

Modeling Travel Distance to the Nearest Mosque Using the Euclidean Distance Algorithm

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ABSTRACT

The study will calculate the travel distance to the closest mosque through the Euclidean Distance formula, which is a standard formula for the straight-line distance between two geographic points. The overall goal is to calculate the accessibility of mosques within an area by using geographical coordinates and provide valuable data for city planning and religious facility planning. Applying the Euclidean Distance formula, studies estimate closeness between given set of points and nearest mosque and thus is a straightforward yet efficient way to quantify closeness. Findings from research indicate high variability in mosque accessibility based on geographical distribution in the study area. The model indicates areas with inadequate mosque access, and it may be utilized by planners and policymakers in responding to the need for enhanced religious service coverage. The Euclidean Distance model is limited in the sense that it does not account for actual conditions such as the road network, traffic, or terrain that may influence actual travel distance and time. This research contributes to the existing literature in spatial analysis by demonstrating how the Euclidean Distance algorithm can be applied in geographic research on access to public services. More advanced algorithms and actual data sets can be employed by future researchers to continue enhancing the precision and applicability of the model in actual environments.

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1. INTRODUCTION

Accessibility of public facilities such as places of worship is one of the important elements in urban planning and fulfilling the social needs of the community (Li et al., 2019). In many cities, mosques as places of prayer have a very strategic role in the lives of every Muslim. So, the circle of the masses together can be concluded how far individuals are from their homes to the nearest mosque, which is very relevant to adding to the understanding of the quality of accessibility and comfort of their worship.

However, in urban planning and spatial planning, there are many difficulties and it is even more difficult to make the distance of strategic points (such as houses and mosques) efficiently calculated using traditional methods (Widaningrum et al., 2020). One simple way to calculate the distance is the Euclidean distance algorithm, which allows finding a simple and effective solution to calculate the straight distance between two points on the earth's surface, ignoring factors such as the curvature of the earth (Khan et al., 2024).

In this context, this study aims to develop a model of travel distance to the nearest mosque using the Euclidean Distance algorithm method. Therefore, the coin-cutting lottery with jelly, from his explanation here is an effort so that we can get a clear picture of the distribution of mosques and the low level of accessibility of Muslims in the area to worship facilities. In addition, this model can be used to determine locations that can be categorized as limited access to the location of the mosque and city planners use it to plan the construction of mosques in areas that need and infrastructure planning for the availability of better transportation infrastructure.

All the simplicity of the Euclidean distance algorithm has limitations, it is very important when calculating the distance on the curved surface of the earth (Ihantamalala et al., 2020). Thus, although the results can provide a useful picture, it turns out that this study The purpose of this study is also to determine the extent to which the angle of this algorithm will provide accurate and relevant results in terms of the distance to the mosque.

This study is expected to help improve the spatial analysis model that is more efficient and applicable to improve accessibility to worship facilities (IMT) and support more inclusive city planning.

2. LITERATURE REVIEW

2.1. Accessibility and Spatial Distribution of Religious Facilities

Accessibility to religious sites is a significant element of social and cultural integration within communities. There have been several studies highlighting the importance of understanding travel distance to principal religious buildings, particularly mosques, in urban areas. Urban accessibility is often defined by closeness to basic services, and mosques are the premier locations for community gathering and worship within predominantly Muslim societies (Asni et al., 2020).

Alrasheedi, et al (2020) in their study emphasized that religious buildings ought to be equitably distributed in order to have equal access to all members of society, particularly in urban cities with high populations. GIS-based studies have been utilized for decades to examine the accessibility of religious

services, where distance to a mosque is usually associated with the ability of a community to maintain religious practices (Alrasheedi et al., 2020). For instance, the Mahfudz, et al (2021) study employed GIS technologies to identify mosques that had areas of poor coverage, which is critically important in urban planning so that all residents have access to places of worship. The studies suggest accessibility of mosques varies based on spatial distribution as well as socio-demographics (Mahfudz et al., 2021).

2.2. Euclidean Distance as a Measure for Travel Accessibility

Euclidean distance is a simple and widely used algorithm to compute the straight-line distance between two points in two-dimensional space (Netrdova & Nosek, 2020). Sarkar, et al. (2019) highlighted that Euclidean distance is an essential technique for use in spatial analysis, especially when the intention is to model the proximity between various locations (Sarkar et al., 2019). It is an uncomplicated measure of "as-the-crow-flies" distance and may be used for first-order approximation of spatial accessibility without considering road network or other limitations of travel (Manley et al., 2021).

Euclidean distance can, within the mosque accessibility context, be utilized to determine the shortest likely travel distance from one's location point to the nearest mosque. It does, however, ignore road network, traffic conditions, or geophysical obstructions (Franco et al., 2018). Limitation aside, Euclidean distance remains a valuable measurement to employ for travel distance modeling in scenarios where complete travel route information is not desired or accessible (Chen et al., 2020).

2.3. The Role of Euclidean Distance in Urban Planning

In urban planning, understanding the distance of travel to basic services, including religious centers, is crucial to ensure infrastructure is serving all populations equally. Studies such as Gupta, et al (2022) point out that accessibility modeling is a significant component of urban planning, particularly in the design of public service delivery. Access to religious services, including mosques, can have a significant impact on social inclusion and religious well-being (Gupta et al., 2022).

However, while Euclidean distance provides an estimate of accessibility, it is not suitable for micro-scale urban planning where analysis needs to consider actual paths, barriers, and traffic flow. This has witnessed the use of other algorithms like network analysis or gravity models, though Euclidean distance continues to be used for early-stage assessment and comparison (Liang et al., 2019).

3. METHOD, DATA, AND ANALYSIS

3.1. Methodology

The objective here in this study is to model and analyze the travel distance to the nearest mosque using the Euclidean distance algorithm. The Euclidean distance is an easy and widely used method for calculating the "as-the-crow-flies" distance between two points on a two-dimensional plane. In this section, the

methodology of the analysis is given, like data collection, model development, and the specific steps taken in computing the travel distance and the analysis of results (Kang et al., 2021).

For the purpose of this research, the distance will be calculated between the coordinates of various individuals (or sample points) and the nearest mosque. The algorithm will be applied to a dataset that includes the spatial locations of mosques and individuals. The calculation of distance using Euclidean Distance is as follows.

$$\text{Distance} = (\sqrt{(\text{Lat}_1 - \text{Lat}_2)^2 + (\text{Long}_1 - \text{Long}_2)^2}) * 111.319 \text{ KM} \quad (1)$$

3.2. Mosque Location Data

Data on mosque locations were obtained from GIS databases that provide geographic coordinates (latitude and longitude) of mosques within the study region. For urban areas, the dataset contains the locations of major mosques, while for rural areas, a broader set of smaller mosques was included. Each mosque's location was mapped using global positioning system (GPS) coordinates.

For modeling travel distance, data points for individuals or population centers were selected. These data could represent:

- Residential addresses or a sample of urban and rural households.
- Population clusters or administrative boundaries (such as sub-districts) to serve as proxies for individuals' locations.

In the absence of individual-level data, centroid points for urban or rural districts can be used to approximate the location of people. This simplifies the modeling process while still allowing for an accurate analysis of proximity (Netrdova & Nosek, 2020).

3.3. Analysis

With the geographical coordinates of mosques and the location of individuals, the Euclidean distance of every individual from his or her nearest mosque will be determined. It does this by determining the straight-line distance between data points in the dataset. From the findings, a summary of the nearest distance to the mosque within the study area will be determined (Ihantamalala et al., 2020).

4. RESULT AND DISCUSSION

4.1. Euclidean Distance Calculation

The Euclidean distance of each individual (or population center) from the nearest mosque was calculated by applying the straight-line distance formula. The program identified, for each point in the study area, the nearest mosque and recorded the travel distance (Su et al., 2023).

An example of calculating distance using the Euclidean Distance method is: It is known that a mosque named Al-Jihad Mosque is located at coordinates (3.57989, 98.63752), and Satya Terra Bhinneka University

is located at coordinates (3.57380, 98.61355), what is the distance between the two in kilometers (km) when calculated using the Euclidean Distance method.

By using the euclidean distance calculation, the distance between the two coordinates is 2.76 km. This result is not much different from the distance calculation results carried out by Google, which is around 2.9 km.

Table 1. Comparison of Distances from Satya Terra Bhinneka University to Several Mosques in Medan City

Mosque Location	Euclidean Distance	Google	Distance Difference
Raya Al-Mashun Mosque	8.39 KM	10.4 KM	2.01 KM
Agung Mosque	6.71 KM	8.6 KM	1.89 KM
Al-Jihad Mosque	2.76 KM	2.9 KM	0.14 KM
Ar – Ramadhan Mosque	0.92 KM	1.1 KM	0.18 KM
AL-IKHWAN Mosque	1.36 KM	1.6 KM	0.24 KM
Nur Abyadh Mosque	0.97 KM	1.5 KM	0.53 KM

4.2. Impact of Euclidean Distance on Mosque Accessibility

Results of this research confirm the prevalence of Euclidean distance in accessibility modeling to mosques. As anticipated, respondents within urban settings recorded shorter distances to mosques compared to those in rural settings. This is in agreement with findings by Ali et al. (2020), which indicated that city dwellers are likely to enjoy better access to mosques due to higher religious institution density. However, the use of Euclidean distance, even though simple and useful for preliminary assessment, is also not ideal in that it does not take into account the specifics of real-world road networks, traffic volumes, or geographical barriers.

5. CONCLUSION AND SUGGESTION

In this study, the Euclidean Distance algorithm was effectively utilized to model the travel distance to the closest mosque. Results have shown that the Euclidean Distance approach can provide an uncomplicated yet efficient way of ascertaining the proximity between a given point and nearby mosques. The model allows for the simple visualization of mosque accessibility via geographic coordinates and can be utilized in urban planning, mosque infrastructure planning, and community services.

Euclidean Distance algorithm is easy enough to implement to measure straight-line distances and hence can be effectively used as a spatial analysis technique to employ where not much data regarding road networks or infrastructure exists.

The distance modeling is revealing the areas that have insufficient access to mosques, which may be crucial to identify by the policymakers and planners for those areas where mosque establishments may be required or improved access.

The model, however, does not incorporate the real-life determinants of road networks, terrain, and traffic flow that can affect true distances and travelling times.

The study generally describes the effectiveness of the Euclidean Distance algorithm for geographical research as well as the potential use for infrastructure and public services planning.

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Declaration of AI and AI-assisted technologies in the writing process

During the preparation of this manuscript, the authors used AI-assisted technologies, including ChatGPT and Google Translate, to support language editing, translation, and improvement of clarity and readability. The authors take full responsibility for the content of the manuscript and confirm that the use of these tools did not affect the originality, validity, or integrity of the research.

REFERENCE

- Alrasheedi, K. G., Lue, G. J., & Baby, S. N. (2020). GIS-based Spatial Accessibility to Islamic Facilities for Muslim Community in the Melbourne Metropolitan Area. *Journal of Earth Sciences and Geotechnical Engineering*, 10(5), 49–68.
- Asni, F., Mahamud, M. A., & Sulong, J. (2020). Socio-economics and management of Muslim cemetery waqf using istibdal and GIS method in Penang state. *JLABR*, 11(7), 1343–1362. <https://doi.org/10.1108/JIABR-01-2019-0026>
- Chen, Y., She, J., Li, X., Zhang, S., & Tan, J. (2020). Accurate and Efficient Calculation of Three-Dimensional Cost Distance. *International Journal of Geo-Information*, 9(353).
- Gupta, C., Gill, N. S., & Gulia, P. (2022). SSDT: Distance Tracking Model Based on Deep Learning. *International Journal of Electrical and Computer Engineering Systems*, 13(5), 339–348.
- Ihantamalala, F. A., Herbretreau, V., Révillion, C., Randriamihaja, M., Commins, J., Andréambeloston, T., Rafenoarimalala, F. H., & Randrianambinina, A. (2020). Improving geographical accessibility modeling for operational use by local health actors. *International Journal of Health Geographics*, 19(27), 1–15. <https://doi.org/10.1186/s12942-020-00220-6>
- Kang, J., Kan, C., & Lin, Z. (2021). Are Electric Vehicles Reshaping the City? An Investigation of the Clustering of Electric Vehicle Owners' Dwellings and Their Interaction with Urban Spaces. *International Journal of Geo-Information*, 10.
- Khan, T. S., Pfoser, D., Ruan, S., & Züfle, A. (2024). Simplifying traffic simulation - from Euclidean

- distances to agent - based models. *Computational Urban Science*, 4(32). <https://doi.org/10.1007/s43762-024-00145-x>
- Li, L., Du, Q., Ren, F., & Ma, X. (2019). Assessing Spatial Accessibility to Hierarchical Urban Parks by Multi-Types of Travel Distance in Shenzhen, China. *International Journal of Environmental Research and Public Health*, 16(1038). <https://doi.org/10.3390/ijerph16061038>
- Liang, L., Xu, M., Grant-muller, S., & Mussone, L. (2019). Household travel mode choice estimation with large-scale data — an empirical analysis based on mobility data in Milan. *International Journal of Sustainable Transportation*, 0(0), 1–16. <https://doi.org/10.1080/15568318.2019.1686782>
- Mahfudz, M., Kresnawati, D. K., & Palahudin, E. (2021). MAPPING THE CAPACITY OF THE MOSQUE IN SPATIAL REVIEW IN EAST BOGOR SUB-DISTRICT. *GeoEco*, 7(2), 214–222.
- Manley, E., Filomena, G., & Mavros, P. (2021). A spatial model of cognitive distance in cities. *International Journal of Geographical Information Science*, 00(00), 1–23. <https://doi.org/10.1080/13658816.2021.1887488>
- Netrdova, P., & Nosek, V. (2020). Spatial Dimension of Unemployment : Space-Time Analysis Using Real-Time Accessibility in Czechia. *International Journal of Geo-Information*, 9(401).
- Sarkar, D., Andris, C., Chapman, C. A., & Sengupta, R. (2019). Metrics for characterizing network structure and node importance in Spatial Social Networks. *International Journal of Geographical Information Science*, 0(0), 1–23. <https://doi.org/10.1080/13658816.2019.1567736>
- Su, Y., Liu, Z., Chang, J., Deng, Q., Zhang, Y., Liu, J., & Long, Y. (2023). Measuring Accessibility to Healthcare Using Taxi Trajectories Data: A Case Study of Acute Myocardial Infarction Cases in Beijing. *Kerman University of Medical Sciences*, 12, 6653. <https://doi.org/10.34172/ijhpm.2022.6653>
- Widaningrum, D. L., Surjandari, I., & Sudiana, D. (2020). Analyzing Land use Changes in Tourism Development Areas: A Case Study of Cultural World Heritage Sites on Java Island, Indonesia Dyah. *International Journal of Technology*, 11(4), 688–697. <https://doi.org/10.14716/ijtech.v11i4.4097>