

Virtual Reality Tourism: Multimedia Art in Preservation of Mughal Heritage

* Dr. Suffi Bilal Khalid, (Corresponding Author)

** Bushra Ishfaq

*** Maham Iqbal

Abstract



This treatise examines most advanced use of multimedia arts and VR, virtual reality to create 3D heritage immersive tourism experience based on Mughal eras. The research digs into methods for both physical and literal cultural heritage through ever changing VR displays for deep immersive experience for the audience about Mughal history. Through utilization of VR's immersive techniques, the research's objective is to enrich the comprehension and appreciation of the Mughal cultural legacy, which in turn contributes to heritage preservation in the realm of the digital world. This study also delves into the potential of creating engaging and interactive, accessible, educational content for a cultural source of tourism all the while confronting and tackling with the challenges posed by historical accuracy and authenticity and surpassing sensory elements to make it as effective as possible. Not only that, it also underscores the entrepreneurial opportunities of increasing digital heritage projects to enable sustainable and educative tourism. Eventually, the objective of this research to set precedents for future heritage preserving projects and expansion. These will enable practitioners and scholars to gain various perspectives in immersive education and cultural preservation.

Keywords: Virtual Reality (VR), Immersive Tourism, 3D Heritage Reconstruction, Mughal Cultural Heritage, Digital Heritage Preservation, Immersive Storytelling, Interactive Educational Content, Cultural Tourism, Historical Authenticity, Sensory, Experience in VR, Multimedia Arts, Heritage Visualization, Sustainable Tourism, Entrepreneurship in Digital Heritage, Immersive Education

Introduction

With the nascent of virtual reality (VR) innumerable fields have progressed by leaps and bounds specially in the areas of education, tourism, entertainment etc. It is worth noting that along with its numerous applications, VR has considerable power to preserving and presenting cultural heritage (Laura Freina, April 2015)¹. This study entails the use of multimedia art and VR technology extensively in order to create a 3D virtual heritage tourism immersive experience of the Mughal era which is to date, known for its grandeur, architectural masterpiece and rich cultural contributions.

The architectural heritage contributed by the Mughal era 16th to the mid-19th has influenced the subcontinent's cultural and architectural heritage intensely² Regardless of this heritage's legacy and its significance, a lot of its history and relics have been lost or at the brink of being lost. Archaic preservation techniques in the form of education fail to capture and convey the glamour and larger than life heritage of the Mughal era.

Virtual Reality is the source of creating a virtual and immersive environment that enable users to interact and explore digital reproductions and reconstructions of historical sites and artifacts in their former glory, and hence, it provides a solution to problem of this study. This immersive technique not only helps preserving cultural heritage but alleviates the educational outcomes, making history more

¹Freina, Laura, and Michela Ott. "A Literature Review on Immersive Virtual Reality in Education: State of the Art and Perspectives." In *Proceedings of eLearning and Software for Education (eLSE)*, Vol. 1, 133-141. 2015.

² Gascoigne, Bamber. *The Great Moghuls*. London: HarperCollins, 1971.

* Department of Multimedia Art, National College of Arts, Lahore. Email: bilalkhalid@nca.edu.pk

** Email: bushraishfaq125@gmail.com

*** Department of Multimedia Art, National College of Arts, Lahore. Email: maham.iqbal@nca.edu.pk

accessible and interactive.³

The main agenda of this study is develop, create and execute processes and procedures of utilizing VR to create, preserve and present the Mughal era's cultural heritage. By conducting in-depth research, cataloguing and analysing this thesis' the objective is to find a realistic and engaging VR experience that is also educational. On the flip side this study also addresses the need for maintaining authenticity, accuracy as much as possible.

The objective of this research is to take maximum advantage of multimedia art and technology to create the era of Mughal through the creation of 3D virtual heritage tourism experience. The aim of this thesis is to educate the audience about both tangible and intangible angles that have faded over time of the Mughal era and to create a 3D immersive visual experience to simulate historical environment, cultural elements and artifacts of the Mughal era. This will enable audience to experience a virtual 3D experience knowledge and insights of the rich heritage of the Mughal era. Not only that, the process of digital creation and preservation and presentation of the cultural elements is also another objective to contribute to the conservation of the legacy of the culture of the Mughal Era, especially for generations to come.

Following are the objectives of the study.

1. To research the technologies, theoretical frameworks and relevant literature regarding heritage of virtual tourism and the role VR can play. Technologies, and literature on virtual heritage tourism and how effectively VR can influence users and involve them in exploring the past glory of the Mughal era.
2. To discover the VR content that is already present which is related to the cultural heritage and how has it been portrayed in various multimedia art forms.
3. To review what is necessary for making an effective 3D immersive experience of the Mughal era such as visual techniques, styles and methods in order to produce novel concept art that includes environments and animations which portray the Mughal era with authenticity.
4. To learn the usage of blueprints required for VR execution to create a seamless and interactive virtual heritage experience.
5. To analyze case studies on the application of technology in cultural preservation and education to understand how VR can effectively build appreciation and empathy for historical cultures among users.
6. To design an engaging and relatable multimedia product that informs the audience about the rich cultural heritage of the Mughal era and its significance for both present and future generations.

To achieve the purpose of the study, the following research questions directed the study:

1. To appreciate and explore the cultural heritage of the Mughal era how can VR environment be designed?
2. What kind of methods and approach can be taken to create a deeply immersive experience that is both tangible and intangible facets of the Mughal era?

This study focuses on developing and implementing methodologies in virtual reality (VR) to create an immersive experience centered on the tangible and intangible cultural aspects of the Mughal era. The study explores techniques for preserving cultural heritage through dynamic VR presentations, aiming to engage users in a meaningful exploration of Mughal history and traditions.

Based on extensive research, this VR experience will incorporate stylized elements to enhance its visual appeal and engage the audience effectively. The production process will carefully follow established methodologies and phases essential for creating a comprehensive and immersive 3D VR experience.

The target audience for this study includes tourists who are enthusiastic about diverse cultural heritages and seek to visit historical sites, tourists interested in immersive heritage experiences, and educators exploring innovative cultural preservation through multimedia art and VR technology.

Virtual Reality comes with its pros and cons which can alter the immersive educational experience which follow as:

³ Guttentag, Daniel A. "Virtual Reality: Applications and Implications for Tourism." *Tourism Management* 31, no. 5 (2010): 637-651

1. VR hardware and software performances and dependency on them may create certain hindrances that can alter the realism and interactivity of the study. VR may not be able to simulate the 6th senses such as temperature of water or the sensation of wetness on the skin.
2. The design of a certain period of Mughal era and artifacts is based on an experimental approach so that can prove to be a challenge to recreate them with accuracy.
3. There are time constraints along with prompt expertise in creating a high end multimedia projects and VR simulations.
4. It is quite probable that VR may not be accessible to people in the form of VR headsets or high speed internet.
5. Another difficulty is the constraint of the spatial factor of creating VR experience that includes the entirety of the vast cultural heritage of the Mughal era. History can be relayed but there may not be tactile element.

Following are the pros of delimitations of this study:

1. It is important to focus on what VR wants the user to experience that is certain facets of the Mughal heritage such as art, architecture and lifestyle.
2. Rather than being overly ambitious by proposing unrealistic features, the study should focus on feasible technological boundaries and implementable solutions, avoiding features that may not be achievable with current VR technology.
3. Being as authentic as possible creating a sound VR experience while following ethical guidelines strictly.

It is noteworthy to focus on the scope of the study that are educational and cultural preservation rather making it use for commercial purposes.

Virtual heritage tourism is fast emerging as a niche that connects cultural heritage preservation and the benefits of education derived from virtual reality (VR). The following is a literature review to establish what the current situation regarding virtual heritage tourism is and where the opportunities are, focusing particularly on how the VR can help preserve and teach people about the Mughal culture heritage. This exploration also involves the methodology and effectiveness of VR in terms of creating immersion and bringing history to life before a broad audience.

Virtual Reality

Virtual reality is essentially a technology meant to create thoroughly immersive simulated experience using more extensive sensory hardware, allowing persons to immerse themselves in complex 3-dimensional virtual environments, with VR becoming used in aspects of gaming and entertainment, among others, while it provides simulated realistic experiences on real-life actions.

Tourism

Tourism is defined by the World Tourism Organization (1993) as "the actions of humans traveling to and staying in areas outside their typical surroundings for not more than one year in a time for pleasure, business, and other objectives."⁴

Tourism facilitates cultural exchange and mutual understanding between diverse societies, enabling individuals to experience and appreciate a wide array of traditions, histories, and lifestyles. It significantly contributes to promoting global awareness and fostering cross-cultural connections.

The Origins of Tourism

By the start of the 21st century, international tourism had established itself as a major economic force globally. The origins of "heritage tourism," which focuses on visiting culturally significant historical sites, can be traced back to Ancient Greece and Rome. Pilgrimages to Buddhist sites began over 2,000 years ago, and in Japan, travel packages featuring hot springs have been popular since at least the sixth century. Over time, tourism evolved into a complex industry, incorporating various commercial activities. The concept of grand tours, particularly the visits to cultural sites in France, Germany, and Italy by royalty, emerged in the 16th century. By the early 19th century, traveling to Europe for health, leisure, and cultural experiences had become a widespread practice.⁵

⁴ World Tourism Organization. "Recommendations on Tourism Statistics." In *World Tourism Organization Collection of Tourism Expenditure Statistics*, 1-20. Madrid: World Tourism Organization, 1993.

⁵ Towner, John. *An Historical Geography of Recreation and Tourism in the Western World 1540-1940*. New York: John Wiley & Sons, 1996.

Cultural Tourism

This a type of tourism where the main incentive for visitors is to explore, learn about, experience, and engage with both tangible and intangible cultural elements of a destination. These elements include unique aspects of a society's material, intellectual, spiritual, and emotional heritage, such as art, architecture, historical landmarks, culinary practices, literature, music, creative industries, and living traditions encompassing lifestyles, values, beliefs, and customs.⁶

Culture and heritage are pivotal in shaping societal identities and profoundly influencing tourist experiences globally. This review delves into their diverse dimensions, encompassing definitions, cultural significance, impacts on tourism, challenges in preservation, and evolving perspectives.⁷

Culture and Heritage

Culture embodies the collective beliefs, values, traditions, arts, and customs that characterize a society.⁸ Heritage encompasses both tangible artifacts and intangible legacies from the past that are conserved and transmitted across generations.⁹ Experiential learning emphasizes the acquisition of knowledge through active engagement and practical application, facilitating deeper understanding and retention of concepts.

Significance of Culture and Heritage

Virtual reality is essentially a technology mean to create thoroughly immersive simulated experience using more extensive sensory hardware, allowing persons to immerse themselves in complex 3-dimensional virtual environments, with VR becoming used in aspects of gaming and entertainment, among others, while it provides simulated realistic experiences on real-life actions.

Virtual Reality in Heritage Tourism

VR generates immersive environments, allowing users to engage with reconstructed historical sites. It has been widely applied in education, gaming, and cultural preservation to enhance understanding and accessibility. Addison highlights VR's role in cultural heritage by creating interactive reconstructions, fostering deeper engagement.

Cultural and Heritage Tourism

Cultural tourism encourages interaction with a destination's tangible and intangible heritage, encompassing historical sites, traditions, and artistic expressions. Heritage tourism promotes social cohesion, preserves collective memory, and enhances appreciation of cultural identity.

VR's Role in Cultural Preservation

Kensek emphasizes VR's contribution to digital preservation by creating precise replicas of historical artifacts and sites, ensuring continued access despite physical deterioration. Dalgarno and Lee highlight VR's effectiveness in education through experiential learning, making historical knowledge more engaging and interactive.

Case Studies in Virtual Heritage Tourism

- *Virtual Giza Project (Harvard University)*: Provides an immersive tour of the Giza Plateau, demonstrating VR's role in global accessibility.
- *Rome Reborn*: Digitally reconstructs ancient Rome, illustrating how VR enhances historical site interpretation.
- *Virtual Angkor*: Recreates 13th-century Angkor Wat, offering insights into urban planning and architecture.

Virtual Heritage of the Mughal Era

The Mughal era's architectural marvels make it an ideal subject for virtual heritage tourism. The Shahi Hammam was selected for its historical and cultural significance.

Shahi Hammam: A Case Study

- **Architectural & Cultural Significance**: Built in 1635, the Shahi Hammam served as a public bathhouse and social hub, showcasing Mughal craftsmanship.

⁶ World Tourism Organization. "Definitions of Tourism." In *UNWTO Tourism Highlights*, 2017 Edition, 14-15. Madrid: UNWTO, 2017.

⁷ UNESCO. (2005). *Convention for the safeguarding of the intangible cultural heritage*.

⁸ Smith, John. *Understanding Cultural Heritage*. London: Routledge, 2010.

⁹ UNESCO. *Convention for the Safeguarding of the Intangible Cultural Heritage*. Paris: UNESCO, 2002.

- **Conservation Efforts:** Restoration by the Aga Khan Trust for Culture has preserved its intricate frescoes and tile work.
- **VR Applications:** Virtual reconstructions can enhance public engagement, providing immersive educational experiences.



Figure 1 Before and After Image from "Restoration and Conservation of Shahi Hammam"

This research integrates VR with cultural heritage theories to develop digital reconstructions of Mughal-era sites. The methodological approach includes:

- **Digital Reconstruction:** 3D modeling in Maya and Unreal Engine ensures historically accurate recreations.
- **Expert Insights:** Historian and tourist guide interviews enhance content authenticity.
- **Multimedia Art Integration:** Texture mapping, lighting, and soundscapes create a vivid, immersive experience.

Approaches

The Shahi Hammam was chosen as the first step for virtual heritage tourism. This Hammam was chosen because of its rich history and architectural importance.

Amalgamation of interviews of historians and Tourist- Guides

Qualitative perspectives will be gained through interviews of historians and tourist guides in the cultural context of the Mughal Era that can enhance reconstruction and add to educational purposes.

Digital Reconstruction in Maya and Unreal Engine

Methodological approaches include digital reconstruction using software like Maya for architectural modeling and Unreal Engine for creating interactive virtual environments. This method ensures accuracy and authenticity in virtual reconstructions of Mughal-era cultural heritage sites.

Multimedia Art Integration

By integrating multimedia art, VR experiences can be significantly enriched visually. Utilizing techniques such as texture mapping, sophisticated lighting effects, and immersive soundscapes, these experiences can vividly bring historical contexts to life, deeply engaging users.

Methods

VR experiences are ever-evolving and multifaceted forms of art; immersion in a virtual environment can be achieved effectively with virtual reality (VR), enhancing both physical and psychological presence; the basic idea of this dissertation started with a personal inclination towards preserving cultural heritage through VR; the primary goal was to create an effective VR experience that is culturally rooted, depicting a realistic environment based on Shahi Hamman.

The next step involved selecting key historical and architectural elements of Shahi Hamman, which formed the foundation of the chosen theme; based on this theme, a detailed storyline was created to guide users through the historical significance and cultural context of the Hamman; the story is set in historical day's scenarios to provide a comprehensive understanding of it.

The synthesis stage focused on conceptualizing the study; this included concept ideation, sketches, development of mood boards, and creating 3D models of the Hamman using Maya and Photoshop; the environment and lighting settings were meticulously designed using Unreal Engine 4 and 5 to ensure accuracy and immersion.

The Articulation stage involved refining the overall lighting and enhancing the visual quality of the study; special effects were added using Unreal Engine, along with background music and sound effects to create a more immersive experience; sound cues and basic blueprinting in Unreal Engine were utilized to achieve this.

The next stage was the presentation, where the study was periodically shown to a jury panel for feedback and evaluation; the final stage was the critical discussion, which assessed user responses, improved clarity, and generated new ideas, leading back to the initial concept generation phase.

The VR study on Lahore's cultural heritage is designed for virtual tourists, and the public with an interest in Lahore's rich history. The development process included selecting a theme and developing a storyline to guide the virtual journey. Detailed environment design involved recreating historical sites, followed by setting up lighting and animations to create an immersive atmosphere. Extensive research was conducted through Pre-Production (Generation, Selection), Production (Synthesis), and Post-Production (Articulation) stages, culminating in the final VR environment, which was presented and critically discussed to ensure it provides an engaging and educational experience.

Site Visits

Site Visit was the first step of this study to analysis the current condition of building and frescoes of Shahi Hammam. Multiple visits were conducted to the Shahi Hammam to capture high-resolution and detailed images of the building and the frescoes on its walls. Goal was to capture every aspect, like the outside of the old building and the colorful artwork inside, so that it can be documented well for future research and preservation efforts. The following image shows the current condition of building and frescoes on the wall of Shahi Hammam.



Figure 2 Entrance Door Shahi Hammam Lahore, Current Condition



Figure 3 Corridor towards the Entrance, Current Condition



Figure 2 Main Hall Octagonal Pool, Current Condition, and Reference form Wikipedia



Figure 3 Waiting Hall, Current Condition



Figure 6 Cold Bath, Current Condition



Figure 4 Warm Bath

Floor Map Acquisition

The floor map of the Shahi Hammam was obtained from the Walled City of Lahore Authority (WCLA) to aid in the accurate reconstruction of the site.



Figure 8 Floor Map

Fresco Documentation

The captured images of the frescoes were analyzed to document their current state and to identify patterns and designs for recreation.



Figure 5 Current Fresco Condition, Shahi Hammam Lahore.



Figure 10 Current Fresco Condition, Shahi Hammam Lahore.

Interviews

Interviews were conducted with historians specializing in Mughal architecture and heritage to gather insights on the historical and cultural significance of the Shahi Hammam. Discussions with WCLA employees provided additional context and understanding of the current condition and historical background of the site.

Architectural Studies

Examination of architectural studies related to Turkish and Persian bath cultures was undertaken to understand the design elements and cultural practices that influenced the Shahi Hammam. Research on similar architectural buildings helped in deriving comparative analysis and references for the reconstruction of the Shahi Hammam.

Arches

The Shahi Hammam in Lahore, an exemplar of Mughal architecture, features a variety of arches that enhance its structural and aesthetic appeal. The arches used include three-point arches, acute arches, shoulder draped arches, and multifoil arches.

Tree point Arch

Three-point arches, also known as three-centered arches, form a semi-elliptical shape using three distinct centers. These arches provide both structural support and visual elegance, creating expansive and graceful openings typical of Mughal architecture.¹⁰

Acute arches

Acute arches are characterized by their sharply pointed apex, forming an isosceles triangle. This type of arch is noted for its vertical emphasis and ability to support heavy loads, making it ideal for large hallways and entryways within the Shahi Hammam.¹¹

Shoulder draped arch

Shoulder draped arches feature a unique design where the arch springs from the shoulders of the supporting columns or walls, creating a visually striking curve that appears to 'drape' over the structure. This design not only adds to the aesthetic appeal but also distributes weight efficiently.¹²

¹⁰ Schaper, Ralf. "Three Centered Arch II: Geometric Construction." Wolfram Demonstrations Project. July 25, 2011.

¹¹ "Mughal Architecture," Islamic Arts and Architecture, accessed June 23, 2024

Multifoil arches

Multifoil arches are distinguished by multiple lobes or foils within the arch, creating a scalloped or floral pattern. This type of arch is particularly ornate and is often used in decorative elements and windows to add intricate beauty to the structure.¹³

Domes

In Shahi Hammam, various types of domes serve both structural and aesthetic functions. Transition domes connect different sections or wings of larger hammam complexes, ensuring a seamless flow while adding architectural interest.

The central dome (Qubba)

The central dome (Qubba) is a prominent feature, situated over the main hall or central chamber of the hammam. It acts as a focal point, often adorned with intricate geometric designs and oculi to facilitate natural light diffusion.

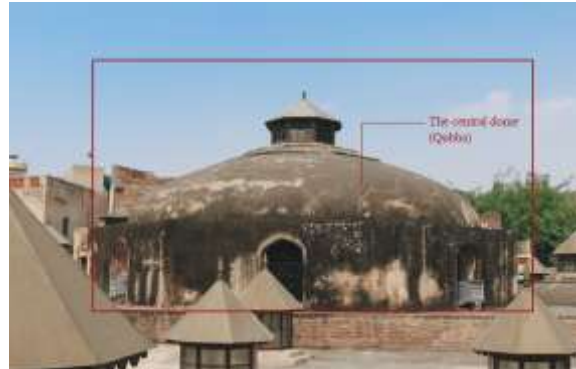


Figure 11 The Central Dome

Smaller cupolas

Smaller cupolas, known as Küçük Kubbe, cover secondary spaces such as steam rooms (sıcaklık) or different bathing chambers within the hammam.



Figure 6 Smaller cupolas

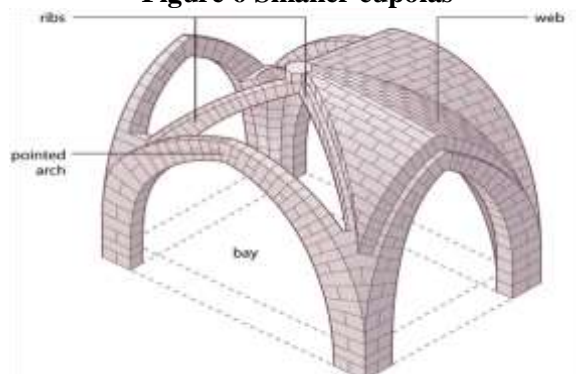


Figure 12 Dome vaults

¹² Bloom, Jonathan M., and Sheila S. Blair. "The Grove Encyclopedia of Islamic Art and Architecture." Oxford University Press, 2009.

¹³ Petersen, Andrew. "Dictionary of Islamic Architecture." Routledge, 1996.

Visual Inspiration

The 3d model for the activities as well as the environments will be simple and not very high poly. The textures will however be a bit plainer solid and vibrant to make the student eye will stay more on activities and they can focus on them easily.

Pre-Production

The initial phase of this study involves pre-production, where the researcher meticulously develops the narrative for the virtual heritage experience centered on Shahi Hammam. This process includes documenting discussions, creating sketches, modules, and establishing the virtual environment settings within Maya 3D software. The storyline is crafted through exploration of various historical structures, narrative plots, genres, and extensive research on Shahi Hammam's architectural and cultural significance.

Methods employed during pre-production also encompass strategic environmental design adjustments. Warm-toned lighting environments aimed to enhance the immersive nature of the virtual experience, effectively capturing the ambiance and historical context of Shahi Hammam. This iterative development process ensures that the virtual environment authentically reflects the architectural details and cultural essence of the site, contributing significantly to its preservation and educational value.

One Liner

Discovering Shahi Hammam's ancient halls, adorned with exquisite frescoes, reveals the timeless beauty of Mughal architecture and bathing traditions.

Story

Upon entering the grand front door of Shahi Hammam, the user was greeted warmly by the guide, who welcomed them with a traditional "خوش آمدید" (Khush Aamdeed). Moving towards the entrance, the user encountered the Dakhaldar, seated behind a table, who courteously stated, "خدمت کی حمام شاہی" (Ashrafiyaan are required for the services of Shahi Hammam). Interacting with the table, coins appeared, and the Dakhaldar provided a towel, allowing the user to proceed.

Entering the main hall, a Hammachi informed them of facilities to change into traditional attire, stating, "ہے مجود سہولت کی کرنے تبدیل لیباس اتاراف چارو کے ہم" (Facility available for changing into traditional attire). Given the option to wait in the hall or proceed directly to the main octagonal pool, which was initially full, the Hammachi politely advised, "گاہ انتظار آپ نہیں میسر جگا لیے کے خدمت ابی جناب" (Sir, there is currently no space available, would you prefer to wait in the hall or enjoy some refreshments).

Opting to wait, the user settled in the waiting hall where a Hammachi offered water, providing a moment to observe the frescoes adorning the walls of Shahi Hammam. Two individuals nearby engaged in conversation, sharing insights on the evolution of these artworks. Character 1 remarked, "تسلسل کا اشکال کی طرح اور بوٹے بیل ہے۔ نقش پر دیواروں پارہ فن کیسا کیسا کا نقاشی فن تو دیکھیے" (Look at the artistry of the frescoes on the walls, depicting various forms and shapes). Character 2 added, "گئے۔ بن حصہ کا اس خال خدو انسانی تدریجا لیکن تھی محدود تک مناظر قدرتی نقاشی پہلے" (Initially limited to natural landscapes, gradually incorporating human figures).

They discussed how these motifs extended beyond palaces to public baths, mosques, and residences, all adorned with intricate designs. Character 1 reminisced, "طرح کی بابر والد اپنے بھی ہمایوں" (Humayun, like his father Babur, cherished aesthetics). They recounted an anecdote where a beautiful bird had once flown in, captured by the emperor, and immortalized in paintings by court artists.

Interrupting their conversation, a Hammachi informed the user of available space, suggesting they proceed to change into their attire. Moving to the main hall, the user settled by the poolside, where two individuals engaged in dialogue. Character 1 remarked, "ہے پانی شفاف کیا" (What clear water this is). Character 2 responded warmly, "دن اور ہیں جانے دیے جوت میں ہٹ بیل دم تازہ ہی سویرے صبح بھائی" (Brother, fresh water from the bullfrog's well is provided here from dawn till dusk, and I also wash clothes here).

Character 2 continued, "ہیں تیار کپڑے کے آپ تو جائے ہو ختم غسل جب" (When the bath is finished, your clothes will be ready). Character 1 mentioned the availability of royal services, stating, "شاہی" (A royal bath is available upon request). Character 2 expressed interest, "ہوں؟ سکتا کر حاصل خدمات کی حمام شاہی بھی میں کیا" (Can I also avail the services of the royal bath?)

Character 1 cautioned, "بے ہوتنا ضروری پروانا شائی لیے کے اس بھائی" (Brother, a royal decree is necessary for that). Just then, a Hammachi approached, asking, "چاہیے؟ کرنا حاصل خدمات حمام گرم آپ کیا" (Would you like to avail the services of the hot bath?) as the scene faded out.

Environment Development

To develop the virtual heritage model of the Shahi Hammam, a comprehensive and multi-faceted approach was undertaken. Initial data collection involved capturing photographs of the Shahi Hammam and its frescoes, followed by extensive internet research to gather additional visual references. Research articles were reviewed, and historical facts and figures pertinent to the Shahi Hammam were studied thoroughly. Further contextual understanding was achieved by studying different Turkish and Persian baths from various countries through web research and interviews with historians and researchers.

The initial phase of the virtual heritage development process involved gathering primary inspiration and motivation. Visual references, including photographs of similar Turkish and Persian baths, were crucial for visualizing and recreating the environments and cultural elements of the Shahi Hammam. This stage required an iterative process of idea generation and reflection to ensure historical accuracy and cultural relevance.

The study's primary goal was to create a realistic and educational virtual model of the Shahi Hammam, integrating both the tangible and intangible cultural elements of Mughal bathing culture. This involved the meticulous recreation of frescoes using Adobe Photoshop, informed by damaged but available frescoes and other historical references. The entire process was driven by the objective of preserving and promoting the heritage of the Shahi Hammam through an immersive virtual experience, combining real historical details with culturally rich elements to engage and educate the audience. This development phase is often referred to as mind mapping, where ideas were systematically organized and refined to achieve the desired outcome.

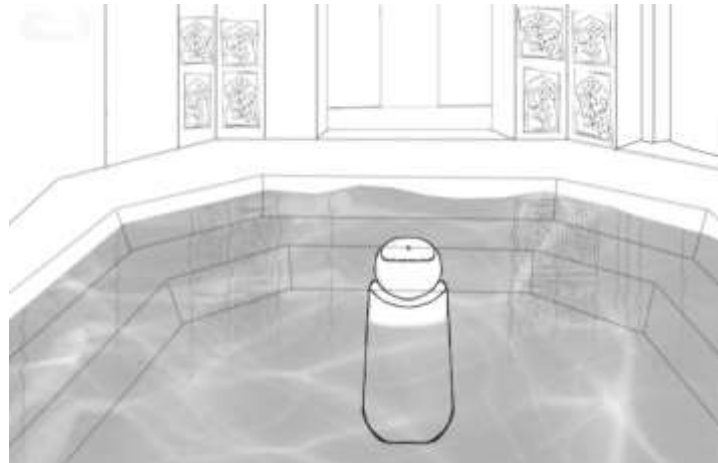


Figure 14 Sketched Main Hall



Figure 15 Sketched Entrance lobby

Drawings



Figure 16 Drawing entrance



Figure 17 Drawing Waiting Hall

Production

As the project transitions into the production phase, mood boards, an Art Bible, and concept art were created using Adobe Photoshop and Adobe Illustrator. These elements were based on the concept ideation and thematic environment developed so far. Once the concept art was finalized and approved, the project proceeded to the production stage. The production phase of the virtual heritage tourism project for Shahi Hammam involved several key steps, using advanced software and techniques to create an accurate and immersive experience.

Initial Blocking and Prototype Development

Using the floor map of Shahi Hammam, the basic geometry of the structure was blocked out in Maya. Concurrently, a prototype of the user experience and journey through Shahi Hammam was developed. This prototype provided a foundation for refining interactive elements and the narrative flow of the virtual tour.

Blocking



Figure 18 Blocking Shahi Hammam



Figure 19 Blocking Entrance Lobby Shahi Hammam



Figure 20 Blocking Main Hall Shahi Hammam



Figure 21 Blocking Warm Bath Shahi Hammam

Flowchart



Figure 22 Flowchart

Experience Journey

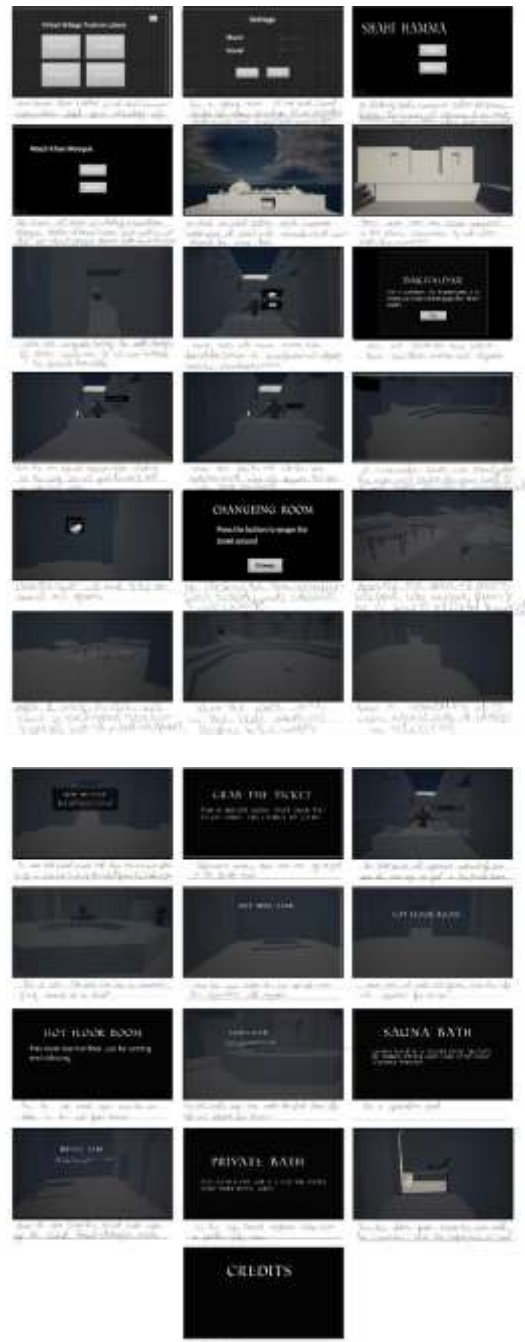


Figure 23 Experience Journey

Fresco Restoration and UV Mapping

Damaged frescoes were restored using Photoshop, maintaining their original artistic style and color schemes. These restored frescoes were then applied to the 3D model's walls using UV mapping in Maya, ensuring precise placement and alignment.



Figure 7 Fresco Restoration using Photoshop



Figure 24 Fresco Restoration using Photoshop

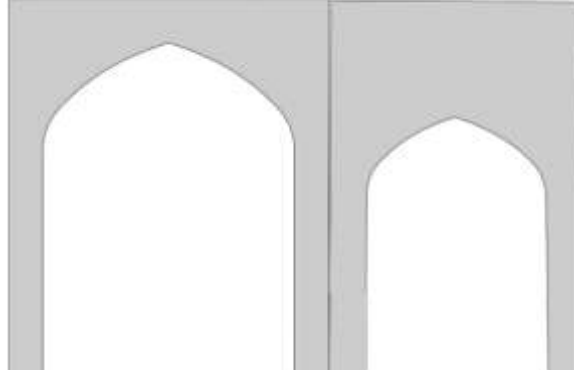


Figure 25 UV Mapping Sheet

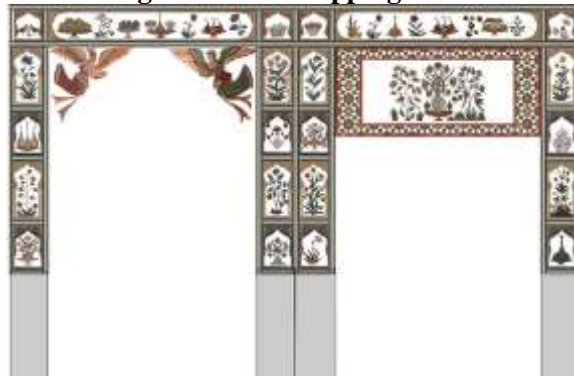


Figure 26 Trim Sheet

Decals and Material Generation

Damaged frescoes were recreated using Photoshop, maintaining their original artistic style and color schemes. These restored frescoes were then applied to the 3D model's walls using UV mapping in Maya and decals in Unreal, ensuring precise placement and alignment.



Figure 27 Decals Entrance Lobby Wall



Figure 28 Material Main Hall Wall



Figure 29 Decals Entrance Lobby Wall



Figure 30 Decals Entrance Lobby Wall



Figure 31 Material Waiting Hall

Lighting and Experience Development

Lighting was designed and implemented in Unreal Engine to replicate historical lighting conditions. The experience cycle, guiding users through the virtual tour, was created using Unreal Engine Blueprints, scripting interactive elements, narrative triggers, and navigation paths for an engaging and informative experience.

This detailed and immersive virtual representation of Shahi Hammam offers users a rich, educational journey through this significant historical site.



Figure 32 Main Hall, Shahi Hammam



Figure 33 Main Hall, Shahi Hammam

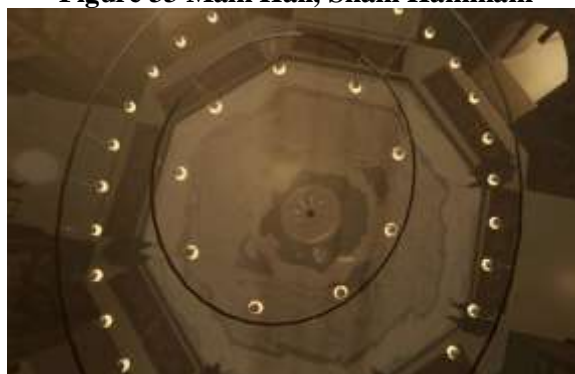


Figure 34 Octagonal Pool, Main Hall



Figure 35 Main Hall Entrance



Figure 36 Lobby, Shahi Hammam



Figure 37 Entrance Door

Presentation and Critical Discussion

The final study was subsequently showcased to a panel of judges who observed it, conducted a thorough assessment, and provided their feedback.

Conclusion

The summary and conclusion of this study and underscores the potential of virtual reality (VR) to preserve and display cultural heritage. Through the implementation of VR, the engaging, interactive and immersive experiences created for the Shahi Hammam research elucidate how digital technology can bridge the gap between the past and present, offering audience a real, engaging, interactive means of experiencing historical places. Such a method not only enhances learning outcomes but also leads to greater appreciation and perspective into cultural heritages. This study majorly highlights VR's ability to simulate reflection and encourage transformation through engaging, immersive simulations in vivid, realistic representations of the outcomes of human actions on nature and cultural heritage.

Section of Recommendations

- Future study should extend the application of the same VR-based methodology to various Mughal and non-Mughal heritage sites, facilitating comparative analyses of architectural styles, cultural narratives, and visitor engagement across different historical contexts.
- Future research may concentrate on assessing the long-term educational, cultural, and economic effects of technologies such as virtual reality, particularly how immersive VR tourism affects cultural preservation awareness, audience learning retention, and sustainable tourist development.

Bibliography

- Anwar, M. (2019). Mughal Architecture. *"The Grandeur of Shahi Hammam."* *Journal of South Asian Studies* , 112-130.
- Bloom, J. M. (2009). *The Grove Encyclopedia of Islamic Art and Architecture*. Oxford University Press.
- Gascoigne, B. (1971). *The Great Moghuls*.
- Guttentag, D. A. (2010). *Virtual Reality: Applications and Implications for Tourism.* *Tourism* .
- Kensek, K. (2007). Digital preservation and cultural heritage . *Digital preservation and cultural heritage. International Journal of Architectural* , 39-55.
- Laura Freina, M. O. (April 2015). *A Literature Review on Immersive Virtual Reality in Education: State Of The Art and Perspectives*.

Mughal Architecture," *Islamic Arts and Architecture*. (2002).

Network, A. K. (2018). *Shahi Hammam Bathhouse*.

Network, A. K. (n.d.). *Shahi Hammam Bathhouse*. Aga Khan Development Network.

Organization, W. T. (1993). "Recommendations on Tourism Statistics." In *World Tourism* .

Rizvi, S. (2017). *Restoration and Conservation of Shahi Hammam*. Lahore: Aga Khan Trust for Culture Report.

Schaper, R. (July 25, 2011). Three Centered Arch II: Geometric Construction.

Smith, J. (2010). *The Routledge Handbook of Cultural Tourism*. London.