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The Evolution of the Islamic Architectural Dome Feature

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The paper intends to provide a discussion on the changes and developments observed in the dome as an architectural feature in Islamic architecture. The findings will be based on several past literature analyses on the historical evolution of the dome until the modern era. The development of the dome in the early centuries followed developments in materials, building technology, elements, shapes, and several other aspects. The dome of Masjid Raja Haji Fi Sabilillah is a suitable representation of a functional modern dome. This dome was designed beyond expectations with high functionality and its ability to contribute to a building that has achieved a platinum level in green building certification proves how this dome is a representation of the future of the field as well. The dome study was carried out through site visits, a semi-structured interview with the project director, and analyzing past publications, which in conclusion proved that the dome at the mosque is a unique representation of the new potential of dome architecture.

Keywords: Dome, Evolution of the Dome, Islamic Dome Architecture, Sustainable

1. INTRODUCTION

Designed by ATSA architects, the Cyberjaya mosque was mainly inspired by the National Mosque in Kuala Lumpur. The design process of the mosque commenced in 2012 to facilitate Cyberjaya, the rapidly expanding city which is also celebrated as the Silicon Valley of Malaysia. The mosque was completed in 2015 as a space functioning more as a place of worship that could accommodate up to 8,300 people (Aziz, 2016). The mosque is designed with the ability to also host special sacrificial offerings during Aidul Adha celebrations and contains several office spaces and bazaars. The ground complex can possibly accommodate 800 people at a time for sports activities or similar activities (Saleh, 2017). On a site of 100 acres, the design follows the concept of portraying Islam as a progressive religion by marrying traditional mosque architecture with modern Malaysian mosque architecture. With the city expected to be a green city in the future, the mosque was based on sustainable principles (Aziz, 2016), which led the Raja Haji Fi Sabilillah Mosque to receive a Green Building Index (GBI) certificate with a platinum rating, becoming the first mosque in Malaysia to receive this certification (Yamin, 2021).

The mosque contains a number of innovative elements, out of which the dome

situated over the main prayer area can be identified as the most innovative feature (Aziz, 2016). The dome, standing as a unique element of Islamic architecture through innovative design, manages to participate in the building's sustainable features such as lighting and ventilating of the prayer area. Discovered in the fourth millennium, the dome was introduced as an architectural element by the Romans and the Byzantines. The domes took different forms when designers attempted to carry the structural load through this circular element (Sqour, 2016). These various forms continued to exist in most architectural fields, including Islamic architecture. The dome can certainly be identified as the most important element in Islamic architecture since the adoption of the dome in Islamic designs. The dome is a historical feature that carries the symbolism of Islamic architecture through different eras (Raghani, 2016). In the modern development of Islamic architecture, the elements are observed to be more functional and technically advanced.

The traditional shapes are overruled by contemporary architecture, where the domes can also be seen changing in appearance and developing in technical aspects while protecting the religious value and the religious architectural language (Hamouche, 2010). The remainder of this study is organized as follows. Following that, an overview of the history of dome architecture and its evolution is followed by a section on methodology. The findings are later presented and thoroughly discussed. The research is summed up with research implications and a conclusion.

2. LITERATURE

2.1 History of the Dome

The dome can be initially identified as an attempt to create long spans through unreinforced masonry. This method can be seen from around 1200 B.C. which was identified as sub-terranean domed tombs. However later about 2900 B.C. small corbelled domes have been discovered in pyramids built in the Fourth Egyptian Dynasty. The dome never played a vital role in Egyptian, Sumerian, Babylonian, Assyrian, or Greek architecture until the Romans made further developments in dome architecture. (Cowan, 1977). The "Temple of Mercury in Baiae" is known to contain the first large dome constructed by the Romans. They went further on to build marvellous domes similar to the one in the Pantheon. In the pantheon, the structure and the material use illustrate how the dome construction was improved by the Romans to become the most celebrated and fascinating element of the building (Youssef, 2014).

2.2 History of the Islamic Dome

The first-ever Islamic dome recorded in history is the Dome of the Rock, which was built by Abdul Malik bin Marwan. There are a few purposes identified behind the construction of the structure by him. It is said that he had a fear of Muslims being religiously influenced by previously built structures similar to churches, causing the design of the dome to be included, and the need to include the dome also represents a demand to promote Islam as the successor of Judaism and Christianity as well. The dome was identified as heaven and the connection to God (Eser, 2017). Following the dome of the Rock, Islamic architecture was further decorated by the dome.

The end of the seventh century proves how the dome had become an architectural symbol of religion. Arab Muslims were responsible for using local craftsmen in further developing the dome into several types, including figures such as waves, stars, zigzags, and other floral geometries with the use of materials such as stone, wood, and bricks. The overall shape of the domes was crafted into different shapes such as onion, pineapple, or semicircular shapes by the skilled workers (Youssef, 2014). Muslims received further compassion towards architectural development with the religion spreading throughout southern and western Asia. Including the decorative features of the previous centuries, Islamic architecture further decorated this region, expanding the boundary from the Mediterranean to the Indian Ocean. This wave of religion carried the architecture so that the dome dominated as the most prominent element (Goussous, Jawdat & Al-Azhari, 2011).

2.3 Importance of the Dome in Islamic Architecture

The dome was initially known for its ability to bring more ambiguity and charm to a structure by covering a wide span using a single element. It is a representation of greatness and holds the known state of being the king of all roofs in construction. Islam as a religion and Muslims, in

general, adapted this greatness in their designs. Domes were commonly used to decorate mosques, palaces, baths, mausoleums, and many other types of construction designed within the Islamic community. Even the most famous constructions in history, similar to the Taj Mahal built by the Mughal ruler, Shah Jahan, have the onion dome as the most superior feature (Elkhateeb, 2012).

In the religious aspect, the dome acts as an immediate shroud for the mosque from other influences, and it is also the symbol of a broad expanse of heaven for the Islamic community. Heaven was considered to be “an empty book where there are clear writings of stars; there are testimonies, everlasting, and uncreative Koran. "The very destiny is given as a lot” (Gachev 1995; Houssin & Zhmurko, 2015). Therefore, for the Islamic people, heaven was understandable and had a direct connection with the sky. The symbolic meaning of the dome creates a connection with heaven in the architecture. The dome, as written in his sacred writings by Prophet Muhammad, is “the leap into heaven”. The dome also functioned as a model for the flow of light, and in Islamic philosophy, light was the substance that molded images. The mosque is the place to pray and reach out to God, and it was also known to be open to the lights of heaven. (Houssin & Zhmurko, 2015)

2.4 Evolution of the dome

In the present, domes have taken on architectural meaning, and the details have evolved more towards practicality. The ancient domes, on the other hand, relied on empirical techniques and word of mouth passed through generations. During the sixth and seventh centuries AD, significant developments occurred in the mathematical and statistical aspects of civilizations. This led to the creation of more precise domes inspired by the traditional domes. Towards the 8th century, the dome developed into a stage where the details were given more attention and the smaller elements were considered the highlights of the feature. In the 18th century, developing countries adopted domes in their architecture as a prominent feature. The materials started to differ and new innovations were made in dome designs. The retranslations of domes later occurred during the 19th century when the industrial revolution assisted more innovative materials such as cast iron being produced for less cost, allowing more architectural flexibility, which led to more buildings, including large residences, adopting the dome as a feature. (Abraham, 2016).

Recently, the dome has developed into a lighter, more transparent element with further developments in construction technology and design. Contemporary domes follow specific criteria beyond using the dome as more than an illustration, as used in the previous design periods, considering its purpose, shape, dimensions, structure, material, lighting element, as well as the overall architectural language of the building. The Montreal dome in Quebec, Canada can be considered a representation of a modern dome. When analysed, there is a clear explanation of how the dome fits modern-day criteria to be more functional for the building, such as (Youssef, 2014),

- Purpose: Environmental and entertainment
- Shape: Spherical
- Span and height: 76 meters and 62 meters.
- Material and Structure: Steel truss of triangular and hexagonal units covered by acrylic cells
- Light: fully transparent and fully lit
- Concept: Creating a space with controlled temperature and climate

Figure 1: The Montreal Dome

2.5 Future of the Dome and design possibilities

Including a dome in a design has become common in the modern design of monumental buildings as well as residential buildings. The endless design possibilities received through including a dome in the design, making the space structurally independent of framing, has received more attention in the present as designers and users seek more open space plans in buildings. The construction methods have improved to the

point where a small labour force is able to assemble and complete a dome construction in very little time. The flexibility of the design of the dome has stretched to new levels (Abraham, 2016). Architects and engineers are moving towards the latest innovative type of dome, “Geodesic domes”. This method is to have a minimum architectural element that functions as a protection to anything beyond or beneath the domes. These are designed by connecting a number of single elements to create roofing for a large span. The discovery of the dome made in early centuries of civilization has developed into the latest geodesic domes, which highlight the possibilities of the design element, where currently the field of the built environment is developing wide spaces without structural disturbance in the interior. These will be brought out in the form of religious buildings, sports arenas, theaters, exhibition halls, etc., in the near future (Yusof et al., 2021).

3. METHODOLOGY

Several data collection approaches were used to determine the concept relating to the evolution of the Islamic architectural dome feature into a functional architectural feature. Observations of the site through site visits, a semi-structured interview with the mosque's project director, and an in-depth analysis of a literature review centred on the Dome in Masjid Raja Haji Fi Sabilillah, Cyberjaya, are among the methods incorporated into the study.

First, existing physical and intangible aspects of the dome will be explained and evaluated using a site visit observation approach in order to gain clarity on the various architectural details and features that were involved in the evolution of the dome from its historical state to its current state. The history of the dome, the history of the Islamic dome, the importance of the dome in Islamic architecture, the evolution of the dome, the future of the dome, and the physical and functional layout of the dome will be reviewed in depth through a literature review of previous publications on the subject of the mosque, Masjid Raja Haji Fi Sabilillah, where the dome is located, done by others (Youssef, 2014), (Goussous, Jawdat & Al-Azhari, 2011), (Abraham, 2016) to better understand the research and support the connection between the evolution of the dome. The semi-structured interview, the final approach for obtaining secondary data, was utilized to validate the findings from the research areas by interviewing the project director involved in the mosque's construction. These data collection methods were employed for this study since prior research articles based on building studies had used similar data collection methods. To reach a full knowledge of the research findings, a qualitative analysis is conducted in order to gain comprehensive information about the evolution of the dome, which serves as the study's foundation.

4. FINDING

The first impression is of a modern structure. The Masjid Raja Haji Fi Sabilillah appears to be more than a simple religious building. Being the second-largest mosque in Selangor, is erected on 17.5 acres as a part of the development of Islamic University Malaysia. It is able to portray a suitable impression of a city similar to Cyberjaya. Compared to any other Islamic religious building, the developers have worked around a dome element in Masjid Raja Haji Fi Sabilillah as well. Interviewee 01 further highlighted the above by mentioning:

“It is the most outstanding and most innovative feature included by the designers to the mosque” (Interviewee 01).

This particular dome follows the modern architectural language of the mosque. The element clearly does not follow the traditional design principles as the shape is significantly different from the commonly used segmental, hemispherical, or onion shapes. Functionality-wise, the dome contributes to the sustainable approach of the mosque by providing shade and also sourcing natural light into the main prayer area. Light will only pass through the double-glazed Low-E glass selected for the dome.

4.1 Natural Lighting

A typical building wastes roughly 30% of its energy by actively controlling the temperature through the building envelope (walls and ceiling). The low-E glass was offered as a viable solution for passive energy savings as technology improved. Insulated glass is used in Low-E windows to limit the amount of heat energy, or infrared radiation (IR), that passes through the window (Rissman & Kennan, 2013). Interviewee

01 further highlighted the Low-E glass use in the mosque as:

"The mosque dome is fitted with a double glazed Low-E glass, which is a composition of 6mm of transparent tempered glass on the outside, 12mm of Argon glass infill, and a 6mm thick solar shade on the inside" (Interviewee 01).

The glass is framed with an aluminium frame that is also removable. The frame is 50mm in thickness, and the openings can be shaded through additional retractable blinds to reduce the amount of sunlight entering the main prayer hall to manage a comfortable temperature inside.

Figures 2: Aluminium framed glass panels

4.2 Natural Ventilation

Adding to the natural light, the dome also contributes to managing the ventilation of the main prayer area and the entire mosque as a whole. The center of the dome is equipped with a ventilator fan from the brand "Big Ass Fans." The large spanning fan can assist the wind flow through the building to move out from the top of the dome, making the airflow cool down the main prayer area. The air conditioning system is expected to be used only during prayer hours as the fan-powered dome is able to keep the main prayer area at a comfortable temperature. This method also contributes to the sustainable approach of the building by reducing the energy used to operate the large air conditioning system. Interviewee 1 further mentioned that:

"The fan-assisted cooling is able to maintain a temperature of 26 degrees Celsius without the air conditioning system." (Interviewee 01)

The dome is designed in a way that the fan is hidden away when viewed from the prayer area as an Islamic geometric pattern has been used below the fan installation, maintaining the architectural language of the dome while reducing the sounds of the fan traveling to the prayer area.

Figure 3: Big Ass Fan

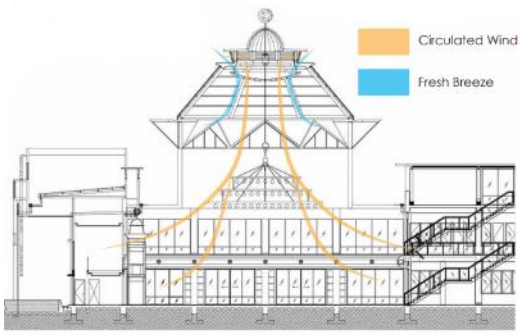

Figure 4: Wind circulation section of the main prayer area

4.3 Artificial Lighting

When artificial lighting is turned on the dome brings out a magnificent appearance towards the main prayer area which can contribute to the prayers psychologically. The lighting is fully

equipped with LED lights, which contribute to energy-saving by cutting down the consumption by 75% compared to traditional incandescent light bulbs. The traditional bulbs also release 90% of the energy as heat which is saved when using LED lights. LED lights are known to last 8 to 25 times longer than traditional bulbs (Zeb et al., 2016). This method has also contributed to the mosque maintaining its energy level at a level to receive the green building certification.

Figure 5: LED Lighting of the Dome

4.4 Patterns and Colours

The appearance of the dome has been enhanced with a geometric pattern. According to Interviewee 1:

"The pattern does not carry any religious message or meaning. However, the shapes have been inspired by basic Islamic patterns." (Interviewee 01)

The pattern contributes by contrasting the modern shape of the dome and also by decorating the natural light falling on the main prayer area during the daytime. The panel is a polyurethane panel that also functions as a sunshade. The colour green has been highlighted around the dome to represent Islam. The lowest level of the dome is decorated with religious wording on a green background. The top of the dome holds the Islamic symbol of the star and the crescent, made out of brass.

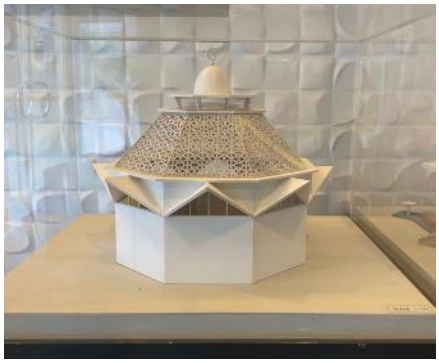

Figure 6: Dome 3D model by the architects

The calligraphy at the base of the dome has been identified as,

- Phrase: Al-Zalzalah
- Style of Script: Thuluth
- Composition: Rotary linear

These phrases have been included around the dome as well as throughout the mosque in order to spread the message of Islam to both Muslim and non-Muslim visitors by displaying the greatness of God and reminding them of their responsibilities as Muslims. (Kamarudin et al., 2020). The dome, decorating the main prayer area, can be concluded as the most highlighted and celebrated feature of Masjid Raja Haji Fi Sabilillah. As highlighted above, the modern contemporary design followed in the mosque has been implemented successfully on the dome design as well. The designers have been completely conscious of carrying Islamic values through the patterns and colours included in the dome as well. Overall, it is proven to be more than a symbol by actively contributing to the functionality of the building through temperature control, lighting, ventilation, etc. securing the sustainable levels achieved by the design to be celebrated as the first and most sustainable mosque in the area.

5. DISCUSSION

This section of the article will further clarify the evolution of the Islamic architectural dome feature into a functional architectural feature based on the Dome in Masjid Raja Haji Fi Sabilillah by incorporating the findings gained through the above-mentioned methods with the past publications reviewed in the literature review.

5.1 Influence of Islam remains on the dome

Since the introduction of the dome in Islamic architecture by Abdul Malik bin Marwan as a symbol of religion, the dome has been the primary architectural element of the mosques designed. With the support of improving skills in craftsmen, the early eras developed the domes into different shapes, including different elements and designing various dome elements for different buildings (Youssef, 2014). However, the dome still remained the primary feature of mosques, symbolizing the connection to God as "the leap to heaven" (Houssin & Zhmurko, 2015). The dome feature in Masjid Raja Haji Fi Sabilillah is also raised above the primary space of the mosque; the main prayer area where the prime functionality of the mosque is carried out. The prayers entering the main prayer hall will always be captivated by the grand dome feature carrying the great meaning and messages of Islam. The calligraphy (Kamarudin et al., 2020). and the use of colours to decorate the mosque demonstrates the use of the dome as an effective religious feature, similar to the main purpose for which it was introduced in Islamic architecture in the 7th century.

5.2 Evolution of the dome into a more functional feature

The dome was introduced and mostly used as a representation of superiority in decorating more celebrated buildings similar to the Taj Mahal (Elkhateeb, 2012). The study demonstrates how the dome has many stages to arrive at a more functional stage in addition to the symbolic value it carries. Dome design has drastically improved with the developments in the mathematical sector and building technological sectors. The shapes and the functionalities of domes were changing with the development of civilizations. Different materials were introduced and the domes were finished in contrasting shapes compared to the traditional shapes. The flexibility of the design is improving (Abraham, 2016), and the dome in Masjid Raja Haji Fi Sabilillah proves the new territory the dome design has reached. Compared to the traditional shapes used in domes, such as the onion, pineapple, or semicircular (Youssef, 2014), the dome follows a modern shape, contrasting with the overall concept of the mosque.

The elements containing sharp edges and a collection of small elements present the developments in design and the more minimalist approach followed in the modern era. The materials used are primarily aluminium and glass, demonstrating the adjustments made to material use towards dome structures by architects and engineers of the 21st century. Analysing the publication on the mosque project by the architects and the interview proceedings highlighted the modern technological building construction tools used during the construction process of the dome (Aziz, 2016).

Figure 7: Placement of the dome structure using a mobile crane

The dome in Masjid Raja Haji Fi Sabilillah brings further functionality and contribution to sustainability management in a building, achieving a platinum level in the green building index as well. This ability of the dome can be highlighted as further development made in the field of a religious architectural feature into functionality. The use of natural lighting controls through the use of geometrical patterns and the use of Low-E glass has contributed to the prayer area maintaining a comfortable temperature with very low energy use. The additional retractable blinds also add to the attention given to the functionality of the dome in the mosque.

Beyond natural lighting and temperature management through openings, the dome center is equipped with a unique ventilation fan that is able to assist the wind flow through the building through the dome, cooling the main prayer area and the building as a whole. As mentioned by interviewee 1, and seconded by visiting the site several times, the prayer area and the surrounding areas were able to maintain a temperature of 26 degrees Celsius at times when the air conditioning was turned off. With time, this symbolic architectural element has entered a functional track and the dome in Masjid Raja Haji Fi Sabilillah can be considered a representation of further developments in the domes expected in the future. Domes have evolved to follow broader

criteria compared to the reason domes were introduced in ancient times, and the dome in Masjid Raja Haji Fi Sabilillah fulfils the criteria following the concept of modern design, equipped with the latest sustainable materials and features representing the latest era of the religious architectural feature.

6. CONCLUSION

In essence, to conclude this study, the context proves how an innovative architectural feature used in the past to cover a large span of space evolved into a symbol of majesty and greatness later adopted by religions such as Islam, blending in as a representation of the religion itself. Decorating religious buildings over centuries has now entered into the developments in functionality and modernization of the current era. The dome in Masjid Raja Haji Fi Sabilillah takes the developments further to contribute toward a building managing a platinum level in the green building index. The dome gracefully fills the atmosphere with a religious ambiance similar to the ancient domes used since the dome of the rock was introduced to Islamic architecture. It is currently able to control the temperature of the building while actively managing ventilation, lighting, and overall material use, which is a reflection of the development in the field of dome architecture. Initially, a symbol, currently a functional feature satisfying the religious needs as well proves the high potential in dome designs, and the dome in Masjid Raja Haji Fi Sabilillah is a perfect representation of it.

7. REFERENCES

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FIGURE REFERENCE

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Figure 2: Lasindu Gamage (2022) Captured during the site visit.

Figure 3: Lasindu Gamage (2022) Modeled on Sketchup 3D.

Figure 4: Brite, J. (2010). Big Ass Fan. https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.architectmagazine.com%2Ftechnology%2Fproducts%2Fbig-ass-fans-isis_o&psig=AOvVaw1Wqsm_Wa1rfpDcdejut9Aq&ust=1653364081989000&source=images&cd=vfe&ved=0CAwQjRxqFwoTCMj79dPc9PcCFQAAAAAdAAAAABAD

Figure 5: Lasindu Gamage (2022) CAD Drawing

Figure 6: Brite, J. (2010). Big Ass Fan.https://www.google.com/url?sa=i&url=https%3A%2F%2Fwww.architectmagazine.com%2Ftechnology%2Fproducts%2Fbig-ass-fans-isis_o&psig=AOvVaw1Wqsm_Wa1rfpDcdejut9Aq&ust=1653364081989000&source=images&cd=vfe&ved=0CAwQjRxqFwoTCMj79dPc9PcCFQAAAAAdAAAAABAD

Figure 7: Lasindu Gamage (2022) Captured at ATSA architect office, Kuala Lumpur.

Figure 8: Placement of the dome structure using a mobile crane Aziz, A. (2016). Placement of the dome structure using a mobile crane [Architectural Publication].