Al-Hilal: Journal of Islamic Astronomy
Vol. 7, No. 1, April 2025: 51-66
DOI: 10.21580/al-hilal.2025.7.1.26050
ISSN: 2775-1236 (printed) ; 2775-2119 (online)

Azimuthal Adaptation of the Moon-Based *Raṣdu al-Qiblah* Method

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‖ *Submitted: 01-04-2025* ‖ *Revised: 22-04-2025* ‖ *Accepted: 23-04-2025* ‖ *Published: 06-05-2025* ‖

Abstract

The *Raṣdu al-Qiblah* of the Moon is a night-time method for determining Qibla direction, but it can only be used once per night and not on specific dates due to natural limitations. This study introduces an innovation by applying azimuth difference values (+90°, +45°, -45°), allowing the method to be used multiple times a night. The research compares this enhanced method with theodolite measurements and the *Raṣdu al-Qiblah* of the Sun to test its accuracy. Using a qualitative approach with astronomical analysis, the study finds that this modified method results in a deviation between 0°9'32.96" and 0°57'17.43". These results fall within acceptable Qibla tolerance limits as defined by some experts, showing that this method is accurate and viable as an alternative for Qibla determination, especially at night.

Keywords: qibla direction, *raṣdu al-qiblah*, Moon, azimuth

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Metode *Raṣdu al-Qiblah* Bulan merupakan cara penentuan arah kiblat di malam hari yang akurat, namun hanya bisa digunakan sekali dalam satu malam dan tidak berlaku di hari-hari tertentu karena faktor alam. Penelitian ini menawarkan inovasi dengan menambahkan variasi selisih azimut (+90°, +45°, -45°) sehingga metode ini dapat digunakan beberapa kali dalam satu malam. Penelitian ini membandingkan metode tersebut dengan pengukuran menggunakan teodolite dan *Raṣdu al-Qiblah* Matahari. Dengan pendekatan kualitatif dan astronomis, ditemukan bahwa metode ini menghasilkan deviasi antara 0°9'32,96" hingga 0°57'17,43". Nilai tersebut masih berada dalam batas toleransi arah kiblat menurut para ahli sehingga metode ini dinilai akurat dan layak menjadi alternatif pengukuran arah kiblat, terutama pada malam hari.

Kata Kunci: arah kiblat, *raṣdu al-qiblah*, Bulan, azimuth

To cite this article (Chicago Manual of Style 17th Edition Full-Note):
Muhammad Farid Azmi, "Azimuthal Adaptation of the Moon-Based Raṣdu al-Qiblah Method", *Jurnal Al-Hilal: Journal of Islamic Astronomy* 7, no. 1 (2025): 51-66.

A. Introduction

The direction of the Qibla is a fundamental aspect of Islamic practice. It is not only the direction Muslims face during their five daily prayers, but also the direction observed in other acts of worship, including when laying the deceased to rest. Because of its deep significance, Muslims have long sought accurate ways to determine the Qibla, using both traditional knowledge and modern tools. Over time, scholars—especially those specializing in Islamic astronomy—have developed various methods to find the direction of the Kaaba. These range from simple observational techniques to complex calculations involving precise instruments. One method that has proven both practical and reliable is *Raṣdu al-Qiblah*. This method involves observing the shadow of a stick (or any vertical object) at a specific time when the sun is directly overhead the Kaaba. At that moment, the shadow line points exactly toward Mecca, offering a simple yet effective way to find the Qibla. Although it can only be done at specific times of the year, the method is popular because it's easy for the public to follow without needing any special equipment.

Originally, *Raṣdu al-Qiblah* was only possible during the daytime, since it relied on sunlight. But recent developments have made it possible to use the Moon as an alternative reference point at night. This idea is discussed in the book *Jāmi'u al-Adillah ilā Ma'rifati Simti al-Qiblah* by Ahmad Ghozali Muhammad Fathullah.[1] By observing the Moon's position at a calculated time, one can use the same principle to find the direction of the Qibla in the dark. This innovation shows how traditional knowledge continues to evolve, combining time-honored methods with new ways of thinking to make religious practices more accessible to everyone, day or night.

The *Raṣdu al-Qiblah* method has been recognized for its historical significance and practical applications in determining the Qibla direction, especially in relation to the Moon's position. However, like many methods rooted in traditional astronomical principles, it has a fundamental drawback. This method cannot be employed on every night; it is only usable when the Moon is above the horizon.[2] The Moon's visibility is governed by a complex set of astronomical phenomena, primarily the changing times of moonrise. Due to this, the Moon is not always visible above the horizon each night. This phenomenon is linked to the moonrise, which shifts by approximately 50 minutes later each night.[3] Consequently, on certain nights, the Moon may not be visible at all, thus rendering the *Raṣdu al-Qiblah* method ineffective for those nights. This inherent limitation has led to a gap in the ability to reliably determine the Qibla direction during those periods when the Moon is not observable.

Given this fundamental limitation, scholars and researchers have sought to improve the *Raṣdu al-Qiblah* method, aiming to make it usable across a wider range of nights, particularly for those that do not align with the Moon's visibility above the horizon. The innovative solution proposed by researchers is the integration of the *Raṣdu al-Qiblah* concept with an alternative geometric approach, one that does not solely rely on the Moon's position but also incorporates the measurement of the azimuth difference angle between the Moon and the direction of the Qibla. This

[1] Ahmad Ghazali Muhammad Fatkhullah, *Jami'u Al-Adillah Ila Ma'rifati Simti Al-Kiblah* (Bangkalan: LAFAL, 2016).

[2] Lukman, "Studi Analisis Rashdul Kiblat Bulan Dalam Kitab Jami'u Al-Adillah Karya KH. Ahmad Ghozali" (UIN Walisongo Semarang, 2016), 71.

[3] Slamet Hambali, *Pengantar Ilmu Falak: Menyimak Proses Pembentukan Alam Semesta* (Yogyakarta: Bismillah Publisher, 2012), 224.

new method introduces the use of two azimuth difference angles, 90° and 45°. These two angles have been specifically chosen for their simplicity and practicality. They are easy to measure without requiring sophisticated instruments, such as a protractor, which makes the method more accessible to practitioners, especially in locations where advanced equipment may not be readily available.

The introduction of these two azimuth angles—90° and 45°—is an essential innovation in the method. It offers a practical solution to the problem of Moon visibility, allowing the determination of the Qibla direction multiple times throughout the night, irrespective of whether the Moon is directly visible or not. The method leverages the principle that the relationship between the Moon's position and the Qibla can still be effectively determined by measuring these specific azimuth angles, which provide enough accuracy for the purpose of Qibla determination. This method ensures that the technique remains functional throughout the night, making it a versatile tool for various contexts and locations. This development represents a significant advancement in the field of Islamic astronomy, particularly in the determination of the Qibla direction during nighttime hours. While traditional methods like *Raṣdu al-Qiblah* are invaluable in their historical context, this new approach offers a more flexible and reliable alternative for modern practitioners. By expanding the applicability of the method to several times during the night, it increases the practicality of Qibla determination, especially in urban environments or areas where the Moon may not be visible due to weather conditions or other obstructions.

Given the need for accurate Qibla direction determination, especially for daily prayers, the importance of developing methods that can be used under varying conditions cannot be overstated. This research is therefore fundamental, not only in presenting a new method for determining the Qibla direction but also in testing its accuracy and evaluating its practical use. By describing, analyzing, and testing the proposed method, this study aims to contribute valuable insights into the field of Islamic astronomy and provide an alternative method that addresses the limitations of existing approaches. Through rigorous scientific examination, this method could become an essential tool for Muslims around the world, enhancing the accuracy and reliability of Qibla determination, especially during the nighttime.

B. Method

This field research uses qualitative descriptive research design. It is said to be field research because the researcher collected some observation data on the direction of the Qibla measurement. Then, the data was processed to obtain a conclusion. It is qualitative research because it also aims to describe and analyze a phenomenon or event.[4] In this case, we describe and analyze a phenomenon that can be used as an alternative measurement of the new direction of the Qibla. This study's focus is limited to measuring the direction of the Qibla using the *Raṣdu al-Qiblah* of the Moon with Azimuth Difference. We provide a detailed description of the *Raṣdu al-Qiblah* of the Moon with the Azimuth Difference method, starting from its basic theory and calculation algorithm and showing how to practice it to its accuracy with other modern techniques.

[4] Nana Syaodih Sukmadinata, *Metode Penelitian Pendidikan* (Bandung: Remaja Rosdakarya, 2012), 60.

Data collection techniques use observation and documentation. Observation is a technique or way of collecting data by directly observing the object of observation.[5] In this case, we practiced measuring the direction of the Qibla using the *Raṣdu al-Qiblah* of the Moon with the Azimuth Difference. The measurement results were compared with other modern Qibla direction measurement methods. We used two comparative methods: measuring the direction of the Qibla at any time with a Theodolite instrument and the *Raṣdu al-Qiblah* of the Sun. The comparison was carried out to determine the value of the deviation of the Qibla direction, the level of accuracy, and whether or not the deviation was within the tolerance limit for deviations in the Qibla direction. The documentation technique was carried out by collecting various literature related to the research theme, such as literature on the direction of the Qibla, the method of measuring the direction of the Qibla, *Raṣdu al-Qiblah* of the Sun, *Raṣdu al-Qiblah* of the Moon, Qibla direction tolerance, and other supporting literatures.

C. Result and Discussion

1. Argument for Facing the Qibla Accurately

Qibla comes from the Arabic word, *al-qiblah*, the maṣdar form of the word *qabala - yaqbilu - qiblatan* meaning Qibla, facing, the Kaaba, and the center of attention.[6] Meanwhile, the term *al-qiblah* emerged, taken from *wazan al-fi'lah*, which means the state of facing something. It is said to be facing something because the *muṣallī* (person performing the prayer) is facing it. Something, namely the Kaaba itself and vice versa, the Kaaba also points to the prayer room.[7] In simple terms, the direction of the Qibla is the direction of the closest distance along the great circle to the Kaaba (Mecca) that passes through the location of the place in question.[8] According to the agreement of the scholars, facing the Qibla when performing prayers is obligatory because it is a requirement for the validity of the prayer.[9] Accurate measurement of the direction of the Qibla is important based on the opinions of two *imāms* of the school of Islamic thought, Imām al-Shāfi'ī and Imām al-Ḥanbalī. They argue that facing the Qibla is not just facing the estimated direction (*Jihātu al-Ka'bah*) but must try to face the physical building of the Kaaba directly (*'Ainu al-Ka'bah*).[10]

The Imām Abū Ḥanīfah's opinion regarding facing the Qibla in *'Ainu al-Ka'bah* is stated in the book by 'Abd al-Ghanī al-Ghunaimī called *al-Lubāb fi Syarḥi al-Kitāb* states that in the Hanafi school, for people who do not see the Kaaba must still face the exact direction of the Kaaba (*'Ainu al-ka'bah*). This condition applies to everyone, even those who can see The Kaaba can be seen directly or

[5] Nyoman Kutha Ratna, *Metodologi Penelitian; Kajian Budaya Dan Ilmu Sosial Humaniora Pada Umumnya* (Yogyakarta: Pustaka Pelajar, 2010), 220.

[6] Ahmad Warson Munawir, *Al-Munawir Kamus Arab-Indonesia* (Surabaya: Pustaka Progressif, 2002), 1087.

[7] Sayyid Abu Bakar Utsman Bin Muhammad Syatho al-Dimyati, *Hasyiyah I'anah at-Thalibin* (Surabaya: Darul Ilmi, n.d.), 123.

[8] Muhyidin Khazin, *Ilmu Falak Dalam Teori Dan Praktik* (Yogyakarta: Buana Pustaka, 2004), 50.

[9] Slamet Hambali, *Ilmu Falak 1; Penentuan Awal Waktu Shalat Dan Arah Kiblat Seluruh Dunia* (Semarang: Program Pascasarjan IAIN Walisongo Semarang, 2011), 25.

[10] Riza Afrian Mustaqim and Reza Akbar, "Study on the Causes of Inaccuracy of Qibla Direction of the Great Mosque Baitul Makmur West Aceh," *Jurnal Ilmiah Al-Syir'ah* 19, no. 1 (June 30, 2021): 30, https://doi.org/10.30984/jis.v19i1.1315.

indirectly The Kaaba, whether in Mecca or outside.[11] Meanwhile, Imām al-Shāfi'ī 's opinion regarding facing the Qibla in *'Ainu al-ka'bah* is stated in the book *al-Umm*, that people who cannot see the Kaaba, whether they are in Mecca or outside, must carry out ijtihad to find out the correct direction of the Kaaba ('*ainu al-Kaaba*) by understanding natural clues, such as stars, the Sun, the Moon, mountains, gusts of wind, and other signs that can point to the direction of the Qibla.[12]

This opinion is based on *Surah al-Baqarah* (2:150) which requires Muslims to face the Grand Mosque, more precisely the Kaaba. This verse also clearly indicate that what is desired is to face the physical building of the Kaaba accurately. This means that it can be understood that facing the Qibla is obligatory to face the physical Kaaba building, as people can see the Kaaba directly.[13] Apart from that, it is also strengthened by the hadith of Ibn Abbas[14] which clearly explains that the proper direction of the Qibla is the physical building of the Kaaba itself, covering all sides of the Kaaba. So, the meaning of facing the Qibla is facing the physical construction of the Kaaba, not necessarily to the exact center point of the Kaaba, but maybe towards one of the sides of the Kaaba, as long as it is still part of the Kaaba building. These two arguments show how significant the problem of facing the Qibla is for every Muslim who performs worship, especially performing prayer.

2. Theoretical Foundations of *Raṣdu al-Qiblah*

The word *Raṣd* (رصد) means surveillance, reconnaissance, and road. Meanwhile, *Qiblah* (قبلة) means the Qibla or direction to the Kaaba.[15] *Raṣdu al-Qiblah* can generally be interpreted as scouting the direction of the Qibla. In terminology, the word *Raṣdu al-Qiblah* refers to a method that utilizes the theory of the shadow of an object standing perpendicularly on a flat surface; this method of determining the direction of the Qibla must wait for a certain time where, at that time, the shadow of the perpendicular object points towards the Qibla due to being hit by sunlight.[16] It can be said that *Raṣdu al-Qiblah* is a time indicator where the Sun's shadow points towards the Qibla.

The phenomenon of changing shadows is something that shows the incredible power of God. The lengthening and shortening of shadows, even the disappearance of shadows, can occur due to the influence of sunlight. The existence of the length and shortness of the shadow of an object shows the process of the Earth's rotation on its axis, or what can be called the rotation of the Earth, as well as describing the circulation of the Earth around the Sun, or called the Earth's revolution. If the circulation process did not exist, the shadow would certainly stay in place because the Sun only shines on one part of the Earth; this could also have fatal consequences for the survival of creatures on Earth.[17]

In the field of astronomy, the phenomenon of shadows plays a significant role in determining prayer times and the direction of the Qibla. One well-known method is *Raṣdu al-Qiblah*, which

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[11] Abd al-Ghani al-Ghunaimi al-Midani, *Al-Lubāb Fi Syarḥi Al-Kitāb* (Damaskus: al-Maktabah al-Umariyyah, 2003), 68.

[12] Muhammad bin Idris al-Syafi'i, *Al-Umm*, Juz II (Mesir: Dar al-Wafa' li al-Tiba'ah wa al-Nasyr wa al-Tauzi,' 2001), 212.

[13] Wahbah Al-Zuḥailī, *Al-Fiqh Al-Islami Wa Adillatuh* (Damaskus: Dar al-Fikr, 1997), 80.

[14] Abū Zakariyyā Muḥyiddīn Yahyā ibn Sharaf An-Nawawī, *Al-Majmū' Sharḥ Al-Muhadhdhab*, vol. 6 (Jeddah: Maktabah al-Irshād, n.d.), 80; Abi Abdillah Muhammad bin Ismail Al-Bukhari, *Shahih Al-Bukhari* (Beirūt: Dar Ibn Kasir, 2002), 398.

[15] Munawir, *Al-Munawir Kamus Arab-Indonesia*, 501, 1088.

[16] Susiknan Azhari, *Ensiklopedi Hisab Rukyat* (Yogyakarta: Pustaka Pelajar, 2012), 179.

[17] Anisa Nur Afida, "Matahari Dalam Perspektif Sains Dan Al-Qur'an" (UIN Raden Intan Lampung, 2018), 77–78.

utilizes the shadow of the Sun to identify the Qibla's direction. This method is based on two distinct principles of astronomical phenomena. The first is the Global *Raṣdu al-Qiblah*, a phenomenon in which the Sun is directly overhead or beneath the Kaaba. This alignment causes shadows of objects to point precisely towards the Qibla. Turaichan Adjhuri's Menara Kudus calendar records this event, noting that on May 27/28 at 16:18 (GMT+7) and July 15/16 at 16:27 (GMT+7), the Sun is directly above the Kaaba. These moments, referred to as "*Yaumu Raṣdu al-Qiblah*," mark the precise times when the Sun's position aligns perfectly with the Kaaba, offering an accurate method to determine the Qibla direction based on the shadow cast at these specific times. This phenomenon serves as an important tool for accurate Qibla determination using simple astronomical observations.[18]

In addition to being called the global *Raṣdu al-Qiblah*, this annual phenomenon can be called *Istiwā' A'dzam* which the Sun passes directly above the zenith point of the Kaaba. As a result of the Earth's axis tilting 66.5° to its orbital plane, the Sun appears to shift position throughout the year. This shift is between 23.5° N in June and 23.5° S in December. When the Sun's declination angle is the same as the Kaaba's Latitude, *Istiwā' A'dzam* occurs.[19] Then, the global *Raṣdu al-Qiblah* phenomenon of the Kaaba's antipode, where the Sun is directly below the Kaaba, occurs every January 13/14 at 06.29(GMT+9) and November 28/29 at 06.09 (GMT+9).[20]

Second, Local *Raṣdu al-Qiblah* is a phenomenon when the Sun touches the qibla circle of a specific place so that all objects standing perpendicularly on a flat surface at that time will have their shadows pointing towards the Qibla of that place.[21] This type of *Raṣdu al-Qiblah* requires a prior calculation to determine when this phenomenon occurs. Local Raṣdu al-Qiblah can happen in the morning before *zawāl* (Sun transit) or in the afternoon after *zawāl*, depending on the declination of the Sun and the coordinates of the place being calculated.

In addition to these two types of *Raṣdu al-Qiblah*, there is another type of *Raṣdu al-Qiblah* that can be used as an alternative to measuring the direction of the qibla, namely the *Raṣdu al-Qiblah* using the moon's position as a reference. Allah says in the letter Al-An'am (6:96).[22] Quraish Shihab interprets the word *ḥusbānan* in this verse as coming from the phrase *ḥisāb*. Adding the letters alif and nun gives the meaning of perfection, so the word means a perfect and precise calculation. Some scholars argue that the meaning of the verse is the rotation of the sun and the earth is carried out in an exact calculation. Some other scholars say that the verse means that Allah made the rotation of the Sun and the Moon as a means of calculation related to time and certain directional positions.[23]

If we look at the verse, not only does the Sun have the potential to be a guide for time and direction, but other objects, Moon, can also be used as a guide that can be calculated carefully and accurately. From this argument, the *Raṣdu al-Qiblah* of the Moon method emerged as an alternative to measuring the direction of the Qibla at night.[24] Like the Local *Raṣdu al-Qiblah*, this type of *Raṣdu*

[18] Ahmad Izzuddin, *Ilmu Falak* (Tangerang: CV Ipa Abong, 2006), 46.

[19] Mutoha Arkanuddin, *Teknik Penentuan Arah Kiblat: Teori Dan Aplikasi* (Yogyakarta: LP2IF Rukyat Hilal Indonesia, n.d.), 9.

[20] Arkanuddin, 11.

[21] Slamet Hambali, *Ilmu Falak Arah Kiblat Setiap Saat* (Yogyakarta: Pustaka Ilmu, 2013), 45.

[22] Kementerian Agama RI, *Al-Qur'an Dan Tafsirnya*, Jilid I (Bekasi: PT Sinergi Pustaka Indonesia, 2012), 140.

[23] M. Quraish Shihab, *Tafsir Al-Misbah: Kesan, Pesan Dan Keserasian Al-Qur'an*, Volume 4 (Jakarta: Lentera Hati, 2006), 210.

[24] Muhamad Zainal Mawahib, "Metode Pengukuran Arah Kiblat Dengan Segitiga Siku-Siku Dari Bayangan Bulan" (UIN Walisongo Semarang, 2016).

al-Qiblah also requires prior calculation and can occur at any time depending on the coordinates and declination of the Moon. This method can be used if the occurrence coincides with the Moon being above the horizon and is very effective if it occurs at night when the Moon is shining brightly.

3. Tolerance Thresholds in Qibla Determination: A Comparative Review

Tolerance is simply two values of the deviation limits of a measurement that are still permitted or allowed from the actual value.[25] This tolerance value includes the addition and subtraction of the actual value, where the actual value is always the middle value of the two deviation limits. In measuring the direction of the Qibla, the tolerance value is also an important part of assessing whether the results of measuring the direction of the Qibla can be said to be accurate. Qibla direction tolerance is the deviation that can still be allowed from the original value of the local Qibla azimuth. This tolerance is unavoidable, considering the many versions of the Qibla direction calculation, such as the calculation of the Qibla with the assumption of a perfectly spherical earth, ellipsoid Earth, and geoid earth with an uneven surface. In addition to the many variations in the coordinates of the Kaaba making the results of the qibla calculation different from one another, the measuring instrument also has certain limitations (resolution). The existence of a Qibla direction tolerance can be analogized with the *iḥtiyāṭ* of prayer times, which functions as a safeguard against doubt. To distinguish it, the qibla direction tolerance can be called *iḥtiyāṭ al-Qiblah*.[26]

According to Ahmad Izuddin, the tolerance limit for deviation of the direction of the Qibla is 2 degrees from the direction of the Kaaba.[27] This is in line with Thomas Djamaluddin, who has an opinion about the tolerance of the direction of the Qibla. He said that the tolerance value of the direction of the Qibla is not calculated from the deviation of the direction of the building to the Kaaba but is measured from the position of the person performing the prayer. The further away from the Kaaba, the more difficult it is to make the person accurate in the direction of the Kaaba. The deviation that is allowed is a deviation that does not significantly change the direction with the naked eye, including on the lines of the mosque or prayer room. For that, according to Thomas Djamaluddin, the deviation of the Qibla is a maximum of 2 degrees. If a person's direction is less than 2 degrees from the actual direction of the Qibla, then the person is still within the tolerance limit for facing the Qibla.[28]

Another expert, Ma'rufin Sudibyo offers an alternative perspective. He formulated the concept of *iḥtiyāṭ al-Qiblah* mathematically, by calculating the permissible deviation based on the configuration of the ball triangle that applies in a particular place.[29] To calculate the tolerance of the direction of the Qibla that is permitted in each region, the following stages need to be carried out to estimate the tolerance of the Qibla of the *Muṣallā* in Gumiwang Army Housing Complex, Pekalongan.

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[25] Universitas Esa Unggul, "Modul 12: Toleransi Linier, Sudut Dan Geometri," Universitas Esa Unggul, 2019, https://bahan-ajar.esaunggul.ac.id/tkt107/wp-content/uploads/sites/953/2019/11/Modul-12-Toleransi.pdf.

[26] Slamet Hambali, "Menguji Tingkat Keakuratan Hasil Pengukuran Arah Kiblat Menggunakan Istiwaaini Karya Slamet Hambali" (Semarang, 2014), 47–51.

[27] Ahmad Izzuddin, "Typology Jihatul Kakbah 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.

[28] Thomas Djamaluddin, "Arah Kiblat Tidak Berubah," tdjamaluddin.com, 2010, https://tdjamaluddin.com/2010/05/25/arah-kiblat-tidak-berubah/.

[29] Muh. Ma'rufin Sudibyo, *Sang Nabi Pun Berputararah Kiblat Dan Tata Cara Pengukurannya* (Solo: Tinta Medina, 2011), 142.

With complex mathematic calculation, according to Sudibyo, tolerance of the direction of the Qibla permitted for this place is 0°23' 59.94”. in another words, a measurement carried out in this place is considered accurate if it is between the azimuth values 294° 18' 11.87” to 295° 6' 11.75”. Furthermore, we use the opinions of Thomas Djamaluddin and Ma'rufin Sudibyo to analyze the accuracy of the *Raṣdu al-Qiblah* method for different azimuth months in the next chapter.

4. Azimuthal Adaptation of the Moon-Based *Raṣdu al-Qiblah* Method

Any celestial body visible from Earth can be used to accurately determine the direction of the Qibla, such as the stars visible in the night sky: Rigel,[30] Aldebaran,[31] Orion,[32] Gienah,[33] and so on. Not only stars, but also planets, the Moon, and the Sun can be utilized in determining the Qibla direction. This is because each celestial object possesses an azimuth value, which refers to the horizontal angle indicating the object's position relative to true north. By calculating the azimuth of a celestial body at a specific time and location, the Qibla direction can be determined with astronomical precision. This principle allows for the use of various celestial bodies as references in Qibla determination, especially in situations where conventional methods are not feasible.[34] When the Moon rises from the East and then moves slowly towards the West, there is a time when the Moon is precisely at a particular azimuth. This principle is what the researcher used to develop the old *Raṣdu al-Qiblah* of the Moon method.

The *Raṣdu al-Qiblah* of the Moon principle is to find the time when the Moon intersects the Qibla circle of a place. When the Moon is at the point of intersection of the Qibla circle, at that time, the direction facing or facing away from the Moon's position is the direction of the Qibla of that place.[35] We later developed this principle, where initially, the Moon only intersects the Qibla circle. It is changed to intersect the circle of angles of difference azimuth +90°, +45°, and -45° from the direction of the Qibla of that place. So, in this *Raṣdu al-Qiblah* of the Moon method of difference azimuth, it not only finds the time when the Moon intersects the Qibla circle but also finds the time when the Moon intersects the Qibla elbow circle (*ṣaff qiblah*) and the diagonal circle of the Qibla. On that basis, every calculation that uses the Qibla azimuth component must be added with the values of the angles of azimuth difference 45°, 90°, and -45°.

Muṣallā of Gumiwang Army housing complex, Pekalongan, with 7° 0' 43.6” S and 109° 35' 37.8” E coordinates, the direction of the Qibla resulting from the spherical trigonometry formula is 65° 17' 48.19" NW, then the qibla azimuth (+90°) is 24° 42' 11.81” NE while the first Qibla diagonal

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[30] Samsul Hakim, “Studi Analisis Terhadap Bintang Rigel Sebagai Acuan Penentu Arah Kiblat Di Malam Hari,” *AL-AFAQ: Jurnal Ilmu Falak Dan Astronomi* 2, no. 1 (June 30, 2020): 31–52, https://doi.org/10.20414/afaq.v2i1.2298.

[31] Muhammad Bachrul ’Ulum, “Studi Analisis Metode Penentuan Arah Kiblat Menggunakan Azimuth Bintang Aldebaran” (UIN Walisongo Semarang, 2021).

[32] H.L. Rahmatiah and Sippah Chotban, “Studi Analisis Rasi Bintang Orion Sebagai Acuan Penentu Arah Kiblat Di Malam Hari Perspektif Astronomi,” *HISABUNA: Jurnal Ilmu Falak* 5, no. 3 (2024).

[33] Rahmawati and Jasdar Agus, “Penentuan Arah Kiblat Menggunakan Azimuth Bintang Gienah (Studi Pengamatan Langit Di Desa Bonto Bulaeng, Kecamatan Sinoa, Kabupaten Bantaeng, Sulawesi Selatan,” *HISABUNA: Jurnal Ilmu Falak* 5, no. 3 (2024), https://doi.org/https://doi.org/10.24252/hisabuna.v5i3.50482.

[34] Siti Anisa Hidayati Siti Anisa Hidayati and Yushardi, “Kajian Penentuan Arah Kiblat Menggunakan Arah Planet Venus,” *AL - AFAQ : Jurnal Ilmu Falak Dan Astronomi* 5, no. 1 (June 25, 2023): 120–28, https://doi.org/10.20414/afaq.v5i1.6338.

[35] Lukman, “Studi Analisis Rashdul Kiblat Bulan Dalam Kitab Jami’u Al-Adillah Karya KH. Ahmad Ghozali,” 70.

(qibla azimuth +45°) is 20° 17' 48.19” NW and the next qibla diagonal (qibla azimuth -45°) is 69° 42' 11.81" SW. These values will later be used to calculate the auxiliary angle.

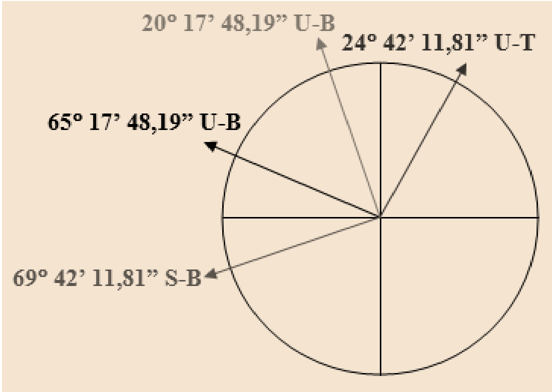

Figure 1. Qibla Direction, *Shaf Qiblah*, and Qibla Diagonal in Pekalongan

According to this calculation, there was three methods have different practices.[36] *Firstly*, In the application of *Raṣdu al-Qiblah* with a +90° azimuth difference (*ṣaff Qiblah*), one practical method involves using a gnomon (stick) by tracing the direction of its shadow and then constructing a perpendicular line to it, which will indicate the Qibla direction. In cases where the Moon’s light is too dim for shadow-based observations, a theodolite may be employed. The procedure involves aligning the theodolite with the Moon at the specified time, locking it in place to maintain accuracy, then activating the instrument and rotating it horizontally by 90°. This rotation effectively redirects the theodolite toward the Qibla

Secondly, In the implementation of *Raṣdu al-Qiblah* with a +45° azimuth difference (Qibla Diagonal 1), the gnomon method can be practically applied by first marking the shadow line of the gnomon. From the tip of the shadow, a second line of equal length is drawn to the left (counterclockwise) at a 90° angle. By connecting the end points of these two lines, an isosceles right triangle is formed, with the diagonal serving as the Qibla direction. Alternatively, when using a theodolite, the observer aligns the instrument with the Moon at the predetermined time, secures its position to prevent deviation, activates the theodolite, unlocks the horizontal axis, and rotates it by 315°. This final orientation indicates the Qibla direction.

Thirdly, in the *Raṣdu al-Qiblah* method with a –45° azimuth difference (Qibla Diagonal 2), the practical application using a gnomon involves tracing the gnomon’s shadow line and drawing a second line of equal length from the shadow tip at a 90° angle to the right (clockwise). Connecting the endpoints of these two lines forms an isosceles right triangle, where the diagonal line represents the Qibla direction. Alternatively, when using a theodolite, the device is initially aimed at the Moon at the predetermined time, and then locked in place to prevent movement. Once activated, the horizontal axis is unlocked and the theodolite is rotated by 45°. The new orientation of the instrument then accurately indicates the Qibla direction

[36] M. Farid Azmi, “Metode Raṣdu Qiblah Dengan Beda Azimut Dalam Penentuan Arah Kiblat,” *Jurnal Ahkam UIN Sayyid Ali Rahmatullah Tulungagung* 7, no. 2 (2019).

Regarding the direction of the Qibla, it is enough to look at the east and west directions of the Moon based on the time of the Moon's culmination. If the practice is carried out before the culmination, then the direction of the Moon is to the East, and vice versa. If the practice time is after the culmination, then the direction of the Moon is to the West; the direction of the Qibla line is adjusted to the direction of the Moon using this reference. For example, the time of the Moon's *Raṣdu al-Qiblah* with azimuth difference +90 in Kajen at 20:00 (GMT+7), while the Moon's culmination occurs at 23:12 (GMT+7) after a right-angle line is made from the gnomon shadow line. The direction of the Qibla line is drawn from the right-angle line is the opposite direction to the direction of the Moon because at that time the position of the Moon was in the East while the direction of the Qibla in Pekalongan is to the West.

This study employs a modified approach, distinct from the formulas presented in *Jāmi'u al-Adillah ilā Ma'rifati Simti al-Qiblah*. Several revisions have been made to enable the calculation of the Moon's *Raṣdu al-Qiblah* with azimuth difference without relying on sidereal time data. Unlike the aforementioned source, which includes sidereal time in its personal ephemeris and is incorporated in applications such as *Pesantren Falakiyah*, our method utilizes the *Ephemeris Hisab Rukyat* data, which does not provide such data. As a result of these adjustments, our findings suggest that the Moon's culmination time serves as the primary reference point in the calculation. To ensure accuracy, the computation must be repeated iteratively until the variation between successive results is less than one minute.

5. Accuration of *Raṣdu al-Qiblah* of the Moon with Azimuth Difference.

To assess the accuracy of the proposed method, a series of observational measurements of the Qibla direction were carried out using three different techniques: the Theodolite, the local *Raṣdu al-Qiblah* of the Sun, and the *Raṣdu al-Qiblah* of the Moon with Azimuth Difference. The observations were conducted on multiple dates—namely, July 29, 30, and 31; August 1, 25, 28, 30, and 31; and September 29, 2023. The research site was the *Muṣallā* located in the Gumiwang Army Housing Complex, Pekalongan, with geographical coordinates of -7° 0' 43.6" latitude (South) and 109° 35' 37.8" longitude (East).

On July 29, 2023, we measured the direction of the Qibla at any time using the Theodolite instrument at 16:40:51 (GMT+7). We also practiced the *Raṣdu al-Qiblah* of the Sun on August 1, 2023, at 15:39:06 GMT. The results of measuring the direction of the Qibla of these two methods did not have any angular differences at all, indicating that these two methods have the same accuracy. Then, the results of the direction of the Qibla of the two methods were used as the primary reference in comparing the direction of the Qibla to be tested.

Then, a few days later, we measured the direction of the Qibla using the *Raṣdu al-Qiblah* of the Moon with azimuth difference, which was then compared with the direction of the Qibla from the two previous methods. On July 30, 2023, we practiced two methods of measuring the direction of the Qibla, namely the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of +45 at 21:05:15 (GMT+7) and the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of +90 at 22:22:46 (GMT+7). The first practice resulted in a difference in the front line of 0.2 cms (9.2 - 9 = 0.2) with a sideline value of 50.8 cms. If entered into the tangent formula, where the tangent of an angle is equal to the front line divided by the sideline, it will produce a deviation angle of 13' 32.06". The second practice resulted in a difference in the front line of 0.2 cms (4.4 - 4.2 = 0.2) with a sideline value of 15 cms so that it will produce an angular deviation of 45' 50.03".

On July 31, 2023, at 23:24:58 (GMT+7), observations were limited to the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of +90°, due to extensive cloud cover throughout the night. During this observation, a front-line discrepancy of 0.25 cm was recorded (calculated from 10.1 cm – 9.85 cm) along a 15 cm sideline. When analyzed using the tangent formula, this resulted in an angular deviation of 57 arcminutes and 17.43 arcseconds (57' 17.43"). Similarly, on August 25, 2023, at 19:00:58 (GMT+7), the same method (Raṣdu al-Qiblah of the Moon with a +90° azimuth difference) was employed, as cloudy weather again restricted visibility. At that time, a front-line difference of 0.2 cm was observed (derived from 9.1 cm – 8.9 cm), with the same 15 cm sideline length. The resulting angular deviation, calculated using the same approach, was consistent with the observation on July 30, 2023, yielding a value of 45 arcminutes and 50.03 arcseconds (45' 50.03").

On August 28, 2023, the researcher practiced the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of +45 and the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of +90. In the first practice at 20:59:15 (GMT), a difference in the front line was found to be 0.2 cm (15 – 14.8 = 0.2) along the 12 cm sideline, so that the angular deviation reached 57' 17.43". Meanwhile, in the second practice at 22:05:02 (GMT), the difference in the front line was found to be only 0.05 cm (38.3 – 38.25 = 0.05), with the sideline 17 cm, so that the angular deviation reached 10' 6.66". On August 30-31, 2023, the weather was clear and supportive for conducting observations. That night, the researcher successfully practiced all the *Raṣdu al-Qiblah* of the Moon with azimuth difference. The first practice of *Raṣdu al-Qiblah* of the Moon with an azimuth difference of + 45 at 23:15:45 (GMT) found a difference in the front line of 0.05 cm (8.05 - 8 = 0.05) with the sideline of 18 cm, resulting in an angular deviation of 9' 32.96".

Second, the implementation of the *Raṣdu al-Qiblah* using an azimuth difference of +90° at 23:42:25 (GMT) yielded a front-line deviation of 0.2 cm (calculated from 23.8 cm – 23.6 cm) with a sideline length of 26.9 cm. Based on the tangent formula, this resulted in an angular deviation of 25 arcminutes and 33.54 arcseconds (25' 33.54"). The third observation involved the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of –45°, conducted on August 31, 2023, at 00:58:10 (GMT). The front-line deviation was measured at 0.2 cm with a sideline of 14.4 cm, producing an angular deviation of 47 arcminutes and 44.6 arcseconds (47' 44.6"). Lastly, on September 29, 2023, at 22:11:32 (GMT), only one observation could be carried out using the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of –45°. This session recorded a front-line deviation of 0.15 cm (from 5.65 cm – 5.5 cm) and a sideline length of 11.3 cm, resulting in an angular deviation of 45 arcminutes and 37.87 arcseconds (45' 37.87").

The observational results related to the determination of the Qibla direction using the azimuth of the Moon, as carried out in this research, are systematically presented in the table below to provide a clear and detailed overview of the measurements obtained.

Table 1. Qibla Measurement by Moon Azimuth

Date	+90		+45		-45	
	Time	Deviation	Time	Deviation	Time	Deviation
July 30, 2023	22:22:46	45'50.03”	21:05:15	13'32.06”	It cannot be counted	
July 31, 2023	23:24:58	57'17.43”	Overcast		It cannot be counted	
August 25, 2023	19:00:58	45'50.03”	Overcast		It cannot be counted	
August 28, 2023	22:05:02	10'6.66”	20:59:15	57'17.43”	It cannot be counted	
August 30-31, 2023	23:42:25	25'33.54”	23:15:45	9'32.96”	00:58:10	47' 44.6”
September 29, 2023	Overcast		Overcast		22:11:32	45'37.87”

From the table above, some methods of *Raṣdu al-Qiblah* with azimuth difference cannot be practiced due to two things, namely because the weather is cloudy and because the *Raṣdu al-Qiblah* with azimuth difference cannot be calculated mathematically. If the calculation process produces a math error value, then this indicates that the *Raṣdu al-Qiblah* with azimuth difference phenomenon does not occur on the date being searched for.

Then, looking at the table above, the smallest deviation value for the *Raṣdu al-Qiblah* of the Moon with azimuth difference is 0° 9' 32.96", while the most significant deviation is 0° 57' 17.43". Suppose it is connected with the opinion of Thomas Djamaluddin, who said that the tolerance or deviation of the direction of the Qibla is 2 degrees. In that case, this deviation range is still within the tolerance limit of the direction of the Qibla, meaning that the *Raṣdu al-Qiblah* of the Moon with azimuth difference can still be considered accurate, considering that the deviation is below 1 degree of arc.

When correlated with Ma'rufin Sudibyo’s calculation regarding the Qibla direction tolerance angle for the *Muṣallā* of the Gumiwang Army Housing Complex—determined to be 0° 23' 59.94"—it becomes evident that only a limited number of the observational data fall within this acceptable deviation range. Specifically, there are three instances where the observed angular deviations meet the tolerance criteria: the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of +45°, conducted on July 30, 2023, which recorded a deviation of 0° 13' 32.06"; the observation on August 30, 2023, with a deviation of 0° 9' 32.96"; and the *Raṣdu al-Qiblah* of the Moon with an azimuth difference of +90°, conducted on August 28, 2023, which resulted in a deviation of 0° 10' 6.66". Other than these three instances, the remaining data recorded deviations that exceeded the permissible tolerance threshold. Therefore, based on Sudibyo’s criteria, only a small portion of the observed practices demonstrated sufficient accuracy in Qibla determination.

6. Analysis of Observational Data and Deviation from Qibla Direction Tolerance Criteria

This section presents an in-depth analysis of the results obtained from the observational measurements of the Qibla direction, as conducted using the *Raṣdu al-Qiblah* with azimuth difference method. The data gathered over multiple dates were compared with established tolerance criteria for Qibla direction, including the tolerance angle defined by Thomas Djamaluddin and Ma'rufin Sudibyo. The purpose of this analysis is to assess the accuracy of the *Raṣdu al-Qiblah* method, particularly focusing on its applicability under varying weather conditions and the extent to which it aligns with the accepted standards of Qibla deviation. Through careful examination of the observed angular deviations, this analysis will determine whether the proposed method meets the accuracy required for practical use in Qibla determination.

Based on these data above, this deviation value can be minimized as much as possible by directly targeting the Moon using a Theodolite. In fact, in the observation, we only used moonlight projection to target the Moon's position easily. This was done because the position of the Moon during the entire observation was always at an altitude above 45 degrees, so it was impossible to target the Moon's physical body with the help of a Theodolite. As we all know, moonlight is reflected light from sunlight, so due to the reflection of that light, the Moon has certain phases, meaning that if you target the Moon by relying on the shadow of the gnomon created by moonlight, then there is a potential when the phase other than the full Moon does not represent the midpoint of the Moon's position, so that the measurement will produce a deviation value slightly larger than the actual value. Suppose the measurement is carried out by targeting the Moon's physical body at the center point of the Moon using a Theodolite. In that case, the measurement results of the Qibla's direction may show the same line as the two comparison methods without any deviation value.

In addition, there is also the potential for human error during field practice, such as not being straight enough in drawing shadows, not being careful in making right angles or diagonal lines, the research location not being flat enough, not being precise in drawing shadows according to the specified time and so on. These errors are very likely to be made by researchers and have the potential to produce excessive deviation values, resulting in the deviation value going outside the tolerance limits of the permitted direction of the Qibla.

The *Raṣdu al-Qiblah* of the Moon with Azimuth Difference aligns with previous research conducted by Nailu Alvi Hidayah. She once tested the *Raṣdu al-Qiblah* of the Sun with azimuth Difference; the conclusion was that the accuracy of the method had consistent and precise results, even in 6 days of testing, he got 13 observation data samples, where only 2 times the observation results showed a deviation value of 1 to 1.5 degrees, the rest of the measurements were always precise with the Theodolite. However, this deviation value is still relatively safe, below the tolerance limit of 2 degrees, according to Thomas Djamaluddin.[37] This is in line with the *Raṣdu al-Qiblah* of the Moon with Azimuth Difference, which is currently being studied; the deviation shows below the tolerance limit according to Thomas Djamaluddin, and there is also a deviation below the tolerance limit according to Ma'rufin Sudibyo.

According to our works, we found the advantages of the *Raṣdu al-Qiblah* of the Moon with the Azimuth Difference. *Firstly*, this method can be an alternative method for measuring the direction of the Qibla that can be practiced several times a night. Secondly, this method has a high level of accuracy comparable to *Raṣdu al-Qiblah* of the Sun and Theodolite instruments. As for the disadvantages of this method, first, the calculation of *Raṣdu al-Qiblah* of the Moon with Azimuth Difference is relatively long because it requires repeated calculations. *Second*, this method is less effective when practiced during the crescent or half Moon phase because the light produced does

[37] Nailul Alvi Hidayah, "Uji Akurasi Penentuan Arah Kiblat Menggunakan Metode Rashdul Qiblah Beda Azimuth" (UIN Sunan Ampel Surabaya, 2022), 80–81.

not represent the center of the Moon. *Third*, using the gnomon can only be done on dates when the Moon is bright enough and can only be done in a relatively dark place to produce a clear gnomon shadow.

D. Conclusion

The Raṣdu al-Qiblah of the Moon with azimuth difference method is adopted from the Raṣdu al-Qiblah of the Moon method, which utilizes the qibla elbow line and the qibla diagonal line from the projection of the Moon's light. The calculation algorithm and the practice method differ slightly from the original method. In its calculation, the qibla azimuth value must be added with the values of 90°, 45°, and -45° and then calculated similarly. In practice, this method must first create an elbow line or diagonal line from the Moon's shadow line to get an accurate qibla line. From several measurements, this method has a deviation from the Theodolite instrument and Raṣdu al-Qiblah of the Sun method (local) of 0°9'32.96" to 0°57'17.43".

According to Thomas Djamaluddin's theory of qibla direction tolerance, the deviation is still within the tolerance limit, which is no more than 2 degrees of arc. In contrast, according to Ma'rufin Sudibyo's theory of qibla direction tolerance, the deviation value of the observation results does not all meet the tolerance limit; there are only three observations that meet the tolerance limit of 0° 23'59.94"; however, this has been able to prove that the Raṣdu al-Qiblah of the Moon with azimuth difference method can be used as an alternative for measuring the direction of the Qibla and has high accuracy comparable to Theodolite and Rashdu Qibla of the Sun.

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