Role of urban malleability’s mechanisms on sustaining cities

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Abstract. Urban sprawl in Iraqi cities and the dynamics of changes in their urban centers has led to accumulating changes that embody in forms that lacking most of their historical planning, architectural, and traditional identity. Building on such nature, allows for preserving references to mark the process of urban malleability within historical city centers, which serve the paths of growth and sustainable development at all scales and levels. Henceforth, the paper hopes to address a comprehensive theoretical framework of urban malleability and how to influence and guide urban malleability to maintain and improve present forms or develop new forms starting with the goals and principles of urban sustainability. This paper builds on recent studies of urban malleability for spaces, infrastructure, and building materials, reshaping them with a new vision that elevates cities towards sustainable perspective, then investigate and evaluating the proposed project for developing city center of Karbala, as local example, according to the concluded indicators of the framework. Furthermore, solutions are proposed to improve modern designs including; recognize the integration reorganization, restructuring and revival to upgrade the historical centers towards competitiveness; consolidating the strategies, components and systems of urban malleability to make a sustainable place within the city centers, adapting to changing conditions, and achieving human harmony.

1. Introduction
Urban malleability is a design strategy that manifests in reorganizing current urban structures in response to different forces and stimuli. Urban malleability strongly affects the sustainability and continuity of city systems throughout history. Achieving this malleability requires three main mechanisms: reorganization, reshaping, and revival. Henceforth, this study aims to develop a comprehensive theoretical framework that defines mechanisms of urban malleability in historic city centers. In addition, the study identifies the most important design indicators, testing these indicators in the proposed development project for Karbala's historic city centers, clarifying the possibility of applying them in the Iraqi cities with historical centers. This will need the following steps:
- Define the concept of urban malleability and its role in sustaining forms to identify the mechanisms of malleability and the most fundamental components and principles that upgrade historical city centers toward malleability.
- Apply the vocabularies obtained from theoretical framework on the proposed development project for Karbala's city center and clarify its results on the malleability of the city’s various spaces and locations, then, analyze the results, provide conclusions and draft recommendations.

2. Urban Malleability
Urban malleability is defined as follows:
- The process of creating harmony between traditionally designed structures built in the midst of developing spaces with more recent designs (Lambe et al., 2017). This harmony is attained by
integrating those structures with their surrounding areas using synthesis within functional reorganization. This strategy is affected by social, cultural, and modern forces in addition to the requirements of sustainable development. Such strategy also results in the derivation of forms that can be considered fundamental for aesthetic congruence in placemaking [1].

- Drafting with the goal of reform to create compatibility between contemporary functions and combine slum models with types and characteristics to achieve continuous forms with symbolic dimensions (Deutsch, 1992). Another goal is to reuse abandoned buildings to align with the environmental needs to achieve an urban scene that has aesthetic, local, and symbolic characteristics through simulation [2].

- Malleability is also regarded as making changes at the element level with relation to typology and breaking down related functions to a basic level that achieves continuity for shapes. Malleable architecture allows extensions and details (tailoring) in the creation of new flexible shapes for various contexts. Moreover, malleable architecture highlights the ideal component characteristics in complex urban systems and smart infrastructure. These characteristics are deployability, lightness, and configurability. The ability to be malleable can be judged from three characteristics: evolvability that represents the degree to which the architecture can be changed without negatively affecting the urban environment, extensibility that is the ability to add new functions to a system, and customizability that represents the ability for function specialization and building simple architectural components that allow for development [3].

- A process that organizes, intervenes, restores, preserves, modifies, uplifts, and analyzes edge environments. Malleability is a new idea that helps read and develop urban codes for traditional contexts by mixing social aspects and spatial morphology. Malleability is a key for morphological transformation and handles element connectivity by explaining its characteristics and reflection on the city, reshaping spatial relations, and showing the context of current modern values for society. Malleability creates active shapes that can be used to enhance the space’s vitality. These shapes guarantee continuity and balance of social typology for traditional contexts. This balance can be considered the main element in achieving social and environmental response [4] & [5]

- Malleability is also defined as reshaping or reproducing sustainable urban spaces that respond to environmental, social, financial, and spatial transformations. Simultaneously, its sustainability and connectivity are maintained between the infrastructure and government policy by deconstructing and modifying space infrastructure using three approaches: walkability to describe the physical relationship between the space and its liveability, rhythm to understand the spatial and time-based transformations, and political dialogue that involves the infrastructure management [6].

- Making the infrastructure of a space malleable (contextual modification and rhythmic change) helps in interactive rebuilding and rehabilitation of urban areas to improve understanding sustainable diversity in locations, land use, and urban morphology (Ibid, p.20). Hence, contextual modification occurs in light of the relationship between the space and its surroundings. The rhythmic change includes altering the urban metabolism and the technical, physical, and social daily rhythms. Malleability is the process of changing the subjective perceptions of the environment through subtle manipulations that in turn affect environmental behavior. The aims are to find environmentally friendly behaviors and promote a more sustainable future in compliance with contextual factors and technological progress, particularly with regard to consumption level, options, and types [7].

- Tzimopoulou et al. (2017) address urban malleability within the concept of renewing the image of the urban landscape in response to dynamic, social, economic, and environmental changes. The goal is to elevate cities toward the perspective of sustainable design where the urban landscape is an area of culture, functionality, and production that follows ecological, infrastructural, and planning requirements. Urban malleability can be organized through qualitative criteria into spatial and functional that include project scale (from small scale like cultural landscapes, dilapidated and
fragmented spaces, and urban contact between places to large scale of infrastructure projects, such as those that go beyond borders); type of intervention such as design, restructuring, or reuse; and flexible and open nature [8].

- Malleability could also be divided into a number of fundamental values: flexibility that can slightly change building planning; convertibility that can change function inside the building; expandability or the ease of placing additions to buildings; and other values that improve environmental and functional performance in the long term. The latter includes durability that embodies choosing good building materials, synthesis, and systems that require maintenance, fixing, and replacing items that reduce malleability. Furthermore, the design principle for disassembly that facilitates the dismantling of products and assemblies that allow components to be easily reused or recycled are also considered. This ability, in turn, reduces the costs and environmental impact associated with making buildings malleable or deliberately designing temporary buildings with various temporary exhibition halls [9].

Henceforth, we can define urban malleability as a strategy to achieve the agreement, guiding, redrafting, controlling, and affecting of shapes according to generating mechanisms under the strong outside forces”. Malleability is an intentional change and modification that sustains urban systems and guarantees continuity. Moreover, it is the exchange between the driving forces that affect existing shapes and push for its modification and response. The transformation and movement toward new designs are derived from the rules of traditional architectural by reorganizing, reshaping, or revival.

Urban malleability within city centers could be organized into spatial and functional criteria that includes the following: project scale (small, medium, and large); type of intervention (design, repair, restructuring, and reuse); and flexible or open nature. Malleability characteristics can be analyzed using the following criteria: evolutionary capability, extension, adaptability and customization based on the principle of flexibility, scalability, durability, and the ability for disassembly.

3. Mechanisms of Urban Malleability
This section includes highlighting different proposals regarding the mechanisms of urban malleability and its role in activating city centers by repairing their most deteriorated spaces. This section also attempts to improve and reorganize the structures functionally, socially, dynamically, and historically as deliberate interventions within the existing context. Moreover, the objective is to review a number of international and Arab studies to build a comprehensive theoretical framework for this study.

- Celikyay (2010) point to the sustainability of cities in light of the mechanisms of urban malleability. Such mechanisms include the following: revival and adaptive employment of historic centers; integration of historical parts and organization of their relationship with other and all parts; intervention with either urban restoration and restructuring of spaces surrounding the target historical center or re-linking the area with the city center. The last mechanism is achieved through three alternative indicators. First, the original function of the building is displaced and invested in tourism, which connects the space’s identity with its original function. The second indicator refers to the re-employment of the historic building with a new function that benefits the community, such as by turning the building into a community service center that is complementary to its basic function. The third indicator focuses on giving the structure a new and distinct identity in the urban environment to attract different segments of society. Urban malleability with regard to historical centers is reflected in several patterns. The first is functional in light of the mechanism of land use regulation either by rehabilitating existing buildings or introducing new buildings. Such buildings fit with the unique function of historical buildings and integrated with the functional structure of the urban center. Second is the pattern of malleability for movement in terms of accessing historic centers. The objectives are to connect to city centers through public transport and then reevaluate and re-employ those buildings.
with historical importance in line with the new identity of the place, in addition to functional attraction within historic districts and centers [10, 11].

- Elnokaly et al. (2013) refer to sustainable urban conservation in historical city centers as a means of malleability (intentional change). They define malleability as a strategy that respects the continuity of history and traditions and the needs and cultural aspirations of the population. This strategy includes certain mechanisms such as: maintaining and restoring older structures; introducing new structures, different in characteristics and significance but have a common identity between the past and the present; rehabilitating deteriorating spaces; and the adaptive reuse of historical buildings either in their original function or in a suitable new function that ensures integration and compatibility with the environment; rebuilding communities by increasing employment, reducing poverty, and empowering the population to participate in management and planning while reviving traditional crafts to promote economic and social development; connecting tourism and culture by activating archeological and anthropological values; reproducing the ideal urban characteristics and standardizing the basic characteristics of historical areas while preventing their decay; developing environmental awareness programs; adapting physical structures with contemporary requirements; creating movement paths consistent with functional change; improving the physical and architectural environment along with the social fabric and urban spaces within historical structures; renewal of historical sites to reaffirm the sense of identity and belonging of the population; weaving different parts of the city in a single cohesive unit; increasing spatial access to public services and employment; repairing or replacing the damaged parts of historic buildings while maintaining the original layout as much as possible; and rebuilding the traditional urban fabric and infrastructure in harmony with the existing morphology of the old city [12].

- Carmona and Heath (2003) address a series of malleability patterns of historic centers or buildings as restoration, preservation, conservation, refurbishment, consolidation, reconstitution, conversion, reconstruction, replication, facades, redevelopment, and demolition [13].

- Stratis (2014) refers to a sustainable city as adaptive and malleable, accommodates uncertainty, and promotes urban continuity and cohesion based on hybridization between natural and artificial (constructed) environments. Moreover, such city reconnects regions and generates new ones through multi-scale connections, using diversifying programs and functions to connect infrastructure networks, in addition to promoting urban porosity [14].

- Al-Hinkawi and Mohammed (2015) look at the malleability mechanisms within the historical city center in accordance with its varying values with its surroundings. Thus, malleability strategies for buildings are as follows: restructuring land use and finding a planning reference to guide newly added elements for structures that are highly distinctive embodiments of history; restructuring land use within a directed context for less distinctive buildings. Contextual buildings rely on the revival of its original traditional functions and restructuring the urban landscape as a design reference that encourages continuity for the traditional identity and full homogenous integration [15].

- The concept of the “Malleable city” refers to the possibility of creating a sustainable place where space consumption is minimized and the intensity of urban interactions are maximized. This city that can be changed (malleable) is where reorganization and improvement happen through polyvalence, modularity, and alternating usage for public places and buildings with different timescales (years, seasons, or days) and spatial scales (housing schemes, neighborhoods, and streets). Malleable cities are not ruptured or fractured but rather work in a smart and collective way. In such cities, experimentation and even the ability to fix mistakes is possible to revive its most neglected spaces [16].

Hence, the sustainable city is one that adapts to change (malleable) in function, meaning, and shape. Such city achieves malleability under the influence of social, political, industrial, structural, environmental, or cultural forces. In addition, city space consumption is minimized, whereas the
The intensity of urban interactions is maximized. Moreover, the sustainable city works in an intelligent collective manner, has room for experimentation and the ability to fix mistakes to revive neglected spaces; has active, competitive, vibrant, and economically feasible city centers; accommodates uncertainty; achieves urban cohesion; and attempts to direct, balance, and connect the needs of historical centers with the diverse community requirements using conservation-oriented development.

4. Literature Review

The research reviewed the following studies to build a comprehensive theoretical framework on the role of urban malleability in sustaining cities.

4.1. Paio et al.’s (2011) “Emerg.cities4all: Toward a sustainable and integrated urban design”

Paio et al. (2011) investigates the concept of urban malleability by describing it as maintaining intervention at various levels, from the physical level of the city to the building construction system. The goal is to generate urban forms or residential units that are affordable, sustainable, scalable, and adaptable, address random spaces, and respect the historical, social, and cultural values in the context of new emerging cities. This study results from the activation of numerous mechanisms including the following: diversity of urban functions; repetition of a typological unit with rhythm; organized and engineered transformations according to diverse user needs; mechanism of social organization and self-construction of slum-like settlements; division of existing urban systems into modules that replicate generating new shapes linked visually and spatially with the context; ability to provide alternatives or solutions that accommodate varied types of everyday life; association by extension with the system by identifying in-context special central areas or points that connect with other spaces; ability to create new urban units that achieve the city’s continuous identity across all levels; rooting and inclusion of inherited human values and customs, including them in creating suitable, urban morphologies; and systematic allocation of habitable spaces in terms of strengthening social and anthropological relations of urban and residential experiments [17].

4.2. Lincoln et al.’s (2018) “The Inherent Malleability of Heritage: Creating China’s Beautiful Villages”

Lincoln et al. (2018) work on making historical heritage malleable as a strategy for improvement and a policy of modernization and development. Such policy can create beautiful, sustainable villages that guarantee social, economic, cultural, and environmental development. This study reveals guidelines by which rural development can be stimulated to transform the area into tourist attractions. A strong focus is given to the following mechanisms: promotion of biological variety, integrating built heritage with the natural environment; reorganization of visual paths with the city center; link of visual relations of the built heritage with nearby spaces; homogeneous integration of the functional and formal transformation of the historic building while preserving its identity; activation of local capital; preserving cultural heritage that are embodied in museums and historical sites and connecting them for tourism; contextual compatibility between the historical building and its surroundings through the continuity of its design characteristics; restoration of local heritage to produce new urban forms that combine the old with the new, and reuse of historical structures in light of the nature of policy-making and specificity of implementing those policies; urban reinterpretation of historical buildings associated with their contexts, natural, cultural, and social environments; replacement of ruined buildings with new ones designed with the historical traits such as proportionality, scale, color, and nature of blocks; restoration of building materials used to maintain the sustainability of traditional and ecological architecture to use them in future plans.

The process of making the village (Shuangyi in the Zhejiang Province) malleable includes three different scenarios. First, temples, ancestral halls, shrines, and other historical spaces are converted into tourist attractions or educational institutions. Such institutions include those serving the local community and the historical value of those spaces are invested for the needs of the local and tourist populations. The second scenario concern the restoration of original religious functions of those spaces.
as a catalyst for development. Finally, historic spaces are used for other functions that preserve its unique and valuable identity while creating job opportunities, sustainability, and development [18]. Figure 1. shows the three scenarios.

![Figure 1.](source: Google Image, zhejiang province.com)

| (A) Reusing heritage for new functions that make opportunities for development and maintain its identity. | (B) Reviving the original functions of the structures and rooting their value by adding elements and reshaping. | (C) permeability of reshaping as it integrates historical buildings with the natural environment as a tourist destination attractive. |
|--------------------------------------------------|--------------------------------------------------|--------------------------------------------------|
| (source: Google Image, preserve street in China zhejiang province.com) | (source: Google Image, wenzhou zhejiang province.com) | (source: Google Image, China Zhejiang) |

**Figure 1.** The scenarios of making heritage Malleable in the province of Zhejiang towards making a sustainable city using the mechanisms of transformation, restoration and expansion and adaptive reuse.

4.3. Creagh’s (2018) “Design Tactics for Urban Places Fragmentation and Malleability in attachment to contested and changing cities”

Creagh’s (2018) study referenced urban malleability as a tactical design strategy that creates sustainable spaces and encourages its development and redevelopment consistent with the overall context. This study facilitates working with cities as sites where meaning changes, cultures are displaced, and architectural details are diversified within urban settings. This process relies on certain mechanisms that include the following: enhancement of the population’s opportunity in reviving traditional functionality and including them in participatory community planning; spatial connectivity forming a new identity through physical maintenance of the old structure; connecting spaces visually and dynamically; segmenting the overall picture that enables reading the interactions while working as spatial contributions; deriving models of places where the levels of experience, process, and meaning overlap with the mechanism of interaction with places in their dynamic/plural/interrelated nature; and promoting connectivity and openness toward changes that achieve originality and develop a sense of belonging [19].

4.4. Wang et al.’s (2019) “Sustainability of Historical Heritage: The Conservation of the Xi’an City Wall”

Wang et al. (2019) investigates sustainability of historical heritage in light of urban malleability, which is embodied in the revival of the wall around the city of Xi’an. Its maintenance integrates with contemporary development projects using a number of indicators, which include the following: combining the processes of improvement and rehabilitation of historical buildings; gathering different elements and parts of historical buildings according to the collage formula and attempting to invest them in generating new models and opportunities for development; opening new gates to help maximize conservation while also meeting the needs of urban transport; transporting the wall into a general urban space that aims to restructure the city in a way that integrates with the ecological natural system; combining social activities and events in public spaces; supporting traditional style as a criterion in designing new spaces; connecting urban malleability with the rest of the city through continuity and visual connectivity between contexts with other buildings; balancing between preserving historical heritage and transforming the natural urban heritage; maintaining the quality of the human environment and sense of location; establishing protected areas and connecting them with a network of infrastructure for the continuity of the cultural value of the heritage; updating the functions of the city wall as a way to enrich life and provide more long-term value; using special laws to manage
maintaining cultural archeology, rehabilitation of urban edges, and rebuilding its ruined parts with a green belt that makes the city an entertainment venue; analyzing the relationship of historical axes within a cohesive urban fabric to reduce the risks of environmental pollution and to spread and occupy abandoned land; improving the functions of the natural ecosystem; and including urban malleability in the formulation of a future sustainable development plan.

This study describes urban malleability as a strategy for development, guiding, conserving, revival, management, and planning in response to environmental, social, economic, and contemporary changes that do not regard the health of historical cities and their natural landscapes. Hence, this study revives cities by combining maintenance of heritage and introduction of contemporary changes toward the idea of the sustainable city that is suitable for living [20], as shown in Figure 2.

![Figure 2. Shows reviving the traditional sustainable heritage of Xi'an City as a mechanism Malleability with contemporary spaces and achieving contextual harmony with existing historical features and styles.](source: Google Image, xi'an city china street.com)

4.5. Suleiman and Awad’s (2011) “The Methodology of dealing with areas of historical value: a case study of the Cairo area”

Suleiman and Awad (2011) looked at the mechanisms of urban malleability for zones with a historical significance within the surrounding context. Urban malleability os described as an intentional design strategy for changing that integrates the new with the old. The objectives are to achieve conservation of historical zones, improve the physical existence and spatial-visual connection with the current form, maintain everyday activities, and achieve sustainable development. These mechanisms can be separated into the following: conservative-revival that embodies the protection, restoration, maintenance, and analogous repair; mechanisms of reshaping that embodies recreating, restoring, removing, and the completion of missing parts; maintaining the traditional characteristics of the building within itself and also when designing new buildings, complete and gradual replacement, and maintenance of facades with radical building development (facade retention); rehabilitation mechanisms, including a functional, social, environmental uplifting, and modification to restore adaptive use and function; mechanisms of rebuilding in filling spaces between buildings and utilizing abandoned spaces with temporary activities; typology transformation of traditional characteristics and utilizing them in preparing guidelines for new urban design; integration of regulations and laws relating to the legislation of historic areas and the principles of sustainable development; developing awareness programs about the importance of malleability to heritage within future projects; sustaining links and buildings (space-related spirituality); functional continuity of new activities and their relation...
with previous uses and the overall architecture for the urban context and with the community culture. These mechanisms are applied to the area of Khedewi Cairo that is known for having a homogenous architectural character that links different styles that share the same height and relatively the same straight roads [21], as shown in Figure 3.

![Figure 3. Mechanisms of urban Malleability for Khedive Cairo as a change that reuses old structures in a way that connects the past with the future and intensifies creative sustainable activities. Source: (Google Image, Cairo Khedive. Com)](image)

Based on these studies, mechanisms of malleability has a reviving, organizing, and a reshaping role in developing and sustaining historical city centers. Malleability is regarded as the means to deliver the spatial identity of the city in addition to the original function of buildings. Malleability allows older structures to become cohesive with its contemporary uses and practices. This cohesion is due to developing practices and mechanisms that respect the continuity of history, population requirements and cultural aspirations, structuring-repairing in redesigning spaces, and activating functionally, dynamically, and socially spaces. Malleability generates buildings that uplift the past in creating shapes that deal with similarities and identically and also differences by harmonizing and taming, as shown in Table 1.

| Mechanisms of urban Malleability on sustaining cities | Indicators |
|------------------------------------------------------|------------|
| Balance between conservation and change in creating the future shape of the spaces, as a reference to stimulate sustainable spatial development | - Accommodates with the previous style and can respond to new conditions and changes.  
- Contextual modifying of the relationship between the space and its neighbors.  
- Synthesizing new and old structures together to achieve connectivity.  
- Displacement of the original function of the building and confirming its tourism investment.  
- Giving a new and clear identity to the urban environment.  
- Functional attraction within historical sectors and centers.  
- Creating movement paths consistent with functional change  
- Diversity in urban functions  
- Contextual compatibility between the historical building and its surroundings through the continuity of its design characteristics.  
- The functional continuity for new activities and their relationship to the previous activities and its association with culture of society as a whole. |
| Functional | - Integration of historical buildings with contemporary intervention in a compromising correcting style that tried to keep traditional characteristics and patterns  
- Displacement of the original function of the building and confirming its tourism investment  
- Giving a new and clear identity to the urban environment  
- Functional attraction within historical sectors and centers  
- Creating movement paths consistent with functional change  
- Diversity in urban functions  
- Contextual compatibility between the historical building and its surroundings through the continuity of its design characteristics  
- The functional continuity for new activities and their relationship to the previous activities and its association with culture of society as a whole |
| Displacement of the original function of the building and confirming its tourism investment | - Simulation, transport and imitation of different European models in the derivation of new buildings in a manner that accommodates their cultural value |
| Interactive | - The continuity of the cultural typology within the traditional context.  
- The public participation in decision making  
- Providing green spaces that achieve an interaction between the inhabitants and the natural environment  
- The convergence between tourism and the culture by activating archeological and anthropological values.  
- Social organization and the self-assessment for slums areas.  
- Merging social activities in public spaces.  
- Reinterpreting historical structures by looking at its relationship with its natural, cultural and social environment. |
| Rhythmic | - Rhythmic change of the flow of everyday urban life.  
- Repeating a typological unit.  
- Dividing the urban system into ideal typical units that repeat to create rhythmic shapes.  
- Providing alternatives or solutions that are compatible with the rhythm of everyday life. |
| Ecological | - Adapting with environmental change.  
- Preserving natural environments and biological diversity.  
- Hybridization between natural and artificial environments  
- Balancing heritage and the creative transformation of urban landscape. |
| Connectivity | - Hierarchical connectivity for elements and relationships.  
- Place making that achieves the values of aestheticism  
- Creating a connecting urban space that encourages the porosity of the city.  
- Connecting the space with the infrastructure in a variety of scales.  
- Reconnecting the area with the center of the city visually and spatially.  
- Connecting the historical building with the city’s system of public transportation.  
- Spatial accessibility to the general public services.  
- Connectivity through expansion with the cities central points.  
- A spatial of massive connectivity to physically sustain traditional buildings.  
- Visual continuity to organize different pathways and spaces.  
- The connectivity of the infrastructure and government policy.  
- Encouraging walkability as a way to describe the physical relationship between the space and its liveability.  
- Political dialogue that relates to the presence of the policies of infrastructure management. |
| Mechanisms of Reshaping | Improvement | - Functional Improvement by adding or displacing functions  
- Spatial polyvalence, modularity and alternating usage for public places and buildings  
- Structural improvement to give the building’s components the ability to withstand weather conditions. |
- The system of urban spaces and how it relates to land use
- Restoring the unique traditional style
- Removing intruding elements from the building
- Replacing or mending missing or damaged pieces
- Investing the characteristics of traditional buildings in designing newer buildings.
- Full and gradual infill of historical buildings within the urban context
- Façade retention with a fundamental development of the buildings
- Renewing historical sites to encourage the sense of belonging and identity of the population.
- Weaving the different parts of the city into one cohesive unit
- Harmonic integration of a historic building and the functional and morphological transformation of the surrounding area
- Grouping unique elements and components of historical building by collage

- Achieving balance between the contradiction and differentiation of current and added elements.
- The adaptive reuse of historical buildings
- Social, functional, and environmental upgrade and improving the building’s level
- Adapting physical structures and activities with contemporary requirements
- Making improvement process compatible with the rehabilitation of existing historical buildings
- Supporting the traditional style as a criteria for designing the styles of contemporary spaces

- Merging slum forms with traditional active styles
- Transforming traditional places into centers of community service
- Activating neglected spaces between buildings with spontaneous activities
- Introducing new different building in meaning and characteristics that shares a common identity
- Copying the characteristics of the ideal urban fabrics and consolidating the fundamental traits of traditional places and stopping its ruin
- Merging special laws that deal with historical areas and the principles of sustainable development

- The preserving and strengthening of buildings that have historical value like temples, museums, shrines, walls and global heritage sites and attempting to invest it in tourism
- Restoring older structures while expanding the addition base of integrated buildings with the neighboring fabric
- Strengthening and supporting traditional crafts and encouraging social and economic development.
- Borrowing myths and cultures from the past.
- Opening new gates that help the process of sustainable conservation.

5. Mechanisms of Malleability in sustaining the Karbala historical city center
Karbala is one of the most significant religious cities in Iraq. This city is unequal in its architectural and historical characteristics and the uniqueness of its historic shrines, bazaars, and streets within its urban center. Moreover, this city has the characteristics of connection permeability between archeological and tourism sites and other Iraqi cities such as the capital, Baghdad. The city center of Karbala contains many unique elements and components of everyday life that restores the city structure and strengthens its collective memory [22].
5.1. Reasons for choosing Karbala city center for the case study

- Contemporary development projects are conducted in Karbala to rehabilitate the old city. The project objective is to make the old city a malleable fabric in deriving sustainable forms depending on formal architecture rules while respecting cultural, historical, and religious values of the city.
- The city is gained symbolic and cultural importance after the fort of Al-Ukhaydhir is included as a UNESCO world heritage site.
- The opportunity to promote urban tourism and transform the historic area or building into a catalyst for sustainable development and the integrated reviving regeneration, as shown in Figure 4.

Figure 4. The location of the Karbala city center and its most important historical landmarks as a reference for sustainable urban Malleability (Source: Google Images, 2018)

5.2. Development project for Karbala historical city center

The General Directorate of Urban Planning at the Ministry of Municipalities and Public Works contracted with a company (Diwan) to design the project of reviving and renovating the old city in Karbala. The design includes streets and buildings with historical value and heritage markets. The study presented a set of formal alternatives to adaptation that achieve the following objectives [22]:

- Make the existing urban fabric of the old city malleable, employ the historical heritage in the placemaking, and strengthen the religious and historical identity of the region in accordance with the mechanisms of revival and renewal
- Develop and expand the zones of the two shrines and the spaces in between that link them, accommodating their importance within the city in addition to creating a balance between achieving requirements and minimizing intervention with the traditional existing fabric during maintenance
- Rehabilitate historically, religiously, culturally, and architecturally significant buildings and conserve them with intentional levels of intervention, such as maintenance, replacement, restoration, rebuilding, and renewal.
- Improve urban and environmental conditions, uplift social, economic, and aesthetic spaces, and connect those spaces with the infrastructure network to serve the local population and tourists
- Adopt new (or different) ways for dealing with urban historical heritage in the city center, to find new interpretations and generate innovative solutions to local problems that in turn enhance aspects of identity and simulation of events within the place
- Promote social and cultural cohesion and achieve sustainable development of the region in light of investment opportunities for the physical and intangible historical value of the building
- Present landmarks, symbols, buildings, or geographical locations relevant to religious and historical events while respecting religious significance and maintaining the continuity of local identity and culture
• Work with the concept of participatory planning to emphasize the involvement of the community in all decisions and stages of project design, planning, and implementation to promote a sense of spatial belonging
• Determine the technical, structural, and urban specifications of existing and new structures and their added economic functions, while respecting the traditional style of architecture, preserving the heritage and re-employing it in a contemporary style (making it malleable) such as through construction materials, typology of facades, organizing streets, squares, building setbacks, and heights

The proposed design to make these spaces malleable and revive the local heritage within the historical center presents the following set of design principles: adaptive and context-sensitive development; communication in the installation of old and new structures; urban continuity of elements, axes, activities, and heritage features in the integration of heritage conservation with adaptive reuse and green construction; physical and moral interconnection between religious shrines and marginalized historical spaces; enhanced visual integration; spatial proximity of the shrines as a focus for restoring and repairing the rest of the fabric; and strengthening and supporting traditions and popular customs of the city (Diwan, 2012), as shown in Figure 5.

Figure 5. generating a new morphology based on the mechanisms of Malleability that embodies in emulating historical values in a contemporary style, the addition with strengthening and maintenance, visual and spatial continuity for previous pattern and types and the modification and connection of the contextual relationships of the spaces with surroundings. (Source: Diwan 2012)

5.3. Analysis of design proposal
This section analyzes the design proposal for urbanization and traditional malleability mechanisms of the urban fabric and heritage buildings within the historic city center of Karbala. Moreover, this section transforms these mechanisms into a catalyst for sustainable development that integrates the past with the present.

Indicators for reorganization mechanisms are embodied in the following: restructuring land use and management; bridging and functionally connecting the historical buildings with public policies and surrounding places; dividing the existing urban system of the old city into seven neighborhoods as ideal units that are guided for future development with the inclusion of heritage; connecting land use with the urban road network within the style of homogenous integration with multi-scale infrastructure systems; determining the common typology (religious) as a reference to organize the rhythms of everyday life and choose the types of other uses; guaranteeing variety in urban land use among its commercial, residential, service, and recreational aspects; determining and using the podium between the ground and middle levels as a unit of shape to repeat in other levels; aligning the buildings into one line to achieve continuity and harmonious sensation; designing outdoor condors, shading them for pedestrian movement, and connecting them with the different spaces and podiums in surrounding spaces to describe the relation between the space and it’s liveability; shaping green, open spaces to
encourage their spirituality while creating an environment that interacts with humans and encourages spontaneous activities in neglected spaces (this indicator supports the values of sustainable development and public safety); creating a connecting urban space between shrines to spatially and functionally show traditional characteristics and religious importance; encouraging porosity in linking the historical center with other parts of the city; and making places with aesthetic traits on the level of furniture and ease of movement for streets and pathways [22]. Figure 6 shows the all of these findings.

Figure 6. Using reorganization as a mechanism for the strategy of urban malleability in the historical city center of Karbala (Source: Diwan 2012).

The reshaping mechanisms adopted in the study are as follows: coordination between the system of laws and legislation of heritage buildings with sustainable urban development standards; modification of existing land use areas adaptively to change; changes in functions incompatible with prevailing use and transforming them into functions consistent with the target development area; reinforcement of facades related to buildings, that is, weaving parts and structural elements in a coherent design unit; rehabilitation of buildings of historic value for societal uses; creation of sustainable historical areas where old elements and different parts are grouped according to the collage formula and in a modern adaptive style inspired by the old Karbala heritage and form (to serve as a living memory for future generations of inhabitants of the old city and its tourists); and finally, natural surveillance of these spaces to encourage weekly, monthly, or daily alternative uses of public spaces and habituating them continuously [22], as shown in Figure 7.

Figure 7. Using reshaping as a mechanism for the strategy of urban malleability in the historical city center of Karbala (Source: Diwan 2012) & (Alansari, 2006 P.225-226)

The style of malleability of historical buildings to preserve them and consolidate their value oscillates between mechanisms of revival, reshaping, and reorganization, as follows: buildings of distinctive historical, religious, and heritage importance are preserved in the same location and model with the
need to highlight their value by creating a space separator from neighboring buildings. Facades of existing buildings are repaired and protected from deterioration through consolidation of different current building elements. The historic wall of ancient Karbala is revived and rehabilitated through addition and improvement. In the case of the heritage building being near one of the elements of the proposed urban design, such as one of the structural components of the mosque, the whole building is considered through organizational–functional mechanisms. Specifically, these mechanisms include contextual adjustment of the building in an integrated manner with its surroundings without affecting the physical sustainability and historical continuity of these important landmarks. **In addition, buildings of medium importance** are rebuilt in a similar manner to their original heritage. Adjacent buildings can be added in harmony with the surrounding urban fabric to create larger heritage communities that benefit the community, in consideration of the possibility of using them as tourist investment sites with suitable activities. **Buildings that would be removed by expansion** can be rebuilt in proposed locations, with spaces that may be larger or smaller, in the same form, style, and original characteristics. Moreover, such buildings are considered as a catalyst for the creation of other projects such as bazaars, walls, recreational halls, and historical buildings. Finally, **buildings of low importance** can be reconstructed and restored in the proposed new places, either in light of the complete and gradual replacement of different styles and patterns. Alternately, they can be revitalized in the same form and old style, with the importance of establishing its significance and moral value [22], as shown in Figure 8.

![Figure 8](image_url)

(A) Historical buildings that could be restored, restructured and rebuilt  
(B) Revival of the old Karbala city wall and rehabilitating it as a historical building with great significance  
(C) The analogous repair of facades by emulating original patterns and consolidating their elements

**Figure 8.** Using revival as a mechanism and integrating it with other mechanisms for the strategy of urban malleability in the historical city center of Karbala (Source: Diwan 2012)

6. **Conclusion and Recommendations**

6.1. **Conclusion**

The research investigate the policy of compatible development with the historical pattern of city's centers in the light of activating urban malleability strategy and its mechanisms that deal with traditional elements and relations in a contemporary manner are activated. This presente a design reference for the added elements and improve existing forms that could work as a deliberate structure in the preservation and revival of heritage. The research presented a comprehensive theoretical framework that support the malleability strategy as a stimulus for urban sustainability. This case study for the proposed development project for Karbala's city center shows the reliability of analogic development within the context and typology of traditional spaces. The goal is to strengthen the local identity and find other sustainable historical city centers. Analogic development could be considered key for supporting physical, social, and economic revival in addition to cultural distinction. The study dealt with malleability mechanisms through the following perspectives: grouping urban spaces in a connected and continuous line to creates integration with all parts of the old city; achieving spatial balance with a continuous and harmonious sensations; and functional and aesthetic revival and restoration of the old city wall
of Karbala and most of its historical bazaars and public bathhouses. Finally, the adjustment of existing land use is in a way that is adaptive with changes and avoiding urban disagreements in the distribution of functions and scales of space.

6.2. Recommendations

- The historical buildings can be used as a stimulus for making existing structures malleable and positive changes at all levels of the urban fabric. Moreover, the following are also advised: balance between preservation processes and redevelopment of urban structure; consolidating the social cohesion, economic development, and improvement of the environment in addition to the sense of space and time.
- Investigate the different modes of malleability that vary according to the reference of influencing forces (such as malleability type of standard, parametric, cumulative, innovative, functional, evolutionary, cognitive, and relational).
- Document and involve historical buildings of distinctive value within their context in a new urban structure. Such a structure should ensure the transformation of these buildings into an attractive nucleus of tourism, a focal point that redefines the old historical center and adds value to existing elements.
- Visible and invisible strategies and elements of urban malleability should be enhanced to produce a sustainable place within city centers.

7. References

[1] Lambe N R and Dongre A R 2017 A shape grammar approach to contextual design: A case study of the Polhouses of Ahmedabad, India, Environment and Planning B: Urban Analytics and City Science 0(0), p.1-4.

[2] Deutsch C V 1992 Annealing Techniques Applied to Reservoir Modeling And The Integration of Geological and Engineering (Well Test) Data, a dissertation submitted to the department of applied earth sciences and the committee on graduate studies of stanford university in partial fulfillment of the requirements for the degree of doctor of philosophy, p.1-8.

[3] Piancastelli G, Benini A and Omicini A 2008 Ricci A. The Architecture and Design of a Malleable Object-Oriented Prolog Engine, sac ’08 Proceedings of the 2008 ACM symposium on Applied computing, Fortaleza, Ceara, Brazil — March 16 – 20, Pages 191-197.

[4] Mohammed G and Mahmoud N 2019 An Urban Code in Traditional Middle Eastern Contexts: The Edge Environment as a Central Theme for Reading the Social Pattern Language of Historic Sites", SAGE Open 9(1):215824401982560 January-March, p.1–17.

[5] Al-Hinkawi W and Al-Sadawi B 2019 Restoring the Local Heritage and its Role in Sustainable Spatial Development the Great Market in Al-Najaf – A Case Study, Engineering and Technology Journal vol.37, part C, No. 1, p.49-51.

[6] Sadoway D and Gopakumar G 2013 Disassembling infrastructure space: Tracing the links between infrastructure, urban space and governance, Paper presented at the International RC21, Research Committee 21 of the International Sociological Association (ISA), Urban and Regional SociologyAt: Berlin (Humboldt Universitat), p.2& 6 & 20.

[7] Benzoni K A, Li M and Thompson L 2007 Bazerman, M H. The Malleability of Environmentalism, Analyses of Social Issues and Public Policy 7(1), p.2-5& 25.

[8] Tzimopoulou M A and Bourliou A 2017 Urban Landscape Architecture in the Reshaping of the Contemporary Cityscape , IOP Conf. Series: Materials Science and Engineering, Published under licence by IOP Publishing Ltd, p.1-2 & 9.

[9] Russell P and Moffatt S 2001 Assessing the Adaptability of Buildings", IEA Annex 31 Energy-Related Environmental Impact of Buildings, November 2001, p.2

[10] Celikyay S, Dönmez Ş, Bollukcu P and Kahrıman E 2010 Ates O An urban design framework for sustainability of historical environment: A case of Safranbolu, Turkey", African journal of
agricultural research 5(12), p.1460-1466.

[11] Celikyay S, Donmez S, Kocan N, Ikiz E and Aydin P 2007 Cetinkale S G A Framework on urban design strategies for sustainability of cultural and historical dimension in urban landscape, Proc. of the 3rd IASME/WSEAS Int. Conf. on Energy, Environment, Ecosystems and Sustainable Development, Agios Nikolaos, Greece, July 24-26, p.330-333.

[12] Elnokaly A and Elseragy A 2013 Sustainable Heritage Development: Learning from Urban Conservation of Heritage Projects in Non Western Contexts”, European Journal of Sustainable Development, 2, p.31-51.

[13] Carmona M, Heath T, Carmona R and Oc T 2003 Tiesdell S. : The Dimensions of Urban Design: public places urban spaces, Editor Matthew Carmona, Architectural Press, Kent, UK Printed and bound in Great Britain, p.201

[14] Stratis S. 2014 Architecture-as-Urbanism for Uncertain Conditions, in Europan 12 Results Catalogue: The Adaptable City I, Europan editions, Paris, p.28-35. http://admin.brainserver.net/uploads/ucy/Essays/Architecture_As_Urbanism_For_Uncertain_Conditions/EU_R-12_Architecture-As-Urbanism-Stratis.pdf

[15] Al-Hinkawi W and Mohammed T. 2015. The Catalyst Historic Building in Urban Development, Journal of Engineering and Technology, Vol. 33, part (A), No. 7, Iraq, p.111-112.

[16] Gwiazdzinski L. 2011 Malleable city: an urban structure geared to the new timeframes of uses, L’Avenir du Temps entretien avec Etienne Klein: Publication in ResearchGate, 2011, p.61. https://www.researchgate.net/publication/280748208_Malleable_city_an_urban_structure_geared_to_the_new_timeframes_of_uses

[17] Paio A, Eloy S, Reis J, Rato V and Santos F 2011 Lopes P F. Emerg.cities4all: Towards a sustainable and integrated urban design, Respecting fragile places [29th eCAADe Conference Proceedings / ISBN 978-9-4912070-1-3], University of Ljubljana, Faculty of Architecture (Slovenia) 21-24 September, Tokyo: Japan, p.639-643.

[18] Lincoln T and Madgin R. 2018 The inherent malleability of heritage: creating China’s beautiful villages, International Journal of Heritage Studies Volume 24, Issue 9, p.1-22.

[19] Creagh R. 2018 Design Tactics for Urban Places Fragmentation and malleability in attachment to contested and changing cities, Home Cultures: The Journal of Architecture, Design and Domestic Space Volume 15, Issue 1, 2018, p.53-67.

[20] Wang S, Jiang Y, Xu Y, Zhang L and Li X 2019 Zhu L. Sustainability of Historical Heritage: The Conservation of the Xi’an City Wall, Sustainability, 11 (3): 740, p.1-10 & 12.

[21] Sulaiman M A and Awad A. 2011 Methodology of Dealing with Areas that have Historical Value: Cairo Khedive Region as a Case Study ” Journal of Azhar University Engineering Sector ISSN: 1110-6409 Vol 6, no 21, 2011, p.1-21.

[22] Ministry of Municipalities and Public Works, General Directorate of Urban Planning, Diwan Design Office, 2012 Comprehensive Urban design: Urban Renewal Project for Karbala City Center (Old City), p.2-206

[23] Al-Ansari R M A. Karbala Architecture Urbanism and Planning Study, First Edition, Damascus: Central Library, Book No: 1, 10, 70, 2006, P.225-226.