

# **AN INVESTIGATION INTO SPATIAL DOME STRUCTURES OF MİMAR SİNAN PROJECTS**

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## **ABSTRACT**

This study aims to reveal spatial analysis of Architect Sinan's mosque projects by focusing on the content of flexibility and superiority of 'a single dome space' by atectonic dome architecture that Sinan used to pass great openings, in terms of basic design of the space creation art of mosques, complexes, madrasas and caravanserais. In the article, the dome space structures used by Sinan are examined and the layout of the atectonic domed cover system is emphasized. In the paper, system of dome-space cover techniques to pass wide spaces without remaining any walls at under structure have been analysed, thus, both upper structure as space covering and under structure as main prayer space and auxiliary sub-spaces that attached to that main space have been investigated together. The great architect Sinan's projects on Ottoman mosques by using domes, made him famous as dome-maker, expressed in the study by variations of four-six-eight baldachin dome structure. Sinan who is known as great dome-maker, used dome variations for space-arranging art on his master pieces such as; Mihrimah Sultan Mosque, Sinan Pasha mosque, Selimiye Mosque, which had been created by baldachin domed structures and the extension of the structure was realized by the addition of a secondary single dome with regards of the spatiality of dome structure. According to the sources, the mosque was enlarged with a second domed volume in the 17th century and becomes its present state. Sinan has analyzed and used domes space structures as additive modular volumetric structures. Therefore, in this article, especially Sinan's architectural style, which gives a new identity to the large domes structure in the history of World architecture, how Sinan uses domed structured as a space creator are examined. The mosques created by Sinan's domes space structures have created a tradition within Ottoman architecture, but the universal symbolism of this tradition is the large domed structures. Just as the classical columns in the history of European Architecture create a symbolic status, so is the degree of domes and domed baldachin in Ottoman architecture. As a result, the aim of this

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article is to reveal the architecture of domed space structures by examining Sinan's superior open, flexible, large and reproducible space layouts with plans and sections through projects such as mosques.

**Keywords:** Dome-space, Space Growth, Flexible Interiors, Architect Sinan's works, Mosques

## 1. INTRODUCTION

### 1.1. Aims

The main aim of the study is to focus on 'domed-space-unit structures' that had been constructed by architect Sinan for Ottoman architecture as upper structures of a mosque that create the basic spatial structure of the building. Only at the Ottoman Turkish period the architectonic spatial potentialities of the domed-square units so persistently explored and its inner logic with secondary dome structure so excellently designed by Sinan in the Ottoman period. In addition, the domed-square unit became the denominator of Ottoman Turkish buildings. Especially the projects of great architect Sinan's on mosque architecture and his aim to enlarge, widen and expand the inner space and main central prayer area by using domes and its variations such as half-dome, arch vaults and pendentives explore the spatial structural diversity that Sinan developed to pass big spaces without any under carrier system. Thus, in the study the methods of widening spatial structures such as; four-six-eight baldachin dome systems have been investigated.

### 1.2. Literature

The study relies on a variety of bodies of literature on space, dome-space-units, spatial and structural integration of dome constructions, especially with the growth and widening ability of domes. This widening ability of dome-space-unit structures create one flexible open spaces dynamic spatially without walls. Thus in the study a comprehensive literature survey have been achieved through academicians writings, books, articles and internet sources, especially because of the originality of the topic 'dome-space-unit' with spatial and structural analyses. Thereby, in the study investigation of literature survey depends on works of respectively; 1) Meiss V. 2013 with Elements of Architecture, where Meiss explores open plan, dynamic, space definitions and density relation of space as a modular and unit system, 2) Kuban D. (2016), Ottoman Architecture book where Kuban explores Ottoman mosques and Sinan's great projects, 3) Kuran A. (2013), The Mosque in Early Ottoman Architecture, which includes historical survey to religious buildings and mosque architecture from Seljuks to Ottoman, 4) Moussavi F., 2009, The Function of Form book where architectural elements have

been explored by 3d drawings and explores the structural analyses of domes as the most common tessellation and widening space element freely, flexibly.

### 1.3. Methodology

The methodology consists of three parts which 1<sup>st</sup> part is a literature survey on space, dome-space-unit and architect Sinan's projects, 2<sup>nd</sup> part introduces; Early Ottoman, Seljuk and Ottoman period (Architect Sinan's) mosque projects with indicating important planning and dome-usage techniques, 3<sup>rd</sup> part consists of cases' analyses with key indicators as shown at the table above which firstly classified as four-six-eight baldachin dome systems.

The main aim of the analyses is to show how Sinan achieved the growth of space by an upper structure in a transparent way which equal to open plan. Methodology of case analyses firstly grouped into two parts through Sinan's dome carrier systems, a) four pillar/baldachin system, b) six pillar/baldachin, c) eight pillar/baldachin system, then each case has been investigated by indicators as; 1) general information, 2) baldachin type, 3) extension type, 4) unit type , 5) upper-under structure

**Table 1. Structure of the paper**

STRUCTURE OF THE PAPER		
1.LITERATURE SURVEY	2.SAMPLE CASES	3.CASE STUDY: ANALYSES OF THE MOSQUES
1.MEISS (2013); Elements of Architecture 2.KUBAN D. (2016); Ottoman Architecture; Ottoman Mosques and Architect Sinan's Great Projects 3.KURAN A. (2013); The Mosque in early Ottoman Architecture 4.MOSSAVI F. (2009); The Function of Form	*Old Fatih Mosque *Sokullu Mehmet Pasha Mosque *Selimiye Mosque *Sultan Ahmed Mosque *Mosque of Alaeddin Bey *Mosque of Haci Özbek *Mosque of Sultan Bayezid *Yeşil Cami in İznik (Green Mosque); *Mosque of Hüdavendigar. Bursa Ulu Cami plan& section	1) General information 2) Baldachin type 3) Extension type 4) Dome-space pattern 5) Unit type 6)Structure 7)Spatiality

**Table 2. Methodology of the cases' analyses**

Four baldachin	Six baldachin	Eight baldachin			
<b>1.</b> General information information of the mosque					
-construction year /place -dome size and height (diameter and height) -exterior planning atrium existence					
<b>2.</b> Baldachin/ Pillar carrier type	<b>3.</b> Extension type  horizontal  -vertical	<b>4.</b> Dome- space pattern	<b>5.</b> Unit type  -single unit mosque  -eyvan mosque (multifunctional)  -multi unit mosque	<b>6.</b> Structure  -Upper structure/dome unit  -Under structure/main prayer area  -Auxiliary sub- spaces	<b>7.</b> Spatiality

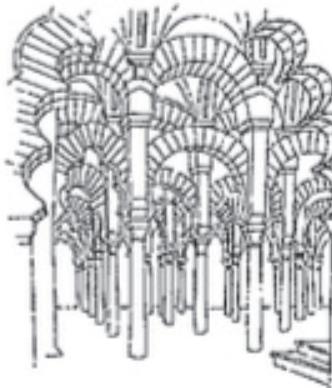
## 2. INVESTIGATION INTO DOMED SPACES AND GROWTH PATTERNS

This part constitutes the first part of methodology as literature review and consists of five parts respectively which the first part of the literature starts with an introduction to 'space-spatiality-open plan' concepts to shed a light for the second step which consists of dome-unit spaces as a device for wide open spaces without wall carriers. At the 3<sup>rd</sup> part dome structures have been investigated from Farshad Moussavi's approach through tessellation method, 4<sup>th</sup> part is an introduction to early ottoman and Seljuk mosques and the development of dome-unit spaces, lastly the 5<sup>th</sup> part presents Architect Sinan's mosque projects by analysing famous baldachin technique.

### 2.1. Introduction to 'space-spatiality-open space' contents

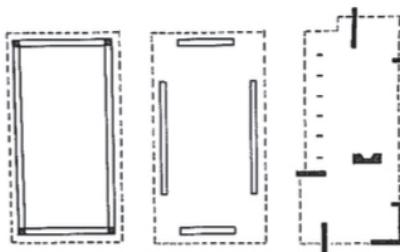
Generally, architectural space must have boundaries to determine and indicate its form, and there is some sort of ways to define spaces from explicit to implicit character by using rijit te and transparent walls/planes/elements that will carry the spatial quality of spaces from low to high and also from traditional to contemporary styles. In fact, to define a space; it is not necessary to use four walls, a space can be highly liveable and spatial without enclosed walls. A space can be defined by a ceiling or upper structure on it. Thus, it is not always the lower structure that creates sub-spaces in one big space, also upper structure has

quite well ability to define sub-space under it. As upper structures domes with varying sizes is quite unique example for the space definition ability of upper structure without any walls (vertical separators) under it. By using different dome sizes, it is possible to define many independent sub spaces under each dome without any rigid walls. As indicated by Meiss V. P. (2013); "Spaces does not only have depth; it is also more or less dense. When greater density is the goal, we can modulate distances by intermediary 'stages of depth' brought closer together. This is generally the case when we work with shallow space, but we can also create density in deep space: The Cordoba Mosque with its 'forest' columns are a deep space of extraordinary density" (Meiss,2013, pp:136). (Figure 1)



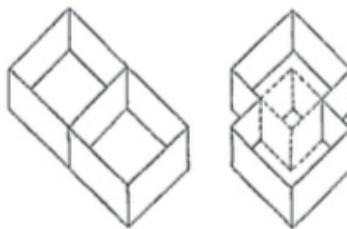
**Figure 1. Interior of the Cordoba Mosque (source: Meiss, 2013)**

The quality of any space increases by the way it integrates with its environment, in addition, its' relations with other spaces, its visibility and perception degree from outside also effects spatiality. Thus, to accommodate a good spatial quality; space enclosure must be low and distinctive space borders must be used instead of rijit walls such as; domes as upper structures/ceilings, level changes in the floors, point-like elements like columns to create sub-space. As Meiss emphasizes that; "one of the fundamental oppositions making it possible to distinguish types of architectural space is that they can either be closed/introverted and concentrated upon themselves, or open/extroverted and centrifugal' (Meiss, 2013) The opening of space is obtained by reduction in its' definition (for example, elimination of a corner) and by presence of elements belonging to both interior and exterior (for example, extension of a wall to the exterior) (Meiss, 2013) (Fig 2)



**Figure 2. These instructional diagrams by Allen Brooks SHOW frank Lloyd Wright's contribution to a new spatial conception: starting with the elimination of corners (source: Meiss, 2013)**

On the other hand, sub-spaces can be added to each other within one open big space, this can be achieved by two different ways juxtaposition and interpenetration. As seen from the picture, two space can be syntax side by side or they can integrate each other and use the same borders. Juxtaposition is generally referring to pre-modern terms which includes low spatial quality. On the other hand, space quality rises by the integration in one big space. This integration happens by elimination of walls and putting implicitly defined spaces side by side horizontally and/or vertically. (Figure 3)



**Figure 3. Juxtaposition and Integration (source: Meiss, 2013)**

## 2.2. Determination of 'Domes' as Spatial Elements

According to Altın M. (2019); definition of a **Dome**, at Turkish dictionary (TDK) is; 'a roof that covers a structure which is half sphere shape' (Altın, 2019, pp:16-17). In addition, from architectural point of view domes are defined as; "a shell that covers spaces, a sphere piece building element that is revealed when a vault is turned around its' vertical axis" (Altın M., 2019 pp:16-17) On the other hand, at encyclopaedic architectural dictionary, Hasol (1993) defines domes as; 'sphere skullcap, half sphere or the building cover, which is shaped like a cupola, or cover formed by the rotation of the bow around the perpendicular descending from the top of the arc' (Hasol, 1993, pp:277).

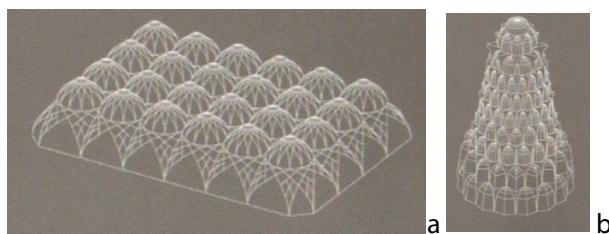
Throughout architectural history, domes are the most used and common architectural elements generally preferred by architects and engineers to cover wide spaces because it doesn't require any vertical carriers. Domes are especially used at religious buildings and they indicate some meanings such as; at Eastern Orthodox churches dome structure means 'heaven' as very famous Pantheon. On the other hand, at mosques domes are used to indicate spaces for gathering and prayer areas. Thus, at mosque architecture domes define one uniform space which architect Sinan's mosques are good samples. (Altın M. pp.16-17)

From, geometrical point of view, a dome defines the structural construction of a sphere form. The sphere is a double curvature rotating surface and is curved (Türkçü, 2003, pp.97). Domes are generally used as top covers for circular or square or polygonal planned spaces by cutting the upper part with a certain plane instead of the entire sphere (Altın M. pp.16-17). In addition, the transition from the circular dome above to the square and polygon plan below is also provided by using structural elements we call transition elements such as; pendant (spherical triangle), slotted bing and trumpets (vault bing). These transition elements are carrier elements and are three-dimensional elements. (Hasol, 1993, pp.277)

### **2.3. Growth Patterns of Domes: Horizontally & Vertically**

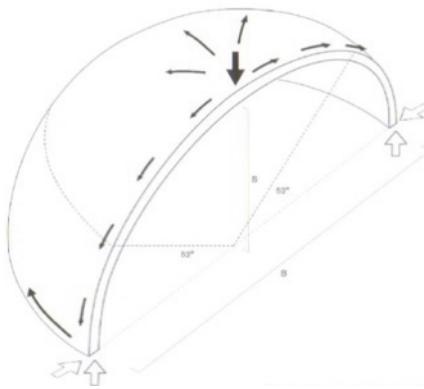
According to Farshad Moussavi (1993), dome is one of the architectural element of form & function concept. Domes are generally composed of; 'surfaces' or 'surfaces and ribs' that distribute loads in plane or along the ribs. Surface domes have greatest efficiency when resisting evenly distributed loads and they distribute loads along a continuous surface. (Moussavi,1993) According to Moussavi (1993);

"Domes tessellate along horizontal and vertical axes of growth to produce horizontal and vertical structural forms; a) Horizontal tessellation (growth) can occur along the horizontal axis. All horizontal tessellations form shed-like structures that may vary in section or ground plan according to variations in the domes as they grow along the horizontal axis, b) Vertical tessellation (growth), when a dome is able to respond to the three-dimensional bending moment which is characteristics of a vertical structure. The vertical tessellation of domes can result in structural forms that vary in plan and profile along the vertical axis of growth" (Moussavi F., 2012) . (Figure 4.a-b)



**Figure 4. a) horizontal tessellation, b) vertical tessellation**

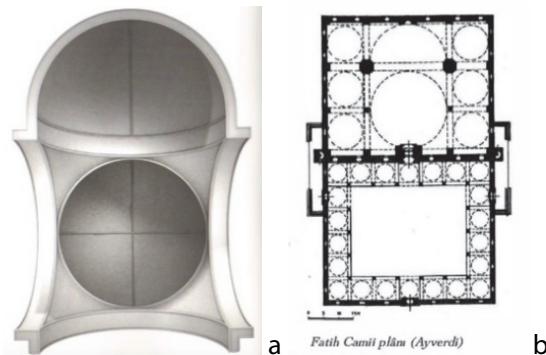
\**Surface dome*; "The base unit of a surface dome consists of an arch rotated around its vertical axis to form a smooth surface. Surface domes are circular in plan, and additional arches and pendentives are required to integrate them with a square or polygonal plan" (Moussavi F., 2009, sf:238). Surface domes can be made of masonry or reinforced, thin-shell concrete. As a result, in addition to enclosure and non-oriented-ness, a surface dome includes axiality, cruciformity, multi-scaling. Below, important mosques of Architect Sinan's have been introduced to demonstrate horizontal tessellation and growth techniques (Figure 5-6-7-8)



**Figure 5. Base unit - surface dome**

\* **Old Fatih Mosque:** "The tessellation of dome and half-dome creates a space. Old Fatih mosque is formed by the horizontal tessellation of a surface dome base unit, repeated, scaled and interconnected by arches and pendentives" (Moussavi, 2009).

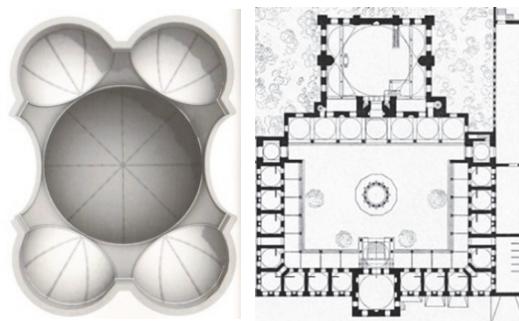
The dome configuration of the mosque consists of one whole dome and a half dome connected to whole with arches and pendentives. Thus dome-unit is: '**1 whole dome + 1\*0.5 dome' system.** (Figure 6)



**Figure 6. Old Fatih Mosque –Sinan the Elder- İstanbul Turkey -1471**

\* **Sokullu Mehmet Pasha Mosque:** “Tessellation of the base unit, involving four half-domes (base units) and a full dome of a larger scale, creates a domed enclosure that defines a complex form. Domes of a smaller scale roof the complex of rooms surrounding the courtyard Sokullu Mehmet Pasha is formed by the horizontal tessellation of a surface dome base unit, repeated, scaled and interconnected by arches and 6 pendentives. The base unit is scaled down as it repeats. The transition from the circular plan of the main dome to the square plan of the perimeter is achieved by four smaller half-domes located at the corners of the square plan.” (Moussavi, 2009). (Figure 7)

The dome configuration of the mosque consists of one bigger whole dome and four smaller half domes connected to whole with arches and pendentives. Thus dome-unit is: **'1 whole dome + 4\*0.5 small dome' system.**

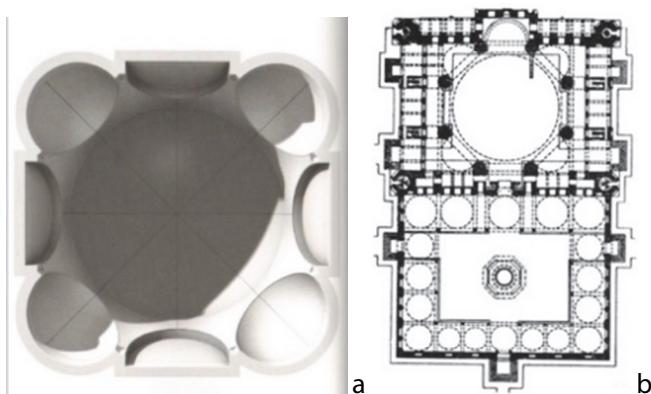


**Figure 7. Sokullu Mehmet Pasha Mosque – Sinan – İstanbul Turkey -1571**

\* **Selimiye Mosque:** “Tessellation of the base unit, involving eight half-domes (base units) and a full dome of a larger scale, creates a domed enclosure that defines a complex plan shape which is almost square despite being formed of domes. Selimiye Mosque is formed by the horizontal tessellation of a surface

dome base unit, repeated, scaled, and interconnected by arches and pendentives. As the base unit repeats and is scaled down , it divides into five half-domes which are situated at the perimeter of the main dome to serve as a transition from the circular plan of the dome to the square plan of the perimeter. The main dome rests on a eight coloumned arches and pendentives, which give away to the five half-domes along the perimeter. Both the main dome and the half-domes are given narrow openings along their bases in order to introduce natural light into the interior”(Moussavi, 2009). (Figure 8)

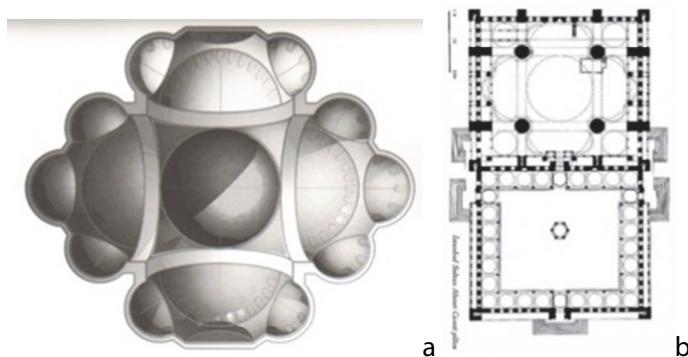
The dome configuration of the mosque consists of one bigger whole dome and eight smaller half domes connected to whole with arches and pendentives. Thus dome-unit is: **‘1 whole dome + 8\*0.5 small dome’ system.**



**Figure 8. Selimiye Mosque**

\* **Sultan Ahmed Mosque;** at this huge mosque (113mt. length/69.9mt.width) the growth and enlargement of prayer area had been achieved by a complex dome system that is developed by Architect Sinan. The repetition, combination, organization of domes with different sizes and proportions as a basic dome unit, refletcs basic design principles in a good way and creaes the design of Sultan Ahmet Mosque.

“Horizontally usage\_of a surface dome with four large and ten small half-domes creates an enclosure with an asymmetrical cross-shaped plan. The main dome rests on a set of four columned arches and pendentives that give way to the four half-domes and the smaller half-domes, which consists of one third of their surface” (Farshid Moussavi, 2009). (Fig 9)



**Figure 9. a. Sultan Ahmed mosque upper structure, b. plan, c. secondary dome pattern**

The dome configuration of the mosque consists of one bigger whole dome and four smaller half domes and ten more smaller half domes connected to whole with arches and pendentives. Thus dome-unit is: **'1 whole dome + 4\*0.5 small dome + 10\*0.5 more smaller half dome' system.**

### 3. HISTORICAL INVESTIGATION INTO DOME SPATIAL STRUCTURES

#### 3.1. Early Ottoman Mosque Architecture

According to Kuran A. (2013); "In Islam buildings for prayer are called mosques. The English Word 'mosque' derived from Arabic word masjid (spelled mescid in Turkish) which means a 'place for prostartng oneself in worship'. A second word used for a religious meeting place of the Muslims is jami (cami in Turkish), meaning a place of assembly for the congregation. In Turkish usage the mescid refers to a small and cami to a large, place of worship. those built by royalty, which generally have two or more minarets- the erection of more than one minaret being a royal pregrative-are known as the Selatin cami (sultan's mosque)" (Kuran A., 2013).

Anatolian Seljuk mosques despite certain common features such as portals, pillared interiors, or domes in front of their mihrabs are generally classified in two majör groups according to the orientation of their rectangular masses. The Ottoman mosques, on the other hand, are more standardized and definable in their basic forms. In terms of exterior form and organization of inner space, the Ottoman Turkish mosques built during the fourteenth and fifteenth centuries can be classified into three majör groups;

- 1) *the single-unit mosque (with complex massing and articulated interior)*
- 2) *the 'eyvan' mosque (axial and cross axial)*

*3) the multi-unit mosque (with similar units and dissimilar units)*

The typical **single-unit mosque** consists of a square, or near square, prayer room, a two or three-bay porch and a minaret. The prayer room is generally surmounted by a dome and the porch by vaults, domes or a combination of two. The **multi-unit mosque** has a large interior space which is divided into compartments by means of columns or piers in order to provide shorter spans. Seljuk mosques of this type usually have flat roofs; but for reasons of emphasis, one or more compartments may be covered by domes. The Ottoman multi-unit mosques, on the other hand, are more standardized, for in them all the compartments are dome-square units. Undoubtedly the most interesting type of early Ottoman mosque is the eyvan mosque. There is a kinship between the eyvan mosque and Seljuk medrese with its central dome. Both types of buildings have two of four focal points that occur at the end of only the longitudinal axis or both the longitudinal and transverse axes around a domed interior court. (Kuran A., 2013).

### **3.1.1. The Single-Unit Mosque (Mosque of Alladdin bey in Bursa and Mosque of Hacı Özbek in İznik)**

The domed-square structure, with the addition of a porch and a minaret, established the basis mass of the typical single-unit mosque. The most important examples of typical single-unit mosques built during the first part of the fourteenth century are those of Alaeddin Bey in Bursa, Hacı Özbek in İznik, and Orhan Gazi in Gebze. The interior of the mosque of Alaeddin Bey comprises a square room measuring 8.20 m. by 8.20 m. surmounted by a hemispherical dome that rests on a sixteen-sided belt of large triangular planes. (Figure.10)

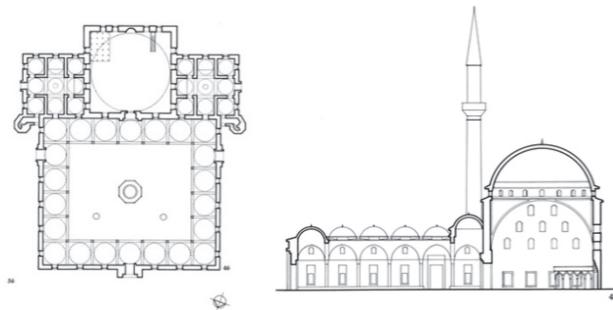


**Figure 10. Mosque of Alaeddin Bey in Bursa, a) plan & section, b) interior, c) exterior**

#### **\* Single Unit Mosque with Complex Massing**

The highlight of the single-unit mosque with complex massing in early Ottoman architecture is the Mosque of Sultan Beyazid II, which occupies the focal point of a large complex of buildings in Edirne. Designed and built for Bayezid II by the

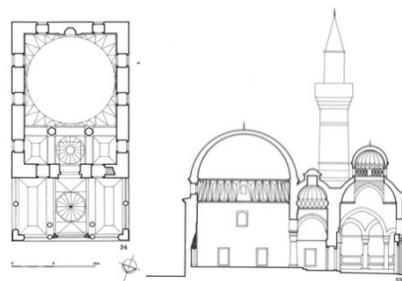
architect Hayrettin between the years 1484 and 1488, the mosque comprises a fountain court, and two minarets. The simplicity of expression observed on the exterior continues inside the prayer hall, which is simple-square room 20.25 m. per side. The huge dome rests on four pendentives and completely envelops the interior space. In terms of organization of space, the domed prayer hall does not have any relationship with the hospices. the hospices tall buildings; they stand about a third as high as the prayer hall, allowing the latter to dominate the scene and to retain its identity as a single-unit structure. (Fig 11)



**Figure 11. Mosque of Sultan Bayezid ,Edirne, a.plan, b.section**

#### \*Single Unit Mosque with Articulated Interior

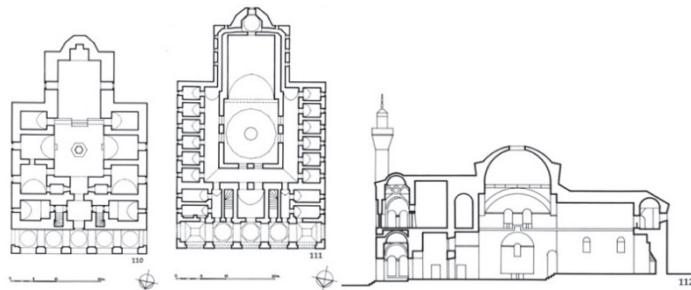
In single-unit mosques with articulated interiors the development takes an opposite path. The external form remains more or less the same, but the interior of the basic-domed square unit is enriched by auxiliary spaces. Yeşil Cami in İznik (Green Mosque); was constructed by the architect Hacı bin Musa between the years 1378-1392. The porch of the mosque has the unusual three-bay arrangement with bipartite open ends. All three bays are surmounted by flat-topped cross-vaults. The prayer hall is basically a typical domed-square space. In this mosque, however one finds a second three-bay space located between the prayer hall and the porch. The main dome measures 11.00 m. in diameter and unlike the two smaller domes, which are pointed, is hemispherical. (Fig 12)



**Figure 12. Mosque of Hacı Özbek a) plan, b) section**

### 3.1.2. The Eyvan Mosque

Eyvan mosque is the most original and interesting type of early Ottoman Turkish mosque, which has been called to date by many names such as 'Bursa Type', the 'Reverse T type' or the 'Multi-functional' mosque. The side rooms were used as hostels for the traveling dervishes and he called these edifices 'Convent mosques' and corner rooms had a different function, such as; guestroom, classroom, court of law, kitchen, etc. Like the single-unit mosque, the eyvan mosques were erected in two groups: the axial eyvan mosque, the cross axial eyvan mosque. Mosque of Hüdavendigar at Çekirge in Bursa as a cross-axial eyvan mosque, is a two story building comprising a mosque-convent on the ground floor with a medrese on the upper level. Its construction was ordered by Murad I in 1365 and completed in 1385. The ground floor is composed of a five-bay porch , a vestibule which gives access to the interior on the south and to staircases on either side, a main interior space of four eyvan around a central hall, and six rooms, three each on the east and the West (Fig 13)



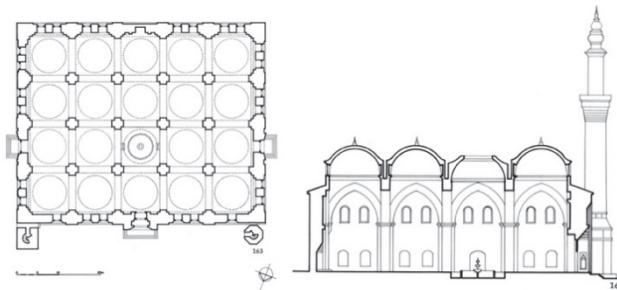
**Figure 13. Mosque of HÜDAVENDIGAR, plans and section**

On the upper level, there is a five-bay gallery directly above the porch, a large room between the two staircases, eight Medrese cells on each side accessible by a corridor that follows the perimeter of the central hall, and a small room above the mihrab on the south. The latter is covered by a dome. The large room, the cells, and the corridors are barrel-vaulted. The three centre bays of the gallery are surmounted by domes, the outer ones by flat-topped cross-vaults. In the centre of the main hall there is a fountain inside a pool. Owing to the two-story structure, the dome-11.00m. in diameter- rises to a height of 23.00 m. It rests on a simple sixteen-sided belt on pendentives.

### 3.1.3. Multi-Unit Mosques

As indicated previously both the single unit and the eyvan mosques are basically one-unit mosques. In the multi-eyvan mosque the various prayer units are fragmented and scattered instead of being integral parts of a unified whole as

they are in the multi-unit mosques. The Ulu Cami in Bursa as a multi-unit mosque with similar units; was begun in the fall of 1369 during the reign of Bayezid I, and according to the inscription above the door of its minber it was completed in 1399. The Ulu Cami of Bursa is a large rectangular building whose exterior dimensions are 68 m by 56 m. Twelve square piers divide the interior into twenty equal units, each of which is surmounted by a dome. Nineteen of these domes are full shells, but the twentieth dome, the second from the main portal in the centre row, is open on top and was originally unglazed. The domes of the Ulu Cami rest on pendentives and are girdled on the exterior by octagonal drums. All the domes have the same diameter but are not the same height. (Fig 14)



**Figure 14. Bursa Ulu cami plan and section**

### 3.2. Architect Sinan's Dome-Space Innovations and Mosque projects

This part mainly focuses on determination of innovations in Sinan's art and domed space usage. The innovative contributions of Sinan's art to the 16th century Ottoman architecture by using dome element as aesthetical and spatial structure to create big open and main space of the mosques and the technics that he developed.

As indicated by Özgüler M. (2008) ; *"if we look into architectural history , we may see innovative contributors, but in Ottoman architecture, there is undoubtedly one name of consensus ; Sinan. His genius art and engineering resulted in architecture and he was responsible for the construction of approximately 400 buildings while he was the chief architect of the Ottoman empire for a half century 1538-1588. The aesthetic excellence of his works together with the variations and endless attempts for new forms made the architecture of his age-magnum-opus-of the empire and his works crystallized the building tradition of the Ottoman"* (Özgüler M.2008)

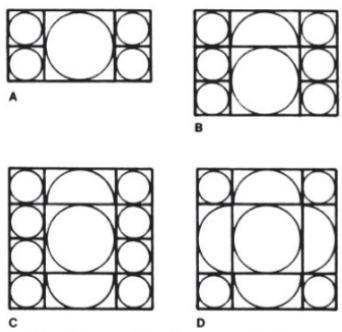
From 11th centuries the most important element of eastern Islamic art to the development of mosque architecture was the dome. This evolution can be seen in Ottoman architecture respectively at Bursa and Edirne mosques with the reverse t-model found in Bursa Green Mosque, or big central dome example

erected at Edirne Üç Şerefeli Cami. These examples and many other indicates the efforts of Sinan to create a structure that transform a space into an uninterrupted one big opening differently form Renaissance works. (Özgüler, 2008)

Sinan's dome usage was representing the continuity and interdependence of space from rigid walls and dynamism through lateral small sub-spaces. When we concentrate on structure of mosques it can be seen that Sinan achieved a double boundary system as the result of his work on form and plan. His big contribution was to create knit structures by dome element, in Sinan's mosques the secondary structural and spatial parts are not just added to the core baldachin but were magnifying the main dome.

At this point Özgüler M.(2008) indicates that; "*In fact, Sinan skilfully places a real baldachin at the centre, and the auxiliary structural elements, arches and buttresses surround it to form a secondary boundary, but when doing this, he pays a quite important attention to make these elements the only carriers of the mass; therefore he enables the transparency of the walls as a result, he not only enlarges the space in an uninterrupted manner, but also increases the illumination of his buildings as the walls given up their weight carrying role and have the opportunity to contain extra windows*" (Özgüler, 2008)

As seen through schematic mosque drawings Sinan achieved the space widening by adding semi domed on each side of the main dome at Şehzade mosque, which he reached the ideal scheme at Edirne Üç Şerefeli than followed by Fatih and Beyazıt. (Fig 15)



**Figure 15. Conceptual development and ideal form reached by Sinan with Şehzade plan; a) Edirne Üç Şerefeli, b) Fatih, c) Beyazıt, d) Şehzade (source: Doğan Kuban , 'The Style of Sinan's Domed Structures' in muqarnas, Vol 4, Leiden: E.J.,Brill,1987,p.839**

Through conceptual drawings it can be clearly seen that each time Sinan developed a different dome structural system for each different mosque plan. For example, at Beyazıt, he put 4 smaller domed bays at each side of the central

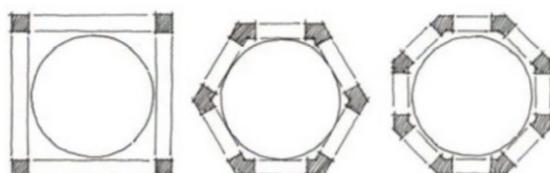
dome and add large semi-dome bays in harmony with the main axis was a distinctive structural solution for Beyazid Mosque. This ensure the widening of the main central space laterally on two axes. On the other hand, Selimiye mosque is masterpiece of Sinan in order to achieve of unification and widening of the main space.

Özgüsel (2008) resembles this baldachin growth scheme as; the outer boundaries circle around the interior one just like water circles caused by drop, the opposition of these drops contribute to spatial quality and result as an innovative space/structure unification by widening of the interior space.

Thus to finalize, it will not be wrong to name Sinan as a '**dome maker**' as also emphasised by Özgüleş, he innovatively used domes with diversity as the '**master of domes**', and he had covered hundreds of buildings of every scale with domes and perfected this technology by experiencing different schemes which Özgüleş later indicated that; '*as Grabar also points out, what Sinan had really done was to take the ideas of the dome-baldachin and of the dome membrane to their most extreme point of growth*' Özgüleş (2008). In addition, Kuban also indicates that; 'the lesson to be learned from the Selimiye is that an architectural element with distant symbolism can become generator of a design without being formally emphasized. This is what makes Sinan's style the purest domical style in the history of architecture' (Kuban D.1987).

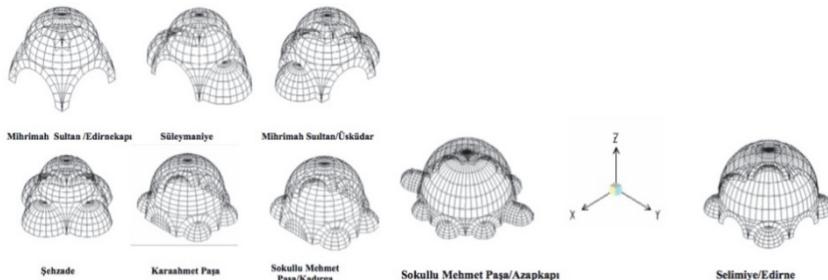
In addition, Erarslan A. (2018) emphasizes that ; "*it was the structure (support) features used in the domes that determined the space and thus plan establishment of Sinan's mosques, in utilizing multi-support systems, such as four, six and eight pillars/baldachin in his dome structures, the Great architect Sinan set up the space-plan domes structures formulated within the framework of these systems*"(Erarslan A.2018, vol 5, pp.31-48).

The plan and space developed around a **baldachin system** and it is possible to create different spatial typologies in this system that allows a rich space organization. Sinan uses multiple support systems such as **four, six, and eight (baldaken)** in the dome structure, and builds the plan around this system in the domed structures created with this support system. (Fig 16)



**Figure 16. The baldachin variations of Sinan four,six and eight. (Tuluk 2006)**

In addition, Bilgin H. (2005) indicates that Sinan in his early ages developed an excellent structural system with the synthesis of '**main dome + arch vault + pendant + half domes + semi-half domes**' and developed four-six-eight pillar support systems. Sinan created a very complex upper shell at his mosque projects by using different variations of domes-half domes-pendant and vaults through his aim of enlarging the space, both horizontally and vertically. (Fig.17)



**Figure 17. Finite element models of domed roof systems (Bilgin H.206)**

At Sinan's mosques dome is the centre of gravity of the structure. He used four/six/eight totally three type carrier system. Sinan used dome with different techniques to construct mosque, education building, bath, bazaar. The effects of loads on dome structures and their current interior forces can be calculated by shell theory numerically. Thus, this part was for to introduce Sinan as genius architect of his era by investigating his works mainly his mosque constructions that he developed an excellent dome structure system to pass as big space as he can.

#### PART 4. DISCOVERING EXPANSIONS & WIDENINGS OF THE DOME-SPACES IN MOSQUE INTERIORS

This part of the study consists of analyses of Sinan's mosque projects under their spatial-widening and growth patterns. The analyses aim to reveal space expansions and widening from a central domed space by the help of four basic architectonic elements; 'dome-half dome-pendantif-arch vault'. The main indicator of the spatial analyses is based on 'space growth' by repetitive variations of dome elements as basic design principle; in order to reveal the quality of open spaces that are planned by upper structure by the help of dome element without inner walls.

The main aim of the analyses is to show how Sinan achieved the growth of space from an upper structure in a flexible way which is equal to open plan. Case projects have been firstly grouped into three parts through Sinan's dome carrier

systems, a) four pillar/baldachin system, b) six pillar/baldachin, c) eight pillar/baldachin system, then each case has been investigated through their; 1) general information, 2) baldachin type, 3) extension type, 4) unit type, 5) upper-under structure (Table 3)

Thus, the dome pattern of growth and expansion of space is the main theme of the study. In the paper, system of dome-space cover techniques to pass wide spaces without remaining any walls at under structure have been analysed, thus, both upper structure as space covering and under structure as main prayer space and auxiliary sub-spaces that attached to that main space have been investigated together.

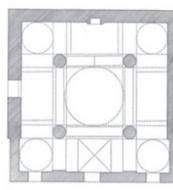
**Table 3. Case Analyses Methodology**

Four baldachin	Six baldachin	Eight baldachin			
<b>1.</b> General information information of the mosque					
-construction year /place					
-dome size and height (diameter and height)					
-exterior planning atrium existence					
<b>2.</b> Baldachin/ Pillar carrier type	<b>3.</b> Extension type -Horizontal -Vertical	<b>4.</b> Dome- space pattern	<b>5.</b> Unit type -single unit mosque -eyvan mosque (multifunctional) -multi unit mosque	<b>6.</b> Structure -Upper structure/dome unit -Under structure/main prayer area -Auxiliary sub- spaces	<b>7.</b> Spatiality

#### **4.1. The Samples of Four Pillars/Baldachin System of Sinan Mosques- 4**

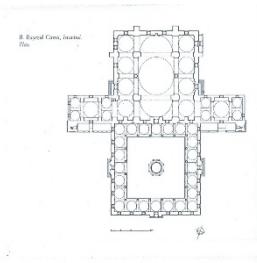
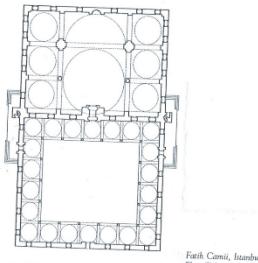
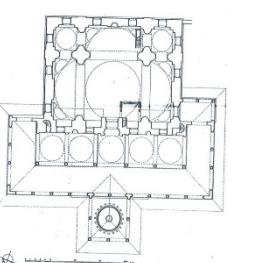
##### **Baldachin (ana kubbesi dört destek üzerine oturan cami örnekleri)**

This first part consists of Sinan's four baldachin type mosque dome technique. (Fig.18)



**Figure 18. Hazar Degaron Mosque , Diameter: 6.5m., early sample for four baldachin system**

**Table 4. Four baldachin dome-space-unit system mosques**

<b>1.st FOUR BALDACCHIN SYSTEM</b>	<b>2 nd FOUR BALDACCHIN SYSTEM</b>	<b>3rd FOUR BALDACCHIN SYSTEM</b>
		

*II Bayezid Mosque, İstanbul, Plan, 1501, Architect Hayrettin and Kemaleddin*

*Fatih Camii, İstanbul, Plan (Rekonstrüksiyon)*

*Mihrimah Sultan Camii, Üsküdar, Plan*

#### \*CASE NO 01\_1: II. Bayezit Mosque İstanbul-1501 / 1506

**1. General Information:** The mosque had been constructed by Sultan II. Bayezid in İstanbul at Bayezid district. It is a structure among the early works of the Ottoman classical architecture. A main dome with a diameter of **16.78m, 31 m. high** sitting on four legs, is supported by two half domes in the north and south. There are twenty windows in the main dome and seven windows in the half domes. The mosque has a square community courtyard surrounded by 24 domed porticos.

**2. Baldachin /Pillar Carrier Type:** 4-baldachin/pillar system with a central axis.

**3. Extension/Growth Type:** Vertical tessellation with strong one basic dome unit in the centre and one-way horizontal growth on north south direction with two half domes.

**4. Dome-space pattern:** 1 whole dome + 2\*0.5 domes system

**5. Unit Type:** Single unit mosque with one wide dome in the centre of interior as a prayer area.

**6. Structure harmony:** Mosque accommodates 'a single-unit dome+2\*05 domes' patterns as upper structure and a rectangular space plan as under structure. Thus, the mosque has a unity and harmony between upper and under structures. There are 6 small dome-unit auxiliary spaces at both sides of the main dome. It has cross-axial symmetry.

**7.Spatiality:** at the end, its found that the mosque accommodates a unique spatial design forms by diversity of dome structures; '**1 big+2 half+6 small dome+4 pillars**' spatiality.(Table 4)

\***CASE NO 01\_2:** Fatih Mosque İstanbul-1766/1771

**1.General Information:** the mosque had been constructed at 1766 at İstanbul and reconstructed at 1771 due to earthquake. From the first construction of the mosque, only three walls of the fountain, the crown gate, the mihrab, the minarets up to the first balcony, and some of the surrounding wall remained. The outer hoops of the domes have eight corners and sit on the arches. In the first construction of the Fatih Mosque, walls and a dome were placed on two legs to expand the mosque area, and a half dome was added in front of it. Thus, the dome with a diameter of **26 m** has remained the largest dome for a century. In the present case, the central dome sits on four elephant oils, and four half domes surround it. The second degree half and full domes around the half domes cover the galleries.

**2.Baldachin /Pillar Carrier Type:** 4 baldachin/pillar system a huge dome-unit with 26 m. diameter with a central axis.

**3.Extension/Growth Type:** Mosque is designed with four baldachin system the central/prayer space is enlarged with just one direction with half dome and side wings are rectangular spaces consists of three domes that are connected to the main space with arch-vaults.

**4. Dome-space pattern:** 1 whole dome + 1\*0.5 dome system

**5.Unit Type:** Single-unit mosque with one main dome in the centre of interior as a prayer area.

**6.Structure:** Mosque accommodates; 'a single-unit dome+1\*05 dome' pattern as upper structure and a rectangular space plan as under structure. Thus, the mosque has a unity and harmony between upper and under structures. There are 6 small dome-unit auxiliary spaces at both sides of the main dome. It has axial symmetry.

**7.Spatiality:** Mosque accommodates a unique spatial design by; '**1 big+2 half+6 small dome+4 pillars**' spatiality. (Table 4)

**\*CASE NO 01\_3:** Mihrimah Sultan Mosque, İstanbul Üsküdar 1562-1565

**1.General Information:** Mihrimah Mosque or Iskele Mosque, is the mosque built by Mimar Sinan, the daughter of Suleiman the Magnificent Suleiman Hürrem Sultan, in the square of Istanbul's Üsküdar district. It is one of Sinan's early works. Its dome is supported by half domes on three sides, but there is no half dome on the front facade. It is also one of the early works of Mimar Sinan. Its dome is supported by half domes on three sides, but there is no half dome on the front façade. The dome of the mosque is **10 m.** in diameter and 37 m. high.

**2.Baldachin /Pillar Carrier Type:** Mosque is constructed with four pillar/baldachin system, as carrier, which is supported and enlarged from three directions with half-domes.

**3.Extension/Growth Type:** reflects both horizontal and vertical tesselation/growth with a central dome with 11m diameter which is 37 m. high articulated with 3 half domes at both sides right and left. The mosque consists of rectangular plan type.

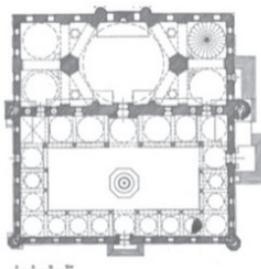
**4.Dome-space pattern:** 1 whole dome+ 3\*0.5 domes+4 small domes system

**5.Unit Type:** single-unit with 1 whole dome and eyvan mosque with madrasah, school, tomb and bathhouse functional spaces.

**6.Structure:** Mosque accommodates; 'a single-unit dome+3\*05 domes' pattern as upper structure and a square space plan as under structure. Thus, the mosque has a unity and harmony between upper and under structures. There are 2 small dome-units as auxiliary spaces at back side of the main dome. It has axial symmetry.

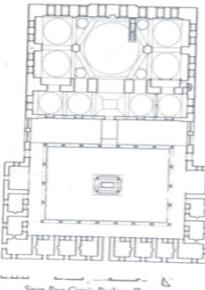
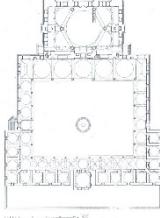
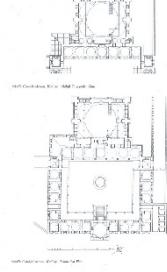
**7.Spatiality:** Mosque accommodates a unique spatial design by; '**1 whole dome+3\*0.5 domes+2 small domes+4 pillars**' spatiality. (Table 4)

**4.2. The Samples of Six Pillars/Baldachin System of Sinan Mosques- 6 Baldachin** (ana kubbesi dört destek üzerine oturan cami örnekleri)



**Figure 19. Edirne Üç Şerefeli Mosque, Diameter 24.10m. Six Baldachin System**

**Table 5. Six baldachin dome-space-unit system mosques**

<b>1st SIX BALDACHIN SYSTEM</b>	<b>2nd SIX BALDACHIN SYSTEM</b>	<b>3rd SIX BALDACHIN SYSTEM</b>
		

Sinan Paşa Camii, Beşiktaş. Plan

Sinan Paşa Mosque, Beşiktaş, 1555, Architect Sinan

İstanbul Topkapı Kara Ahmet Paşa Mosque, 1557-58, Architect Sinan

İstanbul Kadirga Sokullu/İsmihan Hatun Mosque, 1571-72, Architect Sinan

**\*CASE NO 02\_1:** Sinan Paşa Mosque, İstanbul Üsküdar 1550-1553

**1.General Information:** Sinan Pasha Mosque is an Ottoman mosque built by Mimar Sinan located in Beşiktaş district of Istanbul. It was built between 1550 and 1553 by Sinan Pasha, the Captain of the Ottoman Navy. This mosque, which is the work of Mimar Sinan, is placed on a rectangular plan. The central dome is based on columns with six corners with arches and there are two domes on each side. It has been repaired on various dates since its establishment.

**2.Baldachin /Pillar Carrier Type:** Six-baldachin system with a central dome of **12.6 m.** diameter. There are triangle covers between pillars and square side pitches (small Spaces) It is a six baldachin rectangular plan-type mosque.

**3.Extension/Growth Type:** Indicates a horizontal grow type with a rectangular plan. (horizontally tessellation). The central dome sits on south structural wall. All pillars are connected to each other by belts. Similarly, at both east and west sides two spaces with smaller domes exist.

**4.Dome-space pattern:** 1 whole dome+4\*0.5 domes

**5.Unit Type:** Eyvan mosque (multi-functional) Sinan Paşa Mosque is the first sample that both mosque and school shares the common court.

**6.Structure:** Mosque accommodates; 'a single-unit dome+4 small domes' pattern as upper structure and a rectangular space plan as under structure. Thus,

the mosque has a unity and harmony between upper and under structures. It has horizontal axial symmetry.

**7.Spatiality:** Mosque accommodates a unique spatial design by; '**1 whole dome+4\*small domes+6 pillars**' spatiality. (Table 5)

**\*CASE NO 02\_2:** İstanbul Topkapı Mosque, İstanbul , 1558

**1. General Information:** Ahmed Pasha Mosque is a mosque in Fatma Sultan neighbourhood in Topkapi district of Istanbul. Its' architect is Mimar Sinan. Its' construction date is 1558. The architectural plan of the mosque is a rectangle. Like the classical Ottoman mosques, it is covered with a central dome. The central dome is carried by six main arches and 23.5 m. with a 43 m high and 64\*72 m. prayer area dimensions.. <https://tr-tr.facebook.com/TASISTANBUL/posts/338597122944161/>

**2. Baldachin /Pillar Carrier Type:** Prayer area dome is carried by six pillars/baldachin system. There exist belts between the pillars.

**3. Extension/Growth Type:** Three is vertical growth of central space with four half domes on all sides, thus four semi-half domes support the central dome. This two side semi half domes widens/expands central space rectangular and of course in a transparent way as a device of Sinan. General plan scheme indicates; vertical tessellation.

**4. Dome-space pattern:** 1 whole dome+4\*0.5 domes

**5. Unit Type:** Eyvan mosque (multifunctional) and reflects the common court between school and mosque.

**6. Structure:** Mosque accommodates; 'a single-unit dome+4\*0.5 domes' pattern as upper structure and a square plan as under structure. it has cross axial symmetry.

**7. Spatiality:** Reflects a unique spatial design with; '1whole dome+4\*0.5 domes+6 pillars'(Table 5)

**\*CASE NO 02\_3:** İstanbul Kadırga Sokullu /İsmihan Hatun Mosque 1571

**1.General Information:** Mehmed Pasha Sokolovic Ottoman mosque located in the Kadirga neighbourhood of the 16th century in the Fatih district of Istanbul, Turkey. The grand vizier Sokollu Mehmed Pasha and his wife İsmihan Sultan made this partnership. It was designed by the imperial architect Mimar Sinan and was completed in 1571/2. The mosque draws attention with its architecturally

challenging location on a steep slope. This problem was solved with two-storey courtyard mosque type. The sub-story was divided into shops, whose rents were intended to support the mosque's maintenance. The upper floor, with an open column courtyard, had a small window to store a bed that creates a living accommodation, a fireplace and spaces between the columns on three sides, each with closed walls to create small rooms, each with niche. The courtyard is the mosque itself, which is designed as a rectangular hexagon on top of a small semi-domed dome on the fourth side corners of the courtyard. The dome is **13 m.** in diameter and **22.8 m.** high.

**2. Baldachin /Pillar Carrier Type:** The central dome is carried by six pillars/baldachin system, which two pillars on north and two pillars on south walls, and one pillar on east wall and one pillar occupy on the west wall.

**3. Extension/Growth Type:** Central/main dome is supported by four half domes that signs vertical tessellation. In addition, the mosque has 2 story spatiality. As a result, we face with the most widen /expanded central space with six baldachin system type

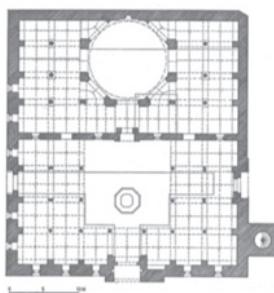
**4. Dome Space Patters:** '1whole dome+4\*0.5 domes' space pattern.

**5. Unit Type:** Eyvan mosque (multifunctional) with 2 storey plan and accommodates; prayer area, living spaces, shops.

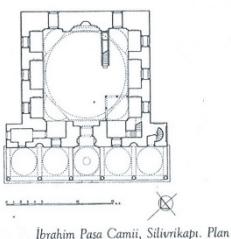
**6. Structure:** Mosque accommodates; 'a single-unit dome+4\*0.5 domes' pattern as upper structure and a square plan as under structure. It has cross axial symmetry.

**7. Spatiality:** Reflects a unique spatial design with ; '1whole dome+4\*0.5 domes+6 pillars'. (Table 5)

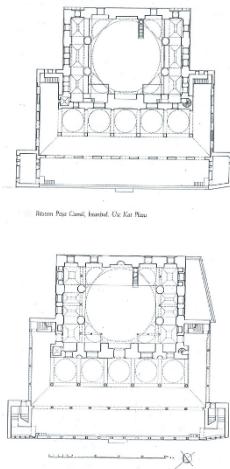
**4.3. Samples of Eight Pillars/Baldachin System of Sinan Mosques - 8 Baldachin (ana kubbesi dört destek üzerine oturan cami örnekleri)**



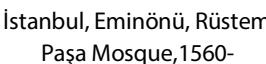
**Figure 20. Manisa Ulu Cami, Eight Baldachin System**

**Table 6. Eight baldachin dome-space-unit system mosques****1.ST EIGHT BALDACHIN SYSTEM**

Ibrahim Paşa Camii, Silivrikapı. Plan

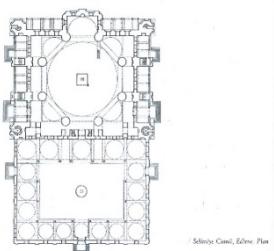
**2.ND EIGHT BALDACHIN SYSTEM**

Rüstem Paşa Camii, İstanbul, Üç. Kat Plan



İstanbul Silivrikapı, Hadım İbrahimpâşa Mosque, 1551, Architect Sinan

İstanbul, Eminönü, Rüstem Paşa Mosque, 1560-62, Architect Sinan

**3.RD EIGHT BALDACHIN SYSTEM**

Selimiye Camii, Edirne. Plan

Edirne, Selimiye Mosque, 1538-1588, Architect Sinan

**\*CASE NO 03\_1: İstanbul Silivrikapı Hadım İbrahim Paşa Mosque**

**1.General Information:** It was built by Hadım İbrahim Pasha in 1551 by Mimar Sinan. The minaret is adjacent. This place was actually built as a complex and the mosque has remained to the present day. In 2007, the mosque was repaired and maintained. It has 12.4 m. dome in diameter with 21.80 m. high.

**2.Baldachin /Pillar Carrier Type: Eight baldachin type;** the tromped dome which covers prayer area does not directly sit on the wall, it sits on eight wall pillars that exist two at each wall.

**3.Extension/Growth Type:** By this way, expansion of interior happens. This plan is the first type for eight pillar/baldachin systems, at Edirne Selimiye Mosque this type will reach its development process.

**4.Dome space pattern:** 1 whole dome of 8 pillars+ 4\*0.5 domes

**5.Unit Type:** It is an eyvan mosque (multifunctional) with a complex, madrasa and a bath.

**6. Structure:** Mosque accommodates; 'a single-unit dome+4\*0.5 domes' pattern as upper structure and a whole square plan as under structure. It has cross axial symmetry.

**7. Spatiality:** Reflects a unique spatial design with; '1whole dome+4\*0.5 domes+8 pillars'. (Table 6)

#### \*CASE NO 03\_2: İstanbul Eminönü, Rüstem Paşa Mosque

**1.General Information:** It was built by Mimar Sinan for Damat Rüstem Pasha, the Grand Vizier of Suleiman the Magnificent and also the husband of his daughter Mihrimah Sultan (1561). The mosque (Konyali) in 1562 is said to have finished the mosque. The mosque can be reached by stairs on both sides.

**2.Baldachin /Pillar Carrier Type:** The central dome sits on eight pillars/baldachin. Four of the pillars are filament-type colon, other four pillars are like wall column on north and south walls.

**3.Extension/Growth Type:** due to high density city area it was built as 'fevkani' which means that the mosque rises on vaults.

**4.Dome-space pattern:** 1 whole dome of 8 pillars+ 4\*0.5 domes

**5.Unit Type:** Its an eyvan mosque; there exists shops and cellar. One has to use staircases to reach the mosque and prayer area which is rectangular in shape and transverse.

**6. Structure:** Mosque accommodates; 'a single-unit dome+4\*0.5 domes' pattern as upper structure and a whole square plan as under structure. It has cross axial symmetry.

**7. Spatiality:** Reflects a unique spatial design with; '1whole dome+4\*0.5 domes+8 pillars'. (Table 6)

#### \*CASE NO 03\_3: Edirne Selimiye Mosque

**1.General Information:** It is not known exactly why the Sultan chose Edirne as the city where the mosque was built. Selimiye Mosque is covered with a single dome, 43.25 meters high, 31.3 meters in diameter. The dome is placed on a pulley based on 8 columns. The pulley is connected to the flaps with arches 6 meters wide. Mimar Sinan provides the space to be easily understood at once with the width and spaciousness he gives to the interior he covers.

**2.Baldachin /Pillar Carrier Type:** Mosque has a central dome prayer area with eight baldachin system, portico courtyard and four minarets. The total square meter of the mosque is 2475 m<sup>2</sup>, the prayer area is 45\*36m.=1629 m<sup>2</sup> , and the

court is 855m<sup>2</sup>. Equally 6000 people can occupy in the mosque, reflects Sinan's space integration and unification, as his master peace.

**3. Extension/Growth Type:** The pillars are two in each direction, at South its adjoined with mihrab wall, others are in front of the walls. Arched vaults have been fix between pillars. The main dome is supported by five half domes with semi-half domes at he corners. Mihrab part is flow outside 6mt., there is a majesty mahfel at upper floor north-east corner. At the centre there is müezzin mahfel with a fountain under. At the mosque, stone, tile, iron works and plaster ornamentals can be found in a balance.

**4. Dome space pattern:** 1 whole dome of 8 pillars+ 4\*0.5 domes

**5. Unit Type:** An eyvan mosque with a mosque + two education structure+ darülkurra + bazaar. It is in the UNESCO list and join the World cultural heritage at 2011.

**6. Structure:** Mosque accommodates; 'a single-unit dome+4\*0.5 domes' pattern as upper structure and a whole square plan as under structure. It has cross axial symmetry.

**7. Spatiality:** Reflects a unique spatial design with; '1whole dome+4\*0.5 domes+8 pillars'. (Table 6)

Main Findings of the analyses:

Through cases' analyses results its mainly found that ;

\*Each mosque has a unique dome-space and spatiality

\*Dome structure as an upper structure cover is a super flexible and harmonious element that can unify with its under structure as space plan.

\*By using diversity of a domes; big, small, half, whole...many different plan types can be produced, both square and rectangular forms can be passed and the most importantly both horizontal and vertical growth can be achieved without any rigid walls.

\*Dome space patterns have been revealed through the discourse of Kuran, as emphasized by Kuran (2013); 'The two groups as the single-unit and the multi-unit mosques have been called to date the '**one-domed**' and '**many-domes**' mosques. The term 'unit' to 'domed' because, although the hemispherical dome is the main feature of the Ottoman mosque, and indeed of all types of Ottoman buildings, it merely refers to the upper structure. The term 'unit' however describes the basic structural and spatial system of architecture, which in this case is square space defined by walls or four piers at the corners and covered by a dome" (Kuran A., 2013).

Thus, at the end of the analyses, '**dome system = space pattern**' have been revealed as indicated by table 7 above;

**Table 7. Dome-space patterns of the cases'**

Four Pillars/Baldachin System	Six Pillars/Baldachin System	Eight Pillars/Baldachin System
*CASE NO 01_1: II. Bayezit Mosque İstanbul-1501 / 1506 -Dome-space pattern: 1 whole dome + 2*0.5 domes system  *CASE NO 01_2: Fatih Mosque İstanbul-1766/1771 -Dome-space pattern: 1 whole dome + 1*0.5 dome system  *CASE NO 01_3: Mihrimah Sultan Mosque, İstanbul Üsküdar 1562-1565 -Dome-space pattern: 1 whole dome+ 3*0.5 domes+4 small domes system	*CASE NO 02_1: Sinan Paşa Mosque, İstanbul Üsküdar 1550-1553 -Dome-space pattern: 1 whole dome+4*0.5 domes  *CASE NO 02_2: İstanbul Topkapı Mosque, İstanbul , 1558 -Dome-space pattern: 1 whole dome+4*0.5 domes  *CASE NO 02_3: İstanbul Kadirga Sokullu /İsmihan Hatun Mosque 1571 -Dome Space Patters: '1whole dome+4*0.5 domes' space pattern.	*CASE NO 03_1: İstanbul Silivrikapı Hadim İbrahim Paşa Mosque -Dome space pattern: 1 whole dome of 8 pillars+ 4*0.5 domes  *CASE NO 03_2: İstanbul Eminönü, Rüstem Paşa Mosque -Dome-space pattern: 1 whole dome of 8 pillars+ 4*0.5 domes  *CASE NO 03_3: Edirne Selimiye Mosque/ -Dome space pattern: 1 whole dome of 8 pillars+ 4*0.5 domes

#### **4. CONCLUSIONS AND & FINDINGS**

Sinan had worked aesthetically on dome spaces aiming to exaggerate the main prayer area by using different shapes and proportions of the dome element. Here, the biggest contribution of Sinan was to make space growth vertically by the help of domes, half domes, triangles on a square plan. Thus it can be truly said that the artful contribution of Sinan was on the widening and unification of the main space, so as the motivation of mosque construction the unified space becomes the first requirement. '**Baldachin dome structure**' is an innovation that was developed by Sinan as upper structure respectively matches on the plan with square, hexagonal and octagonal schemes, which indicates the geometrical excellence had been achieved while widening the main central space as a result of space/structure integration.

Thus, Sinan first constructed mosques with single domes and square plans than after building several mosques with square and hexagonal plans he builds his masterpiece in Edirne with an octagonal scheme. He experienced baldachin structure in smaller scales finally in Selimiye, he finalized with a diameter almost equal to Hagia Sophia. Özgülş (2008). Thus, at each Sinan Sultan mosques,

respectively; Şehzade, Süleymaniye and Selimiye, the baldachin structure is placed closer to the outer boundary which in Selimiye the auxiliary spaces have been completely integrated. In addition, Sinan designed these baldachin structures in a transparent manner thus the auxiliary spaces integrated easily and space growth could be achieved. In addition, by the baldachin/pillar system device of Sinan and dome structures , its revealed by the study that dome element is unique by the way it creates patterns and diverse spatial solutions for diverse plan forms&types.

To sum up, in terms of space architecture, it's aimed that this study will shade a light for further studies on flexible open spaces and transparent spatial structures for future systems to emphasize widening, extending and timely growing of spaces in a flexible way without any construction requirements and rigid walls/carriers on floor plan that can create diverse space plan patterns within a flexible architecture.

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