AL – AFAQ
Jurnal Ilmu Falak dan Astronomi
Fakultas Syariah Universitas Islam Negeri (UIN) Mataram
P-ISSN: 2685-0176. E-ISSN: 2722-0176 Vol. 6, No. 1 Juni 2024

Scientific Analysis of Evaluating the Methodology of Confirming Hilal Observing Reports in Determining the Beginning of the Hijri Month

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Abstract : *The report of hilal rukyat observation has an important role in determining the beginning of the Kamariah month, especially the months of Ramadan, Shawwal, and Zulhijah. To avoid doubts about Hilal witness reports, a methodology is needed that can scientifically confirm the results of observers' witnesses. This research proposes the concept of methodology for confirming Hilal observation reports based on science by considering astrophysical elements such as atmospheric extinction, atmospheric pollution, sky and moon brightness, and sensitivity (acuity) of the human eye when reporting Hilal observations. This research uses a descriptive method to describe the situation that occurs in the field and uses a statistical approach to present the results of data analysis to support the framework. The results showed that computations were performed to test the validity of Hilal observation reports by referring to three components: source, link, and receiver. A methodology was developed as criteria in confirming Hilal witness reports, including reproducibility of observations, consistency with astronomical data, and validation by Falak authorities. The critical analysis involved a review of the literature on Hilal witness confirmation, an evaluation of the accuracy of the observer's rukyat with astronomical data, and an examination of the validity of the methods used.*
Keywords : *Hilal Reports, Methodology, Hilal Observation*

Abstrak : *Laporan hasil pengamatan hilal memiliki peran yang sangat penting dalam menentukan awal bulan hijriyah, terutama di bulan ramadan, syawal, dan zulhijah. Untuk menghindari keraguan terhadap laporan kesaksian rukyat Hilal, maka diperlukan suatu metodologi yang dapat mengkonfirmasi hasil kesaksian perukyat secara sainstifik. Penelitian ini mengusungkan konsep metodologi alat konfirmasi atas laporan hasil pengamatan Hilal yang didasarkan oleh Sains dengan mempertimbangkan elemen astrofisika seperti ekstingsi atmosfer, polusi atmosfer, kecerahan langit dan bulan, dan juga sensitivitas (akuitas) mata manusia ketika melaporkan hasil pengamatan Hilal. penelitian ini menggunakan metode deskriptif untuk mendeskripkan keadaan yang terjadi di lapangan dan menggunakan pendekatan statistik untuk menyajikan hasil analisis data guna mendukung kerangka kerja metodologi konfirmasi kesaksian Hilal ini. Hasil penelitian menunjukkan Hasil komputasi dilakukan untuk menguji keabsahan atas laporan keberhasilan mengamati Hilal dengan merujuk pada 3 komponen. Unsur ketiga komponen yakni sumber, penghubung, dan penerima menjadi cakupan tolak ukur dalam melakukan konfirmasi atas kesaksian Hilal. Berdasarkan 3 komponen tersebut dibangun suatu metodologi sebagai kriteria konfirmasi kesaksian Hilal yaitu reproduktibilitas terhadap pengamatan, konsistensi dengan data astronomi, dan validasi oleh otoritas falak. Proses analisis kritis melibatkan penelitian literatur menyeluruh mengenai konfirmasi kesaksian Hilal, evaluasi keakuratan hasil kesaksian perukyat dengan data astronomi, dan pemeriksaan kritis terhadap validitas metode yang digunakan.*
Kata kunci : *Kesaksian Hilal, Metodologi, Pengamatan Hilal.*

A. Introduction

The hilal witness of a perukyat has a very important role in determining the beginning of the lunar month, especially in Ramadan, Shawwal, and Zulhijah. The potential for disagreement in the results of witness from hilal observation often occurs because the witness of *ru'yah al-hilal* is based on the oath of witnesses who have seen either using their eyes directly or with the help of optical devices, without being accompanied by evidence of the image of the hilal. Based on the fiqh perspective, the decision is considered valid because the witness has sworn.[1]

However, to determine the truth of the object seen, further evidence is needed regarding the correctness of the identification of the Hilal or other celestial objects. In order to avoid doubts about the *ru'yah al-hilal* witness reports, Hilal observers need to get verification from both fiqh and astronomical perspectives of witnessed while observing Hilal. Many scholars, especially among the Syafi'iyah, consider the results of hisab-falak as a means of assessing the validity of rukyat, so the witness of someone who claims to see the hilal is considered invalid if the hisab-falak data states that the hilal has not been seen or is in an invisible position.

The results of the witness report contained in the Decree of the Minister of Religion (KMA) of the Republic of Indonesia regarding the determination of the beginning of Ramadan, Shawwal, and Zulhijah, the location that contributed the most to the results of the Hilal sighting was the Condrodipo Rukyat Center in Gresik,2 which until now is still used as a Hilal rukyat observation location. Hilal rukyat observations at Condrodipo Rukyat Center are routinely carried out every 29th or 30th. There were several reports of Hilal observations successfully seen by one of the observers at Condrodipo Rukyat Center with physical astronomical data of Hilal not meeting the visibility of Hilal Mabims.

Table 1: Hilal observation report data below 3 degrees[3]

Date	Month Height	Elongation	Age Month
29 Zulkaidah 1442H	2° 18'48"	5° 32'40"	09:11:42
29 Sha'ban 1443H	1° 22'35"	3° 48'31"	04:07:37
29 Safar 1445H	2° 34'14"	4° 46'30"	08:48:20

Based on table 1 presented above, the Hilal visibility data is far from the Hilal visibility threshold parameters compared to Hilal visibility studies such as Bruin,[4] Yallop,[5] Ilyas,[6] and others. Hilal observation controversies that occur when Hilal is visible but turns out to be wrong after recalculation, either because of the parameters of *ru'yah al-hilal* or because the position of Hilal is below the horizon. This problem often occurred in the 20th century when the practice

[1] Muh Arif Royyani et al., "Shahadah 'Ilmy; Integrating Fiqh and Astronomy Paradigm in Determining The Arrival of Lunar Months in Indonesia," *Al-Ihkam: Jurnal Hukum dan Pranata Sosial,* vol. 16, no. 2 (2021), https://doi.org/https://doi.org/10.19105/al-lhkam.v16i2.5320.

[2] Direktorat Urusan Agama Islam dan Pembinaan Syari'ah, *Keputusan Menteri Agama RI: 1 Ramadhan, 1 Syawal, dan 1 Dzulhijjah 1381H-1440H/1962M-2019M* (Jakarta: Kementrian Agama RI, 2019).

[3] The data was obtained from the archive of rukyat Hilal observation data contained in the minutes book rukyatul Hilal Lajnah Falakiyah NU Gresik Regency, accessed on March 10, 2024.

[4] This criterion was put forward by F. Bruin in 1977 who introduced a modern theoretical method for constructing physical visibility criteria containing the variables Hilal width (W) and topocentric height of Hilal (aD), following in al-Biruni's footsteps centuries earlier. Frans Bruin, "The First Visibility of the Lunar Crescent," *Vistas in Astronomy*, vol. 21, no. 4 (1977), https://doi.org/https://doi.org/10.1016/0083-6656(77)90021-6, 335.

[5] The Yallop criterion reshapes from Bruin's criterion by applying a change of condition to the topocentric for the variable Hilal width (W). BD Yallop, "A Method for Predicting the First Sighting of the New Crescent Moon," *NAO Technical*, no. 69 (1997), 11.

[6] Mohammad Ilyas, "Lunar Crescent Visibility Criterion and Islamic Calendar," *Quarterly Journal of the Royal Astronomical Society*, No. 35 (1994).

of using digital imaging for Hilal observation was not well utilized.[7] To this day, although most observing practitioners use digital imaging to validate observations, there are still cases where very low-altitude Hilal is wrongly reported without any supporting digital evidence.

Apart from Indonesia, several other regions in the world also reported Hilal observations that did not correspond to astronomical data. In Saudi Arabia, it was found that at least 24 reports of non-conforming Hilal observations were received.[8] In Pakistan in August 2011[9] and Nigeria in November 2017, there were cases of Hilal reports that were accepted but did not correspond after recalculation.[10]

Therefore, the need to confirm the scientific methodology in validating the observation results is the main point of this research. Determining the visibility of Hilal needs to be supported by scientific knowledge and experience, because the success rate of Hilal observation is low, and not everyone can see Hilal at the same time and place.[11]

In previous research conducted by Ramadhan et al. detailed a reduction parameter to confirm crescent moon observations. Their confirmation methodology is as follows:

1. If the altitude difference between the Moon and the Sun (ARCV - Arc of Vision) is smaller than 4 degrees, the accepted observations should be made by three or more independently. In addition, at least one report needs to be checked and re-verified with astronomical calculations.
2. If the recorded observation time is later than the calculated Moonset time, then the witness is rejected.
3. And observations with bright background objects such as Venus or Mercury are rejected.[12]

The parameters appear to be accurate, although they cannot be used as a perfect benchmark. The author found that three Hilal observations that passed Djamaluddin's methodology were too close to the horizon for the Hilal to be visible to the naked eye. Schaefer created an algorithm-based formulation to determine the visibility of the crescent Moon, taking into account the brightness of the sky, the brightness of the Moon, and the contrast threshold of

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[7] Mohammad Ilyas, *Astronomy of Islamic Times for the Twenty-First Century*, 1989, https://api.semanticscholar.org/CorpusID:161276139.

[8] Ayman Kordi, "The Psychological Effect On Sightings Of The New Moon," *The Observatory*, Vol. 123 (2003), https://articles.adsabs.harvard.edu//full/2003Obs...123..219K/0000222.000.html, 219.

[9] Rehman A, M S Qureshi, dan N Sadiq, "Observational Issues of New Moon Sighting in Pakistan," *Pakistan Journal Of Meteorology*, vol. 12, no. 24 (2016),37.

[10] Abdulmajeed Bolade Hassan-bello, "Sharia and Moon Sighting and Calculation Examining Moon Sighting Controversy in Nigeria," *Al-Ahkam*, vol. 30, no. 2, (2020), 215.

[11] Nihayatur Rohmah, "Hukum Sumpah bagi Orang yang Melihat Hilal kurang dari Dua Derajat," *El-Wasathiya: Jurnal Studi Agama*, vol. 1, (2013), http://ejournal.kopertais4.or.id/mataraman/index.php/washatiya/article/view/2766, 113.

[12] T. B Ramadhan, Thomas Djamaluddin, dan Judhistira Aria Utama, "Re-Evaluation of Hilaal Visibility Criteria in Indonesia By Using Indonesia and International Observational Data," in *Proceeding of International Conference On Research, Implementation And Education Of Mathematics And Sciences 2014* (Yogyakarta: Yogyakarta State University, 2014), 87–92.

the human eye.[13] Through the formulation designed by Schaefer, Doggett's extensive Moonwatch projects tested the algorithm and found it to be accurate,[14] and Schaefer finally published the final edition of his algorithm formulation in 2000. Taking into account various effects of observing the crescent Moon including atmospheric extinction, light pollution, and human eye sensitivity,[15] the formulation is effective and can be replicated for future use.

Confirmation of Hilal visibility is necessary because of the weakness of witnessed without image evidence of the Hilal object. The method proposed in this study serves as a confirmation tool for witnessed and reports of Hilal observations based on *Shariah* and Science by considering astrophysical elements such as atmospheric extinction, atmospheric pollution, sky and moon brightness, as well as the sensitivity of the human eye[16] when reporting Hilal observations.

This research is relevant because it contributes to the astronomical literature by presenting a structured and in-depth approach to scientifically support the results of Hilal witness. The aim of this research is to develop a methodology that can scientifically confirm the results of Hilal witness in determining the beginning of the lunar month. By critically analyzing the information, this research will present a reliable and scientifically accepted framework.

B. Method

The method used in this research is descriptive method to describe the situation that occurs in the field and uses a statistical approach to present the results of data analysis to support the framework. Certain mathematical models available in the literature have been deliberately chosen to be able to provide a description of the natural phenomenon of observing the young crescent Moon/Hilal at a certain time, in a certain place, and with a certain mode of observation (naked eye or assisted equipment, such as a telescope). The research method applied was structured and thorough, involving an in-depth analysis of Hilal witnessed. A topic analysis was conducted to understand the context, criteria and circumstances of the actual situation in the field during the observation. The selection of relevant theories and the support of evidence formed a strong basis for conducting this research.

The steps include literature research, field data collection, data analysis, and presentation of results. Hilal observation is categorized into 3 basic components: the source, the link, and the receiver. The source, which is represented by the physical Hilal such as width, position relative to the Sun and horizon, and brightness that can affect the observation of the moon

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[13] bradley E. Schaefer, "Visibility Of The Lunar Crescent," *Royal Astronomical Society, Quarterly Journal,* vol. 29 (1988): 511–523.

[14] A national project to conduct research to get a wide variety of new moon sightings with the naked eye is testing mathematical models to predict the visibility of the first new moon in the Americas.NASA Technical Reports Server, "Moonwatch - July 14, 1988," accessed 22 February 2024, https://ntrs.nasa.gov/citations/19880056280.

[15] bradley E. Schaefer, "New Methods and Techniques for Historical Astronomy and Archaeoastronomy," *Archaeoastronomy,* vol. 15 (2000): 121.

[16] Muhammad Faishol Amin, "Ketajaman Mata Dalam Kriteria Visibilitas Hilal," *Al-Marshad: Jurnal Astronomi Islam dan Ilmu-Ilmu Berkaitan,* vol. 3, no. 2 (2017): 28–40, https://doi.org/10.30596/jam.v3i2.1526.

crescent. The connector is the path the moon's crescent light takes from the source to the receiver, involving factors such as atmospheric extinction, altitude, humidity, temperature, twilight sky brightness, and light pollution. And the receiver, usually an observer, is characterized by human sensitivity referred to as the contrast threshold of the eye.

This study was calculated using Microsoft Excel software with topocentric settings and by taking into account the effects of atmospheric refraction near the horizon. The resulting data were then presented with statistical model graphs. The position data of the Moon and Sun were calculated using VSOP2000 theory, while the data for the Moon were calculated using the ELP-MPP/02 theory. Delta T data were calculated using references from Espenak & Jean Meus.

C. Results And Discussions

Hilal observation is categorized into 3 basic components: the source, the link, and the receiver. The source, which is represented by the physical Hilal such as width, position relative to the Sun and horizon, and brightness that can affect the observation of the moon crescent. The connector is the path the moon's crescent light takes from the source to the receiver, involving factors such as atmospheric extinction, altitude, humidity, temperature, twilight sky brightness, and light pollution. And the recipient, usually an observer, is characterized by human sensitivity referred to as the eye's contrast threshold.

All the component elements are interconnected in determining Hilal visibility. High levels of light pollution and atmospheric extinction can reduce the chances of successful observation as the brightness of the lunar crescent may not reach a level detectable by the human eye. A thin moon crescent has a lower probability of being seen, given the wide limit of the human eye to detect faint objects in the sky. In contrast, a larger moon crescent width, along with low levels of light pollution and atmospheric extinction, can increase the probability of a successful observation.

The local atmosphere's transparency is simulated using different extinction factor values. These values range from 0.2, representing a clean atmosphere, to 0.4 for moderate, and 0.8 for a very dirty atmosphere. A very dirty atmosphere contains 10 times more dust than a clean atmosphere.[17] When observations require a telescope or theodolite, a default setting is used if the specifications are unknown. In this case, a refractor telescope with an aperture diameter of 66 mm and consisting of 3 lenses (6 surfaces) is assumed to be freshly polished and free of dust and mold, providing a transmittance factor of 95%. The telescope used had an angular magnification of 50x, and the correction factors involved in its use refer to Schaefer's formulation.[18] The visibility predictions generated by the model are presented graphically to facilitate confirmation of successful Hilal observation claims.

1. Apparent Moon Brightness

The calculation of the Moon's brightness is divided into two parts, namely the brightness of the Moon outside the Earth's atmosphere and the brightness of the Moon inside the

[17] C. W. Allen, *Astrophysical Quantities* (London: The Athlone Press University Of London, 1976).
[18] Schaefer, "New Methods and Techniques for Historical Astronomy and Archaeoastronomy."

atmosphere. The calculation of the Moon's brightness in the atmosphere depends on the humidity of the air, the location of the observation and the altitude of the observation location because the particle content in the Earth's atmosphere is not constant every day, but changes seasonally.[19] According to Schaefer, every 0.25 increase in the extinction value will cause the Moon's brightness to dim by 1.5 times.[20] This is because atmospheric extinction affects the intensity of the Moon's light.

An object of visual magnitude (mvis) corresponds to 2.51(10-mvis) light in units of tenth-magnitude stars,[21] if the object outside the atmosphere is visible surface then its brightness can be expressed in units of square degrees, the brightness of the object outside the atmosphere is expressed in the equation:

$L*$ $=1 / A \times 2.51\ (10\ Mvis)$ ......(1)

A $=(0.5 \times \pi r2)\ [1 + \cos(180° - ARCL)]$ ......(2)

Calculating the brightness of the Moon in the atmosphere:

$Lmoon = e - kx$ ......(3)

X $=1 / [\mathrm{Cos}z + 0.025\ e - 11\cos z]$ ......(4)

2. The Brilliance of the Twilight Sky During Light Polluted Twilight

Shortly after sunset, the twilight light is yellow-reddish in color which gradually becomes blackish-red as the Sun goes downward, so that the scattering of the Sun's rays by atmospheric dust decreases, and so on until the earth becomes dark. Dusk or maghrib begins when the entire disk of the Sun enters the visible horizon until the Sun's light is relatively unscattered by the Earth's atmosphere.

According to Shariff, the difficulty of seeing the moon will increase 5 times for every 2 magnitude increase in light pollution.[22] A suitable method to calculate the brightness of the light-polluted twilight sky is to consider the local zenith light pollution, so that it can be used for various locations and levels of light pollution with accuracy and minimum error of 0.5 mag/sec. Calculation of twilight sky brightness:[23]

Ls $= 290\ [10\log L + 2.5]$ ...... (5)

$\mathrm{Log}L$ $= -\ (7.5\times10^{-5}z + 5.05 \times 10^{-3})\theta + (3.67 \times 10^{-4}z - 0.458)h + 9.17 \times 10^{-3}\ z + 3.525,$ with $\theta \leq \theta o$ ...... (6)

[19] Samaneh Sabetghadam dan Farhang Ahmadi-Givi, "Relationship Of Extinction Coefficient , Air Pollution , And Meteorological Parameters In An Urban Area During 2007 To 2009," *Environ Sci Pollut Res,* vol. 21 (2013): 538–547, https://doi.org/10.1007/s11356-013-1901-9.

[20] Leroy E Doggett, P. Kenneth Seidelmann, dan bradley E. Schaefer, "Lunar Crescent Visibility," *Icarus* 107, no. 2 (1994): 388–403, https://doi.org/https://doi.org/10.1006/icar.1994.1031.

[21] Binta Yunita, Judhistira Aria Utama, dan Waslaluddin, "Visibilitas Hilal Dalam Modus Pengamatan Berbantuan Alat Optik Dengan Model Kastner Yang Dimodifikasi," in *Proceeding Seminar Nasional Fisika dan Aplikasinya* (Bandung: Universitas Padjadjaran, 2016), 254.

[22] Nur Nafhatun Md Shariff, Zety Sharizat Hamidi, dan Muhamad Syazwan Faid, "The Impact of Light Pollution on Islamic New Moon (hilal) Observation," *International Journal of Sustainable Lighting,* vol. 19, no. 1 (2017): 10–14, https://doi.org/10.26607/ijsl.v19i1.61.

[23] Sidney O. Kastner, "Calculation Of The Twilight Visibility Function Of Near-Sun Objects," *The Journal Of The Royal Astronomical Society Of Canada,* vol. 70, No. 4, (1976), 157.

Log$L$ = -0.0010θ + (1.12 × $10^{-3}z$ -0.470)h -4.17 × $10^{-3}z$ + 3.225, with θ > θ…………………………………………………..………..(7)

find the transition angle (θo),

θo = - (4.12 × 10 − 2 z + 0.582)h + 0.417z + 97.5............................. (8)

determines the brightness of the background with the formula :

Ls = 290 x ($10\log^{L + 2.5}$) .... (9)

night sky brightness

La = 290 + 105 x $\mathrm{Exp}^{(-(90-z)\,2\,/\,1600)}$ .... (10)

visibility function (Δm),

Δm = 2.5 $Log\ R$.. (11)

A positive value for the Dm parameter indicates that the object can be observed directly with the naked eye under favorable weather conditions. This happens only if the brightness of the object exceeds the brightness of the background sky, which can include the twilight and night sky. In other words, a negative Dm value can be interpreted as making it impossible to observe the object, in this case the hilal, without the aid of optical instruments. Nonetheless, observation is still possible using optical devices such as binoculars or telescopes that have the ability to provide specific angular magnification.

3. Observer's Eye Contrast Threshold

A further problem lies in how little contrast sensitivity (the ratio of object and background brightness) the human eye can detect (contrast threshold). The level of acuity of one's eyes is a key factor in hilal rukyatul, where the level of visual acuity can vary between individuals. Whether or not one can see the crescent moon clearly depends largely on the level of eye acuity of each individual.[24] A person who has vision problems or deficiencies without the use of assistive devices will most likely have difficulty in spotting the crescent, given that it is highly dependent on the ability of each individual's eyes.

In practice, the contrast threshold is divided into two, namely the contrast threshold against point sources/extended sources. Hect (1947) in his research used several formulas, including the formula for extended sources is:

$$C = |B_{source} - B| / B$$

The above factors highlight its ability to predict astronomical visibility at light-polluted twilight sky brightness with an effective range of about 25.08 mag/sec^2 to 16.24 mag/sec^2.[25] According to Hoffman, hilal observation involves a number of disciplines, not limited to astronomy alone, but also including optics, meteorology and physiology.[26] In the modern era, when observing celestial objects, it is important to take into account the optical aspects of

[24] Muhammad Faishol Amin, Tesis: *Akuitas mata dalam kriteriavisibilitas hilal*. (Semarang: Universitas Islam Negeri Walisongo, 2018), 65.

[25] H. Richard Blackwell, "Contrast Thresholds of the Human Eye," *J. Opt. Soc* 36 (1946): 624–643, https://doi.org/https://doi.org/10.1364/JOSA.40.000825.

[26] Roy E. Hoffman, "Observing The Moon," *Astron Soc* 340 (2003): 1039.

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Fakultas Syariah Universitas Islam Negeri (UIN) Mataram
P-ISSN: 2685-0176. E-ISSN: 2722-0176 Vol. 6, No. 1 Juni 2024

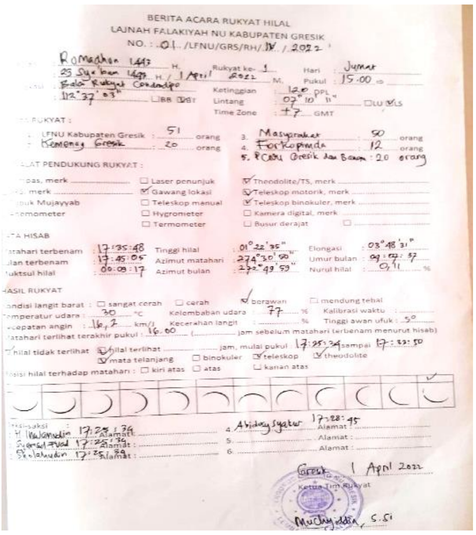
telescopes, given that telescopes are almost a necessity in the observation process. Stargazers, better known as telescopes, play a role in making the view of distant objects clearer and closer.

However, using a telescope requires caution as various small factors can affect the resulting image. For example, the light intensity of the object and its background light will differ when observed with a telescope compared to observation without a telescope. Some of the considerations that should be taken into account when using a telescope involve the choice of telescope type (binocular or monocular), atmospheric correction, light transmission through the telescope lens, light loss outside the pupil, light gathering power of the telescope aperture, eye gaze power, influence of the light source on color, magnification, and other factors.

4. Case Analysis

In the case of the beginning of the month of Ramadan 1443 H or 2022 AD, where there were 4 observers who successfully sighted Hilal at Condrodipo Rukyat Hall with astronomical data of Hilal's altitude 1^o 22' 35" and elongation 3^o 48' 31", Hilal was reportedly seen at 17:25 WIB to 17:32 WIB,[27] with cloudy sky conditions.According to the Neo-MABIMS criteria, Hilal does not meet visibility of less than 3 degrees. The report of the first sighting of Hilal with the naked eye, according to the author's analysis, is irrelevant, as well as using theodolite and the field with a telescope does not correspond to the predicted time span of Hilal's brightness when on the horizon, this is due to the background of the twilight sky being more dominant than the light of Hilal. Thus, the results of the testimony are irrelevant and unacceptable.

Then the author also found that the position of Hilal reported by the observers did not agree with the calculations, both calculations made by the NU Gresik Falakiyah Institute itself and calculations using the ELP-MPP/02 theory. The following is the minutes of the observation report of Hilal at Balai Rukyat Condrodipo at the beginning of Ramadan 1443H.


BERITA ACARA RUKYAT HILAL
LAJNAH FALAKIYAH NU KABUPATEN GRESIK
NO. : 01 /LFNU/GRS/RH/ IV / 2022

: Ramadhan 1443 H. Rukyat ke- 1 Hari : Jumat
: 29 Sya'ban 1443 H. / 1 April 2022 M. Pukul : 15.00
: Balai Rukyat Condrodipo Ketinggian : 120 DPL
: 112° 37' 03" ☐ BB ☑ BT Lintang : 07° 10' 11" ☐ LU ☑ LS
Time Zone : +7 GMT

RUKYAT :
1. LFNU Kabupaten Gresik : 51 orang
2. Kemenag Gresik : 20 orang
3. Masyarakat : 50 orang
4. Forkopimda : 12 orang
5. PCNU Gresik dan Bawean : 20 orang

ALAT PENDUKUNG RUKYAT :
Kompas, merk ☐ Laser penunjuk ☑ Theodolite/TS, merk
GPS, merk ☑ Gawang lokasi ☑ Teleskop motorik, merk
Rubuk Mujayyab ☐ Teleskop manual ☑ Teleskop binokuler, merk
Anemometer ☐ Hygrometer ☐ Kamera digital, merk
☐ Termometer ☐ Busur derajat ☐

DATA HISAB
Matahari terbenam : 17:35:48 Tinggi hilal : 01° 22' 35" Elongasi : 03° 48' 31"
Bulan terbenam : 17:45:05 Azimut matahari : 274° 30' 50" Umur bulan : 09 : 07 : 37
Mukutsul hilal : 00:09:17 Azimut bulan : 272° 49' 59" Nurul hilal : 0,11 %

HASIL RUKYAT
Kondisi langit barat : ☐ sangat cerah ☐ cerah ☑ berawan ☐ mendung tebal
Temperatur udara : 30 °C Kelembaban udara : 77 % Kalibrasi waktu :
Kecepatan angin : 16,2 km/j Kecerahan langit : % Tinggi awan ufuk : 5°
Matahari terlihat terakhir pukul : 16.00 (jam sebelum matahari terbenam menurut hisab)
☐ hilal tidak terlihat ☑ hilal terlihat jam, mulai pukul : 17:25:34 sampai 17:32:50
☑ mata telanjang ☐ binokuler ☑ teleskop ☑ theodolite
Posisi hilal terhadap matahari : ☐ kiri atas ☐ atas ☐ kanan atas

Saksi-saksi :
1. H. Ikhwanudin 17:25:34 Alamat :
2. Suparsid Fuad 17:25:34 Alamat :
3. Sholahudin 17:25:39 Alamat :
4. Abidin Syakur 17:28:45 Alamat :
5. Alamat :
6. Alamat :

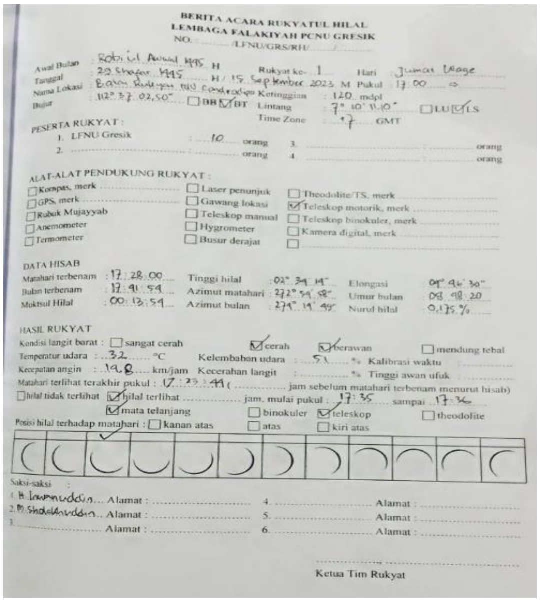
Gresik, 1 April 2022
Ketua Tim Rukyat

Muchyiddin, S.Si

Picture 1: News Show Observation Report Hilal Of The Month Ramadan 1443H In Balai Rukyat Condrodipo Gresik

[27] The data was obtained from the archive of Hilal rukyat observation data contained in the minutes book of rukyatul Hilal Lajnah Falakiyah NU Gresik Regency, accessed on February 24, 2024.

Then this repeats itself in the initial determination of the month of Rabiul Awal 1445H was confirmed based on the Hilal observations made on Friday, September 15, 2023, which coincided with 29 Safar 1445H. The rukyat participants, consisting of 10 people from LFNU Gresik Regency, used binocular telescopes as supporting tools for observation, which further validated the accuracy of the results.[28]


BERITA ACARA RUKYATUL HILAL
LEMBAGA FALAKIYAH PCNU GRESIK
NO. .... /LFNU/GRS/RH/ ....

Awal Bulan : Robi'ul Awwal 1445 H
Tanggal : 29 Shafar 1445 H / 15 September 2023 M
Rukyat ke- 1 Hari : Jum'at Wage Pukul : 17.00
Nama Lokasi : Balai Rukyat NU Condrodipo
Bujur : 112° 37' 02,50" ☐ BB ☑ BT
Ketinggian : 120 mdpl
Lintang : 7° 10' 11,10" ☐ LU ☑ LS
Time Zone : +7 GMT

PESERTA RUKYAT :
1. LFNU Gresik : 10 orang
2. .... orang
3. .... orang
4. .... orang

ALAT-ALAT PENDUKUNG RUKYAT :
☐ Kompas, merk .... ☐ Laser penunjuk ☐ Theodolite/TS, merk ....
☐ GPS, merk .... ☐ Gawang lokasi ☑ Teleskop motorik, merk ....
☐ Rubuk Mujayyab ☐ Teleskop manual ☐ Teleskop binokuler, merk ....
☐ Anemometer ☐ Hygrometer ☐ Kamera digital, merk ....
☐ Termometer ☐ Busur derajat ☐ ....

DATA HISAB
Matahari terbenam : 17 : 28 : 00 Tinggi hilal : 02° 34' 14" Elongasi : 04° 46' 30"
Bulan terbenam : 17 : 41 : 54 Azimut matahari : 272° 54' 58" Umur bulan : 08 48 20
Muktsul Hilal : 00 : 13 : 54 Azimut bulan : 279° 19' 49" Nurul hilal : 0,175 %

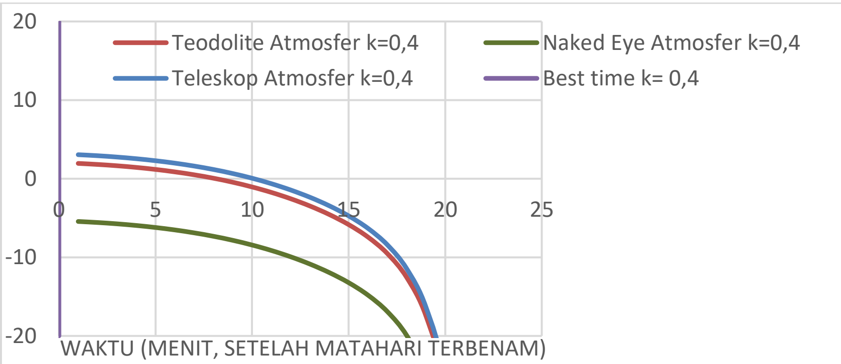
HASIL RUKYAT
Kondisi langit barat : ☐ sangat cerah ☑ cerah ☑ berawan ☐ mendung tebal
Temperatur udara : 32 °C Kelembaban udara : 51 % Kalibrasi waktu ....
Kecepatan angin : 14,8 km/jam Kecerahan langit : .... % Tinggi awan ufuk ....
Matahari terlihat terakhir pukul : 17 : 23 : 44 (........ jam sebelum matahari terbenam menurut hisab)
☐ hilal tidak terlihat ☑ hilal terlihat .... jam, mulai pukul : 17 : 35 sampai 17 : 36
☑ mata telanjang ☐ binokuler ☑ teleskop ☐ theodolite
Posisi hilal terhadap matahari : ☐ kanan atas ☐ atas ☐ kiri atas

Saksi-saksi :
1. H. Inwanuddin Alamat : .... 4. .... Alamat : ....
2. M. Sholahuddin Alamat : .... 5. .... Alamat : ....
3. .... Alamat : .... 6. .... Alamat : ....

....
Ketua Tim Rukyat

Picture 2: News Show Observation Report Hilal Of The Month Rabbiul Awal 1445H In Balai Rukyat Condrodipo Gresik

According to the hisab data collected by Lajnah Falakiyah NU Gresik, the Sun set at 17:28:00 WIB with an azimuth of 272° 54' 58". The Hilal was visible at an altitude of 2° 34' 14" and the elongation between the Sun and the Moon was 4° 46' 30". The western sky was partly cloudy at that time, and the Hilal was successfully observed from 17:35 WIB until 17:36 WIB using both naked eye and telescope by H. Inwanuddin and Sholahuddin. This graph shows the visibility of the Hilal at the beginning of the month of Rabiul Awal 1445 H, with moderate atmospheric conditions (k=0.4) and using the naked eye, Theodolite, and Telescope visuals.



Graph 1: Predicted Hilal Visibility Hilal Of The Month Rabbiul Awal 1445H with Naked Eye Visuals, Theodolite, and Telescope In Balai Rukyat Condrodipo Gresik

[28] The data was obtained from the minutes of the observation report of Hilal at the beginning of the month of Rabiul Awal 1445H on September 15, 2023

The graph above shows a negative trend in the black line observed visually without any instruments since sunset. This indicates that Hilal may not be visible due to negative visibility, which means that the brightness of the twilight sky is dominant over the Hilal illumination. Additionally, the orange trend line, as measured by the theodolite, indicates an upward trend from minute 1 to minute 6, or for 5 minutes after sunset, predicting positive visibility and indicating the potential to see Hilal, as its illumination is greater than the brightness of the twilight sky. The trend line then decreases at minute 7 due to the dimming of the Hilal light, making it impossible to observe. The blue trend line is comparable to the orange trend line in that it increases in the first minute after sunset. However, when using a telescope, the predicted time span is longer and the contrast of Hilal light is greater compared to a theodolite, specifically 1.3 lux.

Based on the facts that occurred in the field, Hilal was first seen at 5:35 PM by H. Inwanuddin using the naked eye. The results of the visible testimony cannot be verified with the predictions in the graph above because the very low height of Hilal resulted in a low illumination contrast owned by Hilal, and the brightness of the twilight sky was more dominant, thus defeating the light from Hilal. Then the results of observations using theodolite and telescope also may not correspond, even if the visibility value is positive, indicating potential visibility. It is simply a matter of the testimony fitting. In this scenario, once it has been confirmed that the testimony is irrelevant, it cannot be scientifically accepted.

For the determination of the beginning of Rabiul Awal 1445 H, BMKG accurately predicted that most parts of Indonesia would experience cloudy and rainy weather, ranging from light to heavy intensity. However, at the Condrodipo Rukyat Center, the Sun was last seen at around 5:23 p.m. until the Sun and Moon set, which took approximately 18 minutes, the western horizon remained obscured by thick clouds. During the event, the option 'clear' was selected to describe the sky conditions in the west, despite the clouds. Furthermore, there is no information regarding the timing or method of the first and last observation of Hilal. Considering the aforementioned facts, it is challenging to regard the information presented in the form of successful Hilal observation testimonies at the start of Rabiul Awal 1445H as valid data that should be considered as evidence.

Observations in Indonesia face many challenges, particularly with regards to sky conditions. Most observations are reported using the naked eye with very low Hilal heights. This is not the first time such an incident has occurred. Although the MABIMS criteria, used by the Indonesian Ministry of Religious Affairs, is intended as a guide for the preparation of the Hijriyah civil calendar and not to ensure observability of Hilal, it is still recognized. Whenever the Sun-Earth-Moon configuration meets or exceeds the minimum criteria values (altitude and elongation of at least 3 degrees each or an interval from conjunction to sunset of at least 8 hours), there are often claims of successful observation of Hilal by multiple observers, particularly at the Condrodipo Rukyat Center. Accompanying supporting evidence is necessary to categorize observations as new data that can change existing theories or criteria. Without authentic evidence, observations cannot be considered as such.

The process of critical analysis involves conducting a comprehensive literature review to confirm Hilal witnesses, evaluating the accuracy of Perukyat witnesses with astronomical data, and critically examining the validity of the methods used. This is done to capture the constantly evolving scientific updates and developments. The computational results were used to test the validity of the report on the success of observing Hilal by referring to the three components that the author had presented earlier. The elements of the three components, namely the source, the link, and the recipient, are the scope of the benchmark in confirming the Hilal witness. Therefore, a methodology was developed as a criterion for confirming Hilal witnessing, namely:

1. Reproducibility. Ensuring that the results of the perukyat's witnessing can be consistently reproduced by recording the results of the observation report in a complete report card for re-examination.
2. Consistency with Astronomical Data: Ensuring the agreement of the results of the witnessing with astronomical data with several factors that are elements of the three important components of hilal observation, and hilal images as additional evidence of observation.
3. Validation by Authority: Validating in the form of an oath on the rukyat performer and presenting additional evidence in the form of images from the observation results so that the results of the testimony can be validated by the authority of falak science experts, and recognized judges.

The process of critical analysis involves thorough literature research on the confirmation of Hilal's testimony, evaluation of the accuracy of the results of perukyat testimony with astronomical data, and critical examination of the validity of the methods used. This can be applied as a confirmation methodology for the Hilal that has been witnessed.

D. Conclusion

The computational results of the research indicate that the Hilal observation reports are valid when tested in accordance with three components: the source, the chain, and the receiver. These three elements serve as important confirmation tools for Hilal observation reports, taking into account astrophysical elements such as atmospheric extinction, atmospheric pollution, sky and moon brightness, and also the sensitivity (acuity) of the human eye. Utilizing these factors, cases of Hilal observations that have been the subject of controversy have been able to demonstrate the veracity of their claims, both through the use of theodolite-assisted models, telescopes, and the naked eye. From these three components, a methodology for the production of acceptable Hilal testimony reports has been developed, namely:

1. Reproducibility: the ability to replicate observations in a consistent manner, ensuring complete and clear documentation.
2. Consistency with astronomical data: the results of the hilal claim are in accordance with astronomical data.
3. Validation from the authority, validated as correct by the authorized authorities, both phalactic experts and judges.

By understanding this context, the research sought to provide a holistic view of Hilal observations and confirmation of related reports. The research highlighted the importance of establishing clear criteria in the confirmation of Hilal observation reports. The analysis covered a range of criteria, including the level of brightness of Hilal, the position of the moon, and the utilization of modern technology in support of the observations. The role of instructions in report confirmation is the focus of this research.

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