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FULL PAPER

The Impact of Engineering Software on Documentation & Preserving Cultural Heritage: A case Study of AL-Ghulitha Heritage Outpost in AL Muthanna Governorate

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ABSTRACT:

This research explores the documentation and preservation of the historical building "Al-Ghulitha outpost" using engineering software. The study emphasizes the significance of integrating engineering methodologies with cultural heritage conservation. The documentation process involved collecting historical information and site surveys for data gathering and applying AutoCAD and SketchUp software to create the 2D site plan and 3D model precisely. Moreover, using engineering software such as Lumion has enhanced visualizations of what a building might have looked like earlier. Based on these visualizations, it is possible to know the damages to which the building's structure has been exposed, determine their locations, and clarify the potential maintenance effects. As a result, these results were adopted as a basis for damage diagnosis and the provision of an initial conservation plan.

The study demonstrates the importance of documenting and preserving Al Ghulitha as a model of late Ottoman architecture and stresses the importance of integrating engineering techniques with elements of culture and history. The study achieved high accuracy in documenting the case study using engineering software and illustrated the importance of this balance in enhancing conservation efforts and ensuring the continuity of heritage. Moreover, this research also saves time and effort in identifying damages in historical buildings before maintaining them. The results indicate the need to spread cultural awareness and include the local community in interacting with cultural activities and planning for future maintenance. The research draws attention to the importance of historical buildings and indicates the need to take the necessary measures to protect them, including funding and legislation, within the framework of integrated cooperation between heritage preservation experts and engineers.

Keywords: Al-Ghulitha Outpost, heritage preservation, engineering software, AutoCAD, Sketchup, Lumion.

1. INTRODUCTION

The term "Cultural Heritage" first appeared in the middle of the 20th century, and organizations like UNESCO—the United Nations Educational, Scientific, and Cultural Organization—that are dedicated to its preservation have collaborated to define it. It specifies all physical and intangible cultural expressions in the text that came out of the 1972 Paris Convention for the Protection of the World Cultural and Natural Heritage [1].

Cultural heritage represents the rich collection of customs, traditions, arts, and languages embodied in a particular culture. Cultural heritage is a symbolic word for the legacy that a society transmits from generation to generation and reflects aspects of life and social interactions. In the context of national identity, cultural heritage plays an essential role in shaping national identity and belonging. Shared cultural elements, whether historical stories or traditional arts, strengthen the national spirit and make each community unique in its identity [2]. At the moment, its preservation faces many challenges that threaten the loss of a large part of it. Among these challenges:

- Environmental and natural degradation: Cultural heritage is exposed to the harmful effects of natural phenomena and environmental disasters, causing damage and loss of cultural monuments [3].
- Economic and social transformations: Changes in the economic and social structure may lead to a loss of interest in cultural heritage and a decline in the funding needed to preserve it [4].
- Globalization and technology: Rapid developments in technology and the effects of globalization may lead to the loss of local cultural identity as a result of the great influence of global culture [5]
- Human threats: Whether resulting from armed conflicts or organized crime, human threats can cause the destruction of cultural monuments and the loss of historical heritage [6]

Though it is arguably the least populous, Al-Muthanna is the second-biggest governorate in Iraq in terms of land area after Anbar, the largest province. The hub of Muthanna is the city of Al-Samawah, which is situated 270 kilometers south of Baghdad, the capital of Iraq [1]. The ancient city of URUK, which was recently added to the UNESCO World Heritage List, is probably the most well-known of the many archeological and heritage sites found in the Al-Muthanna Governorate[7]. However, preserving these cultural heritage places requires adopting effective strategies to confront these challenges and ensure the continuity of this valuable heritage for future generations.

Consequently, the main objectives of this research paper are to preserve one of these important historical landmarks by studying the building in detail and describing and analyzing the building's layout, architecture, and construction materials used, which is considered one of the documentation methods.

Furthermore, the research involves utilizing modern technology and engineering software to document horizontal plans and three-dimensional models, which would be vital tools for preserving cultural heritage in addition to diagnosing and documenting the most prominent damages to which the building's body was exposed, knowing the most prominent challenges it

faces, and presenting proposals for maintaining the building by studying and analyzing the damage and submitting proposals to reduce its impact.
Through this research, we seek to open new horizons for thinking about how to use technology and engineering to contribute to preserving this precious cultural heritage.

2. LITERATURE REVIEW

There are many studies that have addressed the importance of using modern technology and engineering programs in the field of preserving cultural heritage. Among the modern technologies used in the cultural heritage field is the study presented in [8], which uses an integrated methodology to preserve archaeological sites using geomatics techniques and ground radar. This methodology was applied at the Qaser Amra Castle site in Jordan, where it resulted in the creation of an advanced 3D geospatial and geophysical model, including the detection of subsurface structures using ground-based radar. This model is considered an integrated tool for documenting and maintaining archaeological sites accurately and effectively for the purposes of heritage preservation, tourism, and urban planning.
In [9], The study addresses the use of geographic information systems in managing and documenting heritage buildings in Al-Muthanna Governorate, focusing on Saraya Al-Rumaitha. The data is integrated into the geographic information system to form a database that contributes to managing and maintaining heritage sites and provides possibilities for future planning and preservation of heritage documents.
Moreover, using modern and different technological engineering systems [10], environmental control systems have been used to preserve historical buildings by precisely regulating temperature and humidity. This technology relies on sensors and intelligent control systems to maintain optimal environmental conditions, and comprehensive field measurement and monitoring were conducted before developing a model of the historic built environment. Seven monitoring devices have been installed on site (Fig.1).
In 2020 in [11], this study aimed to increase the level of knowledge of historical buildings by understanding their structural evolution using Historical Structural Information Modeling (H-BIM) technology. Steps include critical historical analysis and characterization of materials and soils, data organization using H-BIM, and qualitative static and dynamic structural analysis, with verification of the results. The Quartel da Tropa building in Florianópolis, Brazil, is used as a case study, as this approach contributes to creating an accurate structural model of historic buildings and improving their understanding and structural evaluation.
In the same context, the study in [12] used the H-BIM approach to understand the evolution of the construction phases of historical buildings, enhancing knowledge about their structures. The research performs critical historical analysis and characterization of materials and soils, then organizes the data using H-BIM and performs a structural analysis. The Quartel da Tropa in Florianópolis is used as a case study to illustrate integration in historic buildings, improving structural modeling and evaluation.
However, regarding the impact of rebuilding historic areas on communities, in [13], the research focused on the importance of cultural heritage in achieving urban resilience after disasters. It analyzes several cases of complete reconstruction of historic urban complexes and reviews how urban heritage preservation and reconstruction can contribute to sustainability and give affected communities a sense of continuity. It addresses shifts in the concept of heritage conservation and highlights the increasing emphasis on architectural

reconstruction as an effective strategy. It presents a case study of the reconstruction of a historic urban agglomeration and suggests that reconstruction can contribute to strengthening identity and resilience to disasters.

Finally, it can be said that many studies have discussed the impact of applying modern technology and engineering programs on cultural heritage areas, but in Muthanna Governorate, specifically the study area, the use of such technologies is still very weak and, in many cases, non-existent.

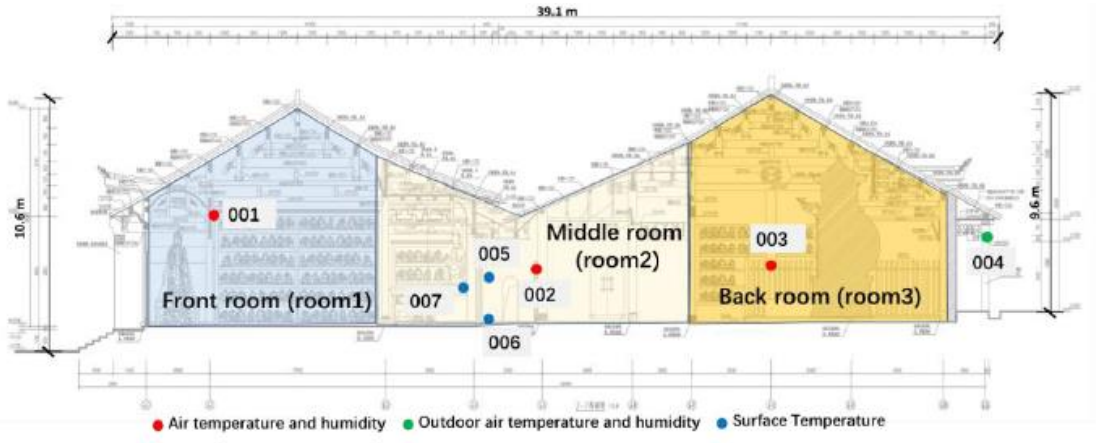

Fig. 4: Layout of environmental monitoring points [10].

3. RESEARCH METHODOLOGY AND CASE STUDY:

Al-Ghulitha Heritage Police Station: The police station is located in Al-Muthanna Governorate - Al-Warka District - District 76 Al-Ghulitha, which is named because of its walls' thickness. This police station was built in the first half of the nineteenth century, specifically in 1935 AD, and its construction continued until 1937 AD. He announced his heritage locally in the Iraqi newspaper Al-Waqae', issue No. 4189, on 05/16/2011 [14]

This outpost was used for the same purpose for which it was established (a military station and barracks), as it was common during that period to build stations in Rumaitha and Samawah to control the clans residing in this region, as they were clans that have not known humility since the Ottoman occupation [15]. The tribes considered building castles and outposts a threat to their authority and a violation of the sanctity of the tribe. They also believed that resources should be directed towards projects that benefit the people and reduce the burden on their shoulders instead of wasting them on building outposts. Work on building them was stopped after the fall of Yassin Al-Hashemi's ministry (29 March 1935- 29 September 1936) After the military coup of Bakr Sidqi (29 Septemper1936) AD, the initiative was resumed in the ministry of Hikmat Suleiman (29 September 1936 -16 August 1937) AD, and this was one of the most prominent factors that contributed to the outbreak of tribal uprisings and the raising of arms against the government.

The government's plan included establishing seven police stations in tribal areas along the Baghdad-Basra railway line. These centers included (Al-Safi police station, Al-Ardiya

police station, Al-Hijamah police station, Al-Ghalaidha police station, Al-Khafoora police station, Al-Zarjiyah police station, and Dabis police station) [14].

This building was chosen as the subject of the research presented here to shed light on it due to its historical and artistic importance, as it is considered an important example of the building style of the late Ottoman era, and through its study, it is possible to identify many of the architectural and artistic landmarks prevalent in that era. Moreover, the building is exposed to numerous damages due to natural factors, aging, and other damages, in addition to other damages due to human influences.

Figure two illustrates the methodology of this research: Information about this site was collected from documents and historical sources published or at the headquarters of the governorate's Inspectorate of Antiquities and Heritage. Then, the site was visited to photograph it and collect data on the construction method, the building materials used, and the shape of the police station and its measurements, which were later entered into the AutoCAD 2022 program to draw the building site plan. This site was later exported to the program Sketchup 2022 to upload blocks. Then, the materials were added to the block in the Lumion 2023 program so that, in this way, an imaginary shape of the police station was drawn, showing the condition it was in before it was exposed to various factors that led to its deterioration. In this way, the most important damages exposed to the building were diagnosed, their causes were determined, and proposals were drawn for a plan to preserve the building.

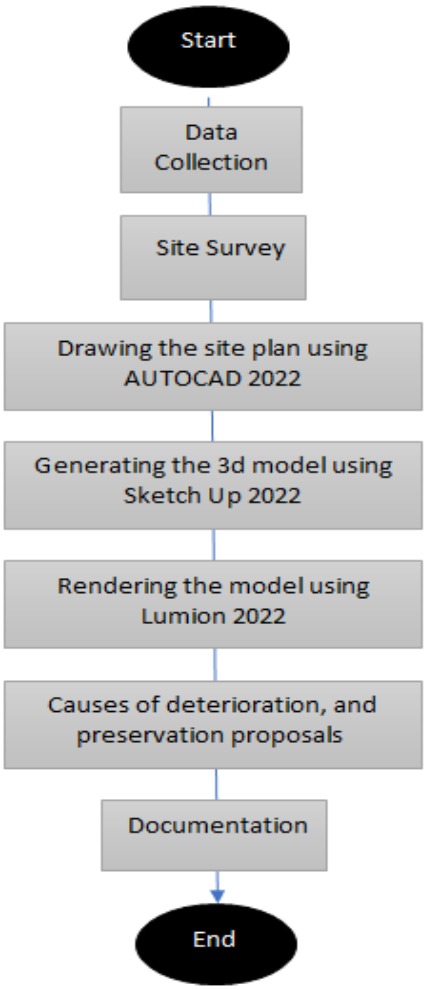

Fig. 2: Research Methodology

4. RESULTS AND DISCUSSIONS

4.1 Building Description:

The outpost has a rectangular-shaped building with dimensions 21.3*20.8 meters, consisting of one floor with walls height of 6.5 meters (Fig. 2).

Fig. 2: Al-Ghulitha outpost (researcher)

As the building is surrounded by an open environment with no adjacent structures, the building has four facades. The entrance of the building is located on the northwestern façade, featuring prominent brick projections from the original wall (0.12 meters). The entrance width is 3.25 m, and its height is 3.65m; it contains in the middle an iron gate with two leaves, 3 meters wide and 2.65 meters high, topped with iron bars with a total number of 25 bars and height of 1 meter. From inside, there is a concrete canopy 5 meters long and 1-meter wide that provides shade for the gate guards (Fig. 3).

Fig. 3: Left: the only entrance to the outpost. Right: the gate (researcher)

The entrance to the building leads to a central courtyard overlooked by the rooms and other facilities (Fig. 4). In its eastern part, it contains a square-shaped well (0.85*0.85m) built with brick and plaster and currently buried. The police station contains remnants of rooms of various dimensions and measurements located on the northeastern and southwestern sides of the building. Its floors were paved with bricks and had openings for doors and windows. The door and window openings are topped with a concrete lintel, 0.3 m high and 0.4 m wide (. On the back side of the building, concrete basins were used as horse feeders, numbering 10 in number).

Fig. 4: The central courtyard (researcher)

The building was roofed using a flat slab construction method, supported by locally known iron beams called "Shilman" and bricks. The building used a semi-structural construction system, employing short-span concrete beams supporting the roof slabs. These concrete beams are supported by load-bearing walls made of 0.5m thick bricks. However, non-bearing walls 0.12 m thick of brick were used, as their function was only to divide the rooms architecturally and had no structural role (Fig. 5).

One of the distinctive elements of the building is the presence of watchtowers in the northern and southern corners of the building, rectangular in shape, with a length of 5 m, width of 4.6 m, and height of 8.4 m. Each tower consists of two floors separated by a roof. Their roof has a square opening with an iron ladder at the bottom. On the ground floor of both towers, there is a concrete terrace adjacent to its three outer walls that was used as a dining table for the soldiers. Each tower contains several embrasures known locally as (Mazaghil), which are openings used for defensive purposes found in many parts. They had two styles; the first one was vertical in shape, with dimensions of 0.12 * 0. 25 m from inside and from outside 0.6 * 0.3 m, While the other one was horizontal, and its dimensions were 1.45*0.6 m from outside and 65*25 m from inside. Several embrasures are distributed at the top of all the external walls of the outpost, except for the facade wall, which contains only one embrasure (Fig .6). The protrusion of the building entrance surrounding the gate forms a distinctive architectural feature. It was constructed with bricks, arranged in a staggered pattern every three rows, with each level followed by a single row at a different level, entering towards the gate horizontally. What also distinguishes it is the construction method and the consistency of dimensions and spacing on both sides**,** as shown in Figure 1.

It is worth mentioning that the building follows the English architectural style (English Bond), and the construction materials used include bricks (0.22*0.11*0.06) m, plaster, and cement, with concrete also used in various parts. Iron bars constitute an essential part of the roofs of this building.

Fig. 5: left: rooms in the northeast section. Right: rooms in the southwest section (researcher)

Fig. 6: left: the northern watchtower. Right: the southern watchtower (researcher)

Additionally, metal sheets were used on the foundations. Moreover, soil and bricks were used to flatten the roof.

of the then-ruling regime, residents of the area attacked the police station, and the metal cover that was covering the southeastern wing (the stable) was stolen. The bricks used to build the walls separating the rooms in the north-eastern and south-western parts were also stolen (Fig. 5) [14].

The station was used until 1975 and then was left unused. Notably, local accounts from residents of the area indicate the presence of large snakes known as "Grape snakes" or "Al-Ghulitha snakes" inside the building. Based on these accounts, the outpost has the advantage that no one enters it at night.

4.2 The Outpost Site Plan and The Imaginary Shape

Based on the on-site visit, the external and internal dimensions of the outpost were measured using a measuring tape. After comparing and following the traces of removed walls, the locations of the removed walls were deduced. In this manner, a detailed outpost plan was drawn, illustrating its building units, measurements, and dimensions using AutoCAD 2022 software with a drawing scale 1:200 (Fig. 7).

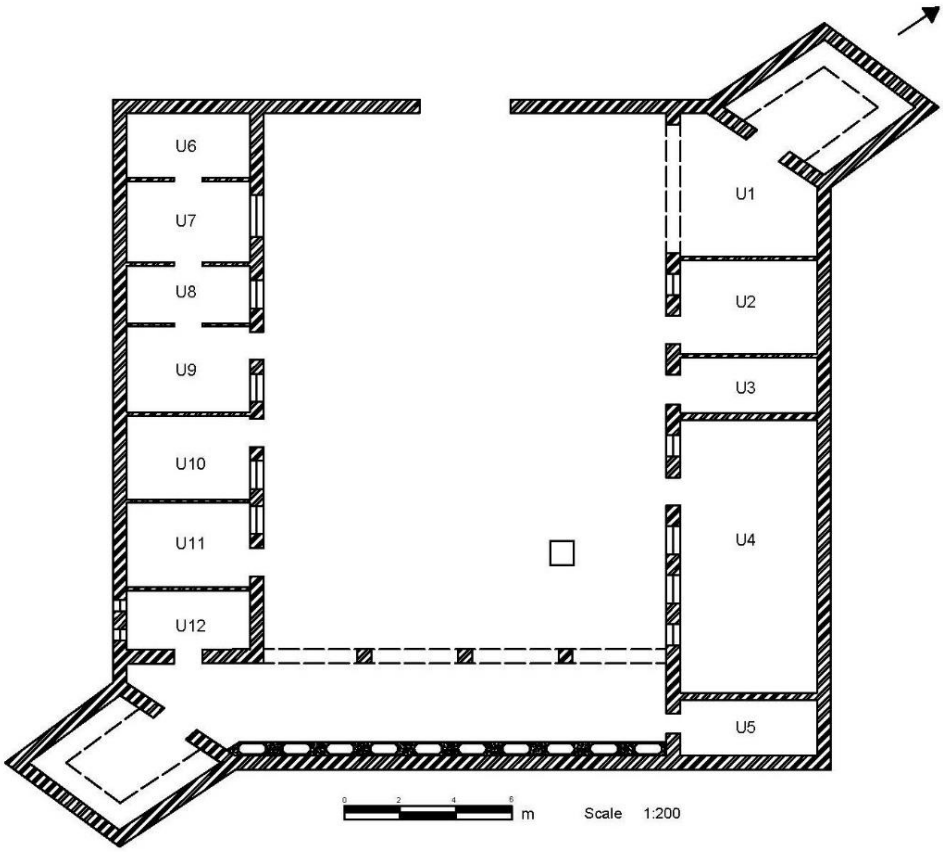

Fig. 7: The outpost site plan (researcher)

Later, relying on the measurements taken on site of the heights of the walls and ceilings and on the plan that had been drawn previously, which was exported into the SketchUp 2022

program to raise the block and draw a three-dimensional shape illustrating the outpost shape.

Subsequently, this model was exported to Lumion 2022 to adjust materials on the model and render it for export as images. These pictures illustrate how the police station looked before it was damaged. When comparing these images with reality, it is possible to know exactly which parts the damage affected the most and what the police station would look like if this damage were treated. Figures (9,10,11) illustrate some of these images.

Fig. 9: The north-western façade of the building. Left: reality shape. Right: Imaginary Shape (researcher)

Fig. 10: The south-western facade of the building. Left: reality shape. Right: Imaginary Shape (researcher)

Fig. 11: The north-eastern facade of the building**.** Left: reality shape. Right: Imaginary Shape (researcher)

4.3 Current Situation, Damages and Preserving Suggestions

Within the framework of this study, and through on-site visits, historical analysis, and the comparison of images generated from engineering programs with the actual condition, the current state of the building was assessed, and the most significant damages were identified. It was noted that the most obvious damage to the building was the damage from human intervention mentioned previously, including the loss of doors and windows and the theft of the structural walls separating the rooms, as well as part of the ceilings of the rooms. It is worth noting. These walls were used only as partitions and not as load-bearing since the building's structural system is a semi-structural system that relied on horizontal concrete beams based on brick walls or brick columns.

One of the other most important damages is the moisture resulting from rainwater, which led to some cells falling from the roofs due to the corrosion of the brick or the bonding material deterioration of the steel used in roofing due to rust.

The rising dampness can be observed with a capillary feature from the ground to the exterior walls of the building, reaching approximately 50 cm high. This moisture has disintegrated the falling of portions of bricks and the deterioration of the bonding material. Moisture rises in the load-bearing walls carrying soluble salts, and when the weather changes and temperatures rise, the damp area contracts, causing the salts to crystallize and increase in volume through the crystallization process. Consequently, the salt crystals disintegrate due to increased size within the building materials.

It is also noted that there are some deep vertical cracks in the walls, especially in the corners, as a result of the failure of the moment of inertia, which can occur due to earthquakes or, perhaps, soil settlement in certain areas.

Some recommendations can be made to preserve the outpost based on the information presented, such as the following:

- Reducing Harmful Human Interventions: This can be achieved by raising awareness in the local community about the importance of cultural heritage as the people's national identity inherited from ancestors. Moreover, they should be educated about the laws governing artifacts and heritage and the penalties for those who violate historical areas.
- Addressing Moisture Sources: Work on cutting off moisture sources affecting the building by properly releveling and isolating the building's foundations from ground moisture. Furthermore, the effects of moisture on the building slab should be addressed properly.
- Soil Investigations: Conduct soil investigations to understand the causes of cracks by collaborating with a specialized engineering firm.
- Reinforcing Threatened Walls: Strengthen walls at risk of collapsing, treat deep cracks, and replace deteriorated components without affecting the original appearance of the building.
- Vegetation Removal and Cleaning: Remove weeds and natural vegetation inside the building and clean the structure.
- Conduct regular inspections to identify any signs of damage or deterioration, implement a routine maintenance schedule, and address issues promptly to prevent further damage.

Finally, the research showed that advanced technology and the integration of engineering have opened a new horizon in cultural heritage preservation efforts. These techniques can be used effectively to ensure the continued preservation of historical sites for current and future

generations, enhancing the role of engineering in preserving the cultural and historical identity of a community.

5. CONCLUSION

1. The research shows the importance of documenting and preserving Al- Ghulitha outpost as an example of late Ottoman architecture. Preserving this heritage contributes to preserving the cultural and historical identity of the region.
2. A high level of accuracy in documenting the outpost has been achieved using civil engineering techniques and engineering software. These methods contributed to preparing an accurate site plan and 3d imaginary shape.
3. The research shows the importance of integrating engineering techniques with cultural and historical elements. This balance enhances the effectiveness of conservation efforts and ensures the continuity of heritage.
4. This research saves a lot of effort and time if the same techniques are used to identify damages in archaeological and heritage buildings before maintaining them. Thereby, this involves understanding the virtual representation of the buildings before commencing maintenance work.
5. The absence of archaeological awareness has significantly contributed to negative impacts on the heritage site. Therefore, cultural awareness must be spread, and the local community must be involved in cultural activities and planning for possible maintenance.
6. This research draws attention to historic structures' significance and gives authorities the power to take the required actions, like funding and passing legislation, to protect these important locations. In the Al-Muthanna Governorate
7. Potential challenges such as costs must be addressed, and maintenance must be sustainable. At the same time, the effective use of engineering technology opens a horizon of new opportunities for cultural heritage preservation.

6. FUTURE STUDIES

1. It is recommended that research be expanded to explore the impact of outpost documentation on tourist attractions and the local economy.
2. The research can be completed by studying sustainable financing techniques for cultural projects.
3. The involvement of restoration experts and structural engineers can facilitate the development of new technologies for the maintenance and restoration of archaeological and heritage sites.
4. Studying the possibility of heritage sites being centers for sustainable development and applying its principles in governorates in tourist-attracting regions.

REFERENCES

[1]M. A. D. Mendoza, E. De La Hoz Franco, and J. E. G. Gómez,(2023)"**Technologies for the Preservation of Cultural Heritage—A Systematic Review of the Literature**," *Sustain.*, vol. 15, no. 2, doi: 10.3390/su15021059.

[2]A. Hiswara, A. M. Aziz, and Y. Pujowati, (2023) **"Cultural Preservation in a Globalized World: Strategies for Sustaining Heritage,**" West Sci. Soc. Humanit. Stud., vol. 1, no. 03, pp. 98–106, doi: 10.58812/wsshs.v1i03.250.

[3]S. A. Orr, J. Richards, and S. Fatorić, "Climate Change and Cultural Heritage: A Systematic Literature Review (2016–2020)," **Hist. Environ. Policy Pract**., vol. 12, no. 3–4, pp. 434–477, 2021, doi: 10.1080/17567505.2021.1957264.

[4]G. Alexandrakis, C. Manasakis, and N. A. Kampanis, (2019) "***Economic and societal impacts on cultural heritage sites, resulting from natural effects and climate chang***e," Heritage, vol. 2, no. 1, pp. 279–305 , doi: 10.3390/heritage2010019.

[5]Vineet Kaul, (2012) ***"Globalisation and crisis of cultural identity Vineet***," Int. Res. Journals, vol. 2(13), no. 1, pp. 341–349..

[6]M. R. A. Al-azm, (2020) **Social Change in the Gulf Region.**

[7]J. Jotheri *et al.*, (2017) **"Holocene fluvial and anthropogenic processes in the region of Uruk in southern Mesopotamia**," *Quat. Int.*, vol. 483, no. December, pp. 57–69, 2018, doi: 10.1016/j.quaint.11.037.

[8]R. Al-Ruzouq, S. Abu Dabous, A. Abueladas, F. Hosny, and F. Ibrahim, (2022) **"Integrated Archaeological Modeling Based on Geomatics Techniques and Ground-Penetrating Rada**r," Remote Sens., vol. 14, no. 7, doi: 10.3390/rs14071622.

[9]A. Ahmed, Talib, S. Ahmed, Harb, and K. Ayat, Abdel Khaleq, (2022) ***"The use of the Geographic Information System in the management and documentation of heritage buildings Case Study: Saray Al-Rumaitha in Al-Muthanna Governorate,***" J. Psychol. English, no. 230, pp. 1–20.

[10] Y. K. Cai, H. R. Xie, Y. Ma, S. Hokoi, and Y. H. Li, (2021) ***"Active environmental control strategies for brick historical buildings, combining heritage conservation and thermal comfort,***" J. Phys. Conf. Ser., vol. 2069, no. 1, doi: 10.1088/1742-6596/2069/1/012080.

[11] A. Calì, P. Dias de Moraes, and Â. Do Valle, (2020) ***"Understanding the structural behavior of historical buildings through its constructive phase evolution***

using H-BIM workflow," J. Civ. Eng. Manag., vol. 26, no. 5, pp. 421–434, doi: 10.3846/jcem.2020.12612.

[12] C. Cecchini, (2018) ***"FROM DATA TO 3D DIGITAL ARCHIVE: A GIS-BIM SPATIAL DATABASE FOR THE HISTORICAL CENTRE OF PAVIA (ITALY)***," J. Inf. Technol. Constr., vol. 24, no. October, p. 459, 2019, [Online]. Available: http://www.itcon.org/2019/24

[13] T. Jeleński, (2018) ***"Practices of built heritage post-disaster reconstruction for resilient cities,***" Buildings, vol. 8, no. 4 , doi: 10.3390/buildings8040053.

[14] S. Mustafa, Kadhim and S. Ali, Obaid, (2022) ***"Heritage Outposts in Al-Muthanna Governorate (Alghuleidha, Alaarzyiat and Alsafi Posts as an Example***)," Athar Al- Rafedain, vol. 7, no. 2, pp. 203–232, 2022.

[15] W. Al-Attiyah, (1954).***The History of Diwaniyah: Past and Present***, 1376th–1418th ed. Qom: Al-Haidariya Library Publications.