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IDENTIFICATION, DIGITAL DOCUMENTATION AND CONSERVATION OF HISTORIC MONUMENTS IN PAKISTAN: A CASE OF SHEESH MEHAL LAHORE

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ABSTRACT

This paper emphasizes the significance of preserving historic monuments, emphasizing their role as tangible records of human history. It highlights the necessity of conserving such heritage assets for the sustainable development of historic cities, with a particular focus on the documentation process. The case study revolves around Sheesh Mehal in Lahore, chosen for its historical importance and the application of digital tools like Total Station and Terrestrial Laser Scanner (TLS) in its preservation efforts. By evaluating the strengths and weaknesses of both documentation techniques, the paper aims to deepen our understanding of the intricate spatial dynamics within heritage sites. Sheesh Mehal, situated within the Shah Burj of Lahore Fort and commissioned by Mughal Emperor Shah Jahan in 1631-32 A.D., holds a prominent position among the 21 significant monuments constructed by the Mughal rulers within Lahore Fort. Its recognition by the Indian Department of Archaeology in 1927, subsequent protection under the Antiquities Act by the Federal Department of Archaeology, Pakistan in 1975, and designation as a UNESCO World Heritage Site in 1981 underline its cultural and historical importance. The digital documentation of Sheesh Mehal, conducted by the Agha Khan Cultural Services of Pakistan (AKCSP) in 2017 using Total Station and by the Walled City Lahore Authority (WCLA) in 2022 using Terrestrial Laser Scanning, exemplifies the application of modern technologies in heritage preservation. In conclusion, the paper provides an analysis of the precision and accuracy of digital documentation techniques, shedding light on their efficacy in capturing and preserving the intricate details of historic monuments. This assessment contributes to the ongoing discourse on leveraging digital tools for the documentation and conservation of heritage sites, ensuring their legacy for future generations.

Keywords: Documentation techniques, Digital technologies, Sheesh Mehal, Historic Monuments, Terrestrial Laser Scanner, Total Station.

INTRODUCTION

The historic monuments are the record of human activities done in the past and they are of two categories, tangible and intangible. Tangible heritage is related with the physical structures but these physical structures are associated with feelings, emotions, memories related with historic evidences. All these associations are part of intangible heritage. It has been realized globally, that cultural heritage, is the context of past and it should be protected (Trillo et al., 2020). The conservation and preservation of historic monuments and heritage sites includes archival data collection, documentation, evaluation of causes of decay, preparation of conservation plan, implementation of conservation plans, management and monitoring (LAH, 2018). The concept of conservation has been spanned from individual monuments to historic areas and with this extended framework, new methods and strategies needs to be envisaged, maintaining the balance between sustainable development and historic preservation (Haddad, 2011).

The key step in the process of conservation is the documentation of historic monuments and historic areas which includes measured data in terms of

architectural drawings, color, texture and three dimensional models. The degree of precision and level of accuracy of documentation decides the quality of conservation works, saving human and financial resources (Rafiq, 1904) The digitization of these documented data can help to manage and monitor the preserved heritage sites (Džikić & Radin, 2019). The application of digital technologies in the field of historic preservation, specifically, for the documentation of monuments and urban spaces, brought a revolution in the conservation community. Conventional methods such as manual surveying and mapping with measuring tapes can't compete with virtual methods which includes digital surveying, mapping, documentation, archiving, management and monitoring (Bastem & Cekmis, 2022). The Digital documentation includes application of digital tools such as digital cameras, total station, laser scanners with multiple software compatible with these tools, updating the conservation procedures and practices (Masciotta et al., 2021).

Selected case study, Sheesh Mehal Lahore Fort is one of the significant historic monuments, constructed by Mughal Emperors and extended, reconstructed, renovated and preserved by the Sikh and British rulers. The heritage site has, not only tangible features but also has intangible characteristics as it is associated with the feelings of Mughal Emperors and their family members (Din, 2018). The UNESCO world heritage site direly needs application of digital technologies, at a large scale as it has been transformed into a tourist site. The digital technologies can also enhance tourist value of the heritage site.

Research Aim

The research focuses the documentation techniques applied for the conservation of UNESCO World Heritage Site, Sheesh Mehal Lahore Fort. The monument is unique due to its intricate mirror work on the walls and ceilings of the main hall, used as an entrance lobby and adjacent sleeping rooms. There were small pieces of glass which were inscribed with pilaster, creating an impact of twinkling stars. The other ornamentation such as pietra dura, fresco paintings, gilt work is also unique in its style and is rarely found, even in Mughal Monuments (Koch, 2008).

The monuments was threatened multiple times due to the interventions done by the Sikh and British rulers. The misuse of the monument is another cause of deterioration. The main focus of the conservation process is to protect as maximum as remaining, without further loss (AKDN, 2015). The application of digital technologies can help us to meet the current challenges of conservation due to the benefits, such as less chances of further decay as they have no direct contact, being done on the basis of laser beams. The results can be more accurate and precise due to the high levels of accuracy and high degrees of precision. Saving time and human resources are also the achievement of digital technologies. However, budget management is a constraint which must be handled for the best future outcomes (Woodward & Heesom, 2019).

The monument has been documented with Total Station (Electronic Measurement Distance) for the development of Wire-frame model and Terrestrial Laser Scanner has been used to get three dimensional model based on point cloud data. Both of the techniques has there pros and cons and resultant three dimensional models has been evaluated to explore the potential of both techniques for the conservation of historic monuments and urban built heritage (Gomes, 2023).

Literature Review

Sheesh Mehal as A UNESCO World heritage site

The Lahore Fort was added in the list of Protected Monuments in 1920 according to the notification number 2425 dated 27-01-1920 under the Ancient Monuments Preservation Act 1904. The Department of Archaeology of Pakistan added Lahore Fort in the list of protected monuments under the Antiquity Act 1975 (DOAM, 2024). The Lahore Fort and Shalimar Garden were added in the list of United Nations Educational, Scientific and Cultural Organization (UNESCO) World heritage Sites in 1981 as a single project. It was added in the list of World Heritage Sites in danger in 2000. UNESCO prepared a Master Plan for the Conservation of the Lahore Fort and Shalimar Garden spanning from 2006 to 2011 with the collaboration of Local Government Authorities (UNESCO, 2011). Being Part of Lahore Fort, Sheesh Mehal is also declared UNESCO World Heritage Site.

Historical Background & Cultural Significance

The Sheesh Mehal was constructed by Mughal Emperor, Shah Jahan for his beloved wife, Mumtaz Mehal in 1631 -1632 AD. The princess stayed here, when she visited Lahore but she died and couldn't

live here, in her dream palace. The palace is the most beautiful monument in the Lahore Fort and is a masterpiece, reflecting the love of Shah Jahan for art and architecture (Hankey, 1999). After occupying Punjab, Ranjit Singh selected the Palace of Mirrors as his residence (Naeem, 2010) and the dream palace of Mughal Princess Mumtaz Mehal, became the residence of Ranjit Singh and his family. Ranjit Singh added a Harem (female residence) for his Queen, Rani Jindan, on the top of Sheesh Mehal. It reflects, not only Mughal grandeur, but also showcase the opulence of the Sikh rule (Tufail, 1962). The palace consists of Bedrooms, main entrance hall to bedrooms, Shahi Hammam, Naulakha Pavillion and courtyard with central fountain. The palace has been decorated with extensive mirror work, semi-precious stones, gilt work, Pietradura, fresco paintings. The palace represent a blend of Persian, Mughal and Sikh art and architecture.

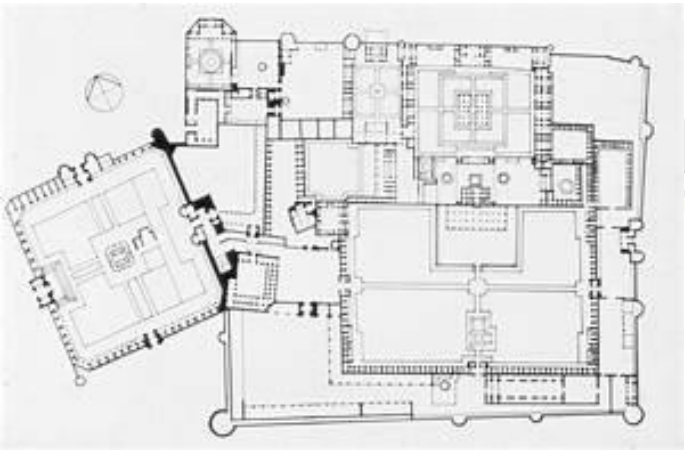


Figure 1: Plan of Lahore Fort (Google Images)

Legislation for Conservation

After independence, conservation of the built heritage was the sole responsibility of the Federal Department of Archaeology, Pakistan according to Antiquity Act 1975 and later amended in 1990 (Qadeer, 1996). The responsibility was shared to provinces after the constitution of provincial Acts/Ordinances. The walled city Lahore came under the umbrella of department of Archaeology Punjab, according to the Punjab Special Premises (Preservation) Ordinance 1985 (Khan et al., 2022). Directorate General of Archaeology, Punjab was established in 1987.

The Punjab Heritage Foundation Act was constituted in 2005 for the protection of Historic monuments. The Walled City Lahore Authority was established in 2012 and authority took the charge of Lahore Fort in 2023 (Hassan Naqvi, 1923).

Architectural Significance

The Sheesh Mehal is a double story palace constructed by Mughal Emperor Shah Jahan for his Queen Mumtaz Mehal. There is a summer palace in the basement for the stay of royal family members during the hot days of summer. The main hall is double height ceiling structure with door and window openings of the sleeping chambers. The structure was constructed with white marble which is a characteristic architectural element of the buildings built by Emperor Shah Jahan. The palace was ornamented with colorful glasswork, extensive mirror work and delicate fresco paintings. The most significant decorative element of Sheesh Mehal is its mirror work, which was done on the ceilings and walls of the bedrooms and main hall. The intricate geometrical patterns have been developed by the number of small pieces of mirrors, embedded into the plaster (Kamran, 2017).

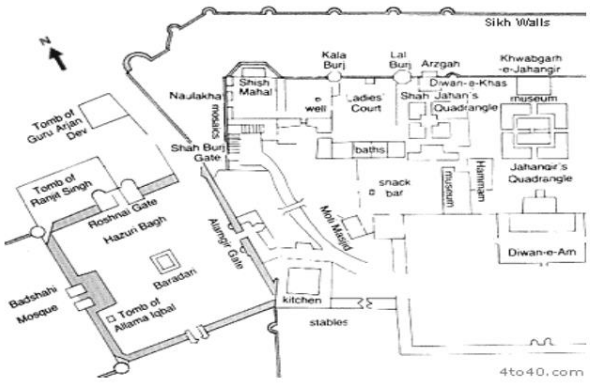


Figure 2: Plan of Lahore Fort showing Shah Burj (Source: (Kamran, 2017)

Another feature of the Sheesh Mehal is its fresco paintings elaborating scenes from the natural royal life. The art work is matchless in terms of craftsmanship of the artists.

Function of Sheesh Mehal in different period of time

The Sheesh Mehal was built by Emperor Shah Jahan for his beloved wife. But she died in 1631 A.D. at Burhanpur,Deccan (present day Madiya Perdash)

and she couldn't revisit the palace which was started for her residence. The Mughal emperor Shah Jahan constructed a magnificent Mausoleum, Taj Mehal, in Agra for his beloved wife. The Mughal emperor Shah Jahan transformed Lahore Fort as a pleasure place and added remarkable structures in it, especially in Shah Burj (Chaudhry, 1998)

After occupying Punjab, Ranjit Singh established his Harem on the top of Sheesh Mehal and this additional construction of room, added dead load to the roof of main hall,resulting a continual damage of the structure of the roof. When there was structural issues were observed in the ceiling of the main hall, these rooms were removed while conserving in the year 1905-1906 during British period, (DOAM, 2024). Ranjit Singh constructed his court, termed as Athdara, at the place of main entrance to Sheesh Mehal, also added kangra style fresco paintings to the Sheesh Mehal (Vandal & Vandal, 2006).

Figure 3: Elevation of Sheesh Mehal , showing Sikh period Additions

During the British Period, the fort was used by the military and closed for the General Public. It is handed over to the Department of archaeology, India in 1927. The summer palace of Sheesh Mehal was used as a store during British period. After freedom, it was under the umbrella of Federal Department of Archaeology, Pakistan. Currently, it is functioning as tourist site and it is being maintained by the walled City Lahore Authority (WCLA) since 2023.

History of Preservation of Sheesh Mehal

Pre-partition conservation (1905-1906)

The Sheesh Mehal, Lahore Fort is perceived its repair and conservation works in different time periods. The most significant and intricate details are related with mirror work and ceiling details of the main hall (Kamran, 2017). The monument was facing two types of damages, one is structural due to the heavy dead loads, increased by vertical interventions made during the Sikh rule and other is deletion of precious ornamentation such as mirror work, stucco tracery, gilt work, pietradura work and fine cut jalies (screens) during Sikh and British periods (Mumtaz, 1985).

The sheesh mehal was declared as residence of Ranjit Singh and his wife Mai Jindan. He constructed additional rooms on the roof. In 1905, according to the archaeological survey of India 1905, published in 1908, the false ceiling of the main hall of sheesh mehal was structurally damaged due to the additional dead load. The condition of the building became serious and can collapse, if not conserved. The ceiling of main hall was preserved by adding an additional roof of metal and mirror work was also saved (India, 1908).

Ceiling of Main Hall

The wooden ceiling of the main hall of Shish Mehal was covered with concrete, increasing dead load on the false ceiling. When the operation was started, the condition of the ceiling is worse than it appeared during the survey. On starting the operation for the protection of the damaged false ceiling, few facts were observed, two wooden beams were rotten at advanced stage and they must have to be replaced. The concrete above the wooden beams were carefully removed and rotten beams were supported by iron and it has to be supported from underneath. It was the first repair for strengthening the false ceiling of main hall, done by the Department of Archaeology of India in 1905-1906 (India, 1908).

Mirror Work

Mirror work of the palace is unique of its kind. There are chances to damage the mirror work on the false ceiling but it was saved carefully. There was a difference of quality between the mirrorwork on ceiling and walls.

Post Partition (1947 – 2024)

Conservation in 1973

The very first master plan for the conservation and restoration of Lahore fort was prepared in1973 by the Department of Archaeology and it was added in the list of protected monuments in1975. The project continued till 1985 but couldn't be completed. Only 25 % of expected work could be completed,

including repair of floors of Sheesh Mehal (UNESCO, 2011).

Conservation in 1991-1992

A scheme was approved for the conservation of Sheesh Mehal was initiated as serious cracks were appeared in the ceiling of the Sheesh Mehal. Federal Ministry of Culture constituted a technical committee to look into the matter (Kamran et al., 2016).

Conservation in 2003-2005

Sir Barnard Feilden also visited the site in 2000 and gave recommendations for the conservation of ceiling of main hall, already, conserved by the British in 1905-1906. On the recommendations of UNESCO, the ceiling of the main hall was conserved during 2003-2005 (UNESCO, 2011).

Conservation in 2008

All the mirrors were cleaned and repaired and works were completed according to the original forms. The chambers on the northern side of the Sheesh Mehal were also restored (Iftikhar, 2019). The maximum funding was done on the preservation of Sheesh Mehal (Ijaz & Sharif, 2011)

Methodology

Archival data has been collected regarding historic significance, previous conservation efforts and current use of the Sheesh Mehal Lahore from the relevant departments, Directorate of Archaeology, Punjab and Walled City Lahore Authority. Archival data in terms of conventional and virtual methodologies, being applied for the conservation of built heritage in the historic core of Lahore.

Visual and Pictorial surveys has been conducted to record current status of the monument and recorded of previous interventions. The monument has been documented with Total Station in 2017 by the Technical experts of Agha Khan Cultural Services of Pakistan (AKCSP) and with Terrestrial Laser Scanner in 2023 the technical experts of Walled City Lahore Authority.

The Scanned data has been processed to develop three dimensional models and auto generated orthographic drawings. Analysis has been done to conclude the application of digital tools for specific monuments for the guidance of future conservation works.

Sheesh Mehal Lahore Fort (Case Study)

Location & Context

The sheesh Mehal is located in fortified structure named as Lahore Fort. The Sheesh Mehal is known as the Palace of Mirrors due to its intricate mirror work on its ceiling and walls. This iconic structure is one of the twenty one monuments located within Lahore Fort (Shahi Qila) (Tufail, 1962). The Lahore Fort is located in the northern end of the historic city of Lahore, adjacent to the Badshahi Mosque. It was constructed for the members of the Royal family and their close courtiers. The Lahore Fort has witnessed the rise and fall of number of dynasties. The foundation stone of the Lahore fort was laid down by the Muhmood Ghazni in the 11th century and additions were made by the following rulers. At present, it includes significant structures such as palaces, mosques, gardens, pavilions, and administrative structures. The reconstruction of various buildings, renovation and conservation works for the protection of historic monuments were done by the Mughal, Sikh and British rulers (Vandal & Vandal, 2006).

The immediate context of Sheesh Mehal is comprised of historic environment, in the north, there is a circular road Lahore (which is now part of new project, greater Iqbal Park), on the south, there is historic city of Lahore. On the east, there is Kashmiri gate and the area of Badami Bagh, Lahore, on the west, Badshahi Mosque is located show-casing the glory and magnificence of its times.

Figure 4 Location Plan of Lahore Fort (Source Mapbox modified by the author)

The Sheesh Mehal is located at Shah Burj, in the north-western corner of the Lahore Fort. The whole complex is comprised of Picture Wall, Shah Burj Gate, Hathi Paer, Sheesh Mehal, Noulakha Pavillian, Sheesh Mehal Courtyard, Shahi Hammam. All these structures are on the ground floor and there is a summer palace in the basement of the Sheesh Mehal.

The corner functioned as Royal residence and is unique due to its construction style, materials of decoration. Sheesh Mehal is located in the south-east corner of the Shah Burj (Mumtaz, 1985).

Digital Documentation of Sheesh Mehal with Total Station (EDM)

The conservation and restoration of historic monuments and urban heritage sites is , now ,a challenge, in terms of authenticity, integrity, quality of work, human and financial resources and time spans (Gomes, 2023). The conservation practices owes to the quality of documentation and availability of multilayer data, with reference to architectural details, materials of construction, damage identification and measurement of the complex heritage structures (Asghar et al., 2021). The traditional methods of documentation are lagging behind due to their constraints such as chances of human errors, chances of access to the heritage site, chances of destruction due to the human contact, long time pans and more human resources (Džikić & Radin, 2019).

The advancement in technology also influenced the conservation procedures and practices through the application of digital technologies for the identification, mapping and surveying, documentation, managing and monitoring of heritage sites. The application of Total Station with TheoLT software, bring a revolution in the documentation areas through the development of wireframe views with electronic distance measurement (EDM) (Bullock & Richard E.Warren, 1998).

The mapping of heritage sites and historic monuments in three dimensions was initiated with the application of Total stations. These digital tools modernized the capturing and analysis of geospatial data to the extents of topographical surveys. The realm of 3D mapping methodologies using total station, transformed the conservation industry towards pinpoint accuracy and evaluating the potential of digital surveying. The 3D models changed the face of mapping for professionals (Haddad, 2011).

Digital Conservation in 2017-2021- Electronic Distance Measuring (EDM) Technique

Total station provide exceedingly precise digital three dimensional data for topographical mapping and it is pioneer in 3D modeling. The key feature of the total station is its Electronic distance meter (EDM), a laser ranger-finder for the measurement up to a distance of several hundred meters with amazing precision (Hassani et al., 2015). The total station has built-in theodolite to measure distances with directions and angles, providing wireframe 3D models. The angle measurement accuracy of total station is one arc second and distance measurement accuracy is up to 0.5 mm (Bullock & Richard E.Warren, 1998). The digital observation and recording of coordinates (horizontal & vertical), along with slope distance and angle proves its ability to transform data into local xyz coordinates, and entering elevation factors, can ensure the precision of 3D model.

Development of Scaled Wireframe Model through EDM Survey

In 2005, Agha Khan Cultural Services of Pakistan (AKCSP) took the initiative to transform documentation techniques from conventional to digital with the application of Total Station (EDM) with TheoLT and AutoCAD for the development of Wireframe 3D models and orthographic drawings for the documentation of historic monuments in KPK (Muhammad, 2009).

The AKCSP used Total Stations of make Leica TCR 805 ultra with the software interface, AutoCAD and TheoLT as plugins on a field laptop for the digital documentation of Lahore Fort in 2017 (Arif & Essa, 2017).

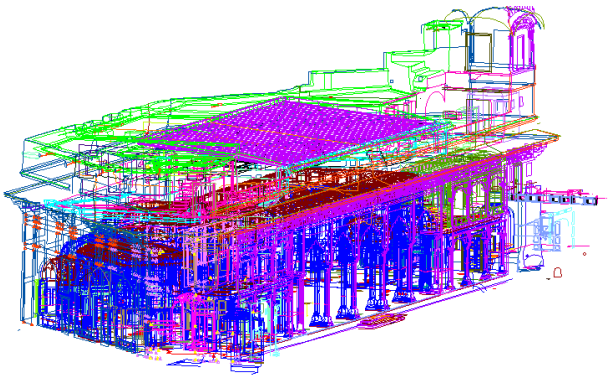


Figure 5: Three dimensional Wire-Frame Model with Total Station (EDM) of Sheesh Mehal

The three dimensional model developed by the application of Total Station is in the form of poly-lines and this model is constituted by the layers (Total 435 in number) for the documentation of Main Hall and its adjacent Sleeping Chambers. Five Total Stations are used to complete the task.

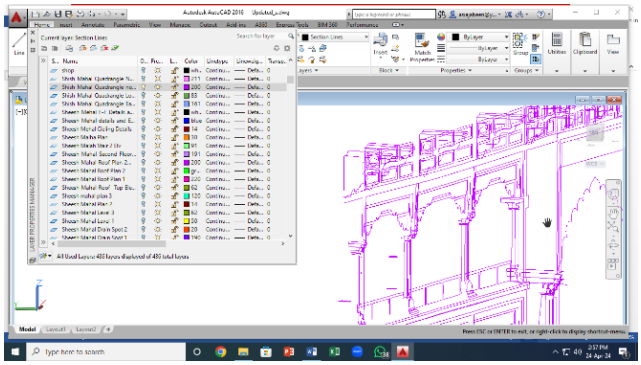


Figure 6: Images of the Roof Plan (Left) & Façade of Main Hall (Right) with layer properties

At that stage, more accurate and modern technology was available, in the form of Total Station which requires large number of experts. It also requires long hours, therefore, it is time consuming. It involves the projected tracing of building based on judgement and skills of surveyor, to align the objects to create a line. The total station records data in the form of polyline, creating a wire-frame model, rather solid form. In AutoCAD, plans and elevations can be extracted through the control of layers.

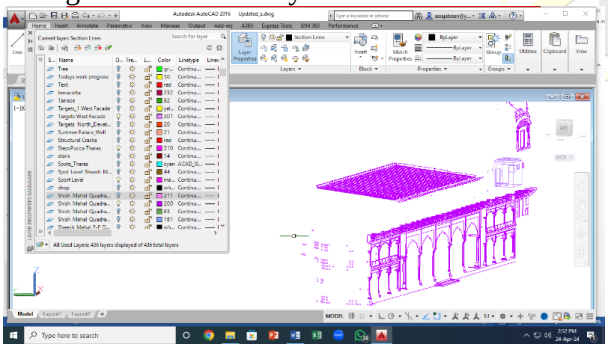
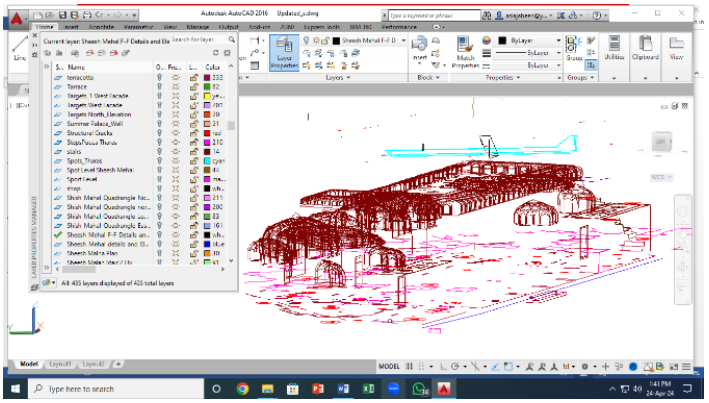


Figure 7: Entrance of the Main Hall and Roof Plan with layer properties, assigned different colors

Digital Conservation-Terrestrial Laser Scanner (TLS) Technique

The TLS is a device to develop 3D models from the point cloud data in XYZ format and it can survey hundreds and thousands of positions per second. Terrestrial Laser scanning can also help to acquire large volumes of accurate multi-layer information. Conventional methods of surveying based on measuring tapes, theodolite and total station can never compete the precision and speed of TLS which is 976000 points per second in case of Faro S70 make (Dore & Murphy, 2015) as compared to Total Station which is 1 arc per second (Muhammad, 2009).



Selected case study, Sheesh Mehal, Lahore Fort has been scanned with Faro Terrestrial Laser scanner (Faro Focus^{s} - Owned by Walled City Lahore Authority) to scan the monument.

Figure 8: Faro Focus ^{S} (TLS) (Left)and Spheres (Targets) (Right) (Source: WCLA)

Architectural Plan has been drawn with the help of data collected during the visual and pictorial surveys, to fix the target points in the monument for the scanning. With the help of "Spheres" Artificial Common Reference Objects (targets), 44 points were fixed to define the range of scanning interior and exterior surfaces. This range can affect the wavelength of laser beams. Forty three scans were done with the help of Terrestrial Laser Scanners to cover the façades, interior and exterior surfaces, capturing the ornamentation details of the sheesh Mehal. Each scan is of 10 minutes duration.

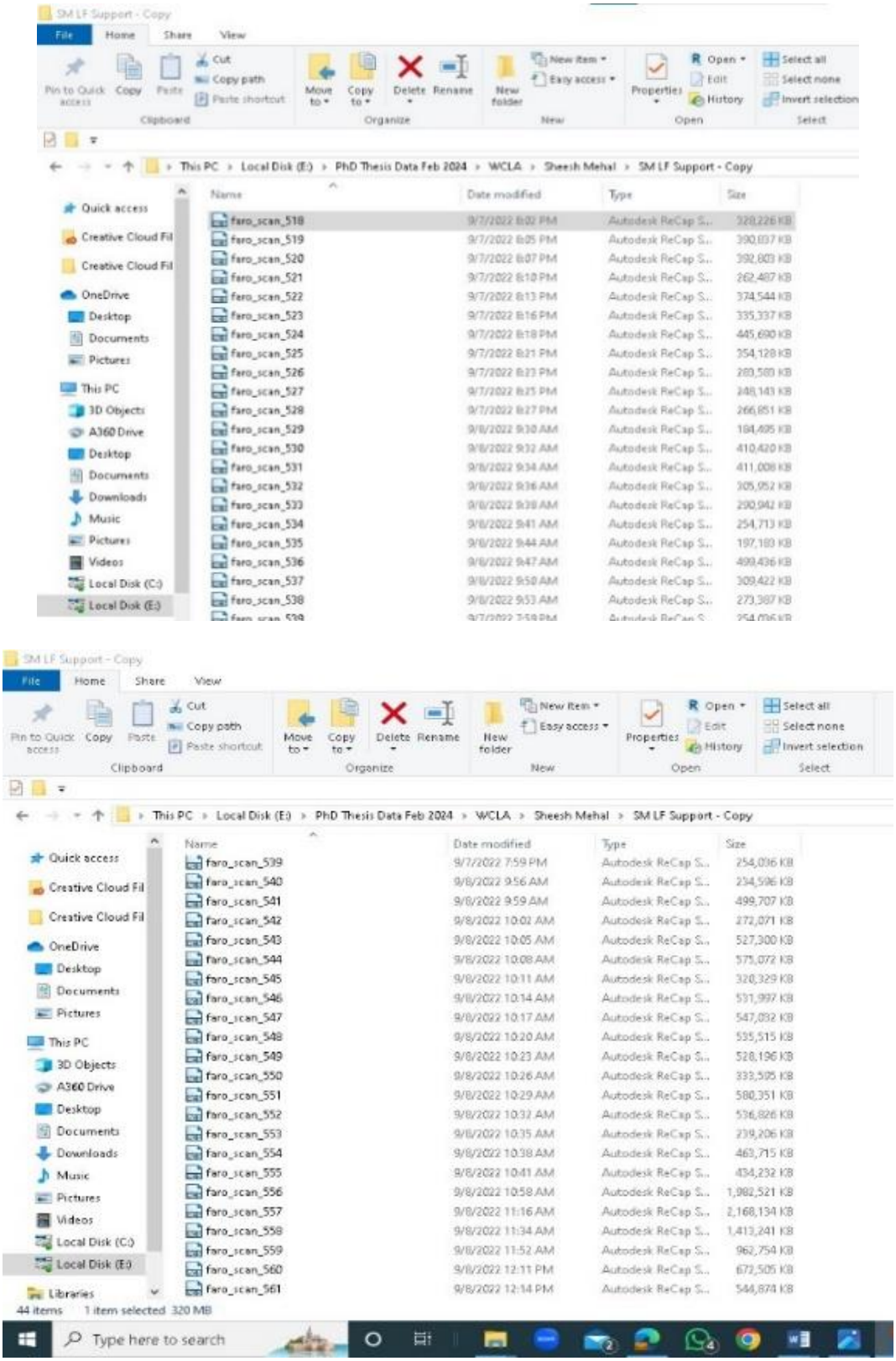


Figure 9: List of Scans from Scan 518 to Scan 538 (Left) and Scans from 539 to 561 (Right)

The scanned data has been combined through Scan manager of the software "Faro Scene 2019" to transform in a single file. This software will give a 3D model of scanned site after combining and we can delete unwanted elements from the scanned data.

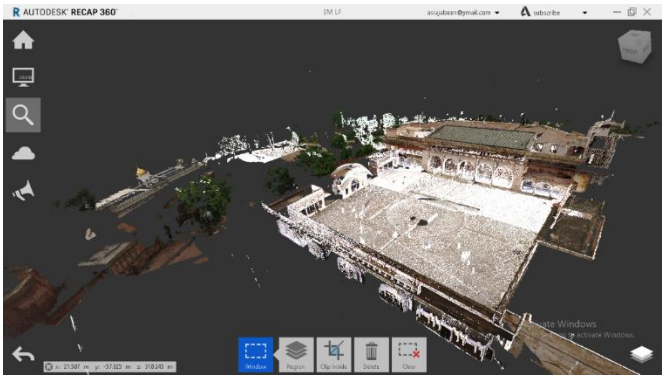


Figure 10: Three Dimensional Model of Sheesh Mehal (Autodesk Recap 360)

The site is scanned with the help of TLS of make "Faro S70" and the scanned data is registered with the help of software "Faro Scenes 2019" and this registered data, in the form of *.rcp file has been transformed into 3D models showing all the details with high level of accuracy and in the minimum time duration. All the scanning has been done in 44 scans, each of 10 minutes, and almost 10 minutes for the processing time for the preparation of next scan. Now the files are ready to transform in AutoCAD model to get the multilayer data.

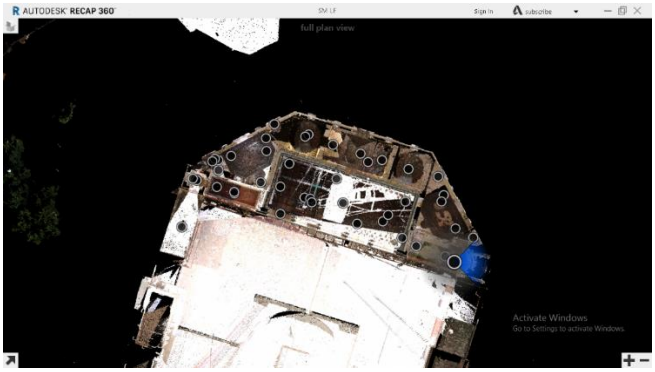


Figure 11: Plan of Sheesh Mehal showing target Points

The scanned data has been combined with the help of "Faro Scene 2016" software. File format is *.rcp, ready to open with a software "Autodesk Recap 360 Pro". These *.rcp files has been imported in "Autodesk Recap 360 Pro" to develop Building Information Model of the scanned site.

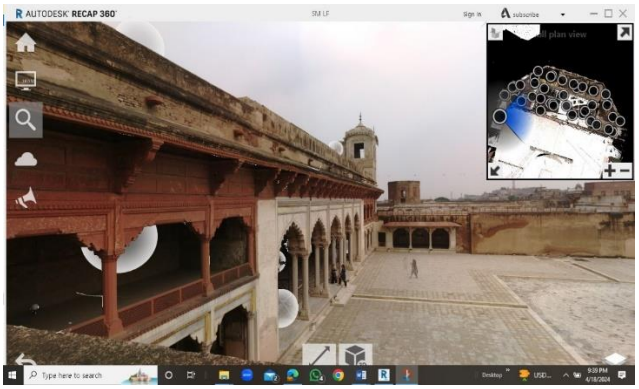


Figure 12: Details showing 3D Rreal Models in the *.rcp support files showing direction of targets

From Scan data to Building Information Modeling

Files edited in "Scenes" in *.rcp format has been transferred "Autodesk Recap 360 Pro" to develop 3D models with multilayer information in RGB colors. In the upper right corner, placement and orientation of targets can be traced to view the desired model with geometrical designs.

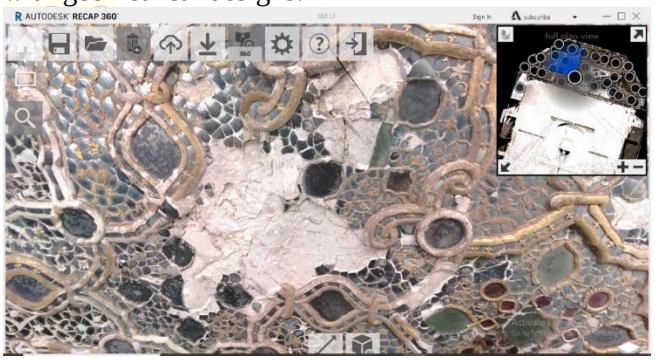


Figure 13: RGB 3D Model of Ornamentation in Autodesk Recap 360 Pro

Autodesk Recap can help to develop HBIM models to provide details, beyond the limits of conventional methods. Key feature is the use of "Field of View" to visualize the details of the HBIM model.

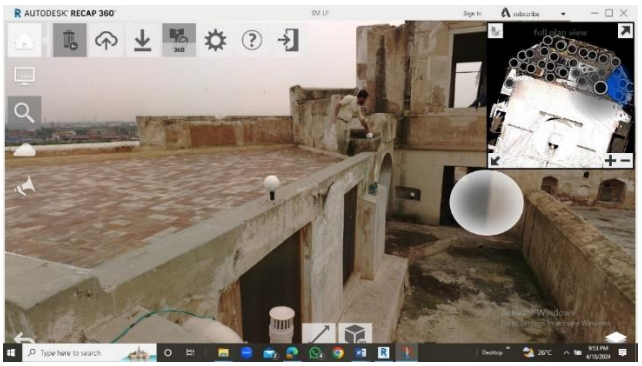


Figure 14: HBIM of Roof of Sheesh Mehal Lahore Fort

Measurements can also be taken from these HBIM model, saving time and energy. The manual drawings will consume number of days to develop measured plans but HBIM models can be developed saving time and money both. The highly technical details of the roof can be drawn in Autodesk to prepare orthographic drawings.

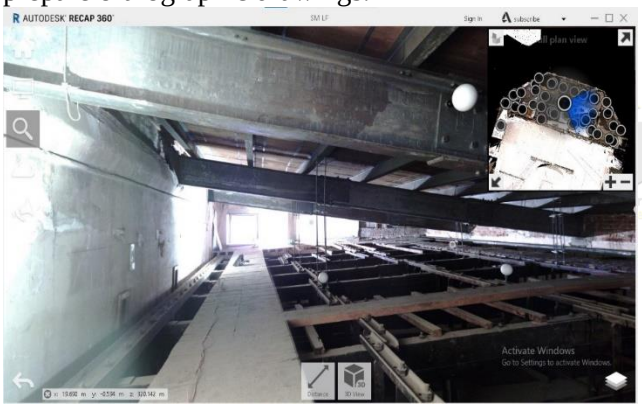


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Figure 15: HBIM Model showing ceiling details after adding new roof structure

In depth details can be extracted from the HBIM model and can be measured and present condition of the deteriorated elements can be recorded, unmatchable with any other conventional technique for the development of digital models

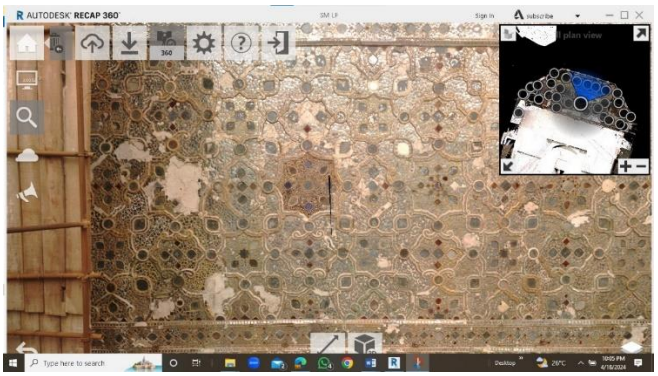

Figure 16: HBIM model with geometrical details of mirror work on ceiling

Building heights is also measured through expression of colors. Autodesk Recap has the option to get the heights of buildings. This image is showing the heights at 288 -314 meters at focal length of 50mm. The software can also support to "crop" unwanted objects from the model.

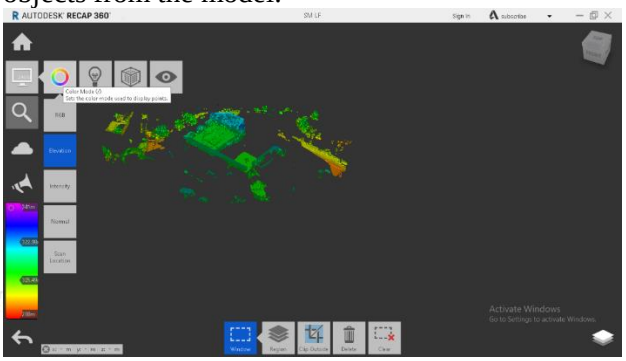

Figure 17: HBIM Model showing structure heights in colors

4.6 HBIM Models in AutoCAD

The files of Autodesk Recap can be transferred through a key feature" import point cloud" to AutoCAD & Revit to develop 3D models for the execution of the projects such as as-built drawings and digital documentation of heritage sites.

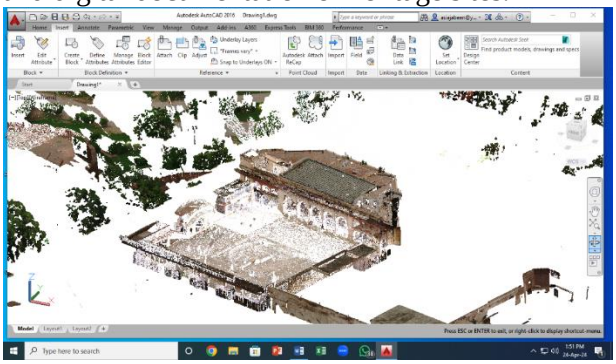

Figure 18: Point Cloud Model attached in Autodesk AutoCAD Suit.

Results and Discussions

Digital technologies are revolutionizing the building industry by optimizing resource utilization in terms of precision, accuracy, time, and cost. Similarly, the heritage conservation sector is transitioning from conventional methods to digital approaches to preserve historic buildings, urban heritage, and archaeological sites. Among the various phases of conservation, documentation stands out as a critical aspect. Conservation experts are exploring authentic methods to digitally document built heritage using advanced tools and software.

The evolution of remote sensing for digital mapping of heritage sites, from total stations to Terrestrial Laser Scanning, has enabled the preservation of intricate architectural details, damage assessment, surface deteriorations, and structural damages. This transition wouldn't have been possible without the application of digital technologies. Total Station (EDM Model) and Terrestrial Laser Scanner (Point Cloud Model) applications are poised to revolutionize Conservation Sciences by providing scan data that can be processed into AutoCAD and Revit 3D models, facilitating conservation planning. Scan data offers precise information in minimal time. For instance, capturing a courtyard, which could take weeks manually, now takes only three hours, reducing the likelihood of human error. Moreover, measuring facades of multistory structures requires additional equipment, but digital tools streamline this process.

While orthographic projections and intricate decorations like kashi kari, mosaic, and engravings are challenging to measure manually, high-resolution point cloud data enables their scanning and conversion into 3D CAD and Revit models. These measured drawings aid in project planning and execution on-site.

Furthermore, digital technologies facilitate the development of digital archives by conservation agencies. This research explores the integrated use of digital tools and software to convert scan data into AutoCAD files, highlighting the potential of Terrestrial Laser Scanning and HBIM approaches for preserving architectural and urban heritage in Pakistan.

Though the cost of equipment remains a challenge, it can be justified based on the number of heritage projects in Pakistan. Scan data not only provides detailed insights into structural and surface damages but also aids in managing and monitoring heritage sites. Leveraging this data for sustainable development of historic cities can prevent loss of heritage in Pakistan.

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