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## Defining Issue of Thermal Comfort Control through Urban Mosque Façade Design

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### Abstract

Urban mosques should be provided with an acceptable thermal comfort for worshippers to feel comfortable and relaxed to attain a feeling of tranquility, peace and serenity. This paper aim is to define the issues related to thermal comfort control through urban mosque facade design to achieve the quality of life. The methodology for the study is an analytical review to define theoretical framework related to the key areas. The results indicated that healthy indoor living, quality of life in the urban environment, energy consumption and implementation of passive design strategies are the issues governing thermal comfort through the design of facade for urban mosque.

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*Keywords:* Façade design; thermal comfort; urban mosque

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### 1. Introduction

The prominence of the masjid (mosque in English) for the Muslim community in Malaysia calls for the provision of thermally comfortable environment for worshippers using the building. A. Hussin et al. (2014) identified that inappropriate thermal comfort in mosques leads to the unsuitable thermal environment for the worshippers and the

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functions held inside the buildings. Abdou et al. (2002) and Ibrahim et al. (2014) also stated that prayers in mosques need to feel comfortable and relaxed to attain a feeling of tranquility, peace and serenity. Hence, providing cooling and thermal comfort to the worshippers by installing air conditioning (A/C) system in mosques in Malaysia has become common practice. The trend of using air conditioning will increase the electricity consumption that leads to the increase in carbon emission. Thus, thermal comfort should be investigated thoroughly to reduce energy requirements in mosques.

Mosque is an important building typology for Muslim; as a place for worshipping and multi-functional community space that involve occupancy. This building typology develops and evolves rapidly to meet the needs of the users and community. As part of the religious institution in Malaysia, the mosques that are located in urban areas act as landmarks and focal points for the public activities (Nizarudin, 2014). The mosques in the urban area that provide a thermally comfortable space for worshippers is vital to comply with urban environment conditions. Moreover, Ibrahim et al. (2014) also claimed that thermal comfort consideration is very important in most buildings involving people occupancy. Besides, a thermally comfortable indoor condition is essential for a healthy indoor living environment and quality of life in the urban environment (Jamaludin et al., 2015). Hence, this paper will address the issues related to thermal comfort control in urban mosques in Malaysia and determine issues related to the urban mosque, façade design, and thermal comfort and to analyse relationship between urban mosque, facade design and thermal comfort with quality of life (QoL).

Buildings in Malaysia received more heat due its location that is near the equator. The researchers identified that heat surplus cause's discomfort to the occupants in the tropical climate because of higher solar and terrestrial radiations reaching the building envelopes. This finding shows that building envelopes play the important role in giving comfort to the occupants. Liping and Hien (2006) also agreed that the impact of building envelope designs is significant on the indoor thermal environment, especially for naturally ventilated buildings. Nevertheless, Ghaffarian et al. (2012) defined that one of the main constitutes of building envelope is facade that acts as a boundary between external and internal environments. The facade considerably impacts the environmental conditions of indoor spaces, the thermal performance of buildings and subsequently the user's satisfaction. Therefore, the building facade designs should respond the local climate to improve thermal comfort conditions, taking urban mosque as a typology for case study to investigate thermal comfort.

## 2. Literature review

### 2.1. Understanding urban mosques in urban environment: Malaysian context

*“Urban Masjid or Urban Mosque refers to the representative religious edifice constructed by Muslims who reside primarily within urban locales in the western countries; often described as an Islamic centre (markaz), it is where the faithful gather to engage in communal worship, spiritual retreat, matrimony, education, and other significant socio-cultural activities”*

(Kahera et al., 2009)

The definition by Kahera is presented in figure 1 which reflects to the western environment. Hence, to adopt the given definition by Kahera et al. (2009), the attributes for urban mosque for Malaysian context is analysed as figure 2. The functional attributes of urban mosques are very important in sustaining an Islamic quality of lifestyle in urban environment.

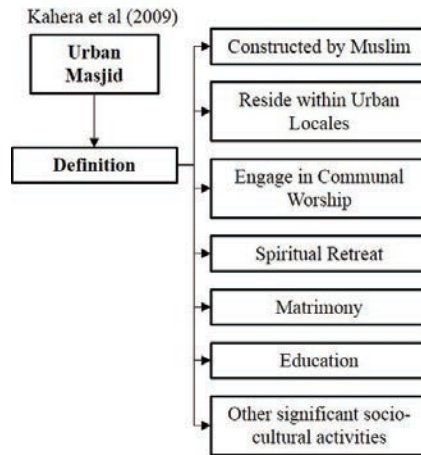


Fig. 1. Definition of urban mosque (Source: Kahera et al., 2009).

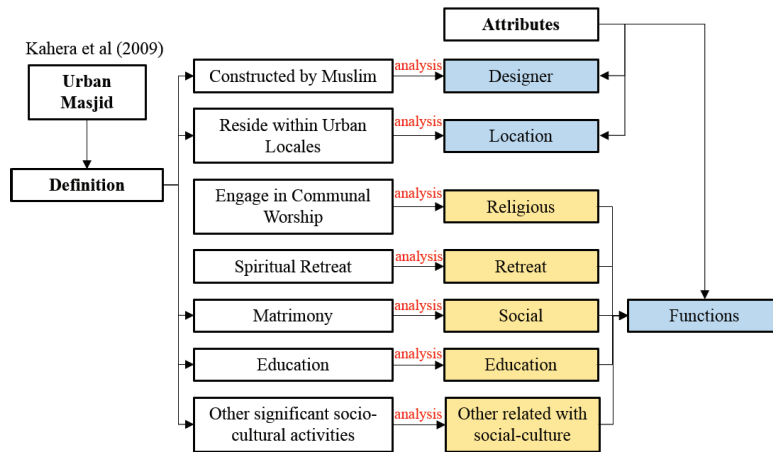


Fig. 2. Attributes of urban mosque in Malaysia context

Besides of the mentioned attributes in figure 2, the mosque should be able to establish the value of human spirituality (Dewiyanti & Kusuma, 2012). Urban mosque should also value this human spirituality as one of its attributes. The urban mosque spiritual attributes promote the religious value that is Islamic lifestyle in the urban environment. The urbanites should balance the physical satisfaction with the spiritual satisfaction while living their life in urban. This balance can be achieved through developing visible urban mosques in the urban area. The physical built of the urban mosque in the urban area, direct and indirectly will provide response towards Muslim urbanites lifestyle and also non-Muslim urbanites. Dewiyanti and Kesuma (2012) also suggest that the increasing of spirituality influence; (1) self-confidence, believe in life/future, peace of mind, harmony or self-consistency, and self-understanding (2) harmony with nature, willingness to walk from home heading to the mosque (3) harmony with others, willingness to help (4) improved relationship with God in one’s own way. All the influences lead to the standard quality of life for Muslim urbanites. However, spiritual attributes for urban mosques should be studied and carried out in order to achieve more satisfactory results.

## 2.2. Design functionality: Facade design as a passive design

Building facade does not only give aesthetics and visual comfort to the people, but it should more than that. Askari and Dola (2009) stated that “facade is the first and most impacting connection between humans and the built environment, the outer shell of a building is not only a reflection of the architectural character of a region but also a representation of local cultural, social, climatic, political and economic circumstances”. Moreover, the design of the facade has enormous significance for both indoor climate and energy consumption, as there are many energies flows both ways over this boundary between the external and internal environments (Johnsen and Winther, 2015). In regards to urban mosque facade design, the facade is one of building envelope that play important functions to connect humans and the built environment and external and internal environment in urban context (Askari and Dola, 2009 and Johnsen and Winther, 2015). Thus, providing a functional design for urban mosque façade design will be beneficial to the functional attributes of urban mosque in Malaysia context.

Figure 3 shows samples of different facade designs the urban mosque façade design in Malaysia. The facades have the impact on both visual comfort and thermal comfort. Facade design implementation may differ due to factors of environment, social and culture, designer’s concepts, political view, economic, historical value and etc. the figure above shows some differentiate of façade design in urban mosques in Kuala Lumpur. These facades will analyze accordingly to the façade design parameter (figure 4). Then, the field measurement for thermal comfort will do later to investigate thermal comfort for each mosque. These two study areas (façade design and thermal comfort) will analyze the relationship in identifying which the façade design is the most suitable in giving comfort to the occupants.

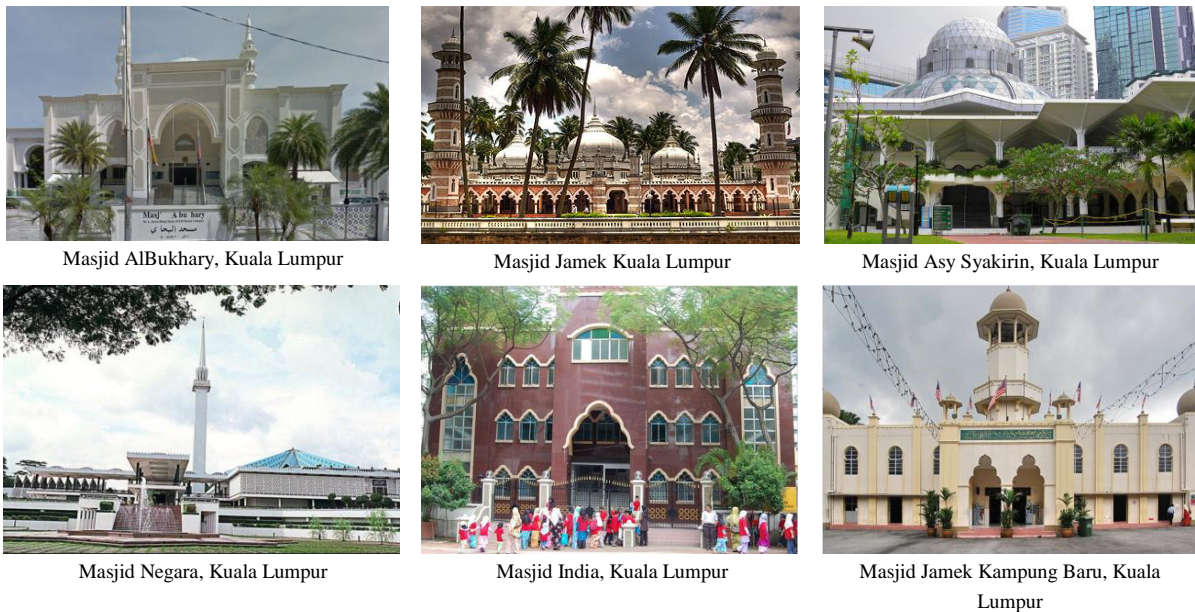


Fig. 3. Example of urban mosque façade design

The facade should be designed efficiently by complimenting the environmental context. Abdel-Aziz and Shuqair (2014) also stated that one of the factors that impact facade design is responsive environmental parameters. The parameters are orientations, voids and windows openings, vertical and horizontal shading devices, building materials and colors. Some facade design parameters compliment the design strategies of passive design, which are responsive towards providing thermal comfort to the building occupants such as opening parameter that allows air to ventilate into the indoor environment, building orientation and shading device (figure 4).

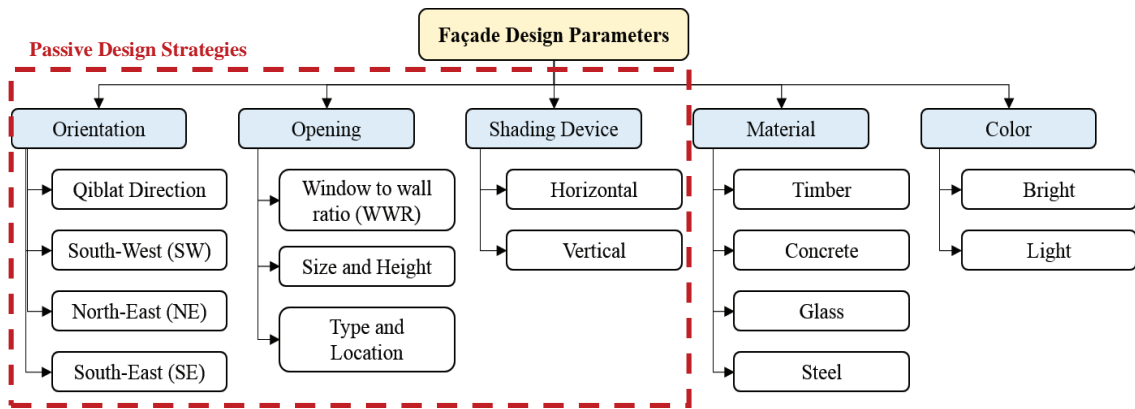


Fig. 4. Façade design parameters

Since the facade plays the significant role for the energy consumption of the building, a major challenge is to design the facade for minimum energy demand for heating, cooling, ventilation, and lighting through maximum exploitation of the natural energy flows offered by the external climate (Johnsen and Winther, 2015). With the concern of energy consumption, it is important to design facade of urban mosque that meets the demand of natural ventilation (Baharudin & Ismail, 2014) and effective shading without depending too much on the mechanical system. Baharudin and Ismail (2014) also highlighted the facade that allow natural lighting and ventilation into the building interior will minimize the usage of energy thus reduce the cost of mechanical maintenance. In addition, many studies have shown decreasing operating costs, improvement in thermal comfort and indoor air quality, to be some of the benefits of the application of natural ventilation in buildings. Hence, it is important for facade design of urban mosques to design passively in reducing energy consumption.

2.3. Thermal comfort control

Thermal Comfort is vital in providing the healthy indoor living, quality of life in the urban environment and reducing energy consumption. Thermal comfort is a condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation (ASHRAE Standard 55, 2010). Six primary factors must be addressed when defining conditions for thermal comfort. These six factors will divide into two categories; (1) environmental parameters and (2) personal parameters.

Offering an acceptable thermal comfort in urban mosques is very significant because urban mosque is not only a congregational place for worship but also a place for urban social-culture gatherings such as providing accommodation (retreat), welfare, education and other social cultural activities. This multi-functional spaces needs energy demands in cooling down the building when the space is accommodated for that functional activities. Al-Homoud et al. (2009) agreed that thermal considerations are vital in most buildings involving people occupancy.

Thermal comfort is significant to determine the quality of the indoor environment in urban mosque. The indoor thermal environment should be designed to increase human productivity and performance. A quality indoor environment of urban mosque can increase people occupancy and level of concentration. Dewiyanti and Kesuma (2012) claimed that the factors that influenced the level of concentration in mosques are; (1) room temperature (2) air circulation (3) continuity of view both inside and outside the main hall, and (4) lighting quality, for the assurance of thermal and visual comfort of the main hall. An ideal room temperature is persons prefer where it is neither warmer nor cooler temperature ((Nasir et al., 2013). However, there is lack study on effect of thermal comfort in determining the quality of an indoor space of urban mosque. Hence, the comfort condition should be thoroughly studied to determine factors of thermal comfort in urban mosque that affect people occupancy and level of concentration.

The increased demand for cooling through the use of the mechanical system such as air conditioning to provide comfort would also mean increased energy usage and electricity cost. In hot and humid climatic regions such as Malaysia, some mosques are mechanically air-conditioned to achieve the required thermal comfort for the occupants. Besides, mosques are characterized by having a unique operation schedule as compared to other types of buildings (Abdou et al., 2005). Mosques are commonly used five times per day and Friday prayer to perform congregational prayers and seasonal occupancy for others activities. This occupancy of worshippers during intermittent operation schedule require energy usage for air conditioning, which is installed at the main praying hall and natural ventilation for extended prayer hall for cooling demand (figure 5). However, the increasing trend of air conditioning use in Malaysian mosques is apparently increasing electricity consumptions in the daily mosques operations. Nevertheless, the study relates to the energy consumption of urban mosque is insufficient even though many studies have been conducted on energy conservation in other types of buildings (Abdou et al., 2005).

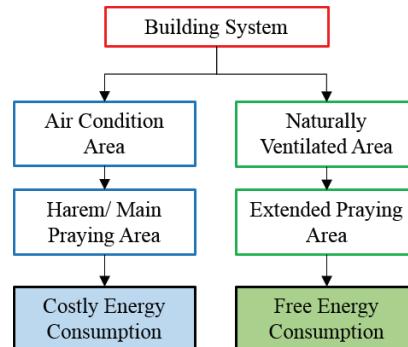


Fig. 5. Building system in urban mosque

### 3. Research methodology

The method used for this paper is analytical review from various fields to idealized and analyzed with the topic of urban mosque, façade design and thermal comfort. The review of the literature aims to provide an overview of key areas; urban mosque, façade design and thermal comfort and analyze the relationships of the three key areas with the quality of life (QoL). This analysis is very important for ongoing research in determining the variable involve for façade design survey checklist and method going to use for thermal comfort. Through this analysis, the issues related to the study have been defined.

### 4. Findings

#### 4.1. Relationship between urban mosque, façade design and thermal comfort with the quality of life (QoL).

As communities and local governments have become increasingly concerned with quality-of life issues, community indicators have become a widely used tool to measure the quality of life and the progress that is being made towards improving it (Mostafa, 2012). The quality of life (QoL) is the standard of health, comfort, and happiness experienced by an individual or group (Oxford Dictionary, n.d.). The standard may vary with different context and condition. QoL is certainly a multi-faceted concept that is frequently used in the media and by politicians but defies precise definition (Marans, 2011). It is difficult to define clearly the quality of life for the architecture conditions where people satisfaction in life defer each other. Mohit (2013) defined QoL as a multi-aspect criterion that related to living satisfaction, need satisfaction and happiness. Decreasing QoL within urban built environment affects the level of people attendance and caused interaction deficiency (Ghasemi et al., 2015). Hitam and Borhan (2012) and Kamaruddin et al. (2013) also supported that the deterioration of the quality of environments has the direct influence on human's QoL or even on threatening the survival of humankind. However, there is the

lack of studies in the literature of QoL that focused on branches of the environment such as architecture that relates to the urban mosque. Therefore, QoL factor for the mosque in the urban environment is recommended to increase levels of worshippers' attendance.

Table 1 below shows standards for quality of life through three key areas of studies; urban mosque, façade design and thermal comfort. The key areas of façade design and thermal comfort are related with each other in improving the quality of life in urban mosque. However, the recommendation of the indicators need to study more.

Table 1 Indicator for three key areas; urban mosque, facade design and thermal comfort in improving QoL

Quality of Life (QoL) Standards	Indicator/ Life Satisfaction
Urban mosque, UM	Condition in urban mosque environment: 1.Physical condition: Good/Bad 2.Functional spaces: Function/Not function 3.Spiritual condition: Religious value & concentration level 4.Social relationship: Unite/ Disunite
Façade Design, FD	Design parameters; 1.Thermal Comfort 2.Aural Comfort 3.Air Quality 4.Visual Comfort
Thermal Comfort, TC	Health condition Economical value-decrease energy consumption Productivity Level Absenteeism: Less or more occupancy

At the end of this paper, a diagram is derived to indicate the relationship between the three key areas. Since urban mosque is an occupancy type building, building elements such as the building facade may have a direct effect on the mosque's occupancy. A good facade design for urban mosques can be solved through implementation of the passive design that in turn resulted in acceptable thermal comfort level to the indoor environment. Hence, the facade design with considerations on the passive design will determine the energy consumption in the urban mosques. The mentioned factors will lead to the attainment of QoL and reduction of the energy consumption and cost operation (figure 6). Thus, the issues of this paper, implementation of passive design through facade design, energy consumptions, and QoL are defined.

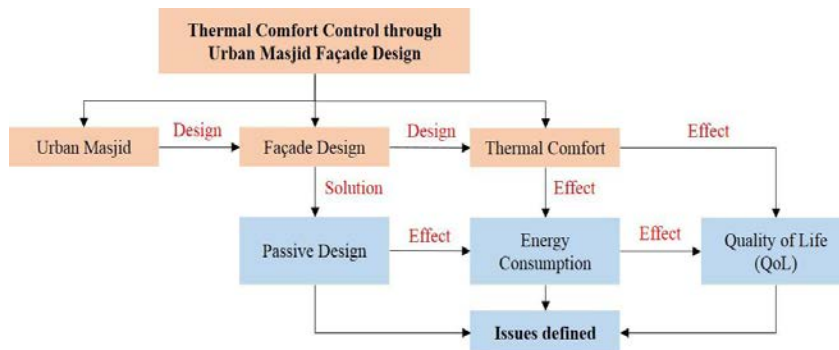


Fig. 6. Issues of thermal comfort control through urban mosque façade designs

### 5. Conclusion

In conclusion, this paper outlined the conceptual theoretical framework of the research and reviewed the issues related to thermal comfort control through urban mosque facade design. The matters relating to the key areas; urban

mosque, facade design and thermal comfort expressed the quality of life in the urban environment, energy consumption and implementation of passive design strategies. Nevertheless, the paper determined that urban mosque facade design is related to passive design that provide thermal comfort to the occupants. At the same time, facade design affects the energy consumption that leads to the quality of life in the urban mosque. Further investigation will be conducted to test the relationship of facade design of urban mosque to thermal comfort. It is hoped that the results will provide significant contribution and new knowledge to the development of Mosque in providing comfort for the worshippers.

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