# Interaction Design in Museum Architecture: A Contemporary Developmental Vision for the Iraqi Museum / Original article

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# تصميم التفاعل في عمارة المتاحف : رؤية معاصرة لتطوير المتحف العراقي

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## Abstract:

The Iraqi Museum's remaining architectural form and traditional display techniques do not allow for enough interaction between visitors and the items, despite the museum's great heritage and cultural value. This between visitors and the exhibits. Additionally, the museum does not include interactive technologies and contemporary architecture, which are now essential components of modern museums around the world.This invites the question of how to optimize the Iraqi Museum's visitor experience by applying the principles of interaction design in museum architecture within a contemporary developmental vision. In order to revive the architectural spaces within the Iraqi Museum, the research aims to generate a modern developmental vision based on interaction design principles and contemporary display technologies. This will improve how visitors interact with the objects and increase the quality of the museum experience.. To achieve this goal, the research adopts a descriptive-analytical approach, focusing on building a theoretical framework for a visitor interaction design plan at the Iraqi Museum.

**Keywords: Iraqi Museum, Interaction design, Interactive technologies, Museum experience**

## المستخلص

لا يسمح الشكل المعماري الحالي للمتحف العراقي وأساليب العرض التقليدية فيه بتفاعل كافٍ بين الزوار والمعروضات، على الرغم من قيمته التراثية والثقافية العظيمة. إضافةً إلى ذلك، يفتقر المتحف إلى التقنيات التفاعلية والهندسة المعمارية المعاصرة، وهما عنصران أساسيان في المتاحف الحديثة حول العالم. يثير هذا التساؤل حول كيفية تحسين تجربة زوار المتحف العراقي من خلال تطبيق مبادئ تصميم التفاعل في هندسة المتاحف ضمن رؤية تطويرية معاصرة. بهدف إحياء المساحات المعمارية داخل المتحف العراقي، يسعى هذا البحث إلى وضع رؤية تطويرية حديثة قائمة على مبادئ تصميم التفاعل وتقنيات العرض المعاصرة. سيساهم ذلك في تحسين تفاعل الزوار مع المعروضات ورفع مستوى تجربة المتحف. لتحقيق هذا الهدف، يتبنى البحث منهجًا وصفيًا تحليليًا، مع التركيز على بناء إطار نظري لخطة تصميم تفاعل الزوار في المتحف العراقي.


**الكلمات المفتاحية: المتحف العراقي، تصميم التفاعل، التقنيات التفاعلية، تجربة المتحف**

# 1. Introduction

Museum display methods and approaches have changed to meet the demands of contemporary societies. Museums today are no longer limited to galleries, halls, and archaeological artifacts; they now offer interactive experiences to the public, distinct from the traditional visit, to enhance understanding of the importance of tangible and intangible heritage. This transformation of the museum from a repository of heritage items into a workshop responsible for extracting impactful museum experiences for the visitor has thus shifted the museum's function, becoming more human-centered than material, in accordance with the new vision of the 21st century [1]. This has focused the research on the necessity of improving the reality of Iraqi museums, leading to the following research questions

- What is the concept of interaction design in the context of museums?
- How is interaction design reflected in the architecture of Iraqi museums? What are the guiding design dimensions?
- Can technology change the visitor's museum experience and redefine their relationship with the museum, as well as the museum's relationship with its overall context? - Is interaction design in the museum environment simply an extension of technological development?
- How can a theoretical framework be defined for a plan to redesign Iraqi museums according to interaction design principles?

# 2. Research Hypothesis

Employing technological techniques in the interaction design process at the Iraqi Museum contributes to enhancing visitor experiences and improving the performance of the Iraqi Museum.

# 3. Research Methodology

The research adopted the analytical and experimental approach, which includes reviewing the specialized literature on digital and smart museums, analyzing the architectural practices of the museum environment and the technological techniques used in it to reveal interaction design indicators in order to build a comprehensive and richer theoretical framework that includes detailed considerations of interaction design in the museum environment and its evaluation indicators, then applying and testing interaction design indicators with the help of expert opinions to reach research results and conclusions.

# 4. The Concept of Interaction Design in the Museum Environment

A museum is a permanent, non-profit cultural institution open to the public, whose purpose is to serve society and promote its development by collecting, preserving, studying, exhibiting, and disseminating the tangible and intangible heritage of humanity and its environment for the purposes of education, research, and appreciation [2]. Many traditional museums provide their exhibits in a static, warehouse-like environment, which frequently ends in low visitor interaction because there are no tools or instructions to help visitors connect with the content, which reduces their interest and understanding. The need to give up old museum exhibition models has become clear because to the changing climate and museums' increasing functions in supporting regional and national culture. In this context, interaction design has grown essential to improving museum operations. By solving the problem of one-way communication, it allows visitors to establish a more dynamic and personal relationship with the exhibits, enhancing their curiosity and

desire to learn. Depending on the various media and interaction methods, this has led to the creation of various interaction patterns, like human-machine interaction, human-environment interaction, and human-to-human interaction. Thanks to the development of multimedia technology, human-machine interaction is typical in contemporary museums. Visitors' role changes from that of a passive recipient of information to that of an active participant in the experience because of interactive technological innovations, which provide a new and exciting journey that sparks their curiosity and helps in the delivery of knowledge in creative ways[3].

**The process of designing interaction in a museum environment can be defined as a design approach focusing on employing smart and interactive media to create dynamic connections between the visitor and the content. This provides a dynamic experience built on sensory, cognitive, temporal, and behavioral interaction that goes over the structural basis. By merging spatial, physical, and technological elements to create a dynamic, enjoyable, and pleasant interactive experience between the visitor and the museum environment, this fundamentally changes the nature of the museum itself from a display space to an experiential space, facilitating communication and knowledge acquisition for the user.**

# 5. Dimensions of Interaction Design in the Museum Environment

The means which contemporary museums interact with visitors and show their displays are developing. Museums are currently advanced, interactive spaces meant to promote visitors' sensory, cognitive, and social interaction rather than just being spaces to keep and present objects. The dimensions of the user interface design process in museums include:

- **The Sensory Dimension**: Knowledge engagement with museums needs knowledge of the sensory dimension. It works on how to create an immersive and integrated experience by engaging human senses in the museum's architectural space. Here, architecture moves beyond its traditional function as a functional enclosure and becomes a sensory medium that uses light, sound, material, and smell to adapt to human emotions and cognitive needs [4]. The architect provides a whole experience that stimulates the senses, the mind, and the emotions instead of just an aesthetic form. The psychological and social design goals like comfort, peace, excitement, and attention all get served with the sensory dimension [5].
- **The cognitive dimension**: is an essential element of interaction analysis which deals with how someone uses their cognitive abilities, consciousness, and memory to view, understand, interpret, and interact with the architectural museum space. The senses alone are not complete the museum experience; in fact, it is shaped by complex mental processes such as symbolic association, mental interpretation, and mental recall [6]. By applying symbols, identifying functions, and recognizing spatial links, guests to architectural museums interact with the space by cognitive communication. The visitor's cognitive map is formed in large part by components that include form, organization, repetition, contrast, sequence, and orientation. Easy navigation and spatial awareness are created easier in this image. In addition, a logical or narrative sequence within the design (narrative architecture) enhances the user's cognitive connection to the museum space by helping them to interpret it as a lived story [7].
- **The technological dimension**: is one of the major factors pushing interactive elements in museum planning. It refers to the medium

making it accessible to the museum to respond to visitors in a lively and dynamic style. The museum spaces is no longer a static entity instead being an intelligent system capable of real-time interaction with human and contextual variables, thanks to the fast advances in artificial intelligence, the Internet of Things (IoT), and digital design [8]. Utilizing tools such sensors, actuators, and digital interfaces, which enable the building to monitor environmental and human data and respond correctly, the technological dimension helps turn museum architecture into a responsive, interactive space [9].

- **The Social Dimension**: A vital aspect of recognizing participation in a museum space is the social dimension. A museum's architectural space is viewed as a field for group participation, communication, and belonging, as well as a tool for developing social connections. Through the architecture of human encounter and interaction, the space aims to serve as a social platform that organizes and builds up social connections rather than just holding the individual.In this sense, the organization of public and private areas, the layout of pathways for movement, the amount of places of interaction, and the division of functions also serve roles in the interaction design of museum architecture, which creates patterns of collective behavior. Each of these elements expresses an architectural vision of social cohesion and enhances social interaction. [10].
- **The Spatial Dimension**: This complex psycho-social dimension organizes people's views, emotions, and behaviors toward the museum as an interactive setting. It develops an interactive relationship within the individual and the museum space across overlapping levels including the individual, the psychological process, and the spatial context by mixing physical components

of the surroundings with individual experiences and developed social meanings.This dimension provide a framework that explains how social, environmental, and physical elements—such as shared symbolism, environments, and architectural aspects—influence the connection to the place, enhance emotional experiences, establish meaning, and enhance links between visitors and locals within the museum space itself [11].

- **The temporal dimension**: This is the dynamic framework that describes how the relationship between humans and museums changes over time, through the succession of perceptual, sensory, and historical experiences that take shape while within the museum environment. This dimension reflects the continuous transformations in lighting, uses, and memory, contributing to the construction of an interactive experience that connects the present with the past and frames the visitor's perception of the museum space as a changing and evolving entity. The user's awareness of this dimension is strengthened the longer they stay in the space or the more frequently they experience it, as the senses—light, movement, and sound—contribute to shaping their understanding of time within the museum space. Integrating time into design is a fundamental value that enriches the work aesthetically and psychologically [12].

**It becomes clear that the process of designing genuine architectural interaction within the museum environment stems from the dynamic integration of dimensions (sensory, perceptual, technological, temporal, spatial, and social) with human existence. This reshapes the architectural museum space and its surroundings, transforming architecture and its spaces into a living entity that keeps pace with changing human needs and establishes a continuous dialogue between the visitor, place, time, culture, environment, and technology, in a comprehensive architectural experience that fulfills the human aspect in all its dimensions**.

# 6.Technological tools and technologies in contemporary museums

The digital transformation of museums has adopted various technologies, including **interactive displays** that allow visitors to interact directly with a variety of screens that capture their attention and enable them to engage with their content [13]. These screens are used to project sound and moving images onto floors, walls, and windows in archaeological museums, in addition to plasma screens, providing visitors with an advanced interactive experience [14]. **QR code technology** allows users to be redirected to specific applications or data when scanned by digital devicesTo enable to minimize the amount of explanatory speech in the museum and keep an engaging and attractive display, it is often added to artwork title plates to direct visitors to electronic resources containing thorough information about the works [15]. Another effective technology based on signals from devices operating in the radio band is Radio Frequency Identification (RFID) technology [16]. (Karimi *et al.*, 2012). Readers tend to be a member of these systems. To interact with visitors, RFID devices are located around the museum. After signing up, visitor profiles usually remain on wristbands, cards, or small discs as are handed out at the museum entrance. These devices keep visitors' personal data or preferences, which are then delivered to a tracking system that analyzes data on preferences and visit frequency [17]. Based on [18], sensors correctly monitor visitor numbers and track their movement during the exhibition with recording a number of variables, like pressure, light, temperature, sound, and movement. In addition, by allowing visitors to preserve a safe distance, these sensors serve establish an invisible barrier between the artwork and the visitor, enhancing the artwork's protection and regulating interaction behavior [19]. Compared to that, **hologram technology** employs a beam of light waves focused on the object to precisely show its three-

dimensional form and clarify its details [20]. The final image has a clean look, with its features floating and clearly visible. These can be viewed over the air without the use of specific tools or eyeglasses [21]. By adding a layer of meaning, **projection mapping**—which uses complex mapping techniques to project virtual elements onto real objects or enhances the realism of the elements and gives real things a more dynamic character [22]. **Digital sound systems** also focus on the auditory dimension of museum exhibits, presenting them in a musical, historical, or social style to activate the role of listening in conveying information [23]. They also contribute to maintaining the artistic accuracy of the works, whether to create a specific atmosphere or to convey information [18]. **Virtual reality technology** can be experienced using a head-mounted screen, allowing users to interact with and move within the environment. Combining computer graphics, sound, and other sensory effects, it provides visitors with an immersive and interactive experience that incorporates sound effects. Sensory experience enhances their understanding of the content and helps them interact with it [24]. **Augmented reality technology**, whose primary function is to instantly calculate the coordinates and angles of each informational element, enhances the human experience by expanding the perceptual, emotional, and cognitive dimensions of interaction with the physical world [25].

**The growth of digital technologies has called awareness to the way technologies are transforming museum architecture to develop an immersive, interactive learning environment promoting interaction between visitors and objects. In addition, this facilitates the intelligent protection and management of collections, providing visitors with a personalized, multi-sensory experience and expanding the boundaries of the museum to encompass the virtual and digital worlds. This has transformed the museum into a living educational and cultural institution that transcends the limitations of space and time, as illustrated in Table 1, which demonstrates the impact and role of technological capabilities in museum architecture**.

**(Table 1) illustrates the impact of technological advancements on museum architecture.**

| Technology | Reflection on the museum | Area of application: | Impact on the visitor |
|---|---|---|---|
| Interactive displays | Making the display multimedia and flexible | Displaying information, images, and video | Direct participation and interactive learning |
| QR codes | Reducing reliance on traditional displays | Linking objects to digital content | Visitor's phone becomes a personal guide |
| RFID | Improving security and smart management | Tracking collections and visitors | Smoother movement and a more organized experience |
| Sensors | Protecting collections and enabling interactive responses | Configuring the interior environment and interaction | Motion sensing and a live experience |
| Holograms | Reviving lost or rare exhibits | Projecting 3D models | Live and impactful viewing of historical artifacts |
| Projection mapping | Employing architectural space as a dynamic display medium | Transforming walls into display screens | An immersive experience filled with visual storytelling |
| Digital audio systems | Enhancing the dramatic and narrative nature of the display | Producing immersive sound effects | sound perception and sensory experience |
| Virtual reality (VR) | Transcending the boundaries of space and time | Creating alternative environments | Entering virtual historical/cultural worlds |
| Augmented reality (AR) | Connecting the physical and digital in the display | Integrating digital information with objects | Direct and hybrid interaction with the artifacts |

# 7 .Stages of Interaction Design in the Museum Environment

The museum encompasses both the personal and physical space of the museum itself. Museums typically receive a large number of visitors at once, representing diverse backgrounds and interests. While the movement of these visitors within the museum may be influenced by various factors, such as spatial organization and the size and distribution of exhibits, they often move around the

museum simultaneously. Tools such as maps, guides, and suggested route plans are essential elements that support the physical movement and exploration of a space, and simultaneously form an integral part of the overall visitor experience [26]. Visitors in museums interact with a variety of physical elements, whether original artifacts, props, or scenographic components. Context is inseparable from the experience; rather, it is an essential part of the visitor's perception and interaction with the exhibit, which has undergone a dematerial transformation through the integration of digital space. This digital space is the primary means of disseminating knowledge available in museums. These are the technological aspects associated with the physical spaces of the exhibition [27]., and their impact on paving the way for the integration of digital technology in museum exhibition design. Consequently, a qualitative shift occurs towards focusing on enhancing the visitor experience through the integration of virtual spaces. This results in the hybrid space (the interactive space), which refers to a space that incorporates tangible interactions as a result of seamlessly integrating technology within the physical context of the museum. This space is generated through an iterative design process that included field studies with Visitors benefit from the integration of technology with artifacts, which can be both effective and engaging. This integration enhances visitors' understanding of the historical context and meaning behind the exhibits [28]. Museums have become multi-sensory through technological integration, designing effective hybrid experiences that combine realistic and digital sensory elements to convey cultural heritage in an innovative and engaging way. The modern visitor seeks not only to access the displayed content but also to engage in a meaningful social and personal experience within the social space generated by interaction. These interactions provide a fertile ground for learning, social experiences, and situations, offering ample opportunities to study social interactions in diverse contexts.

**It is clear from the above that the process of designing interaction in a museum environment includes stages that begin with analyzing the goals, requirements, preferences, movements, behaviors, and personal moods of visitors. The second step focuses on studying the space and the integrated technological capabilities that enable the design of the interactive scenario. This includes determining the type of interaction within the visitor›s journey to integrate museum exhibit elements and visual narrative into the visitor experience. The relationship between the visitor›s movement and the space›s response is carefully controlled. Thus, the type of interaction achieved changes the space, and so on. Each time the interaction changes, the space changes in a dynamic and continuous process centered on the visitor due to the ongoing programming of the content. This process culminates in the design of interactive systems and interfaces, integrated according to movement paths and diagrams**.

# 8. Analytical Study

## 8.1 .Analysis of Specialized Studies in Interaction Design in Museum Environments

Previous studies specializing in interaction design in museum environments will be analyzed in order to derive the theoretical framework for the interaction design process in museum environments:

### 8.1.1 Study of (Vayanou, *et al.*, 2014) [29].

**Personalizing interactive digital storytelling in archaeological museums: the CHESS project**

The study highlighted the importance of achieving social interaction in the museum environment today through technological integration within the museum

environment. It presented what it called interactive digital storytelling, which supports the goals of interaction design by enhancing experiential learning and developing a sense of exploration and appreciation among visitors. The study clarified the aspects of integrating digital technologies and tools within the museum environment to enhance the physical and sensory experience of visitors, which it called (embodied interaction) through augmented reality technologies that integrate the physical and the digital within an adaptive storytelling framework capable of changing in real time with changes in the contextual environment, including the visitor's location, interests, preferences, and speed of movement and response. This is achieved by conducting interactive experiences that align with the principles of sensory and perceptual design. The multimedia and cross-media approach was used by combining (images, sound, and video) to create a film that evokes a specific emotion, in a new experience that engages the visitor in the interactive process. The study also clarified methods for identifying experiences by creating a digital file of visitor interactions, which can then be modeled to serve as design guidelines.

## 8.1.2 Study of (Garcia Carrizosa, *et al.*, 2021) [30].

"**Designing Technologies for Museums: Accessibility and Participation Issues**"

This study addressed how technology design impacts individual activity in museums, particularly for individuals with sensory impairments or learning difficulties. It explored how technology contributes to facilitating access to the physical space of the museum, enhancing the sensory experience of exhibits, and activating the spatial principle through the design of flexible spaces that accommodate visitor movement. Furthermore, it examined how technology conveys cultural knowledge through texts, audio-visual content, and symbolic

graphics to activate the perceptual principle. In addition, researchers strive to create museums that cater to everyone, in line with the principles of inclusive design. Providing personalized and tailored access for each individual enhances the sense of individual interaction and reflects an appreciation for the nature of each place and visitor. The concept of emotional accessibility transcends the physical and cognitive aspects to encompass the emotional needs of visitors. Participatory engagement of users in the actual design phases of the museum strengthens their emotional connection to it. Participants indicated that the opportunity to participate was enjoyable and beneficial, enhancing their emotional connection and meaningful interaction with the museum, its exhibits, and cultural activities. Thus, the concept of participation shifts from mere individual inclusion to a comprehensive engagement of the entire system.

## 8.1.3 Study of (Kaplun, *et al.*, 2023) [31].

**Application of immersive technology in a museum**

This study discussed the application of immersive technologies in museums, such as augmented reality and virtual reality, to create and generate customized interactive simulation environments. (p. 385) Museums are among the most important sources of knowledge related to the history and culture of regions, particularly in promoting cultural identity. To increase the competitiveness of these institutions, especially to attract the contemporary youth generation, it has become essential to adopt modern communication platforms that align with the nature of the contemporary digital audience. p386 Museum professionals and virtual reality technology developers should pay particular attention to the educational and entertaining aspects of the virtual experience. These factors contribute to enhancing visitor engagement within the digital environment, providing them with a more

interactive and stimulating learning experience. The ability to analyze visitor interaction with exhibits increases, allowing for the identification of varying levels of interest. This leads to it attainable to dynamically reorganize exhibits within the museum based on the level of participation, transferring less captivating pieces to more crowded areas. By actively involving the visitor in the experience rather than quietly observing, all of this increases the visitor's experience and improves emotional and cognitive engagement. The importance of integrated sensory interaction and the engagement of the senses—sight, hearing, and body motion—as well as how this improves cognition and cognitive engagement were also highlighted in this study.

## 8.1.4 Study of (Wen & Ma, 2024) [32].

**Enhancing Museum Experience Through Deep Learning and Multimedia Technology**

The paper shows how fast artificial intelligence technologies are evolving, which has made a major effect on the museum field's movement to smart solutions to enhance guest experiences. By merging deep learning algorithms with multimedia technologies, these solutions aim to enhance the interactive environment of contemporary museums. These technologies, which are considered as the basis of current technology, are now necessary for optimizing the experience of museum guests, especially when they are effectively integrated with displays. These technologies, that enables the delivery of accurate and rich information to visitors, include speech recognition, image recognition, and natural language processing. This happens by offering correct and specific explanations of the given content. In addition, gesture, speaking, and touch-sensitive interaction technologies have particular chances to improve visitors' understanding of cultural heritage. p1–p2 The study additionally generated methods for using multimedia, 3D modeling, and

interactive design to transform the museum space into a virtual one. This made it possible for visitors to virtually explore the museum, circumventing temporal and spatial constraints while preserving a rich and realistic interactive experience. P3. The old museum visit paradigm, which was primarily restricted to passively viewing exhibits, was drastically altered by the incorporation of multimedia technology, which resulted in a richer and more effective interactive experience in knowledge transfer. So as to present more immersive and enjoyable experiences, museums have adopted a number of advanced interactive technologies, including augmented reality (AR) and virtual reality (VR).

## 9.Extracting the vocabulary of the theoretical framework for the interaction design process in the museum environment.

Based on the analysis of previous specialized studies, a theoretical framework was developed for levels and indicators of interactive design (as shown in Table 2), which serves as a first step towards proposing a plan for designing interaction in the Iraqi Museum environment in order to transform it into a vibrant interactive environment.

**Table (2) illustrates the theoretical framework for the transition to an interactive museum environment (interaction design plan).( Prepared by the two researchers)**

| Main vocabulary | Secondary vocabulary | Values |
|---|---|---|
| Objectives of Interaction Design | - To promote experiential learning and cognitive acquisition<br>- To stimulate sensory, emotional, and contextual memory<br>- To stimulate sensory, emotional, and contextual memory | |
| Dimensions of interaction design | Sensory Dimension | -Control using digital sound systems<br>-Control of light and visual displays<br>-Integration and control of scents to evoke and enhance visitor emotions<br>- Tactile enhancement |
| | cognitive dimension | -Directing the visitor's attention to key points (time, place, environment, society, culture).<br>-Combining text, images, video, and models to enhance multidimensional understanding.<br>- Organizing the presentation chronologically. |
| | Spatial dimension | -Designing a dynamic, interactive journey (adopting a kinetic sequence that guides the visitor through progressively more engaging and informative displays)<br>-Diversifying spatial scales (combining expansive spaces for group experiences with more intimate, focused spaces for individual or technology-driven experiences)<br>-Integrating stimulating transition zones (creating interstitial spaces where the rhythms of light, sound, or materials change to prepare the visitor for the next experience)<br>-Flexibility and adaptability (designing display units and routes that can be modified to accommodate temporary exhibitions or future development)<br>- Providing points for social interaction and activities |
| | Temporal Dimension | -Temporal rhythm (distributing visual and interactive events along an ascending or gradual curve)<br>- Linking exhibits to a temporal context or a storyline that mimics narrative. |
| | Responsive Dimension | -Designing stimuli (visual or auditory effects that encourage approach and interaction) to elicit responses tailored to visitor groups (age – people with disabilities).<br>- Enhancing emotional response (integrating human stories or impactful dramatizations). |
| | Technological Dimension | -Immersive experiences (VR and AR technologies).<br>- Direct interactive technologies: multi-point touchscreens, motion sensors and body tracking systems, sensory technologies, guided audio systems, digital lighting effects, mobile applications to connect visitors to online content or post-visit content, QR codes and optical character recognition systems for exhibits, and visitor data analytics. |
| | Social Dimension | -Utilizing collaborative mobile applications for content sharing.<br>-Creating rest areas to increase opportunities for intercultural dialogue and interaction.<br>And establishing activities or experiences that simulate different environments and cultures, encouraging visitors to exchange impressions.<br>- Integrating live activities (shows or guided activities that encourage direct audience participation) |

| Main vocabulary | Secondary vocabulary | Values |
|---|---|---|
| Interaction design stages | Analysis phase | -Visitor analysis: Visitor segments (age, culture, digital behavior), disability needs, learning expectations.<br>-Content analysis: Classification of exhibits (informative, sensory, narrative).<br>- Objectives analysis: Learning, emotional engagement, increased visitor frequency, digital participation |
| | Conceptual design phase | -Identifying interactive stations of various types (touch, motion, sound, AR, group experiences).<br>-Selecting appropriate technologies for the content and its presentation.<br>- Arranging stations according to a spatial-temporal rhythm. |
| | Detailed design and modeling phase | -Designing pathways and spaces: movement flowcharts, rest areas, spatial scales.<br>- Designing interaction interfaces: screen prototypes, activity maps, response design: reaction rules (e.g., when element A is touched, box B lights up and sound C is emitted). |
| Evaluating the interactive museum environment model | Sensory experiences | -Speed of visitor stimulation (visual, auditory, olfactory, tactile)<br>- Strength of stimulation and range of attention |
| | Perceptual experiences | -Speed of comprehension of content and level of focus on exhibits<br>- Level of information recall after the visit |
| | Spatial experiences | -Clarity and fluidity of movement and self-direction for the visitor<br>--Diversity of the space (individual – group)<br>- The degree of spatial coherence in recalling stations and its connection to the contex |
| | Temporal experiences | -Duration of the visit and desire to continue it<br>- Recall of experiences after the visit |
| | Response experiences | -The achieved reaction (motor, mental, emotional, social)<br>- The type of response (exploratory, educational, imaginative, realistic, cultural, aesthetic, personal) |
| | Technological experiences | -Ease of use and clear user interface.<br>- The technology's suitability to the content and its avoidance of overwhelming it. |
| | Social experiences | --The duration of interaction between visitors within the space.<br>- The degree of social integration and the formation of groups that share activities or collective experiences within the museum environment. |

# 10. Application to the Iraqi Museum

The research relied on applying the theoretical framework by activating the seven dimensions through the design of interactive stations in the Great Assyrian Hall, which is considered one of the most prominent halls in the museum as it contains artifacts from the Neo-Assyrian civilization between (609-911 BC). As Figure (1) and (2 a, b, c) illustrates, although the hall has undergone radical modifications, the interactive experiences have not yet reached the desired level. Thus, the design of each interactive station was linked to an operational technology that activates the diminished interactive dimension, as shown in (Figure 3). Furthermore, the relationship between the designed station and its technologies and the visitor group (gender, age, cultural level) was determined, as follows:

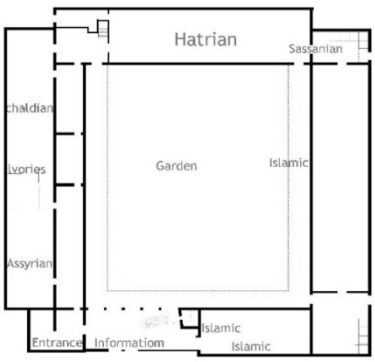


**Figure (1 ) shows Current ground floor plan of the Iraqi Museum**

**Source: Iraqi Department of Antiquities and Heritage**

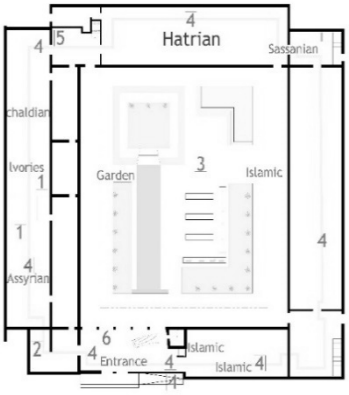


**Figure (3) shows the layout of the Iraqi Museum including the interactive stations**

**Source: (prepared by the researcher)**

**Figure (2) shows the current shape of the Assyrian hall after its restoration, like the Assyrian palaces**

**https://www.france24.com/ar/20161101 :Source**

1-**Interactive Storytelling Station**: Interactive storytelling stations are an essential part of architectural design within museums. They are used to present artifacts and archaeological information in an interactive way that integrates architectural space with modern technology, as shown in Figure (4a and 4b). Through turning information into an extensive sensory experience, these stations attempt to explain and simplify historical concepts. They provide more functions beyond merely displaying content; they also create an architectural context that draws in attention and stimulates the imagination. The architectural design of these stations takes the form of expressive spaces that utilize appropriate dimensions and materials to enhance the sensory connection between the visitor and the displayed content. Instead of simply piling up texts and explanatory panels, these stations are integrated into the architectural space in a way that reflects the cultural and historical context of the exhibits.

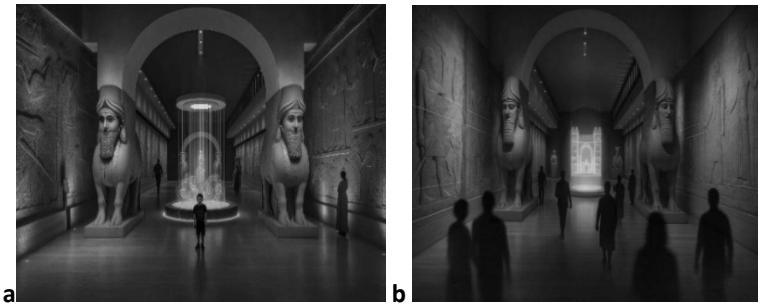

**Figure (4) illustrates the narrative stage and the use of visual stimuli. (Source: Researcher)**

2-**Audio Interaction Station**: The audio interaction station is part of the architectural design where technology integrates with the surrounding environment to enhance the visitor experience. This station includes an interactive device or digital units, as shown in Figure (5a, b, c), but the architectural space itself is designed to reflect the historical and intellectual character of the audio content presented. Sound is used to connect the visitor to a specific historical period, such as translating everyday vocabulary from Assyrian civilization or presenting traditional songs and music from that era. Rather than being a separate digital device, this station is part of an architectural space integrated into the museum environment.

**Figure (5) The source audio interaction station (Source: Researcher)**

3 -**The Interactive Children›s Station**: This station changes the relationship between children and the space, indicating an important turning point in the typical museum experience. So as to promote active exploration and learning, a dedicated children's garden was established within the museum. Children can use planting and watering using simple, safe tools thanks to the garden's design, which imitates agricultural practices in ancient Iraq. Touch, observation, and repetition are all enhanced by this sensory experience.

In addition, the children's museum has a symbolic architectural entrance created up of replicas of iconic architectural symbols like ziggurats and historical gateways like the Assyrian Nergal Gate. Reconstructed to a suitable for children

scale, these models indicate the beginning of the station's exploring journey. As seen in Figure (3), the children's station transforms from a static space into a hybrid architectural context where play and learning interact with architectural form. As a result of this, children's museum visits are comprehensive and dynamic, employing architecture than just words to support cultural and cognitive values.

4-**Special Needs Station**:In an effort to accomplish cultural respect and promote community engagement, the design aims to bring people with disabilities into the architectural space of the museum. Accordingly, the museum is designed to be integrated within the main museum pathway, becoming a natural extension of the overall experience. Gentle ramps, as shown in the museum's layout in Figure 9, are provided to ensure accessibility for people with mobility impairments. Rest areas, non-slip flooring, and ample circular spaces allow for unobstructed wheelchair movement. Exhibits are also rearranged at heights suitable for both visual and tactile access, fostering a sense of independence and complete inclusion for visitors. The design incorporates bilingual elements, using large, high-contrast print for the visually impaired, along with Braille translations and tactile tiles, as illustrated in Figures (6a and 6b), making the museum space readable at all levels. These components represent a vital element of the museum's identity because they are integrated into the architectural space instead of merely external additions.

**Figure (6) illustrates tactile tiles for the blind as a design measure for pathways for people with special needs. (Source: Researcher)**

5-**Virtual Reality and Augmented Reality Station**: The architectural design of this station is based on the principle of respecting the original archaeological space, integrating technology into the setting. The station utilizes all existing architectural elements, from columns with sculpted capitals to arches that formed part of the Assyrian religious and political landscape, and winged bulls that symbolized power and protection, transforming these elements into narrative tools and part of the show's scenography, rather than mere silent decoration. In the Assyrian hall, where the walls acquire a distinctive archaeological character, the virtual and augmented reality station is designed as a hybrid interactive experience that revives Assyrian history through multimedia, without excluding or negating the space, but rather building upon it. Digital interaction stations, represented by VR points or AR panels, are distributed within the architectural spaces, integrated into the floors, thus mitigating the dominance of the modern and technological form over the heritage scene, as shown in Figure (7).

**Figure (7) illustrates the virtual reality and augmented reality station (Source: Researcher)**

6-**The Participatory Visitor Station**: At the final stage of the interactive experience, an interactive space emerges within the museum, designed to give visitors the opportunity to express their opinions, share ideas, and exchange personal impressions about the museum experience. It does not merely provide

information but also provides feedback between the visitor and the museum, thus making the visitor an active participant in producing meaning and developing the social and participatory principle. The design takes place within one of the natural open architectural spaces in the museum building, such as between two halls or at the end of one of the naturally lit corridors that open onto the internal gardens, as shown in the museum plan in Figure (8). The reason for choosing this location is to attract the visitor to an area of tranquility and contemplation away from the noise of visitors, to be a point of reflection where the visitor can express his opinions and feelings.

**Figure (8) illustrated The enhanced participatory visitor station is (Source: Researcher)**

# 12. Survey Conducting

After completing the interactive design plans for the Iraqi Museum's environment, an online survey was conducted. This survey aimed to gauge public attitudes toward digital interaction and their future desire to implement the theoretical framework's components within the planned museum environment. Despite the limited sample size, the survey was directed to a select group of 25 academic architects specializing in digital and cultural architecture, thus enhancing the reliability of their technical and critical opinions on the proposed theoretical framework. Two groups of individuals were examined. This process was to examine

architectural viewpoints and interpretations of the aspects of interaction and function within the interaction design process of the museum spaces, rather than evaluate direct technical performance. The survey was supported with a link to the theoretical framework via Google Forms and a demonstration video of the Iraqi Museum. The results were presented in statistical tables, ensuring that the suggested solutions not only handle the academic flaws observed in the museum survey but also match with actual needs and aims of general viewers.

# 13. Interpretation of Results

Figure (9) shows the interpretation of information related to the experiences obtained through the interactive design of the Iraqi Museum's space. Based to the survey, 92.33% of the participants had technological experiences, showing how effectively the museum's design for buildings employed technology. The percentage of sensory experiences obtained improved to 89.45% because technology is believed to be an aid for enhancing interpretation and perception. This shows the design's potential to provide a space. filled with visual and audio stimuli that can attract visitors, and encourage their immersion and engagement with the displayed content, with a response rate of 87.23% in response to the stimuli that stimulate interaction. Additionally, the perceptual experience earned 86.55%, showing that the exhibits and media can guide visitors and help them collect information and comprehend its meaning. The results of the temporal experiences, which reached 88.65% resulting in a clear and consistent narrative organization, further illustrate the impact of technological experiences on interpreting the sequence of screens. The hall's spatial experience crystallizes with perceptual and temporal preparation, achieving 90.24%, indicating clarity. Using a score of 85.88, the smooth flow of movement for all museum visitor groups creates a sense of spatial connection, which in turn enhances the social

experience. This connection is crucial in activating the social space, making the experience interactive and participatory. These results combine to reveal an interactive environment that fulfills the objectives of the interaction design within the Iraqi Museum's setting. This environment supports experiential learning and knowledge acquisition by stimulating the visitor's sensory, cognitive, and emotional memory, thus creating a lasting relationship between the visitor and the museum.

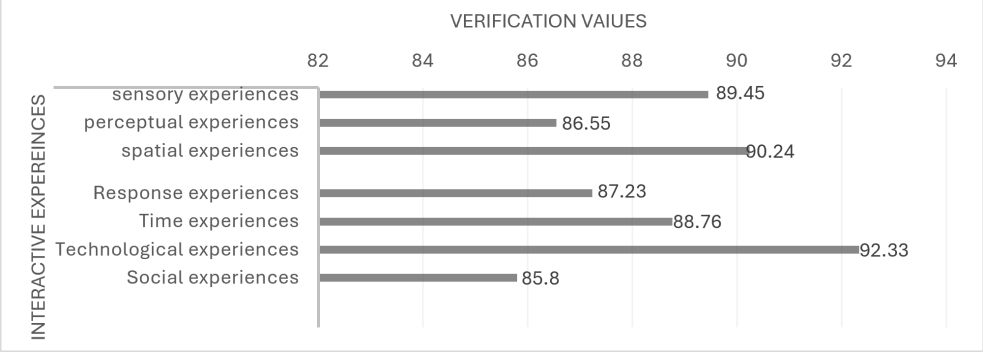


**Figure ( 9) illustrates the success rates of interactive experiences in the Iraqi Museum environment.**

# 14. Conclusions

1. Adopting the concept of interaction design in the museum environment is a fundamental pillar in advancing the contemporary muse um experience. Its role is evident in transforming the museum from a space dedicated solely to exhibition into an interactive, educational, and participatory environment that connects the visitor to the cultural and civilizational heritage
2. The research highlighted the importance of studying spatial organization and structuring museum spaces by organizing, clarifying, and smoothly guiding movement paths to create a comfortable museum environment

that contributes to enhancing the quality of the museum as a dynamic architectural space.

3. The integration of cognitive and sensory stimuli contributes to attracting visitors and raising their level of understanding of the content. This, in turn, underscores the role of thoughtful planning in activating the role of technological and sensory influences to support the cognitive process.
4. The research confirmed that the technical and technological role is one of the strongest drivers and supporters of interaction, as it contributes to making the experience more dynamic and more connected to its historical context.
5. The results of this research underlined how important temporal consideration is in creating an effective and powerful museum experience. The displays' chronological organization is vital for enhancing visitors' knowledge of historical content and allowing them to observe how events through following civilizations are interconnected.
6. The study highlighted how essential the social aspect is to the museum experience and that integrating interactive spaces (interactive stations) may enhance it by promoting social interaction that improves the museum experience.
7. A holistic design vision that is taken into consideration interaction in all of its dimensions—sensory, perceptual, temporal, spatial, technological, and social—is deemed essential to create a comprehensive museum experience. This sets the visitor at the core of the design process and enhances their role in participation and exploration.
8. The availability of powerful, knowledge-based physical content elements is vital to a public museum's performance. These elements can act as base and methodology for interaction design, which will ultimately result in a more interactive and engaging experience.

# 15. Recommendations

1. Adopt methods of design that include a comprehensive organizational plan to enhance the quality of the Iraqi Museum's visitor experience.
2. To enhance responsiveness and interaction, engage the sensory and technological elements of the interactive design structure.
3. Having incorporated interactive, multisensory stations presenting Iraqi civilization-associated subjects.
4. developing the Iraqi Museum as a platform for culture and learning by providing interactive materials for learning to improve engagement and promote a feeling of community.
5. improving the whole museum experience, enhancing the scope of cultural activities presented within the museum, improving visitor services, and strengthening a relationship between the museum and its visitors through smart interactive apps.
6. changing the museum experience from a basic display of objects to an integrated educational, knowledge-based, cultural, and sensory interaction that transforms the museum into a narrative of civilization.

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