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Contextualising *Fajr Sadiq*: Response to Dawn Research Findings with the Sky Quality Meter (SQM)

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Abstract

The article needs to address the problem of dawn time too early in Indonesia. To prove this, the researcher used the Sky Quality Meter (SQM) in four locations with different sky brightness levels: Labuan Bajo, Belitung, Sidoarjo, and Bogor. In addition, the article also seeks to explain the views of the government and Islamic organization using SQM. This research uses normative, astronomical, and sociological approaches. The results showed that the value of the sun's tilt during the Dawn *Sadiq* period was -19.30º to -13.58º. The appearance of dawn can be detected earlier in locations with high sky brightness and low light pollution, such as in Labuan Bajo (-19.30º), while in other places with opposite conditions, the appearance of Dawn *Sadiq* is slower, such as in Bogor (-13.58º). If the SQM observation in Labuan Bajo is used as a reference, it will not significantly impact the current dawn schedule (dip = -20º). The use of SQM for dawn observation is acceptable to the Ministry of Religion and Islamic organizations. However, considering the mixed results of dawn research with SQM, the response of the Ministry of Religious Affairs, Nahdlatul Ulama, and the Islamic Association still uses dip = -20º, while Muhammadiyah shifts to dip = -18º. To minimize differences, it is necessary to conduct joint research on an ongoing basis to produce stable data on the setting of the sun at dawn.

Keywords: Dawn Time, Sky Quality Meter, Organization Mass

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Introduction

There are two kinds of entities of the dawn as described by the Hadith namely dawn, which forbids eating and allows prayer and dawn, which prohibits prayer and allows eating.[1] The characteristics of the two dawn entities are also explained by the Hadith that *Fajr Kazib* (the false dawn*)* is a dawn that looks like a wolf's tail (*kadzanbi al-sirḥân*), so it is forbidden to pray (*Subuh* prayer) and it is not forbidden to eat (*al-saḥūr*) at the dawn rise; while the *Fajr Sadiq* (the true dawn*)* is the dawn that rises lengthwise on the horizon (*mustathīlan fi al-ufuq*), then when it's rise it is permissible to pray and eat is forbidden.[2] *Fajr Kazib* existence does not have implications for the implementation of prayer rituals. At the same time, *Fajr Sadiq* exists as a marker of the beginning of the *Subuh* prayer time as well as the end of the Isha prayer time and the start of fasting.

The two dawn entities appeared simultaneously, beginning with the emergence of *Fajr Kazib* and then, sometime later, the *Fajr Sadiq*. Observation of the dawn phenomenon is crucial so that the accuracy of the prayer time as stipulated in the texts of the Koran and Hadith can be fulfilled. This was criticised by Sheikh Mamduh in a series of writings in Qiblaty Magazine entitled "*Salah Kaprah Waktu Subuh*" in 2009, that Indonesia is one of the countries that set its *Subuh* time earlier, which is about 24 minutes before the *Fajr Sadiq*.[3] The phenomenon of the two

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1 Abu Bakar Muhammad bin Ishaq bin Khuzaimah Al-Naisaburi, *Shahih Ibnu Khuzaimaih, Juz 1* (Beirut: Maktabah al-Islamy, n.d.).184-185.

2 Abū Abdullah Muḥammad bin Abdullah al-Ḥakim Al-Naisaburi, *Al-Mustadrak 'alâ Al-Shaḥīḥain, Juz 1* (Kairo: Dār al-Ḥaramain, n.d.). 291.

3 Syaikh Mamduh Farhan Al-Buhairi, *Koreksi Awal Waktu Subuh* (Malang: Pustaka Qiblaty, 2019).

dawn entities, as mentioned characteristics of the Hadith can be observed factually with the help of science. Therefore, this criticism from Sheikh Mamduh has spurred the Ministry of Religion and Islamic mass organizations such as Nahdlatul Ulama (NU) and Muhammadiyah to conduct research during *Subuh* using scientific assistance.

The use of science can help carry out the *Subuh* prayer accurately. One of the tools that science offers to observe the arrival of *Subuh* time is the Sky Quality Meter (SQM). SQM is a simple photometric tool to quantify the sky's darkness in Unihedron's Magnitude Per Square Arc Second (MPSAS) units. Researchers widely use SQM to monitor sky quality and artificial light pollution,[4] to make maps of the quality of the night sky,[5] determine the site of astronomical observatories,[6] surveys of air pollution[7] to research the determination of prayer time.[8] This science

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4 Andrea Bertolo et al., "Measurements of Night Sky Brightness in the Veneto Region of Italy: Sky Quality Meter Network Results and Differential Photometry by Digital Single Lens Reflex," *Journal of Imaging* 5, no. 5 (2019), https://doi.org/10.3390/jimaging5050056.

5 N. Ochi, "'Large-Area Measurements of the Night Sky Brightness Using the Sky Quality Meter : 2010-2018 Data,'" *JOURNAL OF TOYO UNIVERSITY NATURAL SCIENCE* 63 (2019): 1–13, http://id.nii.ac.jp/1060/00010466/.

6 E. I. Akbar et al., "Report on Sky Brightness, Seeing, and Weather Measurements at Timau Observatory, East Nusa Tenggara," *Journal of Physics: Conference Series* 1245, no. 1 (2019), https://doi.org/10.1088/1742-6596/1245/1/012024. J. Barentine, "'Going for the Gold : Quantifying and Ranking Visual Night Sky Quality in International Dark Sky Places,'" *International Journal of Sustainable Lighting* 18 (2016): 9–15, https://doi.org/DOI:10.26607/ijsl.v18i0.16.

7 P. Cinzano and F. Falchi, "'The Propagation of Light Pollution in the Atmosphere,'" *Mon. Not. R. Astron. Soc* 427, no. 4 (2012): 3337–3357,https://doi.org/https://doi.org/10.1111/j.1365-2966.2012.21884.x.

8 Siti Asma', Mohd Nor, and Mohd Zambri Zainuddin, "Sky Brightness for Determination of Fajr and Isha Prayer by Using Sky

offer can make it easier for Muslims to observe the phenomenon of dawn as a marker of *Subuh* time. Is this offer of science being responded to well by Muslims or not? If accepted, there will be opportunities for correction at *Subuh* time.

There are several kinds of research on the phenomenon of dawn as a marker of *Subuh* time, starting from simple research, namely observations using the naked eye and study with the help of modern science, namely observations with cameras and SQM. Observations of the dawn phenomenon using the naked eye have been carried out by A. Hassan et al.,[9] Semeida et al.[10] and Abdulkader M. Abed[11] in three countries, namely Egypt, Libya and Jordan. The results of his research show that the average height of the sun (sun-dip) at *Subuh* time is between -13.665º to -18º as shown in the following table.

Quality Meter," *International Journal of Scientific & Engineering Research* 3, no. 8 (2012): 3–5, http://www.ijser.org.

9 A.H. Hassan and Yasser A. Abdel-Hadi, ""Naked Eye Determination of the Dawn at Tubruq of Libya Through Four Years Observations"," *Middle-East Journal of Scientific Research* 23, no. 11 (2015): 2627–32, https://doi.org/10.5829/idosi.mejsr.2015.23.11.22607. A.H. Hassan et al., "Naked Eye Determination of the Dawn for Sinai and Assiut of Egypt," *NRIAG Journal of Astronomy and Geophysics* 5, no. 1 (2016): 9–15, https://doi.org/10.1016/j.nrjag.2016.02.001.

10 M.A. Semeida and A.H. Hassan, "Pseudo Dawn and True Dawn Observations by Naked Eye in Egypt," *Beni-Suef University Journal of Basic and Applied Sciences* 7, no. 3 (2018): 286–90, https://doi.org/10.1016/j.bjbas.2018.03.005.

11 Abdulkader M Abed, "Determining The Beginning Of The True Dawn (Al-Fajr Al-Sadek) Observationally By The Naked Eye In Jordan," *Jordan Journal for Islamic Studies* 2, no. 2 (2015): 1–18.

Table 1
Results of Observations in Several Countries by Eyes

No	Year	Researcher	Locations	Result
1	2009-2010	Abdulkader M. Abed	Jordania	-18º
2	2010-2012	A.Hassan et al.	Sinai, Mesir	-14,61º
3	2010-2013	A.Hassan et al.	Tubruq, Libya	-14,7º
4	2012-2014	A.Hassan et al.	Assiut, Mesir	-13,665º
5	2014-2015	Semeida et al.	Wadi Al Natron, Mesir	-14,57º

Research on the phenomenon of dawn using the help of modern science, namely using Digital Single Lens Reflex (DSLR) and SQM cameras. Research on the dawn phenomenon using a DSLR camera has been conducted by Kassim Bahali,[12] with locations in Indonesia and Malaysia. In contrast, research using SQM was conducted by Siti Asma Mohd Nor et al,[13] Kassim Bahali,[14] A.H. Hassan et

[12] Kassim Bahali et al., "Measuring the Sun Depression Angle of Dawn with a DSLR Camera," *Sains Malaysiana* 47, no. 11 (2018): 2877–85, https://doi.org/10.17576/jsm-2018-4711-31. Kassim Bahali et al., "Re-Evaluation of Calculation of the Dawn Prayer Time in the Malay World," *International Journal of the Malay World and Civilisation* 7, no. 2 (2019): 37–48, http://journalarticle.ukm.my/13507/.

[13] Asma', Nor, and Zainuddin, "Sky Brightness for Determination of Fajr and Isha Prayer by Using Sky Quality Meter."

[14] Kassim Bahali et al., "Measuring Luminance and Sun Depression Angle of Dawn," *International Journal of Mechanical Engineering and Technology* 10, no. 2 (2019): 1136–50.

al,[15] Dhani Herdiwijaya,[16] Tono Saksono & Mohamad Ali Fulazzaky,[17] M. Basthoni,[18] Hendro Setyanto,[19] the team of the Phalac Science Observatory, Muhammadiyah University of North Sumatera (OIF UMSU),[20] Center of Astronomy Study Ahmad Dahlan University (Pastron UAD),[21] Falakiyah Institute Executive Board Nahdlatul Ulama (*Lembaga Falakiyah* PB NU),[22] and a team from the Indonesian Ministry of Religious Affairs Team.[23] The results of his research show that the average solar elevation angle (sun-dip) at *Subuh* time is between -14º to -21 ° as shown in the following table:

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15 A.H. Hassan et al., "Time Verification of Twilight Begin and End at Matrouh of Egypt," *NRIAG Journal of Astronomy and Geophysics* 2, no. 1 (2013): 45–53, https://doi.org/10.1016/j.nrjag.2013.06.008.

16 Dhani Herdiwijaya and E. P. Arumaningtyas, "Pengukuran Kecerlangan Langit Arah Zenith Di Bandung Dan Cimahi Dengan Menggunakan Sky Quality Meter," *Prosiding Seminar Himpunan Astronomi Indonesia.* 2011, no. October (2011): 6–8.

17 Tono Saksono and Mohamad Ali Fulazzaky, "Predicting the Accurate Period of True Dawn Using a Third-Degree Polynomial Model," *NRIAG Journal of Astronomy and Geophysics* 9, no. 1 (2020): 238–44, https://doi.org/10.1080/20909977.2020.1738106.

18 M. Basthoni, Thomas Djamaluddin, and Ahmad Izzuddin, "Light Pollution Disturbance in Detecting Zodiacal Light and Twilight," *AIP Conference Proceedings* 2941, no. 1 (2023), https://doi.org/10.1063/5.0181476.

19 Hendro Setyanto et al., "Zodiac Light Detection Based on Sky Quality Meter (Sqm) Data: Preliminary Study," *Al-Hilal: Journal of Islamic Astronomy* 3, no. 2 (2021): 121–34, https://doi.org/10.21580/al-hilal.2021.3.2.8477.

20 Pimpinan Pusat Muhammadiyah, "Tanfidz Keputusan Musyawarah Nasional XXXI Tarjih Muhammadiyah Tentang Kriteria Awal Waktu Subuh," Pimpinan Pusat Muhammadiyah § (2021), https://muhammadiyah.or.id/anggota-pimpinan-pusat-muhammadiyah/.

21 Muhammadiyah.

22 Pengurus Besar Nahdlatul Ulama Lembaga Falakiyah, "Hasil Kajian Awal Waktu Subuh Di Indonesia," 2021.

23 Ismail Fahmi et al., "Zodiacal Light and Astronomical Twilight Measurement at Timau Nasional Observatory Site," *International Conference on Science and Applied Science (ICSAS)*, 2022.

Table 2
The Result of Researches Using Camera and SQM in Several Countries

No	Year	Researcher	Locations	Device	Result
1	2018	Kassim Bahali et al.	Indonesia and Malaysia	DSLR Camera	-16,67º
2	2019	Kassim Bahali et al.	Indonesia and Malaysia	DSLR Camera	-17.00 ° (cloudy); -17. 75 ° (sunny)
3	2019	Kassim Bahali et al.	Indonesia and Malaysia	SQM	-16.56 ° (cloudy); -17,35 ° (suny)
4	2011	Danny Herdiwijaya and E.P. Arumaningtyas	Cimahi and Bandung	SQM	-15º
5	2012	Siti Asma' Mohd Nor et al.	Telok Kemang, Pantai Cahaya Bulan, dan Kuala Trenggan, Malaysia	SQM	-20°
6	2013	A.H. Hassan et al.	Matrouh, Mesir	SQM	-16º sd -14º
7	2014	Dhani Herdiwijaya	Bandung, Boscha, Jogjakart, Cimahi, dan Kupang	SQM	-17º
8	2020	Tono Saksono and Mohamad	Depok	SQM	-14º

		Ali Fulazzaky			
9	2018 sd 2021	M. Basthoni	Bawean, Banyuwangi Biak, Rembang, Pasuruan, Semarang dll	SQM	-19,40º sd -14,10º
10	2013, 2015 & 2018	Hendro Setyanto	Imah Noong, Amfoang, Gresik, Boscha dll	SQM	-19,15º sd -15,26º
11	2017 sd 2020	Tim OIF UMSU	OIF UMSU P.Romantis P.Barus	SQM	-16,48º s.d. -11,19º
12	2016-2017 & 2020	Pastron UAD	Bantul, Kulonprogo, Gunung Kidul	SQM	-15,75º
13	June 2020 sd February 2021	Falakiyah Institute Executive Board Nahdlatul Ulama	Jawa Island, Bawean Island & Nusa Tenggara Timur	SQM & digital camera	-21º 21º sd -19,48º use -20º (*ihtiyath*)
14	2022	The Ministry of Religious Affairs Team	Observatorium Nasional Timau Nusa Tenggara Timur	SQM	-20º

From several researchers on the dawn phenomenon conducted in several countries, various angles of solar depression are found, namely in the range -13,7º to -21º.

The variety of results is influenced by the observation aids, the weather, and the sky's brightness at the observation location. In Indonesia, research on the dawn phenomenon is still limited, even though it is a reasonably wide area stretching from Sabang to Merauke with different brightness conditions. This is a challenge for the government and Islamic mass organizations to carry out sustainable research on this dawn phenomenon. The research must represent Indonesia's territory as a whole, namely western Indonesia, central Indonesia, and eastern Indonesia.

To fill this need, our research can only be carried out in the western and central part of Indonesia, namely Belitung, Bogor, Sidoarjo, and Labuan Bajo, East Nusa Tenggara. The site selection is based on areas with low, moderate, and high light pollution levels according to the bortle scale.

***Subuh* Time-Based Sky Quality Meter**

Research on the phenomenon of dawn was carried out using a tool to measure the sky's brightness, namely SQM. The SQM used in this research is the SQM type Sky Quality Meter Lens USB Data Logger (SQM-LU-DL). Observation with SQM-LU-DL can automatically record and read data via a USB connection with or without a computer.[24] The unihedron SQM type used in the dawn observation is the SQM LU-DL type with MPSAS altitude angle of 30º and serial number AM00H7MU which is aimed at the Eastern horizon with an altitude of 45º. Observation of the dawn is carried out with a time of 3 seconds. The results of observations using SQM are in the form of data on the night sky's brightness in MPSAS and the amount of

[24] Lawrence Avenue Grimsby and Telephone Fax Website, "SQM-LU-DL Operator ' s Manual" 1197, no. 905 (2019).

the sun's depression angle. Determining the presence of dawn light as a marker of the beginning of dawn is done by finding the inflexion point of the SQM observation data. The inflexion point data is obtained from the results of mathematical analysis using the solver, polynomial, and average methods.[25]

Four locations, namely Labuan Bajo, Belitung, Sidoarjo, and Bogor, were chosen as the locations of the dawn observation. The choice of these locations is based on different levels of sky brightness according to the Bortle scale (2 to 9), namely Labuan Bajo >21.5 MPSAS is on scale 2 (dark sky site), Belitung 20.5 MPSAS is on scale 4 (rural transition), Sidoarjo 19 MPSAS is on scale 6 (bright suburban sky), and Bogor 17 MPSAS is on scale 8 (inner city sky). In addition, the time of observation also considers the position of the moon, namely at the end and beginning of the month when the scattering of moonlight is dark and still thin, as described in the following table:

Table 3
The Data of Geographic Locations and Time of Observations

Location	Latitude & Longitude	MPSAS	Date	Date in Islamic Calendar
Labuan Bajo	-8.4613830 S 119.8748 E	< 21,5 MPSAS	August 31 to 1 September 1, 2019	29 Zulhijjah 1440 to 1 Muharram 1441

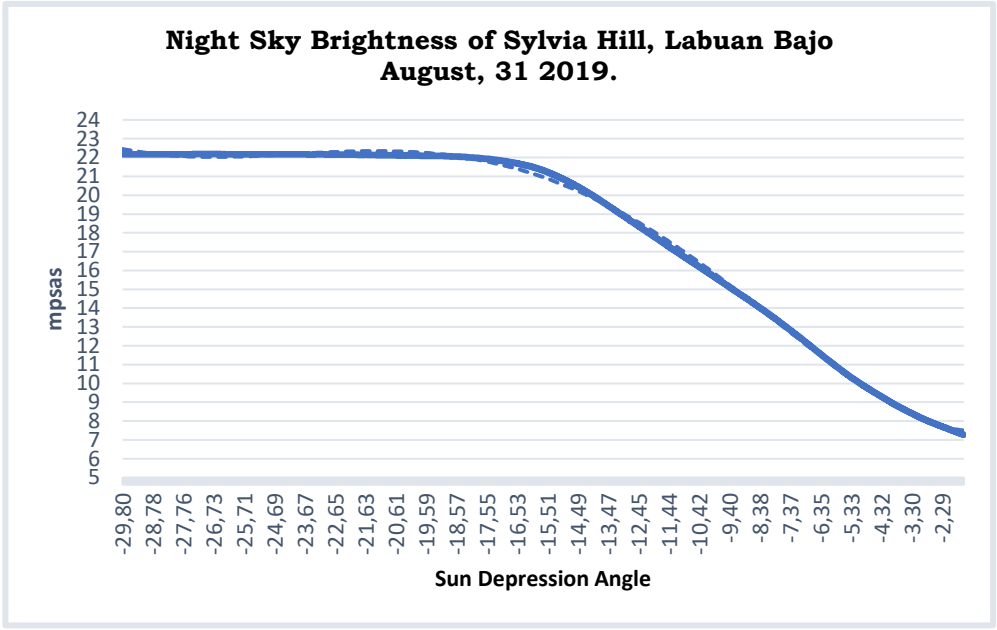
[25] Chairul Hadi Adi Damanhuri, Maskufa, "Determining Subuh Prayer Using GNU Octave to Find Polynomial Roots," *Azimuth Journal of Islamic Astronomy* 3 (2022).

Belitung	-2.5585868 S 107.6694 E	20,5 MPSAS	7 sd 8 September 2019	7 to 8 Muharram 1441
Sidoarjo	-7.399970 S 112.7056 E	19 MPSAS	29 September & 1 Oktober 2019	29 Muharram 1441 to 1 Safar 1441
Bogor	-6.426084 S 106.715338 E	17 MPSAS	28 & 29 September 2019	28 to 29 Muharram 1441

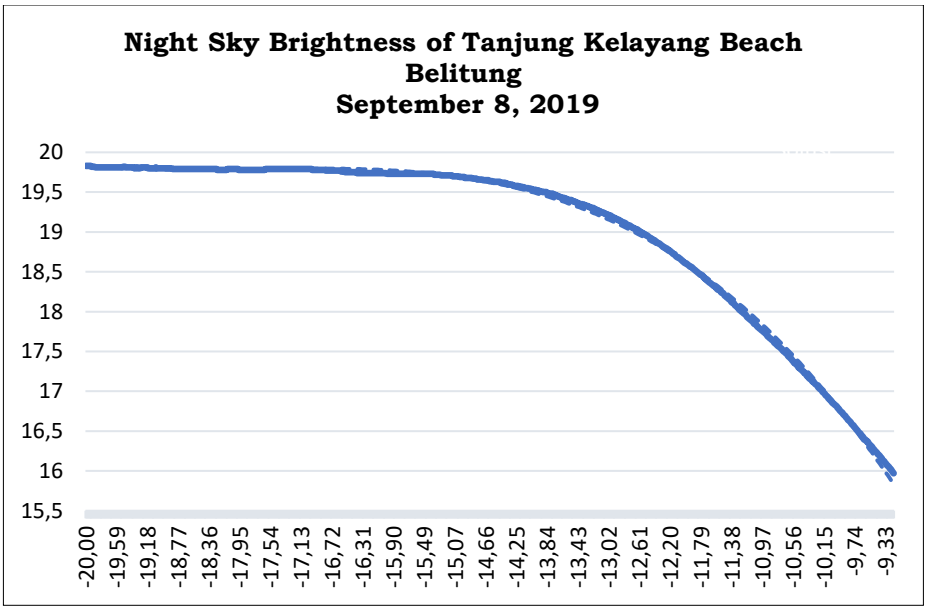
Observations of the dawn phenomenon using SQM technology at the four locations were conducted at various times, from 3.00 in the morning to sunrise. The direction of the SQM also varies to avoid the effects of light from the presence of the Moon. The data generated from SQM is assisted by data on the position of the Sun from NOAA and then processed.

The data processing from the results of these observations are as follows:

1. The data generated by SQM is in the form of ASCI data in the form of a.txt file.
2. The output data must first be converted into Microsoft Excel data (.xsl).
3. In MS Excel, data can be displayed in graphical form as in the following graph:



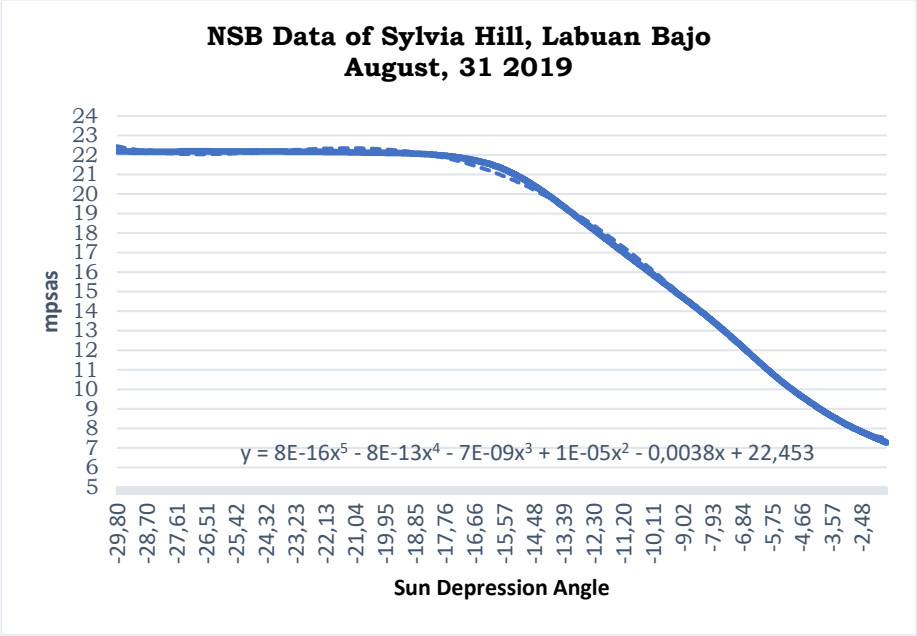
Graph 1.
Labuan Bajo August 31st, 2019



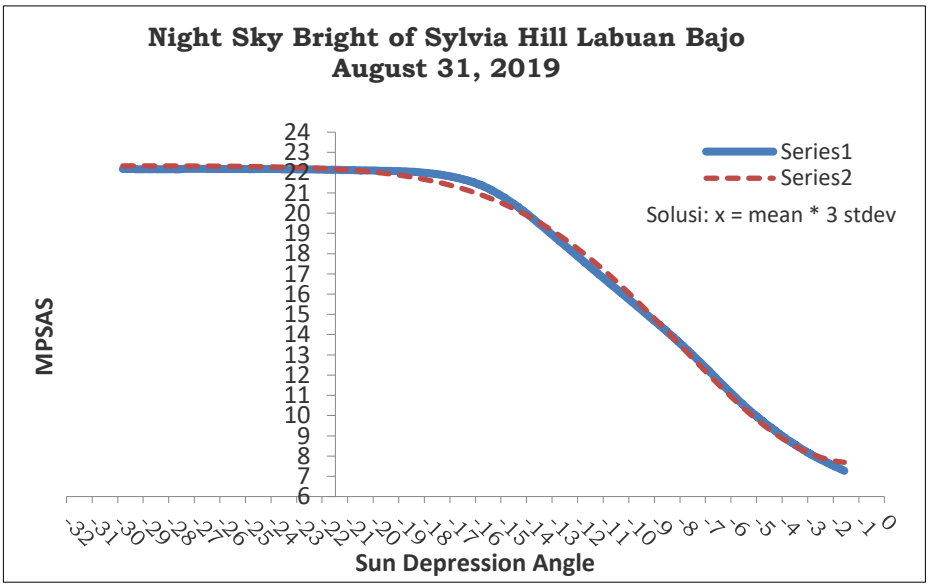
Graph 2.
Belitung September 8th, 2019

Graph 1 Shows data on the brightness of the sky on the hill of Sylvia Labuan Bajo with an observation time of 3 seconds; the y-axis shows the brightness of the sky in units of >21,5 MPSAS while the x-axis shows sun depression angle. Graph 2. shows data of sky brightness at Tanjung Kelayang Beach Belitung with an observation time of 3 seconds; the y-axis shows the brightness of the sky in units of MPSAS while the show sun depression angle.

The two graphs mentioned above still have to be processed using mathematical analysis, namely the polynomial method and the solver method, so that the following results are obtained:

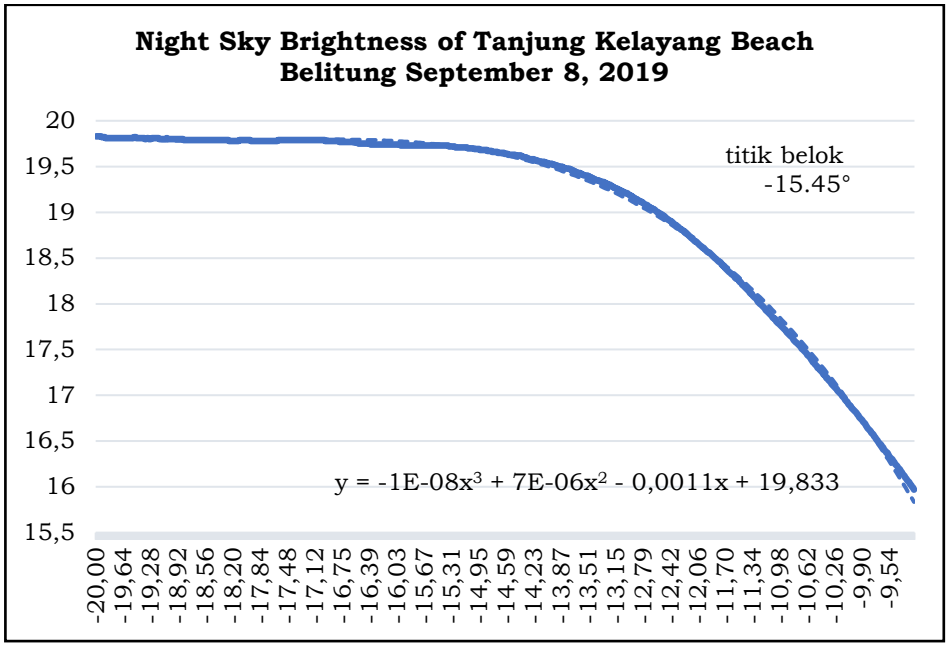


Graph 3.
Polynomials Methods in Labuan Bajo

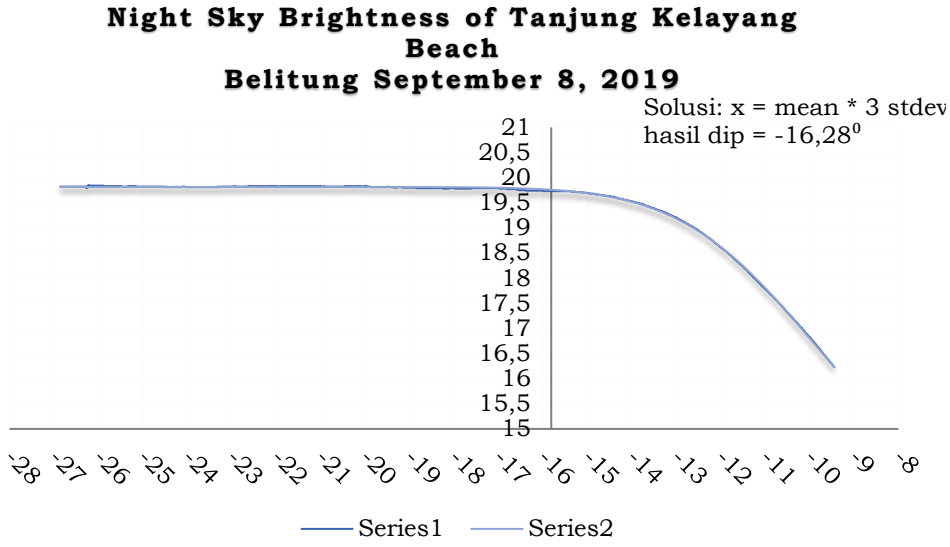


Graph 4.
Solver Methods in Labuan Bajo

The graph above describes sky brightness and sun height data at the beginning of the *Subuh* prayer in Labuan Bajo on August 31, 2019. Graph 3, the y-axis explains the level of sky brightness in Labuan Bajo is greater than 22º MPSAS. The x-axis describes the number of sun elevation angles in Labuan Bajo; this data was obtained using polynomial analysis five so that a shift in the turning point at *Fajr Sadiq* was received at the sun dip figure of -21.53º occurred at 04:38:36. Graph 4, at the exact location and time of observation, if the data from the SQM observations are analysed by the Solver method, the sun dip figure is -21.48º.



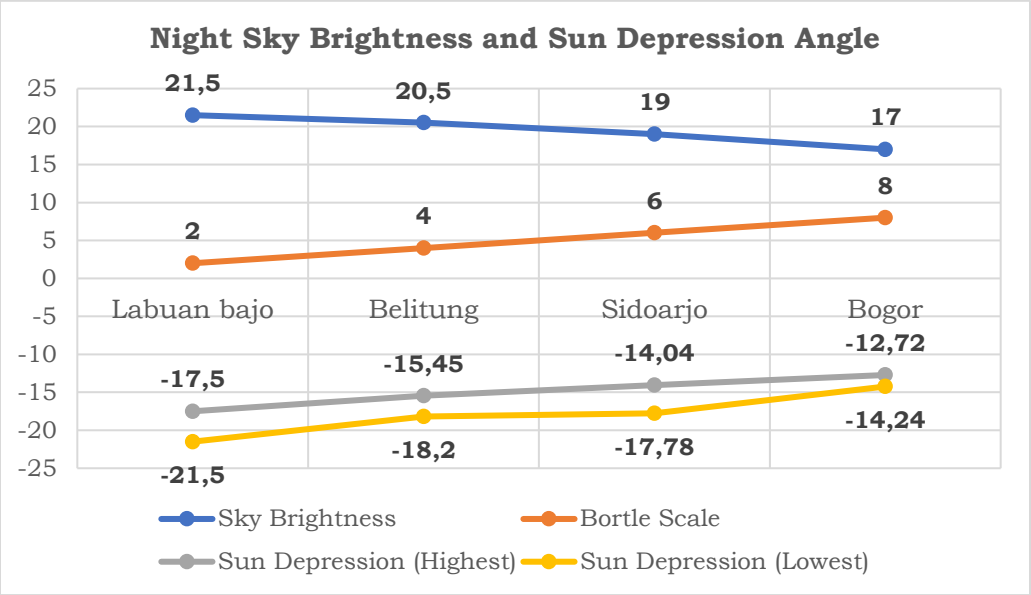
Graph 5.
Polynomial Methods in Belitung



Graph 6.
Solver Methods in Belitung

The graph above shows data on the brightness of the sky and the sun's height at the beginning of *Subuh* time in Belitung on September 8, 2019, with an observation time of 3 seconds. Graph 5, the y-axis explains the level of sky brightness in Belitung is < 20º in units of MPSAS, while the x-axis shows the sun's height. Data on the sun's height was analysed with polynomial 3; it was obtained that the extreme shift of the turning point occurred in the sun dip of -15.45º at 04:45:51. Graph 6, at the exact location and time of observation, if the data from the SQM observations were analysed by the Solver method, it would be found that the extreme turning point shift occurred in the sun dip of -16.28º.

Graph data from the observation of the dawn phenomenon in Labuan Bajo, where the light pollution level is very minimal, found the sun depressive angle figure to be -21º, while in Belitung, although the light pollution is also relatively low, the morning fog or clouds are thick enough in this area so that the sun depression angle shows a number - 16º. Thus, the angle of depression of the sun at the beginning of the appearance of *Fajr Sadiq* at dawn in Labuan Bajo is lower, while in Belitung, it is higher as is found in Sidoarjo and Bogor. The following is a comparison of the results of the observations and explanations.



Graph.7
Sky Brightness Level & Sun dip

From the linear curves of *Fajr Sadiq* appearance in the four observation locations above, it appears that in the observation locations with high sky brightness or low light pollution, the dawn was detected earlier (Labuhan Bajo, Sun dip = -21.9° to -17.5°). However, if the sky brightness level is low due to high levels of light pollution, the dawn break is detected later (Bogor, Sun dip = -14.24° to -12.72°. These are following the research findings of M. Basthoni, OIF UMSU, and Pastron UAD. The three found that the level of sky brightness and light pollution affects the angle of depression of the Sun as a marker of the beginning of *fajr* time.

Furthermore, to determine the time of dawn, the value of the angle of solar depression is taken from the average of the location with the highest sky brightness level and the lowest light pollution level, as shown in the following table:

Table 4
Comparison of Sun dip Values at the Observation Site

Location	Date of observation	Skala Bortle/ MPSAS	SQM's Serial Number	Solver	Poly	Mean
Labuan Bajo	31 Agust 2019	2 (dark sky site)/ >21,5	AM00H7MU	-21.48	-21.53	-21.50
			AL0316VH	-17.32	-16.42	-16.87
	01 Sept 2019		AM00H7MU	-19.09	-19.64	-19.36
			AL0316VH	-20.8	-18.18	-19.49
		Mean		**-19.67**	**-18,94**	**-19.30**
Belitung	07 Sept 2019	4 (rural transition) /20,5	AM00H7MU	-	-	-
			AL0316VH	-18.17	-17.45	-17.81
	8 Sept 2019		AM00H7MU	-16.28	-14.94	-15.61
			AL0316VH	-15.81	-15.45	-15.63
		Mean		**-16.75**	**-15.94**	**-16.35**

Sidoarjo	28 Sept 2019	6 (bright suburban sky)/19	AL031 6VH	-16.28	-14.04	-15.16
	01 Oct 2019			-16.62	-17.78	-17.22
		Mean		**-16.45**	**-15.91**	**-16.19**
Bogor	28 Sep 2019	8 (inner city sky) /17	AM00 H7MU	-12.95	-14.44	-13.69
	29 Sep 2019			-12.72	-14.24	-13.48
		Mean		**-12.83**	**-14.34**	**-13.58**

Based on Table 4, the determination of dawn time can refer to the location with the highest level of sky brightness and the lowest light pollution, namely in Labuan Bajo with an average value of solar depression angle of -19.30º with the consideration that the entry of dawn can be detected earlier because dark sky conditions support it. However, for locations where the sky brightness level is low due to high light pollution due to the large number of lighting lamps, the appearance of dawn can only be detected later than the actual situation. This finding is almost in line with M. Basthoni at -19.40º with a difference of 0º6', and when converted to time, it becomes 24 seconds (no significant difference). This is different from the findings of the Ministry of Religious Affairs Team at -20º with a difference of 0º42' with the conversion of time to 2

minutes 48 seconds or when rounded to 3 minutes (no significant difference).

However, if the average solar depression angle used is the highest, which is -13.58º, the dawn schedule will shift significantly from the existing schedule. The shift will be about 25 minutes 40 seconds from the schedule set by the Ministry of Religious Affairs (-20º). Certain individuals or communities may use this view with the argument that prayer times are local.

The Use of Sky Quality Meter in Determining Dawn Time from the Perspective of the Government and Islamic Community Organizations

Research findings about the suns's elevation angle at *Subuh* prayer time using SQM are pretty diverse, in the range of -13° to -21°, and even in the more profound sun elevation figures, namely -26,7°. This deep angle of the sun's elevation is caused by the rising of the old crescent moon, which coincides with the sunrise of *Fajr Sadiq*, thus affecting the reading of the dawn's inflexion point detected earlier. [26] The diversity of the research findings is influenced by various factors, namely the time of observation, location of observation, weather, and others. The diversity of these findings makes the conclusion and analysis of each researcher need to be confirmed again with other research findings in different areas with more diverse sky brightness conditions. Besides that, it also opens up more research opportunities from various places. Before making valid conclusions based on the analysis of a large number of data representing regions in Indonesia, the Ministry of Religion and Islamic Organizations is still using the angle of the sun's elevation at dawn of -20°.

[26] Zahid, "Tajribah Waktu Fajar Dengan Teknologi SOOF."

The use of the sun's elevation angle of -20° in preparing the *Subuh* prayer schedule in Indonesia has been going on for quite a long time. Historically, the use of the -20° dip refers to the view of Saadoeddin Djambek, which states that it seems that dawn is defined by the position of the sun at 20° below the horizon.[27] The same thing was also expressed by Abd. Rachim, in his book "Falak Science". The -20° degree criterion was later adopted by the Ministry of Religion[28] and Islamic Organizations such as Nahdlatul Ulama,[29] Muhammadiyah,[30] and Central Leadership oft the Islamic Association (*Persatuan Islam*, Persis)[31] to prepare the *Subuh* prayer time schedule.

Even though the government and Islamic Organizations still use the criteria for the *Subuh* prayer time of -20°, research on the *Subuh* prayer time is still being carried out, especially after the sharp criticism from Syekh Mamduh in Qiblaty Magazine in 2009, which stated that the *Subuh* prayer time that had been set so far in Indonesia was too early. This criticism has spurred the Ministry of Religion and Islamic Organizations such as Nahdlatul Ulama and Muhammadiyah to conduct research at *Subuh* prayer time using the SQM photometer technology.

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27 Saadoeddin Djambek, *Salat Dan Puasa Di Daerah Kutub* (Jakarta: Bulan Bintang, 1974). Arwin Juli Rakhmadi Butar-Butar, "Kontribusi Syaikh Muhammad Thahir Jalaluddin Dalam Bidang Ilmu Falak," *MIQOT: Jurnal Ilmu-Ilmu Keislaman* 42, no. 2 (2019): 300, https://doi.org/10.30821/miqot.v42i2.553.

28 Dirjen Binbaga Departemen Agama, *Pedoman Penentuan Jadwal Waktu Salat Sepanjang Masa* (Jakarta: Departemen Agama, 1986).

29 Lembaga Falakiyah PB NU, "Kalkulasi Awal Waktu Salat Per Hari," n.d.

30 MTT PP Muhammadiyah, *Pedoman Hisab Muhammadiyah* (Yogyakarta: MTT PP Muhammadiyah, 2009).

31 Syarief Ahmad Hakim, "Kontroversi Awal Waktu Shalat Shubuh, Begini Solusinya," n.d., https://persis.or.id/kontroversi-awal-waktu-shalat-shubuh-begini-solusinya,.

Hendro Setyanto questioned the determination of the sun depression angle of -20° instead of -19° or -18° as something that deserves further study. According to Hendro, as long as there are no definite results, there is no need to worry about the existing prayer times because the figures have been agreed upon and determined together. If there is any doubt, it is permissible to postpone the *Subuh* prayer for a while. However, for fasting, it is better to use the current schedule so that you do not continue to eat and drink even though it is already dawn. However, his view later changed after he conducted research with the Falakiyah Institute Executive Board Nahdlatul Ulama Team, which resulted in the finding that the solar depression angle at dawn was -20º so that the existing dawn prayer time, according to him, was correct.[32]

Nahdlatul Ulama currently uses SQM to collect data from several locations and times. So far, Nahdlatul Ulama, as stated by Siril Wafa, chairman of the Falakiyah Institute Executive Board Nahdlatul Ulama, has no objections to using SQM.[33] Based on that basis, the *Subuh* prayer time Study Team as formed by the Falakiyah Institute Executive Board Nahdlatul Ulama through decree No. 01/SK/LF-PBNU/XII/2020. The team has conducted research from 2010 – 2020 using various equipment such as cameras and SQM in multiple areas on the island of Java such as Depok, Tangerang, Bandung, Cimahi, Subang, Semarang, Batang, Rembang, Karimun Jawa, Bawean, Jombang, and Banyuwangi. In addition, the research was conducted outside the island of Java, in places such as Bengkulu, Labuan Bajo, and Lampung. The

[32] Falakiyah, "Hasil Kajian Awal Waktu Subuh Di Indonesia."
[33] Siril Wafa Chairman of Falakiyah Institute Executive Board Nahdlatul Ulama, "Interview 21 Maret 2020," 2020.

results showed that the data varied from -18,036 degrees to -21,697 degrees.[34]

For Muhammadiyah, as stated by Sriyatin Shadiq from the Tarjih and Tajdid Council PP Muhammadiyah, *Subuh* prayer time research is still and needs to be carried out. The best detection tool at this time is SQM because other tools have not been found, while cameras and other recording tools are used as support.[35] On that basis, Muhammadiyah assigned three institutions to conduct research *Subuh* prayer time, namely OIF UMSU, Pastron UAD, and Islamic Science Research Network (ISRN) at University of Muhammadiyah Prof. Dr Hamka (UHAMKA).

OIF UMSU conducted research in 2017 – 2020 in North Sumatera by taking locations in Medan, Romantic beach (Deli Serdang), and Barus (Central Tapanuli). The Pastron UAD conducted research in 2016, 2017, and 2020 in four regions: Bantul regency, Yogyakarta, Kulon Progo regency, and Gunungkidul regency. While ISRN UHAMKA, conducted research in 2017 – 2020 in Indonesia (Depok, Bogor, Bekasi, Tangerang, DKI Jakarta, Cirebon, Gunung kidul, Labuan Bajo, Bitung, Balikpapan, Manokwari) and abroad (United Kingdom, United States, Malaysia, Egypt, Turkey, and Saudi Arabia). The results of the research vary, from about -7 degrees to -20 degrees.[36]

Persis gave a response as outlined in the decision of the Hisbah Council of the Central Leadership of the Islamic Association No. 001 of 2016 concerning the beginning of

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[34] K H S Nawawi et al., "Cahaya Fajar Sidik Di Indonesia , Suatu Tinjauan Terhadap Riset Para Peneliti Ilmu Falak Berlatarbelakang Nahdlatul Ulama," *Seminar Panorama Antariksa*, 2021, 124–28.

[35] Sriyatin Shadiq (anggota Divisi Hisab Majelis Tarjih dan Tajdid Pimpinan Pusat Muhammadiyah, "Interview 22 Maret 2020" (Surabaya, 2020).

[36] Muhammadiyah, Tanfidz Keputusan Musyawarah Nasional XXXI Tarjih Muhammadiyah Tentang Kriteria Awal Waktu Subuh.

the *Subuh* prayer time, stipulating that based on the latest research that the sunrise of *Fajr Sadiq*, according to astronomy, is the height of the sun -20 degrees.[37] Although Persis itself did not conduct research directly and did not point to which research result.

According to Nur Khazin, Head of Sub-Directorate for Hisab Rukyat of the Ministry of Religion, stated that research related to the beginning of *Subuh* prayer time needs to be carried out, and until now, the Ministry of Religion has not changed the existing data on the angle of the sun at the beginning *Subuh* prayer time and still referring to the previous data. The Ministry of Religion, through Directorate General of Islamic Community Guidance, (Direktorat Bimbingan Masyarakat Islam, Dirjen Bimas Islam), has sent letters to Meteorological, Climatological, and Geophysical Agency (Badan Meteorologi, Klimatologi, dan Geofisika, BMKG) and National Institute of Aeronautics and Space (Lembaga Penerbangan dan Antariksa Nasional, LAPAN) asking both institutions to conduct research at *Subuh* prayer time, but so far, the two institutions still need to submit the results of their research. If there are new data from those institutions and perhaps from the other researchers, both individual or Islamic Organizations, a comprehensive joint discussion, both in terms of sharia and science, will be facilitated by the Ministry of Religion by inviting the Indonesian Council of Ulama (Majelis Ulama Indonesia, MUI) and Islamic Organizations. The use of SQM as a research tool at *Subuh* prayer time has also been used at the work meeting in Labuan Bajo, but there must be agreed parameters for its use. The research results that are

[37] Dewan Hisbah Persatuan Islam, "Keputusan Dewan Hisbah Persatuan Islam Nomor 001 Tahun 1437H/2016 Tentang Awal Waktu Subuh," Pub. L. No. Nomor 001 tahun 1437H / 2016 (2016).

prioritized are from the BMKG and LAPAN because, institutionally these two agencies have the authority regarding time sign.[38]

The Ministry of Religious Affairs and Islamic organizations respond to the dynamics of shifting dawn time by conducting serious research using SQM and other supporting tools. The latest study was conducted by the Ministry of Religious Affairs at the Timau National Observatory in East Nusa Tenggara, which resulted in a sun angle height of -20º. NU also conducted research using SQM and results in the finding of the sun's depression angle of -20º.[39]

Muhammadiyah researched dawn time through the OIF-UMSU, Pastron UAD, and ISRN UHAMKA using SQM. This research was also complemented by research on classical texts such as Jabir al-Battani, al-Biruni, Ibn Shatir, Izzuddin al-Wafi, and so on, and from Indonesia such as Ahmad Khatib al-Minangkabawi, Muhammad Ma'shum bin Ali, Hasan bin Yahya Jambi. In addition, it was equipped with a study of the results of contemporary astronomical research by Dhani Herdiwijaya and Mahasena Putra. The results were used to revise the sun's angle of depression at dawn from -20º to -18º. [40]

As a result of differences in research locations, data processing techniques and data analysis as described above, the Ministry of Religion and Islamic organisations still use data on the angle of the sun at *Subuh* prayer time, which is 20 degrees below the horizon, except for

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[38] Nur Khazin Kasubdit Hisab Rukyat Ministry of Religious, "Interview 20 Maret 2020," 2020.

[39] Nawawi et al., "Cahaya Fajar Sidik Di Indonesia , Suatu Tinjauan Terhadap Riset Para Peneliti Ilmu Falak Berlatarbelakang Nahdlatul Ulama."

[40] Muhammadiyah, Tanfidz Keputusan Musyawarah Nasional XXXI Tarjih Muhammadiyah Tentang Kriteria Awal Waktu Subuh.

Muhammadiyah which has changed it to -18 degrees through the Munas Tarjih XXXI in 2020.[41] This happens because the determination of the time of *Subuh* prayer is closely related to worship, which is based on normative arguments, so the current scientific findings must be communicated with normative arguments first. *Subuh* prayer time, described by the Hadith begins at *Fajr Sadiq*, which is marked by the appearance of a light that stretches in the eastern sky (*mustathîlan fî al-ardh*) until the sun rises. The appearance of this *Fajr Sadiq* can be observed with the help of the latest science, namely SQM, in the form of sky brightness data at the observation location and data on the sun's height. Scientific findings from the ontology and epistemology side are acceptable, but in terms of axiology or its application in the *Subuh* prayer time schedule, time is still needed. There is a process of rejection, then dialogue and finally acceptance.

When religion based on sacred texts is faced with scientific findings based on logic and senses, then these two entities will hold on to the belief of their knowledge discoveries. Scientific materialism firmly holds onto the ontological that matter is the fundamental reality of the universe, and its epistemological stipulates that the scientific method is the only way to seek knowledge. Science starts from reproducible public data, and then theories are formulated and their implications tested experimentally so that science is objective, open, cumulative, universal, and progressive (science alone is objective, open-minded, universal, cumulative, and progressive).

Meanwhile, religion does not have public data, experimental tests and evaluation criteria like science. On

[41] Muhammadiyah, Tanfidz Keputusan Musyawarah Nasional XXXI Tarjih Muhammadiyah Tentang Kriteria Awal Waktu Subuh.

the other hand, religious traditions are highly subjective, closed, narrow, anti-critical, and resistant to change (Religious traditions, by contrast, are said to be subjective, closed-minded, parochial, uncritical, and resistant to change).[42] This model is what happens when scientific findings about the *Subuh* prayer time are accepted. Some people want to change the *Subuh* prayer time progressively because, based on logic and sensory experience, the existing *Subuh* prayer time is too early. In contrast, others believe that the *Subuh* prayer time that has been done so far is correct and there is no need to change it.

Furthermore, conflict will occur when there is a difference in the distribution of authority that is not located in the individual but on the position. Groups in dominant positions usually maintain the status quo, while groups in subordinate positions try to make changes.[43] In the *Subuh* prayer time discourse, the effort to change it which Muslims in Indonesia have embraced was carried out by the Qiblati Community in several statements submitted by Shaykh Mamduh Farhan al-Bukhairi, "*Salah Kaprah waktu Subuh*," which was published in Qiblati magazine, that the time of *Subuh* prayer in Indonesia is 24 minutes earlier and this, of course, belongs to the category of *bid'ah munkar*.[44]

This statement has caused uproar and confusion among the general public, including those engaged in Falak study and Islamic astronomy. The reaction to the “Qiblati"

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[42] Ian Barbour, “Religion in an Age of Science,” n.d., https://www.religion-online.org/book-chapter/ chapter-1-ways-of-relating-science-and-religion.

[43] Douglas J. Goodman George Ritzer, *Teori Sosiologi Modern, 6th Edition, Translated by Alimandan from Modern Sociological Theori* (Jakarta: Kencana Prenada Media Group, 2010).

[44] Qiblati Magazine, “Salah Kaprah Waktu Subuh (Bag.2) :Memajukan Waktu Subuh Adalah Bid’ah Kuno”,” *9th Edition Volume 4*, 2009.

lawsuit in 2009 regarding correcting the *Subuh* prayer time was immediately carried out by various parties. Rohadi Abdul Fatah, Director of Islamic Religious Affairs and Sharia Guidance at the Ministry of Religion on representing of the government, emphasised that the time for the *Subuh* prayer determined by the government in the prayer schedule was correct because it referred to the results of the reckoning carried out by the Indonesian Hisab Rukyat Board whose members are representatives of Islamic organisations and experts in Falak and Astronomy. Thus, the quality of their calculations should be considered so that the public can feel energized. This view of the government was initially approved by Muhammadiyah as stated by Fatah Wibisono, Deputy Secretary of the Muhammadiyah Tarjih Council, that the *Subuh* prayer time was correct at the position of the sun 20 degrees below the horizon, so there was no need to revise the existing *Subuh* prayer schedule.[45] The same thing was also expressed by a member of Lajnah Falakiyah Institute Executive Board Nahdlatul Ulama that as long as there are no definite results regarding changes in the number of the sun's height at *Subuh* prayer time, there is no need to worry about the existing *Subuh* prayer schedule because the number of the sun's height of 20 degrees below the horizon has been agreed and determined together.[46]

Through the Chair of the Fatwa Commission, the MUI also emphasized that the *Subuh* prayer time schedule in Indonesia is correct but also provides an opportunity for

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[45] Dyah Ratna Meta Novi, "'Muhammadiyah Waktu Subuh Sudah Benar,'" Republika, 2010, http://khazanah.republika.co.id/berita/dunia-islam/islam-nusantara/17/08/21/dunia-islam/islam-nusantara/10/03/25/108000-muhammadiyah-waktu-subuh -sudah-benar.

[46] Setyanto, "Benarkah Awal Waktu Subuh Perlu Dikoreksi."

correction if it is supported by new scientifically justifiable evidence.[47] The reaction from the government and figures from Islamic organisations both Nahdlatul Ulama and Muhammadiyah, was carried out so there would be no conflict and to pacify the people who already thought that the *Subuh* prayer time was correct and final.

Conflict does not always have a negative meaning; it can even help the function of communication between two different parties. In addition, conflict can also strengthen group ties, such as subordinate groups who want change and superordinate groups who wish to the status quo.[48] On the one hand, the Qiblati community who wants a change in the *Subuh* prayer time has been more persistent in offering their views. The other party, namely the government and Islamic organisations, has also emphasised that the *Subuh* prayer time there so far is correct. Both build communication while maintaining their respective opinions with equally strong arguments.

For the conflict between science and religion to be avoided, it is necessary to see science and religion as two independent and autonomous entities. Each has different domains, methods and characteristics and is justified under its terms. Each party will closely guard these two jurisdictions.[49] The independence of science and religion by maintaining the distinctive character of each is a good thing, so that the conflict that confronts religion and science is not sustainable. This independent option is used by those who think that the *Subuh* prayer time is correct and does not need to be changed, while those who believe

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47 Abdul Mughits, "Problematika Jadwal Waktu Salat Subuh Di Indonesia," *Jurnal Ilmu Syari'ah Dan Hukum* 48, no. 2 (2014).

48 George Ritzer, *Teori Sosiologi Modern, 6th Edition, Translated by Alimandan from Modern Sociological Theori.*

49 Barbour, "Religion in an Age of Science."

that the *Subuh* prayer time must be changed because it is no longer following scientific findings. The government and Islamic organizations (other than Muhammadiyah) maintain their stance that the *Subuh* prayer time is correct and does not need to be corrected. At the same time, the Qiblati community requires a 24-minute *fajr* time correction. Each seeks to defend its views independently, independently, and autonomous, not bound by other parties. The negative side of this independence of religion and science is the closed space for dialogue, each of which is in a very different partition, even though the key to knowing the sides of differences and similarities and enriching the treasures is through dialogue.

This dialogue model can be an option so that the uniqueness of each community can be discussed and differences and similarities can be found. The religious practices of a community, including those related to worship, are based on different beliefs that are believed to be accurate by each community. However, religion also opens space so people can read God's verses in the text (Koran verses) and the universe (*kauniyah* verses). Therefore, it takes time to greet more often. This is also what the Ministry of Religion and Islamic organizations have done in response to the views of the Qiblati community, which wants the *Subuh* prayer time to be corrected.

The government and Islamic organizations hold a dialogue about *Subuh* prayer time in various forms of activity. The activities carried out were in the form of a Member's Session of the Hisab Rukyat Board of the Ministry of Religion in 2009 AD, on 3-4 August 2009 AD / 12-13 Syakban 1430 H, regarding the re-examination of the timing of *subuh* prayer. Representatives of Islamic organizations, and several authoritative institutions such

as LAPAN, Supreme court of the Republic of Indonesia (Mahkamah Agung Republik Indonesia, MA RI), Religious Court (Pengadilan Agama, PA), State Islamic University (Universitas Islam negeri, UIN), Jakarta Planetarium, Institute Teknologi Bandung Astronomers, and individual falak experts attended this session. The results, which were then presented to the Qiblati community, further emphasized that the ijtihad used in Indonesia for determining the *Subuh* prayer time was the sun's position 20 degrees below the horizon based on strong star's arguments and astronomical science.[50] Meeting of the Hisab and Rukyat Agency (BHR) in Semarang in 2010 to discuss the *Subuh* prayer time schedule issue. This meeting also strengthens the results of the 2009 Badan Hisab Rukyat of Directors meeting, namely the criteria for the *Subuh* prayer time of 20 degrees below the horizon or 80 minutes before sunrise is still being used until reliable and convincing research results are carried out by in situ observation.[51]

Among Islamic organisations, several studies were also carried out that presented various groups, including the National Halaqah of Hisab and Fiqh Experts of Muhammadiyah "*Kajian Ulang Atas Waktu Subuh dan Tindak Lanjut Konsep Kalender Islam Global Tunggal*" which was held by the *Majelis Tarjih* and *Tajdid* of Muhammadiyah Central in Yogyakarta on August 20 to 21, 2016 and attended by representatives of Islamic

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[50] Moh. Afif Amrulloh, "Penentuan Awal Waktu Shalat Subuh Menurut Kementerian Agama Dan Aliran Salafi," *Jurisdictie*, 2012, https://doi.org/10.18860/j.v0i0.2165.

[51] Qomarus Zaman, "Terbit Fajar Dan Waktu Subuh," *Mahakim* 2 (2018): 27, https://doi.org/https://doi.org/10.30762/mahakim.v2i1.92.

organisations and observers of Hisab Rukyat.[52] This study was conducted as a response to the views of the Qiblati community and to answer the concerns of Muslims about "it's too early" at *subuh* prayer time. Muhammadiyah itself, as contained in the "Pedoman Hisab Muhammadiyah", uses the criteria for the height of the early sun at *Subuh* prayer time to be -20 degrees.[53] The requirements for the height of the sun are the same as those used by the Ministry of Religion and other Islamic organizations.

The national seminar with the theme "*Evaluasi Awal Waktu Shalat Subuh Menurut Sains dan Fikih*" on May 11, 2017. It was initiated by the Islamic Science Research Network (ISRN) Muhammadiyah Prof. Dr. Hamka University (UHAMKA) and attended by representatives of Islamic Organizations and Thomas Djamaluddin from LAPAN. Tono Saksono from ISRN explained that from the latest result, the angle of depression of the sun is in the range 11° to 15° below the horizon instead of -20°.[54] Thomas Djamaluddin, in the seminar also said that it was time to correct the use of the standard 20 degrees below the horizon. However, it is necessary to observe from a location with minimal atmospheric disturbance so that it will not distort the results of the data obtained. The findings were positively welcomed by the Vice Chairman of the *Lembaga Falakiyah* Nahdlatul Ulama (LFNU), Sirril wafa. According to him, Nahdlatul Ulama is ready to open

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52 MTT Pimpinan Pusat Muhammadiyah, "Majelis Tarjih Dan Tajdid Hold Halaqah Nasional Ahli Hisab Dan Fikih Muhammadiyah," 2016, https://tarjih.or.id/majelis-tarjih-dan-tajdid-akan-selenggarakan-halaqah -nasional-ahli-hisab-dan-fikih-muhammadiyah.

53 Muhammadiyah, *Pedoman Hisab Muhammadiyah*.

54 Ribas, ""Hasil Kajian Ilmuwan Muhammadiyah Waktu Shalat Subuh Perlu Dikoreksi," 2017, http://www.suaramuhammadiyah.id/2017/05/11/hasil-kajian-ilmuwan-muhammadiyah-waktu-shalat-subuh-perlu-dikoreksi.

up opportunities for change and proposes the need for research collaboration related to astronomy between Nahdlatul Ulama, Muhammadiyah, MUI, LAPAN and others.[55]

Based on the previous description, it is clear that dialogue and joint research on the phenomenon of dawn need to be carried out continuously so that an appropriate angle of depression is found between the textual narrative and the observations. This dialogue process is still ongoing today. Efforts to have a dialogue between religion and science are carried out to find similarities in two things, namely conceptual and methodological similarities. The similarity in methodological terms is that science is not objective, nor is religion subjective. The claim that science is very objective is only partially true because taking scientific data as the basis of science involves elements of subjectivity. The subjectivity of science begins with the choice of theory, reporting, and interpretation of what is considered as data. Scientific data are theory-laden, not theory-free, theoretical assumptions enter the selection, reporting, and understanding of what are taken to be data.[56] Religious beliefs do not receive rigorous empirical testing, but they can be approached with the same research spirit found in science. There are methodological similarities between religion and science, namely the relationship between experience and theory. Religious beliefs seek to interpret and relate experience, and science seeks to interpret and relate experimental data.[57] With this

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55 M. Muhyidin, "Membedah Awal Waktu Subuh Berdasarkan Sains Dan Fikih," republika, 2017, http://khazanah.republika.co.id/berita/dunia-islam/islam-nusantara/17/05/09/opor7a396-membe-dah-awal-waktu-subuh-berdasarkan-sains-dan-fikih,.

56 Barbour, "Religion in an Age of Science."

57 Barbour.

dialogue, a common thread will be found that allows science to inspire and illuminate religious beliefs, and it can inspire and illuminate science.

Research on the dawn phenomenon that combines normative aspects, science, and the use of SQM technology needs to be carried out continuously so that what is narrated by the texts can be factually described and clarified. Furthermore, efforts should be made to synergies the *fajr syar'i* with the factual dawn obtained from photometer technology. Efforts to synergies and integrate textual narratives about the dawn phenomenon with the results of observations need to be carried out continuously. Integrating the normative and scientific aspects of *Subuh* prayer time still requires a process so that various parties find and agree upon an appropriate formula. Correction of the *Subuh* prayer time must be based on the texts and science arguments that can be justified in astronomical fiqh.

The possibility of *Subuh* prayer time correction indicates the possibility of a change in Islamic law, as predicted by Ibn al-Qoyim al-Jauziyah that Islamic law can change due to changes in place, time, circumstances, and recent findings," *taghayur al-fatwa wa ikhtilâfuhâ bihasbi taghayuri al-'azminah wa al-'amkinah wa al-'ahwâl wa al-niyabah wa al-'awâ'id*".[58] Meanwhile, according to Fathurrahman Djamil, changes in Islamic law related to worship like this can only be made if it is related to worship facilities and infrastructure, not the worship itself.[59] Thus, the *Subuh* prayer remains, but the facilities that can lead

[58] H.A. Djazuli, *Kaidah-Kaidah Fikih, Kaidah-Kaidah Hukum Islam Dalam Menyelesaikan Masalah-Masalahb Yang Praktis*, 4th ed. (jakarta: Prenada Media, 2011).

[59] Fathurrahman Djamil, *Metode Ijtihad Majlis Tarjih Muhammadiyah*, 1st ed. (Jakarta: Logos, 1991).

to the ease of reckoning the *Subuh* prayer time can change following the development of modern technology.

Modernization of worship facilities can lead to the ease of carrying out worship can be carried out, especially the prayer times set by the texts refer to the daily movement of the sun which can be calculated carefully. The achievements of the field of optics for observing the movement of celestial objects are constructive in bringing together the Nash provisions about the beginning of prayer times with scientific findings. The SQM photometry tool can photograph the sun's motion per second in graphic form. The graph will show the direction changes automatically at the true dawn as a marker of *Subuh* prayer time is detected. SQM is very helpful in sky brightness research, including research on the sun's height at dawn.

Conclusion

Based on the results of observations of the phenomenon of *Fajr Sadiq* conducted in four locations with varying levels of sky brightness, namely Labuan Bajo (>21.5 MPSAS), Belitung (20.5 MPSAS), Sidoarjo (19 MPSAS), and Bogor (17 MPSAS), by using SQM, it was found that the appearance of *Fajr Sadiq* was earlier in locations with high levels of sky brightness and the lowest light pollution, namely in Labuan Bajo (-19.30º) so that it can be used as a benchmark in determining dawn time in Indonesia. This finding does not significantly impact the current dawn time schedule (-20º) because there is only a difference of 0º42', and if converted to hours, it becomes 2 minutes 48 seconds (3 minutes if rounded).

The Indonesian government and Islamic NGOs have responded to the dynamics of the dawn time shift by conducting serious research using SQM and other supporting tools. Recent research by the Ministry of

Religious Affairs at the Timau National Observatory in East Nusa Tenggara in 2022 resulted in a solar depression angle height of -20º. Research was also conducted by Islamic NGOs such as NU and Muhammadiyah. NU conducted research through the Falakiah Institute in several locations in 2021, resulting in findings of -20º. Muhammadiyah also conducted research through the OIF UMSU, Pastron UAD, and ISRN UHAMKA, juxtaposed with the findings of classical and contemporary astronomers, resulting in a finding of -18º. Thus, only Muhammadiyah corrected its sunrise schedule from -20º to -18º.

This research findings have limitations, namely that it has only been carried out in a limited location and time. Therefore, it is necessary to conduct further research in several regions in Indonesia which represent areas with low, medium and high levels of light pollution. In addition, areas that represent the Western, Central and Eastern parts of Indonesia are carried out continuously for one year. Thus, more complete and scientifically adequate data will be collected to correct *Subuh* prayer time.

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