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# Evaluating the Feasibility of Yanbu'ul Qur'an Observatory in Menawan Kudus for Lunar Crescent Observation

**Muhammad Maulana Iqbal[1*], Muhammad Akmal Habib[2], Fajri Zulia Ramdhani [3]**

[1] Universitas Islam Negeri Walisongo Semarang, Indonesia
[2] University of Sydney, Australia
[3] University of Western Sydney, Australia
* Corresponding Author, Email: muhammadmaulanaiqbal12@gmail.com

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## Abstract

The Yanbu'ul Qur'an Observatory in Menawan Kudus, Indonesia, functions as a site for crescent moon (*rukyat al-hilāl*) observations and Islamic astronomy education. Despite conducting various observation activities, successful *hilāl* sighting has only occurred during Zulhijjah 1443 H, primarily due to light pollution, limited horizon clarity, and low contrast between the moon and the horizon. This field study analyzes primary data on observatory infrastructure, horizon conditions, sky brightness, and climatological factors, along with secondary data from observation records (2022–2023). The findings indicate two key points: (1) the observatory significantly supports astronomy education at the Yanbu'ul Qur'an Islamic Boarding School, and (2) it is moderately feasible for *hilāl* observation based on parameters from the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG), including favorable westward orientation, minimal obstructions, elevated location, low light pollution, and reliable electricity and internet access.

**Keywords**: Yanbu'ul Qur'an observatory, feasibility, crescent observation

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Observatorium Yanbu'ul Qur'an di Menawan Kudus, Indonesia, berfungsi sebagai tempat pengamatan *hilāl* (*rukyat al-hilāl*) sekaligus pusat edukasi astronomi Islam. Meskipun telah melakukan berbagai aktivitas rukyat, keberhasilan pengamatan *hilāl* baru tercapai pada awal Zulhijjah 1443 H. Hal ini disebabkan oleh polusi cahaya, keterbatasan visibilitas ufuk, dan rendahnya kontras antara *hilāl* dan cakrawala. Penelitian lapangan ini menganalisis data primer berupa kondisi infrastruktur observatorium, ufuk, kecerahan langit, dan faktor klimatologis, serta data sekunder dari hasil rukyat tahun 2022–2023. Hasil penelitian menunjukkan dua temuan utama: (1) observatorium ini berperan penting dalam mendukung pendidikan astronomi di Pondok Pesantren Yanbu'ul Qur'an Menawan Kudus; dan (2) secara moderat layak digunakan untuk pengamatan *hilāl* berdasarkan parameter dari Badan Meteorologi, Klimatologi, dan Geofisika (BMKG), seperti orientasi ke barat, ufuk yang bebas hambatan, lokasi yang tinggi, polusi cahaya rendah, serta akses listrik dan internet yang stabil.

**Kata Kunci**: Observatorium Yanbu'ul Qur'an, kelayakan, observasi *hilāl*


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## A. Introduction

*Rukyat al-hilāl* refers to the practice of sighting the crescent moon (*hilāl*) on the western horizon shortly after sunset, particularly near the end of the lunar month, to determine the beginning of the new Hijri month. This practice is especially significant in marking the commencement of Ramadan, Shawwal, and Zulhijjah, which are pivotal months in the Islamic calendar. In the context of astronomy, this activity corresponds to observational efforts focused on detecting the moon's visibility post-conjunction.[1] Although theoretically accessible to many, not all individuals involved in *rukyat al-hilāl* are able to visually detect the crescent. This limitation arises from several factors, including the extremely thin and faint appearance of the crescent at the beginning of the lunar month, atmospheric clarity, and the observer's visual acuity. Furthermore, environmental conditions such as light pollution, weather, and horizon obstruction can significantly affect the success of the observation.[2]

Historically, *rukyat al-hilāl* has played a central role in the determination of the Islamic calendar and remains a key practice that intertwines religious tradition with empirical observation.[3] Because the results of this rukyatul are the basis for determining the beginning of the hijriah month.[4] This method represents a synthesis between faith and science, where theological imperatives meet astronomical calculations.[5] Despite the advancement of computational methods for lunar predictions, physical observation continues to hold both symbolic and practical significance in many Muslim communities.[6] In contemporary times, observatories and trained personnel are often involved to ensure that *rukyat* is conducted under standardized and scientifically valid conditions, contributing to more accurate and accepted calendar determinations across the Islamic world.[7]

The implementation of *rukyat al-hilāl* frequently encounters a range of challenges that can hinder the success of crescent moon sightings.[8] Among the most common obstacles are adverse weather conditions such as cloud cover, fog, and haze, which obstruct visibility. Astronomical factors also play a crucial role; for instance, the altitude of the *hilāl* and its angular separation from

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[1] Muhyidin Khazin, *Ilmu Falak Dalam Teori Dan Praktik* (Yogyakarta: Buana Pustaka, 2004).

[2] A. Ghozali Masroeri, "Rukyatul Hilāl, Pengertian Dan Aplikasinya," in *Musyawarah Kerja Dan Evaluasi Hisab Tukyat* (Bogor, 2008).

[3] Ahmad Adib Rofiuddin, "Dinamika Sosial Penentuan Awal Bulan Hijriah Di Indonesia," *Istinbath: Jurnal Hukum* 18, no. 2 (2019): 233–54; Ahmad Izzuddin, "Dinamika Hisab Rukyat Di Indonesia," *Istinbath: Jurnal Hukum* 12, no. 2 (2015): 1–19.

[4] Muhamad Zainal Mawahib, "Implikasi Penggunaan Sistem Perhitungan Aboge Dalam Penetapan Awal Bulan Hijriah," *Syaksia : Jurnal Hukum Perdata Islam* 23, no. 2 (May 2, 2022): 182–210, https://doi.org/10.37035/syaksia.v23i2.7052.

[5] Ahmad Adib Rofiuddin and Ahmad Luqman Hakim, "NGOs Contestation On Islamic Hijri Calendar In Urban Muslim Society In Indonesia: From Authority To Identity," *Akademika : Jurnal Pemikiran Islam* 27, no. 2 (November 25, 2022): 171, https://doi.org/10.32332/akademika.v27i2.5357.

[6] Muh Arif Royyani et al., "Religious Dialogue and Astronomy from the Perspective of Indonesian Muslim Scholars," *Samarah: Jurnal Hukum Keluarga Dan Hukum Islam* 7, no. 1 (March 31, 2023): 261, https://doi.org/10.22373/sjhk.v7i1.12406; Badan Hisab Rukyat Departemen Agama RI, *Almanak Hisab Rukyah* (Jakarta: Badan Peradilan Agama Islam, 1981).

[7] Susiknan Azhari, "Gagasan Menyatukan Umat Islam Indonesia Melalui Kalender Islam," *Ahkam: Jurnal Ilmu Syariah* 2, no. 2015 (15AD), https://doi.org/https://doi.org/10.15408/ajis.v15i2.2869.

[8] Fajrullah Fajrullah, Zikrullah Hadi, and Andi Evan Nisastra, "Rukyatul Hilal Instrument Design Based On Arduino," *Al-Hilal: Journal of Islamic Astronomy* 4, no. 1 (April 29, 2022): 17–40, https://doi.org/10.21580/al-hilal.2022.4.1.11685; Holis Holis, Ahmad Musadad, and Tri Pujiati, "The Role of Public Law in Determining the Islamic Calendar in Indonesia," *Al-Hilal: Journal of Islamic Astronomy* 7, no. 1 (2025): 1–17.

the Sun are critical. If the moon is too close to the sun after sunset, residual sunlight may overpower the crescent's visibility, rendering it undetectable.[9] In addition to natural and astronomical conditions, several human and technical factors may affect the reliability of observation. These include the observer's visual acuity, the psychological state of the observer (which may lead to misidentifications, such as confusing Venus or cloud gaps with the crescent), and the quality of optical instruments used during observation. Atmospheric disturbances caused by pollution or humidity further reduce the clarity of the sky, compounding these difficulties.[10] Therefore, *rukyat* is not merely an act of looking at the sky; it necessitates careful technical preparation, precise timing, and strategic site selection to optimize visibility. These factors highlight the need for a standardized approach in conducting *rukyat*, especially in institutional or scientific contexts, to ensure accuracy and reliability.

Effective *rukyat al-hilāl* requires attention not only to astronomical calculations and the quality of observational equipment but also—critically—to the geographic and environmental characteristics of the observation site. Not all locations are suitable for conducting crescent sightings. An ideal site must have an unobstructed view of the western horizon, allowing the Sun to be clearly seen at sunset. Such openness is crucial, as it enhances the contrast between the thin crescent and the twilight sky. This contrast is a key visual factor in detecting the *hilāl*. Therefore, site selection is a fundamental aspect in ensuring the accuracy and success of rukyat activities.[11]

In conducting *rukyat al-hilāl*, selecting a strategically suitable observation site is essential to ensure accurate crescent sightings.[12] Several indications indicate that the place is suitable for *rukyat al-hilāl*. First, the western horizon must be unobstructed by natural or artificial barriers such as hills, tall buildings, or dense vegetation. Second, the site must be free from light and air pollution, including smoke and haze, which can obscure the *hilāl's* visibility. Accessibility is also important, as easily reachable locations facilitate the transport and setup of observational equipment. Moreover, proper infrastructure—such as stable electricity, reliable communication networks, and safety measures for nighttime observation—is vital for operational efficiency and observer security.[13] In urban environments, where light pollution and skyline obstructions are prevalent, many observatories face challenges that lead to inaccurate sightings or observational failures. Therefore, observatories must regularly assess their own site conditions, especially those situated inland or in densely populated areas, to determine their continued suitability for effective *rukyat* implementation.[14]

The integration of traditional *rukyat al-hilāl* practices with modern astronomical technologies is increasingly recognized as essential to improving the reliability and precision of

[9] Tono Saksono, *Mengkompromikan Rukyat Dan Hisab* (Bekasi: Amythas Publicita, 2007).

[10] Ehsan Hidayat Hidayat, "Sejarah Perkembangan Hisab Dan Rukyat," *ELFALAKY* 3, no. 1 (June 11, 2019), https://doi.org/10.24252/ifk.v3i1.9777.

[11] Muhammad Furqon Ahsani and Novi Fitia Maliha, "Kriteria Kelayakan Pos Observasi Bulan (POB) Rukyah Al-Hilal," *Jurnal Antologi Hukum* 1, no. 1 (November 8, 2021): 92–108, https://doi.org/10.21154/antologihukum.v1i1.248.

[12] Badan Hisab Rukyat Departemen Agama RI, *Almanak Hisab Rukyah*.

[13] Nur Faizah Faizah and Khairunnas, "Analysis of Rukyatul Hilal Places in Riau Province," *KULMINASI: Journal of Falak and Sharia* 3, no. 1 (August 2, 2024): 20–44, https://doi.org/10.22373/kulminasi.v3i1.4176.

[14] Hesti Suci Cahyani, Abdul Ghofur, and Muhammad Afan Nur Atqiya, "Rukyatul Hilal: Feasibility of Holiped Observation Site for Aryaduta Hotel Palembang City," *KULMINASI: Journal of Falak and Sharia* 2, no. 2 (December 8, 2024): 28–42, https://doi.org/10.22373/kulminasi.v2i2.5139.

crescent moon observations.[15] The use of advanced instruments—such as telescopes, digital imaging systems, and simulation-based software—plays a significant role in minimizing subjective interpretation and reducing the likelihood of false sightings. These technological tools offer a means of verification that complements visual observation, thereby strengthening the credibility of the *rukyah* process. Moreover, this approach aligns with Islamic legal principles that emphasize the attainment of certainty (*yaqīn*) in religious observances and communal decisions.[16] In this context, observatories such as the Yanbu'ul Qur'an Observatory not only fulfill ritual and devotional functions but also represent a valuable platform for the scientific advancement of Islamic astronomy. As such, they serve as exemplary models for other Islamic institutions seeking to harmonize religious tradition with empirical inquiry and technological innovation.

Indonesia's vast archipelagic geography and diverse climatic conditions demand the establishment of a strategically distributed and well-calibrated network of *rukyat al-hilāl* observation sites.[17] Localized weather patterns—such as monsoonal rains, dense cloud cover, and atmospheric pollution—frequently hinder successful observations, emphasizing the need for detailed feasibility studies tailored to specific locations. Empirical research conducted at sites like Barombong Beach in Makassar and Rupat Island in Riau illustrates how environmental evaluations are essential to distinguishing sites that are merely theoretically suitable from those that are practically effective.[18] These findings reinforce the necessity of assessing observatories such as the Yanbu'ul Qur'an not only in terms of religious engagement but also from a scientific and operational standpoint. A rigorous site evaluation ensures that contributions to the national *hilāl* observation network are both consistent and reliable, particularly in addressing challenges posed by Indonesia's ecological and meteorological variability.

Driven by the need to integrate Islamic astronomy education with the practice of *rukyat al-hilāl*, the Yanbu'ul Qur'an Menawan Kudus Islamic boarding school in Central Java initiated the establishment of an observatory as part of its commitment to both scientific and religious engagement. The observatory serves not only ritual purposes but also functions as a scientific and educational facility, enhancing the institution's academic reputation and becoming a source of pride for the *pesantren* and the local Kudus community. However, as a relatively new facility—and the first of its kind among Qur'an-focused Islamic boarding schools in the region—it is essential to assess its compliance with standards set by official bodies such as BMKG (Meteorology, Climatology, and Geophysical Agency) and MABIMS (Brunei, Indonesia, Malaysia, Singapore) criteria. This evaluation includes technical parameters such as a minimum *hilāl* altitude of 3°, an

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

[16] Desy Kristiane, "Penggunaan Teleskop Untuk Rukyat Al-Hilal: Analisis Pendapat Muhammad Bakhit Al-Muṭī'i Dengan Ibnu Hajar Al-Ḥaitamī," *Bilancia: Jurnal Studi Ilmu Syariah Dan Hukum* 13, no. 2 (December 30, 2019): 331–54, https://doi.org/10.24239/blc.v13i2.498.

[17] Novi Arisafitri et al., "Territory, Hilāl, and Sovereignty: Revisiting Indonesia's Maṭla' under MABIMS' New Criteria," *Al-Hilal: Journal of Islamic Astronomy* 7, no. 1 (2025).

[18] Yulia - Rahmadani and Famawati Hilal Hilal, "Rukyatul Hilal: Kelayakan Tempat Observasi Pantai Barombong Kota Makassar," *HISABUNA: Jurnal Ilmu Falak* 1, no. 1 (March 21, 2020): 18–29, https://doi.org/10.24252/hisabuna.v1i1.13078.

elongation of at least 6.4°, and established visibility thresholds to determine the site's scientific and operational feasibility for reliable crescent observation.[19]

Feasibility assessments of *rukyat al- hilāl* observation sites have been widely conducted by previous scholars. One such study by Muhammad Baha'uddin,[20] titled "Feasibility of Ujung Pangkah Beach, Gresik, as a *rukyat al- hilāl* Observation Site," concluded that the location was suitable due to its open western horizon between 270° and 300° and favorable weather conditions with humidity levels below 80%. Similarly, M. Zainul Musthofa,[21] in his research on Kartini Beach in Jepara, emphasized the importance of geographic and meteorological factors in determining a site's suitability, confirming the beach's viability for crescent moon observation. In contrast, Aina Ainul Inayah's study on Bukit Rakitan in Sluke, Rembang, revealed limitations such as a restricted 28° viewing angle and frequent fog, which hindered reliable *hilāl* visibility. These findings demonstrate the need for rigorous, site-specific evaluations before declaring any location feasible for *rukyat al-hilāl*.

Building upon this body of research, the Yanbu'ul Qur'an Menawan Kudus Islamic boarding school in Central Java has taken the initiative to develop its own observatory dedicated to *hilāl* observation. Although the facility is equipped with modern instruments and supported by trained personnel, it remains relatively new and unassessed in terms of technical feasibility. As the first Qur'an-based institution in Kudus to establish such an observatory, it is crucial to examine whether it meets accepted astronomical and environmental criteria. Specific concerns include its location in a light-polluted urban area, horizon obstructions, and limited contrast between the *hilāl* and twilight sky. This study, therefore, aims to evaluate the observatory's potential to function as a reliable site within Indonesia's broader *hilāl* observation framework.

## B. Method

This study employs a field research approach, focusing directly on the Yanbu'ul Qur'an Observatory as the primary research subject. Field research is particularly suited to obtaining accurate, context-specific information and allows for adaptability to dynamic field conditions. The research methodology is descriptive in nature, aiming to produce qualitative data derived from observable behavior and verbal responses. It emphasizes direct engagement with the research environment, where the natural setting serves as the primary data source and the researcher functions as the main data collection instrument.[22] Data collection consists of both primary and secondary sources. Primary data were obtained through direct observation of the observatory's physical setting, as well as in-depth interviews with key observatory personnel to gather insights into operational procedures and challenges. Meanwhile, secondary data included documented reports on *hilāl* observations conducted at the site, historical background of the observatory's

[19] Moh. Fadllur Rohman Karim and Mahsun Mahsun, "Kriteria Baru Mabims 3-6,4: Upaya Penyatuan Kalender Hijriah Di Indonesia Dalam Perspektif Maqāṣid Al-Syarī'ah," *Astroislamica: Journal of Islamic Astronomy* 3, no. 1 (June 30, 2024): 51–75, https://doi.org/10.47766/astroislamica.v3i1.2735.

[20] Muhammad Baha'uddin, "Kelayakan Pantai Ujung Pangkah Gresik Sebagai Tempat Rukyat Al-Hilal" (Institut Agama Islam Negeri Walisongo Semarang, 2013).

[21] Muhammad Zainul Mustofa, "Uji Kelayakan Pantai Kartini Jepara Sebagai Tempat Rukyat Al-Hilal" (Institut Agama Islam Negeri Walisongo Semarang, 2013).

[22] Sugiyono, *Metode Penelitian Pendidikan (Kuantitatif, Kualitatif, Kombinasi, R&D Dan Penelitian Pendidikan* (Bandung: Alfabeta, 2019).

establishment, and technical criteria relevant to the feasibility of *rukyat al-hilāl* locations. These criteria are sourced from established benchmarks set by Indonesia's Meteorology, Climatology, and Geophysical Agency (BMKG).

To assess the observatory's feasibility as a *hilāl* observation site, the study adopts a deductive analytical framework.[23] BMKG's criteria—such as horizon clarity, light pollution levels, and atmospheric conditions—are used as evaluative standards to interpret the data. Through this approach, the research aims to determine whether the Yanbu'ul Qur'an Observatory meets national and regional standards for effective crescent moon observation, contributing valuable insights into its scientific and practical viability within the broader network of Islamic astronomical observatories in Indonesia.

## C. Result and Discussion

### 1. Institutionalizing *Hilāl* Observation: Contributions of Yanbu'ul Qur'an Observatory to Islamic Astronomy in Indonesia

The success of *hilāl* observation is highly dependent on the suitability of the observation site. Not all locations with elevated ground or unobstructed views automatically qualify as ideal observatory points. While towers or hills may seem suitable due to their altitude, the key requirement is a clear and open western horizon. This horizon should span approximately 28.5 degrees from the true west point—equivalent to about three hand spans to the left and right—free from obstructions such as buildings, trees, smoke, or light pollution. Therefore, standardization of observatory feasibility is essential to ensure both geographical and astronomical appropriateness. A valid *rukyat* site must provide clear visibility conditions toward the west and meet safety and accessibility standards. Locations prone to natural hazards, such as forests inhabited by wild animals, are unsuitable despite having technically clear horizons. Additionally, atmospheric and climatological conditions—like cloud cover, air pollution, and unpredictable rainfall—remain significant challenges. The Meteorology, Climatology, and Geophysics Agency of Indonesia (BMKG) offers short- to medium-term forecasts, but precise long-term predictions of these factors are limited, introducing uncertainty into observation planning. [24]

At the Yanbu'ul Qur'an Observatory, *hilāl* observation is conducted using a combination of classical and modern methods. In calculating the beginning of the Hijri month, the observatory employs contemporary computational tools such as the Ephemeris *Hisab Rukyat* data provided by the Indonesian Ministry of Religious Affairs and Besselian elements for enhanced astronomical accuracy. However, in line with traditional Islamic pedagogy, the observatory also integrates classical manual systems by teaching foundational texts like *Syams al-Hilāl* and *Nūr al-Anwār*. This integrative approach underscores the institution's commitment to both the scientific and religious dimensions of *hilāl* observation. Significantly, the observatory has recorded a successful observation of the crescent moon marking 1 Zulhijjah 1443 H, complete with photographic documentation. This success illustrates the potential of the observatory not only as a religious tool but also as an educational and scientific platform. By maintaining observational integrity and

[23] Margono, *Metodologi Penelitian Pendidikan* (Jakarta: Rineka Cipta, 1997).
[24] Mustofa, "Uji Kelayakan Pantai Kartini Jepara Sebagai Tempat Rukyat Al-Hilal."

meeting operational standards, the Yanbu'ul Qur'an Observatory contributes meaningfully to the national effort of crescent moon sighting and Hijri calendar accuracy.

The Yanbu'ul Qur'an Observatory features an automatic sliding roof, a design considered more practical and functional for educational activities, as it accommodates a larger number of students and allows for frequent use during observational learning. The observatory is strategically located on the rooftop of the Andalusia Building, specifically on the fifth floor, which is a flat concrete roof. Before the observatory's construction, this rooftop was already being utilized informally for sky observations due to its favorable elevation and clear views of celestial objects. At that time, observations were carried out using simple, improvised equipment. Recognizing the site's potential, the school administration decided to formalize its use by establishing a dedicated observatory. The planning phase began with accurate measurements of the rooftop to ensure structural suitability. This was followed by the construction of the observatory framework, ultimately transforming the space into a fully functional facility that enhances both the scientific and educational missions of the institution.

The establishment of the Yanbu'ul Qur'an Observatory was initiated by the vision of *Kyai* Ahmad Faiz, the leader of Yanbu'ul Qur'an Kudus, who aspired to integrate an observatory into the *pesantren's* educational environment. This initiative aimed not only to enhance the quality of student learning but also to reflect the institution's proactive stance in embracing technological advancements. Operated under the Arwaniyah Foundation, the *pesantren* is an all-male institution offering two levels of Islamic education: junior and senior high school. The observatory has since become a symbol of pride for the institution, representing its commitment to scientific and religious excellence. The observatory is managed directly by the *pesantren*, with Nur Sidqon appointed as its head. He oversees all observatory activities and ensures alignment with the *pesantren's* vision: "The realization of Qur'anic, practical, and scholarly individuals." In this context, the observatory plays a crucial role in bridging theoretical Islamic astronomy education with practical observation. Students not only verify astronomical calculations through direct observation but also engage in empirical research to better understand celestial phenomena. Additionally, the observatory provides hands-on training with both classical and modern Islamic astronomical instruments, enabling students to gain practical skills in operation and maintenance. The facility has also adopted computerized systems to streamline its functions, further enriching the learning experience and positioning the *pesantren* as a forward-thinking institution in the field of Islamic astronomy.

The computerized infrastructure of the Yanbu'ul Qur'an Observatory represents a rare and progressive development at the *pesantren* level, offering a substantial enhancement to Islamic astronomy education. Students are trained not only in the operation of telescopes but also in utilizing digital tools such as azimuth-altitude tracking software and sky simulation applications. These technologies allow them to map celestial events, track planetary movements, and simulate *hilāl* appearances. This practical exposure greatly enriches their theoretical studies, fostering a deeper understanding of the cosmos while bridging classical Islamic astronomy with

contemporary scientific practices. Such integration helps students appreciate both the religious significance and scientific dimensions of celestial phenomena.[25]

Beyond its educational function, the observatory also serves as an important communal resource, particularly during the *rukyat al-hilāl* activities for Ramadan, Eid, and the Hajj season. These public observations often involve local religious authorities, alumni, and community members, transforming the observatory into a space for religious-scientific engagement and dialogue. This participatory model reinforces the observatory's dual role as both an academic and outreach center. Institutionally, the presence of the observatory solidifies Yanbu'ul Qur'an Menawan's position as a trailblazer among Qur'an-based Islamic boarding schools in Central Java. It also supports broader national efforts to modernize Islamic astronomy by aligning its practices with the standards set by MABIMS, including minimum *hilāl* visibility criteria of 3° in altitude and 6.4° in elongation. These developments position the observatory as a significant contributor to both the academic landscape and national crescent-sighting protocols.[26]

The Yanbu'ul Qur'an Observatory stands not merely as a physical structure but as a pedagogical innovation that bridges Islamic scholarship and scientific inquiry. It represents a significant step forward in technological integration within the *pesantren* system, showcasing how traditional Islamic institutions can adapt to contemporary challenges. By providing students with practical astronomical skills alongside religious education, the observatory offers a replicable model for other *pesantren* seeking to modernize their curriculum. Its success underscores the potential for faith-based education to engage meaningfully with science in advancing both knowledge and community service.

## 2. Evaluating the Feasibility of the Yanbu'ul Qur'an Observatory

A feasibility study is a systematic process of examining a specific subject through comprehensive methods such as reading, researching, investigating, comparing, or analyzing an object in depth. The purpose is to assess whether the object or activity is acceptable, achievable, and practical in its application. The term "feasibility" implies that something is workable, obtainable, and capable of producing satisfactory outcomes for those conducting the evaluation. This kind of study helps determine the potential effectiveness and suitability of a site, project, or initiative before implementation.[27]

One common issue encountered during *hilāl* observation is the frequent failure to sight the new crescent moon, despite favorable astronomical data indicating that the *hilāl* should be visible. This discrepancy often results from various environmental and geographical factors, such as the location's topography, levels of air pollution, atmospheric conditions, and unpredictable weather patterns. These factors significantly affect the clarity of the sky and thus hinder the visibility of the *hilāl*. As a result, some observation sites consistently experience difficulties or failures in successfully conducting *rukyat al-hilāl*, even when the calculated altitude of the crescent meets or

[25] Kristiane, "Penggunaan Teleskop Untuk Rukyat Al-Hilal: Analisis Pendapat Muhammad Bakhit Al-Muṭī'i Dengan Ibnu Hajar Al-Ḥaitamī."

[26] Rohman Karim and Mahsun, "Kriteria Baru Mabims 3-6,4: Upaya Penyatuan Kalender Hijriah Di Indonesia Dalam Perspektif Maqāṣid Al-Syarī'ah."

[27] Beta Suryokusumo Sudarmo et al., *Dasar Kelayakan Proyek Arsitektur Dan Ekonomi Bangunan* (Malang: UB Press, 2018).

exceeds visibility criteria. Given these recurring obstacles, it is essential to carry out a feasibility assessment of observation sites. Such an evaluation would help identify locations with optimal conditions for *hilāl* observation, thereby improving the reliability and success rate of *rukyat* activities and supporting more accurate determinations of the Hijri calendar's beginning.

A number of specific criteria must be met for a location to be deemed suitable for conducting *rukyat al-hilāl* observations, particularly at the Yanbu'ul Qur'an Observatory. These criteria are generally divided into two categories: primary and additional requirements. The primary requirements include the site's geographical characteristics, an unobstructed view of the western horizon, and favorable weather conditions during the observation period, all of which directly influence the visibility of the new crescent moon. Meanwhile, the additional requirements consist of supporting factors such as accessibility to the site via reliable transportation, availability of communication infrastructure, and the presence of adequate observational tools. A location is considered feasible for *rukyat al-hilāl* if it fulfills all the primary requirements, with particular emphasis on a clear view of the western horizon and minimal atmospheric disturbances, such as cloud cover, at the time of observation. When these critical conditions are met, the location is typically regarded as suitable for crescent moon sightings and can significantly enhance the accuracy and success rate of determining the beginning of the Hijri month.

According to the Meteorological, Climatological, and Geophysical Agency of Indonesia (BMKG), as cited by Ahdina Constantinia,[28] an ideal site for *rukyat al-hilāl* must meet a crucial visibility criterion: a clear and unobstructed view of the western horizon, particularly within the azimuth range of 240° to 300°. This specific requirement ensures that the area used for moon sighting is free from visual obstructions such as trees, buildings, or hills that could block the view of the setting sun or the crescent moon. Given Indonesia's geographical position near the equator, this standard is particularly relevant. The sun's maximum declination is approximately 23°27' either north or south of the equator, while the moon's maximum declination reaches about 5°8'. Therefore, to effectively accommodate the possible positions of celestial objects during *hilāl* observation, the ideal observation site must have a clear view that extends at least 30° to the north and south of the due west direction, which corresponds to an azimuth of 270°. This ensures that any crescent moon appearing near the horizon within that range is not obstructed by natural or manmade features.

[28] Ahdina Constantinia, "Studi Analisis Kriteria Tempat Rukyatul Hilal Menurut Badan Meteorologi, Klimatologi, Dan Geofisika (BMKG)" (Universitas Islam Negeri Walisongo Semarang, 2018).

**Table 1: Suitability of the Observatory Location Based on BMKG Criteria**

| No | BMKG Criteria | Condition at Yanbu'ul Qur'an Observatory | Status |
|---|---|---|---|
| 1 | Unobstructed western horizon (Azimuth 240°–300°) | Free from buildings/trees/obstacles | Meets |
| 2 | Site elevation ≥ 20 meters above sea level | 282 meters above sea level | Meets |
| 3 | Adequate contrast between hilal and Twilight sky | Successfully observed on 1 Dzulhijjah 1443 H | Meets |
| 4 | Free from light pollution | Located on the slopes of Mount Muria | Meets |
| 5 | Stable electricity and internet network | Available | Meets |

In this context, the Yanbu'ul Qur'an Observatory satisfies BMKG's criteria for an optimal moon sighting location. The observatory has a wide and unobstructed view of the western horizon, allowing for clear visibility of celestial bodies during dusk and nightfall. Empirical evidence supports this, as previous astronomical observations from the site have successfully identified bright celestial bodies within the relevant azimuth range. For instance, Sirius was observed at an azimuth of 254°, Procyon at 280°, and Venus slightly northward at 296°, all of which fall within the BMKG-recommended visibility corridor. These observations confirm that the Yanbu'ul Qur'an Observatory provides a clear line of sight to critical parts of the western sky necessary for *hilāl* observation. Consequently, based on both theoretical standards and practical verification, the observatory meets the established criteria for *rukyat al-hilāl* and can be considered a feasible and reliable site for crescent moon sightings in determining the start of the Hijri months.

Secondly, being in a high position and far from the coast. This second condition is not urgent to follow because moonsighting can still be successfully carried out with an altitude of 20-25 masl. The location of the Yanbu'ul Qur'an Kudus Observatory is 282 meters above sea level. In addition to its site located on the slopes of Mount Muria, the Yanbu'ul Qur'an Observatory also stands firmly on one of the boarding school buildings, the Andalusia building. Although the condition of the altitude of the place is ideal and the location far from the beach is not too urgent in determining the *rukyat* location feasibility, the Yanbu'ul Qur'an Observatory itself in terms of altitude is considered relatively high to carry out crescent observations, meaning that it is an ideal location.

Thirdly, the brightness contrast value of the *hilāl* is at a certain threshold against the value of the brightness of the sky. When looking at the predictions of the *rukyat* results, it is also necessary to understand that the *hilāl* phenomenon is not only positional but also a phenomenon of overlaying a thin and faint moon crescent on the initially bright but increasingly fainter twilight sky. The comparison between the brightness of *hilāl* and the twilight sky is often referred to as *hilāl* contrast. If its brightness is higher than the brightness of the twilight, then the observer is likely to sight the *hilāl*. If the opposite case is valid, the *hilāl* should not be observed. Based on this statement, Hilal contrast is vital to observing *hilāl*, even though the Yanbu'ul Qur'an Observatory is not always successful in crescent observation. However, it can be proven that on 1 Dhulhijjah 1443 H. Yanbu'ul Qur'an Observatory succeeded in observing the image of *hilāl*.

Fourthly, the site should be free from light pollution, as it contributes to obstacles in the *hilāl* observation process, especially those carried out near industrial sites or urban areas. Light pollution is caused by excessive artificial light. Artificial lights include garden lights, billboards, and high-powered city lights. Yanbu'ul Qur'an Observatory can be said to be a place free from light pollution. This can be seen from the location on the slopes of Mount Muria, so the observatory is far from industrial and urban locations. Fifthly, the Yanbu'ul Qur'an Observatory has a stable electricity and internet network. Its Islamic boarding school supports providing the electricity and internet network needed during the *rukyat al-hilāl* observation activities. Some of the tools owned by the Yanbu'ul Qur'an Observatory rely on electricity and internet network availability.

The natural conditions of the sky, such as weather, thick clouds, rainfall, and others, are obstacles in implementing *rukyat* that are difficult to predict. Because forecasting rainfall or cloud thickness far in advance is difficult. BMKG's weather forecast can only be expected a week beforehand and a maximum of a month beforehand. Thus, the *rukyat* committee cannot precisely predict how the weather will likely be on the day of *rukyat*.[29] Several challenges can arise during the *rukyat al-hilāl* (crescent moon sighting) process that may affect the success of the observation. One of the most common obstacles is unfavorable weather, including cloudy skies, rain, and dense cloud cover, which can obscure the view of the horizon. Fortunately, such conditions are relatively rare at the Yanbu'ul Qur'an Observatory, where the weather tends to be favorable during observation periods. Another significant factor is the altitude of the *hilal* itself; if the crescent is less than 2 degrees above the horizon, it becomes extremely difficult to observe with the naked eye, even when aided by optical instruments. Additionally, the angular separation between the moon and the sun also plays a critical role. When the moon is too close to the sun, the residual glare can make the crescent nearly impossible to detect, even after sunset. The quality of the observer's vision is another important aspect, as clear and sharp eyesight contributes to accurate and effective sightings. Moreover, the psychological state of the observer should not be underestimated. Given the limited window for *hilāl* visibility—typically only 15 minutes to one hour after sunset—observers often face immense mental pressure due to the spiritual and communal significance of their task. Time and financial constraints also pose practical barriers, as organizing a proper observation session can require substantial resources. Lastly, the transparency and objectivity of the observation process are crucial to ensure the integrity and credibility of the *rukyat al-hilāl* results.

[29] Machzumy Jafar M. Ali, "Pengaruh Curah Hujan Terhadap Keberhasilan Rukyat Hilal Pada Observatorium Lhoknga Aceh," *SAMARAH: Jurnal Hukum Keluarga Dan Hukum Islam* 3, no. 1 (August 9, 2019): 223, https://doi.org/10.22373/sjhk.v3i1.5061.

**Table 2: Common Challenges in Hilal Observation and Site Conditions**

| No | Common Rukyat Challenges | Conditions at the Observatory | Impact Level |
|---|---|---|---|
| 1 | Cloudy/rainy weather | Usually clear, supports the observation | Low |
| 2 | Hilal height < 2° | Matches calendar and hisab calculations | Moderate |
| 3 | Moon-Sun distance too close | Accounted for using hisab software | Moderate |
| 4 | Observer's eye quality and mental condition | Observed by trained santri | Low |

Based on field data and a SWOT analysis conducted by the researcher, the Yanbu'ul Qur'an Observatory demonstrates several notable strengths. It is strategically situated on the slopes of Mount Muria at an altitude of approximately 282 meters above sea level, surpassing the BMKG's minimum elevation requirement of 20 meters. The observatory boasts an unobstructed western horizon, free from visual interference such as tall trees or buildings, making it ideal for crescent moon observation. In addition, its remote location away from urban and industrial centers results in minimal light and air pollution, enhancing the clarity of celestial observations. Supporting infrastructure is also well established, with reliable electricity and internet connectivity facilitating the use of digital equipment and real-time monitoring. Moreover, the observatory plays a significant educational role by serving as a practical learning center for Islamic astronomy.

Despite these strengths, the observatory faces certain weaknesses and external threats. Its proximity to residential areas, though relatively limited, can occasionally impact the visual contrast of the *hilāl*. Furthermore, the number of successful documented observations is still limited, with notable success only recorded as recently as Zulhijjah 1443 H. Observations also lack comprehensive data across varying weather conditions. However, there are promising opportunities for development, including its potential designation as a regional moon-sighting center in Central Java through collaborations with the Ministry of Religious Affairs. The observatory could expand its reach through digital platforms and serve as a training hub for students, researchers, and the broader public. Additionally, partnerships with academic institutions could foster joint research initiatives. Nonetheless, threats such as climate variability, possible future urban development, limited trained personnel, and the risk of falling behind international standards without regular upgrades pose ongoing challenges that must be strategically addressed.

Based on observations and interviews, the observatory located at the Yanbu'ul Qur'an Islamic Boarding School in Kudus, is categorized as having met the feasibility test criteria issued by BMKG (Meteorology, Climatology, and Geophysics Agency). The detailed criteria set by BMKG and the field conditions at the Yanbu'ul Qur'an Observatory are met by these standards. First, in terms of the western horizon, the observatory provides an unobstructed view of the west. Second, the observatory is situated at an elevation of 282 meters above sea level, which is highly suitable when assessed against BMKG's standard of at least 20 meters above sea level. Third, the contrast value of the *hilāl* meets a certain threshold relative to the brightness of the sky, as evidenced by the

successful observation of the *hilāl* image on 1 Zulhijjah 1443 H. Fourth, the Yanbu'ul Qur'an Observatory can be considered free from light pollution. This is due to its location on the slopes of Mount Muria, far from industrial areas and urban centers. Fifth, the electricity and internet networks within the Yanbu'ul Qur'an Islamic Boarding School area are considered very stable. Using electricity at this observatory is crucial in supporting the observation process.

These obstacles are prevalent among the observers. However, these obstacles cannot be used as a benchmark or guideline to declare the infeasibility of a *rukyat* site.[30] In the process of *rukyat*, there are often unwanted yet inevitable obstacles. Atmospheric and weather conditions are very influential in implementing *rukyat al-hilāl*. If the weather is stormy or thick clouds obstruct the observer's vision, this will likely fail *rukyat*. Weather conditions in Indonesia, which the equator crosses, are basically tropical. Therefore, Indonesia only recognizes two seasons: rainy and dry seasons. Indonesia has a wet tropical climate that is influenced by the West monsoon and East monsoon winds. From November to May, the wind blows from the northwest, bringing a lot of water vapor and rain to the Indonesian region; from June to October, the wind blows from the southeast, bringing little water vapor. Air temperature in Indonesian lowland territories ranges from 23 Celsius to 28 Celsius annually. The climate element of air temperature in Indonesia throughout the year is almost constant, but the climate element of rainfall changes significantly with the seasons.

## D. Conclusion

Based on the standardization criteria set by the Indonesian Meteorological, Climatological, and Geophysical Agency (BMKG), the Yanbu'ul Qur'an Observatory fully meets the qualifications for a feasible *rukyat al-hilāl* (crescent moon observation) site. Several key factors contribute to this assessment. Firstly, the observatory has an unobstructed view of the western horizon, a crucial criterion for successful *hilāl* observation, as it enables a clear sightline toward the setting sun and the area of potential crescent emergence. Secondly, the location of the observatory, at 282 meters above sea level, exceeds the minimum elevation requirement of 20 meters set by BMKG, thereby offering a vantage point with reduced atmospheric distortion and increased visibility. Thirdly, the observatory has demonstrated its effectiveness through successful documentation of the *hilāl*, particularly during the 1st of Zulhijjah 1443 H, indicating that the brightness contrast between the *hilāl* and the evening sky is sufficient for visual confirmation.

In addition, the location benefits from minimal light pollution due to its position on the slopes of Mount Muria, far from industrial zones and urban lighting, which enhances the clarity of celestial observations. The presence of stable electricity and internet infrastructure further supports the implementation of digital and optical equipment for real-time data collection, analysis, and dissemination. These strengths not only validate the observatory's current functionality but also position it as a strong candidate for development into a regional crescent observation center in Central Java. To maximize its potential, it is recommended that the observatory pursue formal collaborations with the Ministry of Religious Affairs. Furthermore, systematic data collection throughout various seasonal and weather conditions should be

[30] Resty Irawan Marpaung, "Uji Kelayakan Observatorium Ilmu Falak Muhammadiyah Sumatera Utara Sebagai Tempat Ru'yah Al-Hilal" (Universitas Islam Negeri Walisongo Semarang, 2019).

prioritized to strengthen the site's scientific database. Equally important is the expansion of training programs and academic partnerships to ensure a sustainable pool of skilled observers and to keep pace with international standards in lunar observation practices. By addressing these strategic aspects, the Yanbu'ul Qur'an Observatory can become a leading center for both religious and scientific contributions to the practice of *hilāl* observation in Indonesia.

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