

Calculations Using Rubu' Mujayyab to Determine the Beginning of Maghrib and Isha Times

Muhammad Hidayat^{1*} Alfath Khair² Muhammad Alya Fathi³

^{1,2,3} Universitas Muhammadiyah Sumatera Utara, Jl. Denai No 217 Medan

*Corresponding Author. E-mail: muhammadhidayat@umsu.ac.id

Article Info	ABSTRACT
<p>Article History Received : 17 Januari 2024 Accepted: 05 Februari 2024 Published: 29 Februari 2024</p> <p>Keywords: Rubu' Mujayyab, maghrib, Isya</p>	<p>In determining the start of prayer times, in this case the Maghrib and Isha prayer times, there are several methods that can be used, one of which is using instruments. Apart from calculators and computers, the astronomical instrument that can be used is the Rubu' Mujayyab, which functions as an angle calculating tool. Rubu' Mujayyab is a tool in the shape of a quarter circle which is used to calculate geometric functions which are very useful for projecting the circulation of celestial bodies on a vertical circle. The research methods used are experimentation and direct testing. The results of this research show that Rubu' Al-Mujayyab can calculate prayer times, especially Maghrib and Isha times, using the steps described and the results are close to current modern calculations.</p>

This is an open access article under the [CC-BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) license



To cite this article:

INTRODUCTION

The Falak Science Observatory of the Muhammadiyah University of North Sumatra (OIF UMSU) has several Rubu' Al-Mujayyab instruments and consists of various types including wooden Rubu' Al-Mujayyab (Production of RHI), wooden Rubu' Al-Mujayyab (Production of the University's Falak Science Observatory Team Muhammadiyah North Sumatra, Hand Made), Rubu' Al-Mujayyab Acrilic (Production of Rukyatul Hilal Indonesia (RHI), Rubu' Al-Mujayyab Tiang (Production of Pudak Scientific), Rubu' Al-Mujayyab Tiang Out Dor (Production of RHI Korwil SUMUT).

Rubu' Al-Mujayyab is a classical astronomical instrument in the form of a quarter circle used by Muslim astronomers and later replaced by many variations of the quadrant. The transmission of the theory, construction, and use of the astrolabe to the Muslim world is the latest version as well as the early history of the quadrant. (Butar-Butar, 2016; David A. King, 1990; Hendro Setyanto, 2002, 2004) The figure who played a role in the development of Rubu' Al-Mujayyab was Ibnu al-Shatir (Wahyu, 2011)

Therefore, with the many instruments and types of Rubu' Al-Mujayyab available at OIF UMSU, researchers are encouraged to research and develop classical instruments which were very popular in the Middle Ages and hope to create new creations, types and innovations of Rubu' Al-Mujayyab This.

The scholars agree that the start of Maghrib prayer time is when the sun sets. Maghrib time starts from sunset until Isha time arrives. Meanwhile, the Isha time starts from the moment the mega red disappears until half of the night (some also say that the end of the Isha prayer is when dawn rises. (Arwin Juli Rakhmadi Butar-Butar, 2016; Hidayat, 2018)

The argument for prayer times is found in the Al-Quran, Surah An-Nisa: 103

فَإِذَا قَضَيْتُمُ الصَّلَاةَ فَادْكُرُوا اللَّهَ فَيَا مَأْمُورًا وَعَلَىٰ جُنُوبِكُمْ ۚ فَإِذَا اطْمَأْنَنْتُمْ فَأَقِيمُوا الصَّلَاةَ ۚ إِنَّ الصَّلَاةَ كَانَتْ عَلَى الْمُؤْمِنِينَ كِتَابًا مَّوْقُوتًا

Meaning: Next, when you have finished (your) prayer, remember Allah when you stand, when you sit and when you lie down. Then, when you feel safe, then perform the prayer (as usual). Indeed, prayer is a time-determined obligation for believers. (Q.S An-Nisa : 103)

The hadith history related to prayer times is contained in Hadith History of Muslim No. 612 which means

“Zhuhur time begins when the sun slips to the west (zawal time) until a person's shadow is equal to his height and as long as it is not before 'Asr time. Asr time continues as long as the sun has not turned yellow. The Maghrib prayer time is as long as the red light (at sunset) has not disappeared. The time for the 'Isha' prayer is until mid-night. The Fajr prayer time is from dawn (shodiq) as long as the sun has not yet risen. If the sun rises, then refrain from praying because at that time the sun rises between the two horns of Satan.” (HR. Muslim, no. 612)

And the history of other hadiths related to prayer times is contained in the Hadith History of Abu Daud No. 393 and Ahmad 1333 which means

From Ibn 'Abbas radhiyallahu 'anhuma, the Prophet sallallahu 'alaihi wa sallam said, "Jibril 'alaihi salam once invited me as imam at home twice. The first time, he prayed Zhuhur with me when the sun shifted to the west and at that time the length of the shadow was the same as the length of his sandal strap. Then he prayed 'Asr prayer with me when the length of the shadow was the same as the length of the object. Then he performed the Maghrib prayer with me when people broke their fast. Then he prayed the 'Isha' prayer with me when the red light at sunset disappeared. Then he prayed the Fajr prayer (Shubuh prayer) with me when it was forbidden to eat and drink for those who were fasting. Then the next day, he prayed Zuhur prayer with me when the length of the shadow was the same as the length of the object. Then he prayed 'Asr prayer with me when the length of the shadow was twice the length of the object. Then he prayed the Maghrib prayer when people broke their fast. Then he prayed 'Isha' until a third of the night. Then he prayed the Fajr prayer with me after that it was Isfaar time. Then he turned to me and said, “O Muhammad, this is the prayer time as the prayer times of the prophets before you. The time limit is between these two times.” (HR. Abu Daud, no. 393 and Ahmad, 1:333)

In determining the start of prayer times, in this case the Maghrib and Isha prayer times, there are several methods that can be used, one of which is using instruments. Apart from calculators and computers, the astronomical instrument that can be used is the Rubu' Mujayyab, which functions as an angle calculating tool. Rubu' Mujayyab is a tool in the shape of a quarter circle which is used to calculate geometric functions which are very useful for projecting the circulation of celestial bodies on a vertical circle.

RESEARCH METHOD

The research methods used are experimentation and direct testing. The interim results obtained are that Rubu' Al-Mujayyab has quite high accuracy in calculating prayer times, especially in calculating Maghrib and Isha times. This is proven that there is no difference in the results of calculating Maghrib and Isha times using Rubu' Al-Mujayyab using the contemporary reckoning method. and Accurate Times software. Apart from that, Rubu' Al-Mujayyab can determine the declination of the Sun.

RESULTS AND DISCUSSION

The following are the steps to determine the start of Maghrib time at the Muhammadiyah University of North Sumatra Falak Science Observatory OIF UMSU (3°34' N & 98° 43' E) on December 1 2022 using Rubu' Mujayyab.

1. Determine nishfu al-fadhlah (See Method 1) and the result is -2°
2. Then divide by 15 to get $-00^\circ 08' 00''$
3. Because the Asy-Shamsi mile is January/south, add $06^\circ 00' 00''$ to $-00^\circ 08' 00''$ to get $05^\circ 52' 00''$
4. Add daqiqot tamkiniyah $00^\circ 03' 00''$ and ihtiyath $00^\circ 04' 00''$ to obtain $05^\circ 59' 00''$, which is maghrib Istiwa time.
5. Next, convert the start of Wis maghrib time into WIB through KWD area time correction and time smoother or ta'dil al-waqt (equation of time), so that you get the start of maghrib time, namely 18:19 WIB

Table 1. Conversion of Wis (Special Time) to WIB (West Indonesia Time)

	Darojah	Daqiqoh	Tsawani	
Bujur OIF UMSU	98	43	17	
Bujur WIB	105			
Jarak dua lokasi satuan derajat	-7	43	17	
Dibagi 15	jam	menit	detik	
Jarak dua lokasi satuan waktu		-30	53	
Equation of Time		10	53	
Selisih Wis dan WIB		-20		
Waktu awal Maghrib dalam WIB				
Maghrib waktu istiwa	5	59	00	
Selisih Wis dan WIB		-20		-
	6	19	00	
	12	0	0	+
Maghrib 1 Des 2022	18	19	00	

Method 1

Determining nishful al-fadhlah for OIF UMSU on December 1 2022

1. Place al-muri on the ashl al-muthlaq value (See Method 2) to get $54^\circ 45'$ on sittini
2. Move al-khait until al-muri is connected to the bu'du al-quthr value (See Method 5) $-1^\circ 34'$
3. nishful al-fadhlah, namely $-1^\circ 45'$
4. jaib nishful al-fadhlah, namely -2°
5. finished

Method 2

Determine ashl al-muthlaq using Rubu' Mujayyab on December 1 2022 at OIF UMSU ($3^\circ 34' N$ & $98^\circ 43' E$)

1. Place the al-khait thread on the al-qous arc according to the latitude of the location, then look for jaib tamammu 'ardh al-balad or cosine of the latitude of the location to obtain $59^\circ 45'$
2. Determine the Declination value (see Method 3) to get $23^\circ 00'$
3. The mile is $90^\circ - 23^\circ 00' = 67^\circ 0'$
4. Obtained ashl-muthlaq, namely $54^\circ 45'$
5. finished

Method 3

Determines declination

1. Place the khait on the sittini
2. Place al-muri at jaib mil a'dhom ($23^\circ 52'$)
3. Move al-khait to degrees of the Sun, from the calculation of 1 December 2022 degrees of the Sun (See Method 4) you get 8 degrees qous and south jihah

4. Look at al-Muri's position on Juyub Al-Mabsuthoh. The juyub al-mabsuthoh line on as-sittini will show jaib al-mil, namely $23^{\circ}0'$
5. Meanwhile, the juyub al-mabsuthoh line on al-qous shows the ash-syamsi mile or declination, namely $23^{\circ}0'$ ($-23^{\circ}0'$ south jihah)
6. finished

Method 4

Determine the degree of the Sun from the tafawut schedule

Example: December 1, 2022

Tanggal	1		
Tafawut	7	+	
Darojah asy-syamsi	8	qous	selatan

Method 5

Determining the value of bu'du al-quthr

1. Place the al-khait thread on the al-qous arc according to the latitude of the location, namely (3°).
2. Then look for the jaib 'ardh al-balad or sine of the latitude of the location to obtain $3^{\circ}34'$
3. Bu'du al-quthr is $1^{\circ}34'$
4. Because the latitude is positive and the declination is minus, Bu'du al-Quthr is below ufuq $-1^{\circ} 34'$
5. finished

Meanwhile, the following are the steps to determine the start of Isha' time at the Astronomical Observatory, Muhammadiyah University, North Sumatra, OIF UMSU ($3^{\circ}34'$ N & $98^{\circ} 43'$ E) on December 1, 2022 using Rubu' Mujayyab.

1. Place the al-khait thread on the al-qous irtifa' Isha' arc of 17° , then determine the jaib irtifa' Isha' and get $17^{\circ}30'$
2. Because Mil ash-syamsi 01 December 2022 is janubi [south], then add jaib irtifa' Isha' $17^{\circ}30'$ with bu'du al-quthr $-1^{\circ} 34'$ (See Method 5) to obtain ashl al-mu' addal $15^{\circ}56'$.
3. Place the al-khait thread on the as-sittini, then mark the al-muri on the ashl al-muthlaq $54^{\circ} 45'$ (See Method 2)
4. Then slide the al-khait thread until al-muri cuts the vertical connecting line [juyub mabsuthoh] between ashl al-mu'addal $-16^{\circ}56'$ and the al-qous arc. Straighten the al-khait thread from the intersection point, so that it cuts the al-qous arc at $-17^{\circ}30'$, namely qous tamam al-fadhil which is calculated from the beginning of the al-qous arc or also called qous isya' zawali.
5. Divide qous isya' zawali $-17^{\circ}30'$ by 15 so that the unit of degree is converted into a unit of time, the result is $-1h10m00d$, namely isya' zawali
6. Add $6h0m0d$ to Isha' zawali, namely $-1h10m00d$, then add ihtiyath $0h4m0d$, the result is Isha' Istiwa' time, which is $4h54m0d$.
7. Next, convert the start of Wis Maghrib time into WIB through KWD regional time correction and time averaging or ta'dil al-waqt (equation of time), so that you get the start of Isha' time, namely 18:19 WIB

Tanggal	1	Januari	2022	Janubi
	Darojah	Daqiqoh	Tsawani	
Irtifa' Isya'	18			Tanda [-]
Jaib Irtifa' Isya'	18	30		Tanda [-]
Bu'du al-quthr	-1	34		
ashl al-mu'addal isya'	16	56		
ashl al-muthlaq	54	45		
Qous tamam al-fadhil [qous isya' zawali]	17	30		
Bagi dengan 15	Jam	Menit	detik	

Isya zawali	1	10	00	
jam	6			
Ihtiyath [kehati-hatian]		4		+
Isya' Waktu Istiwa	7	14		

Convert Wis (Special Time) to WIB (West Indonesia Time)

	Darajah	Daqiqoh	Tsawani	
Bujur OIF UMSU	98	43	17	
Bujur WIB	105			
Jarak dua lokasi satuan derajat	-7	43	17	
Dibagi 15	jam	menit	detik	
Jarak dua lokasi satuan waktu		-30	53	
Equation of Time		10	53	
Selisih Wis dan WIB		-20		
Waktu awal Maghrib dalam WIB				
Isya waktu istiwa	7	14	00	
Selisih Wis dan WIB		-20		-
	7	34	00	
	12	0	0	+
Isya 1 Des 2022	19	34	00	

Method 1

Determining nishful al-fadhlah for OIF UMSU on December 1 2022

1. Place al-muri on the ashl al-muthlaq value (See Method 2) to get 54°45' on sittini
2. Move al-khait until al-muri is connected to the bu'du al-quthr value (See Method 5) -1° 34'
3. nishful al-fadhlah, namely -1° 45'
4. jaib nishful al-fadhlah, namely -2°
5. finished

Method 2

Determine ashl al-muthlaq using Rubu' Mujayyab on December 1 2022 at OIF UMSU (3°34' N & 98° 43' E)

1. Place the al-khait thread on the al-qous arc according to the latitude of the location, then look for jaib tamammu 'ardh al-balad or cosine of the latitude of the location to obtain 59°45'
2. Determine the Declination value (see Method 3) to get 23°00'
3. The mile is 90° - 23°00' = 67° 0'
4. Obtained ashl-muthlaq, namely 54° 45'
5. finished

Method 3

Determines declination

1. Place the khait on the sittini
2. Place al-muri at jaib mil a'dhom (23° 52')
3. Move al-khait to degrees of the Sun, from the calculation of 1 December 2022 degrees of the Sun (See Method 4) you get 8 degrees qous and south jihah
4. Look at al-Muri's position on Juyub Al-Mabsuthoh. The juyub al-mabsuthoh line on as-sittini will show jaib al-mil, namely 23°0'
5. Meanwhile, the juyub al-mabsuthoh line on al-qous shows the ash-syamsi mile or declination, namely 23°0' (-23°0' south jihah)
6. finished

Method 4

Determine the degree of the Sun from the tafawut schedule

Example: December 1, 2022

Tanggal	1		
Tafawut	7	+	
Darajah asy-syamsi	8	qous	selatan

Method 5

Determining the value of bu'du al-quthr

1. Place the al-khait thread on the al-qous arc according to the latitude of the location, namely (3°).
2. Then look for the jaib 'ardh al-balad or sine of the latitude of the location to obtain 3°34'
3. Bu'du al-quthr is 1°34'
4. Because the latitude is positive and the declination is minus, Bu'du al-Quthr is below ufuq -1° 34'
5. Done

Method 6

Determining Ashl al-Mu'addal Isha' time

1. Know the value of bu'du al-quthr -1° 34' (See Method 5)
2. Know the irtifa' time of Isha', namely -18°, and if you use Rubu' Mujayyab, jaib [sine] irtifa' time of Isha', namely (-18°30')
3. Determine Ashl al-mu'addal, by calculating the difference between bu'du al-quthr and jaib irtifa' at Isha time, so that if you use rubu' mujayyab, ashl al-mu'addal at Isha time is (-16°56')

CONCLUSION

From the discussion above, it appears that Rubu' Al-Mujayyab can calculate prayer times, especially Maghrib and Isha times, using the steps described and the results are close to current modern calculations. This can become a treasure, learning for the current generation to further deepen, study and develop what has been produced by Muslim scientists in the past so that the progress of science and Islamic civilization which has the spirit of Islamic values, faith and worship can continue to grow in this day and age.

REFERENCES

Arwin Juli Rakhmadi Butar-Butar. (2016). *Waktu Shalat menurut Fikih dan Astronomi*. LPPM UISU.

Butar-Butar, A. J. R. (2016). *Khazanah Astronomi Islam Abad Pertengahan*. UMP Press.

David A. King. (1990). *A Survey of Medieval Islamic Shadow Schemes for Simple Time- Reckoning*. <http://www.jstor.org/stable/1580631>.

Hendro Setyanto. (2002). *Petunjuk Percobaan Guru Rubu' Al-Mujayyab*. Pudak Scientific.

Hendro Setyanto. (2004). Rubu al-Mujayyab : Concept and Practice in Indonesia. *Astronomical Instruments and Archives from the Asia -Pasific Region*, 135–140.

Hidayat, M. (2018). Penyebab Perbedaan Hasil Perhitungan Jadwal Waktu Salat di Sumatera Utara. *AL-MARSHAD: Jurnal Astronomi Islam Dan Ilmu-Ilmu Berkaitan*, 4(2), 204–218.

Wahyu. (2011). *Ilmuwan Muslim Perintis Sains Modern*. Diva Press.