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. 2 Desember 2024

# The Effect of Lunar Elongation and Illumination Fraction on the Visibility of the Moon

Mazratul Aini[a,1*], Arino Bemi Sado [b,2]
[a,b] Mataram State Islamic University, Mataram, 86111, Indonesia
[1] mazratulaini02@gmail.com; [2]arinobemisado@uinmataram.ac.id

**Abstract:** *The visibility of the new* Moon *is significantly influenced by the* Sun*'s position at* Sunset*, often referred to as elongation or the angular distance between the* Sun *and* Moon*. The criteria currently agreed upon by the Indonesian government for determining the start of the lunar month are the NEW-MABIMS criteria, which require a minimum* Moon *height of 3° and a minimum crescent elongation of 6,4°. This thesis aims to (1) determine the influence of elongation and lunar illumination fraction on the visibility of the new* Moon*, and (2) identify the elongation value and lunar illumination fraction that impact the new* Moon*'s visibility at Loang Baloq Beach. This research employs a field research method using a mixed-methods approach. Data collection methods include observation and documentation. The result of this thesis indicates that (1) both elongation and lunar position fraction affect the visibility of the new* Moon*. Multiple linear regression analysis, a correlation value of 68,41%, categorized as strong, a coefficient value of 41,96%, categorized as moderate and* $R^2$ *46,8% also categorized as moderate. This suggests a significant influence of elongation and lunar illumination fraction on the visibility of the crescent* Moon*, though other factors also contribute. (2) the smallest crescent observed was at the elongation of 8° 11' 24.00" with an illumination fraction of 0,69%. This record serves as the minimum elongation and illumination fraction values impacting new* Moon *visibility at Loang Baloq Beach over the last three years. In general, the greater the elongation, the larger the illumination fraction, indicating that as the* Sun*'s distance from the* Moon *increases, the visibility of the illuminated portion of the* Moon *also increases.*
**Keywords:** *Elongation, Lunar Illumination Fraction, Hilal Visibility.*

**Abstrak:** *Ketampakan/visiblitas hilal sangat dipengaruhi oleh posisi matahari saat terbenam yang sering disebut dengan elongasi atau jarak sudut antara posisi matahari dan bulan dimana kriteria penentuan awal bulan yang saat ini disepakati oleh pemerintah indonesia adalah kriteria NEO-MABIMS dengan kriteria tinggi hilal minimal 3° dan elongasi hilal minimal 6,4°. Tujuan yang ingin dicapai dalam skripsi ini adalah (1) Mengetahui pengaruh elongasi dan Fraksi Iluminasi Bulan dalam visiblitas hilal. (2) Mengetahui besar nilai elongasi dan fraksi iluminasi bulan yang dapat mempengaruhi visibilitas hilal di Pantai Loang Baloq. Penelitian ini dilakukan dengan menggunakan metode penelitian lapangan (Field Research) dengan menggunakan pendekatan Mix Method. Adapun metode pengumpulan data menggunakan 2 (dua) jenis, yaitu observasi dan dokumentasi. Hasil penelitian dalam skripsi ini menunjukkan (1) Elongasi dan fraksi iluminasi bulan mempengaruhi visiblitas hilal. Berdasarkan pada pengujian analisis regresi linear berganda terdapat nilai korelasi sebesar 68.41% dengan ketegori kuat, nilai koefisien 41.96% dengan kategori sedang dan* $R^2$ *46.8% dengan kategori sedang. Artinya terdapat pengaruh yang signifikan dari elongasi dan fraksi iluminasi bulan terhadap visiblitas hilal walaupun masuk ketegori sedang. Sisanya dipengaruhi oleh faktor lainnya. (2) Rekor terkecil hilal teramati berada pada elongasi 8° 11' 24.00" dengan Fraksi Iluminasi 0.69%. Rekor tersebut dijadikan sebagai besar nilai elongasi dan fraksi iluminasi bulan minimum yang mempengaruhi visiblitas hilal di Loang Baloq selama kurun waktu pengamatan 3 tahun terakhir. Artinya, semakin besar nilai elongasi maka semakin besar pula nilai fraksi iluminasinya. Hal tersebut mengindikasikan bahwa ketika matahari semakin jauh jaraknya dengan bulan maka, bagian terang dari bulan (fraksi iluminasi bulan) juga semakin besar.*
**Kata Kunci:** *Elongasi, Fraksi Iluminasi Bulan, Visibilitas Hilal.*

## A. Introduction

The Moon receives and reflects light from the Sun which is then received by the Earth. This phenomenon is influenced by the relative positions of the Moon, Earth, and Sun. The Moon continues to move, one of which is by revolutionizing around the Earth, which is known as the Lunar Revolution. On the other hand, the Earth and Moon together circle the Sun in a motion

called the Lunar Revolution. In addition to revolutions, the Moon and Earth also rotate on their respective axes.

The lunar revolution became the main factor affecting the lighting and reflection of Sunlight from the Moon to the Earth. The position of the Moon, Earth, and Sun depended on the angle of elongation during the Lunar Revolution. This movement also plays a role in the change of the Moon's phase.[1] The Moon's phases are determined by the angle of elongation between the Earth, the Moon, and the Sun, which ranges from 0° to 180°. There are eight phases of the Moon, starting when the Moon is first seen to when it is not visible at all (the Moon is dead). The phases of the Moon describe the part of the Moon that receives Sunlight and is visible from the Earth. Astronomically, the eight phases include: *The New* Moon (Hilal), *Waxing Crescent* (young crescent), *First Quarter*, *Waxing Gibbous* (early convexification), *Full* Moon, *Waning Gibbous* (late convex), *Last Quarter* (third quarter), and *Waning Crescent* (old crescent). [2]

Hilal or the new Moon has an important role in the Islamic calendar. The beginning of the month in the Islamic calendar is determined by the appearance of the hilal, which is one of the phases of the Moon. The Hilal can be seen after the conjunction has occurred and usually appears near the direction of Sunset. The appearance of the new Moon is a marker of the beginning of the month and can be observed using the *naked eye*[3] or with the help of *optical aids* to make it easier to observe the new Moon or new Moon[4].

The visibility of the Moon is greatly influenced by the position of the Sun at Sunset which is often called the elongation or angular distance between the position of the Sun and the Moon. Hilal is an object that stretches with a crescent thickness of several arc minutes (1 arc minute corresponds to an angle of 0.017°). Therefore, the position of the hilal above the horizon before Sunset depends on the angle of elongation of the Moon and the Sun. The condition of the hilal, which is very thin, with white light in the orange western sky, makes it difficult to observe the hilal, because there is no contrast between the white and thin hilal light[5] and the orange background of the western horizon at Sunset. In addition to the condition of the Moon, the position of the Moon at Sunset[6] also varies because it is influenced by the shape of the Moon's orbit and the rotation of the Earth.

[1]Jakfar Rizqi, "The Role of the Highest Elongation of the Full Moon in the Determination of the Beginning of the Month of Kamariah as an Aid to the Quality Ru'yatul Hilal Process," 2022.

[2]Abd. Haji Amahoru, Ashari Bayu Prasada Dulhasyim, and Sri Rahmadani Pulu, "Analysis of Visual Images of Moon Phases in the Review of the Celestial Sphere Coordinate System," *Journal of Mipa Education* 14, no. 1 (2024).

[3]Zahrotun Nadhifah, "Determination Of The Beginning Of The Hijri Month (Study of Hadith about Hilal as a Sign of the Beginning of the Hijri Month)," *Elfaly* 4 (2020): 2.

[4]Li'izza Diana Manzil, "Moon Phases in the Month of Kamariah," *Journal of Islamic Law* 16, no. 1 (2018): 35–37, http://en.wikipedia.org/.

[5]University of Muhammadiyah and North Sumatra, "Al-Marshad: Journal of Islamic Astronomy and Related Sciences," *AL-MARSHAD: Journal of Islamic Astronomy and Related Sciences* 6, no. 1 (2020): 1–10, https://doi.org/10.30596/jam.v.

[6]Al Afaq et al., "Mapping the Position of Hilal to Mount Agung at the Location of the Loang Baloq Beach Rukyat in Mataram" 5, no. 1 (2023): 81–89.

Several factors, such as the height of the hilal above the horizon, the age of the hilal after the conjunction, the azimuth difference between the Moon and the Sun, the angle of elongation and the level of illumination of the hilal or illumination fraction influence the characteristics of the sighting/visibility of the hilal at Sunset.[7] The criteria for determining the beginning of the month that is currently agreed upon by the Indonesian government are the NEO-MABIMS criteria with the criteria of a minimum hilal height of 3° and a minimum hilal elongation of 6.4°[8]. The criteria are based on rukyat data supported by international astronomical criteria based on considerations of disturbances in the observation of the hilal.[9]

The Moon's elongation value ranges from 0° to 180°. Elongation of 180° is the highest value that occurs at the peak of the full Moon, where the lunar illumination fraction reaches 100% which produces perfect brightness (Full Moon). In contrast, the elongation of 0° is the lowest value called the phase of the dead Moon, with an illumination fraction of 0°. In observing the hilal to determine the beginning of the lunar month, the new Moon is difficult to see because it appears after the phase of the dead Moon with a low elongation. The Government of Indonesia uses the NEO-MABIMS criterion which sets the minimum elongation value for successful hilal observations to be 6.4°[10].

Based on the description above, there is a correlation between elongation and the lunar illumination fraction on the visibility of the hilal. Therefore, this study aims to determine the level of influence of the elongation and fraction of lunar illumination on the visibility of the Moon based on the Moon data.

## B. Methods

This type of research includes field *research* using *the Mix Method Research* approach, which is a research approach that combines quantitative and qualitative.[11] This type of research includes field research using the Mix Method Research approach, which is a research approach that combines quantitative and qualitative. A qualitative approach is used to describe the facts that occur in the field related to elongation and the lunar illumination fraction that affect the visibility of the hilal. Meanwhile, a quantitative approach was used to analyze relevant data related to the elongation and fraction of the Moon's illumination. The clustered data was

[7]Arino Bemi Sado, *Arino Bemi Sado, "The Problem of Hisab and Rukyat: The Criterion of Brightness as the Root of the Difference in the Results of Hisab and Rukyat* (Mataram: Sanabil, 2019).

[8]Hariyono and Nursodik, "Problems of the Implementation of Neo MABIMS in Determining the Beginning of the Month of Ramadan, Shawwal and Dzulhijjah 1443 H in Indonesia," *Al-Fatih: Journal of Education and Islam* IV, no. 2 (2021): 358–73, http://jurnal.stit-al-ittihadiyahlabura.ac.id/index.php/alfatih/article/view/190%0Ahttp://jurnal.stit-al-ittihadiyahlabura.ac.id/index.php/alfatih/article/download/190/169.

[9]Nur Aini and Youla Afifah Azkarrula, "The Views of Astrological Figures on Elongation in the Early Determination of Shawwal 1443 H in the Neo MABIMS Criteria in Indonesia," *Astroislamica: Journal of Islamic Astronomy*, 2024, https://doi.org/10.47766/astroislamica.v3i1.2762.

[10]Windi Rezani, Fatmawati, and Sippah Chotban, "Implementation of Neo-MABIMS Visibility Criteria in Determining the Beginning of the Hijri Month," *HISABUNA: Journal of Astronomy* 4, no. 2 (2023): 76–86, https://doi.org/10.24252/hisabuna.v4i2.36962.

[11]Sena Wahyu Purwanza et al., *Quantitative, qualitative and combined research methodologies*, *Indonesian Science Media*, 2022.

analyzed using qualitative descriptive analysis methods and simple statistical analysis to obtain accurate results.

## C. Results and discussion

### 1. Analysis of the Effect of Elongation and Illumination Fraction of the Moon on Hilal Visibility

Before establishing the criteria for the visibility of the hilal, observers generally conduct a series of observations of the hilal. The results of these observations are used to conclude the conditions of the hilal that are possible to observe. Observers usually use various parameters to determine whether the hilal can be seen or not. However, the parameters used can vary, because the position of the hilal in each location produces varying visibility values. Several factors, such as the elongation and illumination fraction of the Moon influence this difference.[12]

According to Odeh, the visibility of the new Moon is not only determined by one parameter. However, certain criteria use only one parameter, such as Schaefer's criterion which only considers the age of the Moon or *lag time.* Meanwhile, according to Djamaludin, the lunar illumination fraction or the level of hilal illumination must also be considered to determine the visibility of the hilal[13] and elongation [14] (the distance between the angle of the Sun and the Moon). However, these criteria cannot be used immediately and must be processed first. To produce accurate hilal visibility criteria, at least 2 (two) parameters must be used[15], namely the parameter that functions to express the brightness of the hilal and other parameters to express the distance of the hilal to the horizon. As for finding out more clearly the influence of the elongation and fraction of the Moon's illumination on the visibility of the new Moon, it is necessary to test the data. The hilal data used is the hilal data for the April 2022-March 2024 period.

**Table 1. Hilal Data for the April 2022 – March 2024 Period**

| It | Date | Hilal Height | | Elongation | | FIB | Ket. |
|---|---|---|---|---|---|---|---|
| | | Degree | Decimal | Degree | Decimal | | |
| 1. | Ramadan 1443H/ April 2, 2022 | 11°15’ 03.06” | 11,25 | 12°27’00.00” | 12,5 | 1.46% | Visible |
| 2. | Syawal 1443 H/1 from 2022 | 4°32’ 31.02” | 4,54 | 5° 11’ 24.00” | 5,2 | 0.32% | Invisible |
| 3. | Dzulkaidah 1443 H/31 May 2022 | 7°26’ 06.00” | 7,44 | 9° 13’ 12.00” | 9,2 | 0.80% | Invisible |

[12]Arino Bemi Sado, *"The Problem of Hisab and Rukyat: The Criterion of Brightness as the Root of the Difference in the Results of Hisab and Rukyat*.

[13]Sado.

[14]Sado.

[15]Ridhokimura Soderi and Riza Afrian Mustaqim, "Reconstruction of Hilal Visibility Criteria and the Impact of the Implementation of the New MABIMS Imkanurukyah Criteria in the Benefit of Government Decisions, in This Case the Ministry of Religion" 3, no. 2 (2024): 233–55.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4. | Dzulhijjah 1443 H/ 29 June 2022 | 1°27’ 43.02” | 1,46 | 4° 26’ 12.00” | 4,4 | 0.08% | Invisible |
| 5. | Dzulhijjah 1443 H /29 July 2022 | 6°20’ 06.00” | 6,34 | 7° 37’ 48.00” | 7,6 | 0.43% | Invisible |
| 6. | Safar 1444 H /28 August 2022 | 11°26’ 34.08” | 11,44 | 11° 31’ 48.00” | 11,5 | 1.18% | Visible |
| 7. | R. Awal 1444 H /26 September 2022 | 3°29’ 20.04” | 3,48 | 3° 42’ 00.00” | 3,7 | 0.30% | Invisible |
| 8. | R. End 1444 H /26 October 2022 | 10°32’48.01” | 10,55 | 11° 35’ 31.99” | 11,6 | 1.02% | Visible |
| 9. | J Awal 1444 H /24 November 2022 | 4°40’ 26.04” | 4,67 | 5° 17’ 24.00” | 5,3 | 0.31% | Invisible |
| 10. | J Awal 1444 H /23 December 2022 | 13°19’48.00” | 13,33 | 13° 28’ 12.00” | 13,5 | 1.55% | Invisible |
| 11. | RJAB 1444 h/min January 22, 2023 | 7° 47’ 13.02” | 7,79 | 7° 55’ 48.00” | 7,9 | 0.52% | Invisible |
| 12. | Sha'ban 1444 H /20 February 2023 | 2° 27’ 50.04” | 2,46 | 3° 46’ 12.00” | 3,8 | 0.03% | Invisible |
| 13. | Ramadan 1444 H /22 March 2023 | 7° 29’ 06.00” | 7,49 | 8° 11’ 24.00” | 8,2 | 0.69% | Visible |
| 14. | Shawwal 1444 H/20 April 2023 | 1° 21’ 50.04 | 1,36 | 2° 01’ 12.00” | 2,0 | 0.04% | Invisible |
| 15. | Dzulkaidah 1444 H /20 May 2023 | 5° 44’ 31.02” | 5,74 | 8° 21’ 36.00” | 8,4 | 0.62% | Invisible |
| 16. | Dzulhijjah 1444 H/18 june 2023 | 0° 29’ 31.02” | 0,49 | 4° 40’ 48.00” | 4,7 | 0.05% | Invisible |
| 17. | Muharram 1445 H /18 Jul 2023 | 5° 45’ 07.02” | 5,75 | 7° 29’ 24.00” | 7,5 | 0.39% | Invisible |
| 18. | Safar 1445 H /16 August 2023 | -0°02’ 34.08” | 0,04 | 4° 22’ 48.00” | 4,4 | 0.00% | Invisible |

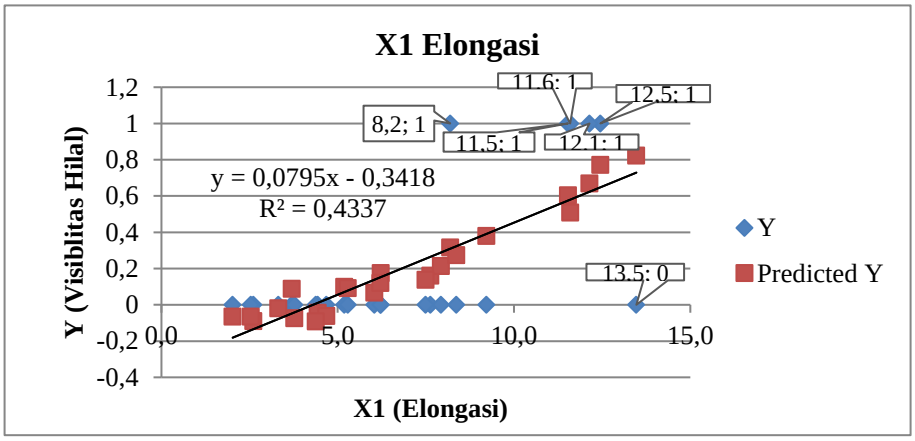
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 19. | R. Awal 1445 H /15 September 2023 | 2° 59’ 13.02” | 2,99 | 3° 19’ 12.00” | 3,3 | 0.12% | No Visible |
| 20. | R. end 1445 H /15 October 2023 | 4° 49’ 37.02” | 4,83 | 6° 13’ 12.00” | 6,2 | 0.45% | Invisible |
| 21. | J. Awal 1445 H /13 November 2023 | -1°08’ 16.08” | -0,86 | 2° 36’ 36.00” | 2,6 | 0.00% | Invisible |
| 22. | J. End 1445 H / December 13, 2023 | 4° 34’ 58.08” | 4,58 | 6° 02’ 24.00” | 6,0 | 0.27% | Invisible |
| 23. | RJAB 1445 H/12 January 2024 | 12°08’06.00” | 12,14 | 12°08’24.00” | 12,1 | 1.29% | Visible |
| 24. | Sha'ban 1445 H /10 February 2024 | 6°12’ 10.08” | 6,20 | 6° 12’ 36.00” | 6,2 | 0.36% | Invisible |
| 25. | Ramadan 1445 H /March 10, 2024 | 0° 31’ 37.02” | 0,53 | 2° 23’ 00.00” | 2,5 | 0.04% | Invisible |

Of the 25 hilal data at the location of the Loang Baloq Beach rukyat, there are 5 visible and 20 invisible hilal data. From the 25 hilal data, an impact test was carried out using Multiple Linear Regression Analysis with 3 components, namely:

a. Effect of elongation on the visibility of the new Moon
b. Effect of illumination fraction on the visibility of the new Moon
c. The effect of elongation and lunar illumination fraction on the visibility of the hilal.

The tests carried out are as follows:

a. Test of the effect of elongation on the visibility of the hilal




**Graphic 1 Effect of Elongation on Hilal Visibility**

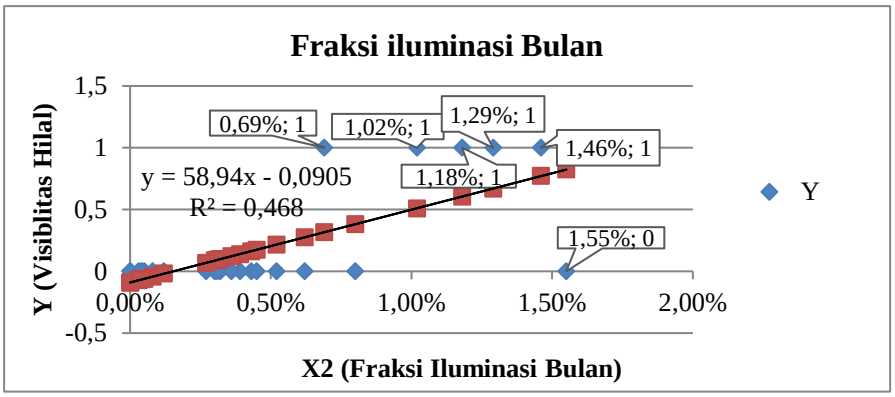
**Table 2 Interval Cowphysin**

| Value Koefisin | Level Relationship |
|---|---|
| 0.00 – 0.199 | Very Low |
| 0.20 – 0.399 | Low |
| 0.40 – 0.599 | Keep |
| 0.60 – 0.799 | Strong |
| 0.80 – 1.000 | Very Strong |

In Graph 1, the effect of elongation on the visibility of the hilal is R2 = 0.4337 or 43.37%. This value is included in the category of medium correlation. This means that there is an effect of elongation (X1) on the visibility of the hilal (Y) with a moderate correlation.

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. 2 Desember 2024

b. Test of the effect of the lunar illumination fraction (X2) on the visibility of the Moon




**Graphs 2. Effect of illumination Fraction on the Visibility of the Hilal**

In Graph 2. the effect of elongation on the visibility of the hilal is R2 = 0.468 or 46.8 %. This value is included in the category of medium correlation. This means that there is an influence of the lunar illumination fraction (X1) on the visibility of the hilal (Y) with a moderate correlation.

c. Test the effect of elongation and lunar illumination fraction on the visibility of the hilal. The following are the results of the elongation analysis (X1), the Lunar Illumination fraction (X2), and the Hilal Visibility (Y)

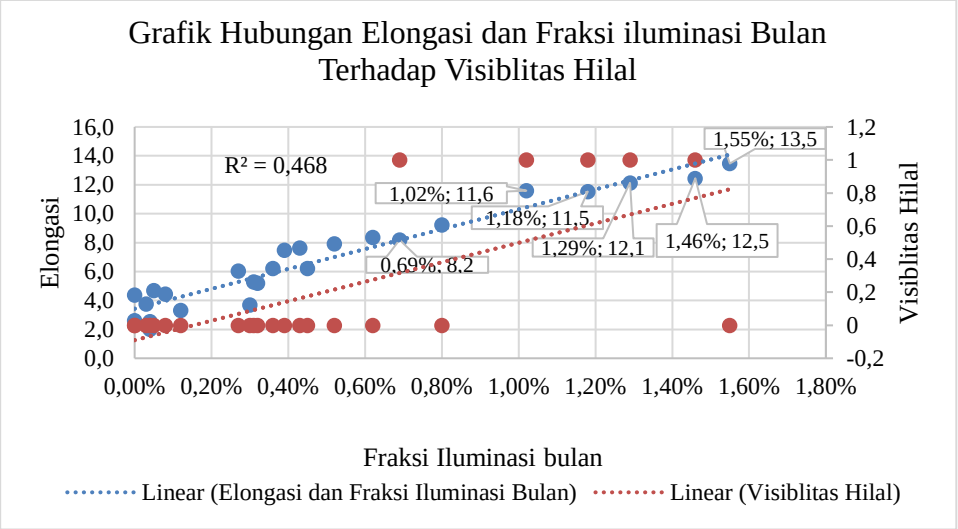
**Table 1 Regresssion Statistics**

| *Regression Statistics* | |
|---|---|
| Multiple R | 0,684100802 |
| R Square | 0,467993907 |
| Adjusted R Square | 0,419629716 |
| Observations | 25 |

From the regression statistical analysis table above, it can be concluded as follows:

1) Multiple R or correlation value between X1, X2 and Y is 0.6841 or around 68.41%. This value is included in the strong category.
2) The R square or determination value ranges from 0.468 or 46.8% of the variation of the dependent variable (X1, X2) can be explained by the dependent variable (Y)
3) Adjusted R square or the value of the determination coefficient is 0.4196 or 41.96%. This means bringing X1, and X2 explains Y of 41.96% which is included in the medium category. The rest is influenced by other factors such as atmospheric conditions, the expertise of the observer, and the sophistication of the equipment.

The following is a graph of the relationship between elongation and the lunar illumination fraction on the visibility of the Moon as follows:




**Graph 4. Graph of the Relationship Between Elongation and Lunar Illumination Fraction to the Visibility of the Moon**

The graph confirms the data from the regression statistics table, namely the influence of the Moon's elongation and illumination fraction on its visibility, which is included in the medium category, $R^2$=0.468 or 46.8%. This means that 53.2% of the Moon's visibility is influenced by other factors, such as atmospheric conditions, observer expertise, and the sophistication of the equipment.

Thus, from the display of the 3 Graphs, it can be concluded that:

1) There was an effect between elongation on the visibility of the hilal with the medium category (Table 4.2), which was 43.37%.
2) There is an influence between the lunar illumination fraction on the visibility of the Moon with the medium category (Table 4.2), which is 46.8%.
3) There is an influence between elongation and the lunar illumination fraction on the visibility of the hilal with a medium category (Table 4.2) which is 46.8%.

## 2. Large Analysis of Elongation Values and Lunar Illumination Fractions Affecting Hilal Visibility at the Location of Rukyatul Hilal Loang Baloq Beach

The visibility of the new Moon is the first crescent Moon sighting which is an important criterion in determining the minimum level of contrast needed to be able to observe the new Moon [16] because the new Moon is a physical phenomenon that occurs in space and is influenced by the conditions of the astrosphere, it is difficult to see the new Moon when it is very young because the light is thin and too dim compared to the bright twilight light that appears when the Sun sets. The brightness of the twilight sky is characterized by the physical condition of the

[16]Zuni Faridatul Magfiroh, "Study on the Effect of Rainfall on Hilal Visibility Based on the Kastner Brightness Model in Pasuruan, East Java in 2019-2021," 2022, 135.

skylight which changes color to red or orange.[17] At that time, the Sun was far away, so Sunlight was more diffused by the atmosphere. This phenomenon is related to the physical condition of the sky, which is influenced by the relative position of the Earth and Moon to the Sun.[18]

When the Sunsets, the light is still visible until it reaches a position of about 6 degrees below the horizon which makes the hilal difficult to observe due to the low illumination fraction of the Moon. Therefore, it is necessary to conduct a more in-depth study of the position of the Sun relative to the Moon during the rukyatul hilal. In addition, the elongation value is also influenced by various factors, such as the altitude of the observation location. [19] To determine the minimum value of elongation and illumination fraction of elongation and illumination fraction of the Moon that affect the visibility of the hilal, historical analysis is needed at the observation location. The minimum value of the observation results is then used as a reference for the visibility of the new Moon at the location.

The location to perform the rukyatul hilal must pay attention to the topographical conditions of the area because topographic conditions play an important role in the visibility of the hilal. In West Nusa Tenggara (NTB), Loang Baloq Beach is one of the main locations for the rukyatul hilal because of its direct direction of view facing the western horizon, the location where the hilal appears after Sunset. This beach has the characteristics of a quite open lowland, making it easier for observers to do rukyatul hilal. However, despite having the advantage of a direct westview direction, the topographic conditions on Loang Baloq beach also experienced several obstacles. One of them is the existence of Mount Agung on the island of Bali, located west of Loang Baloq beach. Mount Agung can affect the visibility of the hilal because its height can obstruct the line of sight to the hilal that is close to the horizon, especially when the hilal has a relatively low altitude.

[17]Dwi Febryanto, "Analysis of the Success of Rukyat Hilal in Bukit Condrodipo Gresik with Hilal Kastner Visibility Parameters from 2015-2020," 2022.

[18]Thomas Djamaluddin, “New Crescent Moon Visibility in Indonesia,” *Research Gate*, no. October 2000 (2022).

[19]Ruslandi Ruslandi and Hasna Tuddar Putri, "Analysis of the Success Rate of Rukyat Hilal at the Teungku Chiek Kuta Karang Lhoknga Aceh Besar Observatory," *Astroislamica: Journal of Islamic Astronomy* 1, no. 1 (2022): 97–122, https://doi.org/10.47766/astroislamica.v1i1.690.

**Figure 1. Condition of the West Horizon of Loang Baloq Beach**

There are 25 hilal data at the location of the Loang Baloq beach rukyat, where there are 5 visible hilal data and the remaining 20 unseen hilal data. To measure the magnitude of the elongation value and the illumination fraction of the Moon, the researcher used the hilal data as a large benchmark for the elongation value and the illumination fraction that affects the visibility of the hilal at the location of the Loang Baloq Beach rukyat. The data of the hilal can be seen in Loang Baloq as follows:

**Table 4 Hilal Data Seen April 2022 - March 2024**

| It | The Month of Kamariah | Hilal Height | Elongation | F. Illumination of the Moon | Information |
|---|---|---|---|---|---|
| 1. | Ramadan 1443H/ April 2, 2022 | 11°15'03.06" | 12° 27' 00.00" | 1.46% | Visible |
| 2. | Safar 1444 H/ August 28, 2022 | 11°26'34.08" | 11° 31' 48.00" | 1.18% | Visible |
| 3. | R. Late 1444 H/ October 26, 2024 | 10°32'48.01" | 11° 35' 31.99" | 1.02% | Visible |
| 4. | Ramadan 1444 H/ March 22, 2023 | 7°29' 06.00" | 8° 11' 24.00" | 0.69% | Visible |
| 5. | Rajab 1445 H/ January 12, 2024 | 12 08'06.00" | 12° 08' 24.00" | 1.29% | Visible |

Based on the hilal data seen above, although the existence of Mount Agung is an obstacle to the success of the rukyatul hilal on Loang Baloq beach, especially when the height of the hilal is low, such as in Ramadan 1444 H, the data shows that the elongation factor, the lunar illumination fraction, and the direction of view of the location of Loang Baloq beach still provide a great opportunity for successful hilal observation. With the elevation of the hilal which is quite high in most data, so that the resistance from Mount Agung becomes insignificant when the height of the hilal, elongation, and lunar illumination fraction are adequate.

Here are some pictures of the hilal seen at the location of the Loang Baloq beach rukyat in Mataram.


**Figure 2. The Image of the Late Rabi'ul 1444 H Hilal Observed at Loang Baloq Beach**


**Figure 3. The Image of the Sighting of Hilal Ramadan 1445 H at Baloq beach**


**Figure 4. Picture of Ramadan 1444 H Hilal at Loang Baloq Beach**


**Figure 5. Image of the Visible Hilal 1 Rajab 1445 H at Loang Baloq Beach**


**Figure 6. Image of the Ramadan 1443 H hilal at Loang Baloq Beach**

Based on the hilal data seen above, the smallest hilal height is in the month of Ramadan 1444 H of 7°29' 06.00", elongation 8° 11' 24.00", and the lunar illumination fraction is 0.69%. Meanwhile, the largest height of the hilal was seen in the month of Rajab 1445 H at 12° 08'06.00", elongation of 12° 08' 24.00", and lunar illumination fraction of 1.29%. The high value of the hilal, elongation, and illumination fraction is the smallest record of visible hilal observations at the location of the Loang Baloq Beach rukyat. Thus, at the location of the Loang Baloq Beach rukyat, the elongation value and the lunar illumination fraction that affects the visibility of the hilal is 8° 11' 24.00" and the lunar illumination fraction is 0.69%. However, there may be additional records in the future, considering that the location of the Loang Baloq beach rukyat is quite feasible for a hilal observation location with several aspects that have been explained.

## D. Conclusion

Based on the description in the previous chapter related to "The Effect of Elongation and Lunar Illumination Fraction on Hilal Visibility (Case Study of the Location of the Loang Baloq Beach Rukyat)". The researcher can draw the following conclusions:

1. Elongation and the illumination fraction of the Moon affect the visibility of the hilal. Based on the test of multiple linear regression analysis, there is a correlation value of 68.41% with a strong category, a coefficient value of 41.96 with the medium category, and an R2 value of 46.8% in the medium category, meaning that there is a significant influence of the elongation and illumination fraction of the Moon on the visibility of the hilal even though it is in the medium category.

2. The smallest record of observed hilal observations was recorded at an elongation of 8° 11' 24.00" with a lunar illumination fraction of 0.69%. Therefore, the elongation value and illumination fraction of the Moon with the smallest record of the hilal observed at Loang Baloq Beach is used as the minimum value of the elongation and illumination fraction that affects the visibility of the hilal in the observation data of the last 3 years. Analysis of the data shows that the value reflects the high elongation value and low fraction of lunar illumination which significantly affects the visibility of the hilal on the coast of Loang Baloq. In this period, there were 25 data on the observation of the hilal, of which 20 data showed that the hilal was not visible, while 5 data showed that the hilal was visible. Therefore, this data confirms that low elongation conditions and lunar illumination fractions can produce difficult or even invisible hilal, as is the case in most observations made on the coast of Loang Baloq outside of other supporting factors.

**Bibliography**

Abd. Haji Amahoru, Ashari Bayu Prasada Dulhasyim, and Sri Rahmadani Pulu. "Analysis of Visual Imagery of Moon Phases in a Review of the Celestial Sphere Coordinate System." *Journal of Mipa Education* 14, no. 1 (2024): 114–23. https://doi.org/10.37630/jpm.v14i1.1492.

Afaq, A L, Journal of Science, Nurnadiyah Syuhada, and Arino Bemi Sado. "Mapping the Position of Hilal to Mount Agung at the Location of the Loang Baloq Beach Rukyat in Mataram" 5, no. 1 (2023): 81–89.

Aini, Nur, and Youla Afifah Azkarrula. "The Views of Astrological Figures on Elongation in the Early Determination of Shawwal 1443 H in the Neo MABIMS Criteria in Indonesia." *Astroislamica: Journal of Islamic Astronomy*, 2024. https://doi.org/10.47766/astroislamica.v3i1.2762.

Djamaluddin, Thomas. "New Crescent Moon Visibility in Indonesia." *Research Gate*, no. October 2000 (2022).

Faridatul Magfiroh, Zuni. "Study on the Effect of Rainfall on Hilal Visibility Based on the Kastner Brightness Model in Pasuruan, East Java in 2019-2021," 2022, 135.

Febryanto, Dwi. "Analysis of the Success of the Hilal Rukyat in Bukit Condrodipo Gresik with the Visibility Parameters of Hilal Kastner from 2015-2020," 2022.

Hariyono, and Nursodik. "Problems of the Application of Neo MABIMS in Determining the Beginning of the Month of Ramadan, Shawwal and Dzulhijjah 1443 H in Indonesia." *Al-Fatih: Journal of Education and Islam* IV, no. 2 (2021): 358–73. http://jurnal.stit-al-ittihadiyahlabura.ac.id/index.php/alfatih/article/view/190%0Ahttp://jurnal.stit-al-ittihadiyahlabura.ac.id/index.php/alfatih/article/download/190/169.

Manzil, Li'izza Diana. "The phases of the Moon in the month of Kamariah." *Journal of Islamic Law* 16, no. 1 (2018): 35–37. http://en.wikipedia.org/.

Muhammadiyah, University, and North Sumatra. "Al-Marshad: Journal of Islamic Astronomy and Related Sciences." *AL-MARSHAD: Journal of Islamic Astronomy and Related Sciences* 6, no. 1 (2020): 1–10. https://doi.org/10.30596/jam.v.

Nadhifah, Zahrotun. "DETERMINATION OF THE BEGINNING OF THE HIJRI MONTH (Hadith Study on Hilal as a Sign of the Beginning of the Hijri Month)." *Elfalaky* 4 (2020): 2.

Purwanza, Sena Wahyu, Aditya Wardhana, Ainul Mufidah, Yuniarti Reny Renggo, Adrianus

Kabubu Hudang, Jan Setiawan, and Darwin. *Quantitative, qualitative and combination research methodologies*. *Indonesian Science Media*, 2022.

Rezani, Windi, Fatmawati, and Sippah Chotban. "Implementation of Neo-MABIMS Visibility Criteria in Determining the Beginning of the Hijri Month." *HISABUNA: Journal of Astronomy* 4, no. 2 (2023): 76–86. https://doi.org/10.24252/hisabuna.v4i2.36962.

Rizqi, Jakfar. "The Role of the Highest Elongation of the Full Moon in the Determination of the Beginning of the Month of Kamariah as an Aid to the Quality Ru'yatul Hilal Process," 2022.

Ruslandi, Ruslandi, and Hasna Tuddar Putri. "Analysis of the Success Rate of Rukyat Hilal at the Teungku Chiek Kuta Karang Lhoknga Observatory, Aceh Besar." *Astroislamica: Journal of Islamic Astronomy* 1, no. 1 (2022): 97–122. https://doi.org/10.47766/astroislamica.v1i1.690.

Sado, Arino Bemi. *Arino Bemi Sado, "The Problem of Hisab and Rukyat: The Criterion of Clarity as the Root of the Difference in Hisab and Rukyat Results*. Mataram: Sanabil, 2019.

Soderi, Ridhokimura, and Riza Afrian Mustaqim. "Reconstruction of Hilal Visibility Criteria and the Impact of the Implementation of the New MABIMS Imkanurukyah Criteria in the Benefit of Government Decisions, in this case the Ministry of Religion" 3, no. 2 (2024): 233–55.