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RESEARCH PAPER

Historic Building Information Modeling as an Integrated Approach for the Documentation of Jogi Mohallah, Walled City Lahore, Pakistan

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ABSTRACT

The research is an effort to reconnoiter the aptitudes of Historic Building Information Modeling as an integrated approach for the documentation of Historic monuments and heritage sites. The Historic Building Information Modeling (HBIM) is a major attribute in the development of virtual models of cultural heritage, based on digital technologies and 3D approaches. The selected case-study, Jogi Mohallah, Walled City Lahore, is located in the neighborhood of Bazaar-e-Hakeema and possesses a number of significant historic structures. The research includes an analysis of the three main stages, data acquisition, pre-processing of survey data, and 3D modeling with HBIM. Virtual and conventional methods have been evaluated to develop an understanding of the complex spatial relationships between various features of heritage sites. In conclusion, an integrated framework based on HBIM Modelling can support for the accurate and authentic documentation of built heritage within stipulated time span.

KEYWORDS Documentation Techniques, Historic Building Information Modeling (HBIM), Jogi Mohallah, Virtual and Conventional Methods

Introduction

Despite the extensive application of Building Information Modeling in the construction industry for new buildings, less attention has been paid to investigating the importance of digital technologies for the protection of existing structures. However, an initiative has been taken to explore quantitative as well as qualitative values of the historic elements through HBIM models. HBIM is an emerging technology that has introduced reliable, digital three-dimensional models of intervening heritage sites, carrying multi-layer smart information to plan and manage projects for conservation, restoration, and rehabilitation. The HBIM with different methodologies has become a necessity of the cultural heritage sector due to its progress in qualities and capabilities (Lopez *et al.*, 2018).

During the last few decades, Historic Building Information Modeling (HBIM) played a vital role to explore comprehensive knowledge of historic buildings, monuments, and archaeological sites with reference to their original concept, historic context, the timeline of interventions, present condition, and causes of deterioration (Chee Wei *et al.*, 2010). The innovative techniques and methodologies have introduced smart data and perceptions in the field of historic preservation due to their advantages as they are innovative, user-friendly, simplified, and also challenging for academicians and researchers. These innovative techniques are being applied for surveying, documenting, mapping, and multi-scale viewing of heritage sites (Caroti et al., 2021).

Selected case study "Choara Khoo, Jogi Mohallah" is located in the Walled City Lahore and it is one of the communal spaces, surveyed and documented by the Aga Khan Cultural Services of Pakistan (AKCSP) under the umbrella of Walled City Lahore Authority (WCLA) by using hybrid methodologies, both manually and digitally (Total

Station & 3D Faro Terrestrial Laser Scanner) from May-December 2016 Site comprises of a group of buildings categorized on account of architectural and historical values (WCLA, 2016).

Emperor Akber divided Lahore into 36 districts and nine of them are within the walled city of Lahore. The districts within the old city have been named after the name of their administrators and professionals termed as Guzars (WCLA, 2009). The Selected site is located in Guzar Talwara (One of the nine forgotten Guzars). Jogi Mohallah is accessible from Bhatti gate and Taxali gate through Bazaar-e-Hakeema and Bazaar Samian. Bhatti Gate was famous due to literary and cultural activities and was titled as "Lahore Ka Chelsea " by Hakeem Ahmad Shujja because of the similarities with an area of London "Chelsea". It is also famous for its connectivity being the oldest gate of the walled city linking the southern area to the Royal fort through Bazaar-e-Hakeema (Shuja, 1988).

Map 1 Map showing Boundaries of Choara Khoo, Jogi Mohallah inside Bhati Gate

Source: Google maps (modified by authors)

After the development of new sensors, data capture techniques, and multi-resolution three-dimensional tools, a lot has been changed in the research area for heritage protection and it has also been well recognized globally with all limitations and potentialities (Remondino, 2011). Many of our historic monuments and archaeological sites are in dilapidated condition and couldn't be saved due to the poor methods of surveying and documenting. Rapid and reliable methods are the need of the hour for the planning, management, and monitoring of heritage assets (Arif & Essa, 2017).

Walled City Lahore comprises historical buildings, monuments, and significant archaeological sites. It contains both types of cultural heritage (tangible and intangible) and they are decaying due to various constraints, one of them is related to the application of digital technologies during the conservation procedures and practices in the current environs. There is a necessity to evaluate workflows and potentials of the Historic Building Information Modeling as an integrated approach for Data acquisition, Pre-processing of Survey Data, and 3D modeling with HBIM for the sustainable development of historic cities.

Literature Review

Globally, it has been accepted as a universal truth that our heritage is a record of human activities of the past and it has to be protected for future generations. Technology is playing a key role in promoting the conservation, restoration, and preservation of built heritage. It also has been realized that we are facing various issues in terms of consumption of our energy resources and we have to adopt measures for saving our energy resources. The construction industry is consuming a high ratio of energy consumption and we can save these resources by protecting and reusing the existing structure through adaptive reuse, enabling them for future needs, rather than building new structures. Following the concept of adaptive reuse of existing buildings, the concept of conservation has been transformed into the Rehabilitation and Redevelopment of heritage sites and historic cities. Considering the need of the hour, conservation techniques, procedures, and practices should be integrated for accurate and authentic workflows. Application of digital methodologies has supported the "Conservation Sector" to achieve reliable and accessible data to develop conservation plans (LAH, 2018).

Pakistan is blessed with a wealth of historic assets and comprises various categories of historic buildings, groups of buildings, and urban areas. Walled cities of Pakistan, possess remarkable historic, cultural and architectural value. These cities can be a source of economic growth by upgrading their "Tourist value". Walled city Lahore is famous for its gates, bazaars, winding streets, Chowks / Urban squares, galies, Mohallahs, Koochas. There are buildings of various categories such as Havelies, mosques, temples, Gurdawars, residential houses, etc. WCL has a specific urban hierarchy and it is one the best examples of pre-colonial urbanism in the Northwestern part of the sub-continent. (Hindi, 1882). Due to its architectural and historic values, it should be protected saving its cultural assets and after conservation, its tourist value will also increase.

Heritage comprehends historical records and showcases the index of society and the historic elements are learning sources of the present, for future generations. Cultural heritage is in the process of continuous decay due to various agents of nature and human neglect (Bruno and Roncella, 2019). Nothing is eternal and every object on the surface of the earth has to be diminished, however, their life can be extended and they can be protected for a longer span with the help of authentic conservation techniques, procedures, and practices. Historic Building Information Modeling is an integrated approach toward more reliable conservation methods and procedures for the sustainable development of historic cities (Escarcena *et al.*, 2011).

Historic Building Information Modeling as an integrated approach

There are noteworthy inadequacies in the planning of projects for the conservation and rehabilitation of built heritage. These inadequacies led to compromises in the legitimacy, authenticity, and accuracy of work done, with the increase in budget and long time span. While using traditional methods, various disciplines such as conservation experts, architects, civil engineers, etc. work separately and produce dispersed data. There is an increasing trend to adopt new methodologies to reduce these inefficiencies (Jordan-Palomar *et al.*, 2018).

In Pakistan, the progress started with the use of a total station with Archicad software to document heritage in three dimensions rather than producing two dimension manual drawings. This technique provided the opportunity to visualize architectural heritage in three-dimension but it has its own constraints and was not proven successful to document facades with rich architectural and decorative details. In 2016, a new phase

came when Dr. Murtaza documented six sites in the four provinces of Pakistan with a 3D terrestrial laser scanner (Laica). The scanned data provided smart information and a hybrid technique started to apply for the surveying, scanning, mapping, and 3D viewing of sites in the walled city of Lahore by AKCSP with the team of WCLA since 2016.

HBIM is the most suitable tool for the restoration and refurbishment of large-scale historic sites due to its capabilities of archieving and managing all the information about the cultural asset, reference data on the 3D HBIM model, and its support for renovation and redevelopment. Planned conservation is considered as a workflow to manage cultural heritage and it can be done through accurate evaluation of potentials and limitations of HBIM with reference to possible risks/damages and weather conditions. Tracking all the interventions and damages can protect heritage property from the worst situations (Bruno and Roncella, 2019)

Murphy defined HBIM as a system of modeling historic structures creating full 2D and 3D models, which include details behind the surface of the objects concerning its method of construction and material makeup. Dore and Murphy also described six areas of HBIM;

1. The current state of the art for BIM Geometry
2. Heritage Documentation Standards
3. Data Collection Techniques
4. 3D Modeling Concepts
5. As-Built BIM
6. Procedural Modeling

They described documentation of heritage which provides accurate information to enable correct conservation, management, and monitoring for the survival of an artifact (Dore and Murphy, 2017).

Digital documentation of existing structures involves a hybrid approach to visualize survey data, computer-aided drawings, photographs, and data collected by the use of a 3D laser scanner. Now the concept of HBIM has been changed and it has been accepted as a technology to collect intelligent data and it also has been accepted BIM as a source to explore the complex relationships between tangible and intangible heritage (Fai *et al.*, 2011).

Choara Khoo Jogi Mohallah – Historical Background

When Mahmood Ghaznavi invaded, Lahore was divided into two parts, one is comprised of Guzar Talwara (area between Bhatti gate and Texali gate) and Guzar Rara (Area near Delhi gate).Guzar Talwara has significant historical structures such as Unchi Mosque near Bhatti gate, Faqir Khana Museum, Haveli Wajid Ali Shah, Haveli Mian Afzal Javed, Naqsh, and Art Academy. Bhati Gate is linked with the Royal Fort through a long spine named Bazaar Hakeema. The other parallel roads are Samian Bazaar/Judge Street and androon-e-Texali Road. The area was famous as it was a hub of art and culture. It was inhabited by writers, poets, doctors, lawyers, and artists (Hindi, 1882).

The area on the premises of Bhati Gate was a favorite place of renowned personalities for the cultural activities and the area in the premises of Texali Gate was captured by the people engaged in performing arts. Guzars (administrative zones) are Mohallahs and koochas named after administrators or professionals. Bazaar-e-Hakeema

is one of the examples which is named after the name of Hakeem Abdullah Ansari who was an expert in medicine and he also constructed a mosque near Unchi Mosque. Jogi Mohallah is situated in the neighborhood of Bazaar-e-Hakeema. Syed Faqiruddin, a member of a rich family, migrated to Lahore at the invitation of the emperor, gave a new cultural value to the area and now, their residence has been transferred into a museum, named after the family name, Fakir Khana Museum (Talbot and Tahir, 2017).

Jogi Mohallah is famous for the literary giants, Syed Muhammad Latif, writer of a number of valuable books on history and he also composed a book with the title "Lahore: Its History, Architectural Remains, and Antiquities. He was also the founder of a famous Magazine " Naqoosh" (Tufail, 1962). The other one belonging to this mohallah is Munshi Tahiruddin who was an intellectual and developed a medicine "Dil Roz" and another one was Mir Miran Bux, Barrister at law. The area was a residential place of renowned intellectual personalities who inhabited this area in the 19th & early 20th centuries (Shuja, 1988).

Conservation of Jogi Mohallah

Jogi Mohallah walled city Lahore was famous for its cultural and literary values. This cultural heritage has lost its significant characteristics due to weather conditions and human neglect. The area has been encroached on by the residents vertically as well as horizontally to increase accommodation in their houses. The city was pedestrian but now two-wheel and four-wheel transport are the basic needs of life. Open spaces have been occupied illegally and narrow streets have lost their breathing spaces as the narrow streets are occupied by residents for motorbike parking. The area taken is a vast area and bears architectural value which needs to be saved.

The area is too large and congested to document manually. In July 2016, walled City Lahore Authority decided to document this area with the collaboration of AKCSP by using technical tools such as Total Station and a 3D laser scanner as a pilot project. Wherever use of this equipment was not possible, manual documentation was done. Streets were too narrow and the scanner documented the facades of the buildings very successfully screening the encroachments as well as damages. Architectural plans were drawn manually. The project was done to conserve a zone of special value (Inner Zone West, 5D). Under this project, 182 properties have been documented and Choara Khoo is a small part of it (WCLA, 2016). Conservation and Rehabilitation have been planned on a project basis rather than an integrated approach. Appropriate conservation can enhance the cultural and tourist value of the area upgrading the socio-spatial management of the heritage site. Tourists can be invited to visit the residential and burial places of literary icons of the past.

Material and Methods

Desk-based research has been implemented for the collection of data from the concerned departments such as Walled City Lahore Authority (WCLA) and Agha Khan Cultural Services of Pakistan (AKCSP). A visual and Pictorial Survey has been conducted to document the present condition, current interventions, and continued cultural activities. The selected site has been digitally documented and conserved in 2016 and it is now part of the digital archive. Previous records and current data have helped to visualize the rate and types of encroachments, changes in cultural values, and identification of the decaying process.

The main objective of the research is to develop an understanding of the application of Historic Building Information Modeling to document historic monuments

and urban areas. Focusing on the core objective, Simulation methodology has been adopted as it is much more efficient in the case of dynamic representation of historical studies. Dynamic representations can be derived through virtual representations such as photographs, videos, and digital images (Groat & Wang, 2013).

A 3D model of an urban space named "Choara Khoo" has been prepared with BIM technologies for the representation current status of the area by the author. The buildings around this urban space with communal activities are of high, medium, and low architectural value. Residents of the area have increased the number of stories, closed balconies, changed the original material of door frames, and provided support to decaying members of the buildings. It has been tried to document all the interventions from 2016 to 2023 in the 3D Model for a better understanding of the historic environment and to record and assess changes during the last decade.

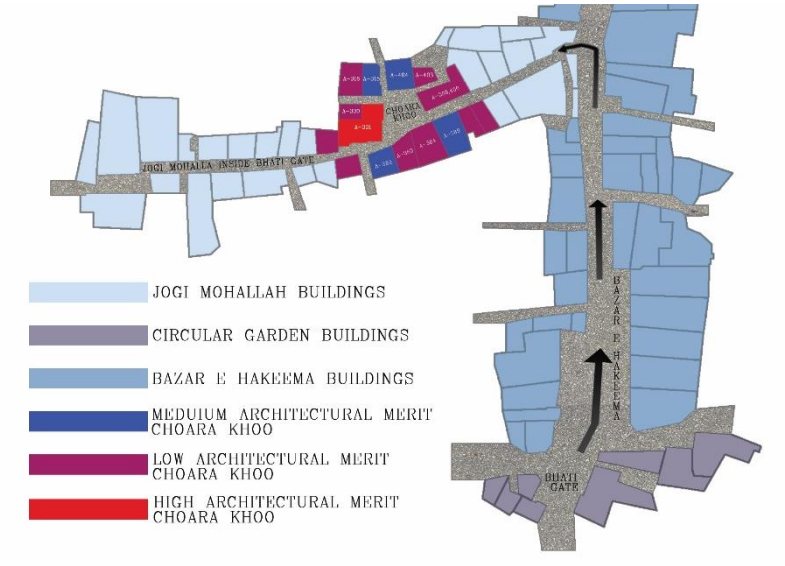
Finally, an analysis has been done to evaluate the accuracy and authenticity of the collected data socio-spatial organization of architectural and urban heritage for data acquisition, pre-processing of survey data, and 3D modeling with HBIM.

Case Study: Choara Khoo Jogi Mohallah

The area in the close vicinity of Bhatti gate is named after the Rajput Bhati migrants by the approval of Mughal Emperor. This gate was used as an entrance from the south end and is linked with Royal Throne through Bazaar-e-Hakeema. The intellectuals from different parts of India migrated and settled here, transforming it into a cultural hub. Many intellectual giants such as Allama Iqbal who wrote his famous book "Bang e Dara" during his stay in a house near Unchi Mosque. Jogi Mohallah is also been a residential place of Syed Mohammad Latif who was a famous writer and he also issued a Journal with the name "Naqoosh". Walled City Lahore Authority has selected this site as a zone of Historic value and documented facades of buildings with the "Faro Terrestrial Laser Scanner" in 2016.

Location and Context

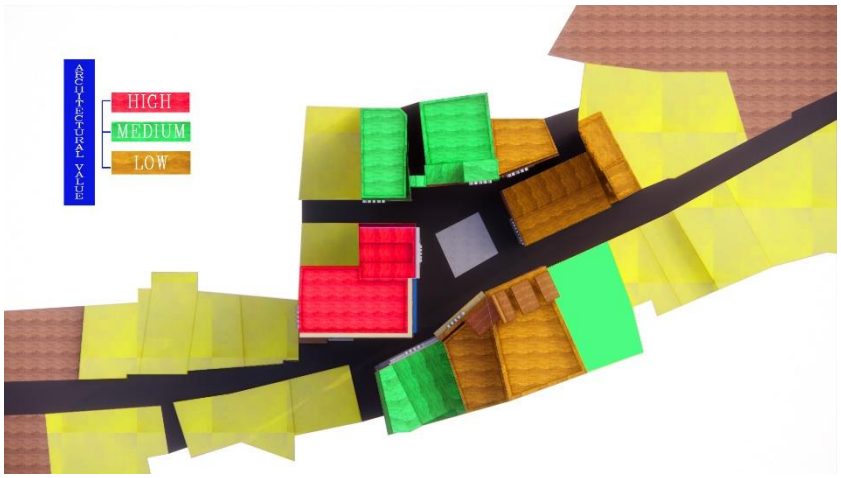
Jogi Mohallah is located on an adjacent road of Bazaar-e-Hakeema on the east side and it can be accessed by both of the gates Bhatti and Texali gate, however, the route through Texali gate is a bit longer. The other side of this Mohallah is adjacent to Bazaar Samia on the west. Kucha Khghzan is in the North and Noor Mohallah is in the South. The selected site is a part of Jogi Mohallah and comprehends significant value due to its cultural, architectural, and historical importance. There are small open spaces, serving as breathtaking vistas in the narrow streets of Jogi Mohallah. Choara Khoo is a small open area, being used for cultural activities around a well (Khoo) in the middle of this open space serving just as a courtyard of a house. This is a junction of streets diverging in four directions linking the main spine to the neighborhood. The open space is at a height compared to the rest of the area and a well was constructed in the middle which was permanently closed on the availability of the Drinking water through the pipeline. Even after closing this "Khoo", the space is still being utilized for communal as well as commercial (Neighborhood Shops) activities.



Map 2 Guide map showing access from Bhati Gate

Cultural, Architectural & Historical Significance

The properties documented under the Project of "Master Conservation and Redevelopment Plan (MCRP)" by the Architectural team of WCLA with AKCSP for the conservation of Inner West Zone (Bazaar-e-Hakeema), 182 properties have been documented. Out of these, there are 07 properties of High, 17 properties are of medium and 158 properties are of low architectural value. Choara Khoo located in the Jogi Mohallah inside Bhati Gate comprises of 01 properties out of 07 of High, and 04 properties out of 17 are of medium architectural value.



Map 3 Choara Khoo Showing buildings of different architectural value

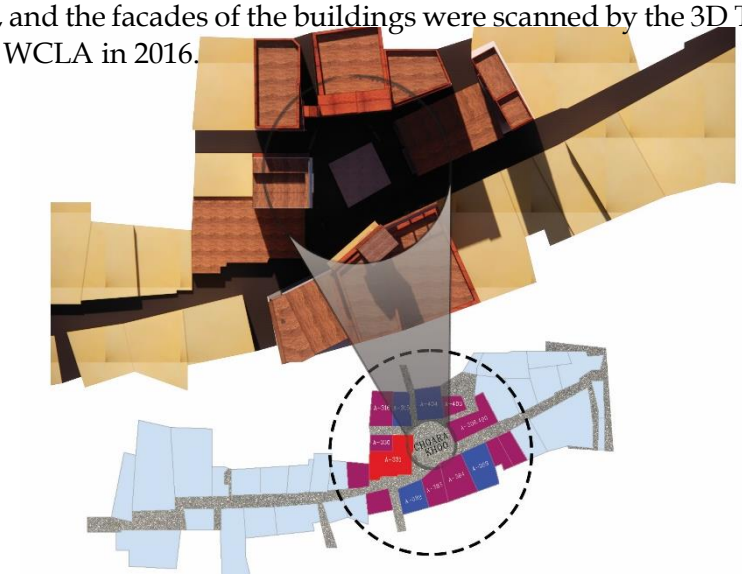
The area is significant with reference to cultural, architectural, and historical value. The place remained the center for writers and poets. Doctors, lawyers, and barristers. It was the land of issuance of newspapers and magazines such as "Pesa Akhbar" Makhzen and Naqoosh. It was also honored with the presence of Dr. Muhammad Allama Iqbal who wrote many books during his stay in this area.

The area is also famous due to the Havelies, the most significant was Haveli Wajid Ali Shah and Haveli Mian Afzal Javed, Unchi Mosque, Shrine of Pir Bhole Shah, Fakir Khana Museum and so many other buildings of architectural value of different categories such as High, medium and low value depending upon the period of construction such as 19th century, early 20th century and built after 1947 respectively. The buildings constructed during the 18th century have been declared as monuments and there are few monuments in this area (Shuja, 1988).

The area is also significant as the gate was constructed by the Emperor Akber and named after the Bhati clan who were invited by the Emperor to come and settle in the area. Due to its significance, it has been documented and protected by the WCLA as a pilot project in 2016 by hybrid methodology e.g. manually, by total station and 3D terrestrial laser scanner of Faro technologies.

Digital documentation of Choara Khoo

The area is composed of narrow and winding streets and few of them are covered partially. The Jogi Mohallah with 182 properties has been digitally documented. The architectural drawings such as plans were drawn manually, open spaces were measured by total station, and the facades of the buildings were scanned by the 3D Terrestrial Laser Scanner by the WCLA in 2016.



Map 4 Context of Choara Khoo, Jogi Mohallah inside Bhati Gate

Being part of Digital Achieve, the properties around the Choara Khoo are of different categories with reference to Architectural values. House no. A-133 is of high house no. A-315, 404, and 382,389 are medium, and house no. A-388,400,382,383 are of low architectural value. The area has been resurveyed to prepare a record of interventions. It will be helpful to check that these interventions are approved by the *Heritage Board* constituted by WCLA for the renovations in the historic city of Lahore.

In 2023, Visual and Pictorial surveys were conducted by the authors and a Virtual model of the urban space was prepared to visualize the site with an integrated approach. A comparison has been done to assess the accuracy and authenticity of the smart data. The buildings around Choara Khoo are of High, medium, and low architectural value.

Figure 1 Visual & Pictorial Survey of Pakistan

Historic Building Information Modeling has been applied for the 3D models of the properties with the help of building plans prepared manually by AKCSP and data collected by Digital cameras. Historic environment has been explored through these models and a record of decays and renovations has been prepared.

Previous records also update the period of construction. As an example House No. A-331 is a structure with high architectural value and possesses a number of significant elements and has been constructed during the 18th century, House no.A-315, 400, 382, 389, are of 19th century and carry medium architectural value, and House no. A-(388,400), 382,383 have been constructed after 1947 and bear no significant features but need to be saved as part of the historic environment. (WCLA, 2016) and the function of the building has been transformed after modifications. Small shops have been developed on facades of property nos. A-(388,400), 384 facing the Choara Khoo adding the commercial activities.

Present Condition

The dust of time can easily be observed in the cultural and architectural value. The place which was once performing as a hub of intellectual activities. Now, it has been transformed into a bunch of squatters and slums and significant structures are showcasing human neglect. Local residents are modifying them to fulfill their needs. In some places, windows have been permanently closed by brick walls. A platform has been constructed in the front of each building to repel rainwater from the doorsteps. More than one floor has been added to increase more accommodation for the family members disturbing the skyline of the area. All of these encroachments destroyed the historic character and reduced air circulation. The open space has lost its cultural value as now it is presenting an enclosure without fresh air. But still, women are doing their leisure activities with their kids in this open place area. There is a law for the protection of built heritage within Walled City Lahore but there is a need for strict compliance to safeguard the historic environment.

3D Models of the Urban Space

Data collected from the WCLA in the form of Architectural Plans drawn manually and with Total Station and elevations scanned with the help of a Terrestrial Laser Scanner. These elevations have been rendered on Adobe Photoshop with the help of images taken during the visual and pictorial surveys. A 3D model of the area has been prepared on Sketch up to visualize the historic environment and to make a record of damages and encroachments.

Figure 2 3D Modeling of Choara Khoo, Jogi Mohallah inside Bhati Gate

Results and Discussions

Historic Building Information Modeling has provided a platform to achieve more authentic and accurate data with the help of digital tools such as 360 Digital Cameras, Total Station, and 3D Terrestrial Laser Scanner. Digital technologies have minimized chances of error on one hand and they also have saved time consumed for different phases of conservation procedure on the other hand. Digital technologies reduce the constraints of traditional methods and open new doors to the world of heritage (Alshawabkeh & Haala, 2004).

Choara Khoo has been documented under a project "Master Conservation & Redevelopment Plan (MCRP) in May 2016 and completed in December 2016. 36 properties of Jogi Mohallah were documented manually and with a total Station and 3D Terrestrial Laser Scanner of Faro Technology. In 2023, the site was again surveyed and documented by the author, and 3D models of the urban space were developed to assess the interventions and changes in architectural and cultural values by the residents and local authorities. The change in color of the doors (From blue to brown) of house no. A-404 has destroyed the historic environment and it can be visualized by the 3D model of the space. The most significant role of this scanning technology for the heritage field to document historic buildings and heritage sites is the capability to express time-based inter-relationship between both kinds of cultural values (tangible & Intangible). It also has reduced hazards for heritage documentation.

Figure 3 Elevations of houses around Choara Khoo *Source: Drawn in 2016 (by AKCSP)*

The cultural values of the urban space can be evaluated from the record of the "Digital Archive" in the form of architectural drawings (manual), urban plans (with Total Station), and 3D models (with terrestrial laser scanner) of the life pattern of the residents couldn't be upgraded due to the financial constraints and they haven't tried to protect their historic environment as they haven't enough money. But a comparison of the previous record and current documentation and 3D models reveals that they are trying to facilitate their families through minor changes such as the closing the openings, changing the color of paint, increasing floors to the existing structures, adding platforms (Tharas) at the outer basis of the houses and transforming their drawing rooms in the squatted shop. Within the pedestrian city, vehicles are running and a mesh of electricity and cable wires has obstructed the views.

Figure 4 Elevations of the Houses around Choara Khoo

The HBIM models can give a perception to plan an environment, free of all above stated issues, adding the tourist value to the city. Which will ultimately help the people to upgrade their standard of living.

Conclusions

In conclusion, our research has guided us about the future potentials of HBIM for the documentation of built heritage.

1. It is serving as a simulation tool as an integrated approach for historical, architectural, and cultural aspects to manage heritage buildings into a single object.

2. BIM has been proven as a tool for the management of the life cycle process showing all the interventions at multiple scales.

3. Collection of BIM data related to methods of construction for heritage documentation.

4. Accuracy and authenticity of the documented work can be assessed at various timelines.

5. An integrated HBIM framework can be generated for accurate and authentic documentation of built heritage to address challenges at heritage sites.

Historic sites like the walled city of Lahore, possess a number of historic monuments and buildings, urban spaces with significant structures around, and breathtaking vistas that need an integrated approach rather than project-based conservation works. The city has been planned on a specific hierarchy such as Guzars (main spines) was designed for vehicular activities and the basic requirement was that it

should be able to run two carts parallel. No vehicle was allowed in streets (Secondary) and galies (Tertiary). There well wells and baolies for water provision. Chowks (Junction of Guzars) was the hub of commercial and cultural activities. Similarly, open spaces in the cluster of buildings (Significant & non-significant) were just like the courtyard of the houses as the residents were used to performing their daily routine work mutually while increasing interaction with other neighbors. These historic cities bear not only tangible values but also intangible values.

Recommendations

It is not an easy task to survey, scan, plan, manage, and monitor such a mega-scale historic city with traditional methodologies which have discrepancies and constraints. It is a challenging task as the answer can be a 3D HBIM approach but these approaches also curtail limitations in terms of operability and functionality with reference to narrow streets and congested overpopulated areas. The future potentials will have to be identified and will have to embark on rules and regulations to get the best outcomes.

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