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Analysis of Sun Declination to Deviation Results: Qiblate Directions al-Mujahidin Mosque, Totokan Village, Mlarak District, Ponorogo Regency

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Abstract: Based on several measurement results, the majority of mosques in Ponorogo district in the initial determination of the direction of the Qibla using the approximate method, in which there is a very significant deviation in one of the mosques that the author has measured, namely the al-Mujahidin mosque in Totokan Village, Mlarak District, Ponorogo Regency. In addition, the assumption from the community is that if the Qibla direction is wrong, then the mosque must be dismantled, even though this assumption is wrong, so if there is an error in the Qibla direction, it is enough to change the prayer rows according to the correct measurement results. This type of research is a field research with a qualitative approach with data collection researchers using 4 techniques, namely; Observation, Interview, Measurement and Documentation. This study resulted in conclusions, among others: the first is to know about the initial determination of the Qibla direction of the al-Mujahidin Mosque, Totokan village, Mlarak district, Ponorogo district which only uses the method of estimating the direction of the sun in the afternoon and the results of calculations and measurements of the Qibla direction of the Al-Mujahidin mosque in Totokan Village. The second Mlarak sub-district, Ponorogo Regency, is to find out the results of the analysis based on the sun's declination to the deviation of the Qibla direction of the al-Mujahidin mosque, Totokan village, Mlarak sub-district, Ponorogo district that when estimating the Qibla direction of the mosque the sun's declination or the position of the sun is in the south or slightly inclined to the south so that the results the approximate direction of the initial determination of the Qibla shows to the southwest not to the west which causes the deviation result to be very large, namely 31º 39' 27.1". (less 31º 39' 27.1". from the real Qibla to the standard Qibla based on the calculation of the Qibla direction).

Keywords: *Qibla direction, sun declination, deviation*

INTRODUCTION

If we look at the historical trajectory, that the method of determining the direction of Qibla in Indonesia from time to time has experienced the development of knowledge owned by the Indonesian Islamic community itself. Concretely, it looks like when there was a change in the direction of the Qibla of the Great Mosque of Kauman Yogyakarta which underwent major changes during the KH era. Ahmad Dahlan and we can also see from the history of the tools used to measure it, such as the bencet or miqyas or istiwa' stick (Azhari, 2005), rubu' al-mujayyab (Khazin, 2004), compass, theodolite and others

(Azhari, 2005). In addition, the calculations used have also developed both in terms of coordinate data and regarding the measurement system (Izzudin, 2003). From this it appears that the method or method of determining the direction of Qibla can be divided into a dichotomy of classical methods with modern methods which eventually leads to crystallization in the symbolization of the Hisab and Rukyah schools. Madhhab rukyah is symbolized by them in determining the direction of Qibla by using a becet or miqyas or stick istiwa' or rubu' al-mujayyab or those who are guided by the position of the sun exactly (or close to exactly) at the zenith point of the Kaaba (Rashd al-Qiblah). While the school of reckoning is symbolized by those who determine the Qibla direction by using spherical trigonometry.

Facing the Qibla direction is an important issue in Islam. According to Shari'ah law, facing towards the Qibla is defined as the whole body or a person's body facing the Kaaba which is located in Makkah al-Mukarramah which is the center of focus for Muslims to complete certain worship. Facing towards the Qibla is a legal requirement for Muslims who want to perform prayers, whether they are fard prayers five times a day and night or other circumcision prayers.

Therefore, knowing for sure about the law of facing the Qibla and how to determine the direction of the Qibla is very important so that we are sure that we have faced the Qibla in performing the required worship. To get confidence in the correct Qibla, we need to determine or calculate carefully the perfection of its direction. Because it shifts a little from the actual direction, it means that it is no longer facing the Masjid al-Haram, but facing Egypt, Iran, or maybe even South Africa and the Soviet Union (Supriatna, 2007).

In this last case, by knowing the direction of the rising and setting of the sun, the direction of East and West can be estimated, and by knowing beforehand the rough position of Mecca relative to where it is located, the direction of Qibla at that place can also be estimated. Even though according to Islamic law, knowledge of very precise Qibla direction is not a substantial matter, but it needs to be stated here, with the development of satellite determination technology based on the Global Positioning System (GPS) satellite system to find position coordinate data accurately, this Qibla direction can be determined accurately anywhere on the earth's surface consistently. Likewise, by using a measurement tool in the form of Theodolite, the measurement results are more accurate.

From the point of view of geodetic (Echols dan Shadily, 1995) science, the direction of Qibla in a place can be calculated mathematically using the coordinates (latitude and longitude) of the place, as well as the coordinates of the Masjid al-Haram or more precisely the Kaaba in Mecca. The latitude and longitude of the place are already available, it's just that the list needs to be verified with a contemporary tool, namely the Global Positioning System (GPS).

From the results of the calculations and measurements of the Al-Mujahidin Mosque in Totokan Village, Mlarak District, Ponorogo Regency, the Qibla direction experienced not a small deviation or deviation, namely 31^{o} 39' 27.1" less to the north. Where the results of measurements with theodolite obtained the standard qibla based on astronomy is 294^{o} 26 ' 57.1". While the Qibla direction of the Al-Mujahidin mosque is 262^{o} 47' 30" which this number leads to the southwest, so that between the real Qibla and the standard Qibla based on astronomy, the difference is very large.

Based on the results of deviations or deviations that are very significant, the results obtained from interviews with the takmir of the Al-Mujahidin mosque that the initial

determination was made using an approximate method with the position of the afternoon sun in the west, then the direction of the Qibla was shifted slightly to the north. From here the author is interested in analyzing the results of the deviation by using the position of the sun with the theory of solar declination.

RESULT AND DISCUSSION

Qibla Direction and Its Proof

Qibla direction consists of two words that come from the word "direction" which means direction, purpose and intent. Another definition according to Saadoe'ddin Djambek is "direction" means the closest distance measured through a large circle. While "Qibla" means the Kaaba (Baitullah) which is located inside the Al-Haram Mosque in Mecca. Qibla is also called “jihad”, “shathrah”, and “azimuth.

Qibla comes from Arabic (قبلة) is a direction that refers to an area / area where the Kaaba building is located at the Masjid al-Haramm, Makkah, Saudi Arabia. Kaaba is also often referred to as Baitullah (House of Allah). The Qibla issue is the azimuth issue. On the horizon plane we can draw a line according to the local Qibla direction, which we call the Qibla line. The Qibla line and the zenith point create a plane that intersects the celestial sphere according to the Qibla vertical circle (= vertical circle through the Mecca zenith) (Sayuthi, 1997).

According to Fiqh scholars in the book of al-Fiqh 'ala al-Madhahib al-Arba'ah states that the Qibla direction is the direction of the Ka'bah or the form of the Ka'bah, then whoever is near the Ka'bah is not valid for prayer unless facing the form of the Ka'bah. bah and people who are far from the Ka'bah (do not see it) then for him ijtihad to face the Qibla (towards the Qibla only).

From the above understanding it can be concluded that the direction of Qibla in terms is a direction that must be addressed by Muslims when performing prayers.

The arguments related to the Qibla direction are:

Surah al-Baqarah verse 150:

وَمِنْ حَيْثُ خَرَجْتَ فَوَلِّ وَجْهَكَ شَطْرَ الْمَسْجِدِ الْحَرَامِ وَحَيْثُ مَا كُنْتُمْ فَوَلُّوا وُجُوهَكُمْ شَطْرَهُ لِئَلاَّ يَكُونَ لِلنَّاسِ عَلَيْكُمْ حُجَّةٌ إِلاَّ الَّذِينَ ظَلَمُوا مِنْهُمْ فَلاَ تَخْشَوْهُمْ وَاخْشَوْنِي وَلأُتِمَّ نِعْمَتِي عَلَيْكُمْ وَلَعَلَّكُمْ تَهْتَدُونَ

It means:

"And wherever you come out, turn your face towards the Masjid al-Haram. And wherever you (all) are, then turn your face towards it, so that there is no proof for humans against you, except those who are wrong among them. So do not fear them and fear Me. And that I may complete My favor upon you, and that you may be guided".

Al-Qur'an verse 150 in the same letter, Allah repeats again about the provisions facing the Grand Mosque. This provision is a hujjah (handle) for the Prophet to deal with people who want to question the direction of Qibla for the Prophet and his people. On the basis of the verses above, it is clear to Muslims that it is their obligation to study

geography and other sciences to determine the direction of the Grand Mosque for those who are far from the Haram Mosque.

As-Shabuni's commentary explains, that with the verses above which mention "Masjidil Haram" and not "Kaaba" is to give an understanding of the obligation of the Qibla direction for people who are far from the Kaaba, it is enough to direct them to the Grand Mosque, while those who are in the Grand Mosque then the Qibla direction is the Kaaba. This information is based on a narration from the Prophet who said (al-Qurtubi, 1967):

اَلْبَيْتُ قِبْلَةٌ لأَهْلِ الْمَسْجِدِ وَالْمَسْجِدُ قِبْلَةٌ لأَهْلِ الْحَرَامِ وَالْحَرَامُ قِبْلَةٌ لأَهْلِ ٱلأَرْضِ فِى مَشَارِقِهَا وَمَغَارِبِهَامِنْ أُمَّتِي.

"The Ka'bah is the mecca for those in the mosque, and the mosque is the qibla for those in the Haram (Makkah) and Haram (Makkah) areas, the qibla for the inhabitants of the earth from west to east of my Ummah" (*Ibn Katsir, 1987*).

Hadith narrated by al-Tirmidhi:

عَنْ أَبِى هُرَيْرَةَ عَنِ النَّبِيِّ ص.م. قَالَ: بَيْنَ الْمَشْرِقِ وَالْمَغْرِبِ قِبْلَةٌ .

(رواه الترميذي)

*"From Abi Hurairah, the Messenger of Allah s.a.w. said: The direction between east and west is the Qiblah" (*Hassan, 1982*).*

Sun Declination

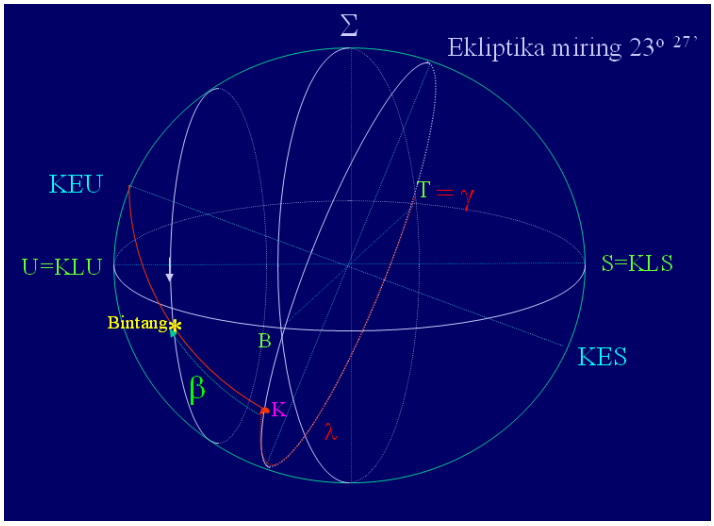
Declination is the distance of a celestial body from the celestial equator. If the celestial body is to the north of the equator, the declination is counted as positive, whereas if the celestial body is to the south of the equator, the declination is counted as negative. Commonly used symbols are d or D or (delta). The sun's declination ranges from + 23.5 degrees to -23.5 degrees. While the declination of the moon can reach a maximum of 59 degrees (greater than the declination of the sun).

The daily journey of the sun rising from the east and setting in the west is not the actual motion of the sun, but is caused by the rotation of the earth on its axis (rotation) during the day and night, so that such a journey of the sun is called the pseudo-sun journey. The apparent travel of the sun and other celestial bodies is always parallel to the celestial equator. In addition, the sun makes an annual journey, namely the sun's journey to the east in one year (365.2425 days) for one rotation, so that it travels a distance of 00^{o} 59' 08.33" every day.

The path of the sun does not coincide with the celestial equator, but it forms an angle of about 23^{o} 27' with the equator. The path of the sun's journey is called the Ecliptic or Da'iratul Buruj, which is a large circle in the celestial sphere that intersects the circle of the celestial equator by forming an angle of 23^{o} 27'. The point of intersection between the circle of the equator and the ecliptic occurs twice. First, it occurs when the sun moves from the southern sky to the northern sky, namely at the Aries point (on March 21) which is called the vernal equinox (♈), and second, occurs when the sun moves from the

northern sky to the southern sky, namely at the libra point (September 23) which is called the Autumnal Equinox (Ω).

The tilt of the ecliptic is not fixed, it changes. In 1100BC the slope was recorded at 22^{o} 54'. Then in 350 BC recorded 23^{o} 49 '. In 1800M it was recorded at 23^{o} 27' 55", in 1900M it was recorded at 23^{o} 27' 09" and in 2000 it was 23^{o} 26' 16". Therefore, the tilt of the ecliptic changes by about -0.468" every year.



Picture 1.

The sun's declination changes from time to time during the year, but on the same dates, the declination number is roughly the same. From March 21 to September 23 the sun's declination is positive, while from September 23 to March 21 it is negative. On March 21 and September 23, the sun is at the equator, its declination is 0^{o} (Rachim, 1983)

After March 21, the sun gradually moved northward away from the equator, from day to day getting farther and farther away, until on June 21 it reached its position farthest from the equator, which is 23^{o} 27' north. After that he moved back to the south, every day closer to the equator, until on September 23 he was at the equator again. He then continued his journey to the south, until on December 22 he reached his farthest place from the equator, which is 23^{o} 26' south. After that it turned to move north again, gradually each day closer to the equator. On March 21 it is right at the equator again.

From the change in the position of the sun during a year, as explained above, it is clear to us that the sun's declination is constantly changing, not only from day to day, but from hour to hour. The change is greatest when the sun is located near the equator, which is around September 21 and 23, then the change is smallest when the sun turns around on its journey, which is around June 21 and December 22.

The examples of changes in solar declination data from hour to hour on special dates of March 21, September 23, June 21 and December 22 which are taken based on ephemeris data are:

21 Maret 2022

DATA MATAHARI

Jam (ET)	Ecliptic Longitude	Ecliptic Latitude	Apparent Right Ascension	Apparent Declination	Geocentric Distance	Semi Diameter	True Obliquity	Equation Of Time
0	00° 21' 28"	0.00"	00° 19' 42"	00° 08' 32"	0.9959212	16' 3.56"	23° 26' 16"	-07 m 18 s
1	00° 23' 57"	0.00"	00° 21' 59"	00° 09' 31"	0.9959330	16' 3.55"	23° 26' 16"	-07 m 18 s
2	00° 26' 26"	-0.01"	00° 24' 16"	00° 10' 31"	0.9959448	16' 3.54"	23° 26' 16"	-07 m 17 s
3	00° 28' 55"	-0.01"	00° 26' 32"	00° 11' 30"	0.9959566	16' 3.53"	23° 26' 16"	-07 m 16 s
4	00° 31' 24"	-0.02"	00° 28' 49"	00° 12' 29"	0.9959685	16' 3.51"	23° 26' 16"	-07 m 15 s
5	00° 33' 53"	-0.02"	00° 31' 06"	00° 13' 28"	0.9959803	16' 3.50"	23° 26' 16"	-07 m 15 s
6	00° 36' 22"	-0.03"	00° 33' 22"	00° 14' 28"	0.9959922	16' 3.49"	23° 26' 16"	-07 m 14 s
7	00° 38' 51"	-0.03"	00° 35' 39"	00° 15' 27"	0.9960040	16' 3.48"	23° 26' 16"	-07 m 13 s
8	00° 41' 20"	-0.04"	00° 37' 56"	00° 16' 26"	0.9960159	16' 3.47"	23° 26' 16"	-07 m 12 s
9	00° 43' 49"	-0.05"	00° 40' 12"	00° 17' 25"	0.9960277	16' 3.46"	23° 26' 16"	-07 m 12 s
10	00° 46' 18"	-0.05"	00° 42' 29"	00° 18' 25"	0.9960396	16' 3.45"	23° 26' 16"	-07 m 11 s
11	00° 48' 47"	-0.06"	00° 44' 46"	00° 19' 24"	0.9960515	16' 3.43"	23° 26' 16"	-07 m 10 s
12	00° 51' 16"	-0.06"	00° 47' 02"	00° 20' 23"	0.9960633	16' 3.42"	23° 26' 16"	-07 m 09 s
13	00° 53' 45"	-0.07"	00° 49' 19"	00° 21' 22"	0.9960752	16' 3.41"	23° 26' 16"	-07 m 09 s
14	00° 56' 14"	-0.07"	00° 51' 36"	00° 22' 22"	0.9960871	16' 3.40"	23° 26' 16"	-07 m 08 s
15	00° 58' 43"	-0.08"	00° 53' 52"	00° 23' 21"	0.9960990	16' 3.39"	23° 26' 16"	-07 m 07 s
16	01° 01' 12"	-0.08"	00° 56' 09"	00° 24' 20"	0.9961109	16' 3.38"	23° 26' 16"	-07 m 06 s
17	01° 03' 41"	-0.09"	00° 58' 26"	00° 25' 19"	0.9961227	16' 3.37"	23° 26' 16"	-07 m 06 s
18	01° 06' 10"	-0.09"	01° 00' 42"	00° 26' 19"	0.9961346	16' 3.35"	23° 26' 16"	-07 m 05 s
19	01° 08' 39"	-0.10"	01° 02' 59"	00° 27' 18"	0.9961465	16' 3.34"	23° 26' 16"	-07 m 04 s
20	01° 11' 08"	-0.10"	01° 05' 16"	00° 28' 17"	0.9961584	16' 3.33"	23° 26' 16"	-07 m 03 s
21	01° 13' 36"	-0.11"	01° 07' 32"	00° 29' 16"	0.9961703	16' 3.32"	23° 26' 16"	-07 m 03 s
22	01° 16' 05"	-0.12"	01° 09' 49"	00° 30' 15"	0.9961822	16' 3.31"	23° 26' 16"	-07 m 02 s
23	01° 18' 34"	-0.12"	01° 12' 05"	00° 31' 15"	0.9961942	16' 3.30"	23° 26' 16"	-07 m 01 s
24	01° 21' 03"	-0.13"	01° 14' 22"	00° 32' 14"	0.9962061	16' 3.28"	23° 26' 16"	-07 m 00 s

Picture 2.

23 September 2022

DATA MATAHARI

Jam (ET)	Ecliptic Longitude	Ecliptic Latitude	Apparent Right Ascension	Apparent Declination	Geocentric Distance	Semi Diameter	True Obliquity	Equation Of Time
0	179° 57' 52"	0.70"	179° 58' 03"	00° 00' 50"	1.0036501	15' 56.14"	23° 26' 17"	07 m 26 s
1	180° 00' 19"	0.70"	180° 00' 18"	00° 00' -07"	1.0036386	15' 56.15"	23° 26' 16"	07 m 27 s
2	180° 02' 46"	0.70"	180° 02' 32"	00° -01' 06"	1.0036271	15' 56.16"	23° 26' 17"	07 m 28 s
3	180° 05' 13"	0.70"	180° 04' 47"	00° -02' 04"	1.0036156	15' 56.17"	23° 26' 17"	07 m 29 s
4	180° 07' 40"	0.70"	180° 07' 02"	00° -03' 02"	1.0036041	15' 56.18"	23° 26' 17"	07 m 30 s
5	180° 10' 06"	0.69"	180° 09' 17"	00° -04' 01"	1.0035926	15' 56.19"	23° 26' 17"	07 m 31 s
6	180° 12' 33"	0.69"	180° 11' 31"	00° -04' 59"	1.0035811	15' 56.21"	23° 26' 17"	07 m 32 s
7	180° 15' 00"	0.69"	180° 13' 46"	00° -05' 58"	1.0035696	15' 56.22"	23° 26' 17"	07 m 32 s
8	180° 17' 27"	0.69"	180° 16' 01"	00° -06' 56"	1.0035581	15' 56.23"	23° 26' 17"	07 m 33 s
9	180° 19' 54"	0.69"	180° 18' 15"	00° -07' 55"	1.0035465	15' 56.24"	23° 26' 17"	07 m 34 s
10	180° 22' 21"	0.69"	180° 20' 30"	00° -08' 53"	1.0035350	15' 56.25"	23° 26' 17"	07 m 35 s
11	180° 24' 47"	0.68"	180° 22' 45"	00° -09' 51"	1.0035235	15' 56.26"	23° 26' 17"	07 m 36 s
12	180° 27' 14"	0.68"	180° 25' 00"	00° -10' 50"	1.0035119	15' 56.27"	23° 26' 17"	07 m 37 s
13	180° 29' 41"	0.68"	180° 27' 14"	00° -11' 48"	1.0035004	15' 56.28"	23° 26' 17"	07 m 38 s
14	180° 32' 08"	0.68"	180° 29' 29"	00° -12' 47"	1.0034888	15' 56.29"	23° 26' 17"	07 m 39 s
15	180° 34' 35"	0.68"	180° 31' 44"	00° -13' 45"	1.0034773	15' 56.30"	23° 26' 17"	07 m 39 s
16	180° 37' 02"	0.67"	180° 33' 59"	00° -14' 43"	1.0034657	15' 56.32"	23° 26' 17"	07 m 40 s
17	180° 39' 29"	0.67"	180° 36' 13"	00° -15' 42"	1.0034542	15' 56.33"	23° 26' 17"	07 m 41 s
18	180° 41' 55"	0.67"	180° 38' 28"	00° -16' 40"	1.0034426	15' 56.34"	23° 26' 17"	07 m 42 s
19	180° 44' 22"	0.67"	180° 40' 43"	00° -17' 39"	1.0034311	15' 56.35"	23° 26' 17"	07 m 43 s
20	180° 46' 49"	0.66"	180° 42' 58"	00° -18' 37"	1.0034195	15' 56.36"	23° 26' 17"	07 m 44 s
21	180° 49' 16"	0.66"	180° 45' 12"	00° -19' 35"	1.0034079	15' 56.37"	23° 26' 17"	07 m 45 s
22	180° 51' 43"	0.66"	180° 47' 27"	00° -20' 34"	1.0033963	15' 56.38"	23° 26' 17"	07 m 46 s
23	180° 54' 10"	0.66"	180° 49' 42"	00° -21' 32"	1.0033848	15' 56.39"	23° 26' 17"	07 m 46 s
24	180° 56' 37"	0.65"	180° 51' 57"	00° -22' 31"	1.0033732	15' 56.40"	23° 26' 17"	07 m 47 s

Picture 3.

21 Juni 2022

DATA MATAHARI

Jam (ET)	Ecliptic Longitude	Ecliptic Latitude	Apparent Right Ascension	Apparent Declination	Geocentric Distance	Semi Diameter	True Obliquity	Equation Of Time
0	89° 38' 28"	-0.29"	89° 36' 32"	23° 26' 15"	1.0162026	15' 44.33"	23° 26' 17"	-01 m 42 s
1	89° 40' 51"	-0.28"	89° 39' 08"	23° 26' 15"	1.0162057	15' 44.33"	23° 26' 16"	-01 m 42 s
2	89° 43' 15"	-0.28"	89° 41' 44"	23° 26' 15"	1.0162088	15' 44.32"	23° 26' 16"	-01 m 43 s
3	89° 45' 38"	-0.28"	89° 44' 20"	23° 26' 15"	1.0162119	15' 44.32"	23° 26' 16"	-01 m 43 s
4	89° 48' 01"	-0.27"	89° 46' 56"	23° 26' 15"	1.0162150	15' 44.32"	23° 26' 16"	-01 m 44 s
5	89° 50' 24"	-0.27"	89° 49' 32"	23° 26' 16"	1.0162181	15' 44.31"	23° 26' 16"	-01 m 44 s
6	89° 52' 47"	-0.27"	89° 52' 08"	23° 26' 16"	1.0162212	15' 44.31"	23° 26' 16"	-01 m 45 s
7	89° 55' 10"	-0.26"	89° 54' 44"	23° 26' 16"	1.0162243	15' 44.31"	23° 26' 16"	-01 m 46 s
8	89° 57' 33"	-0.26"	89° 57' 20"	23° 26' 16"	1.0162274	15' 44.31"	23° 26' 16"	-01 m 46 s
9	89° 59' 57"	-0.26"	89° 59' 56"	23° 26' 16"	1.0162304	15' 44.30"	23° 26' 16"	-01 m 47 s
10	90° 02' 20"	-0.25"	90° 02' 32"	23° 26' 16"	1.0162335	15' 44.30"	23° 26' 16"	-01 m 47 s
11	90° 04' 43"	-0.25"	90° 05' 08"	23° 26' 16"	1.0162366	15' 44.30"	23° 26' 16"	-01 m 48 s
12	90° 07' 06"	-0.25"	90° 07' 44"	23° 26' 16"	1.0162396	15' 44.30"	23° 26' 16"	-01 m 48 s
13	90° 09' 29"	-0.24"	90° 10' 20"	23° 26' 15"	1.0162426	15' 44.29"	23° 26' 16"	-01 m 49 s
14	90° 11' 52"	-0.24"	90° 12' 56"	23° 26' 15"	1.0162457	15' 44.29"	23° 26' 16"	-01 m 49 s
15	90° 14' 15"	-0.24"	90° 15' 32"	23° 26' 15"	1.0162487	15' 44.29"	23° 26' 16"	-01 m 50 s
16	90° 16' 39"	-0.23"	90° 18' 08"	23° 26' 15"	1.0162517	15' 44.28"	23° 26' 16"	-01 m 50 s
17	90° 19' 02"	-0.23"	90° 20' 44"	23° 26' 15"	1.0162547	15' 44.28"	23° 26' 16"	-01 m 51 s
18	90° 21' 25"	-0.23"	90° 23' 20"	23° 26' 14"	1.0162577	15' 44.28"	23° 26' 16"	-01 m 52 s
19	90° 23' 48"	-0.22"	90° 25' 56"	23° 26' 14"	1.0162607	15' 44.28"	23° 26' 16"	-01 m 52 s
20	90° 26' 11"	-0.22"	90° 28' 32"	23° 26' 13"	1.0162636	15' 44.27"	23° 26' 16"	-01 m 53 s
21	90° 28' 34"	-0.21"	90° 31' 08"	23° 26' 13"	1.0162666	15' 44.27"	23° 26' 16"	-01 m 53 s
22	90° 30' 57"	-0.21"	90° 33' 44"	23° 26' 12"	1.0162696	15' 44.27"	23° 26' 16"	-01 m 54 s
23	90° 33' 21"	-0.21"	90° 36' 20"	23° 26' 12"	1.0162725	15' 44.26"	23° 26' 16"	-01 m 54 s
24	90° 35' 44"	-0.20"	90° 38' 56"	23° 26' 11"	1.0162755	15' 44.26"	23° 26' 16"	-01 m 55 s

Picture 4.

22 Desember 2022

DATA MATAHARI

Jam (ET)	Ecliptic Longitude	Ecliptic Latitude	Apparent Right Ascension	Apparent Declination	Geocentric Distance	Semi Diameter	True Obliquity	Equation Of Time
0	270° 06' 03"	-0.43"	270° 06' 36"	-23° 26' 17"	0.9837885	16' 15.44"	23° 26' 17"	01 m 41 s
1	270° 08' 36"	-0.44"	270° 09' 22"	-23° 26' 17"	0.9837858	16' 15.45"	23° 26' 17"	01 m 39 s
2	270° 11' 09"	-0.44"	270° 12' 09"	-23° 26' 17"	0.9837831	16' 15.45"	23° 26' 17"	01 m 38 s
3	270° 13' 42"	-0.45"	270° 14' 56"	-23° 26' 17"	0.9837805	16' 15.45"	23° 26' 17"	01 m 37 s
4	270° 16' 14"	-0.45"	270° 17' 42"	-23° 26' 16"	0.9837778	16' 15.45"	23° 26' 17"	01 m 36 s
5	270° 18' 47"	-0.45"	270° 20' 29"	-23° 26' 16"	0.9837752	16' 15.46"	23° 26' 17"	01 m 34 s
6	270° 21' 20"	-0.46"	270° 23' 15"	-23° 26' 15"	0.9837725	16' 15.46"	23° 26' 17"	01 m 33 s
7	270° 23' 53"	-0.46"	270° 26' 02"	-23° 26' 15"	0.9837699	16' 15.46"	23° 26' 17"	01 m 32 s
8	270° 26' 26"	-0.47"	270° 28' 48"	-23° 26' 14"	0.9837673	16' 15.46"	23° 26' 17"	01 m 31 s
9	270° 28' 58"	-0.47"	270° 31' 35"	-23° 26' 14"	0.9837646	16' 15.47"	23° 26' 17"	01 m 29 s
10	270° 31' 31"	-0.48"	270° 34' 21"	-23° 26' 13"	0.9837620	16' 15.47"	23° 26' 17"	01 m 28 s
11	270° 34' 04"	-0.48"	270° 37' 08"	-23° 26' 13"	0.9837594	16' 15.47"	23° 26' 17"	01 m 27 s
12	270° 36' 37"	-0.49"	270° 39' 55"	-23° 26' 12"	0.9837568	16' 15.47"	23° 26' 17"	01 m 26 s
13	270° 39' 10"	-0.49"	270° 42' 41"	-23° 26' 11"	0.9837542	16' 15.48"	23° 26' 17"	01 m 25 s
14	270° 41' 43"	-0.49"	270° 45' 28"	-23° 26' 10"	0.9837516	16' 15.48"	23° 26' 17"	01 m 23 s
15	270° 44' 15"	-0.50"	270° 48' 14"	-23° 26' 09"	0.9837490	16' 15.48"	23° 26' 17"	01 m 22 s
16	270° 46' 48"	-0.50"	270° 51' 01"	-23° 26' 08"	0.9837464	16' 15.49"	23° 26' 17"	01 m 21 s
17	270° 49' 21"	-0.51"	270° 53' 47"	-23° 26' 07"	0.9837438	16' 15.49"	23° 26' 17"	01 m 20 s
18	270° 51' 54"	-0.51"	270° 56' 34"	-23° 26' 06"	0.9837413	16' 15.49"	23° 26' 17"	01 m 18 s
19	270° 54' 27"	-0.51"	270° 59' 20"	-23° 26' 05"	0.9837387	16' 15.49"	23° 26' 17"	01 m 17 s
20	270° 56' 59"	-0.52"	271° 02' 07"	-23° 26' 04"	0.9837361	16' 15.50"	23° 26' 17"	01 m 16 s
21	270° 59' 32"	-0.52"	271° 04' 54"	-23° 26' 03"	0.9837336	16' 15.50"	23° 26' 17"	01 m 15 s
22	271° 02' 05"	-0.53"	271° 07' 40"	-23° 26' 02"	0.9837310	16' 15.50"	23° 26' 17"	01 m 13 s
23	271° 04' 38"	-0.53"	271° 10' 27"	-23° 26' 01"	0.9837285	16' 15.50"	23° 26' 17"	01 m 12 s
24	271° 07' 11"	-0.53"	271° 13' 13"	-23° 25' 59"	0.9837259	16' 15.51"	23° 26' 17"	01 m 11 s

Picture 5.

Results Of Calculation And Measurement Of The Quality Direction Of Al-Mujahidin Mosque, Totokan Village, Mlarak District, Ponorogo Regency

Al-Mujahidin Mosque is located in the village of Totokan which is the oldest mosque in the village, based on the results of an interview with the ta'mir of the mosque (KH. Hadi Sokiran) that the mosque initially determined the Qibla direction only using the directions/estimated method because it could be said that knowledge and the knowledge of the ancients who wrote the mosque chronicle did not understand at all, especially astronomy. Moreover, regarding the science of astronomy, the religious knowledge of the village community is also very minimal. So it is also very possible if verified with modern technology there will be not a small deviation.

The results of the calculations and measurements are:

Latitude (φ) : -7° 54' 52.98"

Longitude (λ) : 111° 32' 52.5"

The shot was taken at 08.12 WIB atau 01.12 GMT (for the calculation of the solar declination and GHA interpolated data).

a) *Qibla Azimuth*

(1) Formula

$K = \tan^1 (1/((\tan 68^o 35')^{-1} \sin (90 – P)/\sin (L – 39^o 50') – \cos (90 – P)/\tan (L – 39^o 50'))$

(2) Calculation

$K = \tan^1 (1/((\tan 68^o 35')^{-1} \sin (90 – -7^o 54' 52.98")/\sin (111^o 32' 52.5" – 39^o 50') – \cos (90 – -7^o 54' 52.98")/\tan (111^o 32' 52.5" – 39^o 50'))$ EXE

K = 65.55080541 SHIFT ,,,, 65° 33' 2.9"

b) With Shadows as determining True North

(1) Formula

(a) Price Z = 12 – e + ((105 – L) /15)

(b) Time of Shooting (W)

(c) Latitude (P)

(d) Declination at shooting (D) by interpolation formula: A – (A – B) x frac (W)

(e) GHA saat pembidikan (T) by interpolation formula: A – (A – B) x frac (W) + L – 360

(f) *Azimuth True North Formula*:

$\tan^{-1} (1/(-\sin P / \tan T + \cos P \tan D / \sin T))$

(2) Nautical Almanac Data

(a) Deklination : Jam 01 = -23° 24.6'
Jam 02 = -23° 24.5'

(b) GHA : Jam 01 = 195° 04.7'
Jam 02 = 210° 04.4'

(c) *Equation of Time* (e) : $00^j\ 00^m\ 21^d$

(3) Calculation

(a) Z = 12 – $00^j\ 00^m\ 21^d$ + ((105 – 111° 32' 52.5") /15) = EXE 11.55763889 SHIFT ,,,, $11^j\ 33^m\ 27.5^d$

(b) Time at shooting (W) : 08.12

(c) Latitude (P) : -7° 54' 52.98"

(d) Deklination at shooting (D) dengan rumus interpolasi: -23° 24.6' – (-23° 24.6' –- 23° 24.5') x frac (08.12) =EXE --23.40966667 SHIFT ,,,, -23° 24' 34.8"

(e) GHA at shooting (t) by interpolation formula: 195° 04.7'– (195° 04.7'– 210° 04.4') x frac (08.12) + 111° 32' 52.5 – 360 = EXE 198.0773333 SHIFT ,,,, 198° 4' 38.4" + 111° 32' 52.5" – 360 = EXE SHIFT ,,,, -50° 22' 29.1"

(f) Calculation *True North Azimuth*:
$\tan^{-1}$ (1/(-sin -7° 54' 52.98"/ tan -50° 22' 29.1" + cos-7° 54' 52.98" tan -23° 24' 34.8"/ sin-50° 22' 29.1")) EXE 66.1201785 SHIFT ,,,, 66° 7' 2.64"

c) When The Qibla Shadow Occurs

(1) Formula

$S = \tan^{-1}$ (1/(cos (90 – P) tan K)) ➔ Sudut Pembantu

$C = S + \cos^{-1}$ ((tan (90 – D))$^{-1}$ tan (90 – P) cos S)

when the qibla shadow occurs = Z + (C / 15)

(2) Calculation

$S = \tan^{-1}$ (1/(cos (90 – -7° 54' 52.98") tan 65° 33' 2.9")) EXE –73.15031924 SHIFT ,,,, -73° 9' 1.15"

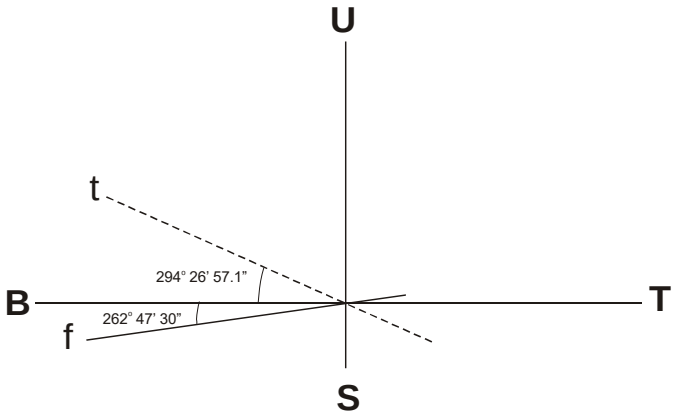
$C = -73° 9' 1.15" + \cos^{-1}$ ((tan (90 – -23° 24' 34.8"))$^{-1}$ tan (90 – -7° 54' 52.98") cos-73° 9' 1.15") EXE -47.66189848 SHIFT ,,,, -47° 39 42.83"

when the qibla shadow occurs = $11^j\ 33^m\ 27.5^d$ + (-47° 39' 42.83" /15) EXE -8.344622222 SHIFT ,,,, $8^j\ 22^m\ 40.64^d$

d) Qibla Direction on *Theodolite* (AK)
360 – K = 294° 26' 57.1"

Then the theodolite is rotated in such a way that the theodolite screen (HA) displays the number 294° 26' 57.1" (standard Qibla)

Furthermore, from the line of saf it is drawn at right angles to the east so that there is a straight line towards the real Qibla, from there it is measured by theodolite and the True North formula so that the real Qibla direction is 262° 47' 30".



Explanation:

t : Standard Qibla direction (measured and calculated based on astronomy with tools that have high accuracy).

f : The real Qibla direction (the direction of the mosque's Qibla which is based on the determination of the initial Qibla direction).

Picture 6.

Picture 7.

Analysis Of Sun Declination On The Results Of The Quality Direction Of The Al-Mujahidin Mosque

Based on the theory of solar declination, the position of the sun from day to day and even from hour to hour changes where if the sun is north of the equator, the sun's declination is positive, and if the sun is south of the equator, the sun's declination is neat. The value or value of the sun's declination, both positive and negative, ranges from 0^o to 23^o 27'. The price declination 0^o occurs on March 21 and September 23. During the time from March 21 to September 23, the solar declination value is positive, and during the time from September 23 to March 21, the solar declination value is negative.

The results of the measurement of the Al-Mujahidin Mosque in Totokan Village, Mlarak District, Ponorogo Regency are experiencing very significant or very large deviations or deviations, where in general, from several measurement results of other mosques, the average is slightly tilted to the right from the west. , however, unlike the Al-Mujahidin Mosque, the direction of the Qibla is actually facing the Southwest (to the South), so the deviation figure is 31^{o} 39' 27.1".

By drawing on the early history of determining the Qibla direction of the Al-Mujahidin Mosque in Totokan Village, Mlarak District, Ponorogo Regency based on information from the Al-Mujahidin Mosque takmir that the determination only uses estimates which state that the west direction is the position where the sun is in the afternoon, so that according to him, it is enough to shift north a little from the west. Actually, the position of the sun sometimes in the north and sometimes in the south can cause a big influence on the deviation of the Qibla direction of the Al-Mujahidin Mosque because the sun's declination changes.

Based on the position of the sun's declination during the initial determination of the Qibla direction of the Al-Mujahidin Mosque, it is estimated that the sun's position at that time is in the south, so that the direction based on measurements with the theodolite is more towards the Southwest (oblique to the south) with the number 262^{o} 47' 30 "(real Qibla), even though the measurement results show the value of the number is 294^{o} 26' 57.1" (standard Qibla). The difference between the standard Qibla and the real Qibla is the deviation number or deviation of 31^{o} 39' 27.1".

The sun's declination is one of the data to calculate and measure the Qibla direction using a theodolite which will get more accurate results, especially compared to the direction estimation method. The sun's declination that the author uses is based on ephemeris data that changes every hour and the data is part of one of the contemporary reckonings by using an application whose data is updated every time.

So, the results of the analysis of the sun's declination to the deviation of the Qibla direction of the Al-Mujahidin Mosque in Totokan Village, Mlarak District, Ponorogo Regency is an error in the initial determination which is only an estimate, at which time the sun's declination or the position of the sun is in the south (a bit oblique to the south), but It is considered that the sun remains exactly in the west. In fact, based on its journey, the sun's declination always changes and runs sometimes in the north and sometimes in the south.

CONCLUTION

Facing the Qibla is a must (condition) for the validity and quality of a Muslim's prayer. The Qibla problem is nothing but a direction problem, namely the direction of the Kaaba in Mecca. The direction of the Kaaba can be determined from any point or place on the earth's surface by calculating and measuring. Therefore, the calculation of the Qibla direction is basically a calculation to find out which direction the Kaaba in Mecca is seen from somewhere on the earth's surface, so that all movements of people who are praying, whether standing, bowing, and prostration always coincide with the direction that leads to the Kaaba.

To gain confidence and stability in the deeds of worship of ainul yaqin, at least approaching or even reaching haqqul yaqin, we need to strive so that the direction of Qibla

we adhere to is approaching exactly to the baitullah. If we have found this direction based on the results of science, for example, it is obligatory to use that direction as long as we have not obtained more accurate results.

REFERENCES

Abi 'Abd Allah Muhammad ibn Ahmad al-Ansari al-Qurtubi. (1967). *Tafsir al-Qurtubi al-Jami' al-Ahkam al-Qur'an*,Jilid II. al-Qahirah: Dar al-katibi al-'Arabiyah Littaba'ati Wa al-Nashri.

Al-Sabuni, Muhammad Ali. *Terjemahan Tafsir Ayat Ahkam Al-Sabuni*. (2003). Surabaya: Bina Ilmu,.

Azhari, Susiknan. (2007). *Ilmu Falak Perjumpaan Khazanah Isla>m dan Sains Modern*. Yogyakarta: Suara Muhammadiyah.

---------. (2005). *Ensiklopedi Hisab Rukyat*. Yogyakarta: Pustaka Pelajar,.

Departemen P dan K. *Kamus Besar Bahasa Indonesia,* edisi 3, cet. III. (2005). Jakarta: Balai Pustaka.

Izzudin, Ahmad. (2003). *Fiqh H{isab Rukyah di Indonesia Upaya Penyatuan Madhhab Rukyah dengan Madhhab Hisab*.Yogyakarta: Logung Pustaka.

Khazin, Muhyidin. (2004)*Ilmu Falak Dalam Teori dan Praktek.* Yogyakarta: Buana Pustaka.

Rachim, Abdur.Drs. *Ilmu Falak*.Yogyakarta: Liberty.

Sayuthi, M. Ali. (1997). *Ilmu Falak 1*. Jakarta: PT Raja Grafindo Persada.

Shadiq, Sriyatin. (1994). *Ilmu Falak 1*. Surabaya: Fakultas Syari'ah Universitas Muh}ammad iyah.

Supriatna, Encup. (2007). *Hisab Rukyat dan Aplikasinya*. Bandung: Refika Aditama.

Susilo, Yunus, Kapten. (2006). *Aplikasi GPS dan Pengukuran Azimuth Matahari Untuk Penentuan dan Koreksi Arah Kiblat.* Makalah ini disampaikan pada Workshop Aplikasi GPS dan Pengukuran Azimuth Matahari untuk Penentuan dan Koreksi Arah Kiblat. SAT MENWA 820: IAIN Surabaya.

Qadir Hassan A. (1982). *Terjemahan Nailul Authar Himpunan Hadith Hadits Hukum*. Surabaya: Bina Ilmu.