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From Philosophical Reinterpretation to Operational Unity: A Mixed-Methods, International Lunar Date Line–Anchored Framework for a Pre-Calculated Global Hijri Calendar (*Imkān al-Ru'yah*)

Abdul Halim Abdul Aziz[1]*, Alim Roswantoro[2]
[1]School of Physics, Universiti Sains Malaysia, Pulau Pinang, Malaysia
[2]Department of Islamic Theology and Philosophy, Faculty of Ushuluddin and Islamic Thought, Universitas Islam Negeri Sunan Kalijaga, Yogyakarta, Indonesia
*Corresponding author: dr.ahaa58@gmail.com

Abstract

This study examines whether—and how—a pre-calculated, single, uniform Hijri calendar can be justified from Qur'an and Hadith and operationalized with established astronomical rules. It addresses persistent disunity arising from fragmented practices in a highly interconnected "global village." A mixed-methods design integrates: (i) a normative–conceptual analysis via Khaled Abou El Fadl's negotiative method (text–author–reader) to derive scriptural bounds (twelve lunar months without intercalation; calculability; 29/30-day months; hilal as civil *mīqāt*; semantic range of *ra'ā*); and (ii) a computational–astronomical evaluation of a two-condition global rule anchored in the International Lunar Date Line (ILDL): S1—global conjunction occurs before local sunset along the IDL (~180°E; ±20° lat), and S2—an imkān al-ru'yah threshold is met on a 60°W test line (±20°; prototype 0.52% illumination). Topocentric ephemerides with standard parallax/refractive corrections (UTC, ΔT) are used, with ~500-year robustness checks and comparisons to regional criteria (e.g., MABIMS). Scriptural analysis legitimizes the use of information/calculation for dating while respecting Sunnah. The two-condition scheme prevents pre-conjunction starts (S1) and ensures expected visibility on the same day (S2). Simulations over ~500 years converge to the lunar synodic mean (~29.53 days) and align with the concept of *ḥukmī ru'yah* and Istanbul 2016 recommendations. Implementation mapping shows regional variation is historically instrumental; an IDL-anchored global maṭla' is operationally coherent. The study unifies a scripturally anchored rationale with ILDL-based *imkān* into a testable, auditable global rule and a realistic pathway for majority/minority contexts. Adoption of the two-condition rule, supported by a cross-national astronomy–fiqh clearing house and multi-year calendars, can synchronize worship dates and public services. Education systems benefit through stable academic calendars, assessment schedules, and digital platform integration across jurisdictions.

Keywords:

Hijri global calendar, *imkān al-ru'yah*, International Lunar Date Line (ILDL), expected visibility, negotiative method

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Introduction

The contemporary world is marked by dense interconnectivity in communication and mobility—a condition often described as a "global village," in which events and information circulate rapidly across vast distances (McLuhan, 2021). Within this landscape, the commencement of Ramadan and the two Eids routinely attracts worldwide attention because the dates are not uniform across regions. Operationally, this study uses *hilal* to denote the first visible new crescent and *imkan al-ru'yah* (expected visibility) as an astronomically derived criterion for sightability. The central concern is how to achieve a pre-calculated, single, uniform Hijri calendar that is both scripturally grounded and scientifically defensible in a globalized context.

Historically, prior to rapid travel and real-time communication, *hilal* sighting and its legal implications were local; this practice functioned adequately within geographically bounded communities. With the rise of nation-states, regional consensus mechanisms emerged, allowing more unified celebrations across larger areas. In Muslim-minority settings, however, communities often referenced different "parent" countries for *hilal* reports, producing recurrent intra-local discrepancies year after year. A seminal advance occurred with Ilyas's (1984) systematic synthesis of reliable observations from multiple observatories, culminating in an expected visibility criterion (*imkan al-ru'yah*). Leveraging IBM 370 mainframe facilities available at Universiti Sains Malaysia (Penang), Ilyas (1984) carried out global-scale computations on a 24 × 10 grid of locations, revealing a patterned distribution of *hilal* visibility worldwide and proposing the International Lunar Date Line (ILDL)—a boundary separating regions of expected visibility from those without such expectation. This discovery remains pivotal for any attempt at a unified global Islamic calendar (Ilyas, 1984).

At the same time, contemporary debates require a coherent reconciliation of primary religious sources with astronomical knowledge. This paper foregrounds the Qur'an as a perennial, general source of guidance while recognizing that certain civil implementations by the Prophet Muhammad and his Companions were necessarily conditioned by the technological realities of their time. In this interpretive posture, Hadith are read contextually for implementation guidance, while the Qur'anic directives frame the enduring normative horizon. To structure this reconciliation, the study draws on El Fadl's negotiative method, which situates decision-making at the intersection of text (*naṣ*), author (God and the Prophet), and reader—while legitimately incorporating auxiliary evidence from statistics and the natural sciences (El Fadl, 2001).

Despite these advances, two tensions remain. First, there is a practical–knowledge conflict gap: the existing knowledge base on calendar calculation has yet to yield a universally adopted practice that addresses the realities of both Muslim-majority and Muslim-minority contexts, where fragmented adoption perpetuates local disunity. Second, there is an evidence/implementation gap regarding how scriptural guidance, *imkan al-ru'yah*, and the ILDL can be integrated into a single, operational global framework without undermining the integrity of the sources. These gaps have tangible communal implications, from social coordination to institutional scheduling and transnational religious observance.

Consequently, the unresolved problem is to determine whether—and how—a pre-calculated, single, uniform Hijri calendar can be justified from the Qur'an and Hadith and operationalized through established astronomical rules (notably *imkan al-ru'yah* and the ILDL), in ways that are applicable across diverse jurisdictions and community settings.

This paper argues for a pre-calculated, single, uniform Hijri calendar for the entire world, grounded in the Qur'an, the Hadith, and established scientific rules and findings. Specifically, it asks: **RQ1.** On what basis can the Qur'an and Hadith—interpreted through Khaled Abou El Fadl's negotiative framework—legitimate a pre-calculated global Hijri calendar under contemporary conditions? (El Fadl, 2001); **RQ2.** How can *imkan al-ru'yah* and the ILDL—building on the astronomical work of Ilyas (1984)—be integrated into a coherent, operational global rule that is empirically tested, for example via a two-condition scheme (global conjunction before local sunset along the International Date Line at ~180°E, and fulfillment of an *imkan* threshold on a 60°W test line within ±20° latitude, such as a 0.52% illumination criterion)? (Ilyas, 1984); **RQ3.** What forms of contextualization and implementation are warranted to address persistent practical disagreements (e.g., regional practice, minority settings) without contravening primary sources?

The study offers a triadic contribution: (i) theoretical, by articulating a scripturally anchored rationale for calculation that respects the Qur'an's general guidance and the Prophet's historically situated implementations (El Fadl, 2001); (ii) methodological/empirical, by systematizing the use

of *imkan al-ru'yah* and the ILDL as operational principles for a global calendar and by aligning them with multi-century computational evaluations (Ilyas, 1984); and (iii) practical/policy, by proposing a unified framework adaptable to Muslim-majority and Muslim-minority contexts in today's "global village" (McLuhan, 2021). Following the negotiative approach, the paper proceeds by (a) interpreting primary texts, (b) contextualizing Prophetic practice relative to technological capacity, and (c) integrating established astronomical criteria to evaluate pathways toward a single, pre-calculated calendar. While definitive policy adoption lies with competent authorities, the analysis aims to narrow the decision space and enhance communal coordination, acknowledging that future scientific or institutional developments may prompt refinement (El Fadl, 2001; Ilyas, 1984; McLuhan, 2021).

Methods

This study employs mixed methods with two streams that run in parallel and are then integrated to align with RQ1–RQ3. The normative–conceptual stream (for RQ1) uses Khaled Abou El Fadl's negotiative method—namely a triadic dialogue of text–author–reader—to derive normative bounds for a pre-calculated global Hijri calendar from the primary corpus: the establishment of twelve months and the prohibition of *nasī*/intercalation (Q 9:36–37), the calculability of Sun–Moon motions (Q 55:5; 10:5), the function of the *hilal* as *mīqāt* for humankind and the *hajj* (Q 2:189), as well as the 29/30-day provision and procedures for overcast conditions (Muslim 13:8; 13:20); the expansion of the semantic field of *ra'ā* (Bukhari No. 3368; Q 105:1; 2:246) opens space for the use of information/calculation without negating the Sunnah (El Fadl, 2001). The historical corpus (de Perceval, 1843; al Bīrūnī, 1048/440 AH) explains the transition from the pre-Islamic lunisolar calendar to a pure lunar one, consistent with that normative horizon. The unit of analysis is the global calendar rule; the operational day boundary is set at *maghrib*. The computational–astronomical stream (for RQ2) refers to the concept of the International Lunar Date Line/ILDL (Ilyas, 1984) and tests a two-condition rule: (S1) conjunction has occurred before sunset at the IDL ≈ 180°E (±20° latitude range; center ~15°S); (S2) the *imkān al-ru'yah* threshold is met on the 60°W line (±20°). The operational definition of *hilal* is the young crescent that is expected to be visible (expected visibility), whereas *imkān* is proxied by an illumination threshold of 0,52% (Ahmad Kamil & Abdul Halim, 2014); regional criteria (MABIMS 2 3 8; MABIMS 3 6.4) are used as comparators.

The computation procedure calculates the topocentric positions of the Sun and Moon at local sunset at the IDL and at 60°W using precise ephemeris conventions and standard parallax and refraction corrections (Urban & Seidelmann, 2006); the time scale is UTC with almanac ΔT. For each month, the algorithm checks S1 at the IDL; if satisfied, it evaluates S2 at 60°W (a pass at any point triggers the designation of *maghrib* that day = 1 as the global new month). Robustness is tested over a horizon of ≈ 500 years to verify the convergence of the average month length to the synodic period of ≈ 29,53 days, the 29/30 distribution, and the absence of S1 violations; results are presented as a list of global month beginnings along with brief metrics. Quality is maintained through an audit trail of citations and reasoning (normative stream), cross-verification of ephemeris samples with independent almanacs, and a simple sensitivity test on the 0,52% threshold, the ±20° range, and the 60°W location; ethics: no human subjects. Derived data (the month list) and pseudocode are available to editors/reviewers. Limitations include dependence on the threshold/test grid and the absence of local weather modeling (because the rule is based on global expected visibility); policy implementation requires cross-jurisdictional consensus. This method is consistent with the path of international forums—from the notion of *ḥukmī ru'yah* (Istanbul, 1978) to the recommendation of a pre-calculated global calendar (Istanbul, 2016)—and directly maps RQ3 through the integration of normative and computational results to assess cross-context applicability (El Fadl, 2001; Ilyas, 1984; IUMS, 2016).

Results

RQ1 - Conceptual–normative results from the primary texts

(1) Establishment of the architecture of the lunar year & prohibition of intercalation. The foundational texts affirm that one year consists of twelve months and that the practice of *nasī'*/intercalation (the periodic addition of a month to align with the seasons) is discontinued. This is indicated by Qur'an 9:36 (trans. Abdullah Yusuf Ali) and Qur'an 9:37 (trans. Muhammad Asad). Historically, the early Muslim community shifted from the pre-Islamic lunisolar calendar to a pure lunar calendar (Hijri) (de Perceval, 1843; al Bīrūnī, d. 440 AH), so that a Hijri year is shorter by ~11 days than the solar year. The hadith record also affirms the format of four sacred months (Bukhari, Book 65, Hadith 184).

(2) Calculability (keterhitungan) of celestial motions. Qur'an 55:5 and 10:5 (trans. Abdul Haleem; Shuaib Abdullah) state the regularity of the motions of the Sun and the Moon as a system of signs for *al hisāb* (calculation). The result relevant to this study: time determination based on calculation does not conflict with the textual horizon, as long as it continues to respect the procedures of worship conveyed through the Sunnah.

(3) The 29/30-day character & procedure when the *hilal* is not visible. Two key hadiths state that the lunar month lasts 29 or 30 days and set out the procedure when the *hilal* is obscured by clouds (Sahih Muslim, Book 13, Hadith 8; Book 13, Hadith 20). The "*ummī*" hadith (Abu Dawud, Book 14, Hadith 7) records the literacy conditions of the time—its operational outcome is a 29/30-day month, not a principled prohibition of calculation.

(4) The civil function of the *hilal* as a general *mīqāt*. Qur'an 2:189 (trans. Abdul Haleem) affirms the *hilal* as *mauqīt li n nās wa l hajj*, namely a time determinant for humankind (general) and for the hajj. The report on the supplication upon seeing the *hilal* (Abu Dawud, Book 43, Hadith 320) is graded *dha'īf*, and thus does not serve as the basis for a specific rite within the sighting process. The net result: functionally the *hilal* operates as a time determinant (civil–communal) that serves the needs of worship.

(5) The semantic field of *ra'ā* (رأى). Textual evidence shows that the root word رأى does not always mean "to see with the naked eye," but also "to know/realize": examples in Sahih al Bukhari No. 3368 and Qur'an 105:1 (trans. Pickthall) and 2:246 (trans. Yusuf Ali). Contemporary lexical analysis (Mohd Fahmi Bin Abdul Khir, 2024) supports this breadth of meaning. This result opens space for information/calculation-based knowledge in date decision-making.

(6) Beginning of the day. The majority practice positions the beginning of the *yaum* at *maghrib*, reflected in the practice of *takbīr* for Eid al-Fitr after *maghrib* and the first-night *tarawih* of Ramadan; there is a minority view that the beginning of the day starts at *fajr* (Irshad Sait, 2022). This global calendar model uses *maghrib* as the operational boundary.

RQ2 - Computational/operational results (pre-calculated global rule)

(1) ILDL (International Lunar Date Line). Astronomical examination (Ilyas, 1984) of visibility data and global computation (a 24×10 location grid) shows a systematic pattern of *hilal* visibility on Earth's surface, giving rise to the concept of the ILDL—a dividing line between areas of expected visibility vs not expected visibility. The ILDL changes monthly following visibility criteria. Its conceptual illustration is shown in Figures 1–2 in the manuscript.

(2) Two-condition scheme (*constrained imkān al ru'yah*). The operational formulation yields a global rule that passes testing and consists of two sequential conditions: a) **Condition 1 (Global conjunction).** The entire world has experienced conjunction before sunset at the IDL (≈180°E) within a ±20° latitude range, centered around ~15°S (proximity to inhabited island clusters such as Niue–Tonga–Samoa–Fiji). This condition prevents the beginning of the month anywhere before the start of the new lunar cycle (Ilyas, 1984; Abdul Halim, 2022); b) **Condition 2 (line-test *imkān*).** Fulfillment of the visibility threshold on the 60°W test line within a ±20° latitude range. The prototype uses an illumination threshold of 0,52% (Ahmad Kamil & Abdul Halim, 2014). If the criteria are met at any point on the test line (after Condition 1 is satisfied), then *maghrib* that day = 1 as the global new month.

(3) Rationale for choosing the test location. The 60°W line is chosen because of the availability of extensive land to its west; thus, if *in situ* testing fails due to weather, there is a higher-probability zone to the west that enables actual *rukyat*—thereby the pre-calculated model still honors the Sunnah of *rukyat* via the decision analogue of *imkān*. The probability pattern that increases to the west and decreases to the east of the visibility line is consistent with regional criteria maps

(MABIMS 2 3 8; new MABIMS 3 6.4) plotted as comparison curves (Figure 2). Except for the conjunction line, these curves represent variations of *imkān*.

(4) Cross-century robustness test. A ±500-year simulation shows that the mean month length produced by the rule converges toward the Moon's synodic period of ≈29,53 days (Urban & Seidelmann, 2006), indicating long-term robustness and adherence to the natural cycle (Abdul Halim, 2022). This result reduces the risk of drift from astronomical reality.

(5) Alignment with international fora/standards. The concept of visibility by judgement (*ḥukmī ru'yah*) was introduced in Istanbul, 1978 (Conference for Determining the Beginnings of Lunar Months, 1978) to complement the conjunction approach. The International Hijri Calendar Unification Conference, Istanbul 2016 recommended a pre-calculated global calendar based on *imkān* with the principle of *ittihād al maṭāli'* and opened space for scientific refinement of parameters/criteria (International Union of Muslim Scholars [IUMS], 2016).

(6) Enabling developments. The accuracy of the modern heliocentric model after Copernicus (1543) and twentieth-/twenty-first-century computation overcame precision limitations of classical geocentric models/*zij* tables (Ptolemy, second century; Kanniah, 2012). The practice of *hisab 'urfī'adadīistiṣlāḥī* (seventeenth–twentieth centuries) proved robust on average but was not tied to the actual motions of the Sun and Moon, so it occasionally missed *rukyat* (Sharifah Hamizah Syed Omar et al., 2023; Majelis Tarjih & Tajdid Muhammadiyah, 2009). This gap is bridged by the concepts of *imkān al ru'yah* and the ILDL (Ilyas, 1984; Conference 1978; IUMS, 2016). In addition, historical skepticism toward lunar calculation has decreased alongside the wide acceptance of calculated prayer times—indicating methodological coherence for adopting a pre-calculated calendar when accuracy meets devotional and civil needs.

RQ3 - Results on the implementation landscape & the need for consensus

(1) Variation in regional practice (Nusantara). Policy data show sharp differences in the three devotional months: Brunei requires actual *rukyat* for Ramadan–Shawwal–Dhu al-Hijjah; Malaysia applies *rukyat–hisab* (using calculation when weather obstructs); Singapore adopts a pre-calculated calendar for all Hijri months (JAKIM/MyRHK; MABIMS profile). Although the annual calendar is uniform, these variations produce non-simultaneity of dates in the three key months.

(2) The 'religious' vs 'civil' status of the *rukyat* process. There is no evidence that the Prophet ﷺ performed a specific *rukyat* ritual for Ramadan/Shawwal/Dhu al-Hijjah; a report related to the supplication upon seeing the *hilal* is *dha'īf* (Abu Dawud, Book 43, Hadith 320). In practice, he accepted companions' reports for the determination (Sahih Muslim, Book 13, Hadith 8; Book 13, Hadith 20). The functional result: *rukyat* is a means of time determination (Qur'an 2:189), not an act of worship in itself that demands ritualization of the process; therefore, its practice can be optimized within the *imkān* framework without negating the Sunnah.

(3) *Maṭla'* and cross-regional validity. The Kuraib report (Sahih Muslim, Book 13, Hadith 34) shows a difference in determination between Sham and Madinah that is then understood as the concept of *maṭla'*. The report regarding late testimony (Sahih Ibn Majah No. 1348, *sahih* according to Albani) shows that *rukyat* information that arrives later can still be accepted. The consistent result: *maṭla'* is instrumental (historical–geopolitical) for intra-regional unification and thus can be expanded—operationally, the IDL functions as a large *maṭla'* that separates the day.

(4) Scientific–practical *fiqh* agreements still needed. Variations in *imkān* criteria (e.g., MABIMS 2 3 8; MABIMS 3 6.4; 0,52% illumination) and test location require international consensus. The findings of this study identify the two-condition scheme as a candidate global rule compatible with the primary sources and astronomical evidence, while remaining open to parameter refinement and field testing.

(5) Gradual adoption & governance needs. The Istanbul 2016 recommendation (IUMS, 2016) affirms the direction of unification (a pre-calculated global calendar based on *imkān*). Our findings mark homework items: alignment per country, public trust in calculation, and harmonization of *maṭla'* toward a single global system that preserves certainty for worship (hajj/fasting) and civil needs (global scheduling).

Discussion

In line with the research aim—testing the possibility of a single, globally uniform pre-calculated Hijri calendar—the findings of this study affirm that orderly reconciliation between the primary *naṣṣ* and astronomical science is not only possible but also necessary within an increasingly tight ecology of communication–mobility ("global village") (McLuhan, 2021). By positioning the Qur'an as a steady normative horizon, reading Hadith contextually, and integrating modern astronomical findings (Ilyas, 1984), Khaled Abou El Fadl's negotiative approach provides a reliable hermeneutic framework to bridge theory and practice. Within the frame of Living Islam—which emphasizes Islamic philosophy as a transformative force for public ethics and the common good—these results suffice to shift the debate from the dichotomy of "*rukyat* vs *hisab*" toward worship time governance that is just, predictive, and compatible with the contemporary global reality.

The normative findings show that (i) the architecture of the twelve-month lunar year without intercalation, (ii) the calculability of Sun–Moon motions (*al-hisāb*), (iii) the 29/30-day character, and (iv) the function of the *hilal* as a communal *mīqāt* (Q 2:189) open space for the use of information/calculation in determining the beginning of the month. The analysis of the semantic field of *ra'ā* indicates that "seeing" is not always limited to naked-eye perception but also includes "knowing/realizing"; therefore, the use of expected visibility does not negate the Sunnah, but rather functions it intelligently in today's technological context. This result is consistent with El Fadl's negotiative method that considers the aims of the *sharī'a*, the context of revelation, and the authority of auxiliary sciences (El Fadl, 2001).

Contrast this with practices that require factual *rukyat* in the devotional months in some countries—historically such practices were instrumental for intra-regional simultaneity, not a theological principle that closes off the possibility of calculation. Thus, the theoretical contribution of this study is the repositioning of *rukyat* as a means of time determination (not a worship act in itself), while knowledge based on *imkān* becomes a way to fulfill the *maqāṣid* of certainty of worship time in a high-technology society.

Operationally, the two-condition rule—(S1) conjunction occurs before *maghrib* around the International Date Line (IDL ≈ 180°E; ±20°), and (S2) the *imkān al-ru'yah* threshold is met on the 60°W test line (±20°; prototype illumination 0,52%)—offers a robust compromise between *shar'ī* certainty and visibility reality. S1 ensures that no determination precedes the birth of the new lunar cycle anywhere, while S2 guarantees that there is real expected visibility on the Earth's surface on the same day, in line with the concept of *ḥukmī ru'yah* (Ilyas, 1984; IUMS Istanbul, 2016). The cross-century test that shows convergence of the average month length to the synodic period (~29,53 days) strengthens its astronomical coherence (Urban & Seidelmann, 2006).

Compared to regional criteria (e.g., MABIMS 2-3-8; revised 3-6.4) or *hisab 'urfī'adadī* that are not always tied to actual motion, this scheme is more aligned with the observational evidence underlying the ILDL, while remaining distinct because it adopts a single global *maṭla'* anchored to the IDL and a standardized test line at 60°W. The rationale for choosing 60°W—the presence of extensive land to the west that increases the chance of actual *rukyat* when weather is poor—creates an ethical–practical bridge between the Sunnah of *rukyat* and pre-calculation.

The mapping of practices in the Nusantara shows a spectrum of policies, from pure *rukyat* for the three devotional months to a fully pre-calculated calendar. Theoretically, the Kuraib report—and the acceptance of *rukyat* information that arrives later—suggests that *maṭla'* is instrumental and can therefore be expanded. Making the IDL a large *maṭla'* that separates the day reorders historical boundaries into an architecture aligned with today's global mobility. This aligns with the unification aspiration of Istanbul 2016, while also acknowledging the need for consensus on *imkān* parameters and test points so that they can be accepted across jurisdictions.

Conceptually, this study shows how Islamic principles of cosmic order (Q 55:5; 10:5) and communal welfare can be translated into institutional design that minimizes social friction (non-simultaneous feast days), strengthens procedural justice (transparent, replicable rules), and meets the demands of digital ethics (platform synchronization, global scheduling). It enriches the discourse of Islamic philosophy on pluralism: the unity of the calendar does not erase local diversity, but provides a coordination framework that can be adopted gradually with clear epistemic justification.

Practical implications and policy recommendations

Practically, the findings of this study point to a series of mutually reinforcing policy steps. The starting point is parameter standardization through the provisional adoption of the two-condition rule—(S1) conjunction occurs before *maghrib* around the International Date Line (≈180°E; ±20°) and (S2) fulfillment of the *imkān al-ru'yah* threshold on the 60°W test line (±20°; prototype illumination 0,52%). This rule is enforced with an explicit commitment to periodic refinement of parameters through transparent scientific audits. To support implementation consistency, a cross-national governance architecture is needed in the form of an astronomy–*fiqh* clearing house that issues multi-year calendars, test procedures, and errata when technical corrections are needed.

These computational results are then integrated into the digital ecosystem—devotional apps, national calendars, and airline and *hajj–'umrah* service systems—so that public service certainty increases and coordination costs decrease. To maintain social–religious legitimacy, the public communication strategy emphasizes that this pre-calculated model honors the Sunnah through the decision analogue of *imkān* and does not negate the *rukyat* experience; educational materials on the ILDL and the concept of expected visibility are prepared to strengthen collective understanding. Implementation is carried out gradually through opt-in schemes at the state/institutional level with a sunset clause toward full convergence, accompanied by fallback communication protocols if transitional differences arise in the three devotional months. At the same time, a field validation program is coordinated within the 60°W corridor—and the regions to its west—through voluntary *rukyat* campaigns to empirically verify pre-calculated decisions without making them an additional legal requirement.

Limitations

This study relies on the selection of parameters (0,52% illumination threshold, ±20° latitude range, 60°W test line) and does not model local weather—consistently so because the rule is based on global expected visibility, not guaranteed local visibility. Sensitivity to ΔT, refraction models, and variations in regional criteria also remains as a limited source of technical uncertainty. On the normative side, the reading of the semantic field of *ra'ā* and the positioning of *rukyat* as a means of time determination depend greatly on the acceptance of the *fiqh* community; therefore, social validity requires dialogue among authorities. Finally, policy implementation demands cross-jurisdictional coordination—a non-trivial challenge in calendar politics.

Future research agenda

Going forward, the research agenda focuses on refining *imkān* parameters through multi-year cross-checking of various thresholds—including other geometric variables—against independent *rukyat* archives, to assess false positives/negatives and calendar lead time. Spatial sensitivity studies would then explore alternative test-line corridors that remain faithful to the spirit of the ILDL without sacrificing the principle of global simultaneity. In the realm of uncertainty, the proposed decision model includes quantification of ΔT and refraction as operational error bounds and evaluates their impact on the multi-year calendar.

The social–normative dimension requires studies of public acceptance regarding perceptions of justice, authority, and trust in calculation—both in Muslim-majority and minority societies—in line with communication ethics in the digital ecosystem. At the level of *fiqh*, inter-madhhab dialogue is aimed at formulating shared *uṣūl* on the status of *rukyat* as a means, the role of a global *maṭla'*, and procedures for *ikhtilāf* that are compatible with the certainty of hajj and fasting. Finally, the technical ecosystem is strengthened through the provision of pseudocode and month-beginning datasets as an open technical standard that is easy to audit and integrate across platforms.

By uniting the normative horizons of the Qur'an and the Sunnah—read through a negotiative method—with modern astronomical apparatus (ILDL, *imkān*), this study offers a pre-calculated global calendar model that is theoretically coherent, operable, and compatible with the ecosystem of modern Muslim life. It contributes to the mission of Living Islam to make Islamic philosophy an intellectual force that bridges conceptual inquiry and real-world application for social justice and communal welfare. Main references: El Fadl (2001); Ilyas (1984); Urban & Seidelmann (2006); IUMS (2016); as well as the Qur'an–Hadith corpus and historical records presented in the results section.

Conclusion

This study shows that a single, globally uniform pre-calculated Hijri calendar can be justified normatively and operationalized astronomically. By positioning the Qur'an as the normative horizon, reading Hadith contextually through the negotiative method, and employing the concepts of *imkān al-ru'yah* and the International Lunar Date Line (ILDL), this research brings together textual foundations and scientific evidence into a single consistent decision-making framework for the beginning of lunar months across jurisdictions. For operational purposes, the geographic reference uses the International Date Line (IDL) at 180°E.

Answering RQ1, the normative findings affirm that the architecture of the twelve-month lunar year without intercalation, the 29/30-day character, and the function of the *hilal* as a communal *mīqāt* open space for the use of information/calculation for date determination. The analysis of the semantic field of *ra'ā* shows that "seeing" does not always require naked-eye perception, so a decision based on expected visibility does not negate the Sunnah but rather functions it appropriately within today's technological ecology. With the operational boundary of the day's start at *maghrib*, calculation fulfills the *maqāṣid* of certainty of worship time while maintaining continuity of practice.

Answering RQ2, this study formulates a global two-condition rule that passes cross-century computational testing: (S1) conjunction has occurred before sunset around the IDL (≈180°E; ±20°), and (S2) the *imkān al-ru'yah* threshold is met on the 60°W test line (±20°) with a prototype illumination threshold of 0,52%. The first condition prevents determination before the birth of the new lunar cycle; the second ensures that there is real expected visibility on the same day, in line with the idea of *ḥukmī ru'yah*. A ~500-year simulation shows convergence of the mean month length to the synodic period (~29,53 days), marking the rule's adherence to astronomical reality.

Answering RQ3, the mapping of practices indicates that regional variations (e.g., the Nusantara) are primarily instrumental–historical. This framework offers unification through a single global *maṭla'* anchored to the IDL, while maintaining respect for the *rukyat* experience via the decision analogue of *imkān*. For implementation, the study recommends gradual steps: parameter standardization based on the two-condition rule with a commitment to periodic refinement; the establishment of a cross-national astronomy–*fiqh* clearing house for multi-year calendars and test procedures; integration into the digital ecosystem of public services; a communication strategy that underscores *imkān–rukyat* coherence; and field-validation campaigns in the 60°W corridor and regions to its west. Replicability is supported by the provision of pseudocode and month-beginning datasets as an open technical standard that can be audited.

Practically, this framework can be immediately applied by the relevant authorities to: (i) publish transparent, auditable multi-year calendars, (ii) align worship schedules and public services across borders (including *hajj–'umrah*, education, and transportation), and (iii) reduce social coordination costs arising from non-simultaneous dates. Thus, this research narrows the space of decision-making uncertainty and strengthens procedural justice in determining the beginning of the month.

Study limitations include dependence on parameter choices (0,52% illumination threshold, ±20° latitude range, 60°W test location), the absence of local weather modeling, and residual sensitivity to ΔT, refraction, and variations in regional criteria. On the normative–sociological side, acceptance of the reading of *ra'ā* and the repositioning of *rukyat* as a means of time determination requires consolidation among *fiqh* authorities and cross-jurisdictional governance.

Implications for further research include the refinement of *imkān* parameters through multi-year cross-checking with independent *rukyat* archives; spatial sensitivity studies for alternative test corridors that remain faithful to the spirit of the ILDL; quantification of the influence of ΔT and refraction in the decision model; studies of public acceptance in majority–minority contexts; inter-madhhab dialogue concerning the global *maṭla'* and the status of *rukyat*; and strengthening of the technical ecosystem through an open technical standard (pseudocode and month-beginning datasets) that is easy to audit across platforms.

Overall, this research has answered RQ1–RQ3: demonstrating the normative legitimacy of calculation, formulating an operational rule that is robust based on ILDL–*imkān*, and preparing a realistic implementation pathway—with policy adoption by the competent authorities and room for refinement based on scientific–*fiqh* consensus. The main message: normative legitimacy blends with the two-condition rule tested across centuries, ready to deliver a single global Hijri calendar that is replicable and operational.

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Declarations

Author contributions (CRediT)

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Data availability

This article is based on published/archival textual sources. No new empirical dataset was generated. Citations to all primary and secondary sources are provided in the References. De-identified excerpted notes supporting the analysis are available from the corresponding author upon reasonable request.

Ethics approval

This research involved archival and textual analysis only; no human participants were involved, and institutional ethics approval was not required.

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The authors declare no competing interests.

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ORCID

Abdul Halim Abdul Aziz -
Alim Roswantoro -

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