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THE LOCATIONAL MEASURE IN THE PLANNING OF QARIAH MOSQUES

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Abstract

Public facilities are vital to contributing positively to people's quality of life. Facilities play an important role in cities by providing public services to communities. Therefore, planning equitable public facilities is crucial for planners to ensure that every citizen has equal access to the planned public facilities. Scholars have conducted various studies to assess the location and distribution of public facilities. Spatial equity is one aspect of locational measures used by scholars to determine the accessibility and spatial distribution of facilities in relation to the user's location. Previous studies by researchers have focused on public facilities such as medical facilities, parks, and schools. However, there have been limited studies that evaluate the spatial equity of religious facilities such as mosques. Therefore, this study attempts to assess the location of qariah mosques (mosques of local jurisdiction) based on the spatial equity concept by measuring their spatial distribution and accessibility. The present study utilised a Geographical Information System (GIS) and used descriptive and statistical analyses to examine the spatial equity of 418 mosques in Selangor Darul Ehsan, Malaysia. GIS data was collected for this study, which includes mosques, populations, and mukim (township or sub-district) boundaries. The study used aggregated data from the population to identify the spatial pattern and spatial distribution of accessibility to mosques. The data was analysed using the container index and local indicators of spatial association (LISA) to assess the accessibility and spatial equity. This method utilised GIS capabilities to explore the spatial relationship between mosques and population characteristics. By adopting this approach, the findings of the study will reveal communities with limited accessibility to mosques.

***Keywords**:* Spatial equity, imarah, mosque planning, GIS

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INTRODUCTION

Public facilities are services provided by the local authorities to their people, and they are important amenities in the urban fabric that contribute positively to the quality of life. Public facilities are provided to the community to offer services such as in the fields of health, education, religion, safety, and recreation. It is therefore of paramount importance that these facilities are planned efficiently and effectively to ensure that they provide benefits to the people. In Peninsular Malaysia, public facilities are provided based on the Planning Standards for Public Facilities developed by PLANMalaysia. Planning of public facilities involves two main components: the public facilities and the user. As a result, any planned public facilities should take into account the existing supply and distribution of public facilities as well as user or community demand. This is to ensure that any spatial mismatch between the distribution of people and public facilities is minimised.

Overall, studies by researchers on the aspects of public facility location have focused on the realm of spatial equity in the distribution of public facilities (Talen & Anselin, 1998; Tomic et al., 2004; Chang & Liao, 2011; Dadashpoor et al., 2016). Spatial equity is used to assess whether people have equal access to public facilities. The question of fairness in the distribution of public facilities remains a matter of debate among researchers and planners. Researchers have conducted several studies in the past on the issue of spatial equity in medical facilities (Taket, 1989; Rosero-Bixby, 2004; Roeger et al., 2010), school facilities (Talen, 2001; Singleton et al., 2011), and recreational park facilities (Talen & Anselin, 1998; Nicholls, 2001; Chang & Liao, 2011).

However, there has been a limited amount of research that has investigated the spatial equity of mosques. A mosque is an important institution in Muslim society and has an important function in the Muslim community as a place for religious activities, educational activities, shelter, and community centre (H. Alami, 2012; S. Omer, 2010; H. Mahamid, 2009; H. Mortada, 2003; T. Rasdi, 1998). It is critical that the spatial distribution of mosques be planned effectively to ensure that people have equal access to the mosques. Despite the fact that it is well-known that a mosque is an important public facility in a mostly Muslim nation, research on the spatial distribution of mosques is limited.

Therefore, the objective of this study is to evaluate the spatial pattern and spatial distribution of mosque accessibility. The state of Selangor was chosen as the case study because it has a population of 6.5 million people, of which 59% are Muslims. The state holds 418 mosques spread throughout nine districts, making it an ideal case study for evaluating the spatial equity and accessibility of mosques.

There are several approaches to exploring the spatial relationship between mosques and population characteristics. This study analyses data using a Geographical Information System (GIS) and local indicators of spatial association (LISA) to measure the spatial equity and accessibility of mosques. This study only focuses on identifying the spatial relationship between mosques and the population characteristics by using total population data by ethnic group and excluding socio-economic data from the analysis. By adopting this approach, the findings of the study will uncover the communities with inadequate access to mosques. The results will shed light on the spatial equity of mosques, aiding planners and policymakers in their decision making.

LITERATURE REVIEW

The issue of equity disparities in the distribution of public facilities has been a topic of interest to scholars. Equity in public facility planning can be described as each citizen having equal access or proximity to the public facilities. Early studies by scholars in the context of equity have focused on determining the definition of equity and the factors causing inequality in the distribution of public facilities.

Many scholars have conducted studies with regard to the spatial equity of public facilities (Talen & Anselin, 1998; Tomic et al., 2004; Chang & Liao, 2011; Dadashpoor et al., 2016). Most of the studies focus on public facilities such as schools, recreational parks, and medical facilities. However, there are limited studies focusing on the spatial equity of mosques. A mosque is an important institution in the Muslim community, serving as a place for religious activities, education, shelter, and community centre (H. Alami, 2012; S. Omer, 2010; H. Mahamid, 2009; H. Mortada, 2003; T. Rasdi, 1998).

In Selangor, the planning of mosques is based on the Planning Guidelines for the Provision of Mosques and *Suraus* (smaller premises for prayers). The planning guidelines for mosques have classified the hierarchy of mosques into 3 categories: State Mosque, District Mosque, and Local Mosque (Jabatan Perancangan Bandar dan Desa Negeri Selangor, 2010). Although there are existing planning standards on mosque planning, it is also important to understand the planning of mosques from the Islamic perspective.

The planning of mosques from an Islamic perspective is derived mainly from two main sources: the Quran and Hadith. Although there are 1006 occurrences of a mosque being mentioned in the Quran, none of the Quranic verses mention anything about the criteria of mosque planning standards. It is also worth highlighting that there is no direct mention of mosque planning standards and locational aspects in the hadith. However, certain requirements of a mosque can be implied indirectly from the hadith. Based on the hadith, it can be interpreted that mosques in the early period of Islam were located within walking distance of populated areas and commercial areas. Ibn Umm Maktum also clearly stated the obligation to perform prayers at the mosque (Hadith 792). Therefore, it is suggested that current planning approaches should take into consideration the locational aspects when siting a mosque. This is due to the fact that Muslims, especially males, are obligated to perform congregational prayers in mosques.

This study focuses on assessing the spatial equity of *qariah* mosques in Selangor. According to the Planning Guidelines for the Provision of Mosques and *Suraus*, *qariah* mosques (mosques of local jurisdiction) should be provided for every 20,000 people. Therefore, this standard was used in the analysis to evaluate the ratio of each mosque per population for each *mukim* (township or sub-district) level. Several methodologies have been suggested by scholars through empirical studies to assess the extent of equitability in the distribution of public facilities. One of the approaches is to measure the accessibility of public facilities to their point of origin, such as a neighbourhood unit or geographic boundary (Talen and Anselin, 1998). The other approach is to use the Local Indicators of Spatial Association (LISA) to visualise and illustrate the spatial pattern of the phenomenon (Anselin, 1995). Both of these approaches have their advantages and can be combined to assess the spatial pattern and accessibility of local mosques. The LISA method proposed by Anselin (1995) has "a useful purpose in an exploratory analysis of spatial data, potentially indicating local spatial clusters and detecting outliers." Therefore, LISA is suitable to be applied to assess the spatial pattern of the local mosques.

In the context of accessibility, there are several methods of measuring accessibility and quantifying access that can be adopted. One of the most frequently cited methods of measuring accessibility is by Talen and Anselin (1998). The method by Talen and Anselin (1998) has been adopted in many studies, such as Mobley, L. R., et al. (2006); Xiao, Y., Wang, Z., Li, Z., & Tang, Z. (2017); and Anselin, L., & Li, X. (2019). It shows that the method for measuring accessibility is still widely accepted by scholars. Accessibility can be assessed using the following approaches:

i. Container Index
ii. Minimum Distance
iii. Travel Cost
iv. Gravity

Table 1: Variations in the measurement of accessibility

Approach	Definition	Suitability	Example
Container Index	The number of facilities in each given unit, such as neighbourhoods, *mukims*, counties, and districts	Suitable for access measures within a geographical boundary	The number of local mosques within the *mukim* boundary

Minimum Distance	The distance between a point of origin, such as a neighbourhood centroid block, and the nearest facility	Suitable for access measures to the closest available facility	The distance between a neighbourhood centroid point and the nearest local mosque
Travel Index	The total or average distance between a point of origin, such as neighbourhood centroid blocks, and all facilities	Suitable for access measures to all facilities available to the user	The average distance between all local mosques and the neighbourhood centroid points
Gravity Index	An index in which the sum of all facilities is divided by distance	Suitable for access measures that consider the effect of distance as a deterrent	All local mosques are weighted by their size and divided by distance

Adapted from Talen (1998)

The various approaches mentioned in Table 1 can produce varying results depending on how the researcher defines accessibility. Therefore, "the choice of access measures has to be considered very carefully when trying to analyse the spatial equity of a given resource distribution" (Talen & Anselin, 1998). Several other studies have also adopted the minimum distance approach to assess spatial equity (Talen & Anselin, 1998; Rosero-Bixby, L., 2004; Smoyer-Tomic, K. E., et al., 2004; Comer, J. C., & Skraastad-Jurney, P. D., 2008; Yin, H., & Xu, J., 2009; Zhang, X., Lu, H., & Holt, J. B., 2011; Pan, J., et al., 2016). In the context of *qariah* mosque planning, most people tend to travel to the closest mosque available to them. Therefore, of the four approaches to measuring the accessibility index, the container index and minimum distance are better suited for adoption.

RESEARCH METHOD

Research Design

This research adopted an empirical study approach. The present study utilised a Geographical Information System (GIS) and used descriptive and statistical analyses to assess the spatial equity of 418 *qariah* mosques in Selangor Darul Ehsan, Malaysia. Selangor was chosen as a case study to evaluate the spatial equity and accessibility of mosques in the state. From the three different types of mosques in Selangor, the sample consists solely of local mosques. The present study attempted to assess the spatial equity of local mosques by measuring their spatial distribution and accessibility. An evaluation was carried out by applying

GIS-based methods to the container index as described by Talen and Anselin (1998). Besides the container index, this study also applied LISA to assess the spatial pattern of local mosques in the study area. Both of these approaches have been selected as the most suitable methods to assess accessibility. They measure the distance between the nearest available local mosques and the population, as well as the spatial pattern of local mosques.

This study used aggregated data on population and human settlement to identify the spatial pattern and distribution of mosque accessibility in each *mukim*. Despite only using aggregated data, it is still considered sufficient to reveal the general pattern of spatial distribution in the study area. The results based on this data would provide meaningful insights on the spatial equity of *qariah* mosques in Selangor. The socio-economic data has been omitted from the analysis because it is not available at the *mukim* level. The data was analysed in GIS using the container index and Local Indicators of Spatial Association (LISA) to assess accessibility and spatial equity. By taking this approach, the study's findings will shed light on communities with limited access to *qariah* mosques as well as spatial equity at the *mukim* level.

Case Study

Selangor was chosen as the case study because the state has the largest population in Malaysia, with a total population of 6.5 million people, and 59% of the population are Muslims. It is the ninth largest state in Malaysia, with a total area of 8,104 km^2. Selangor is located geographically in the central western part of Peninsular Malaysia, neighbouring Kuala Lumpur. Most of the urban areas in Selangor are located in close proximity to Kuala Lumpur, while the rural areas of the state are located mostly in its northern and southern parts.

The state has a total of 418 *qariah* mosques distributed across 9 districts, which makes it a suitable case study to assess the spatial equity and accessibility of local mosques. This study was carried out at the *mukim* level in Selangor, consisting of 54 *mukims*. Data at the *mukim* level revealed the spatial pattern and distribution of local mosques in Selangor. Figure 1 is a map of the study area with all the districts in Selangor.

Figure 1: The location of the study area, the state of Selangor

Data Collection

The study used aggregated data from the population to identify the spatial pattern and spatial distribution of accessibility to local mosques. The spatial pattern was analysed using GIS capabilities. Therefore, to ensure that the analysis could be performed, GIS data was required, which included mosques, populations, and *mukim* boundaries.

Mosques Data

Jabatan Agama Islam Selangor provided the data for *qariah* mosques, which includes a list of 418 *qariah* mosques in Selangor. Due to the lack of GIS-formatted data, a GIS land use map from PLANMalaysia was used to derive the spatial data for *qariah* mosques. Upon inspection of the land use map, the GIS database revealed 448 *qariah* mosques. As a result, data cleansing was performed to validate the GIS database. Using secondary data from high-resolution satellite imaging and Google Street View, the database's accuracy was verified by visually inspecting the data. Only 386 *qariah* mosques were deemed suitable for analysis following the completion of data cleansing procedures. Due to inaccuracies and spatial geometry errors, the remaining data was omitted. The data attributes of the local mosques obtained from Jabatan Agama Islam were entered into the GIS database after the spatial data had been validated.

Population Data

The population data at the *mukim* level was obtained from the Department of Statistics Malaysia. Due to the fact that socioeconomic details are only available at the district level, they were not included in the data collection because they are limited to the total population. Since the study is done at the *mukim* level, only information about the total population is available.

When the study was conducted, the population statistics had the same difficulty. The publicly accessible information is presented as a report. Therefore, it was necessary to convert the report to GIS format. Several procedures had to be followed to guarantee the accuracy of the transformed GIS data. The initial phase was to establish a *mukim* boundary in GIS format. The boundary data was received in the form of polygons from the Department of Survey and Mapping Malaysia. After obtaining the polygon data, a validation procedure was performed to check that the population data matched the *mukim* boundary. The GIS data would remove any discrepancies between the mukim information in the population data and the *mukim* data. Following the completion of the validation procedure, the validated *mukim* information from the population data would be added to the *mukim* GIS data. The data attributes provided in the GIS data include the total population and the total Muslim population.

Data Analysis

This study assessed the spatial pattern and accessibility of local mosques using GIS software. The data underwent GIS analysis, namely the container index and Local Indicators of Spatial Association (LISA). Secondary data from the Jabatan Agama Islam Selangor, PLANMalaysia, the Department of Statistics Malaysia, and the Department of Survey and Mapping Malaysia were used for the analysis.

The container index was used to analyse spatial accessibility. Based on *mukim* boundaries, this analysis was able to identify the total mosques, the total population of Muslims, and the population density per acre. Besides the container index, the study also applied Local Indicators of Spatial Association (LISA) to detect patterns of local spatial clusters and outliers.

RESULTS

Spatial Accessibility Using Container Index

The distribution of mosques was analysed at the *mukim* level. Table 2 shows the total mosque per *mukim* boundary. Based on the container index results, it can be concluded that the largest number of local mosques per *mukim* is 56. To identify the reasons behind the large number of mosques in certain *mukim*, it is important to assess other variables, such as the total population of Muslims and the population density, against the total number of local mosques.

Figure 2 illustrates the findings from the container index based on the total number of local mosques in each *mukim*. Meanwhile, Figure 3 and Figure 4 show the results for both the total population of Muslims and the population density per acre by *mukim* boundary.

Table 2: Total *qariah* mosques per *mukim* boundary

Total Local Mosques	Mukim Boundaries	Total Local Mosques	Mukim Boundaries
0	1	13	1
2	5	14	1
3	3	15	2
4	3	16	2
5	3	17	1
6	2	18	2
7	1	19	1
8	1	26	1
9	2	30	1
11	2	56	1

The results depicted in Figures 2 and 3 clearly demonstrated an essentially identical result between Figures 2 and 3. It can be determined that the total number of mosques is directly proportional to the overall population. This is further demonstrated by the outcome depicted in Figure 6.

Figure 4 and 5 demonstrates the reverse of Figures 2 and 3, as the largest and smallest values in Figures 2 and 3 do not correspond to those of Figure 4 and 5. This data demonstrates that the population density per acre and the total number of local mosques for each *mukim* do not match. It illustrated that the total number of mosques per acre is directly influenced by the population density per acre. Therefore, it is possible that the population density per acre will impact the number of total mosques allocated for the mukim.

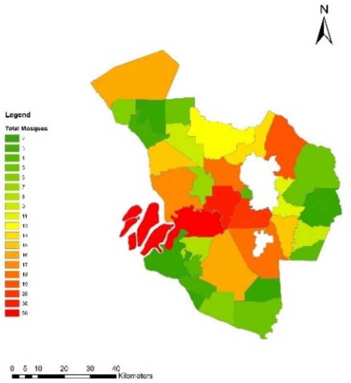

Figure 2: Total local mosques by *mukim* boundary

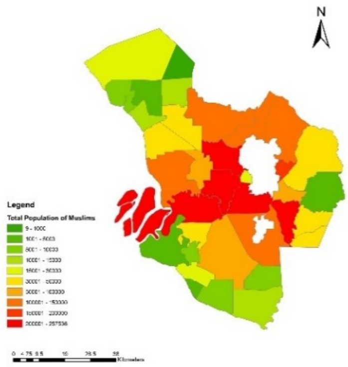

Figure 3: Total population of Muslims by *mukim* boundary

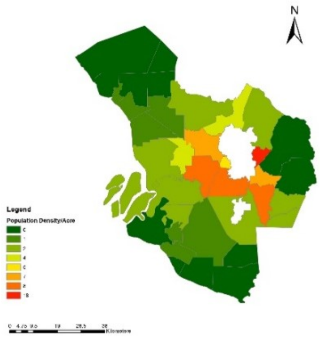

Figure 4: Population Density/Acre by *mukim* boundary

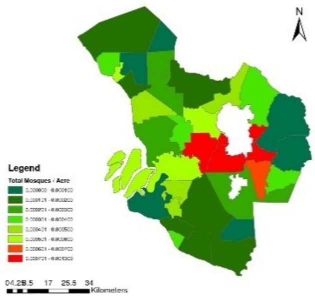

Figure 5: Total Mosque Density/Acre by *mukim* boundary

Figure 6 provides a visual representation of compliance with the planning standard for determining whether each *mukim* is assigned a sufficient number of local mosques in accordance with the standard. Except for the red zones, the majority of *mukim* are distributed with an adequate number of local mosques, as seen in Figure 6. The red zones in Figure 6 (i.e., Petaling, Sungai Buloh, Cheras, Ampang, and Kajang) represent *mukims* with large populations and high population densities. They are urban areas adjacent to Malaysia's capital city of Kuala Lumpur.

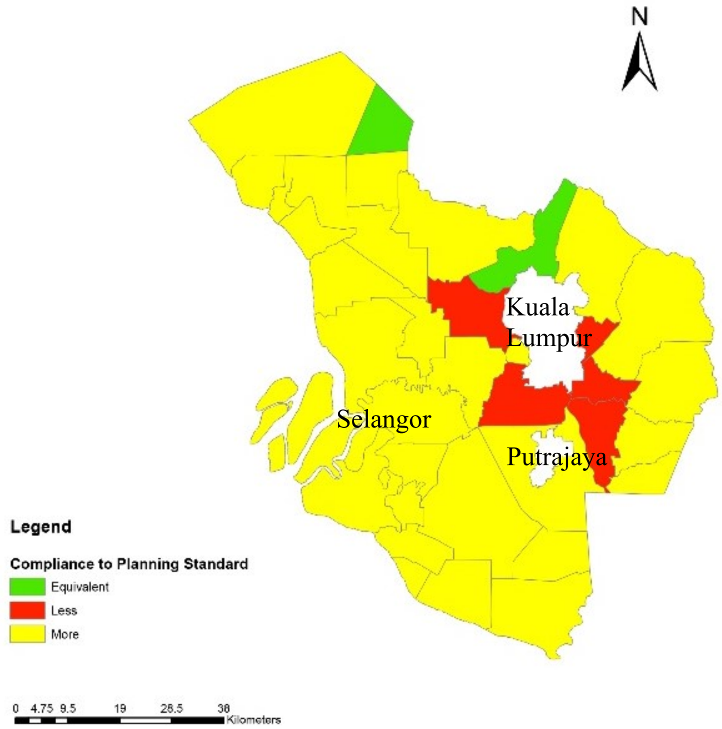

Figure 6: Compliance to the Planning Guidelines for the Provision of Mosques and *Suraus* in Selangor.

The *mukims* with yellow hues are clustered in the red zone's periphery. The majority of these zones have a lower population density than the red zones. According to the data, major population areas receive fewer mosques than required by planning regulations. Therefore, it can be inferred that these densely populated areas receive fewer facilities than those required by planning standards.

Spatial Pattern Based on Local Association

In this study, Local Indicators of Spatial Association (LISA) were utilised to detect spatial clusters and outliers within the data in order to evaluate spatial patterns. This method computes the statistics for I-value, z-score, p-value, and cluster type, which may be high-high, low-high, high-low, or low-high. The z-score and p-value determined by this statistical analysis indicate the statistical importance of each value. The I-value is used to identify characteristics or boundaries whose values are similar or distinct. A positive I-value suggests that it has neighbouring values that are similar, whereas a negative I-value indicates that it has neighbouring values that are dissimilar. Additionally, a negative I-value indicates an outlier in the data. Consequently, the LISA statistics were employed to determine whether there were any significantly high or low values in the research area. Figure 7 depicts the *mukim* boundaries using statistically significant LISA data.

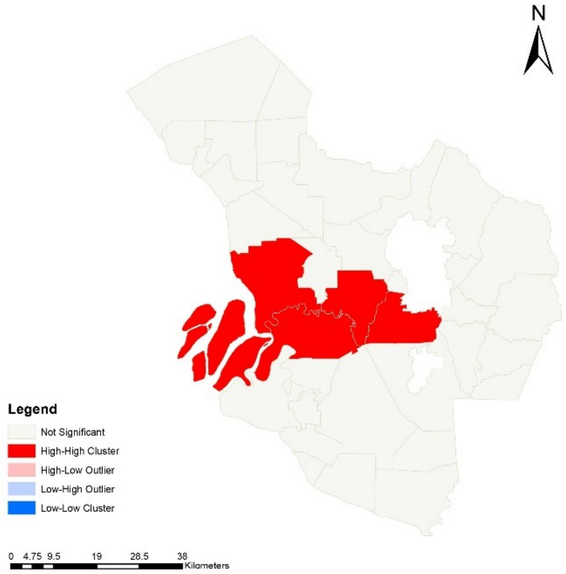

Figure 7: LISA map based on container index

According to the LISA statistics, four *mukim* boundaries (Kelang, Damansara, Petaling, and Kapar) share a comparable I-value. This region contained a large proportion of the *mukim*'s mosques, indicating its high value. The p-value for the four *mukims* is less than 0.05, indicating that it is statistically significant with a 95% level of confidence. The remaining *mukims* are statistically insignificant because the p-value is greater than 0.05. Therefore, it can be concluded that four *mukims* in this study have comparable total mosque counts.

DISCUSSION

The aim of this study is to identify the spatial distribution of accessibility and the spatial pattern of *qariah* mosques. This section will discuss the findings that were obtained from the analysis. The discussion is divided into two categories: the spatial distribution of spatial accessibility and the spatial pattern of spatial accessibility.

Spatial Distribution of Spatial Accessibility

As shown in Figures 2 and 3, the distribution of local mosques is highly dependent on the total number of Muslims at the *mukim* level. Incorporating population density data into the analysis revealed that the majority of high-density areas are allocated with higher mosques per acre than low-density areas. Although some of the higher-density areas have fewer *qariah* mosques, they are still considered to have a higher mosque density than lower-density areas, based on the ratio of mosques per 20,000 people.

Figure 5 reveals that Sungai Buluh, Petaling, Kajang, Cheras, and Ampang are the *mukims* with the fewest local mosques per 20,000 inhabitants. In order to achieve spatial equity in the allocation of *qariah* mosques, policymakers must address areas with fewer mosques per 20,000 inhabitants. It might be better to plan for an even distribution of *qariah* mosques across *mukims* to reduce spatial inequality in areas that have been affected.

This region can be the subject of additional research into the most effective strategies for reducing spatial inequality. This can be explored further by employing a more nuanced method for measuring the accessibility of *qariah* mosques in different neighbourhoods at a local scale.

Spatial Pattern of Spatial Accessibility

LISA provides the capacity to interpret spatial clusters or spatial outliers in the context of their local environment. Based on the findings of this LISA-based study, high concentrations of mosques have been identified from the central portion of Selangor to the western coast of Selangor. This cluster of *mukim* represents the *mukim* with the most *qariah* mosques.

This *mukim* cluster consists of Kelang, Damansara, Petaling, and Kapar. In close proximity to Kuala Lumpur and classified as urban areas in Selangor, the following locations are classified as urban. The areas are also densely populated, with populations ranging from 262,998 to 603,430. Therefore, these regions have a greater number of mosques than other regions.

Although some of these areas have the highest concentration of *qariah* mosques, certain *mukims*, such as Petaling, have a lower allocation of *qariah* mosques than the planning standard mandates. Therefore, the method of allocating the number of *qariah* mosques in each mosque based on population requirements revealed some irregularities, which necessitate additional evaluation to address them. It is suggested that to look into this problem, a more thorough and detailed study be carried out.

CONCLUSION

This study demonstrated that the container index and local indicators of spatial association (LISA) can shed light on the spatial equity of public facilities. Using LISA and GIS to evaluate spatial equity has enabled planners to identify the spatial pattern and clusters of *qariah* mosques, particularly the distribution of *qariah* mosques in each *mukim*. Despite the fact that this study is limited to *qariah* mosques, it has demonstrated that it can provide insight into the spatial pattern and spatial distribution of local mosques. The difference between evaluating *qariah* mosques and other public facilities lies in the planning approach for the latter. The *qariah* mosques in Malaysia are designed to meet the needs of the Muslim population. Therefore, some adjustments must be made to the data before the container index and LISA analysis can be performed. This research modified the methodology by analysing only Muslim populations. Based on the results, planners and policymakers may be able to identify areas with insufficient *qariah* mosques.

Although urban areas have the highest concentration of mosques per 20,000 inhabitants in Selangor, suburban areas such as Tanjung Karang in northern Selangor have more mosques per 20,000 inhabitants than urban areas adjacent to Kuala Lumpur. Consequently, the focus should be on these urban areas, which typically have larger populations than their suburban counterparts.

This study also demonstrated that this methodology, which employs GIS technology and GIS data, can be applied to the analysis of other public facilities, including schools, hospitals, and recreational parks. This methodology yielded insights that may have been difficult to interpret from tabular data. Therefore, it is suggested that this methodology be used to analyse the distribution of public facilities in local and structural plans. It can assist planners to make more informed decisions regarding the provision of public facilities.

This research has some limitations. This study used only aggregated data for fundamental populations. This is due to the lack of availability of GIS population data at the *mukim* level. Consequently, future research can concentrate on the methodology for acquiring precise geocoded population data with comprehensive socio-economic data. Detailed GIS population data is expected to provide additional insight into the various socio-economic groups that benefit from *qariah* mosques and other public facilities.

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