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POINTED DOME ARCHITECTURE IN THE MIDDLE EAST AND CENTRAL ASIA: EVOLUTION, DEFINITIONS OF MORPHOLOGY, AND TYPOLOGIES

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This study aims at offering a closer view of pointed domes as the most significant and important cultural features of Eastern domes in the Middle East and Central Asia. In contrast to previous general historical studies, this study addresses the better comprehension of a formal architectural language of the pointed domes including their morphologies and typologies based on epistemological premise of pointed domes’ structuralism. It starts with defining the proper terminology of the pointed dome type, then, by analytic consideration of selected examples, the study proposes their origin, evolution, formal morphological constitutions, geometrical designs, and finally definitions of three typologies and subtypes of the pointed domes based on their shells’ compositions and geometrical profiles, from the twelfth through sixteenth centuries. Despite varieties of forms and configurations of Islamic domes, the research puts forward some recurring features and shared characteristics that are incorporated into a specific style, that is pointed domes. Furthermore, this study on the significance of pointed domes brings to light undiscovered facts about the essences of traditional dome constructions in the Middle East and Central Asia which may be employed in providing historical documentation for any conservation interventions.

KEY WORDS: dome typologies, dome morphology, pointed domes, Middle East, Central Asia

1. INTRODUCTION

Pointed domes, whether erected on single domical buildings or involved in huge complexes, are considered as greatly significant and important items of Islamic architecture which were widely utilized for both architectural and symbolical purposes. This type of Eastern masonry domes appears on the majority of monuments in Iran, Afghanistan, Kazakhstan, Turkmenistan, and Uzbekistan. They are well known due to their graceful designs, proportion of constitutions, various typologies, and specific configurations. Despite the existence of several historical considerations, studies regarding their formal architectural language such as morphological compositions, typological organizations, and geometrical characteristics are insufficient and the dispersed documents suffer from the lack of profound architectural analysis as to the clarification of exact composition and configuration hierarchies of such domes.
In this regard, this research is an exercise in understanding the architectural structuralism of pointed domes including their proper terminology, origin, evolution, morphological features, and finally their typological structures based on the systematic analysis of certain samples. The central idea adopted in considering the selected pointed domes samples in this study distinguishes itself from the previous general historical analysis in such a way that it dwells on the formalism of the space syntax production as an analytical tool.

Using this approach, the elements of a dome can be considered as vocabularies and its typological characteristics as grammars for setting these words together to form a sentence, a type of pointed domes herein. Beside that, such a process nevertheless requires understanding of their element evolutions and style developments over historic epochs. Thus, a section of this research is devoted to defining an evolution map for exploring logical time-form relations.

Such a study proposed the vital issues for perceiving the essential differences existing between the varieties of Eastern domes, especially, over Islamic periods. Additionally, it may constitute a beginning for more researches aimed at concentrating structurally on different aspects of these merited heritage buildings, with respect to conservation plans and interventions.

Hence this paper is divided into four parts as follows: 1) a brief overview of origins and developments of pointed domes since their beginnings until the sixteenth century by analytic considerations of selected samples; 2) illustration of their regional evolution map and general attributes; 3) elaborations of their common morphological features and typical geometrical designs; and finally 4) classification of common typologies of pointed domes based on the compositions of their shells over a specific time line.

2. POINTED DOMES

2.1. Terminology

All too often individuals note the commonality of shapes of Islamic domes, despite considerable differences between their conceptual forms. Researchers have frequently used both terms of onion and bulbous (Pope 1965; Wilber 1969; Michell 1978; Stierlin 2002) to describe the type of domes under study that may create conflict in comparing their geometrical concepts. Needless to say, the lower part of a pointed dome profile is geometrically tangent to two vertical lines passing from the end points of its span (Figure 1a) as opposed to the profile traits of whether bulbous or onion domes (Figure 1b). As a result of their profile considerations, the term of pointed stems as the most appropriate name according to its dictionary meaning.

2.2. Origin and Types

Historically, the use of the pointed domes as the earliest form of domes was totally unknown in Islamic architecture.¹ In fact, such an architectural item rooted in long-term developments of both ideology and form by various pre-Islamic civilizations and cultures which inhabited in this particular region (Creswell 1958; Grabar 2006).

Chronologically, the earliest samples in the Middle East and Central Asia, which were associated with mud brick-corbelled vaults and domes, often erected over round

¹All drawings were developed by authors.
buildings in Asur (ca. 2000 BC), and then developed in Mesopotamia and Egypt, dating back to 12th and 14th centuries BC (Huerta 2007; Smith 1971) as well as the earliest sample of the demolished dome of Nyssa in Turkmenistan, probably of the 1st century AD (Grabar 1963). However, when the Rome Empire developed into the Middle East, a majority of oval-shaped domes regularly covered sacred temples in Syria and the nearby areas (Huerta 2007). Then, saucer domes became as the main features in covering monumental edifices and churches under the Byzantines such as Hagia Sophia (532–537 AD) (Krautheimer 1984).

Then, before the coming of Islam, two common dome construction techniques emerged in this boundary, which were basically adopted by Arabs into their early Islamic dome architecture both symbolically and architecturally, these are, firstly, the semi-elliptical form of domes over Zoroastrian sacred fire temples in Iran (Ayatollahi 2003) and wooden domes of the early Christian churches in Syria (Smith 1971). Accordingly, it is noted that a majority of the pre-Islamic domes embraced semi-elliptical, oval, and saucer shapes in the Middle East and Central Asia.

Later on, the combination of all previous techniques and thoughts appeared in the construction of the wooden Dome of the Rock (685–691 AD) and the introduction of domes in religious buildings through the Eastern-Islamic lands (Grabar 1963; 2006) (Figure 2a).
In objective point of view, apart from wooden material context of the Dome of the Rock, its well-designed proportion and primary pointed form became consequently a design model for the construction of pointed domes, such as Muntasir mausoleum or Qubbat al-Sulaybiyya (862 AD) at Samarra in Iraq which was later erected as the second earliest sample of the pointed domes, despite the extreme Islamic prohibition against building of tomb structures (Hillenbrand 1994). It embraces an octagonal hallway and was built on a hill site, very similar to the Dome of the Rock (Creswell 1989; Figure 2b).

Apart from these primary examples, the final configuration of the pointed domes resulted from both the continuous development of architectural styles and combination of different local experiments (Creswell 1958) in which the previous technical methods were improved by new artistic qualities, without destroying the older aspects (Bosworth 1996).

By the 12th century, the course of pointed dome renaissance mainly occurred with the appearance of three major types in Iran and Turkmenistan. The first is the plain dome configuration which was often placed on the most enduring masterpieces of Islamic edifices (Figure 3a; Blair and Bloom 1995) such as the Taj-al-Mulk dome (1086–1087 AD) over the Isfahan Friday mosque. The second trend was associated with development of the earliest continuous double-shell dome which was constructed over the Bersian mosque (1105 AD) and the Friday mosque of Zaware (1135/1136 AD) at Isfahan (Figures 3b and 3c; Ayatollahi 2003). Then, such a dome topped the Sultan Sanjar mausoleum (1157 AD) at Marv as one of the most predominant freestanding mausoleums (Hillenbrand 1999; Figure 3d). From the compositional point of view, the external shells of these domes were divorced from the internal shells at approximately 22.5’—30’ angles from their bases. However, their internal shells, which embrace both semi-circular and pointed forms, consist of either six or eight brick ribs which appeared in more complicated composition of ribs in the Sultan Sanjar mausoleum.

The third movement is associated with the appearance of the earliest known discontinuous double-shell domes\(^2\) in the world without using internal connectors which were placed on Iranian twin tomb towers (1067–1093 AD) at Kharaqan in Iran (Mainstone 2001; Figure 4).

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\(^2\)In discontinuous double-shell domes, the distances between internal and external shells are considerable.
These styles of designing dome constitutions likely mark atypical approaches in the construction of the pointed domes that demonstrated early efforts in making a solution to the conflict between their external appearance and aesthetic interior space.

Accordingly, the 14th century is the time for tracing the prior continuous double-shell domes such as the Oljeitu tomb (1302–1312 AD) at Sultaniya in Iran, which was listed in UNESCO World Heritage (Figure 5). The small brick connectors inserted between two shells and small oculus of the Oljeitu dome noticeably distinguish it from the other samples at the same time (Stevens 1979; Pope 1976). Professor Piero Sanpaolesi believed that it might be the origin of the dome of the Cathedral of Santa Maria del Fiore in Florence because of some congruous aspects in their configurations (Vasseghi et al. 2007). As widely known, this dome was constructed by the celebrated Italian architect Filippo Brunelleschi.

Nevertheless, a novel accomplishment was achieved by the construction of the dome of Sultan Bakht Aqa, of 1351–1352 AD, at Isfahan in Iran as the earliest complete sample of a pointed double-shell dome in the Middle East and Central Asia (O’Kane 1998; Wilber 1969; Figure 6). Soon after, the invention of using two different shapes of shells and inserting the radial walls between them, namely discontinuous double-shell domes, rapidly
Figure 6. Sultan Bakhsh Aqa mausoleum, Iran: primary complete sample of the pointed discontinuous double-shell domes at the 14th century (Photo: Authors) (color figure available online).

Diffused through various regions of the Middle East and Central Asia which became a breeding ground for the creation of the final united style of pointed domes in the 15th century.

Along the final path of expansion, the pointed discontinuous double-shell domes evolved into two major types with respect to their external appearances in the 15th century. Firstly, “Gadrooned domes” (Yaghan 2003) as the more common style established in Uzbekistan, Kazakhstan, and Afghanistan, for example, those over the Khawaja Ahmed Yasawi mausoleum (1389–1399 AD) at Hazrat-e Turkestan in Kazakhstan, which is the UNESCO World Heritage site and the largest dome ever built in the Central Asia (Petersen 1999; Figure 7a) as well as the Gur-i Amir mausoleum (1404 AD), which is considered as the masterpiece of the pointed dome architecture at Samarkand in this century (Gibb 1993; Figure 7b). The projected-ribs on the surface of external shell of these pointed domes, occasionally, gave a bulbous effect to their overall exterior shapes of such domes.

In this regard, the most enduring sample of this primary trend is the triple-shell dome of the Gawhar Shad mausoleum (1417–1438 AD) at Herat in Afghanistan, which exposes the advanced level of structural knowledge, proportional developments, and the

Figure 7. Illustration of the first type of pointed domes in the 15th century; a) Mausoleum of Khawaja Ahmed Yasawi, Kazakhstan (photo: www.panoramio.com/photos/2898205); b) Gur-i Amir masuoleum, Uzbekistan (color figure available online).
prevailing of local architecture by using fan-shaped squinches (Knobloch 2002; Memarian 1988; Figure 8).

The second types of the 15th-century style are pointed domes that consist of plain external shells (Byron 1977), which were constructed on the huge high drums, regionally located in Iran, Afghanistan, and Uzbekistan, for example, domes over the holy Shrine of Ali-al-Rida, of 1430 AD, at Mashad in Iran (Pirma and Memarian 2003; Figure 9a), the Tuman Aqa mausoleum, of 1440–1441 AD, at Kuhsan (Figure 9b) in Afghanistan, and finally the tomb of Qazizadeh Rumi, of 1436 AD, at Samarkand in Uzbekistan (Figure 10).

Meanwhile, the tomb of Qazizadeh Rumi (Figure 10a) is one of the most prominent sample amongst the ‘Necropolis’ of Shah-i Zindeh (1066–circa 1350 AD) at Samarkand (Byron 1982) that may be considered as the most essential testament of continuous development of the pointed domes since the 12th until the 14th centuries in Uzbekistan (Golombek and Wilber 1988).

The last generation of the pointed dome samples are those erected over the Kalyan mosque, of 1542 AD, (Figure 11a) and the Mir Arab madrasa, of 1600 AD, (Figure 11b) at Bukhara in Uzbekistan (Grangler 2004). These are well-known due to the specific shape of their internal components, lighter structure, and shells which recalled their 15th century context (Borodina 1987).

Figure 8. Mausoleum of Gawhar Shad, Afghanistan (Photo: www.archnet.org, photographer: Stephen Shucart, 2002) (color figure available online).

Figure 9. Illustration of the second type of the pointed domes in the 15th century: a) Ali-al-Rida shrine, Iran (Photo: Authors); b) Tuman Aqa mausoleum, Afghanistan (Photo: www.archnet.org, photographers: Sheila Blair and Jonathan Bloom, 1970) (color figure available online).
2.3. Evolution

This section attempts at answering how stylistic attributes of pointed domes are regionally distributed throughout the Middle East and Central Asian realm. The whole studied cases in the above section have been chronologically arranged in the following table. Note that time line is not constantly divided. In each region, other samples might not be included. The arrows depict continuous replications of specific trends and do not denote any historically acceptable transfer of architectural techniques.

It begins with the 10th century when the pointed domes appeared in isolation, which can clearly establish theories about their origin and introduction into Islamic architecture (Figure 12). A great number of samples till the twelfth century demonstrated primary considerable movements in both architectural forms and geometrical compositions of the pointed domes if compared to other types of Eastern domes (e.g., conical domes) constructed during this blooming period. Furthermore, the prevailing skillfulness of local architects made notable difference regionally between configurations of pointed domes such as the Sultan Sanjar mausoleum in Turkmenistan in comparison with those Iranian examples. In the 14th century, however, the only novel achievement was the construction of the Sultan Bakht Aqa tomb, as the second major step of evolution of the pointed dome compositions.

Looking again, compositionally, the striking resemblances are obviously manifested in those studied domes, both in the overall form and arrangement in the 15th century.

Several examples of domes in this period are noted in Pope (1976) and the Foundation for Science, Technology, and Civilization (FSTC, 2003).
What is more, the remarkable developments of their form and composition stemmed from the collaboration between Islamic renowned mathematicians in both geometrical and structural designs in this period.\footnote{The role of medieval mathematician comprehensively elaborated in Dold-Samplonius (2000) and Taheri (2009).}

Following this prosperous period, the construction of the pointed domes gradually became less prominent after the appearance of the Safavids (1501–1736 AD) and the introduction of bulbous domes in Iran and nearby regions. However, it is obvious that, consistently, the splendid forms that continued to be erected after the 15th century basically relied on all prior existing trends rather than devising something fundamentally new. Consequently, three territories particularly remarkable in the final and actual development of the pointed domes are Afghanistan, Uzbekistan, and Kazakhstan in which their geographical proximity make it possible to have influenced each other.

The crucial roles of quite special instructions of royal patrons and sponsors in the erection of renowned domes cannot be overlooked such as the scale and complexity in the cases of the Oljeitu mausoleum and the Gur-i Amir mausoleum configurations compared to the small size and plain configuration of the Sultan Bakht Aqa mausoleum. One final point is that in the construction of pointed domes, there were generally dominant skilful use of diverse vernacular architectures and well-developed construction techniques in each region whilst their main concepts and elements remained uniform.
3. MORPHOLOGICAL FEATURES OF THE POINTED DOMES

The morphological features of the dome rely on the basic understanding of both its common internal and external spatial forms, called, “vocabularies of dome”. Eminently, consideration of a traditional Eastern dome’s configuration as a sentence clearly indicates its identical elements as vocabularies.

In this sense, the dome chamber and its related spatial forms put forward much opportunities for promoting variety of spatial experiments both internally and externally. Apart from the possibilities of marking compositional differentials of elements of a pointed dome, the systematical estimation of its archetype revealed four identical vocabularies respectively: supporting system, transition tier, drum, and shell(s). In fact, the evolutions of these elements gave rise to complexity of the final appearances of the pointed domes over the studied periods (Figure 13).

3.1. Supporting System

The combination of load bearing walls and tunnel-vaulted utterly provided the structural requirements of the dome. Its dominant shapes comprise of whether square or octagonal forms. The thicknesses of surrounding bearing walls, accordingly, vary between 1.80–5 m (Sultan Sanjar mausoleum). From the structural point of view, its main role is as a buttress for transferring the load of upper components to the ground.

3.2. Transition Tier

The transition tier often consists of two stories of interesting trilobed arches, which protrude over the lower row. According to the main meanings of squinches, these mini-arches were used to bridge diagonally the four transition corners for easily converting from square to the circular base of the internal shell. Here, distinct geometrical procedures allowed an infinite numbers of compositional variations of those mini arches to be
developed and also amalgamated the small fragments of these components. Architecturally, these crossing mini-arches yielded a visual link between the body of dome and crowning shell. Structurally, the role of these elements is to partially transfer the localized forces in such a way that both vertical and horizontal forces are concentrated on small regions of the transition tier.

### 3.3. Drum

The drum is the cylindrical part of the dome on which the external shell rests. It is the most common component of the pointed dome in the 15th century for making the dome as high as possible and its thickness is not less than 80 cm; structurally, this vertical cylinder wall helps to neutralize the thrusts of the external shell according to the complex and specific static reactions.

### 3.4. Internal Stiffeners and Wooden Struts

These stiffeners and struts are the composition of the radial brick walls with the wooden struts. They were built in the empty space between two shells, not only to unify the external shell to the lower components, but also to fulfill the structural requirements of the whole system (Figure 14). Their arrangement and sizes strongly affiliated with both vernacular architecture agreements and the scale of span. Chronologically, the introduction of using internal stiffeners in the dome constructions occurred since the 14th century when both structural and architectural sciences were enhanced. From the structural point of view, these radial walls play an essential role in the stability of the double-shell domes, especially against earthquakes; but unfortunately these elements were frequently changed or removed during conservation interventions.5

![Figure 14. Illustration of the different arrangements of the radial walls and wooden struts between the shells (Source: Authors) (color figure available online).](image)

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5 A considerable sample and controversy are noted in Hejazi (1997, p. 68).
3.5. Shell

In the double-shell domes, shells may be identified as the internal and external shells. Both thicknesses of shells proportionally reduced from their bases to the top at either 25’ or 30’ angles, for the purpose of reducing the overall weight of shells structurally. The internal shell has the simple forms such as pointed, semi-circular, semi-elliptical, and saucer (Figure 15), although the external shell is the final crowning element that is likely to appear among the studied samples.

In addition to these elements, the key in understanding of diversities in the external shell forms mainly dealt with studying of their geometrical concepts, namely, profile. This profile can be obtained by diminishing the thickness of cross-section of the external shell. It consists of a number of either two or four small arcs. Depending on the positions of their center points, the shapes of these profiles are considerably different. Structurally, proper geometrical forms utterly reduced tensions throughout the external shell (Frashad 1977; Hejazi 1997).

The traditional methods of geometrical designs, drawings of small arcs and their associated proportional relationships possess significant procedures which are beyond the scope of this study. Moreover, the geometrical forms of shells of pointed domes clearly mark advances in the architectural design amongst other types of Islamic domes which certainly affected on their stability in such a way that they are still stand over hundreds of years.

4. COMMON TYPOLOGICAL STYLES OF THE POINTED DOMES

One of the tenets of morphological survey was essentially to find out the programmatic approach for clarifying typological commonality of the pointed domes. Considering again at the configuration of traditional pointed dome as a sentence clearly indicate that its grammar for setting words, vocabularies of a dome herein, into a sentence is namely

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6For more references see Dold-Samplonius (2000) and Hejazi (1997, p. 41).
the typological characteristics. Because of structural requirements, though, the sequence of the identical elements of a pointed dome is constant as follows: load-bearing system, transition tier, internal shell, drum and internal stiffeners, and finally external shell.

Stylistic organization of a domical edifice, however, can deal with distinct arrangements of whether the whole components as a system or identical segments of dome for creating diversities in a domical structure. In this regard, the body of dome (load-bearing walls and transition tier) is subject to vernacular architecture and masonry of time; but, the shells of a pointed dome can be a matter of style definition. With reference to systematical consideration of the studied cases, in every dome, the treatment of shells as crowning elements are more or less the same, namely, *top of dome* which can be used as tools to rank distinct dome typologies.

In contrast, based on how these shells are composed together, the pointed domes may grammatically be categorized into single shell, double-shell, and triple-shell (Figure 16). The few samples of triple-shell can verify its origin as a developed form of the double-shell types in which a shell was often constructed for decorative purposes. Such architectural configurations chronologically appeared in the early 15th century. On the whole, single shell and continuous double-shell domes are common features between the 12th and 14th centuries, while discontinuous double-shell domes were developed in the course of the 15th century and included the majority of domes in the Middle East and Central Asia.

On the other hand, based on the variety of the rises of external shell’s profiles, the pointed domes can be additionally ranked into three subtypes; these are shallow, medium, and sharp (Figure 17). In fact, these attributes are fully conformed with the principles of traditional designs of the pointed domes both geometrically and compositionally.

![Figure 16](color figure available online).
5. CONCLUSION

The pointed domes definitely possess a unique monumental significance amongst different Islamic heritage, which are still considered having symbolic meanings in the life of modern Eastern societies. As stated at the beginning of this discussion, the pointed domes underwent major and continuous systematic evolutions regionally, in Kazakhstan, Uzbekistan, Turkmenistan, Afghanistan, and Iran during the 12th and 15th centuries.

Common morphological components of pointed domes including supporting system, transition tier, drum, and shells make clear the distinguishing among primary and secondary sustaining elements or vocabularies of the pointed domes. Arrangements and compatibility of the compositions of these elements ensure the invariability of their statically mechanical system. In the shell design of almost all instances, geometry proportionally served to obtain the ideal form of shell for the architectural and structural purposes. In contrast, the results obtained from the studies of both geometrical concepts and morphological features of the studied cases demonstrated how exceptional the structural systems were well-designed and constructed by traditional master builders. The typological shell orders of the pointed domes, which are single shell, double-shell, and triple-shell, also significantly provide insight into the characteristics of structural designs of these imposing structures.

This study has tried to show that the configuration of pointed domes in Islamic architecture are more or less similar, despite the complexity of their main elements in the samples which can be related to their sponsors, vernacular architecture, and the mastery of technologies of the times. A unique dome style, pointed dome herein, was revealed according to some similarities and recurring features of dome elements, apart from some atypical attributes in their configurations which may relate to local architecture. Future researches can further explore the needs for detailed structural analysis of the pointed domes; to understand the static role of each component in such a dome configuration; and also open up new programs for realizing the relationship between geometry and stability of the pointed domes.
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