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Comparative Prayer Time Computation: *Nailul Watar*, Ephemeris, and Istiwa' Method

M. Saifulloh[1*], Ahmadi Syifaul Anam[2], Jundil Ikrom[3], Agus Solikin[4], Ahmad Adib Rofiuddin[5]
[1]saifanulo38@gmail.com, [2]syifaulanam@walisongo.ac.id, [3]joerhythm71@gmail.com, [4]agussolikin2@uinsa.ac.id, [5]adibudin08@walisongo.ac.id
[1,2,3,5]Universitas Islam Negeri Walisongo Semarang, Indonesia
[4]Universitas Islam Negeri Sunan Ampel Surabaya, Indonesia

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ABSTRACT

Investigates the accuracy and consistency of prayer time calculations from both classical Islamic texts and modern astronomical data. I used a qualitative-comparative field research design, with Nailul Watar by KH. Ahmad Asrori, as the primary classical source, and the 2022–2023 astronomical ephemeris data, calculated using Akh. Mukkaram's Astrology. I also included supporting references on Islamic astronomy and prayer times. To collect data, I documented and analyzed the two methods before empirically validating them. The results show that the Nailul Watar method provides highly accurate calculations of Zuhr and Asr prayer times, with discrepancies from the ephemeris results measured in seconds and never exceeding one minute, without needing additional safety margins. Validation using the Istiwa' stick confirmed that the method meets the fiqh standards commonly used by Indonesian scholars, although observations showed that shadows appeared slightly earlier than the calculated times. The study suggests that further research be conducted

by combining computational modeling of both methods and incorporating shadow-length data to improve precision in future prayer time determinations.

ARTICLE INFO

ABSTRACT

Penelitian ini menggunakan metode field research dengan pendekatan kualitatif komparatif. Data primer berupa kitab Nailul Watar karya KH. Ahmad Asrori serta data ephemeris 2022–2023, dengan dukungan literatur falak lainnya. Pengumpulan data dilakukan melalui dokumentasi lapangan setelah perhitungan kedua metode. Hasil penelitian menunjukkan bahwa perhitungan waktu salat Zuhur dan Asar menurut Nailul Watar sangat akurat dengan selisih ephemeris hanya dalam hitungan detik, tidak lebih dari satu menit tanpa tambahan ihtiyat. Uji tongkat istiwa' (gnomon) juga membuktikan kesesuaian dengan standar fikih ulama Indonesia, meskipun bayangan tampak masuk lebih dahulu dari waktu hitungan. Penulis merekomendasikan penelitian lanjutan dengan pemrograman yang memadukan kedua metode serta penambahan data panjang bayangan agar hasil perhitungan lebih akurat.

INTRODUCTION

This research builds upon prior studies that utilize instruments and software to determine prayer times, while also referencing established astronomical sources (Ihsan, 2023; Arief, 2023; Intan, 2022). The five daily prayers, which constitute the primary acts of Islamic worship, are scheduled as follows: Zuhr at solar culmination, Asr when an object's shadow equals its

length, Maghrib at sunset on the western horizon, Isha after the disappearance of the red twilight, and Fajar Sadiq at dawn,

indicated by the emergence of white light on the eastern horizon. Observance of these prayers is obligatory for Muslims who are of sound mind and have reached maturity. Neglecting these prayers is considered sinful. The Qur'an explicitly mandates the performance of prayers.[1]

The objective of this research is to analyze data obtained from the Nailul Watar book and ephemeris calculations, with validation through field testing using a gnomon or Istiwa' stick. The study focuses on determining the times for Zuhr and Asr prayers by identifying the culmination time and measuring the length of the Istiwa' shadow for Zuhr, and calculating the shadow length for Asr without including the Istiwa' shadow.[2] The results from both calculation methods are compared, and any differences are verified using the Istiwa' stick, with additional ihtiyat (precautionary margin) considered.[3] The testing process involves aligning the calculated results with field measurements of the Sun's shadow length. At solar culmination, a minimal shadow is cast in the direction opposite the Sun; as the shadow shifts eastward, Zuhr time begins. When the shadow length increases by the amount observed at culmination, Asr time is established.[4]

Understanding prayer times by knowing and understanding the direction of the sun's shadow, with the

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[1]Ahmad Ihsan Alwi and Muhammad Zakiyul Amin, "Uji Akurasi Jam Bencet Dalam Menentukan Awal Waktu Salat Zuhur Di Masjid Al-Muttaqin Desa Tanjunganyar Kecamatan Gajah Kabupaten Demak," *Al-Afaq: Jurnal Ilmu Falak Dan Astronomi* 5, no. 2 (2023).

[2]Ismail Ismail Ismail and Husnaini Husnaini, "Aktualisasi Jadwal Salat Sepanjang Masa Abu Muhammad Isa Mulieng Aceh," *Islamic Review: Jurnal Riset Dan Kajian Keislaman* 10, no. 1 (April 26, 2021): 93–110, https://doi.org/10.35878/ISLAMICREVIEW.V10I1.245.

[3]Encep Abdul Rojak and Ramdan Fawzi, "The Normative Basis of Islamic Astronomy For The Transformation of Prayer Schedules To Digital And Its Accuracy," *El-Usrah: Jurnal Hukum Keluarga* 7, no. 2 (December 31, 2024): 602, https://doi.org/10.22373/ujhk.v7i2.22097.

[4]A S Nawawi, *Ilmu Falak Praktis: Hisab Waktu Salat, Arah Kiblat Dan Kalender Hijriah* (Surabaya: Imtiyaz, 2016).

determination of the value of the sun's height above an object's shadow.[5] To find out, place an object that is upright on a flat surface, which is stuck in the center of the surface. This tool typically comprises two key elements. First, there is the gnomon, an upright object positioned exactly in the center of a surface. Second, the dial field is a tool or surface that is used to project the sun's shadow. In it, there is a line with a predetermined length and position of the shadow to facilitate analysis.[6]

This study aims to investigate the time discrepancies between calculations from the Nailul Watar book and the ephemeris, as well as other reference sources. The observed discrepancies range from several seconds to a few minutes, but do not exceed 2 minutes. These variations are influenced by natural conditions, which serve as supporting factors in the research process. A qualitative methodology was employed, with data from the ephemeris and the book compared simultaneously to identify visible time differences. Unfavorable weather conditions, such as cloudiness and rain, necessitated the rescheduling of fieldwork. The study was conducted from December to February, with intervals between observation days ranging from 2 to 5 days.

METHOD

This research employed a comparative qualitative field approach. Data representing an extended period were collected, analyzed, and compared between the two calculation methods: ephemeris and Nailul Watar, with validation using the Istiwa' stick. The primary data sources included the Nailul Watar book and the Hisab Rukyat ephemeris published by the Indonesian Ministry of Religion in 2023. Secondary sources comprised calculation formulas for Istiwa' and additional references related to the determination of Zuhr and Asr prayer times.

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[5]Intan Mutia and Ismail Ismail, "Analisis Jadwal Waktu Salat Di Dataran Tinggi Kecamatan Bebesen Kabupaten Aceh Tengah," *Astroislamica: Journal of Islamic Astronomy* 1, no. 1 (June 30, 2022): 21–46, https://doi.org/10.47766/ASTROISLAMICA.V1I1.684.

[6]Ahmad Mukarram, *Ilmu Falak: Dasar-Dasar Hisab Praktis* (Sidoarjo: Grafika Media, 2017).

RESULTS AND DISCUSSIONS

Prayer is an obligatory act of worship. Prayer times are determined by the movement of the sun's shadow and the direction of sunlight, following established laws. By observing the position of the sun[7], one can understand when the time is right (Riza, 2020; Atiqah, 2022). Nowadays, there are many ways to study the phenomenon of celestial body movement because each science focuses on existing studies and phenomena. Among them are: astrometry, a science that focuses on the relationship between the earth and the sky mathematically;

astromechanics, a science that studies the state of objects themselves and their changes; astrophysics, a science that studies the energy produced by celestial objects themselves; and cosmogony, a science that studies the shape of celestial objects[8]

The phenomenon directly related to the istiwa' stick is the time of Zuhr and Asr. Duhr begins when the sun passes its culmination point (zawāl), marked by the shadow of an object starting to lengthen eastward after reaching its shortest position[9]. According to the hadith, the Prophet performed the Zuhr prayer when the sun was tilted westward from the meridian (Ismail, 2023; Riza, 2020). Due to the influence of the Earth's axis tilt of 23°27', an allowance of 2–4 minutes is used based on the calculation results. The main time for Zuhr, as stated in *Al-Iqna' fi Hall Alfaz Abi Shuja'* by al-Syarbini, is from the time the sun sets until the shadow of an object reaches a quarter of its length.[10]

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[7]Nawawi, *Ilmu Falak Praktis: Hisab Waktu Salat, Arah Kiblat Dan Kalender Hijriah* (Surabaya: Imtiyaz, 2016).

[8]Mona Vincent, *Kosmogoni Och Apokalyps: Tva Intertextuella Paragram i Birgitta Trotzigs Teologiska Variationer* (Stockholm: Almqvist & Wiksell International, 1983).

[9]A Soleiman and F Franfky, "Penentuan Awal Waktu Shalat," *Journal IAIN Manado* 9, no. 2 (2019).

[10]Mohd Zahid et al., "International Journal Of Humanities Technology And Civilization Pembahagian Waktu Solat Menurut Kitab Al-Iqna ' Fi Hal Al- Alfaz Abi Shuja ' (Categories of Prayers Time According to the Book of Al-Iqna ' Fi Hal Al-Alfaz Abi Shuja ')" 9, no. 2 (2024): 146–52.

Meanwhile, Asr prayer time begins when an object's shadow is the same length as the object itself (Ismail, 2023; Nurdiana, 2023). This period lasts until sunset, when the sun's rays begin to dim[11] In the Hanafi school of thought, Asr prayer begins when an object's shadow reaches twice its length[12]. Therefore, the Hanafi version of Asr prayer tends to be 40–55 minutes later than the majority opinion (Shafi'i, Maliki, and Hambali).[13]

Prayer is the primary form of worship in Islam, as emphasized in the Qur'an, which promises rewards for those who maintain prayer on time and threats for those who abandon it.[14] Thus, understanding the movement of the sun is a crucial basis for accurately determining prayer times in accordance with Islamic law.[15]

إِنَّنِيٓ أَنَا ٱللَّهُ لَآ إِلَٰهَ إِلَّآ أَنَا۠ فَٱعۡبُدۡنِي وَأَقِمِ ٱلصَّلَوٰةَ لِذِكۡرِيٓ

Indeed, I am Allah, there is no (rightful) god but Me, so worship Me and establish prayer to remember Me. (QS Taha: 14)

Prayer is a form of devotion and spiritual communication between humans and Allah SWT, which is obligatory for the followers of the Prophet Muhammad SAW, as stated in QS. Ṭāhā verse 14. This obligation contains the values of discipline, patience, and submission in carrying out the five daily worship times (Qomariah, 2020). The command to pray was conveyed directly through the Isra' Mi'raj event, making prayer the main worship that opens sustenance and guides to piety. The order of prayer starts from Zuhr to Subuh, reflecting the regularity of time and spiritual balance in the life of a Muslim.

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[11]Zahid et al.

[12]Burhan al-Din Ali ibn Abi Bakr al-Marghinani, *Al-Hidayah fi Sharh Bidayat al-Mubtadi*, ed. Talal Yusuf, First Edition (Beirut: Dar Ihya al-Turath al-Arabi, n.d.).

[13]Abdullah Hasan, "Implikasi Bayang Istiwa' Terhadap Penentuan Awal Waktu Sholat," *Jurnal Penelitian Agama* 22, no. 1 (2021).

[14] Wahbah Al-Zuhaili, *Al-Fiqh Al-Islami Wa Adillatuh* (Damaskus: Dar al-Fikr, 1985).

[15]Mukarram, *Ilmu Falak: Dasar-Dasar Hisab Praktis* (Sidoarjo: Grafika Media, 2017).

1. Celestial Cordinate

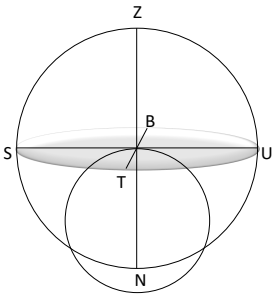

Figure 1. simple model of the celestial sphere

Understanding the movement of celestial bodies requires the concept of celestial sphere coordinates, an imaginary plane centered on the Earth or the observer that depicts the sky as a large semicircle. In astronomy, this system is used to map and predict the apparent motion of celestial bodies using the coordinates of the horizon, equator, and ecliptic (Didin, 2025). The Z and N points form the vertical axes of the celestial sphere, while S, B, U, and T indicate the south, west, north, and east directions from the observer's field of view.[16]

2. Culmination

The astronomical phenomenon where the sun reaches its highest point near the zenith, signaling the start of the Zuhr prayer (Ardiansyah, 2022). After culmination, the sun moves westward until it sets. Twice a year, at latitudes below 23°, objects on Earth's surface cast no shadows, a phenomenon known as a shadowless day.[17]

3. Latitiude and Longitude

Latitude is an imaginary line that divides the Earth into two hemispheres through the equator (0°), with a value of +90° at the North Pole and –90° at the South Pole (Arief, 2023). North latitude is positive, while south latitude is negative. Longitude stretches from the North Pole to the South Pole and intersects the equator at right angles, with 0° longitude at Greenwich, as

[16]E G Sunkar, *Astronomi Dan Astrofisika* (Makassar: Astronomi dan Astrofisika, 2010).

[17]A Padil and A Abbas, "Dasar-Dasar Ilmu Falak Dan Tataordinat: Bola Langit Dan Peredaran Matahari," *Al-Daulah* 2, no. 2 (2013).

determined by the 1884 International Meridian Conference.[18] East longitude is positive, west longitude is negative, and both meet at the International Date Line. The latitude and longitude system allows for accurate global navigation and mapping.

4. Time

According to KH. Abd. Salam Nawawi in Practical Astronomy: Calculating Prayer Times, Qibla Direction, and the Hijri Calendar, time is difficult to understand without a globally agreed-upon unit of measurement. This standard is based on the constant and dynamic movements of the Earth, Sun, and Moon. These movements form units of time, arranged from largest to smallest, encompassing daily, monthly, and annual cycles.[19]

The Earth rotates from west to east once every 24 hours, causing the sky to appear to move from east to west. As a result, the eastern regions experience earlier daylight. Time differences between regions are determined by differences in longitude and the global time system based on Earth's rotation[20].

Table 1. Time difference on longitude.

Difference		*Difference in time*
15°	=	1 Hour
1°	=	4 minute
15’	=	1 minute
1’	=	4 seconds

The time difference between regions on Earth is determined by the difference in longitude, divided by 15, to convert the time angle from degrees to hours. Each region has

[18]Arief Taufikurrahman and Fitriatma Maulani Akbar, “Initial Calculation of Prayer Time Based on Geolocation Using Spreadsheet” 11, no. 1 (2025).

[19]Nawawi, *Ilmu Falak Praktis: Hisab Waktu Salat, Arah Kiblat Dan Kalender Hijriah* (Surabaya: Imtiyaz, 2016).

[20]A F C Wijaya, *Gerak Bumi Dan Bulan* (Jayapura: Digital Learning Lesson Study, 2010).

its own local time based on its longitude. The Earth is divided into 24 time zones, with the day beginning at the International Date Line, which runs along the Pacific Ocean.[21]

The Moon orbits the Earth once every 27.32 sidereal days and moves approximately 12°11'26" per day following the Earth's orbit around the Sun. To return to its normal position with the Sun, the Moon takes 29.53 days, known as a synodic or lunar month.

The annual cycle occurs because the Earth's revolution around the Sun takes 365.242197 days, adjusted for leap years every four years. The Earth's axis is tilted 23°27', and its orbit is elliptical. The closest distance between Earth and the Sun (perihelion) is 147.09 million km on January 4, while the furthest distance (aphelion) is 152.1 million km six months later. This tilt and revolution cause differences in the length of day and night, as well as changes in the seasons, in various regions of the Earth.[22]

5. The book of Nailul Watar

KH. Asrori wrote works in the fields of astronomy, logic, grammar, and philosophy. His famous work, Nailul Watar, was compiled after discussions with KH. Abdurrahman Sakur from Karanganyar. Inspired by the emergence of scientific calculators, this book was published in April 2006 using the method of the Sun's mean daily motion and the equation of time. The elements in the book Nailul Watar are, Constellation :

Table 2. Division of Constellations

no.	Northern Constellation		Southern Constellation	
a.	Aries (Haml)	0	Libra (Mizan)	6
b.	Taurus (Thaur)	1	Scorpio ('Aqrob)	7

[21]Ismail Ismail and Ikhsan Kamilan, "Dynamics of the Ministry of Religious Affairs in Managing Prayer Schedules in Indonesia," *Syarah: Jurnal Hukum Islam & Ekonomi* 12, no. 2 (December 27, 2023): 122–36, https://doi.org/10.47766/syarah.v12i2.1979.

[22]NASA, "Basics of Space Flight: Chapter 2.1" (NASA Science, 2025).

c.	Gemini (Jauza')	2	Sagittarius(Qaus)	8
d.	Cancer (Sartan)	3	Capricorn (Jadyu)	9
e.	Leo ('asad)	4	Aquarius (Dalwu)	10
f.	Virgo (Sun)	5	Pisces (Hut)	11

From the division of the constellations, a poem is made in sequence of 12 constellations:[23]

حملٌ وثور وجوْزَاء سرطان أسدُ سنْبلة لشمَالِ هذهِ نسبَت

ميزان عقربُ قوس جديُ وحو ت نِسبت لِجنوب غفْلتي غلبت

After explaining about constellations, the difference between the moon and the constellations is made according to the inclination of the orbit.

Table 3. Difference in Constellations

Gregorian month		difference	constellation	
January	1	9	9	South → north 23.45°
February	2	10	10	
March	3	8	11	
April	4	10	0	
May	5	9	1	
June	6	9	2	
July	7	7	3	North → South - 23.45°
August	8	7	4	
September	9	7	5	
October	10	6	6	
November	11	7	7	
December	12	7	8	

[23]Ahmad Asrori, *Nailul Wathar* (Winongan: Pustaka Pondok Lebak, 2007).

Solar degress : The solar degree is the position of the sun on a calendar that will be used in calculations. The initial value of the calculation is 0 at point Haml (Aries), which occurs every March 22nd. One rotation requires 360 degrees.[24]

Initial Mail (declination) : On March 22 (Ḥaml), the Sun is above the equator with a declination of 0°, then moves north until it reaches 23.45° on June 21 (Juza'), called mail kulliy. After that, the Sun moves south, crossing the equator on September 23 (Sunbulah) and reaching –23.45° on December 22–23 (Qaus). The initial mail value is calculated by the formula: $\sin^{-1}(\sin DM \times \sin 23.45)$.[25]

Latitude of place and Longitude of place : Calculations require the latitude and longitude of a location, obtained using a GPS or a table. South latitude is negative (–1° to –90°) and north latitude is positive (1° to 90°). Longitude is based on Greenwich (0°), positive to the east, and negative to the west, up to 180° in the Pacific Ocean

Equation of Time : Differences in Earth's daily rotation cause the Sun's culmination to not always occur at exactly 12 noon. It can sometimes occur earlier or later. This book uses a fixed time scale based on the Sun's average movement over time.[26]

Time Zone : The world's time zones are divided into 24 zones, each covering 15° of longitude, equivalent to one hour of Earth's rotation (Agus, 2024). Indonesia has three time zones: WIB (+7), WITA (+8), and WIT (+9) from Greenwich Mean Time.[27]

Bu'dul Qutra : The distance of the center line of the sun's orbit on a given day from the horizon of a given location. The horizon is the boundary of sight that separates the sky from the

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[24]Nurul Atiqah, A Intan Cahiyani, and Sohra, "Analisis Komparatif Perhitungan Waktu Salat Menggunakan Sistem Ephimeris dan Nautika," *Hisabuna* 3, no. 3 (2022): 85.

[25]Asrori, *Nailul Wathar*.

[26]Hilyahtul Uyuni et al., "ANALISIS FATWA MUI TERHADAP WAKTU SALAT DI DAERAH KUTUB PERSPEKTIF KAIDAH-KAIDAH FIQH" 9 (2025): 244–62.

[27]Uyuni et al.

visible surface of the earth. Formula: sin-1 (sin of the initial latitude x sin of the location's latitude)[28]

Ghayatul Irtifa' and Tamamul Ghoyah is the peak of the sun's height on the day used from the horizon. In fact, the sun's height continues to increase when it rises from the east. Until it reaches near the meridian and enters the time of istiwa'.[29] Tamamul Ghayah is an angular distance of 90° with ghayatul irtifa'. Formula: Tamamul Ghayah: Abs(Initial Mail – latitude of the place). Ghayatul irtifa': 90° – Tamamul Ghayah.

Difference between Istiwa' time and Regional Time : Istiwa' time is the time indicated by the actual sun, while regional time is the time indicated by the imaginary sun whose path is uniform. Regional time is indicated by Western

Indonesian Time (WIB), Central Indonesian Time (WITA), and Eastern Indonesian Time (WIT). How to find the difference between Istiwa's time and regional time using a formula.[30] Difference between WIS and WD = (longitude of place – (Time zone x 15))/15 + Time aligner.

6. Shadow

Light that hits an object and is blocked produces a shadow, according to the shape of the object. In astronomy, shadows mark certain activities such as prayer times.[31] At midday, the shortening shadows begin to lengthen to the east as the Sun shifts to the west, signaling the start of prayer time . The length of the istiwa' shadow varies from region to region because it is influenced by the latitude and declination of the Sun (Hasan, 2021; Abd. Salam Nawawi). Namely: There is no shadow, There is a shadow and it does not exceed the length of the object, The length of the object is the same as the length of the shadow, The shadow is twice the length of the object, The

[28]Asrori, *Nailul Wathar*.

[29]Atiqah, Cahiyani, and Sohra, "Analisis Komparatif Perhitungan Waktu Salat Menggunakan Sistem Ephimeris dan Nautika."

[30]Atiqah, Cahiyani, and Sohra.

[31]Hasan, "Implikasi Bayang Istiwa' Terhadap Penentuan Awal Waktu Sholat."

shadow is longer than the object The formula for calculating the shadow is: cotan h sun x height of the object.

7. Istiwa' Stick (Gnomon)

The istiwa' stick is a simple tool for measuring the sun's altitude. It consists of a stick perpendicular to a 90° angle above a flat surface without any light obstructions . This tool functions during the day when sunlight casts a shadow on a flat surface, the length of which corresponds to the sun's height above the horizon. In astronomy, some observers use Muhyiddin Khazin's bencet clock as a comparison.[32] In theory, the istiwa' stick is based on trigonometry, connecting the earth's coordinates and the sun's declination to determine the position and time of worship accurately.[33]

Results of calculating the time for Zuhr and Asr prayers according to the Book of Nailul Watar and Ephemeris This study examines the daily solar cycle to determine the times for Zuhr and Asr prayers based on the book Nailul Watar by KH. Ahmad Asrori compared with the ephemeris data from the Indonesian Ministry of Religious Affairs. Measurements were taken when the Sun was at its lowest point and the shadows of objects were of equal length. Nailul Watar's calculations were formulated in Excel and then compared with those from a scientific calculator. Observations using the istiwa' stick showed Nailul Watar's method to be quite accurate and efficient, although the ephemeris remains the national reference due to its astronomical validation.

Calculation formula. Initial calculations were performed to verify the accuracy of Nailul Watar's book by comparing the results against Akh's guidelines. Mukarram and Ministry of Religion ephemeris data 2022–2023 in Pasuruan using Excel based on local climate conditions. After calculating six sets of data, the accuracy of the Nailul Watar book was tested using the

[32]N A Ma'ruf, "Uji Akurasi True North Berbagai Kompas Dengan Tongkat Istiwa'" (2010).

[33]Anisa Budiwati, "Tongkat Istiwa', Global Positioning System (GPS) Dan Google Earth Untuk Menentukan Titik Koordinat Bumi Dan Aplikasinya Dalam Penentuan Arah Kiblat," *Al-Ahkam* 26, no. 1 (2016).

Ministry of Religion's ephemeris and the Nurul Anwar book, using a customized istiwa stick. The test considered a time tolerance of approximately 5 minutes. The author designed a wooden gnomon with a diameter of 40 cm and a thickness of 1 cm, equipped with a tripod and a water pass for accurate observations .

Accuracy test results showed a small difference between the calculations and observations, but it was still within tolerance. Shadows appeared slightly longer than theoretical. Testing was conducted using a tripod-mounted istiwa stick and a water level, and the north direction was determined using the Stellarium+ app. The measurement difference did not exceed 1 cm across six samples taken during favorable weather conditions.

Table 4. Collected data

Table 4. Collected data								
	Date	Book		Ephemeris		Difference	Long (Current)	Difference in Length
		Hour	Long (cm)	Hour	Long (cm)			
Zuhr	21/12/2022	11:26'7,8"	2,7	11: 26' 13``wib	2,7	5"	3	0,3
	24/12/2022	11:27'37,8"	2,7	11: 28' 52``wib	2,7	14"	3	0,3
	05/01/2023	11:33'24,8"	2,6	11: 33' 26``wib	2,6	1"	2,8	0,2
	07/01/2023	11:34'17,8"	2,5	11: 34' 19``wib	2,5	2"	2,7	0,2
	11/02/2023	11:42'41,8"	1,2	11: 42' 31``wib	1,1	11"	0	-
	12/02/2023	11:42'41,8"	1,1	11: 42' 31``wib	1	11"	1,4	0,4
Asr	21/12/2022	14:53'28,42'	12,3	14: 53' 00``wib	12,3	28"	12,7	0,4
	24/12/2022	14:54'59,19'	12,3	14: 54' 28``wib	12,3	31"	12,7	0,4
	05/01/2023	14:59'56,06'	12,2	15: 00' 22``wib	12,2	26"	12,5	0,3
	07/01/2023	15:0'33,45'	12,1	15: 01' 17``wib	12,1	43"	12,3	0,2
	11/02/2023	14:57'42,52'	10,8	14:56'53``wib	10,7	50"	11,1	0,4
	12/02/2023	14:57'10,13'	10,7	14:56'19``wib	10,6	1'8"	0	-

The calculations were conducted over a 54-day period, from December 21, 2022, to February 12, 2023. This timeframe was selected due to the recency of the Nailul Watar book, which is less than 20 years old. In determining Zuhr time, the observed discrepancies were minimal, with differences not exceeding 15 seconds. The measured shadow lengths were consistent, although a 0.3 cm difference was noted during field observations. This calculation took into account the length of the Istiwa's shadow.

At a different time of zuhur, during asar, a difference of 30 seconds to 1 minute was observed. When the shadow formula was calculated, a difference in shadow length of 0.1 cm was found. This calculation was done without adding the shadow of the equator. Then, the shadow length was measured in the field. A difference of about 0.2 cm to 0.4 cm was obtained. There was a column that was crossed out due to sudden changes in weather conditions. However, this did not reduce the accuracy of the calculation.

CONCLUSION

Based on the results of the research and analysis that have been carried out, the following conclusions can be drawn: Accuracy of Calculations in the Nailul Watar Book: The method for calculating the times for Dhuhr and Asr prayers in the Nailul Watar book by KH. Ahmad Asrori has proven to be highly accurate. The time difference between the book's calculations and the Ministry of Religious Affairs' ephemeris data ranges from a few seconds to less than a minute without any additional adjustments. This indicates that the method has adopted the all-time average of solar time, consistent with modern astronomical data.

Validity of Field Observations with the Istiwa' Stick. Accuracy tests using the Istiwa' stick (gnomon) yielded results that meet the Islamic jurisprudence criteria established by Indonesian scholars for determining prayer times. Empirical observations show that the shadow of an object tends to appear slightly earlier than the theoretically calculated time, but still within the limits of Islamic and scientific tolerance. This confirms that this simple observation method can be implemented by the general public with high accountability and validity. Comparative Analysis and Recommendations for Further Research. The comparison between the Nailul Watar method and the ephemeris method shows consistent results with minimal deviation, indicating a high level of accuracy. Further research is recommended to explore astronomical phenomena that may influence the differences in prayer time

determination between the Hanafi school of thought and the majority of other scholars, in order to obtain a more comprehensive and contextual hisab formulation.

BIBLIOGRAPHY

al-Marghinani, Burhan al-Din Ali ibn Abi Bakr. *Al-Hidayah fi Sharh Bidayat al-Mubtadi*. Edited by Talal Yusuf. First Edition. Beirut: Dar Ihya al-Turath al-Arabi, n.d.

Al-Zuhaili, Wahbah. *Al-Fiqh Al-Islami Wa Adillatuh*. Damaskus: Dar al-Fikr, 1985.

Alwi, Ahmad Ihsan, and Muhammad Zakiyul Amin. "Uji Akurasi Jam Bencet Dalam Menentukan Awal Waktu Salat Zuhur Di Masjid Al-Muttaqin Desa Tanjunganyar Kecamatan Gajah Kabupaten Demak." *Al-Afaq: Jurnal Ilmu Falak Dan Astronomi* 5, no. 2 (2023).

Asrori, Ahmad. *Nailul Wathar*. Winongan: Pustaka Pondok Lebak, 2007.

Atiqah, Nurul, A Intan Cahiyani, and Sohra. "Analisis Komparatif Perhitungan Waktu Salat Menggunakan Sistem Ephimeris dan Nautika." *Hisabuna* 3, no. 3 (2022): 85.

Budiwati, Anisa. "Tongkat Istiwa', Global Positioning System (GPS) Dan Google Earth Untuk Menentukan Titik Koordinat Bumi Dan Aplikasinya Dalam Penentuan Arah Kiblat." *Al-Ahkam* 26, no. 1 (2016).

Hasan, Abdullah. "Implikasi Bayang Istiwa' Terhadap Penentuan Awal Waktu Sholat." *Jurnal Penelitian Agama* 22, no. 1 (2021).

Intan Mutia, and Ismail Ismail. "Analisis Jadwal Waktu Salat Di Dataran Tinggi Kecamatan Bebesen Kabupaten Aceh Tengah." *Astroislamica: Journal of Islamic Astronomy* 1, no. 1 (June 30, 2022): 21–46. https://doi.org/10.47766/ASTROISLAMICA.V1I1.684.

Ismail, Ismail Ismail, and Husnaini Husnaini. "Aktualisasi Jadwal Salat Sepanjang Masa Abu Muhammad Isa Mulieng Aceh." *Islamic Review: Jurnal Riset Dan Kajian Keislaman* 10, no. 1 (April 26, 2021): 93–110. https://doi.org/10.35878/ISLAMICREVIEW.V10I1.245.

Ismail, Ismail, and Ikhsan Kamilan. "Dynamics of the Ministry of Religious Affairs in Managing Prayer Schedules in Indonesia." *Syarah: Jurnal Hukum Islam & Ekonomi* 12, no. 2 (December 27, 2023): 122–36. https://doi.org/10.47766/syarah.v12i2.1979.

Ma'ruf, N A. "Uji Akurasi True North Berbagai Kompas Dengan Tongkat Istiwa'." 2010.

Mukarram, Ahmad. *Ilmu Falak: Dasar-Dasar Hisab Praktis*. Sidoarjo: Grafika Media, 2017.

NASA. "Basics of Space Flight: Chapter 2.1." NASA Science, 2025.

Nawawi, A S. *Ilmu Falak Praktis: Hisab Waktu Salat, Arah Kiblat Dan Kalender Hijriah*. Surabaya: Imtiyaz, 2016.

Padil, A, and A Abbas. "Dasar-Dasar Ilmu Falak Dan Tataordinat: Bola Langit Dan Peredaran Matahari." *Al-Daulah* 2, no. 2 (2013).

Rojak, Encep Abdul, and Ramdan Fawzi. "The Normative Basis of Islamic Astronomy For The Transformation of Prayer Schedules To Digital And Its Accuracy." *El-Usrah: Jurnal Hukum Keluarga* 7, no. 2 (December 31, 2024): 602. https://doi.org/10.22373/ujhk.v7i2.22097.

Soleiman, A, and F Franfky. "Penentuan Awal Waktu Shalat." *Journal IAIN Manado* 9, no. 2 (2019).

Sunkar, E G. *Astronomi Dan Astrofisika*. Makassar: Astronomi dan Astrofisika, 2010.

Taufikurrahman, Arief, and Fitriatma Maulani Akbar. "Initial Calculation of Prayer Time Based on Geolocation Using Spreadsheet" 11, no. 1 (2025).

Uyuni, Hilyahtul, Universitas Islam, Negeri Walisongo, Nurul Wakia, Universitas Islam, and Negeri Alauddin. "ANALISIS FATWA MUI TERHADAP WAKTU SALAT DI DAERAH KUTUB PERSPEKTIF KAIDAH-KAIDAH FIQH" 9 (2025): 244–62.

Vincent, Mona. *Kosmogoni Och Apokalyps: Tva Intertextuella Paragram i Birgitta Trotzigs Teologiska Variationer*. Stockholm: Almqvist & Wiksell International, 1983.

Wijaya, A F C. *Gerak Bumi Dan Bulan*. Jayapura: Digital Learning

Lesson Study, 2010.
Zahid, Mohd, Mohd Zulkifly, Ahmad Irfan, and Mansor Sulaiman. “INTERNATIONAL JOURNAL OF HUMANITIES TECHNOLOGY AND CIVILIZATION PEMBAHAGIAN WAKTU SOLAT MENURUT KITAB AL-IQNA ’ FI HAL AL- ALFAZ ABI SHUJA ’ (Categories of Prayers Time According to the Book of Al-Iqna ’ Fi Hal Al-Alfaz Abi Shuja ’)” 9, no. 2 (2024): 146–52.