

BETWEEN *RU'YAH* AND TECHNOLOGY: OPERATIONALISING A *FIQH*– ASTRONOMY FRAMEWORK FOR SHARIAH-COMPLIANT DIGITAL *HILAL* VERIFICATION

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Abstract

The increasing application of digital imaging technologies, particularly DSLR and CCD systems, has transformed contemporary *hilar* observation, especially under challenging conditions such as haze, humidity, urban light pollution and limited horizon visibility. While Malaysian *hilar* observation guidelines remain rooted in the established principle of direct sighting (*ru'yah 'ainiyyah*), they have been enhanced through updated technical procedures supporting the regulated use of imaging-based confirmation. Using a qualitative interpretive approach, this study draws primarily on semi-structured interviews with 25 experts in Islamic astronomy and digital imaging, supported by classical and contemporary *fiqh* sources, Malaysian regulatory documents, and astronomical visibility research. The findings indicate that the current framework preserves the essential Shariah foundations of *hilar* verification, including witness integrity, authorised observation times and sites, and adherence to visibility criteria. The updated guidelines further strengthen the operational governance of digital imaging through clearer direction on image acquisition, permissible enhancement, metadata preservation, verification procedures and evidentiary standardisation. This paper presents an integrated *fiqh*–astronomy framework that brings together witness qualifications, *hilar* visibility parameters, authorised observation sites and controlled imaging processes. It argues that digital imaging, when confined to visible-spectrum capture, authorised observation periods, single-frame recording and limited non-manipulative enhancement, may function as valid corroborative evidence (*al-qarinah al-mu'tabarah*) without displacing *ru'yah* as the operative legal foundation of *hilar* verification.

Keywords: *Hilar* observation; Digital imaging; *Ru'yah al-hilar*; Islamic astronomy; Shariah governance.



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INTRODUCTION

Calculation of Islamic lunar months, especially Ramadan, Shawwal and Dhu al-Hijjah, is one of the most legally significant elements of Islamic ritual government as it directly governs the fasting, Eid feasts and pilgrimage rituals. In classical Islamic jurisprudence, *ru'yah al-hilal* (sighting of *hilal*) is the major legal trigger (*sabab shar'i*) in the determination of new lunar months, which is based on Quranic injunction (Qur'an 2:185), as well as Prophetic traditions (Al-Bukhari, 2001; Muslim, 2006). Notably, these original sources define the necessity of sighting without strictly defining the technical tools by which such sighting ought to take place.

Modern *hilal* observation, however, occurs under quite different circumstances. Constant cloud cover, atmospheric haze, high moisture content and extensive light pollution particularly in urban environments play a significant role in reducing the chances of successful naked-eye observations when the *hilal* is very thin and has only a limited time period after sunset. According to astronomical research, with these limitations, the use of unaided vision becomes even more fragile, especially in the cases of marginal visibility (Schaefer, 2000; Yallop, 1997).

It is in this context that the application of astronomical instruments and digital images technologies has become integrated in the contemporary practice of *hilal* observation. Telescopes and DSLR-based imaging systems enhance the visual capabilities and create records that can be reviewed separately. These technologies do not just improve observation, but transform the epistemic circumstances in which *ru'yah* is assessed and verified.

The integration of these technologies in Malaysia does not only exist within the juristic discourse but also under the formal legal authority. Under Section 52 of the Administration of the Religion of Islam (State of Selangor) Enactment 2003, binding fatwas may be issued regarding the determination (*ithbat*) of the *hilal*. Fatwas issued under this provision recognise the permissibility of employing astronomical instruments and imaging technologies in *hilal* observation (Administration of the Religion of Islam [State of Selangor] Enactment, 2003). This legal recognition provides a definite normative base on deploying the modern observational instruments to the *hilal* determination procedure.

The existing fatwa confirms permissibility in principle, while the updated guidelines provide clearer direction on the technical conditions governing digital imaging, including spectral range, permissible enhancement, verification procedures and safeguards against manipulation. These improvements support more consistent and auditable imaging practice across observation sites.

The paper aims to fill the gap in the literature on classical principle of *fiqh* and modern administrative law and contemporary astronomical imaging by establishing a consistent *fiqh*-astronomy system of digital *hilal* observation. Specifically, it examines the current and updated *hilal* guidelines by synthesising Shariah and astronomical approaches, and presents a standardised Shariah consistent procedural framework that would control the use of telescopic, DSLR and CCD imaging technology in contemporary *hilal* verification, as well as, suggest a more legal, scientifically rigorous and institutionally consistent standardised Shariah-

compliant. This study will help bring a more transparent, auditable and scientifically focused approach to determining lunar months in the modern world by operationalising the established juristic principles into technically sound procedural guidance.

LITERATURE REVIEW

The history of scholarly discussion of the determination of the Islamic lunar months has gone through a shift in classical formulations based largely on the principles of visual observation by naked eye (*ru'yah al-hilal*) and testimonial validity to the more complicated modern analyses based on the application of Shariah jurisprudence, astronomical modelling and mediation by technology. Contemporary literature, in its turn, does not limit itself to the topic of visibility but refers to the more comprehensive questions of evidentiary reliability and to methodological coherence and institutional government.

To facilitate analytical clarity, the literature review is made in four areas interrelated in themes, Shariah basis of *hilal* determined, *imkan al-ru'yah* and astronomic-visibility models, digital imaging and observation technologies and psychological and sociological influences on *hilal* sightings reports.

Shariah Foundations of *Hilal* Determination

The earliest prominent line of research is the Shariah principles which deal with the calculation of the Islamic months. The use of *ru'yah al-hilal* as the working legal foundation to determine the onset of Ramadan, Shawwal and the other lunar months is a consistent practice of classical jurists of the major Sunni legal schools, based on the Quranic injunctions and the Prophetic traditions (Al-Nawawi, 1996; Ibn Rushd, 1988). The texts thus revealed, though do not lay down a strict technical methodology, jurists established elaborated evidentiary requirements on admissible testimony (*shahada*), such as Muslim identity, moral uprightness (*'adalah*), legal competence and procedural prudence. Although there were juristic variations as to the number of witnesses and about some of the terms of testimony, these variations are not so much due to a difference of opinion as to the authority of *ru'yah* itself, as to the general feeling about the level of evidence.

One of the most significant contributions to this discourse was inspired by al-Subki (2013) whose argument of reliable astronomical calculation (*hisab*) could nullify claims of sighting that are physically impossible because speculative testimony (*zanni*) can never override empirical certainty (*qat'i*). Modern scholarship has gone further to rationalise this argument by defining *hisab* as an epistemic protection which does not displace *ru'yah* as the cause of law of *hilal* in Shariah.

Imkan al-Ru'yah and Astronomical Visibility Models

The second significant literature looks at *imkan al-ru'yah* as a scientific means of differentiating plausible and implausible sightings of the *hilal*. The contemporary astronomical models relate successful observations with quantitative variables like *hilal* altitude, elongation, *hilal* age, atmospheric extinction, sky brightness and human visual physiology (Schaefer, 2000; Guessoum & Meziane, 2001). These models have greatly reinforced the role of *hisab* as a negative filter that can rule out the impossible claims without affecting the overall legal framework of *ru'yah*. Local adjustments such as changes in MABIMS standards can be seen

as attempts to adjust the global standards of visibility to the realities of Southeast Asian weather (MABIMS, 2021).

The need to screen scientifically methodically in safeguarding legal certainty and minimizing observational bias is further justified by retrospective studies that indicate that some of the historically accepted sightings were astronomical impossibilities. Subsequently, *imkan al-ru'yah* is not only an astronomical instrument, but also a significant epistemic intermediary between Shariah principles of evidentiary and empirical astronomical restraints.

Digital Imaging and Observational Technologies

This has been brought about by the growth of the telescopic and digital imaging technologies which have profoundly changed the modern day practices of observing the *hilal*. The telescopes are widely established in both juristic and astronomical discourse since they do not change the essence of the human act of seeing, but only improve the visibility, thus maintaining a continuity with *ru'yah shar'iyah* (Mujahid, 1994; Al-'Attafi, 2005). However, DSLR and CCD technologies raise more complicated methodological and legal issues. Although these systems significantly enhance sensitivity, documentation and verification capabilities, it also comes with image enhancement risks, artefacts and possible exceedances of the physiological limits of natural human vision.

DSLR systems lie between high and low epistemic regions where used within the range of visible spectrum and with low levels of enhancement protocols, whilst CCD systems produce higher levels of juristic caution because of their higher sensitivity and ability to be computationally recreated. Without clear technical boundaries, digital imaging may obscure the important distinction between Shariah-compliant sighting and purely scientific detection. This unresolved tension highlights the necessity of a structured procedural governance framework capable of regulating technological mediation while preserving the epistemic foundations of Islamic legal methodology.

Psychological and Sociological Factors

The psychological and sociological weaknesses of *hilal* observation are also pointed out in an emerging literature. Empirical research reports incidences of recurring false-positive observation on astronomically improbable conditions, usually due to expectation bias, peer pressure, environmental false identification or confusion with celestial objects like Venus (Guessoum & Meziane, 2001). These findings demonstrate that the definition of *hilal* is not just the issue of legal and astronomical facts, but also the issue of cognitive and social processes that may compromise the observational reliability. Digital imaging technologies, in this regard, increasingly undertake a corrective function in that they offer verifiable, reviewable and auditable records which decrease reliance on human perception alone.

However, such imaging can only be legally and technically admissible within the confines of operation that are closely controlled. Although immense research has been conducted in the field of *fiqh*, astronomy and technological research, there is still a lack of current literature in operationalising these fields to form a single governance model. This study contributes to the continuing development of a *fiqh*-astronomy governance model for Shariah-compliant *hilal* determination in Malaysia, where digital imaging is increasingly integrated into observation practice.

METHODOLOGY

Hilal determination involves the interaction of Shariah reasoning, astronomical constraints and administrative practice rather than purely technical or exclusively juristic considerations. Accordingly, this study adopts a qualitative interpretive design integrating document analysis, semi-structured expert interviews and structured roundtable validation (Bowen, 2009; Creswell & Poth, 2018). This approach enables the examination of legal principles, empirical constraints and procedural practices within a unified *fiqh*–astronomy framework.

Document analysis was undertaken across three interrelated domains. The first, classical and contemporary *fiqh* literature of the four Sunni schools is discussed to extract principles that regulate *ru'yah al-hilal*, *hisab*, *imkan al-ru'yah* and standards of admissible testimony (*shahadah*) with a focus on the way jurists dealt with uncertainty and perceptual limitation in worship acts. Second, Malaysian institutional sources, such as JAKIM guidelines, *fatwa*, procedural manuals and MABIMS criteria are examined as practices of administrative *fiqh* that entail assumptions regarding authority, evidence and mediated sighting. Third, to set empirical limits on physical plausibility, astronomical research on lunar visibility, atmospheric influences, human visual limits and optical efficiency is assessed.

Semi-structured interviews were conducted with 25 experts comprising *falak* specialists and technical practitioners in optical and digital imaging. Participants were selected through purposive sampling based on their recognised expertise and direct involvement in Islamic astronomy, *hilal* administration, observatory practice and digital imaging. The expert group included muftis, *falak* officers, observatory specialists and imaging practitioners, ensuring that the study captured juristic, institutional and technical perspectives relevant to contemporary *hilal* verification.

The interviews explored five principal themes, (i) contemporary *hilal* observation practices; (ii) the application of telescopes, DSLR and CCD technologies; (iii) Shariah and evidentiary issues relating to digital imaging; (iv) procedural and governance challenges, and (v) recommendations for strengthening contemporary *hilal* verification. Each interview lasted approximately 45–90 minutes and was conducted face-to-face. With participants' consent, all interviews were audio-recorded and subsequently transcribed verbatim to facilitate thematic analysis. Interviews were conducted primarily in Malay, with selected technical terminology discussed in English where appropriate. Data collection was undertaken between March 2019 and March 2020.

To enhance methodological transparency, Table 1 presents the profile of the interview participants involved in this study. Purposive sampling was employed to ensure representation from key stakeholder groups directly engaged in Malaysia's *hilal* verification process, including muftis, *falak* officers, observatory specialists and digital imaging practitioners. Collectively, these participants provided complementary perspectives on the juristic, astronomical, operational and technological dimensions of contemporary *hilal* verification.

Table 1: Profile of Interview Participants

Participant Category	Number (n)	Years of Experience	Geographic Representation
Muftis / Representatives	12	15–20 years	8 states

<i>Falak</i> Officers	8	8–20 years	8 states
Observatory Specialists	3	5–15 years	National observatories
Digital Imaging Practitioners	2	7–15 years	Multiple states
Total	25	–	8 Malaysian states

As shown in Table 1, the participant composition reflects a multidisciplinary representation of professionals directly involved in Malaysia's *hila* verification system. The inclusion of religious authorities, technical practitioners and observatory personnel ensured that the interview data captured diverse perspectives on Shariah governance, astronomical observation and digital imaging practices. Furthermore, the geographical distribution across eight Malaysian states enhanced the transferability of the findings by incorporating experiences from different administrative and operational contexts. This diversity of expertise strengthened the credibility of the qualitative findings by enabling triangulation across multiple professional perspectives, thereby reducing reliance on a single institutional viewpoint.

To ensure participant confidentiality and preserve institutional anonymity, interview respondents were anonymised and cited as coded personal communications. Interview transcripts were analysed using thematic content analysis following the iterative coding procedures proposed by Braun and Clarke (2006). Initial codes were subsequently refined into broader analytical themes corresponding to the four analytical dimensions discussed in the Results and Discussion section.

To strengthen the credibility and trustworthiness of the findings, the preliminary analytical themes and the proposed *fiqh*–astronomy governance framework were validated through eight structured multidisciplinary roundtable discussions. Each session involved state muftis (or their representatives), *falak* officers, observatory personnel and technical practitioners with direct experience in *hila* observation and digital imaging. A total of 25 experts participated in the eight roundtable discussions, with each session involving between 3 and 4 participants.

During each session, participants critically evaluated the preliminary findings and the proposed governance framework from juristic, administrative, astronomical and technical perspectives. Areas of agreement and differing viewpoints were systematically documented and compared across the participating states before being incorporated into the final framework. The integration of documentary analysis, expert interviews and multi-state roundtable validation enhanced the credibility, transferability and practical applicability of the proposed governance framework across diverse institutional contexts.

RESULTS & DISCUSSION

Analytical Evaluation of *Hila* Observation Guidelines from Integrated *Fiqh*-Astronomy Perspectives

This paper critically re-evaluates the *hila* observation system in Malaysia through four interrelated analytical dimensions, namely witness qualifications (*shahid*), *hila* validity (*mashhud bih*), location of observation governance and regulation of astronomical instruments and digital imaging technologies. Taken together, these dimensions demonstrate that the present system preserves its classical Shariah foundations and has been enhanced through updated observation guidelines that respond to the epistemic challenges and opportunities

arising from modern scientific advancement. The findings suggest that the current guidelines provide a strengthened juristic and operational foundation for the controlled integration of digital technologies within contemporary *hilal* observation practice.

Witness (Shahid)

In Islamic jurisprudence, *hilal* sight becomes the jurisprudential passage through which an obligation socially binding is converted into witnessing. Classical jurists have never relinquished on the Muslim identity (Sharf Qudah, 1999; Al-Zuhayli, 2010), moral uprightness (*'adalah*) (Al-Ansari, 1994; Al-Qalyubi, 1995; Al-Sharbini, 1994), numerical sufficiency (Al-Nawawi, 1996; Al-Juwaini, 2007) and experiential competence as the necessary qualifications to valid testimony (Al-Nawawi, 1996; Al-Subki, 2013). These norms are not meant to only authenticate perception, but to secure the integrity of worship in consideration of speculative claims that lack reliability.

These principles have been preserved to a large degree in the existing order in Malaysia, by restricting official testimony to Muslim members of formally nominated *ru'yah* committees. This form of government offers structure to procedures and upkeep of ritual legitimacy. Technological advancements have substantially altered the epistemic requirements of witnesses. Modern *hilal* verification increasingly relies on technically competent observers with the capability to interpret the output of telescopic, DSLR and CCD cameras. Interviews conducted in 2019 highlighted the importance of continued collaboration between institutional authorities and technical experts in technologically assisted *hilal* observation. The updated guidelines support this collaboration through clearer technical guidance, professional development and ethical reinforcement in relation to *'adalah*. This approach strengthens the integration of classical witness requirements with the technical competencies required for contemporary digitally assisted *hilal* verification. (Mufti, Personal Communication, 2019; Falak Officer, Personal Communication, 2019).

Hilal (Mashhūd Bih)

The *hilal* in itself is the substantive evidentiary object of *hilal* determination. Classical *fiqh* does not give equal weight to all the so-called sightings, but the valid *hilal* testimony has to meet the criteria of time, physical and rational plausibility. Modern *fiqh*-astronomy analysis defines four essential conditions, including visibility after sunset, adherence to *imkan al-ru'yah* limits, adherence to exact astronomical computations (*hisab*) and physically plausible morphology of the *hilal* (Al-Subki, 2013).

This is one of the best sides of Malaysia *hilal* verification system because it is a multidimensional system which shows a gradual convergence between juristic caution and scientific accuracy. With astronomical visibility models included, the legal process is further safeguarded against false-positive claims due to cognitive bias, environmental distortion or even social pressure. Empirical research on historical *hilal* claims has repeatedly identified that a significant number of historical *hilal* claims were made under empirically impossible circumstances, thus confirming the statement of al-Subki that probabilistic testimony (*ẓanni*) can never override certainty (*qat'i*) (Guessoum & Meziane, 2001).

This requirement is even more crucial in the digital imaging world. Although imaging technologies might be able to indicate the faint *hilal*-like structures, the results are legally invalid when they do not correspond to the parameters of *imkan al-ru'yah* that are established.

Imaging, therefore, should act as an evidentiary tool, which is subordinate to legal-astronomical plausibility and not as independent evidence. Furthermore, *hilar* morphology may provide an additional layer of verification that can further strengthen the reliability of contemporary *hilar* assessment.

Hilar orientation geometric consistency can be used as a quick diagnostic tool to rule out false identifications like Venus, cloud edges or sensor artefacts. Malaysian guidelines recognise the use of visibility criteria, which may be further strengthened through the formal integration of morphological verification procedures. Generally, the *mashhud bih* dimension illustrates the fact that Shariah and astronomy are not rival systems but complementary epistemologies that, together, can mitigate uncertainty and enhance legal legitimacy. Accordingly, the current framework provides a scientifically credible basis for *hilar* verification, which may be further strengthened through the formal incorporation of morphological assessment procedures.

Observation Location

Observation locality is not a logistical requirement alone but rather a tool of an institution to protect consistency and authority. The administrative legitimacy of Malaysia and the control centralisation are guaranteed by the use of the officially designated observation sites that are managed by the Keeper of the Rulers Seal. In Malaysia, a total of 29 official *hilar* observation sites have been formally designated by the Office of the Keeper of the Rulers' Seal, serving as authorised locations for national *hilar* observation in accordance with established administrative and Shariah governance procedures (Office of the Keeper of the Rulers Seal Malaysia, 2025). This system supports coordinated national practice and contributes to consistency in *hilar* declarations across Malaysia.

Although geographic standardisation strengthens legal governance, operational conditions may vary across observation sites due to differences in atmospheric quality, horizon conditions, available technological equipment and observer competency. Such contextual variations highlight the value of continued coordination and harmonisation in the application of advanced imaging technologies. A more integrated operational approach can further support Shariah compliance, procedural transparency and public confidence in Malaysia's increasingly technology-assisted *hilar* determination system.

Beyond its conceptual contribution, the proposed framework should undergo empirical pilot testing during official *hilar* observation windows at selected observation stations managed by the Office of the Keeper of the Rulers' Seal Malaysia. Such implementation would allow the proposed governance procedures to be assessed under actual observational conditions, including varying atmospheric visibility, observer competency, equipment performance and institutional workflows. The findings from such pilot implementations may provide evidence-based refinements to support the continued implementation of the framework at the national level, thereby strengthening both the operational robustness and policy relevance of the proposed framework.

Astronomical Instruments and Digital Imaging

One of the most significant developments in contemporary *hilar* verification is the increasing application of astronomical instruments and digital imaging technologies to support official observations. In Malaysia, telescopes, DSLR cameras and, to a more limited extent,

CCD imaging systems are increasingly utilised to improve observational capability under challenging atmospheric conditions such as haze, humidity and low horizon visibility. While these technologies have enhanced the quality of observation and facilitated post-observation review, their operational use is supported by institutional practice and further strengthened through updated national technical guidance.

The findings indicate that Malaysian guidelines recognize astronomical instruments and digital imaging as supporting observational tools. Interviews conducted in 2019 identified variations in camera settings, documentation methods and evidentiary handling between observation stations. These operational aspects have since been improved through updated *hilal* observation guidelines, which provide clearer direction on image acquisition, permissible enhancement, metadata preservation and verification procedures.

Consequently, the principal issue is no longer whether digital imaging may be utilised during *hilal* observation, but how its application should be governed through consistent and transparent operational procedures. The updated nationally standardised imaging protocols support procedural consistency, evidentiary transparency and informed technical judgement. They further provide a comprehensive Shariah-compliant operational basis for the use of digital imaging while preserving the established juristic foundations of official *hilal* verification.

Accordingly, the increasing integration of digital imaging into official *hilal* observation highlights the importance of moving beyond conceptual permissibility towards a systematic evaluation of its operational implementation. The following section therefore examines how the updated procedural and governance framework supports the effective implementation of digitally assisted *hilal* verification in Malaysia.

Taken together, the four analytical dimensions demonstrate that Malaysia's *hilal* determination system remains firmly rooted in classical Shariah jurisprudence, particularly through its emphasis on the validity of testimony, controlled observation and codified legal principles. The updated guidelines further support the integration of technological developments into contemporary *hilal* observation through clearer operational and governance procedures. This approach demonstrates that Islamic law accommodates modern observational tools within an established and systematically regulated Shariah framework.

Further enhancement of the current framework may include strengthening witness competency through relevant technical training, refining the assessment of *mashhud bih* through clearer astronomical and morphological procedures, supporting continued harmonisation across observation locations, and consolidating digital imaging standard operating procedures. These measures can further reinforce scientific credibility, procedural consistency, public confidence and institutional reliability. This integrated *fiqh*–astronomy approach demonstrates that, when appropriately governed, technological development functions not as a challenge to the Islamic jurisprudential tradition but as a legitimate *wasilah* that supports the integrity and validity of contemporary *hilal* verification.

Analytical Evaluation of the Existing *Hilal* Verification Framework

The findings indicate that the existing Malaysian *hilal* verification framework has been strengthened through continued improvements in the operational standardisation of digitally assisted observation, while maintaining its established Shariah legitimacy. Contemporary observatories increasingly utilise telescopes and digital imaging technologies within updated

national operational guidance governing image acquisition, documentation, verification and evidentiary management. These improvements support greater consistency in the generation, assessment and management of observational data across authorised observation stations.

The critical assessment of the current *hilar* determination framework in Malaysia reveals that the existing framework continues to demonstrate strong Shariah validity, particularly in preserving the fundamental juristic principles governing *hilar* determination. National practices remain firmly grounded in classical *fiqh* requirements, including witness eligibility, moral credibility (*'adalah*), observation after sunset and adherence to *imkan al-ru'yah*, thereby maintaining consistency with established Islamic legal methodology (Al-Nawawi, 1996; Al-Subki, 2013).

Taken together, the four analytical dimensions demonstrate that the current Malaysian framework remains juristically robust and has been progressively enhanced to support contemporary technologically assisted *hilar* verification. While its legal foundations remain intact, the updated guidelines provide clearer operational direction on digital imaging governance, technical competency requirements and evidentiary standardisation.

Procedural integrity is also enhanced as the official designation of authorised *hilar* observation sites by state and federal religious authorities minimizes arbitrary claims and supports administrative order (Office of the Keeper of the Rulers Seal Malaysia, 2025). Taken together, these factors suggest that the *hilar* governance in Malaysia is still deeply embedded in the accepted principles of Shariah and still emphasises legal prudence (*ihitiyat*) in issues directly pertaining to communal worship.

At the time of this study, several procedural areas relating to DSLR and CCD imaging required further standardisation, including metadata authentication, permissible image enhancement, calibration procedures and image integrity. Interviews conducted with technical practitioners in 2019 indicated that imaging practices varied across observation stations, particularly due to differences in equipment, technical competency and administrative interpretation (Technical Practitioners, Personal Communication, 2019; Falak Officer and Technical Practitioners, Personal Communication, 2019). Such variation could affect procedural consistency, evidentiary transparency and image interpretation, especially under marginal visibility conditions. These operational matters have since been addressed through updated *hilar* observation guidelines, which provide clearer and more standardised procedures for the use, documentation and verification of digital imaging technologies.

From an integrated *fiqh*–astronomy perspective, the principal consideration is to ensure that technological advancement is translated into coherent operational governance within the established Shariah framework. Classical principles such as *al-qarinah* and adaptive *was'il al-ithbat* provide sufficient juristic flexibility to accommodate technological innovation, supported by transparent and standardised procedures under the updated guidelines. The updated standardised technical procedures enhance procedural consistency, evidentiary transparency and institutional reliability.

Operational Framework for Shariah-Compliant Digital Imaging

The increasing application of digital imaging during official *hilar* observation necessitates a structured operational framework capable of ensuring procedural consistency

without altering the existing Shariah basis of *hilal* determination. Rather than introducing new juristic principles, the proposed framework standardises the practical management of imaging activities, thereby enabling technological assistance to operate within an auditable, transparent and institutionally controlled environment.

Digital imaging technologies may be integrated into contemporary *hilal* observation provided that their application remains consistent with the established juristic principles governing *ru'yah*. Rather than replacing the legal basis of witnessed sighting, these technologies function as controlled *was'il al-ithbat* that support evidentiary reliability within clearly defined operational parameters (Al-Bukhari, 2001; Muslim, 2006). This juristic flexibility explains the longstanding acceptance of telescopes as optical aids that enhance human observation without altering the legal nature of *ru'yah*. Accordingly, telescopes remain the least controversial technological instrument within contemporary *hilal* verification (Al-'Attafi, 2005; Ibn 'Uthaymin, 2008).

The digital imaging systems, in turn, bring about a more complex epistemic spectrum. The DSLR technologies stand in a middle ground between the classical visual sighting (*ru'yah 'ainiyyah*) and scientific detection (*ru'yah 'ilmiyyah*). DSLR systems can be integrated into Shariah governance as *al-qarinah al-mu'tabarah*, meaning corroborative evidence to enhance witness credibility without displace testimonial primacy, when limited to capture in the visible spectrum, real-time capture or capture within the law, single-frame capture and minimal reversible enhancement (Falak Officer and Technical Practitioners, Personal Communication, 2019). Such a conditional acceptance corresponds to the epistemological differentiation of plausible empirical support, and the physically impossible claims of Al-Subki, which thus permits technology to serve as a procedural hedge against error, while maintaining the normative priority of *ru'yah* (Al-Subki, 2013).

On the contrary, CCD systems require much more juristic caution. Their enhanced sensitivity and functionalities of stacking calculations may surpass the physiological limits of normal human vision and may transform *hilal* verification into a legally active witnessing (*shahid*) to a strictly scientific detecting (*wujud al-hilal*). This change has brought up major *fiqh* issues as it is likely to turn *ru'yah* into an action of legally recognised sighting into technologically mediated signal reconstruction (Technical Practitioners, Personal Communication, 2019). As a result, application of CCDs can be deemed Shariah-compliant in a highly limited set of parameters, such as operation with visible light, single-frame capture and a ban on stacking or extended computational amplification.

Collectively, the *fiqh*–astronomy synthesis demonstrates that the principal issue is not technological adoption itself, but ensuring that technological assistance remains within the epistemic boundaries of *ru'yah shar'iyyah*. Accordingly, digital imaging requires a structured operational framework capable of preserving juristic integrity while strengthening procedural reliability. The foregoing *fiqh*–astronomy synthesis demonstrates that the permissibility of digital imaging depends not merely on technological capability but on its conformity with established juristic principles governing evidentiary reliability and procedural integrity.

Accordingly, these juristic principles must be translated into practical operational parameters capable of guiding the contemporary use of digital imaging in official *hilal* observation. Table 2 presents a proposed standard operating procedure (SOP) that specifies the evidentiary status, technical limitations and juristic conditions governing the application of telescopes, DSLR imaging and CCD systems within the Shariah-compliant *hilal* verification framework.

Table 2: Proposed Operational Standard Operating Procedures for Digital Imaging in Contemporary *Hilal* Verification

Operational Component	Telescope	DSLR	CCD
Purpose of Use	Visual observation	Image documentation	Technical verification
Authorised Operator	Certified observer	Certified observer with imaging competency	Certified imaging specialist
Observation Window	Sunset–moonset	Sunset–moonset	Sunset–moonset only
Permitted Spectral Range	Visible light	Visible light (400–700 nm)	Visible light only
Image Capture Mode	Direct observation	Single-frame RAW	Single-frame only
Permitted Image Processing	None	Brightness, contrast, white balance	Minimal enhancement only
Prohibited Processing	–	Stacking, AI reconstruction	Stacking, computational reconstruction
Mandatory Documentation	Observer log	RAW file, timestamp, GPS, EXIF metadata	Timestamp, GPS, device log
Verification Procedure	Observation committee	Technical review + committee validation	Technical validation + committee approval
Data Storage	Observation record	National digital archive	National digital archive
Audit Requirement	Observation report	Metadata verification	Full audit trail
Decision Authority	Religious authority	Religious authority	Religious authority after technical validation

Table 2 operationalises the proposed governance framework by translating broad Shariah principles into measurable technical procedures for official *hilal* observation. Rather than determining the permissibility of individual technologies, the proposed SOPs establish standardised operational requirements governing image acquisition, observer competency, documentation, metadata preservation, technical validation and institutional approval. Collectively, these procedures aim to enhance procedural consistency, evidentiary transparency and administrative accountability across authorised *hilal* observation stations.

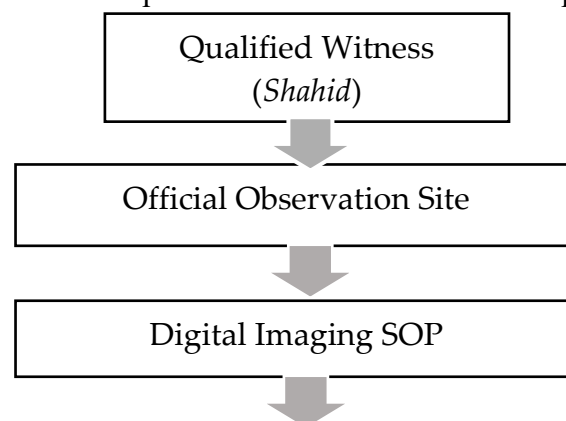
Collectively, these operational procedures transform digital imaging from an individual observational practice into a nationally standardised evidentiary process. By regulating image acquisition, documentation, verification and archival management through uniform procedures, the proposed framework strengthens procedural consistency, institutional transparency and evidentiary reliability while preserving the existing legal foundations governing official *hilal* determination.

Enhanced *Hilal* Observation Guidelines for Contemporary *Hilal* Verification

Building on the updated procedural, epistemic and regulatory guidance, this paper proposes an enhanced verification model that systematically integrates classical Shariah principles with contemporary astronomical and digital imaging realities. The framework is structured around four dimensions that are interrelated, witness qualifications (*shahid*), *hilal* validation (*mashhud bih*), the location of observation and the controlled technological mediation. This model aims to enhance procedural consistency, evidentiary reliability and institutional transparency in contemporary *hilal* verification, rather than replacing traditional *ru'yah*.

To facilitate practical implementation, the proposed *fiqh*–astronomy framework is operationalised through an integrated governance workflow linking witness qualifications, evidentiary assessment, authorised observation sites and controlled digital imaging within a single procedural sequence. Figure 1 illustrates how these four dimensions interact during an official *hilal* observation session, thereby translating the proposed framework into an actionable model for administrators and practitioners.

Figure 1: Institutional Operational Workflow for Contemporary Hilal Verification



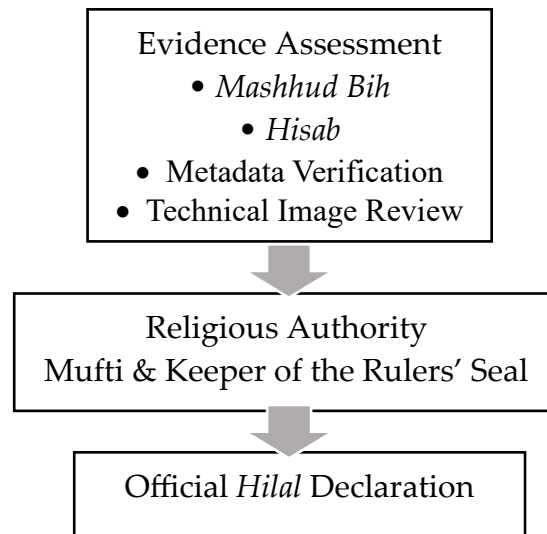


Figure 1 illustrates the institutional operational workflow for contemporary *hilal* verification. Rather than treating witness qualification, evidentiary assessment, observation sites and digital imaging as independent components, the workflow demonstrates how these four dimensions operate as an integrated decision-making process. The sequence begins with the appointment of qualified observers and authorised observation sites, followed by astronomical assessment and controlled digital imaging in accordance with the proposed SOPs. The resulting evidence is subsequently evaluated through juristic and astronomical verification before being submitted to the relevant religious authorities for institutional review and official declaration.

Witness Enhancement (Shahid)

The first pillar of enhancement concerns recalibration of witness qualifications to maintain classical *fiqh* legitimacy and incorporate the technical competencies needed in technologically mediated observation. The necessity of Muslim identity is critical as *hilal* testimony directly defines the religious commitment of the community and, thus, still falls within the legal context of *shahada* (Al-Nawawi, 1996; Al-Zuhayli, 2011). Similarly, the administrative implementation of the principle of moral uprightness (*‘adalah*) should be kept at the centre as well, but it should be institutionalised in a more explicit manner through the formalisation of ethical norms, regulatory controls and professional responsibility.

Simultaneously, modern *hilal* verification is more and more technologically skillful with a legal reputation. To minimize false identifications and procedural error, observers involved with technological aided sighting must demonstrate a demonstrable competence in the operation of telescopes, digital imagery, image interpretation, and any other astronomical parameters. Classical numerical sufficiency conditions should also be maintained but modified to imaging based verification (Mufti, Personal Communication, 2019). To maintain the evidentiary care and procedural trustworthiness, digitally supported *hilal* claims must be validated by at least two upright and technically qualified verifiers in this context (Al-Mawardi, 1999; Al-Shafi'i, 1990). Moreover, continued collaboration between administrative authorities and relevant technical experts may be further supported through structured verification mechanisms within the *hilal* verification process.

Hilal Validation Enhancement (Mashhud Bih)

The second dimension involves strengthening the evaluative criteria applied to the *hilal* itself. Existing *imkan al-ru'yah* standards should remain foundational but require more explicit procedural integration within national guidelines (MABIMS, 2021). All positive *hilal* observations, whether through naked-eye sighting or imaging technologies, should comply with scientifically validated visibility parameters, including conjunction timing, lunar altitude, elongation, moonset, and atmospheric feasibility (Falak Officer, Personal Communication, 2019).

In addition, *hisab falak* should function as an essential negative filter by excluding claims that contradict established astronomical certainty, consistent with the epistemic principle that probabilistic testimony cannot override physical impossibility (Al-Subki, 2013). Formal morphological validation is also necessary to ensure that observed or imaged *hilal* correspond to physically plausible lunar geometry. *Hilal* orientation, arc shape and solar-lunar positional relationships should therefore be systematically assessed to distinguish genuine sightings from artefacts or misidentifications.

Most critically, the legally recognised observation window must remain confined to the period between sunset and moonset. This temporal boundary preserves *ru'yah shar'iyah* as the operative legal basis of *hilal* verification while preventing its transformation into unrestricted scientific detection divorced from established Shariah methodology. All observation outcomes, whether positive or negative, may be progressively consolidated through standardised national reporting, audit and archival protocols coordinated by JAKIM, thereby supporting long-term governance and procedural consistency (Mufti, Personal Communication, 2019; Falak Officer, Personal Communication, 2019; Technical Practitioners, Personal Communication, 2019).

Astronomical Instruments and Digital Imaging SOP Enhancement

The most significant enhancement concerns institutionalisation of comprehensive imaging standard operating procedures. Telescopes remain consistent with the Shariah framework of *ru'yah* because they complement human visual observation without altering its epistemic basis (Al-'Attafi, 2005; Ibn 'Uthaymin, 2008). DSLR systems can also be conditional on the condition of strict procedures. These are visible-spectrum only acquisition (around 400-700 nm), real-time or legally acceptable viewing window, single-frame acquisition, minimal and reversible enhancement and metadata verification (Technical Practitioners, Personal Communication, 2019). The role of DSLR imaging must be that of *al-qarinah al-mu'tabarah*, as supportive, corroborative evidence and not as legal evidence on its own (Mufti, Personal Communication, 2019).

However, CCD systems require greater juristic and technical caution because of their higher sensitivity and capacity for image stacking or extended computational processing. These characteristics may shift the evidentiary character of *hilal* verification from legally recognised sighting (*ru'yah shar'iyah*) towards scientific detection (*ru'yah 'ilmiyyah*), thereby requiring clearly defined operational and juristic safeguards. (Falak Officer, Personal Communication, 2019; Technical Practitioners, Personal Communication, 2019). In this regard, CCD acceptance must be restricted to visible-light applications and in no case should it be stacked or enhanced in any sophisticated signal mode.

For all digital imaging systems, the updated SOPs provide structured guidance on visible-spectrum compliance, metadata authentication, timestamp validation, device integrity, allowable enhancement limits, and prohibited stacking and computational reconstructions. The process of enhancement must be limited to non-destructive manipulations like brightness, contrast, white balance and tonal correction but should not add artificial visual clues.

Policy and Governance Implications

As a whole, the proposed enhancement framework positions Malaysia's *hilar* verification system as a well-established and forward-looking model that responds constructively to contemporary technological developments while preserving its strong juristic foundations. This framework has the merit of operationalising classical principles of Islamic law, including *al-qarinah* (support of evidence by evidence), *raf' al-gharar* (reduction of uncertainty) and *ihtiyat* (juristic precaution) in a scientifically disciplined regulatory space (Al-Subki, 2013; Al-Qaradawi, 2006). Instead of creating a disjuncture between tradition and innovation, this incorporation reinforces the legal integrity of *hilar* verification by having technological instruments regulated as systematic legal instruments (*wasa'il*) as opposed to independent determiners of religious decisions.

At the institutional level, the framework increases the level of scientific reliability to a large extent, adding technical checks of the imaging parameters and visibility standards and evidentiary confirmation, reducing observational error and false-positive claims. Common reporting systems and metadata validation and auditable imaging protocols also contribute to procedural transparency and reduce subjectivity in inter-jurisdictional use. The framework also supports the continued harmonisation of practices across states within a shared regulatory architecture, thereby strengthening the legal coherence and public understanding of *hilar* declarations.

More to the point, this governance framework can further strengthen public confidence through transparent processes and the continued role of religious authorities in evaluating technologically assisted evidence. Notably, this model demonstrates that the technological advancement does not challenge the Islamic legal epistemology necessarily. Whether or not we possess the higher observational instruments is a question, but whether they are sufficiently regulated to keep *ru'yah shar'iyah* the working cause of law, is the question. Digital imaging systems may be centered in well-established Shariah and scientific parameters and may be thought of as legitimate *wasa'il al-ithbat* that enhances and not diminishes the evidentiary soundness of *hilar* verification.

The further sustainability of *hilar* governance is, not incompatible with technological development, but in the institutionalisation of such development, in the form of procedural reform, organised with meticulousness, in Shariah-conformable forms of operation, which can be used to ensure the legal authenticity within an increasingly complex constellation of environmental and observational conditions. Accordingly, the proposed framework should be viewed not merely as a technical guideline but as a governance model capable of strengthening the long-term institutional sustainability of Shariah-compliant *hilar* verification.

CONCLUSION

This study demonstrates that contemporary *hilal* verification increasingly benefits from the use of astronomical instruments and digital imaging technologies, which have expanded the evidentiary and procedural capacity of *hilal* observation. The Malaysian framework continues to preserve the essential juristic foundations of *ru'yah*, including witness credibility, authorised observation procedures and adherence to *imkan al-ru'yah*. The updated observation guidelines further strengthen the governance of technologically assisted observation by providing a more systematic basis for integrating technological innovation within established Shariah principles.

The principal contribution of this study lies in operationalising established juristic principles into an analytical governance framework for digitally assisted *hilal* verification. The framework brings together four interrelated dimensions: witness qualification (*shahid*), evidentiary validation (*mashhud bih*), authorised observation sites, and controlled digital imaging supported by standard operating procedures. By distinguishing between *ru'yah shar'iyah* and technologically mediated scientific detection, the study demonstrates that digital imaging may legitimately function as *al-qarinah al-mu'tabarah* when employed within carefully regulated technical and juristic boundaries.

Beyond its theoretical contribution, the framework offers practical insights that complement the updated *hilal* observation guidelines and contemporary *hilal* governance. The strengthened standardisation of imaging procedures, technical competency requirements, metadata authentication and multidisciplinary verification mechanisms supports procedural consistency, scientific reliability, institutional transparency and public confidence in the national *hilal* determination process. Rather than replacing the classical principles of Islamic law, this approach illustrates how technological advancement may be regulated as a legitimate *was'il al-ithbat* that reinforces the integrity and objectives of Shariah in an increasingly complex observational environment.

While the updated guidelines provide an enhanced operational basis for digitally assisted *hilal* observation, their implementation may be further evaluated under actual field conditions. Future research may undertake pilot or post-implementation studies at authorised *hilal* observation stations to assess the operational effectiveness of the imaging SOPs, observer competency requirements and institutional verification procedures. Such empirical evaluation may contribute to the continuous refinement of the guidelines and their implementation at the national level.

DECLARATIONS

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Authors' contributions [Khairussaadah Wahid: Conceptualization, investigation, data curation, formal analysis and writing—original draft preparation. Mohd Saiful Anwar Mohd Nawawi: Methodology, formal analysis, supervision and writing—review and editing. Nazhatulshima Ahmad: Investigation, validation, supervision and writing—review and editing. Riza Afrian Mustaqim: Review and editing.]	Ethics Approval [Informed consent was obtained from all participants involved in the study]

Data Availability

[The data supporting the findings of this study are available from the corresponding author upon reasonable request, subject to ethical and confidentiality considerations]

Use of Artificial Intelligence

[ChatGPT was used solely to assist with language editing and to improve the clarity of the manuscript. All content, analysis, arguments and conclusions were reviewed, verified and approved by the author(s), who remain fully responsible for the final manuscript]

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