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Digital Heritage: Preservation of Architectural Heritage in the United Arab Emirates: Dubai as a Case Study.

By

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Abstract

Background

Preservation of cultural heritage is among the primary concerns of contemporary societies and governments. Its significance has both economic and cultural roots.

Aim

The purpose of this article is to shed light on digital heritage and its technologies, evaluate its opportunities for governmental and educational purposes, and analyze its current projects in order to contribute to the understanding and development of digital heritage as well as new frameworks and perspectives in the preservation of traditional heritage.

Method

The study is based on the desk review of existing literature on cultural and architectural heritage and its preservation in digital format and the importance of digital heritage in preserving Architectural Heritage in general and in the UAE, focusing on Dubai.

Findings

This paper used the restoration of Shaikh Saeed Al Maktoum's house as a model of traditional house restoration. It illustrates how Dubai utilized digital technology to restore its traditional architecture in its historical residential area, including restoring old houses in the Al Bastakiyyah and Al Shindaghah neighborhoods.

Keyword: Preservation, Digital Heritage, Historic residential area, Digital documentation and photogrammetry

Introduction

The preservation of one's culture and heritage is important to both the individual and the advancement of society as a whole. To fulfil one's aesthetic, spiritual, and cultural requirements, culture and heritage are requirements that must be met. In addition to that, they communicate some economic factors. The achievements of human civilization and the accumulated knowledge of previous generations are reflected in cultural legacy. To preserve the cultural heritage of a people means to preserve human history as well as the works that people have made throughout that history. According to the findings of several studies, "historic structures and locations disclose the occurrences, the challenges, and the advancements of the past" (Yilmaz, Yakar, Gulec, & Dulgerler, 2007, p. 428). In addition, the presence of these artefacts from the past makes it possible to imagine the activities that took place in times gone by. In spite of the numerous efforts that are made to preserve historic cultural heritage, its objects continue to disappear every year as a result of natural or human forces, robbing future generations of the opportunity to view them. In the most recent decades, digital approaches have been proposed as potential ways to document and, as a result, preserve cultural heritage. Understanding and developing digital heritage, as well as new frameworks and perspectives, can be helped along by providing an overview of digital heritage and the

technologies that support it; evaluating the opportunities presented by digital heritage for governmental and educational purposes; and conducting an analysis of the digital heritage projects that are currently underway.

The preservation of architectural heritage is among the most difficult aspects of cultural heritage to undertake. It requires a significant amount of effort as well as the application of relevant technological methods. Yilmaz, Yakar, Gulec, and Dulgerler (2007) investigate the documentation of cultural heritage in general and architecture in particular by outlining the sources of information that can be used during the process of documenting and recording. In particular, the authors focus on the documentation of architectural structures. "old photographs, old maps, old designs and projects, civil and personal archives, pictures and gravures, archaeological data, and travel notes" are examples of the kind of sources that make up these sources (Yilmaz et al., 2007, p. 429). However, in order to make the process of documenting and digitising a historical structure possible, it is first required to determine the significance of the building in the context of the discipline of architecture. In order for a structure to be deemed worthy of preservation, it must bear witness to an important historical event in the past; it must also be genuine; its original function must still be intact; it must have valid documentation; it must be one of a kind from a structural or technical perspective; and it must either be of artistic or technical significance.

Dawlat al-Imrt al-'Arabyyah al-Muttaidah is the Arabic name for the United Arab Emirates (UAE), which is a country made up of seven united emirates: Abu Dhabi (which serves as the capital), Dubai, Sharjah, Ajman, Umm al-Quwain, Fujairah, and Ras al-Khaimah. Abu Dhabi is the country's largest city. The United Arab Emirates has shown an interest in the preservation of its heritage and has implemented modern digital technology that is currently being deployed all over the world in order to both survey its new archaeological sites and protect its heritage.

Methodology

This research paper aims to shed light on how Dubai utilized digital technology to restore its traditional architecture, mainly restoring old houses in its historical residential districts. The research is based on desk review, content analysis and evaluation of current literature on architectural heritage, conservation, and preservation in digital format. In addition, the research paper reviews various internet search engines, including Web of Science, Scopus, and the university library, to critically evaluate the nature of digital preservation of heritage, defining key terms, and establishing existing digital preservation methods of the same, from 2D to 3D. The significance of this paper which combines data and issues and captures academics' and field specialists' perspectives from Dubai Municipality and conferences on digital preservation to bridge a gap in conservation, preservation, and digital records in UAE. Additionally, this paper reviews the most prominent reasons for requiring digital preservation methods for preserving architectural heritage. Of the reasons highlighted and critically evaluated, there is the detailed portrayal of the sites, resilient conservation, saving of the original architectural heritage, and aid with formulating related policies.

Furthermore, in discussing how digital technologies are used to preserve heritage architecture, the review analyzes edge-based segmentation, model-fitting approach, surveying, laser scanning, and photogrammetry. Finally, the paper offered such examples as As-Salt, Hazzazi House in Old Jeddah, KAS, and various examples from the United Arab Emirates.

Literature Review

The Digital Model

The construction of a digital model marks the beginning of the procedure as a whole. Scanning techniques, which are increasingly utilised in the field of heritage, such as laser scanning or photogrammetry, or Computer Aided Design (CAD), or a mix of both, serve as the primary techniques. These techniques can also be employed in conjunction with one another. There are a large number of articles in this topic, however Assi, (2022) provides a helpful overview of it all.

The flexibility offered by such solutions is undeniably one of their primary selling points. It is possible to create (digitally) missing components of buildings by the use of digital operations such as deforming or scaling the model, making a mirror image, etc. The ability to scale images is a significant benefit if one needs to make "copies" of existing metal or ceramic objects due to the fact that these materials shrink during the manufacturing process (for example, significant portions of cast iron constructions, such as columns or balconies). This is because the shrinkage of the materials makes it impossible to make exact replicas of the originals. When it comes to the accurate restoration of priceless artefacts, the use of digital models, in conjunction with digital operations such as adding, distraction, etc., may lead to a digital model that, when "materialised," can fit precisely into the damaged object, without the need to remove any authentic material. This is a significant advantage over traditional restoration techniques. Despite the fact that we see less of a need for this in the construction industry, this is an excellent fit for art pieces. When employing digital techniques for registration and constructing restoration elements, one can simply cope with irregularities, asymmetrical shapes, and other characteristics that are so prevalent in historic buildings. These characteristics can be found in a wide variety of older structures. By using 3D scans of the windows, on which the stained glass is modelled in the workshop, the placement of newly restored stained glass windows in a gothic building (with windows that are mostly visually regular, but very often not so regular at all) is greatly facilitated. This is because gothic buildings typically have windows that are visually regular, but very often not so regular at all. The fact that the object being scanned and the scanning devices do not need to come into direct physical contact with one another is likely to be of great interest. This is especially true in situations in which the object being scanned is particularly delicate, such as when it is polychromed or gilded, in which case the "traditional" method of creating a mould may even be completely impossible. In this scenario, scanning is the most efficient method for copying, duplicating, and measuring things (Fig. 1) Vanhellemont, et al. 2016 .

Figure 1: *Vanhellemont, et al. (2016)*

What is Digital Preservation of Heritage?

Since the eighteenth century, when Europe first started paying attention to distinct national identities and cultural variety, heritage preservation has been a vital occurrence. However, in light of the consequences of climate change, globalisation, industrialization, and growing urbanisation, the traditional approaches to the preservation of heritage have been shown to be unreliable (Gao et al., 2018). In addition, there are no comprehensive policies in place to conserve and preserve the cultural heritage. Ancient Chinese architectural designs, for instance, are more vulnerable to the effects of natural calamities such as earthquakes and fires. The majority of heritage cities are currently facing some kind of danger, and there is widespread agreement that they require protection and preservation for the sake of future generations.

The digital preservation of legacy has been a significant topic of research for the past two decades, despite the fact that the technology has encountered a great deal of opposition. In order to address these issues, researchers have developed cutting-edge strategies for preserving cultural artefacts through the use of digital tools (Singh, 2012). The primary goals of digital preservation are to enable the supply of heritage through digital outlets to large audiences, to guarantee that initial measurements and forms of natural heritage are not lost in the event of natural disasters, to identify instances of art forgery, to develop replicas, and to enable the collection of particular textural and geometrical information from the natural objects being preserved (Gomes et al., 2014). Therefore, digital preservation is a revolution against the old approach of maintaining natural and cultural assets.

In the past, legacy was captured using models that were only two dimensions. The geographic information system (GIS) was initially utilised by the model, which assisted in linking a heritage with its semantics. In other situations, they connected the cultural heritage with the spatial information system, particularly for individual buildings (Pepe et al., 2021). This method, however, was insufficient because it was only restricted to 2D; as a result, there was a need for greater digitalization of heritage preservations, which saw the emergence of 3D. Nevertheless, this method was only limited to 2D. (Evens & Hauttekeete, 2011). The utilisation of volumetric picture images is the primary emphasis of the 3D systems. Although it is difficult to construct 3D images due to the nature of the environment, scientists have used complex shapes such as Non-Uniform Rational Basis-Splines (NURBS) to have a digital recording of natural heritage. This was accomplished despite the fact that it is difficult to construct 3D images. The other digital method for collecting cultural heritage involves a laser scan Building Information Modelling (BIM) software (Valetutti, 2015). (Valetutti, 2015). The construction of a map using photogrammetric data can be accomplished with the use of a laser in this form of reverse engineering. However, this technique cannot be applied to the architecture of ancient China because the lasers have the potential to destroy the ancient Chinese paintings as well as the materials that were used to construct the buildings, and the architecture is structurally complex, necessitating the use of close-range scanning.

These days, an increasing number of communities are turning to innovative digital means of archiving their cultural history for the benefit of future generations. These methods emphasise the significance of various cultural terminology. Because of this, the preservation of digital heritage is strongly dependent on 3D imaging (Peters et al., 2017). It uses computer-based technologies like as NURBS and BIM to develop, share, and save natural and cultural heritage information. The more advanced means of digital preservation become, the greater the number of distinct civilizations that will be able to archive their natural and cultural history and communicate it to a vast number of people. One example of a digital heritage product is the ability of the internet to disseminate a cultural heritage to a large number of users simultaneously.

Reasons for Digital Preservations for Architectural Heritage

The ability to depict legacy in a manner that is both specific and all-encompassing is one of the primary advantages of using digital preservation methods for architectural heritage. According to the findings of a study that was carried out by Aburamadan et al. (2021), Jordan has increased its reliance on digital technology in order to create a representation of their culture that is both more accurate and comprehensive. The use of digital technology allows for the documentation and removal of a variety of obstacles that were present in earlier versions. For example, a laser scan may record an entire building in only one day and send the data to specialists located thousands of miles away via the internet. This represents a huge advancement in comparison to earlier methods of protecting natural and cultural assets (Aburamadan et al., 2021). AutoCad, which is a tool that works in two dimensions, and laser scanning, which works in three dimensions, are both examples of technology that enable more accurate recording. Consequently, these techniques allow for the capture of historical structures through the use of computerised 2D and 3D pictures. On the other hand, it has been discovered that these technologies can occasionally yield inconsistent findings due to the impacts of lasers on historic buildings. This can have a negative impact on the value and relevance of these buildings (Gao et al., 2018). Therefore, the processes are connected with BIM in order to deliver precise and consistent results while also protecting the cultural and functional components of the heritage sites.

The employment of digital preservation methods has become widespread because these methods contribute to the achievement of resilient conservation. The development of resilient communities and buildings has been facilitated by the application of cutting-edge technologies. The Internet of Things (IoT) and Heritage Building Information Modeling (HBIM) are two of the cutting-edge technologies that are currently available (Elabd et al., 2021). These tools are frequently used by designers as a means of assisting them in overcoming the complications that lead to competing aims. Researchers are able to use photogrammetry and laser scanners to document cultural and natural heritage assets when they have access to 3D heritage models. Through the use of reverse engineering, HBIM assists in mapping parametric objects to image survey data and the cloud (Khalid, 2021). The use of HBIM to map historical buildings results in the production of comprehensive 3D images as well as orthographic images, which are beneficial to the preservation of heritage. The HBIM facilitates group decision-making through the visualisation of data and the improvement of system thinking through comparison to alternative designs. On the other hand, the Internet of Things facilitates the communication of information technologies that link researchers to other designs so that they can compare their results (Elabd et al., 2021). It makes it possible for people located in different parts of the world to communicate with one another in real time, which makes the process of digital preservation both more trustworthy and speedier. Therefore, the Internet of Things and building information modelling (HBIM) can help digital preservation attain robustness.

The original architectural legacy can be saved thanks to the support of digital preservation. This technique is most commonly applied when dealing with manuscripts or other architectural heritage aspects that are only available in unique forms and have a high level of demand (Boamah, 2018). Because there may only be a single copy of some architectural heritage features available in some cases, this can make it more difficult for individuals who are interested in making use of them to do so. The presence of an excessive number of people would also result in the destruction of the original architectural heritage. Therefore, the greatest way to avoid losing genuine architectural legacy, such as a text, buildings, or structures, would be through digitalization, where the original copy is securely stored or guarded. This would prevent the destruction of any legitimate architectural heritage (Boussaa, 2014). After that, a

copy of that will be made accessible for others to view. Because several individuals can utilise digital replicas at the same time, digital preservation also promotes access to the architectural legacy. For instance, if people visit a particular architectural heritage site in order to read a manuscript, that manuscript could be digitised, and people could pay to view it online. This would cut down on the number of people visiting the architectural heritage site, which would protect it from further deterioration.

The utilisation of digital preservation contributes to the consolidation of policy with regard to the preservation of architectural heritage. With the conventional approaches, there were no regulations or formal procedures in place to allocate resources to the architectural heritage (Boamah, 2018). There was a significant amount of reliance placed on the oldest members of the society for information regarding the cultural and architectural heritage; yet, there were occasions when information was lost as it was passed down through the generations (Boamah, 2018). This is due to the fact that the information and knowledge were transmitted verbally, and the passing of certain persons could result in the loss of knowledge regarding architectural and cultural legacy. Consequently, the utilisation of digital preservation methods contributed to the development of sound regulations on the efficient management of information for architectural historic buildings. During the process of digitalization, extensive consultation is given to both local societies and individuals who possess the most knowledge. This helps to ensure that information is transmitted in a way that is both accurate and frictionless.

How Digital Technologies Preserve the Architectural Heritage

The preservation of architectural history is accomplished by the application of 2D and 3D segmentation and categorization procedures enabled by digital technologies. While 2D photographs search for colour, form, scale, and patterning in shape, 3D images search for gradients, surface normals, and other geometric properties (Deligiorgi et al., 2021). In order to carry out medical assessments, recognise vehicles, identify objects, and categorise microbes, they make use of picture segmentation as well as cloud segmentation. The process of segmentation involves locating point clouds, pictures, or meshes that have a similar composition while taking into account their many individual characteristics.

Edge-based segmentation is one of the techniques that are utilised in the process of recording architectural history. This method may be broken down into two primary steps: the first step locates the segment's edges, and the second step merges points from within the segment to provide the completed details. Principal curvatures, gradients, and high-order derivatives are the primary means by which edges are recognised, and they are recorded at locations that meet a predetermined threshold (Grilli & Remondino, 2019). Although this method of segmentation is quick, the findings it produces may be erroneous due to the unequal density of clouds and the noise in the data. In addition, when employing this method in 3D framing, you may use segmentation filling to simplify the process of identifying objects, which is quite useful.

The model-fitting approach is the other type of segmentation that sees widespread application. This technique requires the observation of artificial things, the determination of fundamental shapes (such as cubes, cylinders, and spheres), and the subsequent return of the objects to their initial form based on the mathematical representations of those fundamental shapes (Grilli & Remondino, 2019). The Random Sample Consensus (RANSAC) and the Hough Transformation are two approaches that are frequently utilised in order to recreate these shapes (HT). This is a speedy way for recreating architectural heritage; nevertheless, it might occasionally display complex shapes that require further labour.

Surveying involves taking instantaneous measurements of defining angles and distances in order to determine a feature's initial position by orthogonalizing the data and putting it into a coordinate system. This technique utilises very accurate measuring instruments like total stations, which are dependent on a three-dimensional orthogonal coordinate system (El Araby & Okeil, 2004). The surveying method is one that can be used to restore architectural history in the process of digitising monuments. This technique has a high level of precision and reliability, and it makes it simple to determine the original location of the monument. Despite this, the approach is so demanding that it requires one to be personally present at the spot in order to apply it, and it is typically employed under difficult circumstances.

The restoration of architectural history is another potential application of laser scanning technology. They make it possible for the researchers to assess topographic quantities and make use of an optical line that connects the characteristic point and merges it with the device's reference point (Pavlidis et al., 2007). In addition to this, they make use of the triangulation principle in order to automatically estimate the distance and plot it in a Cartesian plane. This method is trustworthy, quick, and accurate, and it enables the collecting of a substantial amount of data in a relatively short amount of time.

The use of photogrammetry as the last approach to the preservation of architectural heritage is recommended. Accurate measurements are extracted from digital photos by the application of topographic techniques. The use of CAD software enables photogrammetry to perform transformations on photographs in order to obtain precise coordinate measurements (Pavlidis et al., 2007). However, this process could be completed in a shorter amount of time, and it should be combined with other procedures in order to provide reliable findings. Additionally, it can be utilised for architectural heritages that are either inaccessible to the public or have entry restrictions.

Some Worldwide Examples of the Preserving of Architectural Heritage in Digital Form

The majority of urban and architectural preservation efforts have been concentrated in nations that speak the Arabic language. As-Salt, which is located in Jordan, is one of the cities that has experienced the process of digital conservation. The local yellow stone was used to construct historic homes in the city that were either two or three stories tall. Even though it was the capital city in 1922, the town was allowed to fall into disrepair (Trillo et al., 2020). The city's growing population prioritised the construction of newer homes rather than the renovation of older structures. As a result, the Salt Development Corporation made the decision to construct just one famous home, which they named the Qaqish House. This home underwent extensive renovation in three stages between the years 1989 and 2000, and it is now home to the As-Salt City Development Office (Trillo et al., 2020). The team was able to restore the property by employing BIM objects to locate the pertinent architectural parts within the house and utilising a variety of applications such as Autodesk Revit and AutoCAD. The assets in the residence were located with the use of 3D laser scanning. This renovation has given the city an instantly recognisable landmark, and each stage of the process has been meticulously documented for use in the future.

One further case in point is the Hazzazi House, which is located in Old Jeddah and was renovated with the use of the HBIM model and ArchiCAD software. Due to the rarity of restoration work in the city, King Abdulaziz University and a group of volunteers carried out the preservation. The house known as Hazzazi can be found in the Al Mazloum area. It got its name from the family that used to reside there (Baik et al., 2021). The local government made the decision to preserve the historical value of Jeddah by selecting this structure, which had

four stories when it was first constructed in the year 1875. The renovation of this home took place in five stages, with the first being the collection of information pertinent to the project from King Abdulaziz University using the various web sources that were available. The next phase was arranging the information that had been gathered and checking to make sure it was accurate (Baik et al., 2021). The house of Hazzizi was scanned with a laser in the third stage of the process; the information obtained from the laser was used in the fourth stage to redraft the floor plan for the house; and the fifth and final stage was the development of a remodelled dwelling. Following the completion of the home, it was recognised as a significant piece of architectural history in the city of Jeddah. In 2014, Jeddah was designated as a key cultural and architectural heritage centre by UNESCO.

The final illustration is the neighbourhood of Al Bastakia, which originated in the early 1900s. The majority of the buildings in the neighbourhood date from between the years 1890 and 1950, making it Dubai's oldest and most significant concentration of architectural history (Hadjri & Boussaa, 2007). In the 1970s, the neighbourhood was left desolate as a result of people moving to the contemporary towns that were being built in Dubai at the time. Llewellyn Davies was tasked with developing a conservation plan in 1994 when the government discovered that residents of the district had begun to leave. This was done in an effort to preserve the district's history (Hadjri & Boussaa, 2007). After tearing down a large number of historic structures, the government put aside cash for the area's preservation. The reconstruction of the old homes followed the same layout as the originals, and it made use of materials that were readily available in the area. On the other hand, because there are no policies or laws in place, there is a need for additional evidence to determine whether the materials that were utilised to rebuild the district had the same composition as those that were employed in those ancient periods (Abdelmonem, 2017). This suggests that even though the neighbourhood was rebuilt, UNESCO has not yet designated it as a cultural or architectural heritage site, despite the fact that it has been renovated.

Examples of UAE Digital Preservations of Architectural Heritage

Dawlat al-Imrt al-'Arabyyah al-Muttaidah, more commonly referred to as the United Arab Emirates (UAE), places a strong emphasis on the protection of its cultural history. For the purposes of preserving its heritage and surveying its newly discovered archaeological sites, it made use of the most modern digital technology currently in use across the globe.

I will only briefly select the Emirate of Fujairah as an example of employing digital technology in locating its ancient sites and for purposes of restoration and conservation. This is because I will only quickly select the Emirate of Fujairah. Dubai, with its forward-thinking strategy to fully integrate digital technology, is positioned to become the second emirate. For instance, the Dubai Future Foundation (DFF) created a 3D-printed replica of Palmyra's Arch of Triumph to immortalise the historical gateway to the ancient Syrian city in a joint effort with the Oxford University's Institute of Digital Archaeology (IDA) and Harvard University to highlight the importance and the potential of 3D printing that will play a key role in reserving Emirates' and the worldwide nations' civilizations, history, and accordingly its tangible heritage. This was done to highlight the importance and The Dubai Future Foundation provided help to UNESCO in order to document more than a million 3D photos of archaeological monuments all around the world that were in danger of being destroyed or sabotaged. These photographs would be exhibited on an electronic portal that was developed. Foundation for the Future of Dubai

Fujairah

The Emirate of Fujairah has made use of digital technology such as terrestrial laser scanning (TLS) in order to locate a large number of significant archaeological sites that date

back approximately 500 years. These sites include castles, forts, towers, and mosques, and the goal is to restore and preserve them.

The Fujairah Tourist and Antiquities Authority (FTAA) acknowledged the significance of Fujairah's legacy and how it may contribute to the growth of the city's cultural tourism business. They conducted the survey of the archaeological sites in the emirate in collaboration with a number of companies and academics from higher educational institutions all over the world. Researchers from the School of Mathematics and Geospatial Science at RMIT University conducted many terrestrial laser scanning (TLS) examinations of ancient sites in Fujairah in the year 2012. They performed surveys at many locations, focusing on the following three in particular: 1) The Fort of Fujairah, 2) The Fort of Al Bithnah, and 3) The Mosque of Al Bidya.

Fujairah Fort

It was constructed in 1670 and was regarded as one of the most important and huge forts in the emirate at the time of its completion. It is ingrained in the culture of the emirate that it played a role in the defence of the territory by warding off potential invaders. The Fujairah Museum asserts that the fort's strategic position is defined by the fact that it is situated on a steep hill in the historical area of Fujairah. It was built roughly 20 metres above the level of the sea, not too far from the coast, and it looks out over the entirety of Fujairah. When compared to the majority of the other engineering concepts that are typically used in the UAE, the Fujairah Fort's construction is quite distinctive. In 1925, the English navy launched a bombardment against the fort, which resulted in significant damage. Despite this, the FTAA was successful in restoring the fort, and it is now widely regarded as one of the most significant cultural and tourism sites in the city of Fujairah (Holden, Silcock, & Arrowsmith, 2015). In addition to a tall structure that is sectioned off like a tower, the existing building of the fort features three circular towers, a fourth square tower, and a fifth tower that is rectangular. These structures are joined together by a wall that runs between the towers, which creates a central hall in the middle of the structure. The uneven shape of the stones that were used to create the fort contributed to the one-of-a-kind architecture of the structure. Stone, gravel, clay, hay, and an Alsarooj substance (also known as gypsum) were among the many resources that were utilised during the process of construction (Fujairah Tourism and Antiquities Authority, n.d.).

The Al Bithnah Fort is in the shape of a rectangle, and its south-west and north-west corners each include a substantial watchtower. It has a view of Wadi Ham, which was historically one of the most significant inland roads coming from the shore of Fujairah. Because of its advantageous location, the monarch was able to use it to exert dominance over trade in Fujairah. Not only was the Al Bithnah Fort used for defensive purposes, but it also served as a gathering place for those living in and around Fujairah. In most cases, the first half of the 19th century is considered to represent the time period during which the fort was built. Even though significant portions of the fort were destroyed, Fujairah was able to restore it, and it is now available for visitors to explore (Holden et al., 2015).

Built into the side of a granite mountain in Al Bidya City in Fujairah, the Al Bidya Mosque is a square structure that measures roughly 6.8 by 6.8 metres. Because of the disparity in scale between the mosque's four domes, it stands out among other examples of architecture from across the Arab world. Each dome is composed of three layers and is held up by a single pillar in the centre. A modest patio can be found outside of the mosque. Researchers and anthropologists believe that the architecture of this mosque should be contextualised within the broader framework of the Indian Ocean commerce network during the fifteenth and seventeenth centuries AD. This is because the mosque was built during this time period. The

Al Bidya Mosque is on the list of protected heritage monuments maintained by UNESCO. Radiocarbon dating suggests it was constructed between around AD 1650 and 1670, and the organisation has put it in this time period (Holden et al., 2015).

The aforementioned Fujairah architectural sites were severely damaged as a result of hostilities that took place in the region in the past. They were threatened by a variety of factors including urbanisation, weather conditions, modernization, and the tourism industry. In addition, the coastal location of these sites posed a threat to them because Fujairah is developing its ports for oil exportation. Urbanization posed the greatest risk to these sites. The FTAA came to the conclusion that the best way to preserve archaeological sites was to work together with specialised firms to restore the historical building and with the study team from RMIT University that was stated to create digital documentation of the three historical buildings. During the process of surveying these buildings, a variety of digital technology was used to create accurate data that could assist decision-makers and the restoration companies. One example of this technology is "a Trimble CX Terrestrial Laser Scanner (TLS) for mapping cultural and archaeological sites within the Fujairah Emirate," which was used to map cultural and archaeological sites within the Fujairah Emirate. This device is a phase-pulse hybrid scanner that has the capacity to measure up to 50,000 points per second across a distance of 80 metres at a nominal range (Trimble Navigation Ltd. 2012). Due to the capabilities of this instrument, they were able to effectively cover the numerous historical locations. The high-resolution scans were utilised to gain clear details of architectural features, such as the internal courtyards at the Fujairah and Al-Bithna forts. These forts are located in the United Arab Emirates. The scientists used differential GPS to set up a local control in each of the three locations so that they could carry out ongoing future surveys that could be compared to the initial study. 2) Trimble Navigation Ltd. 2012, the modelling software that allowed the group to produce realistic models for tracking adjustments together with long-term as-built plans and also to display output for Internet tourists. This programme was developed by Trimble Navigation Ltd. In conclusion, three digital images were taken at a variety of sites across the country in order to compile an accurate database that may be used for future projects (Holden et al., 2015).

Dubai Historical neighbourhood

According to Heard-Bey (2011), in the year 1833, Maktoum bin Butti led a party of approximately eight hundred members of the Al Bu Falasa subtribe of the Bani Yas tribe as they relocated from Abu Dhabi and established on the creek of Dubai. After Maktoum bi Butt passed away in 1852, the Al Maktoum family became the ruling family of Dubai, and they have maintained their position up till the present day. At the turn of the century, as a result of its success in trade and the expansion of its pearl business, Dubai becomes an important hub for immigration. It was estimated that there were 10,000 people living in the emirate, and they were distributed over the town's four primary sections. The first neighbourhood that has been identified is called Al Shindaghah. After migrating from Abu Dhabi, members of the Bani Yas tribe lived in an area that formed a triangle with the open sea on one side and a creek on the other. This location was chosen because of its proximity to both bodies of water. They built the first neighbourhood, which consisted of 250 homes. All of the residents of this neighbourhood were Arabs, and among them were members of the ruling family as well as other Bani Yas families. Shindaghah, which is located in Al Shindaghah, is the primary residence of Dubai's ruling family as well as the majority of members of the Bani Yas tribe. Due to its commanding vantage point overlooking the mouth of Dubai Creek, the Al Shindaghah neighbourhood rose to prominence as a result of its strategic location, which allowed it to exercise control over the passage of sailboats and commercial vessels to Dubai Port.

Deira and Dubai side are located on opposite sides of Dubai, separated by the creek that receives water from the Arabian Gulf and travels inland. In Arabic, the creek is referred to as Khor Dubai, and the historic neighbourhoods that surround it have been designated as a UNESCO World Heritage Site. The second neighbourhood is called the Dubai side, and it is similar in location to Shindaghah but is further inland. Both neighbourhoods are on the same bank of the creek. Indian immigrants first arrived in this region and made their homes right adjacent to the Al Fahidi Fort. Roughly one hundred homes and fifty commercial establishments made up the Indian community (Heard-Bey, 2011).

In the year 1920, the government of Persia placed significant limitations on the activities of merchants who worked in the ports of southern Persia. These businesspeople received an invitation from Sheikh Saeed bin Maktoum, the ruler of Dubai, to make a permanent home for themselves in Dubai. They settled their family in the homes that they had constructed to the east of the old Al Fahidi Fort, which was located on the creek. The current position of the neighbourhood is in close proximity to both the creek, where boats may be unloaded, and the Souq, which is Dubai's main market. As a result of the significant number of people that settled here who were originally from Bastek in Persia, the locals formerly referred to this region as Al Bastakiyyah. Today, people refer to this place as the Al Fahidi historical quarter (Heard-Bey, 2011). The neighbourhoods of Dubai and Al Fahidi can be found side by side on the same bank of the creek.

The third neighbourhood is called Deira, and it may be found on the eastern bank of the creek. It has become home to people of many different ethnicities, including approximately 1600 homes that are of Arab, Persian, or Baloch origin. It was believed that the Souq (Market) in Deirah was the largest market in all of the Emirates because it contained over 350 shops. The other and only inland settlement is called Hatta, and due to its proximity to Oman, the ruler of Dubai personally oversees its administration. At this point, the municipal government of Dubai is responsible for it. In the end, Bedouin tribes colonised the inland oases of Al Khawaneej and Al Awir, and the ruler of Dubai erected specialised buildings for them in order to preserve their ancient way of life.

The administration of Dubai acknowledged the significance of the city's historical quarter and made efforts to protect it. To begin, preservation will broaden the base of economic activity by fostering the growth of the national economy through the promotion of heritage tourism. Second, the distinctive characteristics of Dubai's traditional architecture are regarded as a cause for pride and an essential component of the national identity of Dubaians. In addition, gaining knowledge from older forms of architecture will make it possible to construct new buildings that use traditional design elements in the both the present and the future. Additionally, it will promote the conduct of scholarly study in the area of architectural heritage (Bukhash, 2013). On both the Dubai and Deira sides of the city, the Dubai Municipality, Dubai's Department of Tourism and Commerce Marketing (DTCM), and Dubai Culture all collaborated on the restoration of Dubai's historical neighbourhoods.

The Restoration of the House of Sheikh Said Al Maktoum

The Sheikh Said Al Maktoum House is considered to be one of the first homes ever constructed in the Al Shindaghah region. During the reign of Sheikh Maktoum bin Hasher Al Maktoum, construction began in 1896 on this building, and Sheikh Saeed al Maktoum called it home from 1912 until 1958. This house went through a lot of renovations, and they added a tonne of new rooms to the main part of the house. The sheikh and his sons lived in the house, but in addition to that, it served as the administrative headquarters for both the sheikh and the sheik's court (Bukhash, 2013).

It is one of the largest residences ever constructed in the old Al Shindaghah neighbourhood, and it was constructed on a plot of land that is 3,600 square metres in size. It features four wind towers that are easily identifiable and are embellished with gypsum. These wind towers overlook the creek. According to Engineer Rashad, the progression of the home may be seen reflected in the Liwans in the form of numerous types of arcades (corridors). Additionally interesting is the verandah with columns that is located in front of the rooms on the ground floor. Different types of wood beams, such as chandal wood beams and square wood section beams, can be used in the roofing of a house. The home is organised primarily around the open court that is located in the middle and is flanked by several sections. Each of the sheikh's sons had their very own personal living quarters in one of the four distinct portions of the compound. In addition, there are two Majlises, one of which is a public majlis located on the ground floor, while the other is a seasonal majlis located on the first floor. The structure featured two primary entrances, and the majority of the sections featured two entrances as well. Additionally, there was one main entry that was indirect and was accessible from the creekside via chairs constructed into the wall. Additionally, built-in seating can be seen on the exterior elevation (Bukhash, 2013).

The interior and exterior of the house are both outfitted with stunning geometric gypsum designs, which contribute to the home's attractive design. In tandem with the rest of the property, the Dubai Municipality has twice completed repairs on these recessed areas. In 1981, the first round of repairs began, and they consisted of reinforcing the buildings, foundations, and ceilings, in addition to performing any necessary electromechanical work. Nevertheless, preserving its classic appearance was one of the principal objectives of this project. The second round of renovations took place in 1996, when the mansion was converted by the government into a museum where historical artefacts from Dubai are displayed (Bukhash, 2013).

The government of Dubai wants to highlight this house digitally and make it available online so that it may be used for educational and research reasons while also preserving its beauty. Therefore, the Municipality of Dubai tasked the business 3Deling with working on eight projects to conserve ancient buildings online or display them in virtual museums using digital technology.

When it comes to digital heritage, there are typically several processes required in order to obtain correct data. For instance, 3Deling utilised 3D laser scanning in order to conduct a survey of Saeed Al Maktoum House due to the fact that such scanners are able to accurately identify a wide variety of complex aspects of structures in a very short amount of time. Then The creation of a comprehensive database, which will be used in the future for a variety of products such as sections, 2D Deliverables, elevations, plans, and topographic surveys, as well as 3D Models delivered in DGN, DWG, or Revit format, was accomplished with the assistance of photographic imagery. A topographic survey in three dimensions. Combining scanned information with high-resolution digital images printed in 3D as well as animations and fly-throughs results in the creation of RGB (Color) point clouds, Orthoimages, and Mesh Models.

After 3Deling scanned eight historic architectural locations in Dubai and acquired point clouds in RGB colours using Faro Focus and Riegl VZ 400, photographic information was obtained by using equipment from Nikon and Cannon while the Leica TCRA 1101 total station was in charge. The team from the company presented extremely detailed datasets and a variety of products to Dubai's Municipality on the spot. These included textured 3D CAD models, TruViews, Panotours, 2D CAD drawings, and interactive walkthroughs. It was challenging for the 3Deling team to get profound results in terms of modelling because of the historical

characteristics of the structure that were taken into consideration. These problems included the building's changing and intricate shapes. The massive amount of data that needed to be edited was another obstacle that needed to be overcome. On the other hand, they discovered ways to simplify models in order to create animations that were textured and detailed. In addition, the government of Dubai requested that the company give an interactive walkthrough as a product, which is an excellent product for historic buildings or other locations in which customers wish to offer an online interactive experience (3Deling)

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In an interview with my mother one of the resident locals of al Shindaghah , I asked her about the reasons that they abandoned their houses, she said that Dubai government offered them new houses and the Air-conditions were newly presented to us so people preferred the newly airconditioned houses additionally we did not have the money to restore our houses. She continued mentioning that people are looking for modern houses and when theIndians lived in their houses , the locals left the areas for the strangers and lived in national communities