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Assessment of Qibla Direction Accuracy at Tanwir Mosque, Surabaya,Using Theodolite Measurements

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ABSTRACT

Every Muslim is obliged to perform the five daily prayers, the validity of whichis contingent upon the fulfillment of several essential conditions, one of which is observing the prescribed prayer times. In addition, the orientation toward the Qibla constitutes a fundamental requirement that must be determined accurately based on geographical location. Regions situated to the east of the Kaaba are required to face westward in determining the Qibla direction, and conversely, regions located to the west must face eastward. This study aims to examine the accuracy of the Qibla direction at the Tanwir Mosque in Surabaya using a theodolite. The research employed a field-based observational method to obtain precise empirical data. The theodolite, as a modern surveying instrument, is widely recognized for its high level of precision in angular measurements. The findings indicate that minor discrepancies exist among measurements obtained using different instruments; however, these differences remain within acceptable tolerance limits. Compared to other measurement tools, the theodolite demonstrates the highest degree of accuracy. This research is significant in ensuring the correctness of the Qibla direction and in enhancing public awareness regarding the importance of precision in the performance of religious worship.

ARTICLE INFO

ABSTRAK

Setiap umat Muslim wajib melaksanakan salat lima waktu, yang harus memenuhi beberapa syarat agar sah, salah satunya adalah pelaksanaan di waktu yang tepat. Selain itu, arah kiblat juga harus sesuai,

tergantung pada lokasi geografis. Jika suatu daerah berada di timur Kakbah, arah kiblatnya menghadap ke barat, dan sebaliknya, sesuai posisi wilayah tersebut. Penelitian ini bertujuan untuk mengecek keakuratan arah kiblat di Masjid Tanwir Surabaya dengan alat Theodolite. Penelitian dilakukan melalui observasi langsung di lapangan untuk mendapatkan data yang akurat. Theodolite, sebagai alat ukur modern yang biasa digunakan dalam survei, memberikan hasil yang sangat presisi. Hasil penelitian menunjukkan ada perbedaan kecil dalam pengukuran menggunakan beberapa alat, tetapi masih dalam batas wajar. Dibandingkan alat lain, Theodolite memberikan hasil paling akurat. Penelitian ini penting untuk memastikan arah kiblat yang benar dan meningkatkan kesadaran akan pentingnya ketepatan dalam menjalankan ibadah.

INTRODUCTION

Every Muslim is religiously obligated to perform the five daily prayers. The validity of this act of worship is contingent upon the fulfillment of several essential conditions prescribed by Islamic law. One of the fundamental requirements is that the prayer be performed within its designated time. In addition to temporal accuracy, spatial orientation also plays a crucial role in the validity of prayer. Specifically, facing the Qibla constitutes a mandatory condition that must be fulfilled. According to Islamic jurisprudence, Muslims are required to orient themselves toward the Qibla when performing their prayers, regardless of their geographical location.[1]

In *'ilm al-falak* (Islamic astronomy), the Qibla is defined as the shortest direction leading toward the Kaaba at the time of performing prayer. The Kaaba, also known as *Bayt Allāh* (the House of God), is a sacred structure that serves as the central

[1]Anwar Anwar, Bukhari Bukhari, and Andi Mardika, "Bridging Law and Astronomy: The Influence of Astronomy on Islamic Law," *Astroislamica: Journal of Islamic Astronomy* 3, no. 2 (December 1, 2024): 156–70, https://doi.org/10.47766/astroislamica.v3i2.3646.

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focal point of worship for Muslims worldwide. This building is located in the city of Mecca, Saudi Arabia, and its name is derived from the Arabic word *muka'ab*, meaning "cube," which reflects its cubic form.[2] From this term, the name "*Kaaba*" is derived. This structure holds profound spiritual significance in the life of Muslims, as it not only serves as the focal point of the Qibla direction but also symbolizes the unity of the Muslim community worldwide.[3] Every day, millions of Muslims from different parts of the world face the Kaaba during the performance of prayer, reflecting a unity of faith and purpose in worshiping Allah.[4]

The Kaaba is not only the central focal point of the daily prayer but also plays a crucial role in the rituals of Hajj and Umrah, in which one of the principal rites is *ṭawāf*, or circumambulation of the Kaaba. Consequently, the Qibla—defined as the direction facing the Kaaba—constitutes a fundamental orientation in Islamic worship. Ensuring the accuracy of the Qibla direction is therefore a shared responsibility, particularly in the planning and construction of mosques and other prayer facilities, so that Muslims may perform their prayers with full confidence in the correctness of the Qibla orientation.[5]

In this study, the theodolite was selected as the primary instrument for measuring the Qibla direction. The choice of the theodolite was based on its recognized capability as a modern surveying instrument that offers a high level of accuracy in

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[2]Jayusman, *Ilmu Falak Fiqh Hisab Rukyat* (Banten: Media Edu Pustaka, 2022), 3.

[3]Ismail Ismail, "Akurasi Waktu Jam Masjid Di Kota Lhokseumawe," *Jurnal Al-Ijtimaiyyah* 6, no. 1 (2020): 75, https://doi.org/10.22373/al-ijtimaiyyah.v6i1.6301.

[4]Muhammad Jayusman, "Hukum Islam Dan Astronomi" X, No. 2, no. 3 (2011).

[5]Nurul Izza and Sartika Sartika, "Implementation of L-Qibla for Qibla Direction Indicators in Graves," *Astroislamica: Journal of Islamic Astronomy* 4, no. 1 (June 1, 2025): 142–61, https://doi.org/10.47766/ASTROISLAMICA.V4I1.3938.

directional measurements. In addition, this research employed the right-triangle method, which involves trigonometric calculations to determine the Qibla direction.[6] This method was implemented by first determining the true north direction and the Qibla angle at the selected location. By combining these two approaches, the study aimed to examine the accuracy and precision of Qibla direction measurements. The research was conducted at Tanwir Mosque, located at Jl. Masjid No. 37 A, Asemrowo, Asemrowo District, Surabaya.

Based on these considerations, the researchers were motivated to conduct further investigation by remeasuring the Qibla direction of the mosque using more modern methods and more accurate instruments. The primary objective of this study is to obtain a more comprehensive understanding of the correct Qibla direction and to evaluate the extent to which the accuracy and precision of modern measurement instruments can enhance Muslims' awareness of the importance of correct Qibla orientation in the performance of prayer. Accordingly, this research aims not only to verify the accuracy of the Qibla direction, but also to contribute to the improvement of the quality of worship among the Muslim community at Tanwir Mosque and its surrounding areas.

The theodolite was employed as the main instrument for measuring horizontal and vertical angles with a high degree of accuracy, including for the determination of the Qibla direction. Its distinction from other measuring tools lies in its method of operation. While other instruments may rely on map-based calculations or compass directions, the theodolite utilizes the position of the Sun as a reference point, allowing for more precise and reliable determination of directional measurements.[7] Its application involves directly sighting the

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[6] 'Alamul Yaqin and Iqbal Kamalludin, "Qibla Direction of the Historical Mosque in Pekalongan City: Accuracy and Tolerance," *AL - AFAQ : Jurnal Ilmu Falak Dan Astronomi* 6, no. 2 (October 20, 2024): 135–50, https://doi.org/10.20414/afaq.v6i2.11149.

[7] Kusdiyana Kusdiyana et al., "A Comparative Study of Islamic Astronomy and Jurisprudence on the Qibla Direction of Historical Mosques in Cirebon Indonesia," *Jurnal Ilmiah Mizani: Wacana Hukum, Ekonomi Dan*

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Sun through the theodolite's optical lens, which is then used to calculate the precise angle corresponding to the Qibla direction. This method enables highly accurate determination of the Qibla orientation, as the position of the Sun can be calculated astronomically and integrated with angular measurements obtained through the theodolite.[8]

In February 2010, the Indonesian Council of Ulama (Majelis Ulama Indonesia, MUI) issued Fatwa No. 3 of 2010 concerning the determination of the Qibla direction in Indonesia.[9] This fatwa outlines three principal guidelines regarding the determination of the Qibla direction:

1. For individuals who are able to directly see the Kaaba, the Qibla direction during prayer is to face the physical structure of the Kaaba itself.
2. For individuals performing prayer who are unable to see the Kaaba directly, the Qibla direction is to orient one's body and face toward the Kaaba.
3. Based on Indonesia's geographical position, which lies to the east of the Kaaba, Muslims in Indonesia are required to face west when performing prayer.[10]

In addition to issuing the fatwa, the Indonesian Council of Ulama (Majelis Ulama Indonesia, MUI) also provided important guidance regarding the adjustment of the Qibla direction in Indonesia. The fatwa recommends that mosques and prayer halls (musala) whose Qibla orientation is already directed

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Keagamaan 11, no. 2 (October 26, 2024): 450, https://doi.org/10.29300/mzn.v11i2.4902.

[8]Ismail Ismail, "Standar Operasional Prosedur (SOP) Kalibrasi Arah Kiblat Masjid Di Era Digital," *Al-Marshad: Jurnal Astronomi Islam Dan Ilmu-Ilmu Berkaitan* 5, no. 1 (June 20, 2019): 90–110, https://doi.org/10.30596/jam.v5i1.3126.

[9]Annisa Mawarni and Dhiauddin Tanjung, "Problematics of Qibla Direction Determination in Sei Lepan Brandan District, Langkat Regency (Analysis of MUI Fatwa No. 5 of 2010 on the Amendment of MUI Fatwa No. 3 of 2010)," *Journal of Law, Politic and Humanities* 4, no. 3 (March 30, 2024): 227–38, https://doi.org/10.38035/jlph.v4i3.341.

[10]Fatwa Majelis Ulama Nomor 03 Tahun 2010 Tentang Arah Kiblat

generally toward the west do not require major alterations, such as demolition, extensive renovation, or structural modification of the building. Although the existing Qibla orientation may not be fully precise, the necessary correction can be implemented through a simple adjustment, namely by realigning the prayer rows (ṣaff) to correspond with the corrected and more accurate Qibla direction.

This approach is intended to avoid substantial losses resulting from building demolition or reconstruction, which may involve significant financial costs and prolonged time. By adjusting only the orientation of the prayer rows, Muslims can continue to perform prayers facing the correct Qibla direction without disrupting the physical structure of the mosque or prayer hall. Such an adjustment offers a practical solution while maintaining respect for existing religious buildings.[11]

Furthermore, MUI urges all Muslims in Indonesia to take proactive measures to ensure that the Qibla orientation of their mosques and prayer halls is in accordance with the correct requirements. This includes rechecking the Qibla direction using more accurate methods or instruments, in line with the principles stipulated in the fatwa. By adhering to this guidance, it is expected that Muslims in Indonesia will be able to perform their prayers with full confidence that they are facing the correct Qibla direction, as prescribed by Islamic law.

METHOD

In writing the article entitled *"Analysis of Qibla Direction Calculation Using a Theodolite (An Analytical Study of Tanwir Mosque, Asemrowo, Surabaya)"*, the data collection methods employed include direct observation and field measurement. The researcher determined the Qibla direction using a theodolite in order to obtain highly accurate results. In addition,

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[11]Arwin Juli Rakhmadi Butar-Butar et al., "The Feasibility Study of Barus City as the New Astrotourism Destination from Astronomical and Meteorological Aspect," *Journal of Physics: Conference Series* 2214, no. 1 (February 1, 2022): 012026, https://doi.org/10.1088/1742-6596/2214/1/012026.

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interviews were conducted with the management board (*takmir*) of Tanwir Mosque to gather further information regarding the mosque. Supporting literature, such as scholarly articles, academic journals, and relevant websites, was also utilized to enrich and substantiate the collected data.

RESULTS AND DISCUSSIONS

The term *Qibla* refers to the direction that Muslims are required to face when performing the ritual prayer (*ṣalāh*), namely toward the Kaʿbah in Makkah. According to the *Kamus Besar Bahasa Indonesia* (KBBI), Qibla is defined as the direction oriented toward the Kaʿbah during prayer. In Arabic, direction is expressed by the terms *jihah* or *al-shaṭrah*, and it is also commonly referred to as *qiblah*. Ibn Manẓūr explains that the word *qiblah* is derived from the same root as the term for direction in Arabic, namely *al-jihah* or *al-shaṭrah*. Ibn ʿArabī and al-Qurṭubī further clarify that, linguistically, *shaṭrah* denotes half of something or a specific orientation, while *al-qiblah* signifies facing or directing oneself toward a particular direction. The term originates from the Arabic root *qabala–yaqbulu–qiblatan*, which means "to face" or "to orient oneself toward" a particular direction—specifically, in this context, facing the Kaʿbah during prayer.[12]

Terminologically, the Qibla is defined as the direction that Muslims are required to face when performing the ritual prayer (*ṣalāh*). For those who are in close proximity to the Kaʿbah and are able to see it directly, the prayer is considered valid only if they face the Kaʿbah itself (*ʿayn al-Kaʿbah*). Conversely, for those who are located far from the Kaʿbah and

[12]Sukron Ahmad, "Studi Akurasi Arah Kiblat Masjid Baiturrohim Desa Ganting Kec. Gedangan, Kabupaten Sidoarjo: Analisis Menggunakan Metode Bayang-Bayang Azimuth" (Skripsi, Surabaya, UIN Sunan Ampel Surabaya, 2013), 18.

are unable to see it, they are required to exercise *ijtihād* in determining and facing the correct Qibla direction.[13]

After the time of Prophet Ismāʿīl, the custodianship of the Kaʿbah was continued by his descendants and subsequently assumed by the tribes of Banū Jurhum and Banū Khuzaʿah, who at that time practiced idol worship. Later, the responsibility for maintaining the Kaʿbah was transferred to the Quraysh tribe. Prior to the advent of Islam, ʿAbd al-Muṭṭalib, the grandfather of the Prophet Muḥammad, served as the custodian of the Kaʿbah. Following the event of *Fatḥ Makkah*, the custodianship of the Kaʿbah was fully assumed by the Muslim community.[14]

During the period when the Prophet Muḥammad resided in Mecca and prior to the event of *Isrāʾ* and *Miʿrāj*, no divine injunction had yet been revealed regarding the obligation to face a specific Qibla during prayer. At that time, based on his *ijtihād*, the Prophet faced Bayt al-Maqdis (Jerusalem), in accordance with the practice of the prophets of the Children of Israel. Nevertheless, the Prophet inwardly preferred the Qibla inherited from Prophet Ibrāhīm, namely the Kaʿbah. Historical reports indicate that whenever the Prophet performed prayer facing Bayt al-Maqdis, he positioned himself to the south of the Kaʿbah, thereby simultaneously aligning himself with both Qiblas—Bayt al-Maqdis and Bayt Allāh (the Kaʿbah).[15]

After the Prophet Muhammad migrated to Medina, he performed the prayer facing *Bayt al-Maqdis* (Jerusalem), as it was no longer possible to simultaneously align with both qiblas. This practice continued for approximately sixteen months. During this period, the Jewish community mocked the Prophet,

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[13]Moh. Murtadho, *Ilmu Hisab Praktis Dasar-Dasar Falakiyah* (Malang: Fakultas Syari'ah UIN Malang, 2002), 44.

[14] Ismail Ismail, "Urgensi Dan Legitimasi Fatwa Majelis Permusyawaratan Ulama Aceh Nomor 3 Tahun 2018 Tentang Penetapan Arah Kiblat," *Al-Manahij: Jurnal Kajian Hukum Islam* 14, no. 1 (June 2, 2020): 87–98, https://doi.org/10.24090/MNH.V14I1.3669.

[15]Elly Uzlifatul Jannah, "Sejarah Dan Hikmah Astronomis Peralihan Arah Kiblat Umat Muslim," *International Conference on Sharia and Law*, 2022, 238.

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claiming that although Muhammad brought a different religion, his direction of prayer followed theirs. They asserted that without their tradition, the Prophet would not have known which direction to face in prayer. These remarks caused the Prophet Muhammad to feel discomfort with continuing to face *Bayt al-Maqdis*. Several narrations report that the Prophet expressed to the Angel Jibril his hope that Allah would redirect the qibla away from that of the Jewish community. The Prophet frequently raised his gaze toward the sky after prayer, earnestly supplicating that the Ka'bah be established as the qibla for the Muslim community.[16]

In the second year of the Hijrah, while the Prophet Muḥammad was performing the prayer, a divine revelation was revealed instructing him to redirect the Qibla toward the Kaʿbah. The Prophet immediately turned in that direction, followed by the Companions who were praying behind him. This event occurred during the Ẓuhr prayer at the Mosque of Banū Salamah, where the Prophet faced *Bayt al-Maqdis* during the first two units (*rakʿahs*) of the prayer and then turned toward al-Masjid al-Ḥarām for the remaining units. Consequently, the Mosque of Banū Salamah later became known as *Masjid al-Qiblatayn* (the Mosque of the Two Qiblas).[17]

Islamic scholars unanimously agree that individuals who are in close proximity to the Kaʿbah or are able to see it directly are obligated to face the Kaʿbah itself during prayer. However, scholarly opinions differ regarding the obligation of those who are distant from the Kaʿbah and unable to see it. According to the Ḥanafī school of jurisprudence, there are two conditions concerning the obligation of facing the Qibla in prayer. First, if a

[16]Arwin Juli Rakhmadi et al., "Frequency-Based Analysis of Mosque Qibla Errors in Medan," *Al-Hilal: Journal of Islamic Astronomy* 7, no. 1 (2025): 37–50, https://doi.org/10.21580/AL-HILAL.2025.7.1.24203.

[17]Ardana Ash Siddiqi and Friska Linia Sari, "Implementation of Cattle Grazing Positions for Determining Cardinal Directions and the Qibla Direction," *Astroislamica: Journal of Islamic Astronomy* 4, no. 1 (June 1, 2025): 180–98, https://doi.org/10.47766/ASTROISLAMICA.V4I1.3470.

person is able to face or directly see the Kaʿbah, they are required to face it precisely; otherwise, the prayer is considered invalid. Second, for those who are unable to face or see the Kaʿbah, they are required to orient themselves toward the direction of the Kaʿbah (*jihat al-Kaʿbah*).[18] For individuals who are located outside the vicinity of the Kaʿbah and are uncertain about the direction of the Qibla, several criteria should be taken into consideration. First, if there exists an ancient mosque miḥrāb established by the Companions:

1. if there exists an ancient mosque miḥrāb established by the Companions (*Ṣaḥābah*) or the Successors (*Tābiʿīn*), it is obligatory to follow its orientation.
2. in the absence of such a reference, one is required to seek guidance from a trustworthy and knowledgeable individual.
3. if uncertainty persists, one must exert maximum *ijtihād* to determine the Qibla direction to the best of one's ability.

Mazhab Hambali[19] classifies the conditions of individuals facing the Kaʿbah into four categories.:

1. Individuals with absolute certainty, such as those who are able to see the Ka'bah directly or who reside in its immediate vicinity, are strictly obliged to face the Ka'bah precisely. Any deviation from the exact direction renders the prayer invalid.
2. Individuals who obtain information regarding the direction of the Qibla from a trustworthy source are required to follow that information. Reliance on credible

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[18] Aindana Zulfa and Riza Afrian Mustaqim, "Method For Determining the Qiblat Direction of The Mosque: Analysis of Determining the Qibla Direction of the Al-Islahiyah Mosque, Gampong Lambhuk, Ulee Kareng District, Banda Aceh City," *Astroislamica: Journal of Islamic Astronomy* 3, no. 2 (December 1, 2024): 171–92, https://doi.org/10.47766/astroislamica.v3i2.3442.

[19] Sakirman Sakirman, "Unifikasi Kalender Rasydhul Qiblah Harian Wilayah Sumatera Barat," *Astroislamica: Journal of Islamic Astronomy* 2, no. 2 (December 23, 2023): 120–42, https://doi.org/10.47766/astroislamica.v2i2.1701.

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testimony is considered sufficient in the absence of direct observation.

3. Individuals who are unable to see the Ka'bah and do not receive reliable information are obligated to perform *ijtihad* by utilizing available signs and indicators.

Mazhab Maliki of thought holds that facing the physical structure of the Kaʿbah is an obligation; however, this requirement is not intended to impose undue hardship. For individuals who are located far from the Kaʿbah, it is considered sufficient to orient oneself toward the general direction of the Kaʿbah.[20] Mazhab Syafi'i classifies the obligation of facing the Qibla into three categories:

1. if a person has certain knowledge of the Qibla direction, they are not permitted to seek guidance from others
2. if certainty has not been attained, one may seek information from a trustworthy individual or rely on instruments such as a compass or the orientation of a mosque miḥrāb.
3. if no reliable source or instrument is available, one is required to perform *ijtihād* to determine the Qibla direction.

Al-Qurṭubī argues that the opinion requiring worshippers to face the *ʿayn al-Kaʿbah* (the exact physical structure of the Kaʿbah) is weak, as it imposes excessive hardship. He maintains that facing the *jihat al-Kaʿbah* (the general direction of the Kaʿbah) is more justifiable, as it is more realistic and in accordance with the divine command, as stated in the Qur'ān: "*So turn your face toward al-Masjid al-Ḥarām* ".[21]

[20]Iyan Hasjun, Andi Jusran Kasim, and Nur Astaman Putra, "Uji Akurasi Hasil Pengukuran Arah Kiblat Pegawai Kemasjidan Kua Menggunakan Aplikasi Google Earth," *Astroislamica: Journal of Islamic Astronomy* 3, no. 1 (June 30, 2024): 114–35, https://doi.org/10.47766/astroislamica.v3i1.2796.

[21]Muhammad Hadi Bashori, *Pengantar Ilmu Falak* (Jakarta: Pustaka Al-Kautsar, 2015), 92–95.

The obligation to face the Qibla is explicitly stated in several verses of the Qur'an.[22] These verses emphasize the importance of orienting oneself toward the Qibla in the performance of acts of worship, particularly prayer. The following are among them:

قَدْ نَرٰى تَقَلُّبَ وَجْهِكَ فِى السَّمَآءِۚ فَلَنُوَلِّيَنَّكَ قِبْلَةً تَرْضٰىهَاۗ فَوَلِّ وَجْهَكَ شَطْرَ الْمَسْجِدِ الْحَرَامِۗ وَحَيْثُ مَا كُنْتُمْ فَوَلُّوْا وُجُوْهَكُمْ شَطْرَهٗۗ وَاِنَّ الَّذِيْنَ اُوْتُوا الْكِتٰبَ لَيَعْلَمُوْنَ اَنَّهُ الْحَقُّ مِنْ رَّبِّهِمْۗ وَمَا اللّٰهُ بِغَافِلٍ عَمَّا يَعْمَلُوْنَ

Indeed, we have seen your face turning repeatedly toward the sky. Therefore, we will surely direct you to a Qibla that pleases you. So turn your face toward al-Masjid al-Ḥarām. And wherever you may be, turn your faces toward it. Indeed, those who were given the Scripture certainly know that this (change of the Qibla to al-Masjid al-Ḥarām) is the truth from their Lord. And Allah is not unaware of what they do

وَمِنْ حَيْثُ خَرَجْتَ فَوَلِّ وَجْهَكَ شَطْرَ الْمَسْجِدِ الْحَرَامِۗ وَاِنَّهٗ لَلْحَقُّ مِنْ رَّبِّكَۗ وَمَا اللّٰهُ بِغَافِلٍ عَمَّا تَعْمَلُوْنَ

From wherever you go forth, direct your face toward al-Masjid al-Ḥarām. Indeed, this is certainly the truth from your Lord, and Allah is not unaware of what you do

وَمِنْ حَيْثُ خَرَجْتَ فَوَلِّ وَجْهَكَ شَطْرَ الْمَسْجِدِ الْحَرَامِۗ وَحَيْثُ مَا كُنْتُمْ فَوَلُّوْا وُجُوْهَكُمْ شَطْرَهٗۙ لِئَلَّا يَكُوْنَ لِلنَّاسِ عَلَيْكُمْ حُجَّةٌ اِلَّا الَّذِيْنَ ظَلَمُوْا مِنْهُمْ فَلَا تَخْشَوْهُمْ وَاخْشَوْنِيْ وَلِاُتِمَّ نِعْمَتِيْ عَلَيْكُمْ وَلَعَلَّكُمْ تَهْتَدُوْنَۙ

[22]Cut Nazar Mutia Hanum and Ismail Ismail, "Pandangan Tokoh Agama Jungka Gajah Terhadap Arah Kiblat Bagi Orang Yang Jauh Dari Ka'bah," *Astroislamica: Journal of Islamic Astronomy* 1, no. 2 (December 28, 2022): 169–86, https://doi.org/10.47766/ASTROISLAMICA.V1I2.934.

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From wherever you depart, turn your face toward al-Masjid al-Ḥarām; and wherever you may be, turn your faces toward it, so that people may have no argument against you—except those who are unjust among them. Therefore, do not fear them, but fear Me, so that I may perfect My favor upon you and so that you may be rightly guided.

The Qibla Direction of Masjid Tanwir

Masjid Tanwir, whose construction commenced in 1960 and which began operations in 1963, is located at 37A Masjid Street in the Asemrowo area of Surabaya, situated on the outskirts of the city within the Surabaya Municipality. The mosque was established concurrently with the development of the Asemrowo housing complex, initiated by the East Java People's Social Housing Foundation (Yayasan Perumahan Sosial Rakyat Jawa Timur) as part of the East Java Governor Wiyono's program. The housing complex was situated near the Asemrowo residential community, which at the time was home to approximately 60 families. Over time, Masjid Tanwir became part of the Tanwir Foundation, which also manages various other facilities, including schools, an orphanage, and a polyclinic.[23]

Figure 1. Masjid Tanwir

[23]Hasan, Sejarah Masjid Tanwir Surabaya, Mei 2024.

Masjid Tanwir encompasses an area of approximately 1,125 square meters and has a substantial capacity. On the ground floor, the mosque can accommodate around 2,500 worshippers, while the upper floor can host approximately 500 individuals. According to the Decree of the Head of the Mosque Welfare Board of Tandes District, numbered KM.11.05/02.02/BA.032/320/1992, Masjid Tanwir is officially designated as a *Masjid Jami* at the sub-district (*kelurahan*) level, serving simultaneously as a center for religious activities at the district (*kecamatan*) level. Despite its large capacity, the mosque typically sees a regular congregation of around 150 worshippers.

Since 1998, the area in which Masjid Tanwir is located has been administratively incorporated into the Asemrowo District. Since that time, the mosque has increasingly functioned as a hub for Islamic propagation within the Asemrowo community specifically, while also contributing to the broader development of Islamic da'wah in Indonesia. At Masjid Tanwir Surabaya, a range of routine activities are conducted, including congregational prayers, Friday prayers, and religious study sessions (*pengajian*) attended by local residents.[24]

Based on available information, the astronomical location of Masjid Tanwir in Asemrowo is at the coordinates -7° 14' 58" S and 112° 42' 45" E. These coordinates were obtained using the Google Maps application accessed on May 23, 2024. Geographically, the mosque is situated at 37A Masjid Street, Asemrowo District, Surabaya, with the following boundaries:

1. North**:** Residential street along Masjid Street
2. East**:** Residential street along Mas
3. South**:** Asem I Street
4. West**:** Private residential houses

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[24] Masjid Tanwir Surabaya, "MASJID TANWIR ASEMROWO SURABAYA: Sekilas Pandang Sejarah Masjid Tanwir Asemrowo Surabaya," *MASJID TANWIR ASEMROWO SURABAYA* (blog), Sabtu, Desember 2009, https://masjidtanwir.blogspot.com/2009/12/sekilas-pandangsejarah-masjid-tanwir.html.

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The establishment of Masjid Tanwir was strongly influenced by local leaders and community members. During the initial construction phase, the community agreed to involve an expert in *falak* (Islamic astronomy) to ensure the accurate determination of the qibla direction. This was done because the community believed that consulting a specialist would result in a highly precise qibla alignment. Consequently, the mosque's qibla is not parallel to the street in front or beside it, but is slightly angled.

During subsequent renovations, the original mosque structure was demolished and expanded to accommodate a larger congregation. Despite these modifications, the qibla direction was preserved based on the original measurements determined during the initial construction phase.

Theodolite

A theodolite is an instrument used to measure both horizontal angles (HA) and vertical angles (VA). The device is equipped with a telescope featuring various levels of lens magnification, and several modern models are additionally fitted with laser technology to facilitate the precise determination of the qibla direction. [25] The theodolite is recognized as a highly accurate instrument for determining the qibla direction compared to other methods. It operates by utilizing the movements of celestial bodies, such as the Sun, to measure angles with exceptional precision, even down to the arcsecond level.[26] By this method, the position of the Sun can be calculated based on its azimuth, enabling the determination of true north as well as the qibla direction at a given location with

[25] Ahmad Fuad Al-Anshary, "INOVASI ALAT PERAGA FALAK DALAM PENGUKURAN ARAH
KIBLAT (Studi Analisis 'Mutsalatsah Qiblah' Menggunakan Bayangan Matahari Setiap Saat)," *ELFALAKY* 6, no. 2 (December 7, 2022): 171, https://doi.org/10.24252/ifk.v6i2.32116.

[26] Ahmad Izzuddin, "Typology Jihatul Ka'bah on Qibla Direction of Mosques in Semarang," *Ulul Albab: Jurnal Studi Dan Penelitian Hukum Islam* 4, no. 1 (November 1, 2020): 1–15, https://doi.org/10.30659/JUA.V4I1.12186.

high accuracy. However, theodolites have a limitation as their operation depends on sunlight. If the location or weather conditions prevent sunlight from reaching the instrument, such as during overcast conditions or in covered areas, the qibla measurement cannot be performed. Consequently, the use of the theodolite is restricted to certain conditions.

The procedure for using a theodolite is as follows:

1. Set Up the Theodolite**:** Place the theodolite properly on a tripod or flat surface. Ensure it is perfectly vertical, check that the level bubble is balanced in all directions, and verify that the instrument remains stable.
2. Check and Activate the Theodolite**:** Inspect the battery condition to ensure proper functioning, then turn on the theodolite. Make sure all locks are disengaged.
3. Align the Telescope to the Sun**:** Aim the theodolite telescope at the Sun's position at a pre-determined time. Never look directly at the Sun with the naked eye to protect vision.
4. Lock and Zero the Theodolite**:** Once the instrument is properly aligned, engage the locks and adjust the angle reading to zero.
5. Orient to True North**:** Reactivate the theodolite, release the locks, and rotate the telescope toward true north.

After orienting the instrument toward true north, lock and zero the theodolite again to ensure accurate readings. The subsequent steps are as follows:

1. Align to the Qibla Azimuth**:** Reactivate the theodolite, disengage the locks, and rotate the telescope toward the pre-calculated qibla azimuth. At this stage, the theodolite indicates the precise qibla direction.
2. Mark the Qibla Line**:** Identify two points along the line indicated by the theodolite and connect them with a straight line. This line serves as a guide for the qibla direction.
3. Establish Perpendicular Lines for Shaf Alignment**:** If necessary, create additional lines perpendicular to the previously established qibla line, forming 90-degree

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angles. These lines can be used to determine the alignment of prayer rows (*shaf*) accurately.

Analysis of Qibla Direction Determination at Masjid Tanwir Surabaya Using Mizwala Qibla Finder, Right-Angle Triangle, and Theodolite

To ensure comprehensive and accurate data, the information obtained through interviews and observations must be analyzed thoroughly. In the measurement process, the researcher employed a high-precision instrument, namely the theodolite. Prior to performing calculations, the following qibla angle data were required:

Latitude of Masjid Tanwir	= -7° 14′ 58″
Longitude of Masjid Tanwir	= 112° 42′ 45″
Latitude of the Kaaba	= 21° 25′ 15″
Longitude of the Kaaba	= 39° 49′ 40″
A Value	= 90° - Latitude of Masjid Tanwir = 90° – (-7° 14′ 57,83″) = 97° 23′ 47.75″
B Value	= 90° - Latitude of the Kaaba = 90° – (21° 25′ 15″)
	= 68° 34′ 45″
C Value	= Longitude of Masjid Tanwir Longitude of the Kaaba = 112° 42′ 44,7″ – 39° 49′ 40″ =72° 53′ 4,7″

Cotan B	= cotan b x sin a ÷ sin C – cos a x cotan C = cotan 68º 34′ 45″ x sin 97º 23′ 47.75″: sin 72º 52′ 58.76″ – cos 97º 23′ 52.2″ x cotan 72º 52′ 58.76″ = 65º 57′46″ (North West), 24º 02′ 14″ (West-North). 294º 4′ 40.82″(UTSB)

After the required data were obtained, the calculations were carried out using a theodolite. The measurements were conducted on May 22, 2022, at 09:35 AM Western Indonesia Time (WIB). The procedure for measuring the qibla direction using the theodolite is as follows:

1. Set Up the Tripod and Theodolite**:** Place the tripod in a secure location and mount the theodolite. Ensure that the instrument is balanced, verifying with the two built-in levels on the theodolite.
2. Install the Batteries and Activate the Instrument: Insert AA batteries as required and turn on the theodolite using the ON button.
3. Prepare True North and Qibla Azimuth Data: Before conducting the measurement, input the true north and qibla azimuth data, which can be prepared and entered via an Excel spreadsheet.

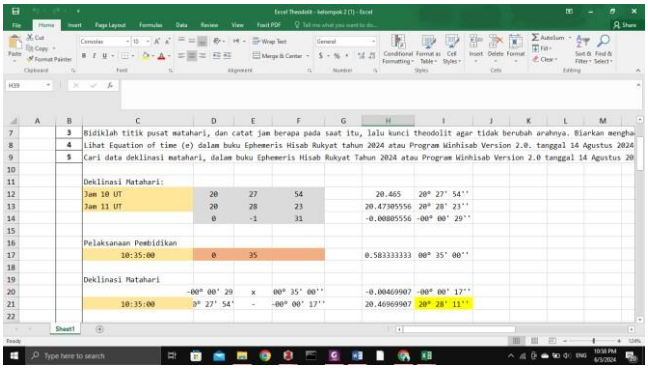

Figure 2: True North Data

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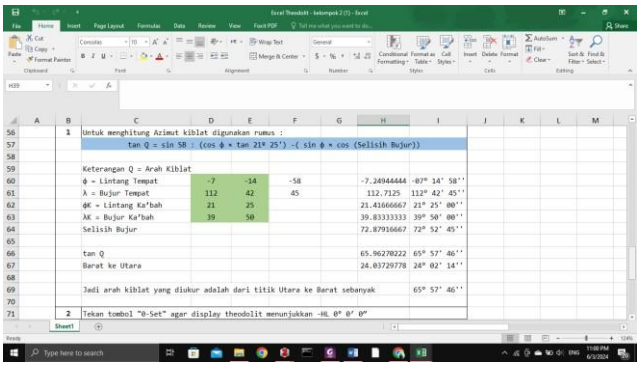

56	1	Untuk menghitung Azimut kiblat digunakan rumus :										
57		tan Q = sin SB : (cos ϕ × tan 21° 25') -(sin ϕ × cos (Selisih Bujur))										
58												
59		Keterangan Q = Arah Kiblat										
60		ϕ = Lintang Tempat	-7	-14	-58		-7.24944444	-07° 14' 58''				
61		λ = Bujur Tempat	112	42	45		112.7125	112° 42' 45''				
62		ϕK = Lintang Ka'bah	21	25			21.41666667	21° 25' 00''				
63		λK = Bujur Ka'bah	39	50			39.83333333	39° 50' 00''				
64		Selisih Bujur					72.87916667	72° 52' 45''				
65												
66		tan Q					65.96270222	65° 57' 46''				
67		Barat ke Utara					24.03729778	24° 02' 14''				
68												
69		Jadi arah kiblat yang diukur adalah dari titik Utara ke Barat sebanyak						65° 57' 46''				
70												
71	2	Tekan tombol "0-Set" agar display theodolit menunjukkan -HL 0° 0' 0"										

Figure 3: Qibla Azimuth Data

1. Aim the Theodolite at the Sun**:** Precisely target the Sun at 09:35 AM Western Indonesia Time (WIB).
2. Lock and Zero the Theodolite**:** Engage the lock and reset the reading to zero.
3. Rotate Toward the Sun**:** Release the lock and rotate the instrument clockwise according to the true north reference until aligned with the Sun's position, then lock and zero the theodolite again.
4. Set the Qibla Azimuth**:** Release the lock and rotate the theodolite clockwise until the horizontal angle indicates the qibla azimuth of 65^{o} 57′ 46″.

Figure 4: Theodolite Rotation Result According to the Qibla Azimuth

1. **Lock the Theodolite:** After the previous adjustments, engage the lock to fix the theodolite in the qibla direction.
2. **Mark Two Reference Points:** Using the telescope, aim at two points in front of the theodolite and connect them to form a straight line.
3. **Determine Shaf Alignment Deviation:** The resulting difference between the mosque's prayer rows (*shaf*) and the line indicated by the theodolite is 1° 01′ 00″.

Figure 5: Deviation Result After Targeting Theodolite Points and Drawing the Shaf Line

Analysis of Qibla Direction at Masjid Tanwir Using a Theodolite

After measuring the qibla direction of Masjid Tanwir Surabaya using a theodolite and comparing it with the orientation of the mosque's *shaf*, a slight deviation was observed between the two. Nevertheless, the theodolite measurements proved to be highly accurate. This instrument is capable of measuring horizontal and vertical angles with exceptional precision, resulting in a qibla direction that is nearly perfect.

Instruments	**Inclination**	**Description**
Theodolite	1° 01′00′	Deviation toward the North

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The comparison above indicates that the qibla direction of Masjid Tanwir Surabaya, located at 37A Masjid Street, Asemrowo District, Surabaya, currently exhibits a deviation of approximately 1°. Mathematically, one degree of arc corresponds to 111 km. Therefore, the qibla deviation of Masjid Tanwir, as measured using a theodolite, is estimated to be approximately 112.8 km.

CONCLUSION

This study underscores the critical importance of verifying the validity of the qibla direction as a fundamental requirement for the proper performance of *salat* among Muslims, particularly for congregants at Masjid Tanwir in Asemrowo, Surabaya. By employing a theodolite, an instrument renowned for its high precision in measuring both horizontal and vertical angles, this research successfully verified the mosque's qibla accuracy using a modern scientific approach that integrates principles of *falak* (Islamic astronomy) with contemporary surveying technology.

The measurement methodology primarily relied on the Sun's position as the principal astronomical reference to determine true north and the precise qibla azimuth. This approach provided significantly more accurate results compared to conventional methods or standard magnetic compasses. By utilizing specific astronomical coordinates—namely latitude -7° 14′ 58″ and longitude 112° 42′ 45″—this study not only meets rigorous academic standards but also serves as a form of ijtihad verification, ensuring that worshippers located far from the Kaaba can perform their prayers with confidence. The use of theodolite in this study demonstrates that the integration of modern measurement instruments is crucial for minimizing directional errors commonly encountered in the construction of older mosques.

Based on the analysis of the field data collected on May 22, 2022, empirical findings indicate a deviation of the qibla direction in the physical structure of Masjid Tanwir amounting

to 1° 01′ 00″ toward the north relative to the intended azimuth. Although this angular deviation appears minimal in degrees, mathematically it corresponds to a linear displacement of approximately 112.8 kilometers on the Earth's surface from the center of the Kaaba, suggesting a notable inaccuracy if extrapolated in a straight line.

In response to these findings, and with reference to the guidelines of the Indonesian Council of Ulama (Majelis Ulama Indonesia, MUI) Fatwa No. 3 of 2010, the recommended solution does not necessitate the costly and time-consuming demolition or total renovation of the mosque structure. The most practical and judicious corrective measure is to adjust the alignment of the prayer rows (*shaf*) within the mosque according to the corrected theodolite measurements, thereby enabling congregants to perform their prayers with full confidence that they are facing the correct qibla direction.

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