AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v12i1.28090|| Vol. 12, No. 1 June 2026

The Validity of the Geometry of the *Hilal* Position in the *Hilal* Observation Report at the International Astronomical Center (IAC) in 1436–1446 H

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Abstract

This study examines the validity of 641 crescent moon sighting reports published by the *International Astronomical Center* (IAC) during the period 1436–1446 H using geometric parameters and the visibility thresholds of the Odeh (2004) model. The reports consist of 231 naked-eye observations, 57 binocular observations, 27 telescopic observations, 60 CCD (Charge-Coupled Device) observations, as well as several combinations of methods. This research employs a descriptive-analytical approach with computational astronomical methods. The IAC reports were collected through documentation techniques and subsequently processed by recalculating the positions of the Moon and the Sun using the VSOP2000 and ELP2000 ephemerides in a topocentric framework at sunset and best time. The results show that naked-eye observations with ArcV 7.4989°, ArcL 9.228°, W 0.2011′, DAz 0.8029°, and lag −31.0593 minutes fall within Zones A–B; binocular observations with ArcV 3.9893°, ArcL 9.4993°, W 0.1967′, DAz 0.3329°, and lag 17.9419 minutes fall within Zones C–B; telescopic observations with ArcV 2.6134°, ArcL 6.9358°, W 0.1162′, DAz 0.1195°, and lag 15.0096 minutes fall within Zones D–C; and CCD observations with ArcV 3.4399°, ArcL 6.7413°, W 0.1033′, DAz 0.2769°, and lag 17.6455 minutes fall within Zone D. These findings indicate the necessity of automatically integrating geometric parameters to enhance the accuracy and accountability of crescent moon reporting at the IAC.

Keywords: ***Crescent Moon Visibility, Geometric Parameters, International Astronomical Center (IAC)***

Article Info
Received: 13 April 2026
Revised: 21 May 2026
Accepted: 30 June 2026
Published: 30 June 2026

A. Introduction

The determination of the beginning of the Hijri month is an important aspect in the religious life of Muslims because it determines the time of implementation of a number of worship based on the lunar calendar, such as Ramadan, Eid al-Fitr, and Eid al-Adha.[1] Hilal observation itself is not just a visual activity, but a scientific process that is influenced by astronomical, atmospheric, and complex optical factors. With the increasing need for a uniform and accountable global Hijri calendar, research on the visibility of the moon

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requires a scientific approach based on verifiable geometric parameters, so that observation reports do not rely solely on the visual perception of observers in the field.[2]

In the context of documentation of international lunar observations, *the International Astronomical Center* (IAC) is one of the reference platforms that collects rukyat reports from various countries with different geographical, weather, latitudinal, and technical conditions of observers.[3] The observation was made through various methods, such as the naked eye which is strongly influenced by the conditions of the sky, binoculars that provide limited optical assistance, telescopes that increase the sensitivity of light detection, and CCD cameras that are able to capture the sickle first before it is visible to the human eye.[4] The potential of the data collected is enormous for Islamic astronomical research, but its effectiveness depends heavily on the completeness of the technical information included in each report. Without adequate parameters, the data cannot be scientifically analyzed.[4]

One of the fundamental problems in the observation success report published by the IAC is the absence of important geometric parameters used in the study of the visibility of the hilal. These parameters include *the Arc of Vision* (ArcV), which is the difference in height of the Moon–Sun; *Arc of Light* (ArcL), which is the elongation or angular distance between the two; azimuth difference (DAz), which is the difference in the direction of the Moon and Sun on the horizon; crescent width (W), which is the thickness of the crescent; and *lag*, which is the difference in time between the setting of the Sun and the Moon.[5] The absence of this parameter makes the success report objectively verifiable so that the validity of the hilal visibility claim cannot be scientifically assessed.

Odeh's (2004) hilal visibility model is the main theoretical foundation of this study because it presents a comprehensive approach that combines ArcV, ArcL, and W parameters in determining the chances of visibility of the Moon crescent. This model generates visibility zoning ranging from impossible to visible categories based on calibrated global empirical data.[6] Odeh's approach allows for an objective evaluation of the conditions of the moon at the time of observation, regardless of the instrument used. Although this model does not directly distinguish the sensitivity of methods such as telescopes or CCDs, it still provides a solid basis for assessing the consistency between visual reports and astronomical possibilities of moon visibility.

Several previous studies have tried to answer this problem from various perspectives. Yallop (1998), through a study of the visibility of the moon based on global observation data, proposed an empirical visibility limit which then became a reference in

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international criteria for determining the beginning of the lunar month.[7] Meanwhile, Qureshi & Ilyas (2007) developed a predictive model based on geometric and atmospheric parameters to assess the visibility of the moon in the Southeast Asian region, demonstrating the importance of a combination of geometric data and sky conditions in the validation of rukyat reports. These two studies show the need for uniform parameter standards so that the results of observations can be scientifically tested and compared across regions.[8]

In Indonesia, a number of researchers also examined the validity of rukyat reports and the hilal visibility model. Sofyan (2019) emphasized the need to strengthen the scientific aspect of the national rukyat system so that the results of observations can be accounted for astronomically.[9] Susiknan Azhari (2011) in his study on the unification of the Hijri calendar highlights the importance of using quantitative visibility parameters in decision-making to determine the beginning of the month. Meanwhile, Wahyu et al. (2020) applied the Odeh and Yallop models to Indonesian rukyat data and found a strong correlation between minimum elongation and field observation results.

This study aims to recalculate the geometry parameters of the hilal from the IAC success report for ten years and evaluate its conformity with the visibility limits of the Odeh model. In addition, this study also intends to map how different observation methods—both direct observation, the use of optical devices, and camera-based detection—are related to the opportunity of moon visibility. Thus, the study not only offers numerical data on ArcV, ArcL, DAz, W, and lag, but also presents an empirical understanding of the variation in observation results in various regions influenced by instruments, geographical conditions, and observer skill settings.

Theoretically and practically, this research is expected to make an important contribution to the development of Islamic astronomy through the provision of a comprehensive and structured lunar geometry dataset and the retesting of visibility limits based on the Odeh model. The results of the analysis can enrich scientific understanding of the relationship between geometric parameters, atmospheric conditions, and human observation capabilities, as well as become a reference for hilal observation institutions in developing more complete and scientific reporting standards. The recommendation for the implementation of automatic calculations of ArcV, ArcL, DAz, W, and lag on platforms such as IAC is expected to improve transparency, accuracy, and consistency in determining the beginning of the Hijri month at the global level.

B. Research Methods

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This study uses a descriptive approach with computational astronomical analysis to evaluate the geometric parameters of the hilal in 641 observation success reports published by the IAC during the period 1436–1446 H. Data were collected through a documentation method by extracting the time, location, and observation method from each report, then processed using a computational astronomical approach based on ephemeris of VSOP2000 and ELP2000 models topocentrically to obtain position of the Sun and Moon with high accuracy and precision. Calculations were performed at *sunset* and *best time* to produce ArcV, ArcL, DAz, W, and lag time values, which were then compared with the visibility threshold according to Odeh's (2004) model to assess the degree of conformity between the observation success claims and the supposed astronomical conditions.

C. Results and discussion

Criteria for Hilal Visibility according to Mohammad Shawkat Odeh

Contains data on research results obtained during the research. Prioritize data that is important and becomes the main goal of the research, or data that can be used as an answer to the formulation of problems in research.

In compiling this criterion, Odeh used two main parameters, namely the *topocentric* altitude and the *topocentric crescent width (ARCV*). Based on the combination of these two parameters, Odeh divides the possibility of hilal visibility into four zones as follows:[6]

- Zone A (ARCV > ARCV3): The hilal is very likely to be seen with the naked eye.
- Zone B (ARCV > ARCV2): The Hilal can be seen with optical devices, and possibly also with the naked eye in very clear sky conditions.
- Zone C (ARCV > ARCV1): The Hilal can only be seen with the help of optical devices.
- Zone D (ARCV < ARCV1): The hilal cannot be seen, even with optical aids.

A complete table related to the ARCV threshold values (ARCV1, ARCV2, ARCV3) for each zone is included in the criteria and serves as the basis for evaluating visibility in various contemporary moon observation studies.

Table 1. Criteria for visibility of the Odeh hilal (2004)

W	0.1′	0.2′	0.3′	0.4′	0.5′	0.6′	0.7′	0.8′	0.9′
ARCV1	5.6°	5.0°	4.4°	3.8°	3.2°	2.7°	2.1°	1.6°	1.0°
ARCV2	8.5°	7.9°	7.3°	6.7°	6.2°	5.6°	5.1°	4.5°	4.0°
ARCV3	12.2°	11.6°	11.0°	10.4°	9.8°	9.3°	8.7°	8.2°	7.6°

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Source: Odeh, Mohammad Shawkat. (2004). *New Criterion for Lunar Crescent Visibility*. Experimental Astronomy.

Based on the table above, it can be concluded that the hilal tends to be easily visible to the naked eye if it has a width of at least 0.1' with an arc of no more than 12.2° (ARCV). If the width of the hilal increases to 0.2', then the minimum rukyat arc required is 11.6°, and if the width reaches 0.9', then the minimum rukyat arc drops to 7.6°.

In sunny weather conditions, the hilal can also be easily seen with optical devices and has the potential to be seen with the naked eye if the width of the hilal is 0.1' with a rukyat arc of at least 8.5°. For a hilal with a width of 0.2', the minimum rukyat arc is 7.9°, while if the width of the hilal is 0.9', then a rukyat arc of 4.0° is sufficient.

If you only use an optical device, the hilal can be seen with a width of 0.1' if the arc is at least 5.6°. If the width of the hilal is 0.2', then the rukyat arc is at least 5.0°, and for the width of 0.9', it is enough with a rukyat arc of 1.0°. However, if the rukyat arc is less than 5.6° with a width of 0.1', then the hilal is impossible to see even with optical aids.

To make it easier to predict the visibility of the new moon, Odeh compiled a mathematical formula as follows:[6]

$$V=ARCV(0.1018W3+0.7319W2-6.3226W+7.1651)$$

Where:

- V is the value of the visibility of the hilal
- ARCV is a rukyat arc
- W is the *crescent width*

This V value is used as the basis for the division of the hilal visibility zone by Odeh, namely:

- Zone A: If $V > 5.65$ → the hilal may be visible to the naked eye.
- Zone B: If $2 < V \leq 5.65$ → the hilal is easily visible with optical devices, and potentially visible to the naked eye if the weather is sunny.
- Zone C: If $-0.96 < V \leq 2$ → the hilal can only be seen with the help of optical devices.
- Zone D: If $V \leq -0.96$ → the hilal is impossible to see, even with optical devices.

These visibility criteria are implemented in a software called *Al-Mawaqit al-Daqiqah* (*Accurate Times*), developed by Odeh. The device utilizes the VSOP82 algorithm

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(of French origin) to calculate the position of the Sun and ELP-2000-85 (also from France) for the position of the Moon.[10] Both have a high level of accuracy. VSOP82 was able to calculate the position of the Sun between 1900 and 2100 with a margin of error of only about 0.005 arcseconds. For the period 2000 BC to 6000 AD, the error ranged from one arcsecond to one arc. While ELP-2000-85 allows calculations of the position of the Moon between 1900 and 2100 with an accuracy of about 1.44 arc seconds, and for the years 500 BC to 3500 AD with a difference of about 2.8 arc minutes.[10]

Geometry of the Hilal Position in the Report on the Success of the Hilal Observation on the *International Astronomical Center* (IAC) Website in 1436 H – 1446 H

In the study of the lunar observation, the validity of the success report cannot be separated from the geometric position of the Moon with respect to the Sun and the horizon during observation.[11] Hilal, as an astronomical phenomenon as well as a marker of sharia worship, must be evaluated through measurable visibility parameters and can be modeled with precision. Along with the development of ephemeric devices and observation instruments, scientific assessment of rukyat reports no longer relies only on visual testimony, but requires verification based on geometric data using modern visibility models, one of which is the Odeh Model (2004) which has a broad and comprehensive empirical basis.

This study collected as many as 641 reports of the success of moon observation from various countries with a variety of observation methods, geographical location, and atmospheric conditions.[12] Of the total reports, 231 were conducted with the naked eye, 57 with binoculars, 27 with telescopes, and 60 using CCD cameras, while the rest were reports with a combination of more than one observation method. All data were recalculated to value the geometric parameters of the hilal, namely ArcV, ArcL, DAz, W, and lag, to evaluate the astronomical consistency of the hilal visibility based on modern visibility models. However, due to space constraints in scientific publications, not all data can be presented and analyzed individually. Therefore, the discussion is focused on the most critical and representative extreme data for further analysis.

Analysis was carried out on hundreds of reports of the success of lunar observations published by the *International Astronomical Center* (IAC) in the period 1436–1446 H. The reports came from various countries with diverse atmospheric conditions, horizons, and location characters. For analytical purposes, the reports were grouped based on four types of observation methods used, namely CCD cameras, telescopes, binoculars, and the naked eye. This classification is important because each method has different sensitivity and

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detection capabilities, so visibility decisions cannot be assessed in general without considering the instruments and techniques of observation.

One of the obstacles in the analysis is the unavailability of geographic coordinate information (latitude and longitude) directly in the IAC report, even though geographical position is an important variable in the calculation of the moon geometry parameters. To overcome this, the author conducted a manual search using Google Maps based on the name of the city or observation area. The coordinate point is determined at the centroid position of the most representative administrative region. If there are identical location names in multiple countries, the selection of coordinates is adjusted to the reporting context and additional information so that the data remains consistent, accurate, and astronomically relevant.

The five parameters were then analyzed using the Odeh Model (2004) to determine the level of likelihood of the visibility of the hilal based on its visibility zone, ranging from very visible to impossible to see. This approach allows an objective evaluation of the scientific consistency of the hilal observation claims, especially if there are reports with extreme geometric values but still declare the success of the rukyat. Thus, geometric analysis not only assesses the theoretical feasibility of the visibility of the hilal, but also tests the reliability, accuracy, and scientific credibility of globally published observation reports.

CCD Method

The CCD method uses a high-sensitivity camera sensor that is able to record the moon's crescent light earlier than the human eye can do. This technology allows for hilal detection at smaller ArcV, ArcL, and W values, even when light contrast is very low. CCD-based observations are generally carried out through telescopes equipped with digital shooting systems. Therefore, the results often reflect the lowest limit of the visibility of the new moon instrumentally.[13]

Table 2. Results of Extreme Geometric Calculations Based on CCD Observation Method

Geometry Parameters	Extreme Value	Observer & Location (Date)	Visibility Zone (Odeh, 2004)
ArcV (°)	3,4399	Mohammed Awda – Khatim, UAE (13 Dec 2023)	Zone D
ArcL (°)	6,7413	Turkey Alamri – Medina, Saudi Arabia (28 Jan 2017)	Zone D

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Geometry Parameters	Extreme Value	Observer & Location (Date)	Visibility Zone (Odeh, 2004)
W (′)	0,1033	Turkey Alamri – Medina, Saudi Arabia (28 Jan 2017)	Zone D
DAz (°)	0,2769	Turkey Alamri – Medina, Saudi Arabia (28 Jan 2017)	Zone D
Lag	17,6455	Mohammed Awda – Khatim, UAE (13 Dec 2023)	Zone D

The CCD method shows the highest ability to detect the hilal in extreme geometric conditions. The elongation value (ArcL) is at an interval of 6.7413° ≤ ArcL ≤ 18.1514°, with a minimum value of 6.7413° (Turki Alamri, Medina; January 28, 2017), which is close to the Danjon limit (~6.4°). This value is at the physical limit of crescent formation but is still successfully recorded by CCD. The Moon–Sun height difference interval (ArcV) is 3.4399° ≤ ArcV ≤ 18.0823°, with a minimum of 3.4399° (Mohammed Awda, UAE; December 13, 2023), which occupies the transition region of Zone C–D. The azimuth difference parameter (DAz) is at the interval of 0.27699° ≤ DAz ≤ 14.6293°, while the crescent width (W) is at 0.1033′ ≤ W ≤ 0.7980′. The lag was recorded at an interval of 17.6455 minutes ≤ a lag ≤ 92.5691 minutes, where the minimum value of 17.6 minutes was below the minimum limit of optical visibility according to Odeh. Overall, CCDs work at the lower limit of visibility geometry, and successfully record the hilal under conditions that cannot be detected by the visual observer.

Telescope Method

The telescope method utilizes optical magnification capabilities to increase the clarity of the Moon's crescent so that the moon can be detected at lower geometric conditions than the naked eye. This instrument allows the observer to see a very thin crescent and close to the Sun at dusk. The use of telescopes also helps to minimize atmospheric disturbances through stable focus and tracking. Thus, the results of telescope observations are usually in the lower visibility zone.[14]

Table 3. Results of Extreme Geometric Calculations Based on Telescope Observation Methods

Geometry Parameters	Extreme Value	Observer & Location (Date)	Visibility Zone (Odeh, 2004)
ArcV (°)	2,6134	Farid Fofana – France (15 August 2015)	Zone D–C

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Geometry Parameters	Extreme Value	Observer & Location (Date)	Visibility Zone (Odeh, 2004)
ArcL (°)	6,9358	Eng. Ibrahim Ghneimat – UAE (28 February 2025)	Zone D–C
W (′)	0,1162	Eng. Ibrahim Ghneimat – UAE (28 February 2025)	Zone C
DAz (°)	0,1195	Hazarry Haji Ali Ahmad – Brunei Darussalam (19 April 2015)	Zone D
Lag	15,0096	Farid Fofana – France (15 August 2015)	Zone D–C

The telescope method shows high sensitivity, although it is still below the CCD. The elongation value is around 6.9358° ≤ ArcL ≤ 18.5477°, with a minimum value of 6.94° (Ibrahim Ghneimat, UAE; 28 February 2025), indicating that the position of the crescent is very close to the Danjon limit. The ArcV parameter is at 2.6134° ≤ ArcV ≤ 15.8615°, with a minimum value of 2.61° (Farid Fofana, France; August 15, 2015), included in Zone D according to the Odeh criteria. The DAz parameter is at 0.1195° ≤ DAz ≤ 17.2312°, with a minimum extreme value of 0.12° (Hazarry H. A. Ahmad, Brunei; April 19, 2015). The telescopic crescent width has a distribution of 0.1162′ ≤ W ≤ 0.7588′, while the lag parameter is at 15.0096 minutes ≤ lag ≤ 96.2776 minutes, with a minimum value of 15.01 minutes still below the ideal limit of optical visibility (≥21 minutes). In general, the telescope is able to detect scythes in the geometric conditions that are in the transition from Zone D–C to Zone A.

Binocular Method

The binocular method provides simple optical assistance with a wide field of view, thus allowing the observer to detect the hilal that is not visible to the naked eye. Binoculars improve visual sensitivity without the need for special astronomical equipment. Although the increased detection capability is not as large as a telescope or CCD, it is often used for initial verification of the position of the hilal. The results of binocular observations are generally in the middle zone of hilal visibility.

Table 4. Results of Extreme Geometric Calculations Based on Binocular Observation Methods

Geometry Parameters	Extreme Value	Observer & Location (Date)	Visibility Zone (Odeh, 2004)
ArcV (°)	3,9893	Eng. Ali Janghorbani – Iran (15 August 2015)	Zone C
ArcL (°)	9,4993	Hossein Janghorbani – Iran (31 October 2016)	Zones B–C

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Geometry Parameters	Extreme Value	Observer & Location (Date)	Visibility Zone (Odeh, 2004)
W (′)	0,1967	Hossein Janghorbani – Iran (31 October 2016)	Zone C
DAz (°)	0,3329	Abdellatif Fareh – Iran (April 28, 2025)	Zone C
Lag	17,9419	Mr. Hossein Janghorbani – Iran (November 2, 2024)	Zone C

Observations using binoculars show a secondary geometric range, better than the naked eye but lower than a telescope. The ArcL value is at 9.4993° ≤ ArcL ≤ 23.3835°, with a minimum value of 9.50° (Hossein Janghorbani, Iran; October 31, 2016), which is in Zone B–C. ArcV parameters are within the interval of 3.9893° ≤ ArcV ≤ 21.8543°, with a minimum value of 3.99° (Ali Janghorbani, Iran; August 15, 2015), slightly below the minimum threshold of theoretical optical visibility. The DAz parameter was recorded at 0.3329° ≤ DAz ≤ 21.8629°. The crescent width value (W) is at 0.1967′ ≤ W ≤ 1.3307′, while the lag is at an interval of 17.9419 minutes ≤ a lag ≤ 96.4769 minutes. This range shows that the binoculars work at the boundary of Zones B–C according to the Odeh model, which is the transition region between optical and visual visibility.

Naked Eye Method

The naked eye method is the most traditional form of observation that relies entirely on human visual abilities without optical devices. The success of the observation is greatly influenced by atmospheric conditions, the clarity of the sky, and the observer's experience.[1] The value of geometric parameters in this method tends to be at a relatively high limit compared to the optical method. Nevertheless, this method remains an important reference in the practice of rukyat in various countries.

Table 5. Results of Extreme Geometric Calculations Based on Naked Eye Observation Method

Geometry Parameters	Extreme Value	Observer & Location (Date)	Visibility Zone (Odeh, 2004)
ArcV (°)	7,4989	Dr. Javad Torabinejad – Douala, Cameroon (26 January 2020)	Zone B
ArcL (°)	9,228	Abdoul Karimi Fatihi – Douala, Cameroon (7 September 2021)	Zone B
W (′)	0,2011	Abdoul Karimi Fatihi – Douala, Cameroon (7 September 2021)	Zone B
DAz (°)	0,8029	ABM Ruhul Hassan – Dhaka, Bangladesh (21 March 2015)	Zone B
Lag	−31.0593	Abdul Rahman Razeen – Colombo, Sri Lanka (19 September 2017)	Irrelevant (Moon sets before Sun)

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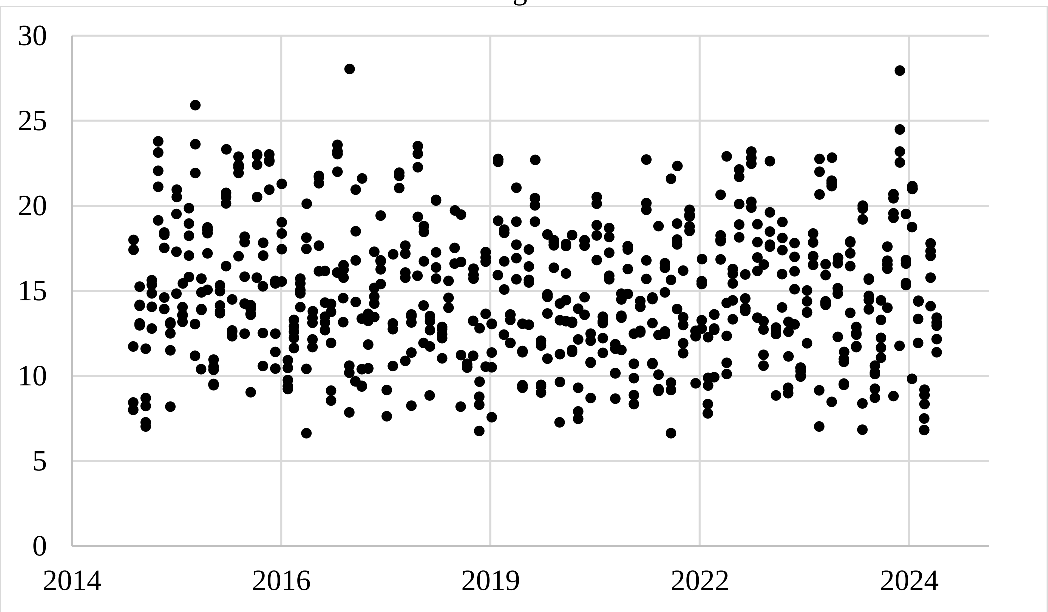
Visual observations show that all successes are in relatively safe geometric conditions (Zones A–B), without extreme cases as in optical and digital methods. The elongation value is at 9.228° ≤ ArcL ≤ 28.325°, while ArcV is at 7.4989° ≤ ArcV ≤ 23.2595°. The DAz parameter was recorded at 0.8029° ≤ DAz ≤ 23.577°, although the minimum value of 0.80° was very small and was likely the result of the calculation of ephemeris best time, not the actual condition. The crescent width is at the interval of 0.2011′ ≤ W ≤ 1.8373′, and the parameter lag is at –31.0593 minutes ≤ lag ≤ 132.4271 minutes. A negative lag value indicates a non-physical computational condition and is irrelevant to visual visibility. Overall, the naked eye observation was only successful on the scythe geometry that was already large and bright, consistent with Zones A–B in the Odeh model.

The relatively safe geometric characteristics of the naked eye observation also underscore the need to take a more thorough look at how certain parameters, especially elongation (ArcL), play a role in the entire spectrum of observation methods used in the IAC report. The graph presented below shows the distribution of ArcL at sunset and the best time for all types of observations, since elongation is a key parameter that determines the formation of a crescent and the minimum limit of its visibility, both visually and opically. The visualization focus only on ArcL provides a clearer picture of the variation in the angular distance of the Moon–Sun under various observation conditions, so that the reader can understand the fundamental role of elongation in explaining the consistency and validity of each rukyat success analyzed in this study.

Table 6. Elongation at Sunset



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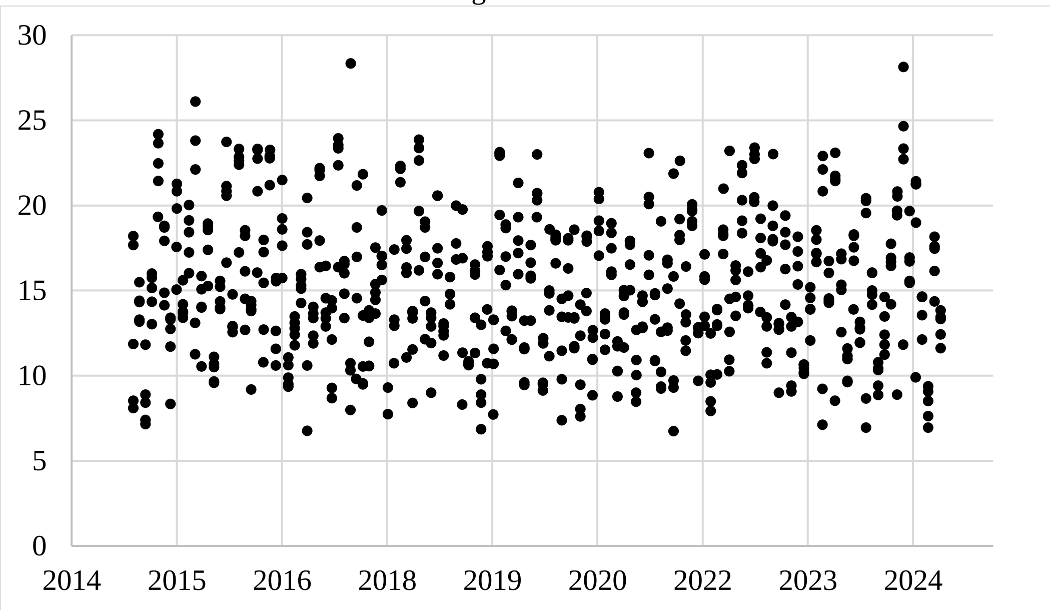
The elongation graph at sunset shows that the majority of reports are in the range of 10°–22°, with the densest distribution at 13°–18°, indicating geometric conditions that are generally safe for the visibility of the moon. Some drop points are close to 9°–10°, in line with the role of optical methods, which in studies have been recorded to be able to achieve a minimum elongation of 9.228° (visual) to 6.7413° in extreme cases of CCD. The high points at 25°–28° depict a very bright crescent. The stable pattern from 2014–2024 confirms that the variation in success is more determined by the geometric conditions during the rukyat, and that elongation remains the dominant parameter in the validity of the IAC observation report.

Table 7. Elongation at the Best Time



The elongation graph at the best time shows the dominant distribution in the range of 11°–23°, with the greatest concentration at 14°–18°, indicating the most favorable geometric conditions. Some points are at the low limit of 9°–10°, in line with the ability of optical methods which in the study were able to detect minimum elongations of up to 9.4993° (binoculars) and 6.9358° (telescopes). The high points at 25°–27° depict a very bright crescent. The slightly larger ArcL value than at sunset indicates a natural shift in the Moon's position after sunset. This pattern confirms that elongation is a key parameter in the overall IAC rukyat success report.

D. Conclusion

Research on 641 reports of the IAC hilal rukyat period 1436–1446 H shows that verification based on geometric parameters is able to provide a more accurate picture of the consistency of hilal visibility claims. The reports studied came from 231 naked eye

ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
DOI: https://doi.org/10.30596/jam.v12i1.28090|| Vol. 12, No. 1 June 2026

observations, 57 binoculars, 27 telescopes, 60 CCD cameras, as well as several observations using the combination method.

The results of the geometry recalculation show a firm difference in characteristics in each method. Naked eye observations showed ArcV values of 7.4989°, ArcL 9.228°, W 0.2011′, DAz 0.8029°, and a lag of −31.0593 minutes in Zone A–B. Binocular showed ArcV of 3.9893°, ArcL 9.4993°, W 0.1967′, DAz 0.3329°, and a lag of 17.9419 minutes in Zone C–B. The telescope recorded ArcV of 2.6134°, ArcL of 6.9358°, W of 0.1162′, DAz of 0.1195°, and a lag of 15.0096 minutes in Zone D–C. Meanwhile, The CCD camera was at ArcV values of 3.4399°, ArcL 6.7413°, W 0.1033′, DAz 0.2769°, and a lag of 17.6455 minutes which included Zone D. This variation shows that the higher the sensitivity of the instrument, the smaller the geometric value of the hilal that can still be detected.

Overall, the results of this study confirm that numerical verification is very important to ensure the accuracy of rukyat reports. Automatic integration of ArcV, ArcL, DAz, W, and lag parameters in the IAC reporting system is necessary so that the moon visibility assessment process can take place more objectively, consistently, and accountably at the global level.

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AL-MARSHAD: JURNAL ASTRONOMI ISLAM DAN ILMU-ILMU BERKAITAN
ISSN 2442-5729 (print) || ISSN 2598-2559 (online)
http://jurnal.umsu.ac.id/index.php/almarshad
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