

Interconnection of Mathematics and Dhuha Time

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Abstrak

Interkoneksi matematika dan ilmu agama dapat dilakukan dengan melihat interkoneksi matematika dan shalat sunnah dhuha. Keunikan shalat sunnah dhuha pada waktu pelaksanaannya, memberikan tantangan untuk melihat bagaimana matematika hadir pada penetapan awal waktu shalat dhuha, untuk memudahkan manusia dalam melaksanakannya. Pada penelitian ini, metode *library research* digunakan sebagai metode penelitian untuk melihat interkoneksi matematika dan waktu pelaksanaan shalat dhuha. Terdapat empat langkah yang dilakukan dalam penelitian, pertama pengumpulan data, kedua reduksi data, ketiga penyajian data, dan keempat analisis serta tafsir data. Dari penelitian yang telah dilakukan, konsep-konsep matematika yang ada pada penentuan waktu pelaksanaan shalat dhuha adalah konsep dasar operasi hitung matematika (penjumlahan, pengurangan, perkalian, dan pembagian), konsep trigonometri, konsep dasar geometri (sudut lancip), dan konsep perhitungan waktu. Pada perhitungan awal waktu pelaksanaan shalat dhuha, konsep trigonometri (sin, cos, tan), konsep dasar operasi hitung, serta konsep perhitungan waktu banyak digunakan. Konsep dasar geometri (sudut lancip) terhubung dengan sudut yang terbentuk pada ketinggian matahari awal waktu pelaksanaan shalat dhuha dilihat dari pengamat.

Kata kunci: Interkoneksi; Matematika; Ilmu Agama; Shalat dhuha; Waktu Shalat Dhuha;

Abstract

The interconnection of mathematics and religion can be done by looking at the interconnectedness of mathematics and the sunnah dhuha. The uniqueness of the sunnah dhuha, provides a challenge to see how mathematics is present in the initial determination of the dhuha time, to make it easier for humans to do. In this study, the library research method was used as a research method to see the mathematical interconnection with dhuha time. There are four steps carried out in the research, the first is data collection, the second is data reduction, third is display data, and fourth data analysis and interpretation. From the research that has been done, the mathematical concepts that exist in determining the timing of the dhuha prayer are the basic concepts of mathematical arithmetic operations (addition, subtraction, multiplication, and division), trigonometric concepts, basic concepts of geometry (acute angles), and the concept of calculating time. . In the initial calculation of the implementation of dhuha prayer, the concept of trigonometry (sin, cos, tan), the basic concepts of arithmetic operations, and the concept of calculating the amount of time used. The basic concept of geometry (an acute angle) is connected with the angle formed at the height of the sun at the beginning of the time of the dhuha prayer seen from the observer.

Keywords: *Interconnection; mathematics; religion; dhuha; dhuha time.*

INTRODUCTION

Knowledge was an important component in life, both worldly science and religion. The diversity of knowledge is very broad whether the afterlife (religious science), science,

or social sciences, each science must be based on a mindset, so in studying science not only studying one field of science but all sciences must be studied by integrating it. Interconnection-integration is two different words with the same meaning and purpose, namely connecting or connecting two fields of science that are considered separate (different). Interconnection is a science that aims to see the connection between a science and various other scientific disciplines (Rodiyah, 2014). Integration is the study or study of one particular scientific field while still looking at the connectedness of other fields of science (Rodiyah, 2014). There are three points in the interconnection paradigm, namely *natural science*, *social science*, and *humanities* (Siswanto, 2015). The concept of interconnection-integration in the Qur'an is described in Q.S Al-Alaq: 1-5 which means:

"Read by the name of your God who created, He has created man from a lump of blood. Read it, and it is your Lord who is most merciful, who teaches (man) by the intercession of kalam. He teaches man what he does not know."

The verse describes that the religion contained in the Qur'an and science are two interconnected knowledge. The above verse describes the interconnection between the components of faith, science or phenomenon, and methods of obtaining knowledge. Science is a science that studies all phenomena in the world, as well as religious science which is the science of spirit phenomena and world phenomena, are two important sciences and do not separate from each other. Religion (Islam) teaches how the creation of the world and its entirety *sir* (not detailed), and science proves what has been taught by religion (Islam) scientifically so that it can be accepted by human logic. The integration and interconnection of religion (Islam) with science has one of its goals, namely to form a prospective generation of Islamic scientists who receive or know the object of science through the heart, reason, and senses based on the values of tawhid (Izudin, 2015). The interconnection of religion and science refers to ontological, epistemological, and axiological perspectives (Mudzakir, 2016). Ontologically, integrations arise from the results of in-depth, systematic, objective, and thorough studies, so that the results of the study are easily understood and accepted. Epistemologically, integration arises from the results of science and technology obtained from the effort with vision, hearing, and heart towards the laws of nature. Axiologically integration-integration-integration arises from the results of extracting benefits for the needs of human life (Mudzakir, 2016).

Mathematics is one part of science that is very important and most influential in the development of technology and science. Mathematics is very interesting and always appears in every aspect of human activities in everyday life. Human life is greatly influenced by mathematics. Human life cannot be separated from mathematics. The religious knowledge contained in the Qur'an is integrated-connected with mathematical concepts. Many mathematical concepts are connected with religious teachings in the Qur'an, such as the concept of number theory, sets, algorithms in determining the Qibla direction, geometry, and other mathematical concepts. Similarly, prayer which is part of the science of religion (Islam) which cannot be separated from human life, also has an interconnection with mathematics. This is explained by Wardatus and Hilwatus in their writings, that, in the prayer movement which is always done by humans, there is a mathematical concept of geometry, namely angles (Soimah & Tilawah, 2021). Every movement from takbiratul ihram to the final tahiyyat, forms acute, right, and obtuse angles. In the Qur'an, prayer is a spiritual activity that must be carried out by every human being. Prayers are divided into two types, namely sunnah prayers and obligatory prayers. Basically, the sunnah prayer has its privileges, just like the sunnah prayer dhuha. In the view of Islam, one of the privileges of the dhuha prayer is that the dhuha prayer is a substitute for alms from the body (HR. Ahmad, Muslim, and Abu Daud). People who perform the Duha prayer with full humility and sincerity will be provided with the necessities of life, get a reward equal to Hajj and Umrah, enter heaven through the Duha door, build a golden palace in heaven, have breakfast for their spirituality, and have their sins are forgiven (HR. Tirmidhi).

Dhuha is a prayer in the morning that is highly recommended for implementation. By the hadith of Al-Bukhari, which says "*Prophet Muhammad (PBUH) told me three things (which I never left until I died), namely fasting three days every month, two raka'at dhuha, and witr prayer before going to bed.*" (Bukhari, n.d.). The Apostle also explained in the Hadith of Bukhari History, that whoever prays four raka'at in the morning undoubtedly Allah SWT is sufficient in the afternoon. The time of dhuha prayer is different from the time of other sunnah prayers. Sunnah dhuha prayer is only done in the morning, until noon.

The verse above explains that the time for the implementation of dhuha is in the morning (judging from the word dhuha which means morning). In other surahs, namely QS Taha: 59 and 119, QS Al-A'raf: 98, QS An-Naziat: 29 and 46, QS As-Sham: 1, and QS Ad-Dhuha: 1, it is also shown that specifically Duha is performed in the morning when the sun

shines. The uniqueness of the time of the dhuha prayer, which can only be done in the morning, attracted the attention of researchers to find the interconnection of the dhuha prayer time with mathematics. The researcher wants to know whether there is a mathematical element in determining the timing of the Duha prayer and how the mathematical description is contained in the time of the Duha prayer.

RESEARCH METHODS

This research uses *library research methods* with a non-interactive qualitative approach. *Library Research* is an activity related to methods of collecting library data, reading, and recording and managing research materials.

Research Type

This research uses a non-interactive qualitative approach. This research is carried out using literature in the form of books, notes, articles, and reports on the results of previous research.

Research Time and Place of

The research was conducted at the IAIN Curup Library, as a data center for the knowledge science center in Curup. The research was conducted within 3 months, namely January-March 2021.

Procedure

Procedure of this research served on Figure.1.

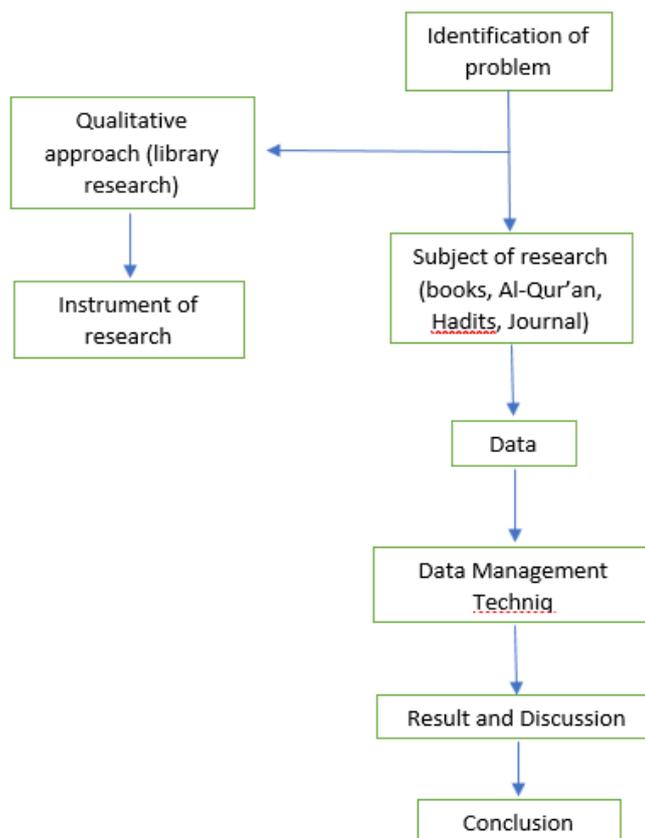


Figure 1. Procedure of Research

.Data Source, Instrument, and DataCollection Techniques

The primary data in this study are in the form of books, the Qur'an, and journals related to mathematics and the time of dhuha prayer. The secondary data used is data obtained from experts in the initial calculation of prayers, namely Prof.Dr.H. Budi Kisworo, M.Ag, Dr.Abdussakir, M.Pd, Muzakkir Syamaun, M.Ed, and Zakiyah, M.Ag.

The research data collection techniques are carried out in three stages, first, orientation stage, the second stage of exploration, and third stage of member check. The orientation stage is carried out for the preparation of researchers collecting materials, and collecting *human information*. The exploration phase is carried out by collecting the primary sources of research, followed by categorizing each data obtained and analyzed. The *member check* stage is a stage to validate the results that have been obtained. The instrument used is a human instrument, where the researcher acts as an instrument of data collection. Validation of the results of the research is carried out by means of expert validation, providing research results to experts, namely Prof.Dr.H. Budi Kisworo. The validity of the data is carried out

with four categories, namely a) trust, b) reliability, c) the dependence of research on the data obtained, and d) certainty. The validity of research data is carried out by expert checking.

Data Analysis Technique

Data analysis is carried out using four stages, namely *data collection*, *data reduction*, *data display* and *conclusion drawing and verifying*. The *data collection* stage is carried out by collecting all data related to mathematics and the time of dhuha prayer. The data reduction stage is a step for researchers to sort the necessary data and those that are not. The *stages of displaying data* are carried out by presenting data so that it is easy to understand and analyze, data that has been reduced, presented in the form of a brief description, and in the form of important points to facilitate researchers. The *conclusion drawing and verifying stage*, at this stage the researchers conducted an analysis of the connectedness of mathematical concepts and the time of the dhuha prayer based on existing data.

RESULTS AND DISCUSSION

Results

In contemporary Arabic-Indonesian dictionaries the word ضَحَى was derivation of the ضَحْوَةٌ which has the meaning of dhuha time or the sun that emits heat (Ali & Muhdlar, 1998) . From the meaning of the word, the dhuha prayer can be said as a work and speech that begins with takbir and ends with greetings when the sun has risen and the light is bright (Sabiq, 2008) . Ahmad Warsan Munawwir interprets the word dhuha as a name for the time of dhuha, namely the time when the sun has risen which is taken from the words وَالضُّحَى – وَالضُّحَى وَالضُّحَى – وَالضُّحَى (Munawwir, 1984). This is in line with the opinion of Muhammad Idris Al-Marbawi who interprets the word dhuha as the name of the time of dhuha or when the sun rises (Taufik, 2020) . In the Big Indonesian Dictionary (KBBI) what is meant by dhuha time is the time before noon or approximately 10.00 (Depdikbut, 1994) . In the al-Munjid Fi al-Laughagh wa al-A'lam dictionary, it is stated that the word dhuha means the rising of the eye of the heart after it rises so that there is no longer a barrier against it (Ma'luf, 1999) . Abi Husain Ahmad bin Faris bin Zakariyya, also emphasized that the time for the Duha prayer is the time when the sun is bright or begins to enter the afternoon. Judging from the fragment of the word dhuha in the Qur'an in QS Thaha: 59 and 119, QS Al-A'raf: 98, QS An-Nazi'at: 29 and 46, QS As-Sham: 1-2, and QS. Ad-Dhuha: 1, the word الضحى can be

interpreted with hot sunlight (Al-Qurtubi, 1993) . In other references the time of dhuha can be said to start when the sun begins to rise by a piece or approximately as high as 7 cubits and ends when the sun goes down (Abdillah, 2010) . In the opinion of fiqh scholars the word dhuha is defined as: *ما بين ارتفاع الشمس إلى زولها* “The time between the suns starting to rise until the zawal or the sun slipping from the zenith point” (Kemenag Ri, 2013).

Thabarani Hadith explains the beginning of the time of dhuha prayer is when the sun has risen on the east side, as described in the hadith below (al-Mungdzari, 1994):

عَنْ مَامَةَ رَضِيَ اللَّهُ عَنْهُ قَالَ قَالَ رَسُولُ اللَّهِ صَلَّى اللَّهُ عَلَيْهِ وَسَلَّمَ إِذَا طَلَعَتِ الشَّمْسُ مِنَ مَطْلَعِهَا كَهَيْئَتِهَا لِصَلَاةِ الْعَصْرِ حِينَ تَغْرُبُ مِنْ مَغْرِبِهَا فَصَلِّ رَخْلًا رَكْعَتَيْنِ وَأَرْبَعَ سَجَدَاتٍ فَإِنَّ لَهُ أَجْرَ ذَلِكَ الْيَوْمِ (رواه لتبرن)

“From Abi Umamah RA, said Rasulullah SAW when the sun has risen in the east like the sun in the west at the time of Asr before sunset, then pray two raka'at and four prostrations, because it is a reward for him on that day.”(HR. Thabarani)

An illustration of the height of the sun referred to in the hadith above can be seen in Figure 2.

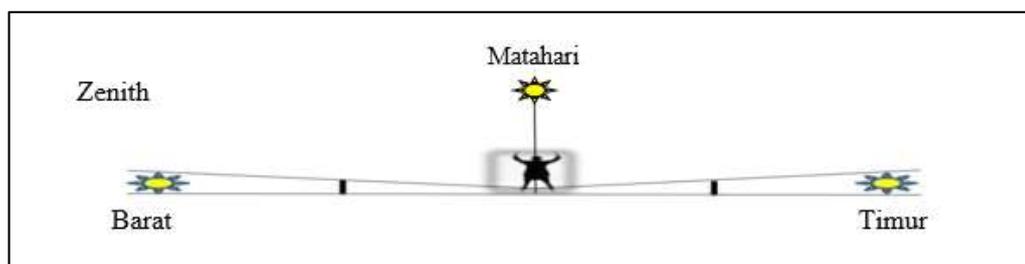


Figure 2. Illustration of the position of the sun slipping at the zenith point (Firdos, 2015)

From the explanations according to several opinions as well as hadiths and verses of the Qur'an, the initial time for the dhuha prayer begins when the sun has risen perfectly and ends when the light is hot. When adjusted to the time of the clock, the time for the dhuha prayer, according to the sources previously mentioned, is approximately from 07.00 to 11.00 (Nur, 2016) . However, according to sayyid, the most preferred time to perform the dhuha prayer is in the morning when the sun is rising as high as a spear and ends when the sun is slipping, but it is sunnah to end it until the sun is high enough and the heat is already hot (Sabiq, 2008) . To determine the initial time of the dhuha prayer, you can use the approximate unit of a spear, as narrated in the hadith of Imam Nasa'I modified by Imam Abi Daud which reads:

“He told us Robbi 'bin Nafi', Muhammad bin Al-Muhajir told us from 'Abbas bin Salim from Abi Salam from Abi Umamah from 'Umar bin 'Abasah As-Sulami. That 'Umar said: I asked, O Messenger of Allah, on which night the prayer is answered

sooner. The Prophet replied: In the middle of the last night, then pray because the prayer was witnessed and written directly by the Angels until the morning prayer. Then do not pray until the sun rises and has risen by about a spear or two, because the sun rises between the two horns of Satan and at that time the disbelievers are praying. Then pray because your prayer is witnessed and written by the angels until the spear is in line with its shadow. Then stop your prayers because at that time the Hellfire is spread out and its doors are opened. When the sun has fallen, pray because your prayers are witnessed by angels until the Asr prayer. Then stop praying until the sun goes down because the sun is sinking between the two horns of Satan and the disbelievers are praying.” (Al-Sajistani, n.d.)

The hadith is a reference in the use of the spear unit as a reference in determining the dhuha prayer using the height of the sun. There are five mentions in Arabic for the use of spear units, namely *قاد ب رمح - قدة رمح*. The meaning of the sun has risen and rises about one spear or two spears (*رمحين قدر رمح او*) is the eye of the heart rises and someone sees the sun in the east with such conditions, then the time for praying is forbidden or entering the dhuha prayer. In the book *Buhuts Al-Falakiyyah* it is explained that the meaning of dhuha in Arabic has the meaning of time starting with the rising of the sun about one spear. The equation of the Spear Unit in mathematical units is presented below:

$$\begin{array}{ll}
 1 \text{ spear} = 12 \text{ feet} & 12 \text{ feet} = 36.76 \text{ cm} \\
 1 \text{ inch} = 2.54 \text{ cm} & = 3.6576 \text{ cm} \\
 1 \text{ foot} = 12 \text{ inches} = 30.48 \text{ cm} &
 \end{array}$$

According to Imam Nawawi in the book *Raudlalah-Thalibin* said that 1 spear = 7 dzira' (Yahya, 2003). The dzira' unit used is dzira' adami, where 1 dzira adami = 0.48000 m. If the unit is converted in meters, then 1 spear = 0.48000 mx 7 dzira' = 3.36 m. the approximate height of the sun using a spear as a measuring tool, can be approximated by the triangular pattern presented in Figure 3.

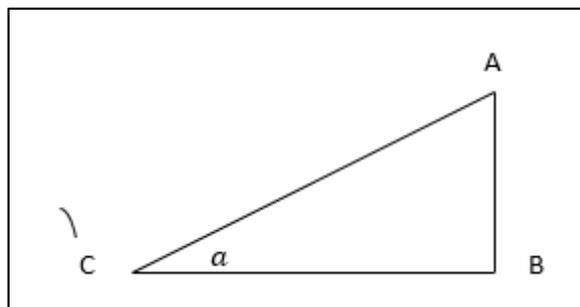


Figure 3. triangle pattern illustration

From the triangle pattern, we can use the trigonometric formula to determine the position of the sun's height for the beginning of dhuha time. The trigonometric formula in question is presented in the explanation below:

$$\sin \alpha = \frac{\text{perpendicular}}{\text{hypotenuse}} \quad \text{atau} \quad \frac{AB}{AC}$$

$$\cos \alpha = \frac{\text{base}}{\text{hypotenuse}} \quad \text{atau} \quad \frac{BC}{AC}$$

$$\tan \alpha = \frac{\text{perpendicular}}{\text{base}} \quad \text{atau} \quad \frac{AB}{BC} \quad (\text{Jamil, 2022})$$

In determining the initial time of dhuha, if it is connected or interconnected with concepts or principles of mathematics, it will be related to the concept of trigonometry which is a branch of geometry. Trigonometry is also known as the science of measuring triangles, in its basic form it is commonly used as a tool in the fields of astronomy and navigation. The interconnection between the geometry of the mathematical triangle and the science of jurisprudence, and astronomy in calculating the Qibla direction, is illustrated in Figure 4.

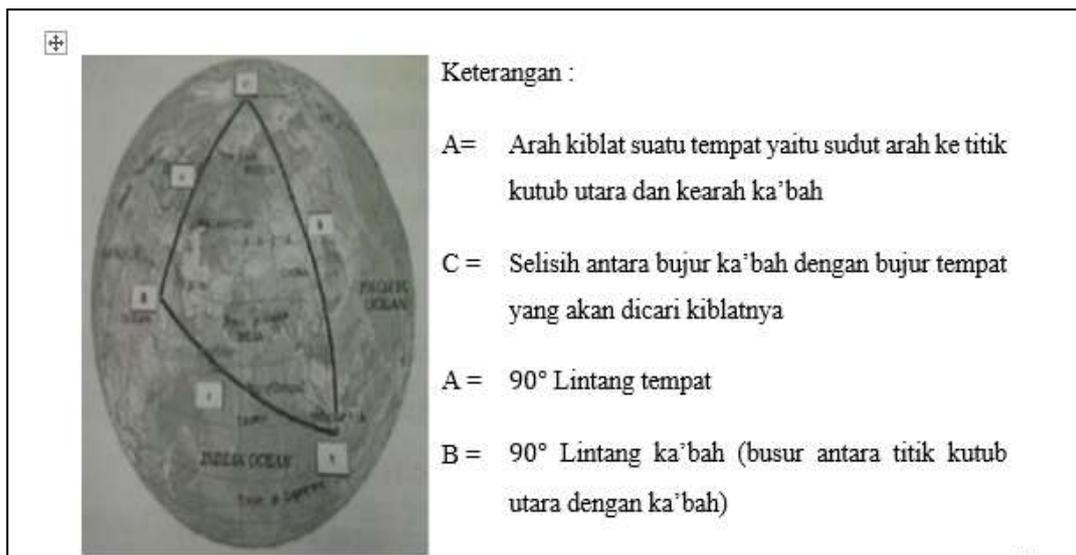


Figure 4. The principle of calculating angles on a globe (Jamil, 2022)

Trigonometry applies the values of trigonometric functions such as *sine*, *cosine*, *cosecant*, *cotangent*, *secant*, and *tangent*. Meanwhile, in geometry, the geometry of the triangle includes the angles contained, which include:

- An angle that has no distance between the two lines is the angle 0° ,
- An acute angle is an angle whose measure is $< 90^\circ$,
- A right angle is an angle whose measure = 90° ,
- An obtuse angle is an angle whose measure is $> 90^\circ$,

e). A straight angle is an angle whose measure = 180°.

In addition to calculations using a spear unit to determine the height of the sun, the initial determination of prayer times can also use the criteria for the height of the sun offered by fiqh scholars and practical astronomy, which are presented in Table 1.

Table 1. Kriteria ketinggian matahari awal waktu dhuha.

No.	Tokoh	Kriteria
1.	Zubair ‘Umar Jailani (Jailani, 2000), Slamet Hambali (Hambali, 2011), Ahmad Izzuddin (Izudin, 2015)	4°30’
2.	Muhyiddin Khanzi (Khanzi, n.d.), Kemenag RI (Kemenag Ri, 2013)	3°30’
3.	A. Kadir (Kadir, 2012) , A.Djamil (Djamil, 2011)	12°
4.	Susiknan Azhari (Azhari, 2008)	4°
5.	Muhammad Abdul Karim Nashr (Nashr, 2003)	3°

The calculation of the initial determination of the time of dhuha offered by fiqh and astronomy experts uses a trigonometric mathematical approach, namely the application of *sin*, *cos*, *tan*, *cosecant*, *tangent*, *cosecant*, and *secant* (Tresnaningsi & Risa, nd) . To see the degrees, minutes and hours that can be used to determine the beginning of the time of dhuha in measuring astronomy, it is presented in the formula below with a description of the symbols presented in Table 2.

Formula.

Rumus:

$$\cos t_o = \sin h_o : \cos \Phi^x \cos \delta^m - \tan \Phi^x \times \tan \delta^m.$$

$$Atau \cos t_o = \sin h : \cos LT : \cos \delta - \tan LT \times \tan \delta.$$

Table 1. Symbol Explanation

No.	Simbol	Keterangan
1.	λ^x	Bujur tempat BT ^x
2.	λ^d	Bujur daerah BT ^d
3.	Φ^x	Lintang tempat
4.	δ^m	Deklinasi waktu
5.	h_o	Ketinggian matahari saat dhuha
6.	t_o	Sudut waktu matahari (dhuha $t_o = -$ (negatif))
7.	E	Equation of time (perata waktu/ta’dil Al-Zaman)
8.	LT	Lintang tempat

To determine the initial time of the dhuha prayer, it is necessary to know in advance, the height of the sun by using the spear height approach. The explanation for calculating the sun's height is as follows:

The height of the sun using Spear Height

The height of the sun at the beginning of the dhuha prayer can be found using the criteria for the size of the first angle, namely $4^{\circ}30'$ where the height of the spear is 3.36 m. Illustration of the position of the sun can be seen in Figure 5. Figure 5 shows that, we can find the distance between the observer and the sun by using the trigonometric concept using the *tan formula*. It can be seen in Figure 5 that the angle formed, and the vertical side (height of the spear) are known. The size of the angle formed is $4^{\circ}30'$ and the upright side is 3.36 m. So the calculation to find the value of X in Figure 5 which is the height of the sun is the result of the distance between the observer and the spear.

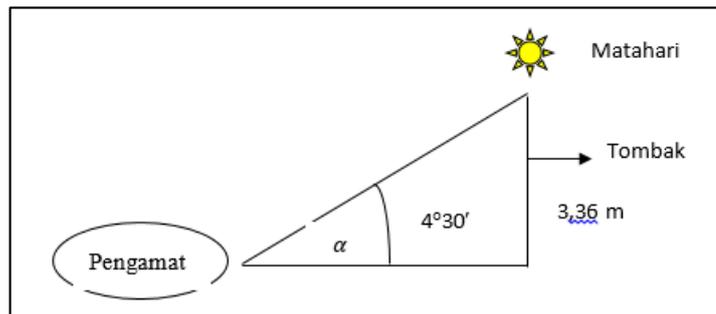


Figure 5. The angle formed by the length of the distance between the observer and the tip of the spear

The calculation is as follows:

$$\begin{aligned} \tan a &= \frac{\text{perpendicular}}{\text{hypotenuse}} \\ \tan 4^{\circ}30' &= \frac{3,36 \text{ m}}{X} \\ X &= \frac{3,36 \text{ m}}{4^{\circ}30'} \\ X &= \frac{3,36 \text{ m}}{0,0787017068} \\ &= 42,69284792 \text{ m} \end{aligned}$$

So, the height of the sun $X = 42,69284792 \text{ m}$.

To find the beginning of the time for the dhuha prayer, the criteria for the angle of the sun's elevation by experts are used, which are presented in Table 1. The formula for calculating the beginning of time for each criterion is presented in the review below:

The initial calculation of the time for the dhuha prayer.

1. The initial calculation of the dhuha prayer time using the first criterion, $4^{\circ}30'$ according to Ahmad Izzudin, has the following steps (Izzudin, 2013) :

For example, the time for the start of the Dhuha prayer in the Semarang area will be calculated, then the data needed is:

- a. Place BT (λ^X)= $110^{\circ}24'' \text{ BT}$
- b. Latitude (Φ^x)= $-7^{\circ}00'' \text{ LS}$
- c. Declaration of the sun (δ^m) = $23^{\circ} 14' 44''$
- d. h_{\circ} (height of the sun) during dhuha = $+4^{\circ}30'$
- e. Equation of time = $-0^{\circ} 01' 44''$
- f. t_o (angle of sun times) during dhuha

The Formula :

$$\begin{aligned} \cos t_o &= \sin h_{\circ} : \cos \Phi^X \cos \delta^m - \tan \Phi^x \times \tan \delta^m \\ &= \sin 4^{\circ} 30' : \cos -7^{\circ} 00' \cos -23^{\circ} 14' 44'' - \text{Tan } -7^{\circ} 00' \times \text{Tan } - \\ &\quad 23^{\circ} 14' 44'' \end{aligned}$$

$$t_o = -88^{\circ} 51' 37.08'' : 15$$

$$t_o = -05^j 55^m 26^d$$

Calculate with calculator I :

$$4^{\circ}30' \sin : 7^{\circ} 00' + / - \text{Cos} : 23^{\circ} 14' 44'' + / - \text{Cos} - 7^{\circ} 00' + / - \text{Tan} \times 23^{\circ} 14' 44'' + / - \text{Tan} = \text{Shift Cos Shift}^{\circ}$$

4° 30' si	:	7° 00'	+	/	-	Cos :	23° 14' 44''	+	/	-	Cos - 7° 00'
+	/	-Tan	×	23° 14' 44''	+	/	-Tan)	=	Shift Cos Shift°	

Calculate with calculator II :

Shift Cos (Sin 4°30' : Cos (-)7° 00' : Cos(-)23°14'44" -Tan(-)7° 00' × Tan (-)23°14'44")

Shift	Co	(	Sin	:	Co	(	-	)	7° 00'	(	-	)	23°14'44"
	s		4°30'		s								
-	tan	(	-	)	7° 00'	×	Tan	(	-	)	23°14'44")	

a. The Beginning of Duha Time (AWD)

$$\begin{aligned}
 AWD &= \text{pkl. } 12 - (-0^{\circ} 01'44") \text{ ultimate time} \\
 &= \text{pkl. } 12^{\text{j}}01^{\text{m}}44^{\text{d}} - 05^{\text{j}}55^{\text{m}}26^{\text{d}} \\
 &= \text{pkl. } 06^{\text{j}}06^{\text{m}}18^{\text{d}} \text{ (local time)} + 00^{\text{j}}01^{\text{m}}42^{\text{d}} \text{ (ikhtiyat)} \\
 &= \text{pkl. } 06^{\text{j}}08^{\text{m}} \\
 &= \text{pkl. } 06:08 \text{ WIB}
 \end{aligned}$$

So the start of the dhuha time in Semarang is 06.08 on 29-12-2011. If the criteria for the angle or height of the sun 4°30' is illustrated in the form of a Cartecius graph, the second unit is converted to decimal degrees first, by:

$$4^{\circ}30' = \dots^{\circ} \quad (\text{first, convert from hours and minutes to degrees})$$

$$\text{Let, } 1^{\circ} = 60' = 360^{\circ}$$

$$\text{So, } 4^{\circ}30' = 4^{\circ} + \frac{30'}{60} \quad \left(\frac{30'}{60} \text{ convert first}\right)$$

$$= 4^{\circ} + \frac{5}{10} = 4^{\circ} + 0,5 = 4,5^{\circ}$$

So, from the criteria 4°30' if it is changed in the form of degrees then it produces 4,5°. If it is depicted on a Cartecius graph, an acute angle will be formed as shown in Figure 6.

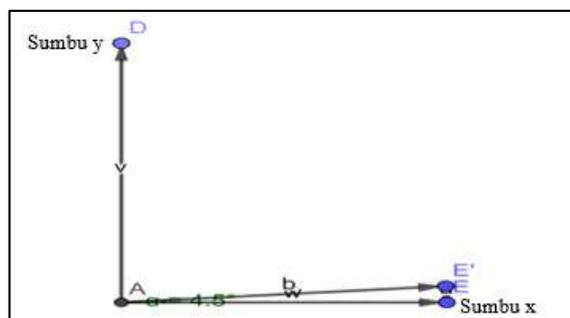


Figure 6. Angle 4,5°

2. The initial calculation of dhuha time uses the third criterion, 12° according to A.Djamil. For example, the initial time for dhuha in the city of Metro Lampung will be calculated as for the calculation steps as follows (Djamil, 2011) :

Because what you are looking for is time or t , then based on the calculation of the sun's declination, latitude, and sun's height (h), if the formula:

$$\cos A = \frac{\cos a - \cos b \cos c}{\sin b \sin c} = \frac{\cos a}{\sin b \sin c} - \cotan b \cotan c$$

Replaced symbols and signs:

$$A = t$$

$$a = 90^\circ - h$$

$$b = 90^\circ - \delta\varphi$$

$$c = 90^\circ - \varphi, \text{ then the form becomes :}$$

$$\begin{aligned} \cos t &= \frac{\sin h - \sin \varphi \sin \delta}{\cos \varphi \cos \delta} = \frac{\sin h}{\cos \varphi \cos \delta} - \tan \varphi \tan \delta \\ &= -\tan \varphi \tan \delta + \cos \varphi \cos \delta \sin h \\ &= -\tan \varphi \tan \delta + \sec \varphi \sec \delta \sin h \\ &= -\tan \varphi \tan \delta + \sin h : (\cos \varphi \cos \delta) \\ &= -\tan \varphi \tan \delta + \sin h : \cos \varphi : \cos \delta \end{aligned}$$

Furthermore, if the formula:

$$\sin^2 \frac{1}{2} A = \frac{\sin(s-b) \sin(s-c)}{\sin b \sin c}$$

If the symbol or sign is replaced as per the above formula, it $2s = a + b + c$, becomes:

$$(90^\circ - h) + (90^\circ - \delta) + (90^\circ - \varphi) = 270 - (h + \delta + \varphi)$$

Then the complete formula is:

$$\sin^2 \frac{1}{2} t = \frac{\cos(s - \varphi) \sin(s - \delta)}{\cos \varphi \cos \delta}$$

To complete the calculation with the astronomy formula, it is written in the following form:

$$\sin^2 \frac{1}{2} t = \sqrt{\frac{\cos(S + \varphi) \sin(S + \delta_{mh})}{\cos \varphi \cos \delta_{mh}}}$$

$$2S = 270^\circ - (\varphi + \delta_{mh} + h_{mh})$$

$$S = \frac{270^\circ - (\varphi + \delta_{mh} + h_{mh})}{2}$$

Langkah selanjutnya:

1) Menentukan data yang diperlukan

$$\varphi = -05^\circ 07'$$

$$\delta_{mh} = 03^\circ 14' 29''$$

$$\lambda = 105^\circ 18' \text{ Timur}$$

$$\lambda_\omega = 105^\circ \text{ Timur}$$

$$e = 00^J 04^m 29^d$$

$$MP = 12^J 00^m 00^d - (e)$$

$$h_{mh} = 12^\circ$$

2) Finding the meridian pass (MP)

$$MP = 12^J 00^m 00^d - (e)$$

$$= 12^J 00^m 00^d$$

$$MP = \frac{12^J 04^m 29^d - 11^J 55^m 31^d}{11^J 55^m 31^d}$$

3) Find the angle of time (t) dhuha with the formula

$$\cos t = -\tan \varphi \tan \delta + (\sec \varphi \sec \delta_{mh} \sin h_{mh})$$

$$-\tan(-05^\circ 07') = 0,0895 \text{ (x)}$$

$$\tan(03^\circ 14' 29'') = \underline{0,0566 \text{ (=)}}$$

$$-\tan \varphi \tan \delta = 0,0051$$

$$-\sec(-05^\circ 07'') = 1,0041 \text{ (x)}$$

$$\sec(03^\circ 14' 29'') = 1,0016 \text{ (x)}$$

$$\sin(12^\circ) = \underline{0,2079 \text{ (=)}}$$

$$\sec \varphi \sec \delta \sin h$$

$$\cos t = \frac{0,2091 (+)}{0,2142}$$

$$t = 77^{\circ}37'53''$$

4) Formula of early dhuha times

$$\begin{aligned} (t - \lambda + \lambda_{\omega}) : 15 + MP - i &= \\ &= (77^{\circ}37'53'') - 105^{\circ} 18' + 105^{\circ} \\ &\quad : 15 + 11^J55^m31^d + i \\ &= (77^{\circ}37'53'') : 15 + 11^J55^m31^d + i \\ &= -05^J09^m19,54^d + 11^J55^m31^d + i \\ &\quad 06^J49^m11,46^d \\ i &= \frac{00^J01^d11,54^d(+)}{06^J49^m00^d \text{ WIB}} \end{aligned}$$

Thus, the start of the dhuha time for the city of Metro Lampung on September 15, 2007 is 06^J49^m00^d WIB.

3. Calculation of the time of dhuha according to A. Kadir, using the criteria for the height of the sun of 12° (Kadir, 2012) , assuming that the initial time for the dhuha of Palu city will be searched, the steps are as follows:

$$\text{latitude } (\varphi) = -0^{\circ}53'37,44''$$

$$\text{Longitude of place } (\lambda) = 119^{\circ}51'8,4''$$

$$\text{Standard time longitude } (\omega) \text{ WITA} = 120^{\circ}$$

$$\text{Solar declination } (\delta m) \text{ 23 GMT (5 March 2020 Miladiah)} = -5^{\circ}35'07''$$

$$\text{The height of the sun } (\hat{h}m) \text{ dhuha time} = 12^{\circ}$$

$$\text{Equation of time (e) at 23 GMT} = -11'15''$$

$$\begin{aligned} \text{Meridian Pass (M)} &= 12 - e \\ &= 12 - (-0^{\circ}11'15'') \\ &= 12^J11^m15^d \end{aligned}$$

$$\cos \hat{t}m = \frac{\sin \hat{h}m}{\sin \varphi} - \tan \varphi \cdot \tan \varphi m$$

$$\begin{aligned}
&= \frac{(\cos \varphi \cdot \cos \delta m)}{\sin 12^\circ} - \tan -0^\circ 35' 44'' \times \tan 5^\circ 35' 07'' \\
&= \text{Exe } 0.207403357 \\
&= \text{Shift Cos Ans Exe Shift,,, } 78^\circ 01' 47.19'' \\
&78^\circ 01' 47.19''
\end{aligned}$$

$\acute{t}m$

Because what you are looking for is the initial time of dhuha, it $\acute{t}m$ was negative ($\acute{t}m = -$)

$$\begin{aligned}
\text{Beginning of Duha Time} &= \frac{(-\acute{t}m - \lambda + \omega)}{15} + M \\
&= \frac{(-78^\circ 01' 19'' - 119^\circ 51' 4'' + 120^\circ)}{15} + 12^J 11^m 15^d \\
&\text{Exe Shift,,, } 6^\circ 59' 43.29'' \\
\text{Beginning of Duha Time} &= 6^\circ 59' 43.29'' \\
&\text{WITA}
\end{aligned}$$

Ihtiyath plus a maximum of 2 minutes ($1^m 16.71^d$)

So the start of the dhuha time in the city of Palu on March 6, 2020 Miladiah is at 07.01^mWITA.

If the angle 12° , is drawn on the Cartesian coordinate plane, then the angle will form an acute angle as shown in Figure 7.

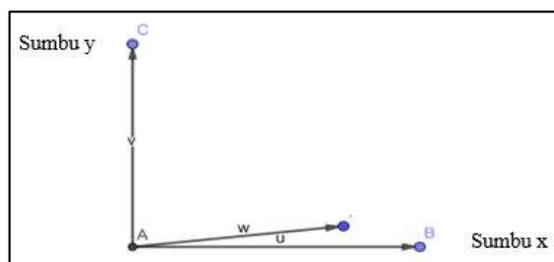


Figure 7. Angle 12

From calculations using several criteria for the angle of elevation of the sun offered by the scholars of Dikih and astronomy, if applied to the Curup area, according to Prof. Budi Kisworo criteria by Ahmad Izzudin, Slamet Hambali, and Zubair 'Umar Jailani are the most appropriate criteria to use, which is equal to $04^\circ 30'$ (Kisworo, 2010) . This is because these

criteria are the most appropriate when viewed from the longitude and latitude of the area belonging to the Curup region of 102 °31'24" east longitude and -30 °28'33" south latitude which is a geographical area located on the equator line. The initial calculation of the time of dhuha according to Prof. Budi Kisworo is as follows (Kisworo, 2010) :

4. Initial calculation of dhuha in Curup city:

The available astronomical data are:

- The star of the curup (ϕ) = -30°28'33" LS
- Longitude of place (λ) = 102°31'24" BT
- Solar declination (δ) = 13°21'00" U
- Equation of Time* (e) = -04^m05^d
- h sun dhuha time = 04°30'
- Zenit of sun (zm) = 85°30'

Calculation steps:

Find the angular time of time (t) using the formula:

$$\begin{aligned} \text{Cos } t &= -\text{tg } \phi \text{ tg } \delta + \text{sec } \phi \text{ sec } \delta \cos \text{zm} \\ \text{Atau} &= -\text{tg } \phi \text{ tg } \delta + \sin h : \cos \phi : \cos \delta \\ &= -\text{tg } -03^{\circ}28'33'' \text{ tg } 13^{\circ}21'00'' + \sin 04^{\circ}30' : \cos - \\ &\quad 03^{\circ}28'33'' : \cos 13^{\circ}21'00'' \\ &= (0,060739265) (0,237311602) + (0,078459095 : \\ &\quad 0,99816045^{\cdot}9 : 0,972977746) \\ &\quad 84,53711922 \quad \text{---} \text{---} \text{---} \rightarrow 84^{\circ}32'14'' \end{aligned}$$

If the calculation is done using a Casio fx 3650P calculator, then the steps are as follows:

Shift	Cos	(	-	Tan	-	03°28'33"	X	Tan	13°21'00"	+
Sin	04°30'	:	Co	-	03°28'33"	:	Cos	13°21'00"	)	Exe
Shift	o''	Display on screen 84°32'13,63"								

$$\text{Mer. Pass} = 12 - (-04^m 05^d) = 12^j 04^m 05^d$$

$$t \text{ of sun} = 84^{\circ}32'13,63'' : 15 = 05^j 38^m 09^d$$

Regional time	= 06 ^j 25 ^m 56 ^d
Longitude difference (105° - 102°31'24" : 15	= 00 ^j 25 ^m 56 ^d ----- + 06 ^j 35 ^m 50 ^d
Local time	= 00 ^j 01 ^m 10 ^d
Ihtiyat	----- + 06 ^j 37 ^m

Thus, the beginning of the dhuha of Curup pata on August 17, 2009 is at 06^j 37^m.

Although the start of the Duha prayer time in each region is different, it does not affect the angle of the sun's elevation which has been determined by some experts in jurisprudence and astronomy. If the criteria for the height of the sun presented in Table 1 are drawn in Cartesian coordinates, then we will see the shape of the angle that is formed. The illustration of the angle measure for each criterion in Table 1 is reviewed as follows:

1) Angle 4°30'

Before the criteria for the sun's height of 4 °30 'is described in Cartecius coordinates, it must be converted to decimal degrees first, in the following way:

4°30' =.....° (*first, convert from hours and minutes to degrees*)

Misalkan, 1° = 60' = 360°

$$\text{Maka, } 4^{\circ}30' = 4^{\circ} + \frac{30'}{60} \quad \left(\frac{30'}{60} \text{ convert first}\right)$$

$$= 4^{\circ} + \frac{5}{10}$$

$$= 4^{\circ} + 0,5$$

$$= 4,5^{\circ}$$

so, from criteri of angle 4°30' if it is converted into degrees then the result is

$$4,5^{\circ}$$

The illustration of the angle $04^{\circ}30'$ or equal to 4.5° can be seen in Figure 8

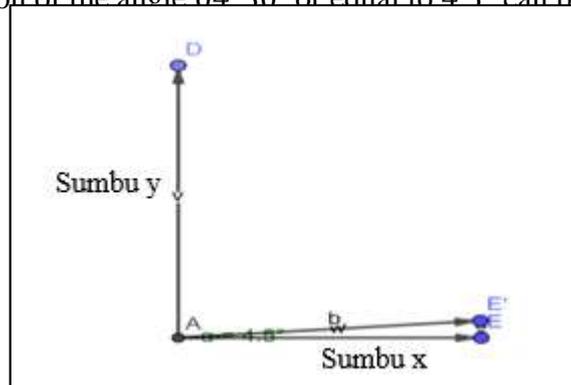


Figure 8. Angle 4.5°

2) Angle $3^{\circ}30'$

For angles $3^{\circ}30'$ if converted into decimal degrees it will produce;

$$3^{\circ}30' = 3^{\circ} + \frac{30'}{60} = 3^{\circ} + \frac{5}{10} = 3^{\circ} + 0,5 = 3,5^{\circ}$$

The illustration of an angle $3^{\circ}30'$ or equal to the angle $3,5^{\circ}$ is presented in Figure 9.

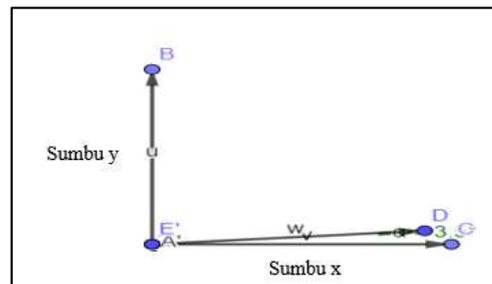


Figure 9. Angle 3.5°

3) Angle 12° , presented in Figure 10

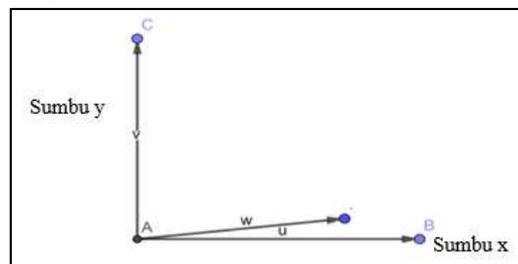


Figure 10. Angle 12°

4) Angle 4° , presented in Figure 11.

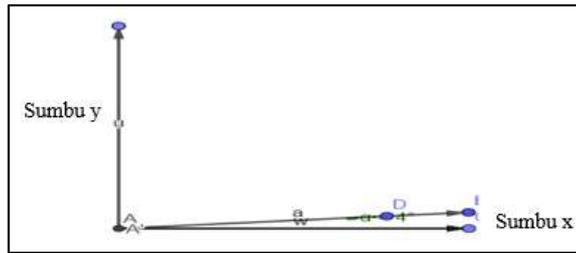


Figure 11. Angle 4°

5) Angle 3°, presented in Figure 12.

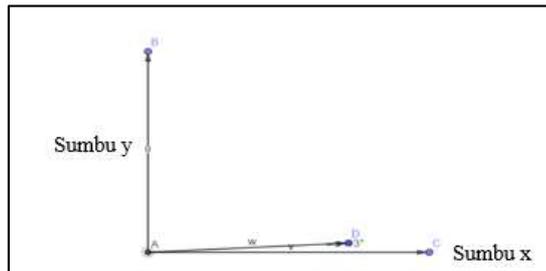


Figure 12. Angle 3°

From the illustration of the angle criteria offered by the fiqh and astronomy experts presented in Figure 9-11, we can see that if each criterion for the angle of the sun's elevation is connected with geometry, then each criterion forms an acute angle even though the angles given are different. This is if we observe in each Figure 9-11, if we take point 0 for example with the observer, then the position of the sun is not close to the observer's head, this indicates that the day is still early and has not yet reached noon (midday).

If the formulas contained in the initial calculation of the dhuha time presented in points 1-4 we connect or interconnect with mathematics, then there is some mathematics as follows:

1. basic concepts of mathematical arithmetic operations, namely addition, subtraction, multiplication and division;
2. trigonometric concepts such as: $\sin \alpha = \frac{AB}{AC}$, $\cos \alpha = \frac{BC}{AC}$, dan $\tan \alpha = \frac{AC}{BC}$;
3. The basic concept of geometry is an acute angle;
4. The concept of calculating time in mathematics, namely:

$$\begin{array}{rcl}
 \text{Mer. Pass} & = & 12 - (-04^m 05^d) = 12^j 04^m 05^d \\
 \text{t sun} & = & 84^\circ 32' 13,63'' : 15 = 05^j 38^m 09^d \\
 & & \text{-----} \\
 \text{Regional} & & = 06^j 25^m 56^d \\
 \text{Time} & &
 \end{array}$$

Longitude difference ($105^\circ -$	$= 00^j 25^m 56^d$
$102^\circ 31' 24'' : 15$	----- +
	$06^j 35^m 50^d$
Local time	$= 00^j 01^m 10^d$
Ihtiyat	----- +
	$06^j 37^m$

CONCLUSION

At the time of the implementation of the sunnah prayer dhuha there are mathematical concepts in it. The mathematical concepts that are connected at the time of the dhuha prayer are the concept of angles, the concept of numbers, the concept of arithmetic, the concept of trigonometry, and the concept of geometry. The results of the connection between angles and numbers in the Qur'an, especially the verses relating to the beginning of the time of the implementation of dhuha which are associated with angles, numbers, and QS number patterns . At-Taha verses 59 and 119, QS. Al-A'raf verse 98, QS. An-Nazi'at verses 29 and 46, QS. Al-Sham verses 1-2, and QS. Ad-Dhuha verse 1. The mathematical concepts contained in the dhuha prayer time are also trigonometric concepts, geometric mathematical concepts about acute angles formed from the position and degrees of the sun's height at the beginning of dhuha time such as $4,5^\circ$, $3,5^\circ$, 12° , 4° , and 5° , the basic concepts of mathematical arithmetic operations (+, -, ÷, and ×), and the basic concepts of time calculation.

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