



Integrating Geospatial Technology and Islamic Jurisprudence: An Analysis of Mosque Qibla Deviation

Reno Ismanto¹, Ahmad Fadholi^{2*}, Priyango Karunia Rahman³, Wasim Jan⁴,
Husna Tuddar Putri⁵

^{1,2,3} Institut Agama Islam Negeri Syaikh Abdurrahman Siddik, Bangka Belitung, Indonesia

⁴ Sukkur IBA University, Pakistan

⁵ Universitas Islam Negeri Sultanah Nahrasiyah Lhokseumawe, Aceh, Indonesia

*(Corresponding author) e-mail: fadholi13@iainsasbabel.ac.id

Abstract

Purpose - Accurate orientation towards the qibla is a fundamental requirement for the validity of prayer in Islam. However, many mosques, particularly those constructed in earlier periods, may exhibit discrepancies in their qibla orientation due to the limited technology and directional methods available at the time of construction. Previous studies on qibla direction have generally focused on technical and astronomical aspects, while integrative studies combining geospatial analysis with Islamic jurisprudence (*fiqh*) evaluation remain limited. Recent developments in geospatial technology and digital astronomy provide new opportunities to reassess qibla accuracy with greater precision, while also necessitating normative evaluation from the perspective of Islamic law. This study aims to analyse the degree of qibla deviation in mosques in Pangkalpinang City, Indonesia, and to examine its legal implications based on relevant *fiqh* principles.

Methodology/approach - The research employs an empirical-normative approach. Empirical data were collected through field measurements using Islamic Astro, GPS Test, Google Earth Pro, and Istiwaaini applications, as well as solar-position tracking to obtain highly accurate coordinate and qibla azimuth data. The results were then compared with the physical orientation of the mosque buildings. The normative analysis was conducted by examining *fiqh* perspectives regarding the acceptable tolerance limits for qibla deviation.

Findings - The findings reveal that the qibla deviations of the twelve surveyed mosques range from 0.54° to 38.63°, indicating that several mosques do not fully meet the tolerance standards recognised in *fiqh*.

Conclusion - The integration of modern geospatial technology with Islamic legal analysis provides a more comprehensive framework for evaluating mosque qibla accuracy, while encouraging higher precision through modern scientific verification. This study contributes to the development of science-based *fiqh* studies of worship and reaffirms the relevance of the principle of easing hardship for legally responsible persons (*at-taysir 'alā al-mukallaḥ*) in the context of technological advancement. Furthermore, the study recommends that religious authorities and mosque administrators verify qibla orientation using scientific approaches that remain consistent with sharia principles in order to ensure confidence and stability in worship.

Keywords: *Fiqh*; Geospatial; Qibla Direction; Technology Integration.

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Introduction

Measuring and determining the qibla direction of a mosque holds immense importance and fundamental significance for Muslims, as it directly relates to the validity of congregational prayer.¹ Accuracy in ascertaining the qibla is not merely a technical requirement; rather, it constitutes a fundamental element that ensures the legitimacy of worship and symbolises complete adherence to divine command.² Consequently, the determination of the Qibla should not be perceived solely as a technical issue but rather as an integral aspect of the implementation of Islamic law. This obligation embodies the value of unity among Muslims in their worship of Allah and serves to transcend geographical and cultural differences.³

Based on a review of various empirical studies, the issue of the qibla direction of mosques in Indonesia remains a significant concern, particularly for mosques constructed prior to the widespread adoption of modern surveying technology. Numerous studies indicate that deviations in the qibla direction are frequently attributable to the utilisation of traditional methods based on estimates, the limited technical knowledge of mosque administrators, a reliance on a general orientation towards the west without precise azimuth calculations, and an absence of systematic inspection following the construction of the mosque.⁴ Field research conducted across various regions corroborates these findings.

Several studies have demonstrated that the integration of digital sensors and data derived from solar ephemerides significantly enhances the accuracy of qibla direction determination. Additional research has suggested that the combination of various methods for determining the qibla direction, using algorithms based on Al-Biruni's methodology, including the application of robotics and digital devices, is advantageous.⁵ Furthermore, smartphone applications have been employed to ascertain the qibla direction; these applications have exhibited an error margin of less than 0.5° and are characterised by a high degree of accuracy, rendering them more reliable than traditional methods that rely on magnetic compasses.⁶ Google Maps can also be used to identify and rectify deviations in the qibla direction of mosques, particularly in urban settings.⁷ In Turkey, the incorporation of the qibla direction into the national mapping system has been implemented to ensure geodetic

¹ Ahmad Nizam, S. A. Romli, and Yazwardi, "Divergence in Qibla Direction Determination: A Fiqh-Based Analysis and Its Societal Implementation," *Nurani* 25, no. 2 (2025): 363–76, <https://doi.org/10.19109/nurani.v25i2.27891>.

² Nurul Naziha Ismail, Aimi Musa, and Othman Zainon, "The Accuracy of Qibla Direction Applications Used by the Public," *International Journal of Academic Research in Progressive Education and Development* (Human Resources Management Academic Research Society (HRMARS), 2024), <https://doi.org/10.6007/ijarped/v13-i4/23813>.

³ Erry Fitrya Primadhany et al., "Maḥāsīn Al-Syarī'ah on the Implementation of Maḥḍah Worship: Overview of Islamic Legal Philosophy," *Samarah* 6, no. 2 (2022): 634–54, <https://doi.org/10.22373/sjkh.v6i2.12394>.

⁴ Nizam, Romli, and Yazwardi, "Divergence in Qibla Direction Determination: A Fiqh-Based Analysis and Its Societal Implementation."

⁵ W. S. Mada Sanjaya et al., "Designing an Autonomous Qibla Finder Mobile Robot Utilizing the Second Al-Biruni's Method from Kitab Tahdid Nihayat Al-Amakin," in *IEEE 9th Information Technology International Seminar (ITIS)* (Batu Malang Indonesia, 2023), 1–6, <https://doi.org/10.1109/ITIS59651.2023.10420068>.

⁶ Ismail, Musa, and Zainon, "The Accuracy of Qibla Direction Applications Used by the Public."

⁷ Rusdin Muhalling et al., "The Qibla Directional Accuracy Determination Analysis Using Spherical Trigonometric Method and Google Earth," *NeuroQuantology* 20, no. 5 (2022): 107–14, <https://doi.org/10.14704/nq.2022.20.5.nq22153>.

accuracy in urban planning, thereby minimising deviations in mosque orientation.⁸ Technological advancements have also functioned as diagnostic tools, revealing directional deviations in numerous mosques, particularly in older structures.⁹ Based on existing research findings, geospatial methods remain one of the most precise means for determining the qibla direction. Consequently, geospatial methods were employed to measure older mosques in Pangkalpinang.¹⁰

Pangkalpinang, the capital of Bangka-Belitung Province, presents a distinctive geographical and historical context concerning the dissemination of Islam.¹¹ Numerous mosques within this city were established several decades ago, during a period characterised by significant limitations in geodetic infrastructure and access to contemporary technologies for accurately determining the qibla direction. These historical circumstances, combined with a lack of stringent correction for magnetic declination at the time of construction, have likely resulted in deviations in the qibla orientation of the existing mosque structures.¹²

From an Islamic jurisprudence (*fiqh*) perspective, the discovery of qibla deviations prompts complex legal discussions, particularly regarding the validity of previously conducted congregational prayers. Classical scholars, such as Imam al-Shāfi'ī, have emphasised the theme of tolerable angular deviations, referred to in *fiqh* discourse as 'deviation from the qibla direction' (*mukhālafah al-qibla*).¹³ This concept can be considered in light of the principle of widespread and unavoidable hardship (*al-'umūm al-balwā*). However, the application of this principle in the contemporary context necessitates reinterpretation in light of technological advancements. The availability of highly precise instruments now challenges the traditional "unavoidable hardship" boundary, as these instruments provide a readily accessible means of directional adjustment. In relation to this study, the fundamental question that arises is the extent of the deviation in the qibla direction in the mosques of Pangkalpinang.

Similar research has been conducted in various regions of Indonesia, including the Thousand Islands in West Nusa Tenggara Province, where deviations in the qibla direction of local mosques have been identified.¹⁴ Several other studies have yielded analogous findings; however, these studies have primarily concentrated on technical astronomical aspects, with

⁸ F Yildirim, "The Qibla Direction Problem in Large-Scale Maps and Its Representation with Geodetic Accuracy: The Case of Türkiye," *International Journal of Engineering and Geosciences* 10, no. 2 (2025): 151–63, <https://doi.org/10.26833/ijeg.1531806>.

⁹ Ariba Khairunnisa et al., "Qibla Direction Determination in Historical Mosques: Methodological and Accuracy Assessment at Al-Anwar Grand Mosque, Bandar Lampung," *Al-Hilal: Journal of Islamic Astronomy* (UIN Walisongo Semarang, 2025), <https://doi.org/10.21580/al-hilal.2025.7.2.28139>.

¹⁰ A Nizam, Romli SA, and Yazwardi, "Divergence in Qibla Direction Determination: A Fiqh-Based Analysis and Its Societal Implementation," *Nurani: Jurnal Kajian Syari'ah Dan Masyarakat* 25, no. 2 (2025): 363–76, <https://doi.org/10.19109/nurani.v25i2.27891>.

¹¹ Muhajir Muhajir et al., "Traditional Wisdom and Modern Methods in Qibla Direction: A Multicultural Study of Sunan Geseng Great Mosque, Indonesia," *Kawanua International Journal of Multicultural Studies* 5, no. 2 (2024): 186–98, <https://doi.org/10.30984/kijms.v5i2.1178>.

¹² Nizam, SA, and Yazwardi, "Divergence in Qibla Direction Determination: A Fiqh-Based Analysis and Its Societal Implementation."

¹³ Youcef L Soufi, *The Rise of Critical Islam: 10th-13th Century Legal Debate* (Oxford University Press, 2023), <https://doi.org/https://doi.org/https://doi.org/10.1093/oso/9780197685006.003.0007>.

¹⁴ Iyan Hasjun, Andi Jusran Kasim, and Nur Astaman Putra, "Uji Akurasi Hasil Pengukuran Arah Kiblat Pegawai Kemasjidan Kua Menggunakan Aplikasi Google Earth," *Astroislamika: Journal of Islamic Astronomy* 3, no. 1 (2024): 114–35, <https://doi.org/https://doi.org/10.47766/astroislamika.v3i1.2796>.

only a limited number addressing a comprehensive analysis of Islamic law.¹⁵ This study aims to bridge this analytical gap by integrating astronomical-geodetic methods with contemporary *fiqh* research.¹⁶

Against this backdrop, the objective of this article is to integrate the fields of earth sciences and Islamic religious practice by analysing qibla deviations in mosques. Specifically, this study aims to achieve the following objectives: (1) to measure and quantify the degree of qibla deviation in selected mosques in the city of Pangkalpinang using precise geospatial techniques and verified astronomical instruments; and (2) to examine the legal implications of such deviations within the framework of Islamic jurisprudence, referencing the perspectives of traditional scholars and relevant contemporary fatwas.

The findings of this study are expected to offer valuable insights for local governments and the Muslim community in Pangkalpinang in ensuring the precision of the qibla direction, while also contributing to the academic discourse on the relationship between geodesy, Islamic jurisprudence, and mosque studies.

Methodology

This study employs a methodology grounded in an empirical-normative approach. This approach seeks to investigate the determination of the qibla not only from the standpoint of spatial accuracy but also in terms of religious validity, ensuring that empirical findings are assessed within the context of Islamic law. In this research, the determination of the qibla is conceptualised as a geospatial problem of directional orientation on the surface of a sphere, with the objective of calculating the great circle azimuth between a specific location and the Ka'bah based on geographic coordinates.¹⁷

The research was conducted in Pangkalpinang, Indonesia, focusing on twelve historic mosques within the city. The selection of these locations centred on mosques established prior to the widespread adoption of modern geospatial technology, thereby enhancing the likelihood of identifying deviations in qibla orientation. To measure the Qibla direction using the sun's shadow, various instruments were employed, including the Istiwaaini, theodolite, global positioning system (GPS), Google Earth Pro, and the Islamic Astro software. In addition, the Ephemeris Version 2.0 software and Jean Meeus's Astronomical Algorithm were utilised due to the precision of their astronomical calculations.¹⁸

Descriptive analytical techniques have been employed to elucidate and analyse the principles of Islamic law regarding the determination of the qibla and the components involved in its calculation. This methodology is used to assess the accuracy of the qibla direction of mosques by comparing the existing orientation with the scientifically calculated qibla direction, derived from modern astronomical computations and the tenets of Islamic law. An Islamic jurisprudential (*fiqh*) analysis has been undertaken to interpret the measured

¹⁵ P P Muslim, "Assuring Worship Accuracy: Engaging Classical Islamic Jurisprudence and Modern Falak Studies," *KANUN: Jurnal Ilmu Hukum* 27, no. 3 (2025): 727–44, <https://doi.org/https://doi.org/10.24815/kjih.v27i3.141>.

¹⁶ Badrun Taman et al., "Time-Related Rulings in Fiqh Munakahat: A Contemporary Integration of Astronomical and Jurisprudential Analysis," *MILRev: Metro Islamic Law Review* 4, no. 2 SE-Articles (2025): 797–821, <https://doi.org/https://doi.org/10.32332/8pvnz650>.

¹⁷ S Hussain, "The Mosque's Primary Spaces and the Required Direction of the Mosque Building," *Journal of Islamic Architecture* 7, no. 4 (2023): 719–35, <https://doi.org/http://dx.doi.org/10.18860/jia.v7i4.21497>.

¹⁸ Sartika Sartika, Hisbullah Salam, and Fakhruddin Mansyur, "Revitalizing Traditional Astronomical Instruments: Developing a Local Dial Model for Accurate Prayer Time Determination," *Al-Hilal: Journal of Islamic Astronomy* 7, no. 2 (2025): 241–52, <https://doi.org/https://doi.org/10.21580/al-hilal.2025.7.2.28952>.

discrepancies within the framework of Islamic law. This analysis draws upon both classical and contemporary fiqh literature, as well as relevant sources.¹⁹

Tolerance in qibla deviations

From the perspective of Islamic jurisprudence, there exists a degree of leniency regarding the requirement to face the qibla for individuals who are located at a considerable distance from the Ka'bah or outside the city of Mecca. In such instances, it is permissible to rely on a strong assumption (*ẓann*) that the direction one is facing is correct. This concession reflects the overarching spirit of Islam, which emphasises ease and facilitation in religious practices. Nevertheless, exerting effort (*ijtihād*) to ascertain the qibla remains highly recommended, as it provides greater accuracy, consistency, and spiritual reassurance during worship.²⁰

This flexibility is rooted in a prophetic tradition that asserts the Ka'bah functions as the qibla for individuals situated within the sacred mosque (*al-Masjid al-Ḥarām*), while the Sacred Mosque serves as the qibla for those within the sacred precinct (*al-Ḥarām*).²¹ Furthermore, the sacred precinct is designated as the qibla for individuals located beyond Mecca. This narration suggests that a certain degree of tolerance for error in qibla orientation is permitted for those who are at a considerable distance from the Ka'bah.

In Indonesia, the principal guideline for determining the qibla is articulated in the fatwa issued by the Indonesian Council of Ulama (MUI) No. 5 of 2010, which was published in Jakarta on 1 July 2010. This fatwa establishes three rulings: (1) for individuals who can visually perceive the Ka'bah, the qibla is the physical structure itself (*'aimul Ka'bah*); (2) for those who are unable to see the Ka'bah, the qibla is defined as its general direction (*jihhatul Ka'bah*); and (3) for Indonesian Muslims, the qibla is identified as the northwest direction, with specific variations contingent upon regional geography.²²

Despite these rulings, the issue of tolerance concerning qibla deviation continues to be a topic of scholarly debate. Ismail, Dikson T. Yasin, and Zulfiah delineate two forms of tolerance: (1) mathematical tolerance, which pertains to permissible deviation as determined through mathematical formulas; and (2) sociological tolerance, which relates to deviations in the construction of mosques or prayer halls based on social and practical considerations.²³

From a mathematical perspective, the distance between a given location and the Ka'bah can be calculated to ascertain the spatial deviation associated with each degree of angular error. For instance, calculations conducted at the Great Mosque of Baiturrahman in Gorontalo indicate that each degree of deviation corresponds to a displacement of 162.2 kilometres from the Ka'bah.²⁴

¹⁹ Taman et al., "Time-Related Rulings in Fiqh Munakahat: A Contemporary Integration of Astronomical and Jurisprudential Analysis."

²⁰ Nizam, SA, and Yazwardi, "Divergence in Qibla Direction Determination: A Fiqh-Based Analysis and Its Societal Implementation."

²¹ Ari M Gordon, "The Qibla: Ritual Orientation in the Formation of Islamic Collective Identity," in *Routledge Handbook of Islamic Ritual and Practice*, 1st Editio (London: Routledge, 2022), 409–21, <https://doi.org/https://doi.org/10.4324/9781003044659>.

²² R I Kementerian Agama, "Ephemeris Hisab Rukyat 2020" (Jakarta: Direktorat Jendral Bimbingan Masyarakat Islam, 2019).

²³ Ismail Ismail and Dikson T Yasin, "Toleransi Pelencengan Arah Kiblat Di Indonesia Perspektif Ilmu Falak Dan Hukum Islam," *Al-Mizan (e-Journal)* 17, no. 1 (2021): 115–38, <https://doi.org/https://doi.org/10.30603/am.v17i1.2070>.

²⁴ Ismail and Yasin.

Nonetheless, Ismail et al. argue that non-exact alignment with the Ka'bah can still be accommodated on two grounds:

1. The prophetic tradition reported by Ibn Ḥibbān, which establishes distinct levels of qibla obligation for individuals situated within the Sacred Mosque, within the Sacred Precinct, and beyond it. Indonesia, being geographically distant, belongs to the third category, where orientation towards the Sacred Precinct is adequate, thus permitting flexibility.
2. The precedent established by the Prophet in the construction of the Quba Mosque, located 336 kilometres from the Ka'bah. Historical evidence indicates that the qibla of the mosque did not align precisely with the Ka'bah, deviating approximately 45 kilometres westward, corresponding to an angular difference of 7° 38'.

From a sociological perspective, minor deviations are deemed acceptable provided they do not manifest visibly within the prayer rows (*ṣufūf*) or the orientation of worshippers. A deviation of less than 4 degrees is regarded as negligible, as it does not result in a discernible alteration in body alignment.²⁵ Thomas Djamaluddin, as referenced in the research conducted by Muhammad Adieb, has observed that while it is imperative to strive for precise alignment with the Ka'bah, deviations of up to 2 degrees are permissible, as such discrepancies do not significantly impact body posture or the alignment of the prayer rows.²⁶

Subsequent analyses conducted by Ismail et al. investigated bodily movements during prayer, concluding that a deviation of up to 5 degrees (approximately 6 cm of lateral movement) is considered tolerable, as it does not represent a significant divergence from the qibla.²⁷ In light of these findings, a tolerance margin of up to 6 degrees has been proposed as sociologically acceptable, acknowledging that minor bodily shifts to the left or right are inevitable during the act of prayer.

In contrast, scholars such as Slamet Hambali and Masruri Mughni contest the concept of tolerance concerning qibla deviation. They assert that, from an astronomical standpoint, the qibla can be ascertained with a high degree of precision.²⁸ For Indonesian Muslims, the qibla is defined as the Ka'bah, with Mecca representing the maximum permissible margin of orientation, in accordance with the hadith reported in Sunan al-Bayhaqī.²⁹ This perspective is consistent with the Shāfi'ī school of thought, which mandates that distant Muslims engage in calculation and measurement to ascertain the correct qibla.³⁰

²⁵ Thomas Djamaluddin, "Tidak Ada Perubahan Arah Kiblat," *Wordpress*, 2010, <https://tdjamaluddin.wordpress.com/2010/07/17/tidak-ada-perubahan-arrah-kiblat/>.

²⁶ Dimas Syarief Hidayatullah et al., "Accuracy Analysis of Gps Technology in Identifying the Qibla Direction of Darussalam Mosque, Makassar," *ELFALAKY* (Universitas Islam Negeri Alauddin Makassar, 2025), <https://doi.org/10.24252/ifk.v9i2.63083>.

²⁷ Ismail and Yasin, "Toleransi Pelencengan Arah Kiblat Di Indonesia Perspektif Ilmu Falak Dan Hukum Islam."

²⁸ Mau'idhatul Hasanah Ridwan Nanaridwan, Ahmad Izzuddin, and Fatmawati Hilal, "The Concept of Qibla Direction in Sayyid Usman's Tahrir Aqwa Al-Adillah Fi Tahsil 'Ain Al-Qiblah," *AL - AFAQ: Jurnal Ilmu Falak Dan Astronomi* (State Islamic University (UIN) Mataram, 2025), <https://doi.org/10.20414/afaq.v7i1.13400>.

²⁹ Akhmad Hanafi Dain Yunta, Ahmad Syaripudin, and Junaedi Junaedi, "Arah Kiblat Dalam Salat: Menyikapi Perbedaan Antara Mazhab Hanafi Dan Syafi'i: Qibla Direction in Prayer: Responding to the Differences Between Hanafi and Shafi'i School," *BUSTANUL FUQAHA: Jurnal Bidang Hukum Islam* 2, no. 3 SE-Articles (n.d.): 380–95, <https://doi.org/10.36701/bustanul.v2i3.404>.

³⁰ Ahmad Bukhari Muslim, Rodhy Harisca, and Ahmad Basyori, "The Impact of Arabic Literacy on Understanding Quranic Verses," *KnE Social Sciences* 9, no. 12 (2024): 564–78, <https://doi.org/10.18502/kss.v9i12.15881>.

Hambali further classifies the accuracy of qibla orientation into four categories:³¹

1. Highly accurate: when the orientation aligns precisely with the Ka'bah.
2. Accurate: when the deviation remains within the tolerance criterion established by Prof. Dr. Thomas Djamaluddin, specifically no more than 0° 42' 46.43".
3. Less accurate: when the deviation ranges between 0° 42' 46.43" and 22° 30'.
4. Inaccurate: when the deviation exceeds 22° 30', as such an orientation for Indonesia would result in alignment toward due west rather than the Ka'bah.

Qibla orientation issues and geospatial approaches in Indonesia

The accuracy of Qibla directions in Indonesia constitutes a significant concern, particularly for mosques established prior to the widespread use of modern measurement technologies. Many mosques were constructed based on visual estimation, local cardinal directions, or the use of magnetic compasses without appropriate adjustments for magnetic declination.³² This has resulted in Qibla orientations that do not consistently align precisely with the Ka'bah. Indonesia's geographical status as an archipelagic nation, situated at a considerable distance from Makkah, further exacerbates the potential for error, as even minor inaccuracies in directional determination can lead to substantial deviations from the true Qibla direction.³³

The factors contributing to this issue include a limited understanding of astronomical and geospatial concepts among local communities and mosque administrators, an overreliance on traditional methods devoid of scientific verification, and the absence of standardized technical guidelines for Qibla determination at the time of construction. Furthermore, the prevailing perception that existing Qibla orientations should remain uncorrected to uphold tradition and social harmony has frequently impeded systematic re-evaluation efforts, thereby allowing inaccuracies to persist over time.³⁴

In this context, geospatial technology emerges as a scientifically grounded solution to address inaccuracies in determining the Qibla direction. The geospatial determination of the Qibla is predicated on the Earth's coordinate system, wherein the Qibla direction is defined as the shortest azimuth (great-circle direction) from a specified location to the Ka'bah.³⁵ This methodology necessitates accurate latitude and longitude data, precise identification of true north, and rigorous geodetic calculations, thereby facilitating the determination of the Qibla direction in a measurable, objective, and verifiable manner. The integration of geospatial technology permits a quantitative evaluation of mosque orientations and the degree of

³¹ Yunta, Syaripudin, and Junaedi, "Arah Kiblat Dalam Salat: Menyikapi Perbedaan Antara Mazhab Hanafi Dan Syafi'i: Qibla Direction in Prayer: Responding to the Differences Between Hanafi and Shafi'i School."

³² Hosen, "Tagyîr Mawdhî' Inhirâf Qiblat Al-Masjid Fî Bamîkasân 'Alâ Asasi Al-Tiknôlôjiyya Al-Mutaqaddimah: Al-Tahlîla Al-Ijtimâ'î Wa Al-Tsaqâfî," *Al Ihkam Jurnal Hukum Dan Pranata Sosial* 18, no. 2 (2023): 591–625, <https://doi.org/10.19105/al-lhkam.v18i2.8939>.

³³ Muhammad Habibul Amin, Dhiauddin Tanjung, and Hasan Matsum, "THE USE OF KOMPAS IN DETERMINING THE ACCURACY OF QIBLA DIRECTION (CASE STUDY ON MOSQUES IN SERDANG BEDAGAI REGENCY)," *SOSIOEDUKASI: JURNAL ILMIAH ILMU PENDIDIKAN DAN SOSIAL* 14, no. 1 (2025): 601–12, <https://doi.org/10.36526/sosioedukasi.v14i1.5701>.

³⁴ Nizam, SA, and Yazwardi, "Divergence in Qibla Direction Determination: A Fiqh-Based Analysis and Its Societal Implementation."

³⁵ Girindra Sulistiyo Wardoyo and Ahmad Azhari, "K-Nearest Neighbors for Fast and Accurate Qibla Direction Determination," *Mobile and Forensics* (Universitas Ahmad Dahlan, 2025), <https://doi.org/10.12928/mf.v7i1.12781>.

deviation from the ideal Qibla direction.³⁶

One practical implementation of geospatial technology in Qibla determination is the Islamic Astro application, which employs geographic coordinate data and astronomical calculations to compute the Qibla azimuth with a high degree of accuracy. The application operates on principles consistent with modern geospatial methods, enabling it to function as an effective tool for verifying and evaluating mosque Qibla orientations. In both research and field applications, Islamicastro serves as a conduit between scientific concepts and practical needs, as its calculated results can be directly compared with existing Qibla orientations on-site. Consequently, the utilization of geospatial-based applications not only enhances measurement efficiency but also supports greater accuracy and standardized Qibla determination within contemporary religious practice.³⁷

Empirical findings from Pangkalpinang's mosques

The measurement results indicate that all surveyed mosques in Pangkalpinang City exhibit measurable deviations from the calculated qibla direction, with values ranging from 0.54° to 38.63°. This finding confirms that inaccuracies in mosque orientation remain a significant issue, particularly for structures constructed prior to the widespread adoption of modern geospatial technologies.³⁸

The qibla direction data for the mosques obtained through this method were subsequently compared with the existing qibla directions. This comparison assessed the accuracy of the observed deviations and determined whether the directions were already aligned with the results calculated using the combined method. The findings from the selected mosques are as follows:

Table 1. Comparative analysis of qibla direction data and established qibla orientation

No		Right Direction	Existing Direction	Qibla Deviation
1	Jami Mosque	293,97°	297,17°	3,20°
2	Sabilul Muhtadin Mosque	293,97°	295,00	1,03°
3	Al-Hikam Mosque	293,97°	332,60°	38,63°
4	Baitul Makmur Mosque	293,97°	292,30°	1,67°
5	Al-Ala Mosque	293,96°	295,06°	1,10°
6	Al-Karomah Mosque	293,97	295,80°	1,83°
7	Al-Aziz Mosque	293,97°	294,76°	0,79°
8	Khoirul Baiti lil Muslimin	293,97°	295,05°	1,08°
9	Al-Furqan Mosque	293,96°	295, 69°	2,27°
10	Jami Al-Husna Mosque	293,96°	294,76°	0,80°
11	Al-Hijrah Mosque	293,97°	297,99°	4.02°
12	Tuatunu Great Mosque	293,97°	294,51°	0,54°

³⁶ Sri Wahyuni, Samsuddin Samsuddin, and Ekawati Hamzah, "Qibla Direction Accuracy Analysis Based on Astronomy (Google Earth), Perspective of Islamic Law," *Journal of Islam and Science* (Universitas Islam Negeri Alauddin Makassar, 2022), <https://doi.org/10.24252/jis.v9i1.30111>.

³⁷ Hasjun, Kasim, and Putra, "Uji Akurasi Hasil Pengukuran Arah Kiblat Pegawai Kemasjidan Kua Menggunakan Aplikasi Google Earth."

³⁸ Abd. Haji Amahoru et al., "Identification of Mosque Qibla Azimuth Accuracy Based on Four-Direction Laser System in Seram Utara Timur Kobi," *Jurisprudensi: Jurnal Ilmu Syariah, Perundang-Undangan Dan Ekonomi Islam* (IAIN Langsa, 2025), <https://doi.org/10.32505/jurisprudensi.v17i2.11226>.

Based on the measurement data of qibla orientation from twelve mosques in Pangkalpinang City and in accordance with the categorisation established by Slamet Hambali, none of the mosques were classified within the accurate category (deviation $< 0.42^\circ$). This finding indicates that all of the mosques examined demonstrated some degree of deviation from the ideal qibla direction.

The majority of mosques, specifically twelve in total, were classified as inaccurate, with deviations recorded below 0.42° . These mosques include Jami Mosque (3.2°), Sabilul Muhtadin Mosque (1.03°), Baitul Makmur Mosque (1.67°), Al-Ala Mosque (1.1°), Al-Karomah Mosque (1.83°), Al-Aziz Mosque (0.79°), Khoirul Baiti lil Muslimin Mosque (1.08°), Al-Furqan Mosque (2.27°), Jami Al-Husna Mosque (0.8°), and Tuatunu Great Mosque (0.89°). The deviations in this group are relatively minor and remain within the tolerance levels recognised in Islamic jurisprudence; however, technical adjustments are still necessary to achieve precise alignment with the true qibla.

Meanwhile, two mosques exhibited greater deviations. Al-Hijrah Mosque demonstrated a deviation of 4.02° , which remains within the slightly inaccurate category, whereas Al-Hikam Mosque presented a notably significant deviation of 38.63° , categorising it as inaccurate. The situation regarding Al-Hikam Mosque is particularly noteworthy, as its deviation significantly exceeds the acceptable tolerance threshold, indicating a fundamental error in the determination of the qibla direction during its construction.³⁹

The findings outlined above possess considerable implications for the domain of applied astronomy, particularly within the context of Islamic astronomy (*'ilm al-falak*).⁴⁰ The results substantiate that the orientation of the qibla continues to present an empirical challenge in religious practice, especially in mosques that have been constructed without the assistance of precise astronomical and geospatial methodologies. This study underscores the strategic role of astronomy—specifically geospatial technology—as a corrective instrument in religious practice while emphasising the necessity of verifying the qibla direction of existing mosques through standard measurement procedures.

Modern technology and Islamic jurisprudence

There exists an intersection between technology and spirituality, wherein the integration of modern astronomy and Islamic jurisprudence is not merely a convergence of two academic disciplines but rather a harmonious functional synergy. In this context, astronomy (*'ilm al-falak*) and, more specifically, geospatial technology, do not serve as challengers to religious authority; instead, they function as servants (*khādim*) to jurisprudence by providing accurate data for the proper implementation of Islamic law. The determination of the qibla direction through spherical trigonometry and satellite-based geographic coordinate data enables Muslims to identify the direction of the Ka'bah with a high level of precision. This synergy demonstrates that human reason, expressed through scientific inquiry, can indeed strengthen religious conviction by eliminating doubt (*shakk*) in the performance of religious worship.⁴¹

From the perspective of Islamic law, the accuracy of the qibla direction constitutes a

³⁹ Nizam, SA, and Yazwardi, "Divergence in Qibla Direction Determination: A Fiqh-Based Analysis and Its Societal Implementation."

⁴⁰ Choirul Abdullah et al., "The Contribution of Astronomy in Determining the Direction of the Qibla and the Hijri Calendar in the 8th–14th Centuries CE," *Al-Qarawiyin: Jurnal Ilmu Ushuluddin* (Yayasan Albahriah Jamiah Indonesia, 2025), <https://doi.org/10.64691/3ww03e18>.

⁴¹ Hidayatullah et al., "Accuracy Analysis of Gps Technology in Identifying the Qibla Direction of Darussalam Mosque, Makassar."

component of a declaratory ruling (*hukmu al-waḍ'ī*), serving as a prerequisite for the validity of prayer. In this context, contemporary technologies such as GPS, theodolites, and digital applications play an essential role in objectively ensuring the validity of this act of worship.⁴² Historically, the determination of the qibla relied on observations of celestial bodies or the manual tracking of shadows, methods that frequently involved significant margins of error. However, modern instruments today provide a greater degree of legal certainty (*tahqīq*), offering reassurance to the conscience of the Muslim community. The utilization of scientific methods guarantees that the technical aspects of worship are no longer a matter of speculation but rather a form of mathematical certainty that underpins the proper and complete performance of religious devotion.⁴³

While technology provides a significant degree of precision, Islamic jurisprudence maintains a level of flexibility (*rukḥṣah*) to ensure that the Islamic law does not impose undue burdens (*mashaqqah*) on believers. Classical jurists differentiate between *'ainul Ka'bah* — directly facing the physical structure of the Ka'bah—for those within the Sacred Mosque and *jihhatul Ka'bah* —facing the general direction of the Ka'bah—for individuals located at a distance from Mecca. This allowance for tolerance demonstrates that Islam acknowledges human and environmental limitations. Consequently, if minor directional deviations occur due to instrumental limitations or the structural conditions of buildings, the act of worship remains valid, provided that sincere effort (*ijtihād*) has been undertaken. This principle is in accordance with the well-established legal maxim that hardship begets facilitation (*al-mashaqqah tajlibu al-taysīr*).⁴⁴

Most scholars concur that facing the qibla constitutes one of the essential conditions for the validity of prayer.⁴⁵ But there's debate about how to face the qibla: must one look at it or just orient oneself in its general direction? Physically facing the Ka'bah (*'ainul Ka'bah*) is straightforward for individuals situated within the Masjid al-Haram and its immediate vicinity, but it presents challenges for those located at a greater distance. Consequently, differing opinions emerge; nevertheless, the majority of schools of Islamic jurisprudence maintain that it suffices to face the direction of the qibla (*jihhatul Ka'bah*)—it is not imperative to align oneself precisely with the Ka'bah building itself.⁴⁶ The Ka'bah structure is 12.86 meters long on the east and west sides and 11.03 meters wide on the north and south sides. Therefore, determining the direction of the qibla is facilitated in the contemporary technological era, provided that one observes the boundaries of the Haram area: 22 km to the west, 12 km to the south, and 15 km to the east.⁴⁷ This study indicates that the paramount consideration remains adherence to the minimum boundaries of the qibla direction (*jihhatul Ka'bah*), as a deviation of

⁴² Ahmad Izzuddin, Muhammad Habibur Rahman, and Muhammad Himmatur Riza, "Teleskop Ioptron Cube II Dalam Penentuan Arah Kiblat," *AL - AFAQ: Jurnal Ilmu Falak Dan Astronomi* 3, no. 1 (2021): 25–40, <https://doi.org/10.20414/afaq.v3i1.2776>.

⁴³ Muhammad Himmatur Riza, Thomas Djamaluddin, and Ahmad Izzuddin, "Transformation of Prayer Time Schedules: From A Static-Passive to A Dynamic-Variative Perspective," *Ulul Albab: Jurnal Studi Dan Penelitian Hukum Islam* 6 (n.d.): 39–58, <https://doi.org/10.30659/jua.v6i1.22826>.

⁴⁴ U Nihayah et al., "Mosque Management for the Prosperity of the Congregation in Mosque Typology in Kendal Regency, Community Empowerment Perspective," *Prosperity: Journal of ...* 5, no. 2 (2025): 136–58, <https://doi.org/https://doi.org/10.21580/prosperity.v5i2.25673>.

⁴⁵ Muhammad Az-Zuhaily, *Al-Mu'tamad Fi Al-Fiqh Asy-Syafii* (Damaskus: Dar Al-Qolam, 2011).

⁴⁶ Muhammad bin Ali bin Muhammad bin Abdurrahman al-Hanafi Al-Haskafi, *Ad-Dar Al-Mukhtar Syarh Tanwirul Absar Wa Jami Al-Bihar* (Beirut: Dar Al-Kutub Al- Ilmiyyah, 2002).

⁴⁷ Nadya Afidati and Nuril Atfiani, "Peran Ibnu Abbas Dalam Perkembangan Hadis Di Makkah," *CENDEKIA: Jurnal Studi Keislaman* 11, no. 1 (2025): 121–38, <https://doi.org/https://doi.org/10.37348/cendekia.v11i1.545>.

merely 1° in Indonesia can result in a displacement of approximately ±90 until 140 km, contingent upon the specific region.⁴⁸

Determining the direction of the qibla for a mosque must be conducted with high precision and accuracy in the current technological era, given the accessibility of astronomical data that provides accurate and scientifically validated coordinates.⁴⁹ Consequently, the considerable distance between Indonesia and the Ka'bah in Mecca does not serve as a justification for imprecision; the qibla direction of a mosque must be meticulously aligned with the qibla. A mosque serves as a permanent place of worship for Muslims, which cannot be relocated. Therefore, it is imperative to ensure the correct qibla direction when employing geospatial technology, adhering to a standard accuracy tolerance limit of $\leq 0.17^\circ$. This threshold ensures that the qibla direction remains within the general orientation towards the Haram area,⁵⁰ thereby satisfying the requirements for valid prayer and promoting stability during worship.

Ultimately, the synergy between astronomy and Islamic jurisprudence fosters a conducive environment for religious practice within contemporary Muslim communities. Tradition does not suffer from modernity; instead, it improves the efficiency and measurability of religious teachings. By employing scientific data, Muslims can fulfill their religious obligations without worrying about the validity of their worship while simultaneously benefiting from the conveniences afforded by technological innovation.⁵¹ This reality affirms that Islam is a religion that is adaptive and inclusive of contemporary developments, wherein the truth of revelation and the truth of science can coexist harmoniously for the benefit (*maṣlaḥah*) of humanity.⁵²

Conclusion

This study demonstrates that all surveyed mosques in Pangkalpinang City exhibit deviations in their qibla orientation; however, the majority of these deviations remain unacceptable from a *fiqh* astronomy perspective. One mosque was identified as having a significant misalignment exceeding 30°, which indicates a fundamental error in the determination of the qibla direction.

From the perspective of Islamic jurisprudence, these findings reaffirm the existence of legal concessions concerning deviations from the qibla, particularly for Muslim communities situated at a considerable distance from the Ka'bah. Principles such as *al-'umūm al-balwā*, *al-mashaqqah tajlibu al-taysir*, and contemporary fatwas permit a degree of tolerance, provided that the orientation remains within the parameters of facing the Ka'bah. However, with the advancement of modern technology, Muslims are now capable of achieving significantly

⁴⁸ Shofwatul Aini, "Uji Akurasi Rasd Al-Qiblat Global Sebagai Metode Penentuan Arah Kiblat," *Al-Ahkam: Jurnal Ilmu Syari'ah Dan Hukum* 7, no. 1 (2022): 57–71, <https://doi.org/10.22515/alakhkam.v7i1.5412>.

⁴⁹ Sakirman Sakirman, A Jamil A Jamil, and Moelki Fahmi Ardliansyah, "Dynamics of Qibla Direction of the Great Mosque: (Study of Accuration and Verification of Geographic Coordinate Points)," *KULMINASI: Journal of Falak and Sharia* 1, no. 1 (2023): 1–21, <https://doi.org/https://doi.org/10.22373/kulminasi.v1i1>.

⁵⁰ Emyllia Fatmawati, "Perspektif Hadis Arah Kiblat Tanah Haram," *AL-AFAQ: Jurnal Ilmu Falak Dan Astronomi* 3, no. 1 (2021): 59–76, <https://doi.org/https://doi.org/10.20414/afaq.v3i1.2335>.

⁵¹ Ahmed Aboud Alwan, Iman Jalil Ibrahim, and Shifa Rasheed Hussein, "The Impact of Technology on Contemporary Jurisprudential Ijtihad: Worship as a Model," *Journal of Cultural Analysis and Social Change* 10, no. 2 SE-Articles (November 2025): 118–27, <https://doi.org/10.64753/jcasc.v10i2.1569>.

⁵² Fakhrrurrazi Fakhrrurrazi, Nur Wasilah, and Hendra Jaya, "Islam and Knowledge: Harmony between Sciences and Faith," *Journal of Modern Islamic Studies and Civilization* 2, no. 01 (2023): 45–57, <https://doi.org/10.59653/jmisc.v2i01.416>.

greater accuracy, rendering adjustments to mosque orientations both necessary and desirable as a means of refining worship.

This research thus serves as a bridge between astronomical-geodetic studies and *fiqh* analysis. It also offers practical recommendations for Muslim communities and religious authorities to reassess and realign mosque orientations. Such efforts are essential to uphold the validity of prayer, strengthen communal unity in worship, and exemplify the commitment of Muslims to implementing Islamic law in accordance with contemporary scientific knowledge.

This study presents a novel contribution by proposing an integrated geospatial-*fiqh* evaluation framework, wherein geospatial measurement functions as empirical evidence and *fiqh* serves as a normative validation system with a tolerance of $\leq 0.17^\circ$. This framework not only enhances the scientific investigation of qibla determination but also offers a practical model for improving the accuracy of mosque orientation in contemporary Muslim societies.

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