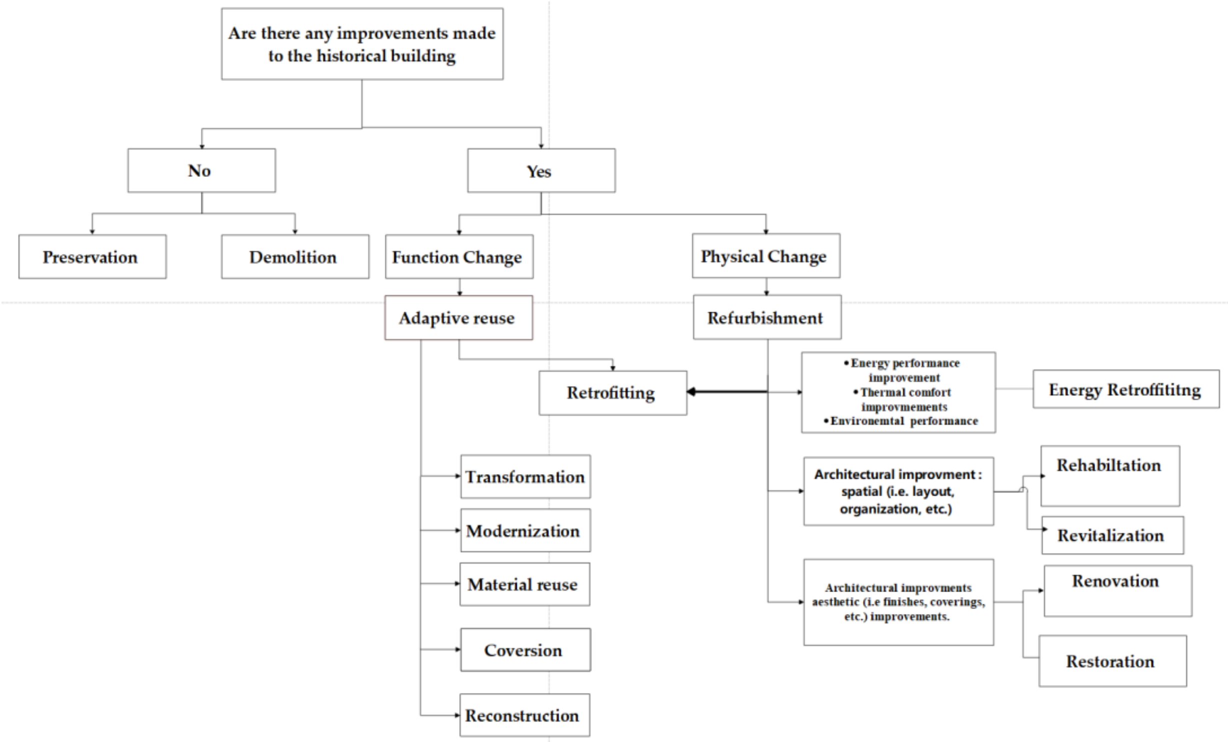

Figure 5. Theoretical model based on heritage building adaptation.

Each building was tested according to the above framework. Understanding the building's historical characteristics and heritage value is necessary to find the relationship between the building's heritage and historical value and the degree of intervention and amount of work it has received over time. As a result, in addition to the current or intended function of these heritage buildings, the framework included an assessment of their heritage value and grade. Therefore, the Table 2 depicts the final master sheet for the historic building preservation framework.

2.2. Erbil Citadel and the Buffer Zone

Only 330 out of 580 houses with cultural heritage value remain in the citadel today. There are 180 houses out of 330 that are in a state where they can be renovated, including 13 public buildings [133]. The remainder of the buildings have various levels of architectural significance and, to some extent, need careful consideration to repair and maintain the buildings. In various locations, the houses, public buildings, and urban areas have cultural components and demonstrate the inventiveness and skill of the local architectural tradition [9]. According to the conservation and restoration master plan, 97.5% of the buildings are in poor condition, whereas 2.5% have minor issues [134].

Table 2. Overall framework of the study.

Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8	Column 9	Column 10	Column 11	Column 12	Column 13
Scope	Conservation	Adaptive reuse Change in function	Adaptive reuse	Adaptive reuse	Adaptive reuse	Adaptive reuse	Refurbishment No function change	Refurbishment Repair	Refurbishment Building upgrading	Refurbishment Building efficiency	Refurbishment maintenance	Demolition
Terminology	Preservation	Transformation	Modernization	Material reuse	Conversion	Reconstruction	Revitalization	Rehabilitation	Renovation	Retrofitting	Restoration	Demolition
Objective 1	Maintain the fabric of the place in its current state	Change the function of the building	Interior remodeling	Recovery and reuse of existing materials	Changing the building's function	Returning to the original state	Mobilize, renovate, and activate	Reinforcement of the failing structure	Structural and nonstructural interior (spatial layout) replacing walls with columns	Nonstructural energy improvement	Enhancements to the aesthetic (finishes, covering)	Faulty foundation
Objective 2	Restore decay	Transform the building structurally and nonstructural	Using new construction materials for interior design	Abatement and rescue of salvageable materials for use in other construction	Converting internal or external areas	Introduction of the new material	Strengthen	Nonstructural rehabilitation (deteriorating systems, envelope, and opening)	Replacing exterior cladding	Structural energy improvements	Reverting to an original state without the insertion of new material	Safety hazards
Objective 3	Continuous repair of the building's exterior and interior	Add or remove part of the building	Using new technology for the building structure	Removing and reusing construction elements within the same structure	An expansion that converts spaces	Restoring the original interior and exterior cladding while using new construction materials	Renew and modernize	Structural (damaged structure)	Upgrading building systems	Improved building performance	Replicating the historic elements	Façadism: a historic structure is destroyed except for its outer facade, and a new structure is built behind it

Selection Criteria for the Case Studies in Erbil City

The houses in these areas provide a typical case for other similar heritage and historical buildings in the Kurdistan region. The historic heritage area of Erbil City consists mostly of residences with typical courtyards and a small number of public buildings. As houses are the largest prototype of historical buildings, the case study involved heritage houses with the following criteria:

- Most of the buildings with heritage value (no less than 100 years) [135].
- A building that has world or local heritage values; hence, the chosen caste study of the study was the Erbil Citadel as a world heritage site that has four different grades according to the HECER [136]
- A building with historical value (a place where a notable historical event took place or that belongs to a famous person or family) (Figure 6).
- The building's aesthetical and architectural significance.
- Availability of information and access to resources
- Different building heritage grades were selected. The building grades were set up by UNESCO in cooperation with HECER: grade 1, which denotes a very important building; grade 2, which signifies an important building; grade 3, a less important building. Selected case studies can be seen in (Figure 7).

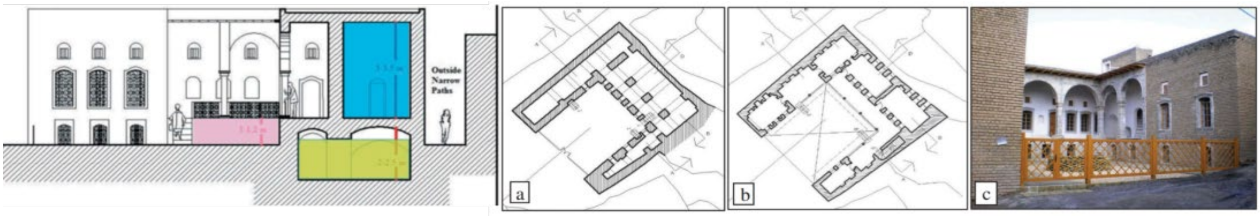

Figure 6. Detail of a heritage building in the citadel with historical value. (**a**) Basement floor plan. (**b**) Ground floor plan. (**c**) View of the building.

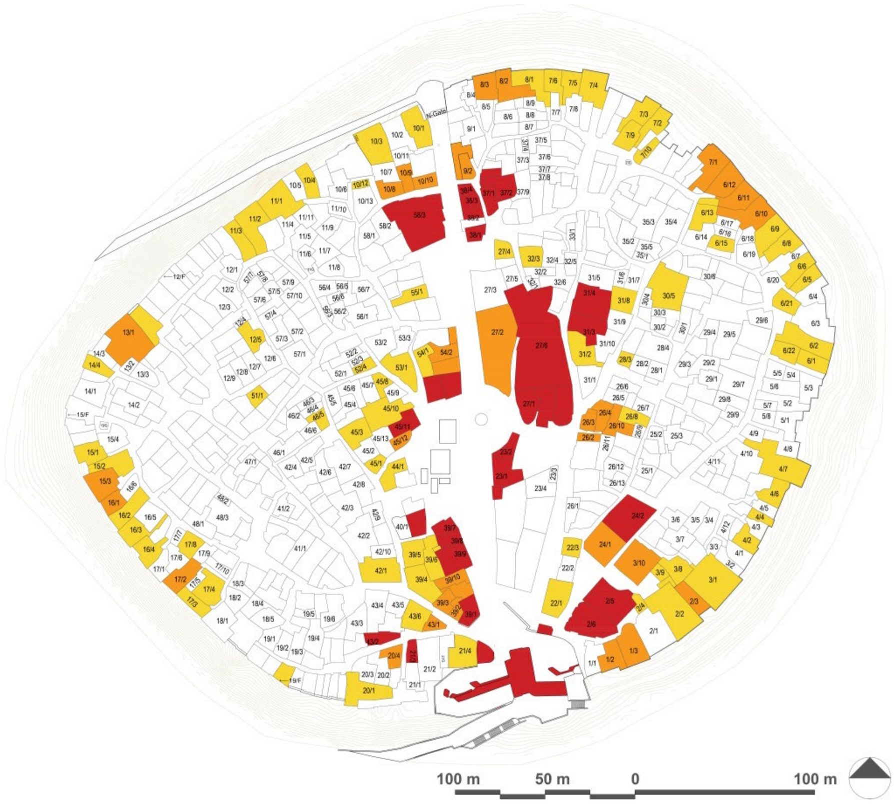

Figure 7. The selected case studies in the citadel.

2.3. Case Study Analysis

The case studies were chosen randomly from two areas, the Erbil Citadel and the buffer zone. The buildings were selected from the citadel according to the selection criteria with a different range of grades, architectural importance, and functions. Only a few buildings were selected from the buffer zone, and they were generally not renovated buildings.

The choice of building began with collecting general information about the building, such as its functions, UNESCO building grade, architectural significance determined by the HCECR, and building age, if available. The model was then used to investigate the case studies. The defining framework was confirmed by functional demonstrations in several cases of building adaptation. As an example, the scope of one of these case studies and the adaptation techniques examined during adaptation were thoroughly detailed, and the framework's applicability was proved by defining the adaptation terms engaged in the case study. Figure 8 summarizes the actions needed to use the framework.

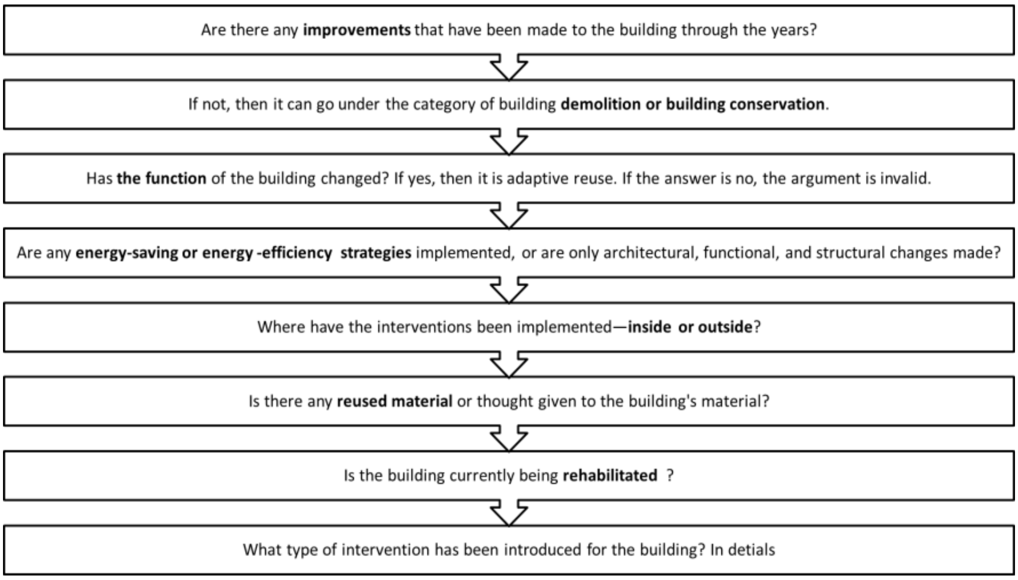

Figure 8. Steps for applying the developed definition framework to the case studies.

3. Results and Discussion

The selected cases were from different grades and had different architectural importance according to the criteria. Figure 9 shows the percentages of selected buildings, grades, and architectural significance, showing the rates of heritage building grades chosen for the research survey. All grade 1 buildings in the citadel were selected for the survey, representing 24% of the selected buildings. These buildings were going through an adaptation process before being opened for public interaction. Nearly 30% of the selected buildings were grade 2, having all been adapted at some point in time. The most significant selected buildings that were adapted were grade 3 buildings, because UNESCO had studied them, and, in partnership with the HCECR, they were reopened for public and tourist use.

The architectural significance of a building was evaluated according to the following points:

- Its architectural and historic interest
- The aesthetic qualities and interest of its design and character
- Its archaeological importance
- The fabric and materials used to build it
- The furnishings—identifying the age, rarity, and quality of internal furnishings and fittings
- Its physical characteristic, including its external composition and internal plan form
- Its spatial qualities and ornamental schemes

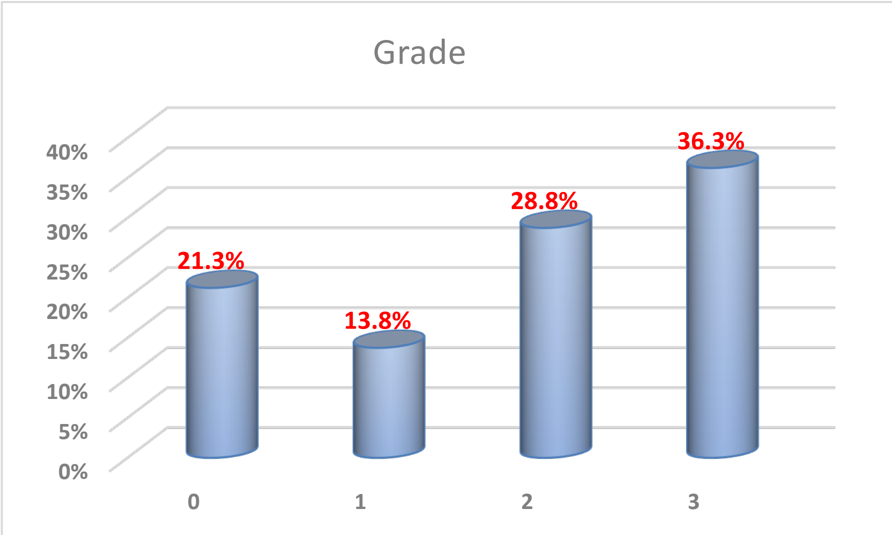

Figure 9. Percentages of selected adapted buildings according to their grade.

A score of 3 indicates that the building is of great architectural importance, a score of 2 indicates moderate importance, and a score of 1 indicates low importance. The study showed that the majority of grade 1 buildings had great importance due to their high level of originality, the uniqueness of their building materials and components, and their spatial layout (Figure 1). However, the most significant factor was the strategic position and size of these structures because they were generally located in the district of Sarai and belonged to individuals with considerable political and social status. According to Figure 10, more than 57% of the selected buildings had moderate architectural importance, whereas 42% had high architectural importance. These buildings could be found in different areas around the citadel. Most of the buildings within the grade categories had poor architectural value, and only 37% had moderate architectural value. Shack buildings were of very low importance; they tended to deteriorate because of poor construction quality, and they received the least number of interventions because they had no heritage or architectural value.

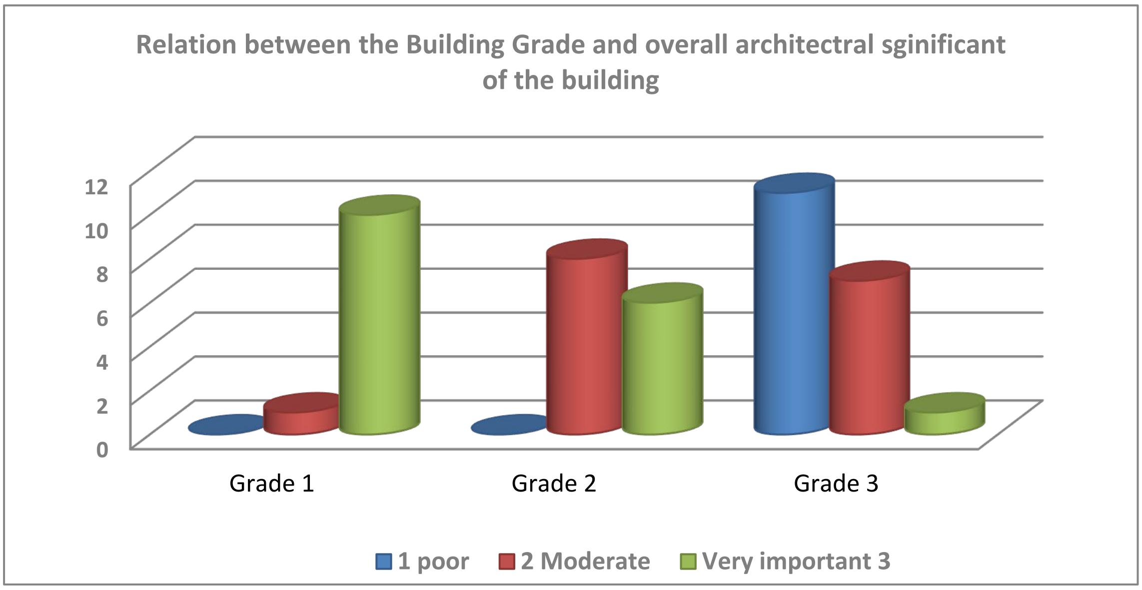

Figure 10. Relation between the building grade and overall architectural significance of buildings.

3.1. Type and Frequency of Interventions in Heritage Buildings

The most frequent intervention introduced to the Erbil Citadel houses was restoration—more than 57.5% of the buildings have been restored (Figure 11). Restoration intervention is categorized under the structural and physical category; thus, the restored building does not necessarily adapt to new functions as most of these buildings are unhabituated or unoccupied. Restoration includes the enhancements of aesthetics (finishes and covers of building façades and interiors, reverting the building to its original state, or replicating historical elements). An example is provided of the Shihab Chalabi house with collaboration between the IFPO (French Institute of the Middle East) and the HCECR (Figure 12).

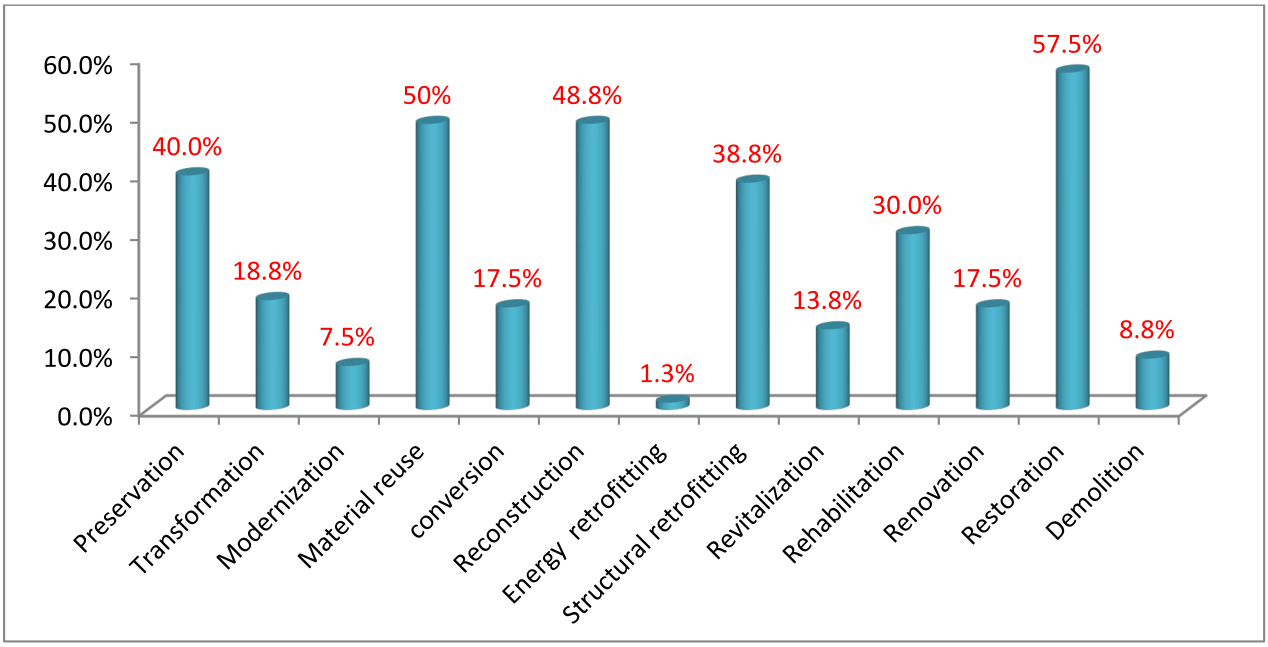

Figure 11. Percentages of adaptation projects in the Erbil Citadel and the buffer zone.

Figure 12. Renovation of Shihab Chalabi house [137].

Restoration is typically accompanied by material reuse interventions, as shown in the preceding example, which is the second most common practice in refurbished buildings with a frequency of 50%. Material reuse involves the use of the original material, if available, or a new material that has the same physical appearance or material properties as the original material. However, many structural problems appeared in buildings owing to inefficient material reuse and restoration interventions; the example in Figure 13 shows the Rashid Agah House.

Figure 13. Structure in the façades of Rashid Agah House (photos taken by authors).

Reconstruction was the third most common intervention employed in the citadel buildings, accounting for approximately 49% of the total. The majority of reconstruction entailed partial reconstruction of the collapsed portions of buildings or structures. The majority of the reconstructed structures were grade 2 and 3 structures. While structural retrofitting was often employed for grade 1 structures, it was only employed when there is no threat of risk. The objective of structural retrofitting is to reinforce and repair a structure to meet current seismic design regulations. The structural retrofitting of historic structures may attempt to restore and/or reinforce the building's components. When the purpose is to restore the load-bearing ability to build elements, a repair is performed, whereas strengthening enhances the load-bearing capacity. Material variations between the past and the present cause several hurdles for engineers. In contrast to the traditional usage of lime and mud mortar as binding materials for stone façades and structural components, retrofit methods for modern structures involve the use of cement-based plaster, mortar, concrete, and plaster. Due to the insufficient use of new materials and how the original structure was repaired, these buildings have witnessed several negative effects such as structural cracks, collapse, and subsidence (Figure 14). Further examples of houses that have been reconstructed and had structural retrofitting are provided in Figure 15.

Figure 14. Diagnosis of the defaults and cracks in the ceilings and envelop after the refurbishment process by author.

The investigation of the negative effects of the structures indicates that the majority of problems were caused by the use of inadequate or new materials that are incompatible with the original materials and inappropriate structural technologies. Thus, structural retrofitting allows transitions that may be required within a building to reduce any irregularities within the structure, as well as strengthening and mass reduction of the structure along with base isolation for seismic safety. It aims to improve the structural behavior of the buildings following the building codes and helps preserve the historic structure.

Figure 15. Examples of house renovation and restoration in the citadel [136].

Only 30% of the identified historical and heritage buildings in the Erbil Citadel have been rehabilitated, mostly within categories 1 and 2, which are notably those with architectural significance. Some of the rehabilitated buildings embraced the UNESCO- and HCERCE-proposed transformation and conversion into new purposes, such as museums, art galleries, and advertising offices. To be suitable for their intended use, these transformed buildings were required to modify the spatial organization of their spaces and interior partitions, regardless of grade. The majority of the rehabilitated buildings have been transformed (19%), converted (17.5%), and renovated (17.5%).

Figure 11 clearly shows that energy retrofitting was the least common adaptation technique in adapted or refurbished buildings. Only 2% of the buildings have undergone some retrofitting intervention to make them more comfortable for occupants, such as active system improvements with mechanical ventilation. However, most of the original passive cooling technologies were demolished or shut down, and they do not work anymore.

3.2. Building Grade and the Adaptation Process

Grade 1 buildings have very high architectural value with high historical significance owing to the history and position of their owners and their strategic locations; they are designated focal points for tourists in the proposed master plan by the HCERC. Eleven buildings were chosen for this category; all of them were partly preserved and maintained to boost the degree of authenticity. All structures in this category need immediate physical and functional intervention to restore them and reduce or even eliminate damage. Six of these buildings have been adaptively reused for various purposes, primarily for tourists (culture centers, different sorts of museums, interpretation centers, and art and craft centers), along with one for mixed residential use (a motel). However, adaptive interventions were pervasive; more than half of the buildings have undergone reconstruction and material reuse, while a handful have undertaken structural retrofitting and transformation and conversion. No building has received extensive energy retrofitting intervention; all grade 1 buildings have received refurbishment with the following interventions: restoration and renovation to improve their aesthetics (finishes or coverings) and restore some missing parts in the original building's finish and structure. Five buildings have been rehabilitated and are ready for usage following the master plan.

In terms of energy performance and thermal comfort, however, none of the structures have undergone retrofitting. In addition, the structures have been mistreated by occupants misusing and destroying some vital components, such as windows, basement windows, and air catchers, which were utilized to provide passive cooling, resulting in high summer temperatures and poor indoor air quality.

Secondly, 23 grade 2 houses were selected randomly; most of these houses had a high to moderate architectural significance. The functions of these buildings were primarily oriented toward tourism, including cultural and art museums; only three of them had the potential to be used for residential purposes. Grade 2 buildings had generally moderate architectural significance, and they were buildings with good building conditions. Grade 3 buildings were located in different places around the citadel and had poor or moderate architectural value.

Table 3 indicates that the building grade and its architectural significance are strongly correlated with the level and degree of intervention. It can be seen that grade and architectural significance have a positive relation with overall intervention; however, architectural significance has a significant relationship with the overall adaptation interventions.

Table 3. Correlation between the overall architectural significance assessment of the building and adaptation intervention level and frequency.

		Grade	**Overall Architecture Significance Assessment**	**Adaptation Interventions**		
Grade	**Pearson Correlation**	–				
			N	80		
Overall architecture significance assessment	Pearson correlation	0.184	–			
			Sig. (2-tailed)	0.103		
			N	80	80	
Overall	Pearson correlation	0.256 *	0.605 **	–		
			Sig. (2-tailed)	0.022	0.000	
			N	80	80	80

* The correlation is significant at the 0.05 level (two-tailed). ** The correlation is significant at the 0.01 level (two-tailed).

However, the building grade had an impact on the degree and type of intervention (Figure 16). Grade 1 received the highest number of interventions due to their architectural significance. Grade 2 received the second-highest intervention. The lower grade had less importance and, thus, received fewer interventions (Figure 16). Irrespective of the type of intervention, which varied by grade, grade 2 received more adaptive reuse interventions than other grade buildings in relation to the degree of refurbishment.

Most of the grade 1 heritage buildings in the Erbil Citadel have undergone functional and physical changes to prepare them for the function proposed by UNESCO and HECER. Most grade 1 heritage buildings with a high architectural value have been reused for new functions, while other grades have been reused, refurbished, or preserved to varying degrees.

To summarize, different types of interventions and measures have been applied to these heritage houses, which can generally be divided into two types.

The first type comprises physical preservation procedures. These processes are intended to preserve, enhance, and promote the architectural, physical, and structural quality of the citadel's buildings and structures (1) to ensure the stability of the buildings, (2) to increase the durability of the building and prevent degradation due to external conditions, and (3) to restore the exterior of the building and use the interior elements as a museum that conveys the history of these traditional buildings and how they were used.

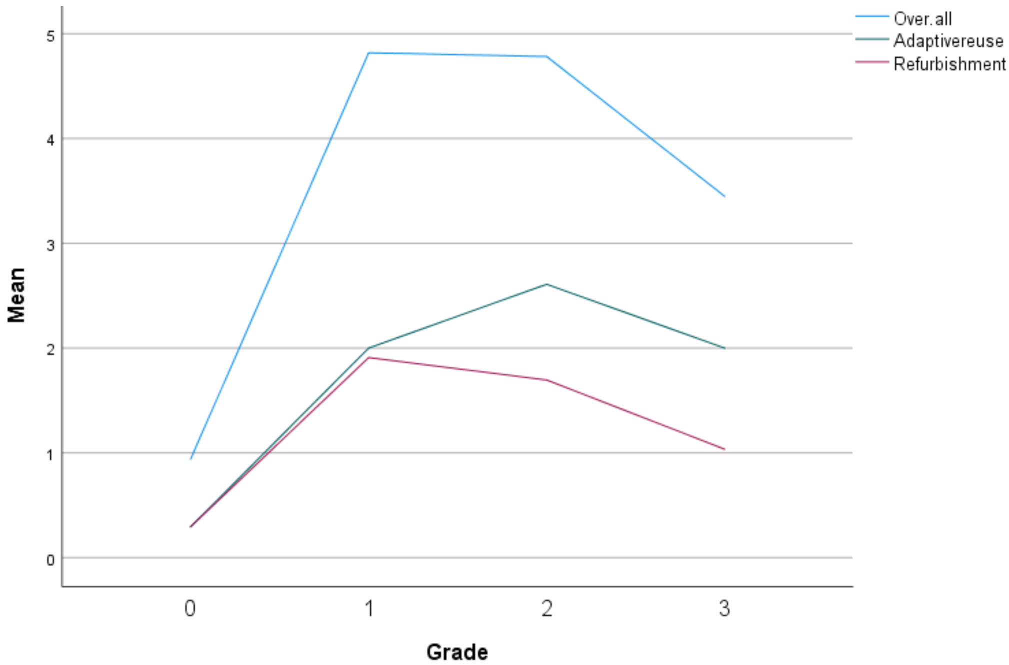

Figure 16. Correlation between the building grade and types of interventions it has received.

The second type comprises the adaptive reuse process, including initiatives such as modernization, material reuse, conversion, and reconstruction, which transform the function of the private dwellings into public buildings that require interior modifications. Hence, they alter the building's structural and nonstructural components.

Lastly, nearly 90% of the adopted buildings in the Erbil Citadel have not undergone any treatments to improve their environmental performance or activate a passive cooling system to enhance performance, air quality, or occupant satisfaction. Retrofitting strategies in historic buildings are required to assess the influence of retrofit interventions on these significant structures and investigate whether these strategies may contribute to the physical preservation and adaptive reuse of these structures within a sustainable framework.

3.3. Developing Building Typologies Depending on the Most Frequant Combination of the Adaptation Intiatives

By grouping buildings according to their adaptation scope and terminologies, a new typology was developed for heritage buildings (Figure 17). For each case study, this new typology can be used by researchers, conservationists, institutions, and organizations that deal with heritage and historical building preservation practices. This typology can be used as a base for researchers and organizations to determine the required interventions and retrofitting strategies based on the building's situation.

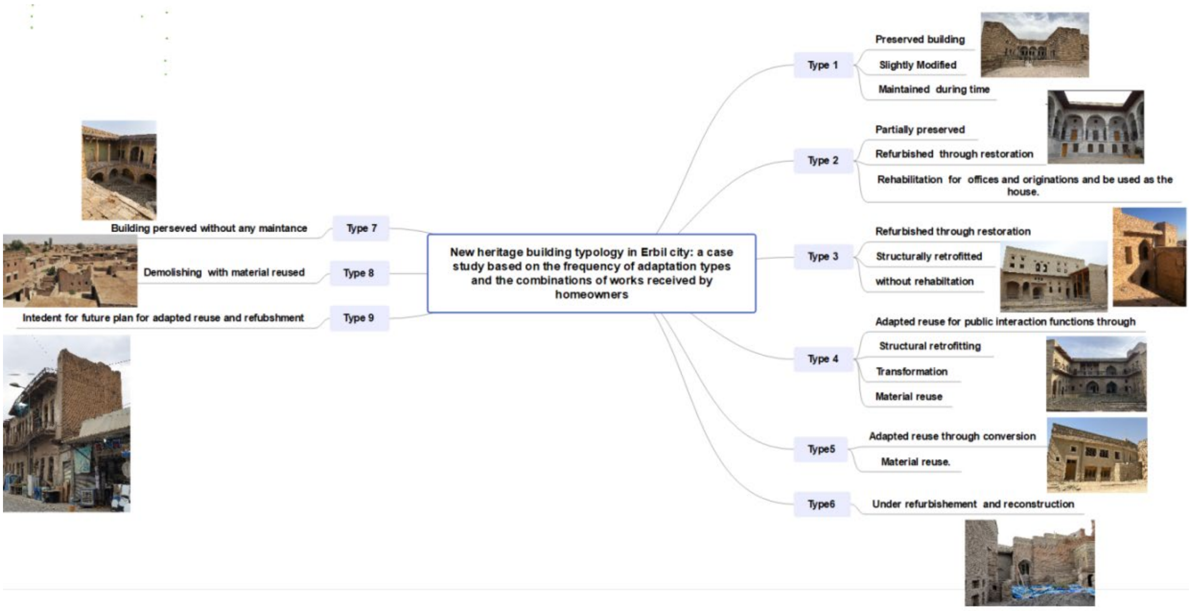

Figure 17. Prototype developed by heritage building adaptation applications in Erbil City.

4. Conclusions

Mediated through historic buildings, the historic environment around us creates a sense of local identity. Thus, these structures are a unique resource. Once lost, they cannot be replaced. By nature, these structures are sustainable. Many components of older buildings were constructed with sustainability in mind, considering factors such as climate and site conditions. These historic structures can serve present and future generations for a long time into the future if they are conserved appropriately [138]. Adaptation of historical buildings is vital to the prosperity of historic cities. A wide range of building adaptation options can reactivate a historic building's participation in the socioeconomic life of the neighborhood [138]. The scope of adaptation is broad and relies on the scale and intent of the proposed building modification.

The process of adapting historical buildings is frequently influenced by a variety of factors, including occupant change, environmental requirements, need for accessibility, increase or decrease in income or social status, variations in the household organization, differing housing requirements, improvements in technology (e.g., heating, cooling, and plumbing), periodic replacement and repair of degraded or deteriorated fabric, and fashion.

The suggested definition framework, as established by the case studies in this article, may be used to clearly describe the scope of the project by responding to a few basic questions. We anticipate that research in this sector will continue to develop according to the exponential rise in the literature on building adaptation initiatives over the past decades. Future studies can make this definition framework a helpful reference point, while future researchers will need to examine these terminologies to guarantee consistency with the potentially altered scope of future projects. On the basis of a survey and quantitative analysis of the buildings, new prototypes for heritage building were investigated depending on the frequency and prevalent interventions used.

The analysis of the conservation state of heritage buildings in Erbil Citadel indicated that most of the buildings underwent a restoration process (57% of the total houses), while nearly 50% were structurally refurbished. Moreover, the materials were reused in 50% of the buildings. Different types of interventions and measures were applied to these heritage houses at different levels, which could be divided into two types: physical preservation procedures that improve the structural and architectural quality of the building, and adaptive reuse procedures that enhance the interior and exterior of the building to be ready for modern use. However, most of the buildings have not undergone any intervention to improve the energy efficiency and energy-saving retrofits. In the same house, passive cooling techniques that were previously used have been prevented from working. Therefore, there is a crucial need for an investigation of the possible energy efficiency and energy-saving interventions that can be applied in these heritage buildings to be further improved as green and more resilient buildings with cultural value.

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