



RESEARCH PAPER

Form Analysis of Mughal Funerary Architecture: A Study of Lahore's Imperial Tombs

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ABSTRACT

This study investigates the intricate form development process of imperial tombs of Lahore. The major objective of the study is to investigate the form development process based on geometric analysis and formation in Mughal funerary monuments. Furthermore, it inspects how Mughal dynasty reflects the influences of Architectural styles from neighboring regions on Mughal funerary monuments of Lahore. This research employs methodology of using existing literature to procedurally analyzes and compare underlying geometric principles and design such as shape, symmetry, scale, ratio and portion, symmetry, importance of sacred geometry, use of golden ratios and concept of hast bahisht is studied in detail. Furthermore, it also analyzes evolution of the form of these magnificent tombs from simple basic geometric shapes. By examining the prime examples of Mughal funerary monuments, this paper uncovers the geometric formation, evolution process, concept of octagonal formation and use of design principles such as symmetry in these tombs. Through, detailed analysis and historic connotation, the research provides an insight into the geometric formation in Mughal era and its amalgamation with indigenous architectural styles. This comprehensive study contributes towards better understanding of form evolution in Mughal funerary monuments and its impacts on enduring legacy on the architecture of subcontinent. To further understand the Mughal Funerary Architecture, authors recommend that future research focus on analysis of the detailed study on symmetry, spatial analysis, 3d evolution of form.

KEYWORDS Funerary Architecture, Geometric Forms, Lahore, Mughal Architecture

Introduction

Mughal architecture culminated with creation of monumental structures leaving breathtaking architecture in the Indian subcontinent. Among the best examples is Mughal funerary architecture, characterized by its grandeur, symmetry, and intricate geometric patterns. These tombs for the royals also symbolize the fusion of various cultural and architectural influences. These structures showcase the Mughals' mastery of geometric design and their ability to integrate Persian, Central Asian, and indigenous Indian elements into a cohesive architectural form. Mughal architectural elements such as arches and Chahar Bagh continue to be utilized by politicians in Pakistan to exert political influence and to emphasize Islamic ideology, even in the modern era (Asghar et al., 2016).

Lahore, a cultural and political center during the Mughal period, has some of the finest examples of Mughal funerary architecture. The tombs of Jahangir and Nur Jahan in Lahore are examples of Mughal imperial funerary architecture standing as testaments to the architectural ingenuity of the Mughal architects. These structures showcase the Mughals' proficiency in geometric design and their ability to integrate various elements from Persian, Central Asian, and indigenous Indian architecture. By studying these tombs, this paper aims

to uncover the underlying geometric principles and evolutionary processes that shaped their development. This study provides an in-depth analysis on the design formation and provides guidance for better integration of Islamic ideology into contemporary architecture.

This paper is structured in four parts to provide a comprehensive analysis of the geometric and form analysis of Mughal imperial tombs in Lahore. Following this introduction, the second section offers a literature review, summarizing existing research on geometric and form analysis in the literature. The third section discusses the tombs of Jahangir, Nur Jahan, and Asif Khan as case studies. Finally, in the fourth section the paper ends with a summary of the insights gained from this study and gives future directions.

Literature Review

The Mughals, who ruled the subcontinent from fifteenth century till eighteenth century, profoundly influenced the cultural, economic, and political landscape of the region. Unlike their contemporaries in Iran and Turkey, the Mughals ruled mainly non-Muslim population, assimilating and respecting indigenous architectural styles and incorporating them into the arts, architecture and literature. Over time, Mughal architecture evolved, blending Indian, Timurid, and European elements, and while early Mughal patronage largely ignored non-Islamic traditions, Akbar's reign marked a conscious inclusion of these elements. Later Mughal architecture frequently reverted to emphasizing Islamic symbols. This innovative architecture drew from multiple sources, reshaping them to fulfill the purposes, and was built on a legacy of former Indo-Islamic dynasties as well. (Asher, 1992)

The Mughal architecture is deeply influenced by earlier Indian, Persian, and central Asian architecture (Khan, 2023; Koch, 1991). The Mughals Timurid background and artisans from Central Asia (Asher, 1992) brought Persian and Islamic architectural principles to the Indian subcontinent, influencing the design and construction of their funerary monuments (Khan, 2023, p. 102). These funerary monuments exhibited features like geometry, symmetry, unity and harmony (Bhalla, 2009, p. 39). These features and geometry principles are evident in the layout of their structures and gardens which evolved over time (Nath, 1972). This instigated a beginning of a novel approach of prosperity and innovation into subcontinent that enhanced the artistic capabilities of the Indian masons through skill transfer from Persian land to Indian subcontinent. This led to the establishment of magnificent structures that nicely amalgamate the various cultural and historic connotations and architectural elements.

Beside creating architectural marvels, Mughal structures and gardens also incorporated symbolic meaning. (Bakhtiar, L) in sense of unity provides insight into the sacred architecture and symbolism in the Islamic world (Ardalan & Bakhtiar, 1973). Researchers have also discussed and explored the symbolic and cosmological meaning in Mughal Funerary architecture (Begley, 1979; Begley et al., 1989). Shapes used in layouts and decorations hold symbolic meanings and have layouts based on geometric design principles. For instance, the hasht bahisht concept that is used in the design of the tombs and the garden layouts as well using octagonal planning is all based on the philosophical concept of eight paradises mentioned Quran. Gardens were incorporated in the planning of the funerary monuments as a metaphor of paradise on earth. Water channels, fountains, terraces and baradaris were added in and around the funerary complex to mimic the idea of earthly paradise, especially for the deceased imperial ruler. (Koch, 1997) Thus, the chahrbagh and location of the mausoleum was indented to symbolize the connection between death and paradise. The serene walkways alongside the water channels symbolizes that the deceased emperor is resting peacefully in the earthly paradise. Moreover, Mughal funerary monuments were designed on perfect symmetrical layouts and follow strictly grid pattern that presents a comprehensive and unified building complex.

The tomb of emperor Jahangir and Nur Jahan that are the only two Mughal imperial funerary monuments in Lahore represent the true essence of Mughal style. Although, these two are quite different and humble in design approach but still they copiously depict the strong architecture heritage embedded in their architectural vocabulary. This research focuses on the form development process of these magnificent tombs and highlighting their historical and architectural connotations from various architectural resources.

Material and Methods

To explore the form development process of Mughal imperial tombs of Lahore, a comprehensive research methodology is used. For this purpose, the whole process is divided into four major steps. The first step involves the detailed analysis of literature and influences of diverse regions, is done to form a solid knowledge base for Mughal imperial funerary architecture. It includes the importance of shape, symmetry, scale, ratio and portion, symmetry, importance of sacred geometry, use of golden ratios and concept of *hasht bahisht* is studied in detail. Mughals have used utilized these basic architectural concepts while designing their funerary monuments that was their prime source of proliferation of their inherited kingship and power. Likewise, it also involves the study of Mughal architecture as the synthesis of Persian, Indian and Islamic architectural traditions, precisely focusing on geometric principles and proportional systems used in these monuments.

Following the literature review, the research focuses on evolution of Mughal funerary architecture in subcontinent in the second phase. It commences with innovations in architectural landscape brought by Babur. Later in the subsequent phase, the study analyzes the architectural advances introduced by later Mughal emperors Humayun, Akbar, Jahangir and shah Jahan and finally in the era of Aurangzeb. It stimulates a strong understanding for the formation Mughal funerary architecture and paves way for better understanding their geometric principles.

Subsequently, in the third phase, Mughal funerary monuments of Jahangir and NurJahan are selected based on their architectural significance, state of preservation accessibility for the purpose of site visits and their convergence from various cultural influences. Both of these tombs are unique with respect to other imperial tombs of Mughal era, in geometric formations and design methodologies that are essential to study and understand.

Data collection and site visits are the next critical stage in which detailed plans of the monuments are studied and analyzed keeping in view literature survey. In this phase, the plans deeply studied with reference to the geometric forms, *hasht bahisht* pattern, grid development, repetitive shapes and stepwise development of layouts of the monuments which is elaborated in the mentioned section. Finally, the study analyzes the Mughal monuments form development in the light of analysis done. This includes relating the geometric principles with historic and traditional connotations, deliberating the development of architectural forms, and highlighting the effect of these principles on later architectural styles in the subcontinent especially for funerary monuments. The research directs towards an innovative approach while studying Mughal funerary monuments and a novel perspective on the significance of geometry, enhancing understanding of the Mughal empire's ethnic and architectural inheritance.

The following section reviews the existing literature on the Mughal design elements and their significance in Mughal Architecture.

Results and Discussion

Analysis of The From

The perfect geometric shapes such as the circle and square have been symbolically used to show completeness (Critchlow, 1976a) in traditional architecture. On occasion, the triangle is also used for symbolism. (Krusche et al., 2010) These have been given remarkable prominence because of their simplicity. (Chang & Park, 2022) They are believed to be perfect shapes due to the regularity of the distance from the perimeter to the centre. These basic geometric shapes also hold symbolic meaning in sacred geometry throughout history. Symbolic meaning of these shapes are linked to concepts such as eternity, completeness, divinity and trinity (Kingston, 2023; Whitmore, n.d.). Later in Renaissance, the circle and the square have been related to the human figure proportioning system. Vitruvian man by Vitruvius is well known example of using circle and square with human proportions (*Vitruvius the Ten Books on Architecture*, 2022). Furthermore, Variations are often created with these geometric forms such as the octagon, hexagon and pentagon. These polygon variations are usually found in Mughal architecture as a direct derivation of the circle or sphere. (Aryaman Agarwal, 2018) These polygonal variations represent the advanced understanding of Mughal architects for creating variations out of basic forms. The octagon, hexagon and pentagon don't only represent visual complexity but also shows cultural and artistic significance attached to these forms. There are different methods to deal with such situations when circle and square overlap in planning. Formation of domical structures by using a circular over a square space and adjusting using geometric transitions is a characteristic of Persian architecture. (Hooman Koliji, 2012) Squinches and pendentives are the ways which are used mostly in Mughal tombs to deal with such spaces.

Shapes

Mughals architecture evidently has basic shapes of circle and square, as well as polygons such as octagons and hexagons. In the case of imperial tombs, Mughals favored square for the layout. However, in elevation domes cover the square rooms. The changes and transitions are often in the interior. From inside, the geometry of square room to octagon geometry. Octagon is used at the corners in the form of minaret in the corner. However, sub imperial tombs employ shapes other than square in plans. They are diverse and have used polygons such as octagon as well as circles. Mughals were also known for their perfect octagon formation.

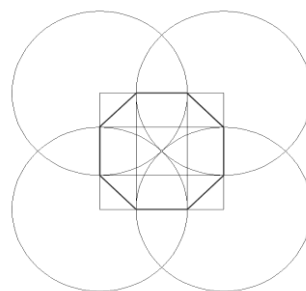


Figure 1: Transformation from square to Octagon

Deriving octagon from square has been the focus of the research. One method researched is using a compass and drawing four circles from corners of the square with radius from corner of the square to center of the square (Critchlow, 1976b, p. 34). Intersecting points of circles and squares are joined to make an octagon as shown in the above picture. The construction of octagon from square with just a compass shows the Mughals proficiency in geometry. They used basic shapes and instruments to construct more complex polygons as shown in Figure 1.

Mughals have used basic geometric forms to create more complex geometric shapes. By comparing in the usage of axis, symmetry, scale and proportion, it is found that each of the mausoleums is planned in a manner that emphasized centralized planning and bilateral and radial symmetry expressed in both plan and elevation. Central point is emphasized by the use of double dome in some cases so there is gradual procession towards upward from minarets to dome as in case of Taj Mahal and Humayun tomb. Planning is other way round as well by shifting the point of focus towards corner minarets by removing the central dome as in case of Jahangir tomb. However, dome is completely removed in case of Noor Jahan tomb and overall form is humble and emphasized by corner minarets which are just larger in size but of same height as the rest of the elevation.

Circle and square overlap

Mughal tombs demonstrate perfect transition of square into circles (Figure 2). The square rooms and chambers have domes rising from circles. Mughals considered the contrast in the geometry and visual aesthetics of circle and square overlap. They used squinches and pendentives in tombs to provide transition between the square room and circular base of the dome (Parihar, 1985, p. 3). Muqarnas, stalactite decorations, were further developed from pendentives. In some cases, octagonal or hexagonal rooms or spaces were given as transition from square to circle (Nath, 1970, p. 73).

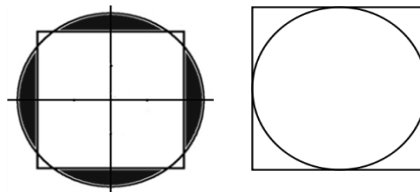


Figure 2: Circle and square overlap

Symmetry

Symmetry is the balanced relationship between individual parts and the overall structure. The Mughal tombs in this study exhibited symmetry along both horizontal and vertical axes. This symmetry was achieved by using regular geometric shapes arranged around a central point. However, the symmetrical design still emphasizes a primary entrance to the tomb. The grave inside tomb follows the religious custom of positioning the deceased's body along a north-south axis with the head facing Mecca (Aitken et al., 2001, p. 41). Both the tombs of Jahangir and Noor Jahan are designed with axial symmetry. Furthermore, both tombs have the classical Chahar Bagh layout and include a Chauk-i-Jilan Khana (ceremonial forecourt or square). Additionally, the Jahangir tomb complex also features an enclosed mosque.

Scale

Imperial Mughal tombs favored monumental scale. The Tomb of Humayun is recognized as the first example of its grand scale. It set a precedent for subsequent Mughal imperial architecture (Brown, 2010, p. 105; Gibb, 1993, p. 329). Unlike Humayun, Babur had a different ideology for his burial. He wanted an open-to-the-sky grave with no roof as per Islamic tradition. However, Humayun constructed a magnificent tomb for himself. Akbar also followed the tradition set by Humayun. However, Jahangir, like Babur, preferred his grave to be uncovered. Jahangir's tomb lacks a dome as he prohibited it. The tomb of Nur Jahan also followed the same approach and didn't have dome. The minarets in Jahangir's tomb serve as the terminating points. For Nur Jahan's tomb, the minarets are capped at the roof level. The overall composition forms a straight rectangle, with the entrance portal providing a break in the symmetry. However, sub-imperial tombs have simpler designs featuring symmetrical plans and proportional layouts.

Proportion

A proportional system is a fundamental design principle in Mughal architecture. It brings unity among the parts and the whole. Geometry has been used since ancient times to create proportionate buildings. The ancient Roman architect Vitruvius emphasized the importance of proportion in construction. He wrote in his famous treatise, "De Architectura" or "Ten Books on Architecture," that "builders should always use precise ratios when constructing temples. For without symmetry and proportion, no temple can have a regular plan." Mughal have used proportional systems while designing their tombs and it is evident in their layouts and also in elevations.

Ratios and Proportions

A ratio describes the relationship between numbers and quantities. Proportions, on the other hand, represent the relationship between these ratios. Proportion can be defined as a comparative relationship between the sizes and quantities of objects or numbers. Mughal tombs also exhibit proportion system as a whole and between different elements. Studies show different ratios like 1:2, 2:3, and 4:5 are evident in Mughal Tombs (Krusche et al., 2010).

Sacred Numbers

The religious buildings like churches, mosques, and temples in history have used sacred geometry. It involves mathematical relationships for constructing religious structures. The golden mean or golden ratio is one of the well-known ratios used in sacred geometry. Egyptians, ancient Indians, Greeks, and Romans have used these sacred numbers and geometries in their building designs and layouts. Numbers are considered a way to understand unity which is reflected in nature. Numbers are considered the foundation of all sciences. In the Pythagorean system, numbers are both qualitative and quantitative. They are not just about addition, subtraction, multiplication, and division.

Golden Mean or Ratio

Throughout history, the golden ratio has been known by many names, including the Golden Mean, Phi, the Divine Section, the Golden Cut, the Golden Proportion, the Divine Proportion, and tau (τ). The golden ratio is the most used ratio in nature. It is also used in man-made structures for aesthetics. In the series form, the golden ratio is represented as a harmonic progression of whole numbers: 1, 1, 2, 3, 5, 8, 13, 21. In this sequence, the sum of any two consecutive numbers equals the next number, known as the Fibonacci sequence. These sacred numbers or ratios were introduced to Europe through translations of Arabic texts by the Italian researcher Fibonacci. This concept frequently appears in both human creation and nature. Two quantities are in the golden ratio if the ratio of the sum of those numbers to the larger number is the same as the ratio of the larger number to the smaller one.

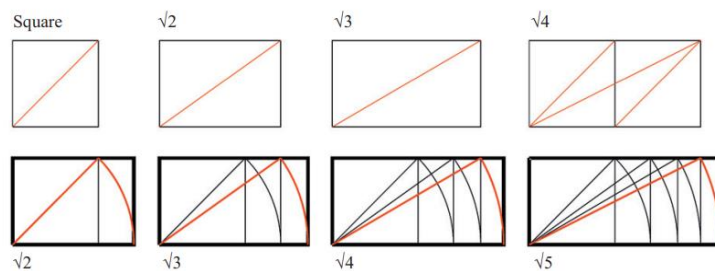


Figure 3: The root proportions based on the square(source: (Dabbour, 2012)

One of the earliest examples of the golden ratio is the Great Pyramid of Giza, built in Egypt around 2560 BC. The base of the pyramid measures 756 feet on each side, and the height is 481 feet. The ratio of the base to the height is $756/481 = 1.5717$, which is also close to the golden ratio of 1.618. (Shammsuddin, 2017, p. 324). Mughal funerary monuments also follow the golden ratios in their layouts and elevations as well.

Concept of Hasht Bahisht

The term hasht bahisht (eight paradises) has been interpreted as a reference to eight rooms surrounding the central chamber. (Jairazbhoy, 1958) The word Hasht Bahisht means eight paradises. The concept is inspired from the famous poem of Persian poet Amir Khusru around 1320AD. It is type of floor plan in which central hall is surrounded by eight rooms which represent eight paradises. The central chamber is mostly domed. It was introduced and popularized by Timur and his followers both in palatial and religious monuments. Later on, many additions were made in the basic layouts, like addition of gardens around in hasht bahisht patter, and addition of corner turrets to empathise the turns. (Rabbat, n.d.)

Mughals arrived this concept of hasht bahisht or chahr Bagh from its late Timurid version. The abbreviated form had appeared in Sabz Burj and Nila Gumbad. A fuller form had already been employed in the khanqah of Shaykh Armani in Deh-I-Minar southwest of Herat (late fifteenth century) and still more complex in khanqah of Qasim at Kermin, northwest of Bukhara.

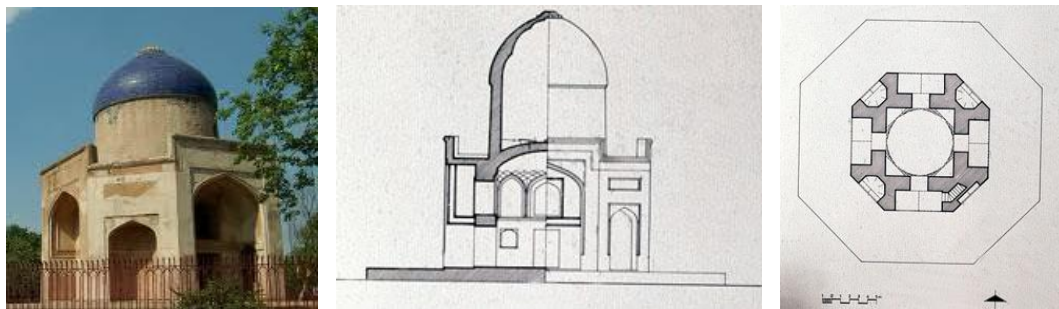


Figure 4: Sabz Burj in Delhi

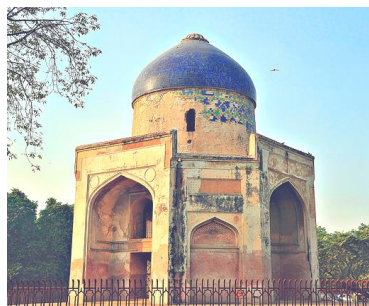


Figure 4: Nila Gumbad in Lahore

“The complete nine folded plan- as it became current in Mughal architecture consists of a square (or rectangle), sometimes with corners fortified by towers but more often chamfered so as to form an irregular octagon (termed muthamman Baghdadi by the Mughals). The layout is divided by four intersecting construction lines into nine parts, comprising a domed chamber in the center, rectangular open hall in the middle of the sides, in the form either of Peshtaq or of flat-roofed verandahs supported by pillars (the Mughal Iwans) and two storey vaulted rooms or blocks in the corners, reflected on façade by superimposed vaulted niches (Nashi man) in radially planned versions of this scheme the

corner rooms are linked to the main domed chamber by additional diagonal passage.(Koch & Asher, 1994)

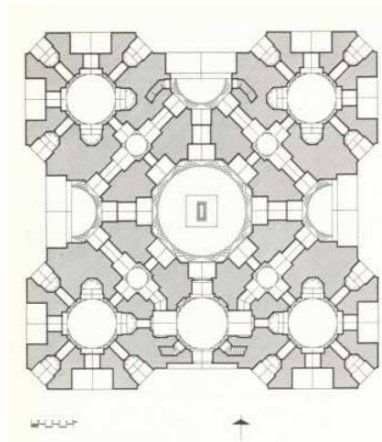


Figure 6: Nine Folded Plan of Hasht Bahisht, plan of Humayun tomb (source: (Koch & Asher, 1994)

This nine folded layout was employed in tomb of Humayun tomb and later in Taj mahal as well. While in preserved Timurid architecture buildings with such a definitely symmetrical nine folded plan characterize the exception rather than the rule, it is the distinguishing contribution of Mughal architecture to have adopted and further developed the model in a perfect symmetry truthfully replicated in the elevation as well.

Evolution of Mughal funerary architecture

Among the various architectural styles advanced by the Muslim dynasties in India, the Mughal style was the most successful and influential. The style still carries influence in the twenty first century. Initially, the Mughals heavily relied on their Timurid architectural heritage, while also incorporating local building traditions and conditions. The fusion of Timurid heritage and local building style gradually evolved to become Mughal Architecture. Under Babur and Humayun, the imports from Transoxiana and broader Khorasan indicated their Timurid influence. However, they also revived ornamental sandstone tradition of the Delhi Sultanate, acknowledging significance of the local traditions and styles. These elements were successfully merged into a grand architectural synthesis under Akbar, integrating additional Indian sources. However, Mughal emperors have always used Mughal funerary architecture as a strong symbolism of their solid inheritance and their presence in India. (Golombek & Koch, 2017)

From Babur to Aurangzeb, six successive generations of rulers combined political, military, prowess. These abilities allowed them to act as absolute rulers and embody their ideal of kingship. Their approach was influenced by Muslim caliphs, Quranic prophets, ancient Iranian kings, Hinduism, and Sufism. They also combined scientific, artistic, and mystical knowledge in their era. From Humayun to Shah Jahan, the Mughals surrounded themselves with the mystique of ancient kings of Iran and India, promoting their rule as a golden age of peace.

Evaluating the initial phase of Mughal architecture under Babur is challenging. His writings show he set high Timurid standards. However, inconsistency exists between his high Timurid standards and the few surviving buildings from his reign. While Babur is celebrated for his incorporation of gardens in the Mughal style in India. Babur laid out gardens of Bagh-e Safa at Kalar Kahar, Agra and Dholpur. These gardens exhibit a strong urge of Babur towards transformation in the landscape of urban settlements of India.(Akhtar, n.d.)

During Humayun's reign, up to the mid-sixteenth century, Mughal architecture presented a heterogeneous picture. He was forced into exile by Sher Shah Suri in 1540. However, he returned to power in 1555. Humayun's reign can be characterized by his efforts to import style like in the mosque at Kachpura, Agra. This building, although lacks an outer dome, shares key features with the sixteenth-century Namazgah mosque at Qarshi, southwest of Samarqand. These features included a central domed chamber preceded by a high peshtaq and flanked by lower lateral wings of domed bays. The bays are defined by masonry piers, while all the domes also have arch-netting. (Koch & Asher, 1994).



Figure 7: Kachpura Masjid, Agra, India (source: www.archnet.org/sites/3997)

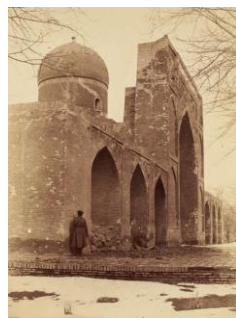


Figure 8: Namazgah Mosque, Samarkand, Uzbekistan (source: www.archnet.org/sites/3997)

Mughal architecture gained its distinctive character during Akbar's reign. He was not only a powerful ruler reflecting his syncretic genius in politics but was also the one who became patronage for the spread of the arts in subcontinent. He continued to conquer the land and Military conquests brought craftsmen from new provinces to the Mughal court. This combined with his interest in art enhanced architectural development. Akbar's contributions also marked the achievement of a monumental scale and the complete form of the nine-fold plan, known as the hasht bahisht pattern in tomb formation and garden layouts. His major contribution in funerary architecture is tomb for his father Humayun which is considered as major milestone towards the Mughal funerary architecture. The tomb is perfectly symmetrical in layout. He was the one who set foundation of strong Mughal empire both politically and set direction for Mughal architectural style different from the previous examples. (Millia, n.d.)

After Akbar came the Jahangir's reign, represented as a transitional period marked by reflection and experimentation. This period was further advanced the Mughal architectural style. Although this period has not received due recognition, it adopted architectural ideas from the previous era and further developed them into highly influential models. Following are the characteristic features of Jahangir's era: Jahangir favored fully decorated surfaces, deeply paneled walls with bands also became common, another characteristic of Jahangir's era is the abundance of materials such as sandstone carving, white marble, stone intarsia, painted stucco, and tile work. Jahangir's architectural innovations are evident in his father's tomb at Sikandra. He designed the tomb for his father

Akbar which is considered a major milestone in the evolution of Mughal funerary architecture. His tomb was designed under the era of Shah Jahan but his wife Nur Jahan has major contribution in designing and layout. (Mehreen Chitta Rizvi, 2014) Nur Jahan designed her own tomb as well which is located in the close vicinity of Jahangir's tomb in Shahdrah. Jahangir's tomb is designed on hasht bahisht pattern and without dome. It is also designed on perfect proportions and ratios.

Under Shah Jahan, Mughal architecture reached the peak. He perfected the Mughal architecture characterized by aesthetics, symmetry, and uniformity. Architectural standards emphasized bilateral symmetry. Shah Jahan is also known to perfect the decorative elements in Mughal architecture. Innovations such as the art of Qalib Kari were creatively utilized during this period. Shah Jahan's reign is well-documented in contemporary sources, reflecting the era's architectural awareness. His major contribution was the construction of Taj Mahal for his beloved wife which is the prime example and climax of Mughal funerary architecture. Aurangzeb's architectural contributions are lesser comparatively. Unlike his father, he adhered to orthodox religious principles and focused on constructing religious buildings and public works.

In conclusion, Mughal tombs followed basic principles of symmetry, scale and proportion. Tombs had centralized layouts. Spaces around the main chamber were arranged to maintain either bilateral or radial symmetry, expressed in both plan and elevation. The tomb is designed around center point which is evident in plans as radial or bilateral symmetry. In elevation, centralized planning is accentuated with sometimes single or other times double dome. Minaret are placed at the corners equidistant from center rising above dome. Taj Mahal and Humayun Tomb are examples with both domes and minaret. However, in some cases like Nur Jahan and Jahangir's tomb, the dome is removed from elevation and one can only see minaret rising from the corners.

Jahangir's Tomb

Emperor Jahangir passed away in 1037 AH (1637 AD) at Chingas Hatti while he was traveling from Kashmir to Lahore. To honor Jahangir's wish, he was buried in Dilkasha Garden, near the river Ravi. This site was a favorite spot for both Jahangir and Nur Jahan. They often used this garden as their departure point for their travels. His tomb was completed in a decade (1627-1637 AD). His favorite wife, Nur Jahan, designed his and her tomb.



Figure 9: Exterior view of Jahangir's tomb (source: www.thehistoryhub.com)

After the death of Jahangir, Shah Jahan built his father's tomb in Lahore, across the Ravi River, after he ascended to the throne. Jahangir's tomb features a classical Chahar Bagh layout combined with a *Chauk-I-Jilau Khana*, which also includes a mosque. Jahangir's desire to be buried under the open sky, like his ancestor Babur, influenced the unique design of his

mausoleum. As a result, a tombstone was placed on a platform (chahbutra), which rested on a monumental podium (Takhtgah) with corner minarets.



Figure 10: Views of Interior and exterior of Jahangir tomb

This design draws from the platform tomb traditions of previous reigns, a concept Shah Jahan's authors retrospectively described using the term Takhtgah. The podium is clad in sandstone from Fatehpur Sikri, inlaid with stone. The tombstone is one of the earliest examples of pietre dure, featuring naturalistic flowers inlaid in marble. The tomb is a square, each side measuring 100 gaz. Its overall layout is horizontal, with corner minarets and a flat roof covering the entire structure. The central chamber is octagonal, each side measuring 8 meters, and is connected to four hallways extending in the cardinal directions. The tomb is centrally located in a Chahar Bagh measuring 1600 square feet. The layout follows fine folded plan with central tomb chamber typical of Timurid funerary tradition, having basement for original grave. It is divided into sixteen equal squares by paved causeways with fountain pools at the intersections. The Chahar Bagh also has two large gates on the north and south sides which highlight the corners as discussed earlier in literature. However, the entry is through the south gate, which also serves as a Peshtaq

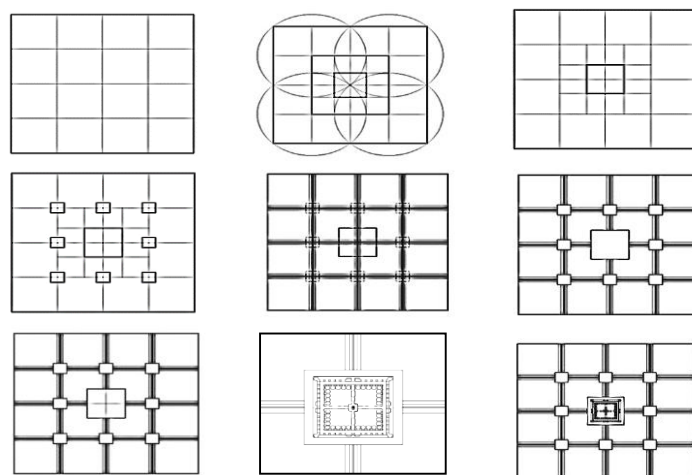


Figure 11: Form development of plan of Mughal imperial tomb of Jahangir

In the figure 11, the plan of Jahangir tomb is developed using grid pattern. chahrbagh development is shown using the grid layout. The position of the tomb is designed central to the layout. In the first step, the whole layout of the tombs is divided into the grid of sixteen. Then using circles having centres with corners of the grid, the grid is further divided into smaller, grid of equivalent size which helps to locate the central tomb chamber. Then, position of fountains is marked using centres of crossing around the tomb chamber.

The tomb's central square adheres to the golden ratio, and the elevation follows a 1:2 ratios. The tomb doesn't have a dome and minarets on each corner of the tomb are used as frame to enhance the height. The overall elevation forms a straight rectangle, but the minarets add verticality, achieving a 1:2 ratios as shown in figure 12.

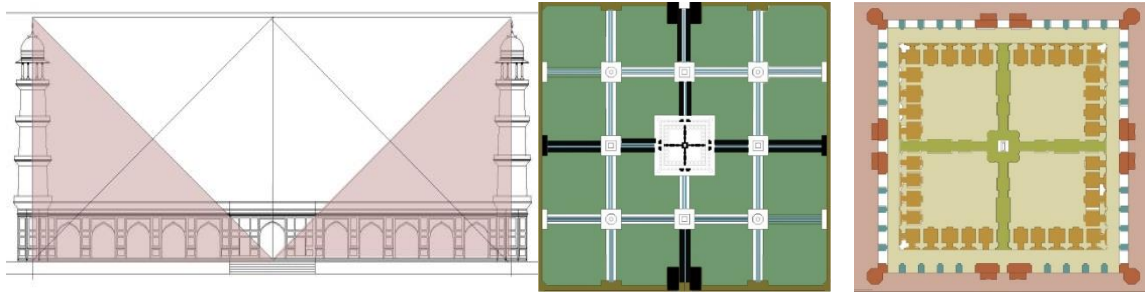


Figure 12: plan & elevation of Jahangir tomb

Noor Jahan Tomb

Noor Jahan (1577 - 1645), the favourite wife of Mughal Emperor Jahangir, passed away in 1645. She was buried in a separate tomb but on the same site as Jahangir's tomb in Shahdrah, Lahore. She built her tomb west of Jahangir's enclosure. After Jahangir's death, Noor Jahan dedicated much of her time to constructing both tombs and the adjacent Dilkusha Garden. Later, she built her own tomb in Shahdrah.

The overall layout of Nur Jahan's tomb is like Jahangir's, but on a smaller scale and without corner minarets. The elevation of Nur Jahan's tomb is a simple rectangle like Jahangir's tomb with four peshtaqs on each side. The peshtaqs are designed to break the geometry of the square plan. The central vaulted tomb chamber contains a marble platform for the graves of Nur Jahan and her daughter, Ladli Begum. Rulers kept the graves underground at that time and the actual graves of Nur Jahan and her daughter are also below ground.



Figure 5 Front elevation of Noor Jahan tomb



Figure 6 Front elevation of Noor Jahan tomb

The tomb is square in plan with octagonal towers at each corner and four projecting peshtaqs on all sides. Over time, the tomb has been stripped of its decorative veneer. Originally the tomb had red sandstone inlaid with white marble motifs. However, it was stripped down by the Sikhs under Ranjit Singh’s orders. In 1958, the Department of Archaeology attempted to restore the front elevation with cement panels painted red, but the effort was only partially successful.

The tomb is based on modular planning and the plan has sixteen small squares as divisions. At the intersection of four corners, layout has deviation from square rooms into octagonal chambers. the central quadrangle housing the grave at the central intersection. The minarets at the corners stop at the roof level. The four peshtaqs on the sides break the simple square geometry. In this plan, the tomb's layout is strictly modular, divided into equal squares, maintaining a consistent and harmonious design.

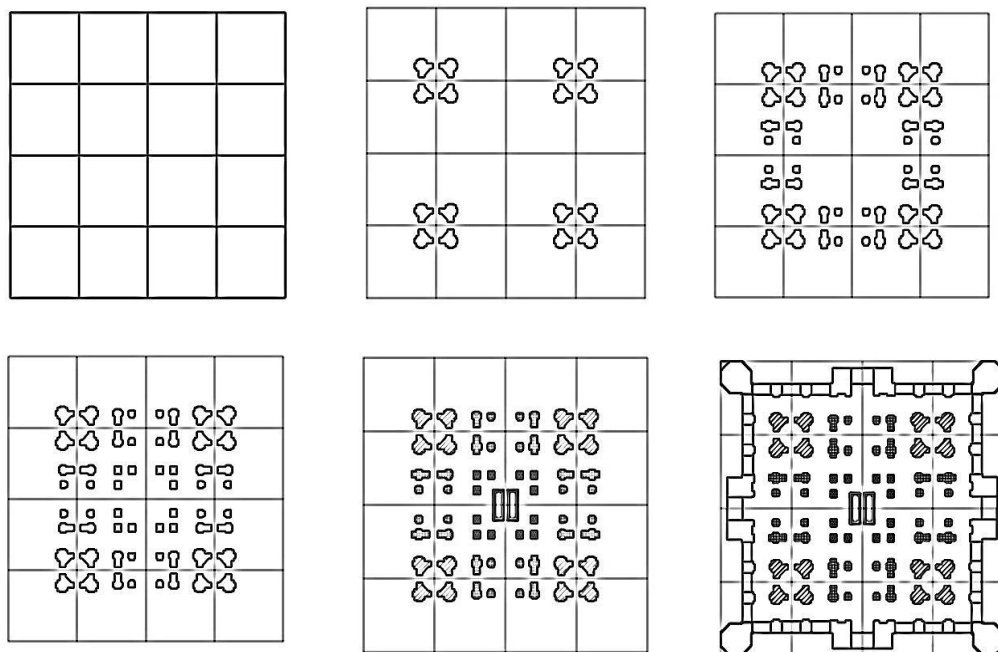


Figure 7 Form development of NurJahan tomb plan

The study of Mughal imperial tombs of Lahore reveals many key findings about the geometric principles, design concepts and methodologies implied by Mughals. By studying the imperial tombs of Jahangir and Nur Jahan, the research points towards the consistency while application of geometric principles and formation. It also identifies Mughals inventiveness for designing the imperial tombs of Mughals. Both of the tombs reveal precise geometric configuration and symmetrical layouts not only in the design of interior of the tombs but also in garden layouts as well. The tombs layouts are strictly on grid and harmonious in plan and

elevations. Ratios and proportional system used in the tombs is not only implemented in the planning but also profoundly addressed in the elevation and 3d formation as well.

The architectural styles depict influences from Persian, Indian and Islamic ideologies and also depict the ability of the Mughals to harmoniously blend these concepts as balanced composition as a whole. It also portrays the adaptation of the Mughal to finely blend the local materials and context in the design composition and techniques. The amalgamation also highlights their ability to blend themselves with the local cultures and traditions and experiment with innovative ideas while rooted themselves to their architectural heritage.

The study reflects that the evolution of design process of Mughal tombs is not an aesthetic excellence but also transmits symbolic meaning. The octagon which is often associated with the symbol of completeness and perfection but Mughals have used the octagon as to represent the concept of hasht bahisht inspired from Islamic mythologies. The same concept is represented not only in the design of tomb but also in the garden layout as well.

The comprehensive understanding from the study has wide spread implications on contemporary art and architecture especially on the region which is highly influenced by Mughal architecture. Understanding geometric principles and historical connections of Mughal tombs can provide insight for modern and contemporary architectural practices who are seeking to create an innovative balance between modernity and tradition. The detailed analysis of the study emphasizes the importance of the preservation of these imperial tombs as well as these are the only two imperial Mughal tombs in the vicinity of Lahore which truly depict the influences and architectural contributions of the Mughal style. The geometric and proportional systems identified in the study can guide the preservation efforts ensuring that these important architectural monuments are to be maintained for their true architectural intent.

Conclusion and

In conclusion, the analysis of Mughal funerary monuments indicates the significance of careful approach and refined approach used by Mughals for achieving the perfect proportional systems in plans, elevations and 3d formations. By using modular geometry and grid layouts, they were able to create plans that were not only proportionally stable but also had a sense of harmony that is important characteristic of Mughal funerary architecture. Furthermore, they successfully incorporated the concept of hasht bahisht not only in plans but also in the garden layouts that shows the continuation of Persian and Timurid traditions introduced by Mughal in subcontinent. The specific case studies of tomb of Jahangir and NurJahan illustrate these concepts effectively. Jahangir's tomb is designed on a 1:1 ratio in its plan and a 1:2 ratio in its elevation, with the height achieved through the use of minarets. Nur Jahan's tomb lacks the tall corner minarets, although increased in size at corners minarets. It follows to a 1:1 ratio in its plan, maintaining a harmonious rectangular formation, with its composition finely intercepted by the entrance portal and corner minarets.

Recommendation

The research recommends future research should investigate deeper into geometric analysis and mathematical proportional system implied by Mughals. This includes a comprehensive analysis of the symmetry, spatial analysis, a systematic evolution of the plan and 3d formation that channelized the architectural process. A comparative study of the contemporary funerary monuments of the Mughal period can help a deeper and comprehensive analysis of the Mughal geometric principles. This study and comprehensive investigation can also aid designers in the application of these geometric principles in contemporary architecture. Moreover, Increasing the public awareness and education about geometric and mathematical system about the funerary monuments can help the students to understand the strongly rooted heritage of Mughal funerary monuments. This will be a valuable resource for the students and scholars working in this directions. In addition, cultural

and historic connotation related to Persian, Indian and Islamic philosophies, attached to these funerary monuments can be a valuable insight into symbolism of religious, philosophical and artistic context of the Mughal imperial funerary monuments.

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