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Functions and Activities as a Catalyst for Successful Sustainable Adaptive Reuse of Heritage Areas: A Study of the Religious Center of Karbala City, Iraq

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ABSTRACT

One of the most significant cities in the Islamic world in terms of history, culture, and religion is Karbala. The distinctive heritage buildings and cultural sites can be found throughout its urban fabric and it attracts many pilgrims annually. The approach for achieving this goal is sustainable adaptive reuse, or the reuse of existing structures for new purposes. Sustainable adaptive reuse success is connected with various factors including social, economic, and environmental, while positing that the purposefully intended function and activity will drive urban sustainability. However, quantifying the performance of these functions and activities has been difficult, given fluctuating user numbers and a dearth of standardized sustainability standards for existing use. To fill this gap, this study describes the functions and activities in the study area, in particular heritage buildings. Three primary indicators were employed to assess these functions: changes in land use, heritage space usage and building function. Data were collected and analyzed through a GIS based analysis, quantitative methods, and field surveys of heritage areas. Results show a level of functional performance that was satisfactory for the study area, and was due to the alignment of existing uses with the city's religious events. While these findings are positive, the study highlighted areas where improvement is needed including in the planning for land use and the management of functions and activities within heritage areas.

1. INTRODUCTION

An efficient and advantageous strategy for protecting urban history and raising city dwellers' standards of living is the idea of sustainable adaptive reuse. It is a continual process that aims to achieve contentment with the current structural fabric. This originates from the fact that urban areas are treated with great interest in order to make the greatest use of each section of this area to meet the intended goals of society on the one hand and ensure the sustainability of these areas on the other. Sustainable adaptive reuse is not limited to heritage conservation, but rather works to revitalize the region to meet social, economic and environmental requirements, as this adaptation provides great flexibility to perform activities to achieve sustainability.

The research is significant because it opens up new possibilities for residence, commercial and cultural activities, as well as its positive impact on urban construction by reducing the use of spaces. Adaptive reuse projects can strengthen links between communities by providing basic needs for living and modern coexistence activities to ensure that urban areas and buildings of historical and cultural value reach future generations.

This research contains two sections. The first section covered the theoretical concepts of adaptive reuse, the most important of which is the factor of functions and activities, on which this research will focus. The second part is an application of the indicators of the factor of functions and activities in the study area chosen by the researcher, which is the historical center of the City of Karbala. In addition, this research mentions some proposals for heritage and cultural areas to be more community-oriented and in a way that suits their current structure and the surrounding fabric.

The significance of activities and functions in attaining the sustainable adaptive use of urban heritage has been underlined in numerous research. To evaluate the possibility of adaptive reuse of pre-war heritage shop houses for sustainable urban development, for instance, Abdullah et al. [1] suggest a set of criteria (economic, environmental, social, architectural, technological, and legislative). Kıran Çakır et al. [2] examine the challenges and opportunities of adapting open spaces within historic buildings to new uses, with a view to balancing function and preserving the heritage value of the building.

A multi-criteria analysis was performed on the case study of Certosa di Pisa in Calci (Tuscany), a former Karthusian monastery that is now a publicly owned museum center, according to Amato et al. [3]. Three scenarios in which new functions were introduced with the goal of paying the expenses of restoration and maintenance were identified through a SWOT analysis based on the information acquired from the literature and the participation of key stakeholders.

Broniewicz et al. [4] came up with criteria for evaluating the

adaptive reuse of existing buildings, with a focus on sustainability and economic efficiency. Criteria include technical, economic, social, spatial and environmental factors. The authors conducted a survey to verify the relevance of these standards among practitioners involved in adaptive reuse projects.

Kee et al. [5] examined the economic impact of different types of jobs and activities on adaptive reuse projects. They concluded that business and tourism activities can generate significant revenues and contribute to local economic development. However, they also cautioned that these activities must be carefully managed to avoid congestion and negative impacts on the heritage site.

Recent research evidence on heritage area functions and activities has focused on a range of perspectives: community, built environment, economic benefits and environmental sustainability. More research is needed to examine the link between employment, activism and urban sustainability. In order to obtain the best success for the sustainable adaptive reuse of urban heritage, the study focuses specifically on the indications of the functional component. As a result, the research poses the questions: What are the markers of the activities and functions of adaptive reuse initiatives that are sustainable? How much does the success of sustainable adaptive reuse of urban heritage depend on the factors of functions and activities? Determining the indicators of functions and activities that impact cultural sites' sustainability and guarantee their optimal usage is what makes the research so important. In addition to enhancing the characteristics of urban areas, emergence of urban activities and uses.

2. SUSTAINABLE ADAPTIVE REUSE CONCEPT

Since it extends a building's lifespan, prevents demolition, and promotes the reuse of the energy that buildings contain, adaptive reuse of buildings is a type of sustainable urban regeneration. In European cities, historic residential structures are frequently renovated to become office buildings. In addition, Wilkinson et al. [6] define it as a significant alteration to the structure that involves changes to the building itself as well as the purpose it serves. It is described by the authors Rodrigues and Freire [7] as a process that develops existing, structurally sound places for new, valuable uses, while Shen and Langston [8] defined adaptive reuse as a way to breathe new life into existing areas and buildings by leaving the basic structure and fabric of the building unchanged and changing its use. Adaptive reuse is also described by Schmidt et al. [9] as a building's capacity to efficiently satisfy the changing needs of its environment, hence optimizing value over time. The ability to modify a building's built environment to meet the changing needs of its occupants is known as adaptability.

Peterson [10] explained in his book the difference between reuse, adaptive reuse and recycling, as he showed that traditional reuse, where the building is used again for the same function, and adaptive reuse, where it is used for a different function.

2.1 Sustainability of built heritage

Sustainable development is a top priority for both contemporary societies and academic institutions. The concept focuses on the need for society to grant the same opportunities and choices that the current generation has for future generations. Because cities are constantly changing, the principle of controllability and adaptability embodied in the sustainable development model can only be achieved by preserving existing infrastructure. Thus, the necessary physical and environmental inputs must be provided and the appropriate model was applied to create a variety of jobs in urban areas. Adaptive reuse of urban historic buildings is a method that can provide a solution to this. Rather than letting old buildings deteriorate, offering an incomplete note of the history of urban settlements and leaving an unused heritage, these buildings can become part of modern city life by fully integrating with contemporary activities [11].

Effective adaptive reuse is accordingly a careful negotiation of heritage value and contemporary architectural quality; the best projects respect and sustain heritage significance while adding new layers of architecture that speak to value for the future [12, 13].

First, the new use shall not only have imperceptible effects on the significance of the building and its heritage context (Home Secretary's Standards for Rehabilitation, 2006), second, any alteration to a significant fabric needs a compatible and contemporary meaning capable of adding values which may be usable for future generations; third, that such new uses will enhance the place spirit; finally, this should do its duty in preserving culturally important features of an existing building [14]. Overall, the ultimate goal of preserving heritage buildings is not to preserve materials for their own sake, but rather to preserve the values that this heritage embodies [15].

Relying on the previous studies, it is possible to sum up the factors of sustainable adaptive reuse with social, economic, environmental, urban and functional factors, and the focus will be on the factor of functions and activities in heritage areas.

3. EXPERIENCES IN SUSTINABLE ADAPTIVE REUSE OF HERITAGE AREAS

3.1 Artilleristallet in Gothenburg, Sweden

The idea behind using the adaptive reuse to revive unused areas and create prosperous social places, as the success of the project is due to the preservation of historical and personal features and the sense of place in the Artilleristallet area.

To preserve its local features, the city keeps the city center's elevation consistent. The City Museum of Gothenburg identifies and provides knowledge about cultural and historical values in the planning process and the City of Gothenburg implements a conservation program to care for and preserve valuable built spaces and buildings. The city's vision for future development is based on preserving and promoting cultural and historical values for the city's attractiveness and sustainability. Preserving cultural and historical values contributes to socially sustainable development and improves the well-being of citizens through the development of inclusive and usable public spaces that enhance cultural value and strengthen local identity.

Artilleristallet has been successfully transformed from an untapped area into a thriving environment social. Adaptive reuse and revitalization were key factors in the success of the project. The project has created a mix of residential, commercial and cultural spaces that meet the needs of a wide range of users and is designed to be sustainable and environmentally friendly. The quality of the place is determined by the value and quality of the built environment including health, social, economic and environmental aspects.

A sense of place is described as the interaction between people and the environment, and is reinforced by the connection of place, its identity, and its character. Social inclusion is important for creating a successful, fun, accessible, and welcoming place for everyone. Participation of local communities in planning and implementation is critical to creating inclusive spaces. Physical appearance and the function of public space have an effective role in creating a sense of welcome and determining who feels included.

As a result, socially sustainable development has been facilitated by the conservation of historical and cultural assets. The quality of the venue at the Artilleristallet has become open, attractive and accessible as well as the physical appearance of the buildings attractive (see Figures 1 and 2), with a harmonious historical character. There is a range of activities in the neighbourhood, with various kinds of food and products offered by carefully selected companies [16].

Figure 1. Location of Artilleristallet, Lindholmen Street

Figure 2. Photographs of Artilleristallet today

3.2 Miramare park and Casa Jellinek palace in Trieste, Italy

between formal gardens and landscapes, both aesthetically and scientifically. Casa Jellinek, a historic building and garden, is located in the mountainous northeastern area of the park and housed court gardener Anton Jellinek in 1868. However, the site has been under-maintained since Casa Jellinek was emptied in 2018.

The project aimed to rejuvenate Casa Jellinek through an "adaptive reuse" strategy that hosts permanent jobs to avoid gradual neglect and transfer of hidden history related to public education. For this purpose, the methodology of the study was Phase 1 of the three-stage design process involves analyzing city, architectural, heritage, and natural data to determine historical relevance and chronicle the existing state of affairs to conserve the present with accurate information. Phase 2: Intervention selection in order to find heritage-compliant ways to restore the garden and adaptively reuse the building. Regarding the third phase, the project designs horticultural and architectural features to preserve heritage and energy transformation.

The study aims to balance comfort needs, energy demand, and heritage preservation through adaptive reuse of Casa Jellinek. In addition to focusing on the building itself, the study attaches great importance to, among other things, preserving the original appearance of the historical park and its landscape buildings, protecting historical plants and biodiversity within the heritage area, incorporating archaeological bodies in the decision-making process, integrating solar panel systems, which is seen as an alteration to the external look, and taking into account the building's and its surroundings' heritage significance, including the physical, visual, and spatial changes brought about by the solar photovoltaic (PV) panel system. Paying attention to the quality of the landscape and its associated heritage, and ensuring the preservation of historical gardens and their environmental specialization, as shown in Figures 3 and 4.

Figure 3. Miramare park and its forest

Figure 4. The Casa Jelinek complex plan

The preservation plan for Casa Jellinek emphasizes the annex building's fundamental restoration and little alteration to the main structure, ensuring that its historical texture is preserved and that adaptive reuse is functional and includes the introduction of new functions to revive the underutilized historical building, helping to avoid loss of cultural identity due to demolition. The flexibility of the interior space is a functional factor that is taken into account when reusing the adaptive use of Casa Jellinek, in order to ensure that it is able to accommodate the needs of the local community. The project reflects the concerns of the local community, ensuring their participation and satisfaction as joint workshops were conducted with the Antiquities Authority and the owner to identify heritage-compliant functions and solutions, taking into account the social impacts of sustainable development [17].

By reviewing the above experiences, indicators related to functions and activities can be derived as in Figure 5, which will be explained in detail below.

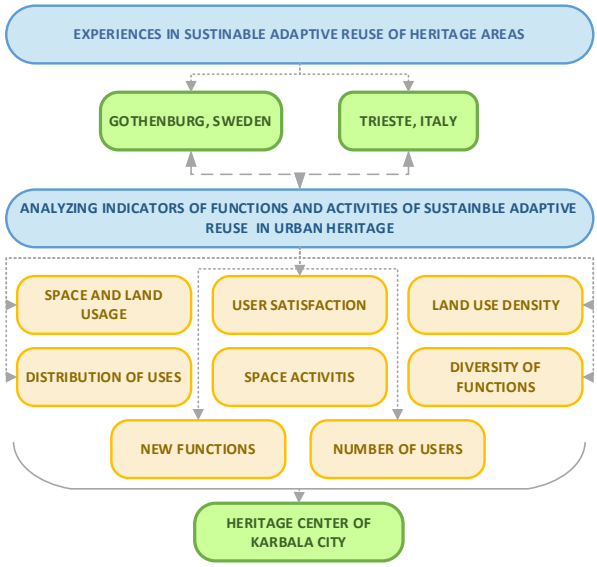

Figure 5. Deriving indicators of functions from previous experiences

4. FUNCTIONAL FACTOR AND ITS ROLE IN SUSTAINABLE ADAPTIVE REUSE

Safe environments are attractive to a variety of uses and activities. In order to offer services to users, including commercial, recreational, health, and institutional functions, urban spaces usually require a range of uses. Urban space is more dynamic, effective, and safe when there is a high volume of residential use. The urban structure should adapt to new urban functions brought about by changing needs; in turn, this leads to the introduction of new architectural and urban forms [18, 19]. In addition to being an independent and ever-expanding entity, urban structure is a component of a continuous process of development and evolution [20, 21]. According to what have been mentioned above, the most important indicators expressing the functions and activities of heritage city centers can be included as follows:

4.1 Land use

It refers to the existence of a mixture of different functions and activities in an area of historical or cultural value. The combination of land uses includes two types of shapes, where the vertical pattern exists at the level of individual buildings, which includes a number of uses such as residential, commercial, recreational and heritage use, which are usually distributed within these multiple floors of buildings. The other form is the horizontal pattern of neighborhoods and blocks. A variety of residential, commercial, recreational, heritage, industrial, and other uses are present throughout the entire area. It is also important to consider how these uses are distributed spatially, as well as the proportion of each use and the extent to which they interact. The diversity of land uses is not limited to the physical side and the exchange of material activities only, but also the exchange of human relations, cultural and religious exchange and social activities [22-49].

4.1.1 Land use diversity

The number of uses within unit space, this means that the more uses and types of uses there are in an urban area, the more lively the area becomes. Diversity of land uses is among the most effective indicators of ecosystem health and resilience, and demonstrates the ability of land to provide a variety of environmental services. This diversity encompasses a wide range of uses, from agriculture and grazing to urban and industrial areas [50]. The relative distribution of different types of land uses in a given area. The more land-use types there are and the more different they are, the more diverse they are [29]. The following equation is used to calculate the Simpson Index:

$$D = 1 - \Sigma\, pi$$

4.1.2 Horizontal and vertical diversity

The uses number within the unit space. That is, the greater the number and type of uses in urban space, the more vibrant the space becomes. The entropy index can be used to calculate the multiple land use index [23, 24]. One of the ideas related to thermodynamics is entropy, which is frequently used to quantify chaos and disorder. It can also be used to quantify other things like urban sprawl, diversity, and inequality.

Beginning in 1989, the land-use mix in American suburbs has been measured using the entropy formula. Scores on the entropy index vary from 0 to 1. When there is a mixture of land uses, it approaches one, and when there is just one land use and no mixture, it approaches zero [25, 26]. Equation [27, 28] can be used to measure the entropy index.

$$ENT = -\left[\sum_{j=1}^{k} P^j \ln(P^j)\right] / \ln(k)$$

where, P^j is the area ratio of each type of use inside the urban environment, and k is the number of uses. This indicator's value falls between 0 and 1. The indication value is closer to [1] the larger the variation.

4.1.3 Spatial distribution of use

It means the distribution of the types of uses in the region. For example, a certain use is spatially distributed on a regular basis, while another use, such as commercial use, is concentrated in one area of the city and not another, or we find another use that is dispersed or scattered in different locations of the city [17, 51]. The spatial distribution of these activities and uses can be measured by the Moran's Index to measure the spatial distribution of the various activities, through which we can conclude whether these uses or activities are interactive and homogeneous with each other or not.

The Moran's Index reveals the extent of subjective correlation between the elements of the studied area and assesses the pattern of spatial distribution of it, whether it is a dispersed, regular or random pattern. The evidence's value falls between (-1) and (+1). If the evidence value is near (+1), it means that the pattern is clustered; if it is near (-1), it means that the pattern is random; and if the value is at or near zero, it means that the pattern is regular. The distribution pattern between clustering, regularity and randomness varies according to the value of the evidence [30].

4.2 Space usage

This indicator is represented by including fountains, areas for relaxation and seats, and surfaces that allow for easy mobility. These specifications make rest areas more dynamic and encourage people to use them more frequently. Since permeability increases with liveliness, this indicator shows the

likelihood of pedestrians streaming into urban areas. The number of nodes in a hectare is used to calculate the permeability index using the following formula [31]:

$$R/A \geq 1$$

where, A is the area in hectares and R is the number of nodes. The permeability of urban space increases as the number of nodes increases and the space becomes smaller. Public spaces are an important element of any community, they represent the lungs of the city and give people the opportunity to communicate and interact with each other and enjoy the outdoors. These spaces also play an important role in promoting the cultural and historical values of communities, providing opportunities for recreation, education and physical activity. Public spaces can be designed in a way that embodies the cultural and historical values of the community, such as creating monuments or gardens that commemorate important historical events. Public spaces can be designed in a way that contributes to sustainable development, such as the use of environmentally friendly building practices and the creation of green spaces that help reduce pollution. As well as exploiting them in ways that enhance the cultural and historical values of the site, taking into account the needs of the local community and achieving sustainable development. This depends on the density of use by the population, the density of construction and the diversity of existing functions and activities.

4.2.1 Number of users

Attention to providing a comfortable and uncrowded environment for users in urban spaces is necessary to achieve visitor satisfaction and efficiency of movement.

The allocation of 1.5 square meters per visitor/user is an approximate measure of the personal space an individual needs to move freely and comfortably without feeling crowded and can also be interpreted as a safe distance to maintain social distancing. This criterion is not fixed, and may vary depending on the type of place and activity in which it takes place, for example, in places that require greater interaction between individuals, the required space may be slightly less. A comprehensive study of the area must be conducted to determine the influential factors such as the total area, the number of entrances and exits, the activities of users in and around the heritage areas, as well as the prediction of the number of users [32].

4.2.2 Users' diversity

The diversity of users in urban areas is a vital indicator of how inclusive the city is and its ability to accommodate different social and cultural groups. This diversity includes age group, ethnicity, and gender, as well as other factors such as income, education, and marital status. Measuring this diversity requires a set of statistical tools and techniques, and aims to understand the needs of these groups and provide public services that meet their aspirations.

The diversity of users is measured by demographic data such as census data, which is the primary source of detailed data on the population. as well as opinion surveys and community participation surveys [52].

4.2.3 Types of activities within the space

In addition to establishing the speed rate of the streets connecting to the spaces, the number of people inside the spaces must support the rest areas, seating terraces, drinking fountains, shade, and landscaping. Since it calculates the distance from space to other uses that include services at a distance of no more than half a mile, this indication can be quantified by the distance to services and other land uses. Accessing services from this distance is convenient [33]. Along with the availability of public squares and spaces, the more expansive and central locations the city has, the more people it can hold, increasing the dynamic nature of the space [34].

4.3 Change of usage (Function)

Incorporating new functions into heritage buildings or sites while preserving their cultural and historical value Revitalizing these sites and using them for multiple purposes beyond their original function, the multiplicity of use requires different levels of dealings and different types of interaction, as it is an effective tool in assessing the possibility of sustainable adaptation of heritage areas. This indicator measures the diversity of uses and functions that the area can accommodate, taking into account the needs of the population and preserving its heritage characteristics. A number of analytical studies were conducted to assess the possibility of sustainable adaptation of heritage areas using multi-use indicators. It was found that areas with multiple uses and functions have better resistance to economic and social changes as they have the ability to absorb various activities, which makes them more sustainable in the long term [35]. As for measuring the strength of this indicator, it is done by knowing the number of users of this region as well as their diversity in terms of age and cultural group and the extent of users' satisfaction with the urban area.

4.3.1 Intensity of space use

The number of people in a given area is known as its density. Since the number of users rises as the proportion of security and safety in the spaces increases, the presence of people is directly correlated with the availability of these factors. The density of travelers to space, regardless of whether the trip is for enjoyment or spiritual and psychological reasons, reflects this [36, 37]. Two primary indicators can be used to categorize this factor: Index of Space User Density: It shows how many people use a certain metropolitan area and is a gauge of the conditions that promote walking and access to various locations. Numerous uses and activities within urban space are ensured and stimulated by these densities [38]. Best indicator of space vitality is the Urban Space Density Index. Dynamic settings with a high density encourage foot traffic and boost the vibrancy of the surrounding area. The following formula can be used to compute it [39].

$$0 \leq UDIi \geq 1 = (Usrsi/Ai)/Maximum\ (Usrsi/Ai)$$

where, GFA i: is the total land area of commercial activity in urban space, and (i) is the projected urban area. The area of urban space i is denoted by Ai. The previous equation was interpreted in the same way, but in this case, the extracted value is divided by the density of activities for the greatest use value in the city, and the space allotted for business and functional purposes is divided by the total area.

4.3.2 Users' satisfaction

People around the world are proud of their civilization, history, and structural heritage. People's public perception,

feeling of place, sense of belonging, and connection to their local environment are all improved by the preservation and reuse of built heritage. By introducing a common cultural identity and memory of the past into people's lives, a well-adapted historical structure should help them connect with their cultural heritage [40]. Literature frequently mentions certain significant indicators of heritage structures that are changing socially and culturally. The needs and preferences of the community and its users must be considered while implementing adaptive reuse [41, 42]. Furthermore, socially adaptive reuse projects should enhance public spaces, maintain the area's character, and foster a feeling of place. Older structures are frequently linked to inherent social advantages and are essential to preserving the street view's allure, giving neighborhoods personality, and presenting a positive picture of the neighborhood.

4.3.3 Diversity of functions

The effectiveness of evaluating the success new usage can be used to assess of an adaptive reuse project. Therefore, it is impossible to dispute the new function's significance in adaptive reuse. The original use and the new function must work together. Furthermore, the building's compatibility with its function is not restricted to its usage within or across uses; the new use must also be compatible with the heritage structures' original form and historic character [43]. On this basis, the functions of the previous and current heritage areas will be compared and suitable functions will be proposed for the untapped heritage areas, see Figure 6.

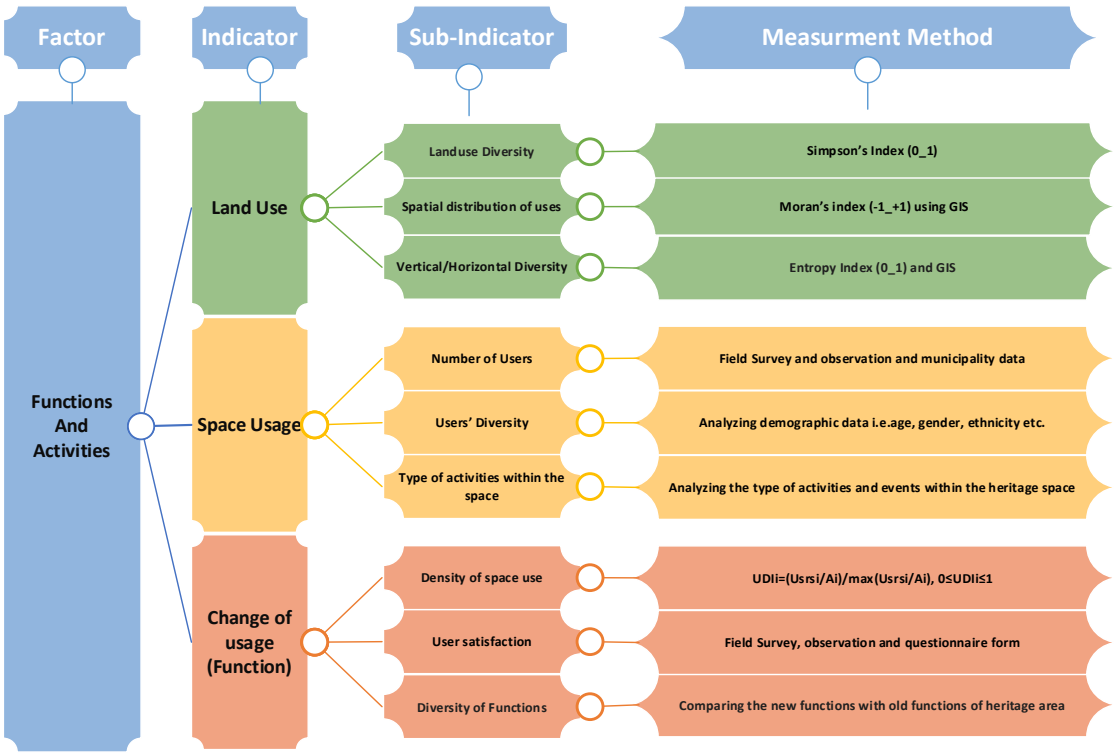

Figure 6. The main and sub-indicators of functions and measurement method

5. METHODOLOGY

By collecting information from the pertinent agencies and organizations in the City of Karbala—represented by the Municipality Directorate, the Urban Planning Directorate, and the Karbala Center of Study and Research—the study relied on a descriptive analytical technique. field survey as well. Historical details regarding the research region, its location and size, the kind and quantity of land uses, the kind and quantity of heritage structures, the ease of access to the area and the modes of transportation utilized there, as well as psychological and sociological characteristics gathered via the questionnaire form, were all covered in the data. In order to extract the percentages from the questionnaire form, some mathematical equations have been utilized to measure and analyze quantitative indicators depending on the restrictions given by these equations. Based on the indicators generated from the theoretical framework, the religious center of the holy City of Karbala will be examined and evaluated in the following section of the study (Figure 7).

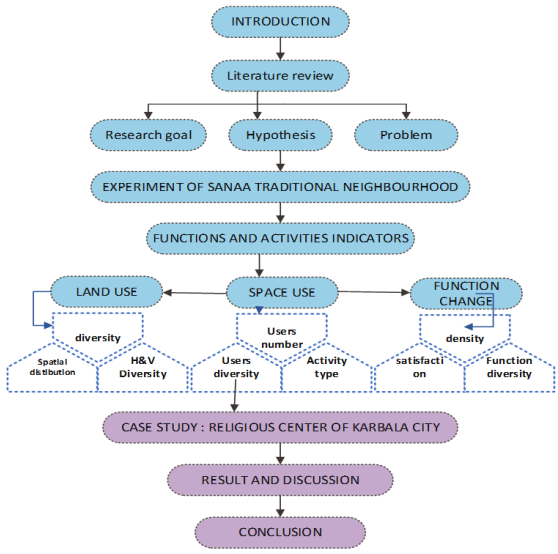

Figure 7. Research methodology

6. CASE STUDY

6.1 The heritage center of the holy City of Karbala

Karbala City is considered a model for shrine cities in Iraq, and the old city within the ring road (Ocean Street) that surrounds it occupies an area of more than one square kilometer, with a mosque and the resting place of Imam Hussein and his brother Abbas (PBUH). The ring road passes in most of its path along the green areas. It surrounds the city except for the western and southwestern parts of it, which helped in the large modern urban expansions in these two parts. The study of the dimensions of the old city in relation to the center of its formation shows that the borders of the center are about 400 meters to about 800 meters. It is within the limits of the walking distance. That is, the size and shape of the city depends mainly on the human scale of pedestrian movement (Pedestrian-scaled environment), which is a property that can be invested in keeping vehicle movement away from the heart of the city to the street that surrounds it, especially on important religious occasions, and allocating some of its streets to pedestrian movement only, especially near the center.

Because Karbala receives an infinite number of tourists all year round, it is more complicated than other pilgrimage cities [44]. Due to the city's rapid commercial growth, which is a result of the constant rise in tourists, commercial areas have begun to grow and unpredictably expand until they now outnumber residential regions. The Iraqi capital, Baghdad, is 100 kilometers south of the City of Karbala (Iraq - Ministry of Planning, 2010 and Ministry of Planning of the Republic of Iraq, Central Bureau of Statistics, 2010). Its total area is 5,023 km². According to the Iraqi Central Bureau of Statistics, the population of Karbala governorate is 1,003,516 citizens [45]. The mosque or shrine in other religious cities marks the city's center, but in Karbala, the mosques and morgues of Imam Hussein and his brother Abbas (PBUH), as well as the large square between them, all reflect the city center's urban space formation elements. This is one of the qualities that gives the city center its unique character. Therefore, the two mosques constitute the dominant elements in the shape and composition of the city functionally and visually and on the skyline of the city (Skyline).

The historic center also has mosques, libraries, and religious schools, as well as blank areas. Buildings that have been destroyed offer the chance to be renovated or redeveloped with a suitable layout to better serve tourists. The historical center's primary characteristic is the stability of its urban and historical districts. The historic core is a unique entity that is distinguished from modern development regions by a number of features, even if roads have recently been destroyed and rebuilt. These characteristics include the layout of the Old City's tiny streets and alleyways that are inappropriate for automobile traffic, the traditional brick buildings that predominate there, and the visual and urban influence of the holy shrines of Imam Hussein and Abbas over the urban landscape.

6.2 Urban and environmental fabric of Karbala City's historic center

Karbala is one of the cities that has preserved its relatively urban fabric, for religious and historical reasons, and because of its strategic location for many centuries. However, the sabotage caused to it left a clear mark on its old traditional architecture, in a way that threatens its characteristics and Islamic identity with change unless effective measures are taken to preserve it. Arguably the most notable event in the city's contemporary history, which has fundamentally affected its urban fabric, is the removal of areas between and around the two mosques. The most unique characteristic of the urban fabric of the city is the dominance of the two mosques architecture over the traditional urban fabric in which the main corridors of pedestrian movement from the two mosques form a link between them and the surrounding areas.

Residential neighborhoods like other ancient historic cities such as Najaf [46]. come out of there. Due to a variety of activities, viewpoints, and civilizations, Karbala was able to attain the qualities of the ancient Islamic metropolis, which resulted in the current land use balance. This emphasizes how important it is to save the historic structures and the essence of the remaining ancient city. The two sacred mosques that house the members of the House of Imam Hussein at the locations of their martyrdom, as well as the most significant shrines and shrines accessible to tourists in the city center. As a result, its location and locations directly affect the City of Karbala overall as well as the neighborhood surrounding the old city center. The climatic conditions of the region where this city is located have influenced the dominant lifestyle and architectural structures over the centuries. The use of mud and bricks for construction, as well as the design of houses with small courtyards, resulted from these climatic conditions. Wars and other calamities in the country's history are also easily discernible in the physical plan of the city. The Shiite architecture has also tended upwards as the design of the interior and exterior of mosques, shrines and other religious buildings reflect the religion and beliefs of the people. Nonetheless, today many environmental problems such as pollution and climate changes are processes that can negatively impact the architectural monuments of the city. Thus, the socio-esthetic solution of the problem of preserving the architectural appearance of Karbala is based on the need to use an integrated approach, which, on the one hand, is connected with the declared ambitions and goals of preserving cultural and historical values, and with the challenge of adapting to their modern environmental requirements (Figure 8).

Figure 8. Location of the study area from the City of Karbala

6.2.1 Land use of the historic city center of Karbala

Commercial use: Over 45% of the old city's workforce is employed in trade, which is the city's primary economic activity. This is because the community depends on commercial events, primarily because Karbala receives a

constant stream of tourists all year long. Their numbers increase from 5 to 8 times in weekly and seasonal visits and rise to almost a hundred times in important religious events such as the visit of half of Sha 'ban, the first ten days of the month of Muharram, and the Arba'een of Imam Hussein (PBUH). The commercial areas in the city are characterized by the existence of two basic patterns: the traditional markets: they embodied the characteristics of the eastern markets, the most prominent of which was the Merchants Market, Al-Hussein Market and Al-Abbas Market, but they were removed after 1991, after they formed, with some other markets, a homogeneous structure with the two mosques and the rest of the other buildings. Commercial areas include the streets surrounding the two mosques, as well as the streets leading to them, which have been built since 1980. The ground floor of the buildings located on these streets is used for commercial and other service uses, while the upper floors include hotels, apartments and professional offices.

Residential use: The residential use of the land covers about 40% of the traditional urban fabric of the old city. The population of the old city is about 12,360 people for the year 2024 (see Table 1). The residential areas extended very close to the outer walls of the two shrines. However, due to the demolition of the city center after 1991, the wide square between and around the two mosques separates these areas from the two mosques. These residential areas generally lack essential supplies such as maintenance and restoration [47] (Figure 9).

Table 1. The main land use size and percentage, from data base of Karbala municipality

Usage	Number	Size (sqm)	Percentage of Use 100%
Residential	1836	212744	40.8
Commercial	668	147872	28.3
Religious and Heritage	108	121350	23.2
Health	6	1963	0.4
Educational	1	2349	0.4
Civil	18	6509	1.2
Transportation	7	29266	5.6
Total	-	**522**	100

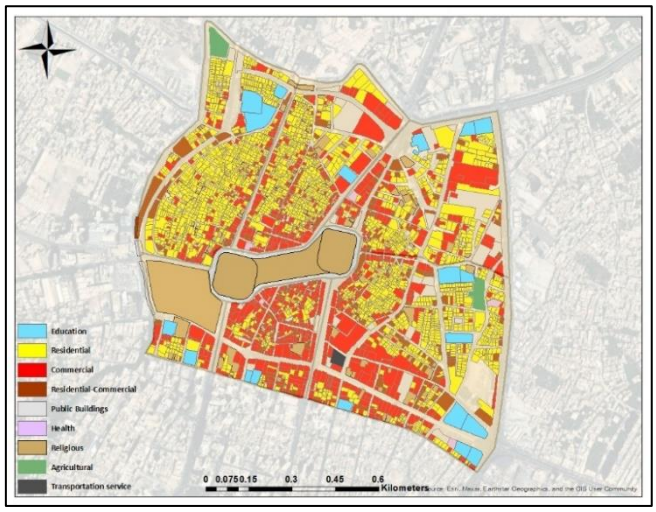

Figure 9. Land uses of the study area by using GIS analysis and data from Karbala municipality

(1) Diversity of use

The diversity of urban land uses in the research area was measured using the Simpson equation, and the indicator's result was 0.72, which means that there is a great diversity in land uses in this area without clarity or dominance of one use over another, and this is a good indicator that the region still maintains the vitality of overlapping uses to perform all activities effectively.

(2) Spatial distribution of use

Through the application of the Moran's Index coefficient to measure the patterns of spatial distribution of land uses through the ARC map program by the GIS application, the pattern of distribution of each use was analyzed separately from the total study area, where residential and commercial use was of a regular pattern, that is, systematically spread in the city center, while the pattern of distribution of public and service buildings and religious heritage areas was random pattern (Figure 10). As in the following Moran's Index analysis report.

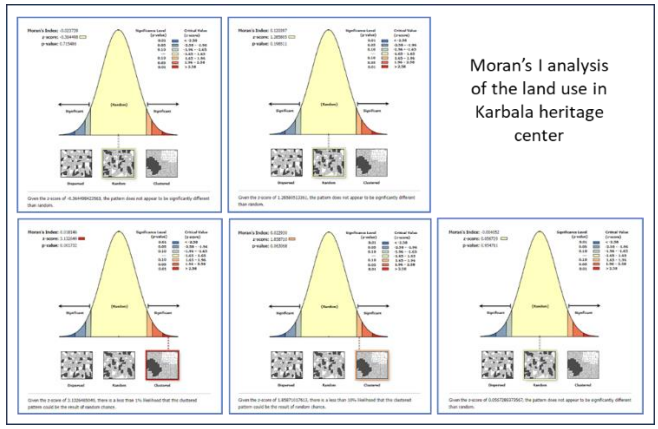

Figure 10. The results of spatial analysis by Moran's Index using ArcGIS analysis

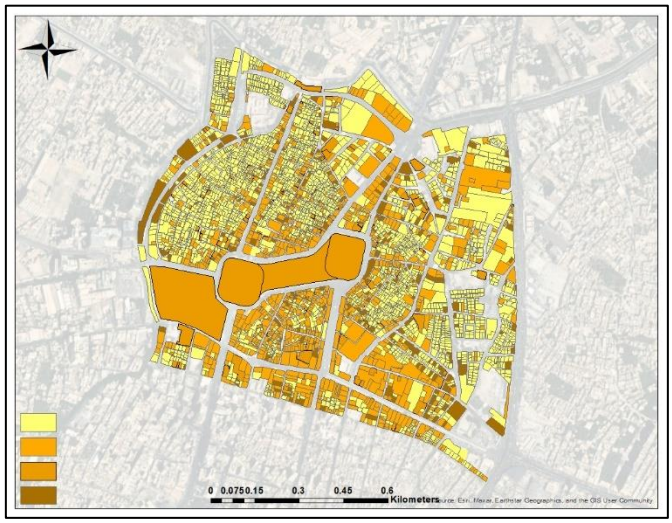

Figure 11. The percentage of horizontal/vertical construction in the study area based on the heights of the buildings, using GIS analysis

(3) Vertical and horizontal diversity

After calculating the percentages for each category, the entropy value was calculated. In this study, the calculated value was 0.35. They reflect a moderate level of diversity in the distribution of urban groups. This indicates that there is a reasonable distribution between the different urban patterns,

as the value of the low coefficient, that is, close to 0, means that the distribution of urban patterns is largely homogeneous (that is, one or more groups dominate the area). A high value approaching 1 or higher means that there is considerable diversity in urban patterns, indicating a diversity in the types of construction or land use. In this case, the calculated value (0.35) reflects a moderate diversity between the different urban categories in terms of horizontal and vertical construction (Figure 11).

6.2.2 Space usage

The number of open spaces, assembly points, public and private spaces, as well as the spaces of the religious heritage areas were calculated. After counting the number of residents and visitors who visit these spaces and carry out certain activities in them, it was found that these spaces are often active while some of them are transit point for residents from one area to another. The effectiveness of these spaces and areas increases during religious events and events held on certain days of the year (Figure 12).

According to the Iraqi standards for the year 2018 issued by the Iraqi Ministry of Planning, the urban center of the City of Karbala is considered at the level of an integrated residential neighborhood because it consists of 5 residential shops and is classified according to the population of 12360 people, so the per capita share of spaces and open spaces is 2.25-0.75 m^2, so the area to be allocated from spaces is 27810 m^2, while the area of spaces currently available in the study area is 42600 m^2.

Figure 12. Reality of the open spaces of heritage buildings of the study area

(1) Number of users

The maximum number of visitors to the center of the City of Karbala during religious events ranges from 200,000 to 300,000 visitors per day, according to the statistics of the General Secretariat of the Holy Shrine of Hussein for the year 2024, while the area calculated for public and private spaces in heritage areas was 71,817 m^2.

After applying the equation of calculating the share of each individual of the allocated area, the output was 0.45, meaning that for every 100 people, they share an area of 45 meters of space or public space during peak times or important events, while the standard for the per capita share of space is 1.5 meters. Therefore, we conclude from the above statistics that the number of users of public spaces and spaces of heritage areas is. 50538 – 151160 inhabitants.

(2) Users' diversity

By collecting information from the competent authorities represented by the Central Statistical Organization and the Karbala Center for Studies and Research - the Holy Shrine of Hussein's General Secretariat, the age groups in the City of Karbala can be classified into three main categories, including the category of young people (under 14 years), which consists of 3.7% of the total population of the religious center, while the second age group, which is middle-aged from 15 to 59 years old, and this percentage reached (51.3), which means more than half of the age groups. "As for the elderly group (60 years and older), this group is one of the age groups with a low percentage, which forms the top of the population pyramid and is inversely proportional to the young age group. The more ages within this group, the more they become unable to work. This percentage in Karbala reached 7% for the year 2024 AD. As for gender data, There were 5,933 females and 6,427 males out of the total population of the old city, which is 12,360. Accordingly, these indicators reflect an effective use of spaces where there is a great diversity of users without limiting space to one category or another.

(3) Types of activities within the space

The center of the City of Karbala is a small integrated city in its own right at the present time, with an area of about (90) hectares, by field survey and observation, the old commercial markets, craft factories and industrial workshops are spread, in addition to the main commercial activity and religious tourism activity, and its various activities are connected by a network of narrow roads. The most important feature of the city center (the old city) is the density of visitors to the two holy shrines at most times of the year. As a result of this influx, various activities and events were found in many areas, including religious, commercial and hotel. Some heritage areas are often exploited for certain uses during times of religious visits or events, such as being used as temporary housing for visitors or as places to perform prayers or other religious events related to the visit.

6.2.3 Change of usage (Functions)

The religious center of Karbala City includes archaeological and heritage buildings with different historical periods, in addition to having exceptional building conditions, it contains 108 monuments, including the shrines of Hussein and Abbass, and significant religious historical locations in the study area. The region is more than 200 years old and has unique shapes and designs related to the history and identity of the city.

As well as mosques, husseiniyat, religious schools and traditional buildings that are concentrated around the two kindergartens and then their density decreases by moving away from them. Some of them are still in use, others have been converted into places of prayer and worship, and others have not yet been exploited (Figure 13).

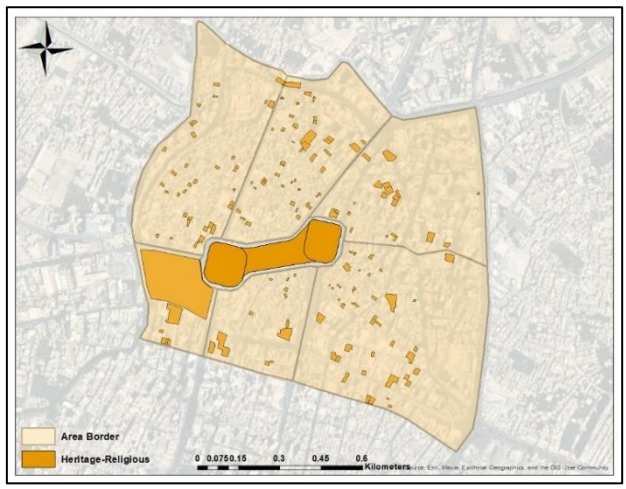

Figure 13. The location of religious and heritage areas in the study area using GIS based analysis

(1) Density of space use

The total area of the spaces and open spaces in the center of Karbala City is 113711 m^2. The total area of the spaces of the heritage areas and between and around the two sanctuaries constitutes 62% of the total area of the open spaces, which is about 71817 m^2 [48]. Therefore, this area will be used to calculate the density of use by residents and visitors to the study area, which is (0.17 m^2) per person.

The total area of the area between the two mosques is approximately (20143 m^2). The area allocated to the crowds inside the Holy Shrine is approximately (8940 m^2). The area allocated to the crowds inside the Holy Shrine is approximately (7125 m^2). According to the density index (0.25m^2) per person, the area between the two mosques accommodates a maximum of (80,572 visitors) in the peak period, so there must be solutions to the problems facing this important space [53]. All the indicators summary is shown in Table 2.

Table 2. Measurement of indicators summary

Indicator	Sub-Indicator	Measurement Method	Standard	The Study Area Reality
Land use	Diversity of land uses	$D = 1 - \Sigma\, pi^2$	(0–1)	(0.72) The value of the indicator is close to 1, so there is a great diversity in the land attractions of the region
	Spatial Distribution of Uses	Moran's I using GIS	(-1_+1)	0.026 The indicator value is close to 0, so the distribution of uses is a regular distribution pattern
	Horizontal and Vertical Diversity	$ENT = -\left[\sum_{j=1}^{k} P^j \ln(P^j)\right] / \ln(k)$	(0-1)	(0.35) The value of the indicator is close to 0, so there is a moderate diversity between the different urban categories in terms of horizontal and vertical construction
Space usage	Number of users	Number of visitors and users per space area	According to the per capita share, which is 1.5 meters of space	Every 100 people share an area of 45 meters So the number of users is 50538 – 151160 people
	Users' Diversity	Demographic data such as census data as well as field surveys	Age, ethnicity and gender groups of visitors and users of urban space	These indicators reflect the effective use of spaces where there is a great diversity of users without limiting space to one category and not another
	Type of activities within space	Field survey	Type of events and activities for residents and visitors held in heritage areas spaces	There are various activities for the population, especially in open spaces that contain physical elements such as seating and rest areas and green areas, as well as most of these spaces are used for purposes that serve religious events (such as prayer, worship, processions, etc.) at specific times
	Density of space use	UDIi=(Usrsi/Ai)/max(Usrsi/Ai), 0≤UDIi≤1	[0–1)	0.25 m^2 per person on religious occasions, 0.8 on normal days It is considered a high intensity compared to the standard during peak times for visitors, but during regular days the percentage is acceptable
Change of usage (function)	User Satisfaction	Questionnaire and Survey Form	People's feeling of place, belonging, and connection to their local surroundings	A great sense of place because of the religious and spiritual sanctity of the area because there are many holy shrines surrounding the study area and they feel satisfied with the place and its services
	Diversity of Functions	Field survey	Compare the old function of the building or heritage area with the new function	20-25% of the religious heritage buildings are still underutilized, while about 40% of the heritage buildings are used only during the times of the Arba'een of Imam Hussein (AS)

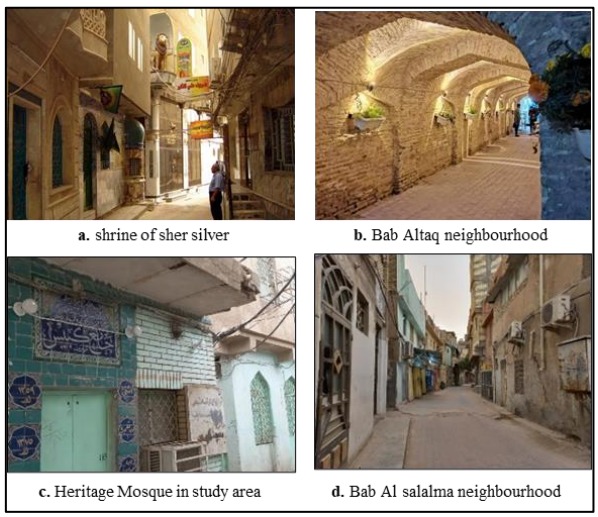

Figure 14. Samples of the heritage buildings in the historic center of Karbala City

(2) User satisfaction

The results of a survey the researcher administered to some of the space's users reveal that the great majority of locals and tourists are pleased with the location and its offerings and experience a sense of place because of the area's religious and spiritual holiness, which is attributed to the numerous sacred shrines that surround the study area. In addition to its historical significance, this location is linked to other significant occasions in Islamic history. Social engagement between people is also increased by popular commercial activities.

(3) Diversity of functions

One of the most important buildings and religious heritage areas in the center of the City of Karbala is the shrine of Imam Ali the Younger and Ali the Greater (PBUH) where they were restored and made some modifications and construction works and the shrine of the palms of Abbas (PBUH**)** while the locality of Bab al-Khan is the heart of the holy City of Karbala as well as the shrine of Sher Silver and the door of the staircase, which are considered one of the oldest heritage places in the

region. After conducting field surveys and observations by the researcher, it was found that 20-25% of the religious heritage buildings are still underutilized, while about 40% of the heritage buildings are exploited only during the times of Arba'een of Imam Hussein (AS). The majority of the restored religious heritage buildings have been modestly restored and serve only a certain period of time. Therefore, some of these areas need to develop new functions commensurate with their structural condition and location (Figure 14).

7. RESULTS AND DISCUSSION

The information in the table gives us a thorough and detailed picture of Karbala's land and space use situation, which greatly advances our comprehension of the community's requirements and goals for urban heritage repair and activation. Through the analysis of this data, we are able to make a number of conclusions that help direct the city's historic adaptive reuse project's activities. The high index of land use diversity indicates the presence of a diverse mix of activities and functions in the city, reflecting an integrated social and economic dynamic. There is also a relatively regular distribution of uses, which may indicate a balanced distribution of facilities and services. The entropy index indicates a moderate diversity of buildings in terms of height and area, reflecting the historical development of the city and diversity in architectural styles.

The data also show a high density of use of public spaces during peak times. Opinion polls reflect a general feeling of satisfaction with urban spaces and a strong connection to the local environment. Due to the large number of studies that have studied this area and its importance, the results that depend on data collected from residents were very similar. This indicates that there is no bias from residents, which in turn indicates their interest in developing the area and helping researchers to do so. This motivates them to provide correct information. The analysis indicates that there is a percentage of heritage buildings that are not used or are partially used, which opens up broad horizons for their rehabilitation and employment in new forms. The data provided serves as a roadmap for a sustainable adaptive reuse project for heritage in Karbala City. Through a deeper understanding of the current reality and exploiting the available opportunities, positive results can be achieved that contribute to the development of the city and improve the quality of life for its residents.

8. CONCLUSION

The extent to which sustainable adaptive reuse occurs is contingent upon the proper identification and application of functions and activities in and around heritage buildings. Remembering that cities are continuously developing, it is more and more important to protect and revitalize the existing cultural properties. Balancing the conflict of economic growth and the wish to preserve cultural and historical essence is absolutely crucial.

Therefore the extent of fragmentation of land uses, efficiency by which the heritage spaces are used, the kinds of uses that are done and thus the kinds of uses that are facilitated by the adaptive reuse indicators reflect the quality of the execution of the programs for adaptive reuse. The utilisation of a heritage site for the specific aim or intent is called function and activity. Sustainable land uses include residential, commercial, cultural, educational or tourism related and other types of activities.

The decision has a broad erudition for long-term sustainability and the degree of the project's impact.

Consequently, this research establishes the fact that the effective function and organisation of these functions and activities are critical to the sustainable adaptive reuse of the urban heritage. Through the assessment of current uses of heritage being proposed and creating new uses for idle heritage sites, the three objectives can be met as seen in this paper.

9. SUGGESTIONS

The research suggests future directions for development, which are to expand the database further to obtain detailed results, which in turn helps in working on the rest of the factors of sustainable adaptive reuse projects, which are economic and environmental factors. The research also suggests conducting detailed studies for each heritage building to determine the potential for its rehabilitation and employment to achieve urban sustainability in its integrated form.

REFERENCES

[1] Abdullah, M.S.M., Suratkon, A., Mohamad, S.B.H.S. (2020). Criteria for adaptive reuse of heritage shop houses towards sustainable urban development. International Journal of Sustainable Construction Engineering and Technology, 11(1): 42-52.

[2] Kıran Çakır, H., Aydın, D., Arabulan, S. (2020). Adaptive reuse of open spaces in historical buildings. International Journal of Building Pathology and Adaptation, 38(5): 703-719. https://doi.org/10.1108/ijbpa-04-2019-0034

[3] Amato, A., Andreoli, M., Rovai, M. (2021). Adaptive reuse of a historic building by introducing new functions: A scenario evaluation based on participatory MCA applied to a former Carthusian Monastery in Tuscany, Italy. Sustainability, 13(4): 2335. https://doi.org/10.3390/su13042335

[4] Broniewicz, E., Broniewicz, M., Skubiak, B., Bryliński, A., Grabowska, P. (2022). Adaptive reuse of buildings. Economics and Environment, 83(4): 338-357. https://doi.org/10.34659/eis.2022.83.4.575

[5] Kee, T. (2019). Sustainable adaptive reuse—Economic impact of cultural heritage. Journal of Cultural Heritage Management and Sustainable Development, 9(2): 165-183. https://doi.org/10.1108/JCHMSD-06-2018-0044

[6] Wilkinson, S.J., Remøy, H., Langston, C. (2014). Sustainable Building Adaptation: Innovations in Decision-Making. John Wiley & Sons. https://doi.org/10.1002/9781118477151

[7] Rodrigues, C., Freire, F. (2017). Adaptive reuse of buildings: Eco-efficiency assessment of retrofit strategies for alternative uses of an historic building. Journal of Cleaner Production, 157: 94-105. https://doi.org/10.1016/j.jclepro.2017.04.104

[8] Shen, L.Y., Langston, C. (2010). Adaptive reuse potential: An examination of differences between urban and non-urban projects. Facilities, 28(1/2): 6-16. https://doi.org/10.1108/02632771011011369

[9] Schmidt III, R., Eguchi, T., Austin, S., Gibb, A. (2009). Adaptable futures: A 21st century challenge. Changing Roles-New Roles, New Challenges, Noordwijk AAN ZEE, The Netherlands.
[10] Peterson, S. (2015). Forget ruin porn: 5 awesome adapted spaces that used to be dead malls. Vox Media, LLC. https://www.curbed.com/2015/3/18/9982614/things-that-used-to-be-malls.
[11] Bullen, P., Love, P. (2011). Factors influencing the adaptive re-use of buildings. Journal of Engineering, Design and Technology, 9(1): 32-46. https://doi.org/10.1108/17260531111121459
[12] Djebbour, I., Biara, R.W. (2020). The challenge of adaptive reuse towards the sustainability of heritage buildings. International Journal of Conservation Science, 11(2): 519-530. http://doi.org/10.36868/ijcs
[13] Philokyprou, M. (2014). Adaptation of new university uses in old buildings: The case of rehabilitation of listed buildings in Limassol Cyprus for university purpose. International Journal of Architectural Heritage, 8(5): 758-782. https://doi.org/10.1080/15583058.2012.738282
[14] Love, P., Arthur Bullen, P. (2009). Toward the sustainable adaptation of existing facilities. Facilities, 27(9/10): 357-367. https://doi.org/10.1108/02632770910969603
[15] Bridgland, J. (1995). The getty conservation institute 1985-1995: A retrospective. Conservation, the Getty Conservation Institute Newsletter, 10(2): 5-19.
[16] Häger, M., Pehrson, R. (2023). Adaptive reuse of cultural historical values to enhance public places: A case study of Artilleristallet in Gothenburg. Degree project in the Built Environment. Gothenburg, Sweden: University of Gothenburg. https://www.diva-portal.org/smash/get/diva2:1683690/FULLTEXT02.pdf.
[17] Jiang, L., Lucchi, E., Del Curto, D. (2023). Adaptive reuse and energy transition of built heritage and historic gardens: The sustainable conservation of Casa Jelinek in Trieste (Italy). Sustainable Cities and Society, 97: 104767. https://doi.org/10.1016/j.scs.2023.104767
[18] Ahmad, B. (1995). Urbanization and urban development in the Muslim World: From the Islamic City Model to megacities. GeoJournal, 37(1): 113-123. https://doi.org/10.1007/BF00814892
[19] Rossi, A. (1982). The Architecture of the City (Opposition Books). The MIT Press.
[20] Nakanishi, H. (2014). Urban transformation, transit oriented development and the sustainable city. Australian Planner, 50(2): 175-176. http://doi.org/10.1080/07293682.2012.670121
[21] Abdelmonem, M.G., Selim, G., Mushatat, S. (2017). Virtual platforms for heritage preservation in the Middle East: The case of Medieval Cairo. Archnet-IJAR: International Journal of Architectural Research, 11(3): 28-41. https://doi.org/10.26687/archnet-ijar.v11i3.1404
[22] Vafaie, F., Remøy, H., Gruis, V. (2023). Adaptive reuse of heritage buildings; A systematic literature review of success factors. Habitat International, 142: 102926. https://doi.org/10.1016/j.habitatint.2023.102926
[23] Al-Jaberi, A., Al-Khafaji, A., Ivankina, N., Al-Sawafi, M. (2019). The idea of pedestrian pockets as a key for successful transit-oriented development for Najaf city Republic of Iraq. IOP Conference Series: Materials Science and Engineering, 698(3): 033029. https://doi.org/10.1088/1757-899X/698/3/033029
[24] Steurer, M., Bayr, C. (2020). Measuring urban sprawl using land use data. Land Use Policy, 97: 104799. https://doi.org/10.1016/j.landusepol.2020.104799
[25] Al-Ansari, H.A., Al-Khafaji, A.S. (2023). Enhancing public health through sustainable urban design: An examination of transportation and green space integration. Journal of Urban Development and Management, 2(2): 104-114. https://doi.org/10.56578/judm020205
[26] Hussein, W.A., Al-Khafaji, A.S. (2023). Planning and preservation of natural areas in urban contexts: Application of biophilic approach in Kufa City. International Journal of Sustainable Development & Planning, 18(9): 2829-2837. https://doi.org/10.18280/ijsdp.180921
[27] Alrobaee, T., Al-Khafaji, A., Al-Jawari, S. (2021). Measurement of physical environment characteristics for supporting transit-oriented development areas for the Kufa city-Iraq. International Journal of Scientific & Engineering Research, 12(1): 635-642.
[28] Im, H.N., Choi, C.G. (2019). The hidden side of the entropy-based land-use mix index: Clarifying the relationship between pedestrian volume and land-use mix. Urban Studies, 56(9): 1865-1881. https://doi.org/10.1177/0042098018763331
[29] Al-Khafaji, A.S.J., Al-Salam, N.A. (2018). Measurement of urban sprawl and compactness characteristics: Nasiriyah City-Iraq as case study. International Journal of Civil Engineering and Technology (IJCIET), 9(9): 335-343. https://iaeme.com/MasterAdmin/Journal_uploads/IJCIET/VOLUME_9_ISSUE_9/IJCIET_09_09_035.pdf.
[30] Dawod, G.M. (2012). Principles of GIS spatial analysis (in Arabic). Holly Makkah, Saudi Arabia. http://doi.org/10.13140/RG.2.1.3328.4322
[31] Cervero, R., Sarmiento, O.L., Jacoby, E., Gomez, L.F., Neiman, A. (2009). Influences of built environments on walking and cycling: Lessons from Bogotá. International Journal of Sustainable Transportation, 3(4): 203-226. https://doi.org/10.1080/15568310802178314
[32] Highway Capacity Manual (2000). Washington, D.C: Transportation Research Board, National Research Council. https://sjnavarro.wordpress.com/wp-content/uploads/2008/08/highway_capacital_manual.pdf.
[33] Al-Mosawy, S.K., Al-Jaberi, A.A., Alrobaee, T.R., Al-Khafaji, A.S. (2021). Urban planning and reconstruction of cities post-wars by the approach of events and response images. Civil Engineering Journal, 7(11): 1836-1852. https://doi.org/10.28991/cej-2021-03091763
[34] Ujang, N., Kozlowski, M., Maulan, S. (2018). Linking place attachment and social interaction: Towards meaningful public places. Journal of Place Management and Development, 11(1): 115-129. https://doi.org/10.1108/JPMD-01-2017-0012
[35] Kennedy, H., Hill, R.L., Allen, W., Kirk, A. (2016). Engaging with (big) data visualizations: Factors that affect engagement and resulting new definitions of effectiveness. First Monday, 21(11): 1-20. https://doi.org/10.5210/fm.v21i11.6389
[36] Chen, Z., Dong, B., Pei, Q., Zhang, Z. (2022). The impacts of urban vitality and urban density on innovation:

Evidence from China's Greater Bay Area. Habitat International, 119: 102490 https://doi.org/10.1016/j.habitatint.2021.102490
[37] Alrobaee, T.R., Al-Khafaji, A.S., Al-salam, N.A., Al-jaberi, A.A. (2023). The safer city: A new planning perspective for the Traditional City development. International Journal of Safety & Security Engineering, 13(1): 139-149. https://doi.org/10.18280/ijsse.130116
[38] Al-Jaberi, A.A., Al-Khafaji, A., Ahmed, S., Al-Salam, N.A., Alrobaee, T.R. (2021). The crossing as a new approach for the urban transformation of traditional cities towards the sustainability. International Journal of Sustainable Development & Planning, 16(6): 1049-1059. https://doi.org/10.18280/ijsdp.160606
[39] Peiravian, F., Derrible, S., Ijaz, F. (2014). Development and application of the pedestrian environment index (PEI). Journal of Transport Geography, 39: 73-84. https://doi.org/10.1016/j.jtrangeo.2014.06.020
[40] Garzillo, C., Balenciaga, I., Izulain, A., Escribano, T.R., Wildman, A. (2020). Adaptive reuse of cultural heritage—An examination of circular governance models from 16 international case studies. Synthesis Report, 64: 15-56. https://www.clicproject.eu/wp-content/uploads/2019/11/Circular-governance-models-Report_b.pdf.
[41] De Gregorio, D., Aguilar-Valles, A., Preller, K.H., Heifets, B.D., Hibicke, M., Mitchell, J., Gobbi, G. (2021). Hallucinogens in mental health: Preclinical and clinical studies on LSD, psilocybin, MDMA, and ketamine. Journal of Neuroscience, 41(5): 891-900. https://doi.org/10.1523/JNEUROSCI.1659-20.2020
[42] Sharifi, A., Farahinia, A. (2019). Evaluation of the adaptive reuse potential of historic buildings and proposition of preventive protective measures. International Journal of Building Pathology and Adaptation, 38(3): 493-507. https://doi.org/10.1108/IJBPA-07-2019-0057
[43] Zhang, X., Edelenbos, J., Gianoli, A. (2024). Identifying modes of managing urban heritage: Results from a systematic literature review. City, Culture and Society, 36: 100560. https://doi.org/10.1016/j.ccs.2023.100560
[44] Attia, H.N. (2008). Notes on the Expansion of the Sanctuary Roofing Al-Husseini Al-Sharif. Taf Printing Press: Karbala.
[45] Howard, I.K.A. (1977). 'Kitab al-Irshad' by Al-Mufid. Sibtayn International Foundation. https://www.sibtayn.com/en/index.php?option=com_content&view=article&id=2755:kitab-al-irshad-by-al-mufid&catid=317&Itemid=262.
[46] Pyla, P. (2008). Back to the future: Doxiadis's plans for Baghdad. Journal of Planning History, 7(1): 3-19. https://dx.doi.org/10.1177/1538513207304697
[47] Farhan, S.L., Abdelmonem, M.G., Nasar, Z.A. (2018). The urban transformation of traditional city centres: Holy Karbala as a case study. Archnet-IJAR: International Journal of Architectural Research, 12(3): 53-67. http://doi.org/10.26687/archnet-ijar.v12i3.1625
[48] Alrawe, M.K., Qasim, M.M. (2018). Simulating the movement of crowds in the Holy City of Karbala. KnE Engineering, 3(4): 225-240. https://doi.org/10.18502/keg.v3i4.2171
[49] Al-Abayechi, Y.F., Al-Khafaji, A.S. (2023). Forecasting the impact of the environmental and energy factor to improve urban sustainability by using (SEM). Civil Engineering Journal, 9(10): 2554-2567. https://doi.org/10.28991/CEJ-2023-09-10-013
[50] Savitri, M., Amalia, F. (2024). Technology and AI implementation in heritage adaptive reuse as strategy for sustainable and Smart City. Earth and Environmental Science, 1324(1): 012056. https://doi.org/10.1088/1755-1315/1324/1/012056
[51] Dheyaa Al-Shouk, N., Shamkhi Al-Khfaji, A. (2018). Toward sustainable Compact City: (Study in convert traditional Najaf city to sustainable Compact City). KnE Engineering, 3(4): 167-192. https://doi.org/10.18502/keg.v3i4.2168
[52] Abdulameer, H.N., Al-Jaberi, A.A., Al-Khafaji, A.S., Alrobaee, T.R., Al-Ansari, H.A. (2024). Evaluating of urban space vitality: The role of safety, security, and urban planning in the religion center of Kufa City, Iraq. International Journal of Design & Nature and Ecodynamics, 19(1): 155-167. https://doi.org/10.18280/ijdne.190118
[53] Kattanh, M.A., Al-Jaberi, A.A., Al-Mosawy, A., Kadhem, S., Al-Khafaji, A.S., Alrobaee, T.R. (2023). Estimating parking demand for commercial areas in Baghdad-Iraq. International Journal of Sustainable Development & Planning, 18(12): 3823-3829. https://doi.org/10.18280/ijsdp.181214