

## Initial Calculation of Prayer Time Based on Geolocation Using Spreadsheet

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### Abstract

The time of prayer is influenced by the position of the sun relative to the earth, which varies with the location and time of the observer. Astronomically, this is related to the position of latitude and longitude that can be obtained from the map using geolocation techniques. The sample of this study is the coordinates of large mosques in 15 regions in Indonesia on the 15th of each month throughout 2024. To facilitate the process of collecting and calculating data and avoiding errors in calculations, researchers use Spreadsheet calculation tools in the form of Microsoft Excel applications. This research uses a quantitative approach with an experimental method to test the effectiveness of using the coordinate points of large mosques in determining prayer times. The results show that there is a difference of about 11.2%, from a total of 900 calculation results, compared to the results of Bimas Kemenag Islam using midpoint data. This difference is relatively small because the value only ranges from less than 1 minute to more than 1 minute, so it can be used in determining the beginning of prayer time.

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### A. Introduction

The initial calculation of the prayer time is based on the position of the sun with respect to the earth. However, these positions have a value that changes in line with changes in location and time. This means that the time difference in the prayer schedule can be influenced by the position of an observer on earth, which is astronomically related to the position of latitude and [1] longitude of a place. The position of latitude and longitude of a place has different values even though it is in the same time zone with relatively similar solar declination. [2]

It takes 24 hours for the Earth to rotate  $360^\circ$  on its axis, so the angle traveled in an hour is  $360^\circ \div 24 = 15^\circ$ . An hour consists of 60 minutes, then in  $1^\circ$  it takes  $60 \text{ minutes} \div 15^\circ = 4 \text{ minutes}$ . It is assumed that the circumference of the earth's surface is 40,000 kilometers, then the distance traveled in  $1^\circ$  is  $40,000 \text{ kilometers} \div 360^\circ = 111 \text{ kilometers}$ ,

so that the distance traveled per minute is  $111 \div 4 \text{ minutes} = 27.75$  kilometers. This means that every 27.75 kilometers to the west will add 1 minute to the time. [3]

The use of different latitude and longitude coordinate points has a significant impact on the results of the initial calculation of prayer time, because it can affect the value of time zone data, regional time correction (KWD), solar declination values and time equalizers, sun height at the time of Asr prayer, and the angle of the sun at the time of Asar prayer, Maghrib, Isha, and Fajr prayers. Therefore, it is important to study and analyze the coordinate points of each location in the calculation of the initial schedule of prayer times, not just by taking one point in the region as a reference. If the area is not too large and the distribution of the city is not much, it is not too much of a problem because there is an addition to the value of ihtiyat, but in a very large area, there needs to be a solution in taking the reference point of coordinates at each location in the calculation of prayer time so that it can reduce the error rate and provide more benefits. Therefore, to determine the coordinate point of a place precisely, geolocation techniques are needed. [4] [2]

Geolocation is a technique for finding, determining, and providing a location based on a location coordinate point. Geolocation works through a built-in GPS/Map that spreads the latitude and longitude coordinates of a place to provide a complete address which usually includes countries, cities, building names and street addresses. This technique can be used to determine the coordinate point of a specific place. So that when making and compiling calculations based on the coordinate points of each place using the latest and [5] real-time astronomical data, the results of the initial calculation of the prayer time will be more accurate. [2]

To facilitate the calculation process and avoid errors in calculations, the researcher uses a calculation tool that prioritizes speed, accuracy, and accuracy in the calculation process. One of the calculation tools included in this criterion is [6] Spreadsheets. Spreadsheets are computational tools that provide simple, easy-to-learn and almost universally available calculation tools. The positive impact of its use includes the speed of calculation, the accuracy of the calculation results, the ease of data collection, and its easy use to be applied by various groups. This can be used to develop a way to calculate the initial prayer time, which initially required complicated manual calculations, to become more practical and accurate. [7] [7].

## B. Method

This study uses a quantitative approach with the type of experimental research to test whether or not the experimental variables are effective. The population in this study is the beginning of mandatory prayer time in Indonesia in 2024, while the sample used includes data on the beginning of prayer time in 15 regions in Indonesia taken on the 15th of every month throughout 2024. This research was carried out for approximately one month with the location of the research adjusting to the conditions of the researcher at that time. [8] In this study, variable data that changes are variables whose value is influenced by changes in coordinate points such as sun data from the NOAA Solar Calculator, latitude and longitude data from Map XL, and time zone data from API, while for solar height and the number of *Ihtiyat* still use the standard used in the book *Ephemeris Hisab Rukyat 2024* as a control variable. The data collection technique is carried out through documentation from NOAA Solar Calculator, Map XL, and several websites that provide APIs with data in JSON format. The analysis of research data used descriptive statistics, namely frequency distribution and measurement of central tendencies.

## C. Results and Discussion

### Research Results

#### 1. The Effect of Coordinate Points on the Calculation of Prayer Time

The initial prayer time calculation program compiled in this study refers to the formula for calculating the initial prayer time published by the Ministry of Religion of the Republic of Indonesia which is listed in the book *Ephemeris Hisab Rukyat 2024*. In the process of early hisab prayer time, astronomical data is needed, such as geographical data of latitude and longitude of places, time zone data, solar data such as solar declination data and *equations of time*, solar altitude data, and *Ihtiyat*. The use of different latitude and longitude coordinate points can change the data of the sun's declination, *equation of time*, solar altitude, and time zone. Therefore, changes in the coordinates of the place have a significant impact on the results of the initial calculation of prayer time, because it

can affect the value of time zone data, regional time correction, sun data, sun altitude and solar time angle. Here's the presentation: [13]

- a. Time Zone. In the determination of time in Indonesia, there are three time zones, each of which uses a different time standard. The western part of Indonesia uses West Indonesia Time (WIB) with a longitude of  $105^\circ$  as a benchmark, which is equivalent to +7 hours from GMT. The central part of Indonesia uses Central Indonesia Time (WITA) as the time standard, with an area longitude reference of  $120^\circ$  or +8 hours from GMT. Meanwhile, the eastern part of Indonesia uses Eastern Indonesia Time (WIT) as the standard time, with a regional longitude reference of  $135^\circ$  or +9 hours from GMT. [14]

- b. Regional Time Correction (KWD). Regional Time Correction is a time adjustment that is set and applied based on a certain region by referring to geographical coordinates, especially the longitude value of an area. The formula for calculating the time correction of the area is as follows:

$$\text{KWD} = (\text{Region Longitude} - \text{Spot Longitude}) : 15 \quad [13]$$

- c. The Value of Solar Declination and *the Equation Of Time*. The value of the sun's declination and *equation of time* is adjusted to the time zone in the location where it is located. The values of latitude and longitude of a place have different time zones, therefore the declination values and *equations of time* are different according to the time zone of that place. The western time zone of Indonesia is +7 hours from GMT, central Indonesia is +8 from GMT, while eastern Indonesia is +9 from GMT. So to determine the reference time based on GMT in finding the value of declination and *equation of time* can be done as follows:

$$\begin{aligned} \text{WIB (+7)} & : 12:00 - 07:00 = 05:00 \text{ GMT} \\ \text{WITA (+8)} & : 12:00 - 08:00 = 04:00 \text{ GMT} \\ \text{WIT (+9)} & : 12:00 - 09:00 = 03:00 \text{ GMT} \quad [14] \end{aligned}$$

- d. Height of the Sun. The value of the height of the sun, especially at the time of Asar uses data on the latitude and declination of the sun, so it is greatly influenced by the value of latitude and longitude of a place. The formula for calculating the height of the sun at the time of Asar is as follows:

$$\text{Cot } h = \tan (|p - d|) + 1 \quad [13]$$

- e. Angle of Time of the Sun. The value of the sun's time angle is not used in the initial calculation of the time of the zuhur prayer, because at the time of zuhur the value of the sun's time angle at the time of zuhur is zero. While at prayer times other than zuhur, the angle of the sun's time has different values, depending on the latitude of the place, the declination of the sun and the height of the sun. The formula for calculating the angle of the sun's time is as follows:

$$\text{Cos } t = - \tan p \times \tan d + \text{without } h : \cos p : \cos d \quad [13]$$

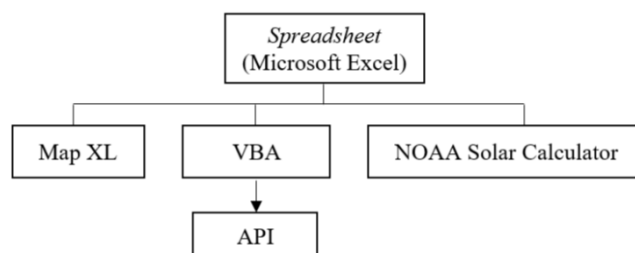
Information:

- $p$  = latitude of place
- $d$  = solar declination
- $h$  = height of the sun

Because the use of different coordinate points can affect the results of the initial calculation of prayer times, a geolocation technique is needed to identify the location or geographical coordinates of a place. The geolocation referred to in this study is the practice of locating locations that can be accessed directly through GPS/Map. By getting data through Maps integrated with calculation tools, *Spreadsheets*, data such as latitude and longitude of a location will be more specific and easy to obtain.

## 2. Preparation of the Initial Calculation of Prayer Time on a Spreadsheet

In this study, there are a number of elements that support the implementation of the geolocation-based prayer time initial calculation program. These elements include *Spreadsheets*, Map XL, NOAA Solar Calculator, VBA (*Visual Basic for Applications*), and API (*Application Programming Interface*). Each of these elements has a specific role and complements each other so that the process of calculating the initial prayer time becomes more efficient and practical. An explanation of the relationship between these elements is shown in Figure 1:



**Figure 1.** Relationship Between Elements

a. A spreadsheet, or in Indonesian spreadsheet, is an application or program designed to process data in the form of numbers, text, or formulas. The data is placed in cells that are the intersection between rows and columns. There are different types of [15] Spreadsheets, one of the most commonly used is Microsoft Excel, developed by Microsoft Corporation. Microsoft Excel has ease of use and has many facilities in the form of ready-to-use formulas (functions) available in it. Thanks to these advantages, researchers use Microsoft Excel as the main platform in geolocation data processing with the help of parameters from astronomical data to calculate the beginning of prayer time practically and efficiently. [15]

b. Map is a tool used to provide information about the location of a place. In this study, the researcher utilizes an online map application that can be integrated directly into Microsoft Excel, namely Map XL. Basically, Map XL is an add-in in the Microsoft Excel application that allows users to display online maps based on specified point data. This map has a feature that allows users to zoom in or out of the map view. In addition, the resulting map is able to display data on the coordinate points of a specific location, which is determined by two main parameters, namely latitude and longitude. [16]

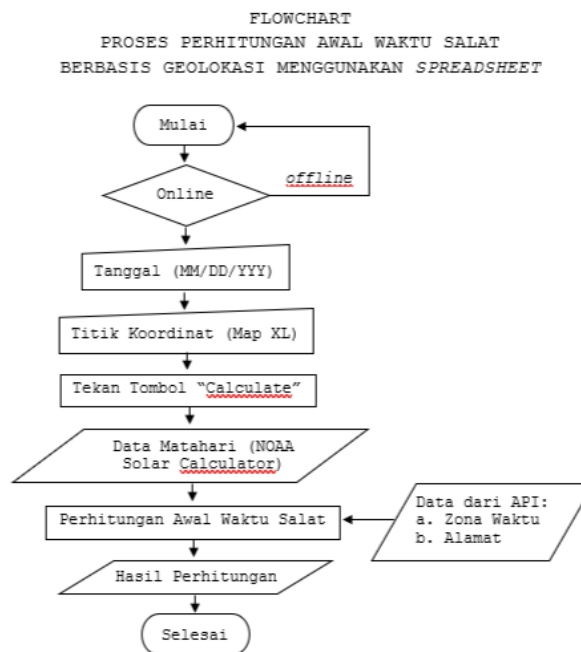
c. VBA (Visual Basic for Applications) is an object-based programming language available on the Developers tab in Microsoft Excel applications. The main function of VBA is to assist users in creating various programs or functions that are capable of automating processes and formulating many functions at once. Tasks that previously required long steps can be transformed into much simpler processes with a single step. In this study, VBA is used as a programming language to send data requests as well as call data from APIs.

d. An API (Application Programming Interface), or in Indonesian means Application Programming Interface, is a set of rules that allow two separate systems or applications, namely a client and a server, to communicate with each other using a predefined protocol. APIs allow data from websites to be viewed, accessed, viewed, and leveraged by computers or applications, so that tasks can be automated more easily and quickly. In this study, APIs are used to simplify the process of collecting data from external sources (such

as websites) online, so that manual data input is not required. The data taken includes the time zone and the address of the coordinate point. [17]

e. The NOAA Solar Calculator is a solar calculator released by the National Oceanic and Atmospheric Administration (NOAA) in Spreadsheet format. This calculator was developed based on calculations found in the book *Astronomical Algorithm* by Jean Meeus. Because it is presented in the form of a Spreadsheet file, the NOAA Solar Calculator can be easily integrated with various other Spreadsheet applications to obtain the desired data, such as data equation of time and solar declination. [18]

The workflow of the geolocation-based early calculation of prayer time using *Spreadsheets* can be understood through the following flowchart:

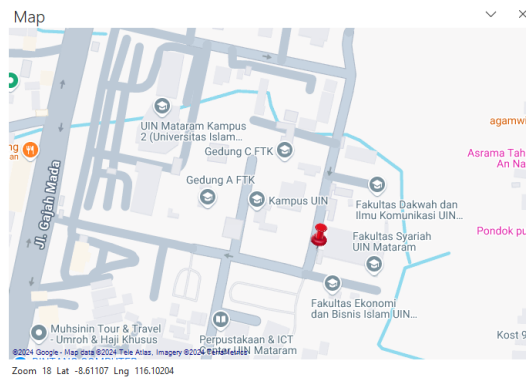


**Figure 2.** Calculation Program Flow Chart

The calculation in this program fully refers to the initial calculation of prayer time listed in the book *Ephemeris Hisab Rukyat 2024*. The book is the main reference because it is published by the Ministry of Religion of the Republic of Indonesia and is the basic formula for calculating the initial schedule of prayer times in Indonesia, the results of which can be accessed through the Islamic Community Guidance website. Based on the results of these calculations, the researcher then designed a simple display to make it

easier for users to operate geolocation-based calculation programs, so that they can be accessed and used more practically. This simple view ensures that the calculation process can be done quickly and efficiently without the need for in-depth technical expertise. Here is an explanation of how the program works:

- a. Choose a location. The researcher took the location at the Faculty of Sharia UIN Mataram. See Figure 3.



**Figure 3.** Location Pickup View in Map XL

- b. Copy the coordinate points on the latitude and longitude cells, fill in the desired date, and click the 'Calculate' button. See Figure 4.

Date	<input type="text" value="3/15/2024"/>	mm/dd/yyyy
Lat	<input type="text" value="-8.611074574"/>	
Lng	<input type="text" value="116.1020458"/>	<input type="button" value="Calculate"/>

**Figure 4.** Data Input Display and ActiveX Control Button Usage

- c. Then the data will appear as shown in Figure 5 below.

Date	<input type="text" value="3/15/2024"/>	mm/dd/yyyy
Lat	<input type="text" value="-8.611074574"/>	
Lng	<input type="text" value="116.1020458"/>	<input type="button" value="Calculate"/>

Timezone	<input type="text" value="8"/>
Address	<input type="text" value="Rumah Sakit Islam Siti Hajar, Jalan Catur Warga, Lingk. Karang Sukun, Kel. Mataram Timur, Pagesangan, Mataram, Kec. Selaparang, West"/>
Sun Declin	<input type="text" value="-2.093319051"/>
Eq of Time	<input type="text" value="-8.934628957"/>

Zuhur	<input type="text" value="12:28:00"/>
Asar	<input type="text" value="15:39:00"/>
Magrib	<input type="text" value="18:32:00"/>
Isya	<input type="text" value="19:41:00"/>
Subuh	<input type="text" value="5:05:00"/>

**Figure 5.** Output Display of Initial Calculation of Prayer Time Based on Geolocation Using *Spreadsheet***Discussion of Results and Accuracy Levels**

As previously explained, the results of the initial calculation of prayer time based on this geolocation use the same formula as the formula for calculating the initial prayer time contained in the book *Ephemeris Hisab Rukyat 2024*. In fact, the process of rounding up before adding *ihiyat* also follows the same method. The addition of *ihiyat* applied is also no different, namely 3 minutes for the time of zuhur and 2 minutes for the time of asar, magrib, isha, and dawn. In addition, the solar altitude data used in this calculation is in accordance with the standards that have been set in the book. Therefore, if there is a difference in the calculation results, it is due to the difference in the data sources used, especially at the coordinate points obtained through geolocation techniques.

To analyze the accuracy of the results, the researcher compared the results of the calculation of the initial prayer time based on geolocation with the results of the initial calculation of prayer time obtained from the Islamic Guidance of the Ministry of Religion of the Republic of Indonesia. This comparison is carried out using coordinate points that represent the center or center of each city/district. The Ministry of Religion in calculating the initial prayer time, using data on the middle or center coordinate points of an area issued by the Geospatial Information Agency (BIG), can be seen in Table 1 below.

**Table 1.** Latitude and Central Longitude or City Center data from BIG [4]

Location	Across	Longitude
Banda Aceh City	5° 33' 43"	95° 19' 49,01"
Pekanbaru City	0° 34' 7"	101° 27' 38,88"
Central Jakarta City	-6° 10' 54,01"	106° 50' 8,16"
Pontianak City	0° 0' 33,13"	109° 19' 45,84"
Surabaya City	-7° 16' 23,02"	112° 43' 13,08"
Samarinda City	-0° 27' 1,01"	117° 10' 18,12"
Mataram City	-8° 35' 17,02"	116° 6' 51,84"
Kendari City	-3° 15' 10"	122° 34' 54,12"
Kupang City	-10° 10' 17,04"	123° 35' 15"
Manado City	1° 30' 53"	124° 52' 32,88"
Ternate City	0° 47' 29"	127° 20' 47,04"
Ambon City	-3° 41' 3,98"	128° 12' 56,16"
Manokwari City	-0° 57' 16,99"	133° 48' 33,12"
Merauke Regency	-7° 54' 58"	139° 30' 47,88"
Jayapura City	-2° 38' 57,01"	140° 46' 41,16"

The coordinate point data above is old data, so it has several changes due to regional expansion in Indonesia in 2022 and 2023. In Government Regulation of the Republic of Indonesia Number 78 of 2007 concerning Procedures for the Formation, Abolition, and Merger of Regions, regional expansion is the division of provinces or districts/cities into two or more regions. The expansion of an area can result in a change in the area area, so that it can change the value of its midpoint. [19]

To update the midpoint data, the researcher uses an approach formula to find the central coordinates of an area: [4]

Middle Latitude = [ Northernmost latitude - [Northernmost latitude – Southernmost latitude]/2]

Middle Longitude = [ Westernmost longitude + [Easternmost longitude – Westernmost longitude]/2]

So that the midpoint data is obtained as follows:

**Table 2.** Latitude and Center Longitude Data After Expansion

Location	Across	Longitude
Banda Aceh City	5° 33' 39,97"	95° 19' 43,49"
Pekanbaru City	0° 30' 49,65"	101° 26' 28,23"
Central Jakarta City	-6° 10' 56,58"	106° 50' 10,27"
Pontianak City	-0° 2' 7,18"	109° 19' 53,63"
Surabaya City	-7° 16' 32,06"	112° 42' 46,46"
Samarinda City	-0° 30' 6,18"	117° 7' 56,77"
Mataram City	-8° 35' 19,46"	116° 7' 12,78"
Kendari City	-3° 59' 6,49"	122° 32' 13,12"
Kupang City	-10° 10' 29,77"	123° 36' 53,07"
Manado City	1° 28' 58,56"	124° 50' 8,39"
Ternate City	0° 48' 37,98"	127° 20' 31,37"
Ambon City	-3° 40' 52,69"	128° 10' 12,05"
Manokwari City	-0° 51' 51,72"	134° 4' 26,75"
Merauke Regency	-8° 30' 2,36"	140° 24' 25,76"
Jayapura City	-2° 33' 54,07"	140° 40' 51,96"

The results of the comparison are then presented in the form of a single frequency distribution table in the following Table 3 :

**Table 3.** Single Frequency Distribution Table from the Results of Comparison of the Initial Calculation of Prayer Time with the Middle Coordinate Point and Islamic Guidance

Difference	Frequency
+1 minute	56
-1 minute	60
<b>Total</b>	<b>116</b>

In the table above, there are 116 calculation results that show differences. Among them, 56 results had a difference of more than 1 minute, while 60 results had a difference of less than 1 minute. This difference can be caused by the use of middle coordinate points that have not been corrected with certain adjustments in determining the coordinate points of city centers and districts. Even though the difference is relatively small, only in units of seconds, it can still affect the results of the initial calculation of prayer time. [4]

In the formula for calculating the initial prayer time listed in the book Ephemeris Hisab Rukyat 2024, there is a rounding process upwards that is carried out before the addition of *ihdiyat* in the initial calculation of prayer time. This upward rounding process can cause a change in the calculation results in a range of up to 1 minute. See the following summary of the initial calculation of prayer times for Asar and Maghrib:

Awal waktu salat Asar  
Mencari sudut waktu matahari (t)  

$$\text{Cos } t = -\tan p \times \tan d + \sin h : \cos p : \cos d$$

$$= -\tan (-8^{\circ} 36') \times \tan (-1^{\circ} 57' 45'') + \sin (41^{\circ} 51' 10,05'') : \cos (-8^{\circ} 36') : \cos (-1^{\circ} 57' 45'')$$

$$= 0^{\circ} 40' 12,07''$$

$$t = 47^{\circ} 55' 53,16''$$

$$t/15 = 03:11:43,54$$

Mer. Pass = 12:08:50  

$$t/15 = 03:11:43,54 +$$

$$= 15:20:33,54 \text{ LMT (Local Mean Time)}$$

KWD =  $00:15:28$  +  

$$= 15:36:1,54$$

$$= 15:37 \text{ (dibulatkan ke atas)}$$

*Ihtiyat* (i) =  $00:02$  +  

$$= 15:39:00 \text{ WITA}$$

Awal waktu salat Maghrib  
Mencari sudut waktu matahari (t)  

$$\text{Cos } t = -\tan p \times \tan d + \sin h : \cos p : \cos d$$

$$= -\tan (-8^{\circ} 36') \times \tan (-1^{\circ} 57' 45'') + \sin (-1^{\circ}) : \cos (-8^{\circ} 36') : \cos (-1^{\circ} 57' 45'')$$

$$= -0^{\circ} 1' 22,24''$$

$$t = 91^{\circ} 18' 32,41''$$

$$t/15 = 06:05:14,16$$

Mer. Pass = 12:08:50  

$$t/15 = 06:05:14,16 +$$

$$= 18:14:04,16 \text{ LMT (Local Mean Time)}$$

KWD =  $00:15:28$  +  

$$= 18:29:32,16$$

$$= 18:30 \text{ (dibulatkan ke atas)}$$

*Ihtiyat* (i) =  $00:02$  +  

$$= 18:32:00 \text{ WITA}$$

**Figure 6.** Fragment of the Initial Calculation of the Asar and Maghrib Prayer Time from the Ephemeris Hisab Rukyat 2024 Book

In the bolded part, it can be seen that no matter what second value is generated after the addition of the KWD value, the result is still rounded up. In other words, if the coordinate points used are different and cause an excess or deficiency in the second value, this will result in a difference in the final result by 1 minute.

The *ihhtiyat* value of 2 minutes applied by the Ministry of Religion is able to cover an area with a radius of up to 55.5 kilometers to the west. Therefore, a difference of 1 minute in the results of the above calculation can be considered quite accurate. Of the total 900 samples tested, namely 5 prayer times in 15 regions in Indonesia as of the 15th of every month throughout 2024, there were only 116 different values, or around 12.8% with differences ranging from less than 1 minute to more than 1 minute.

To ensure that this calculation program can be applied to other coordinate points, calculations are made based on the coordinate points of large mosques in the 15 areas. The coordinate points used in this calculation are obtained through geolocation techniques. After that, the value of the coordinate points obtained is converted from decimal units to degrees.

**Table 4.** Latitude and Longitude data obtained from Geolocation Engineering

Location	Address	Across	Longitude
Banda Aceh	Baiturrahman Grand Mosque	5° 33' 12,87"	95° 19' 2,23"
Pekanbaru	An-Nur Grand Mosque	0° 31' 36"	101° 27' 3,07"
Central Jakarta	Istiqlal Mosque	-6° 10' 12,6"	106° 49' 53"
Pontianak	The Mujahideen Grand Mosque	-0° 2' 29,96"	109° 20' 10,24"
Surabaya	Al-Akbar Mosque	-7° 20' 11,19"	112° 42' 54,07"
Samarinda	Baitul Muttaqien Mosque	-0° 30' 7,8"	117° 7' 10,74"
São Paulo	Hubbul Wathan Mosque	-8° 34' 47,87"	116° 6' 2,18"
Kendari	Al-Alam Mosque	-3° 58' 40,81"	122° 32' 40,36"
São Paulo	Kupang Grand Mosque	-10° 9' 51,96"	123° 34' 44,91"
Manado	M. Agung Awwal Fathul Mubien	1° 30' 23,54"	124° 50' 44,69"
Ternate	Al-Munawwar Mosque	0° 47' 21,13"	127° 23' 26,54"
Ambon	Al Fatah Grand Mosque	-3° 41' 47,3"	128° 10' 39,4"
Manokwari	Ridwanul Bahri Mosque	-0° 52' 4,83"	134° 3' 57,31"
Merauke	Al-Aqsa Grand Mosque	-8° 29' 37,8"	140° 24' 2,22"
Jayapura	Baiturrahim Grand Mosque	-2° 32' 41,21"	140° 41' 57,36"

The farthest distance difference when compared to the middle coordinate point is as follows:

- a. Al-Akbar Mosque Surabaya has a distance of  $0^{\circ} 3' 39.13''$  to the south from the midpoint of the city.
- b. The Great Mosque of Awwal Fathul Mubien Manado is located  $1^{\circ} 24' 98''$  north of the central point of the city.
- c. The Great Mosque of Kupang is  $0^{\circ} 2' 8.16''$  to the west from the midpoint of the city.
- d. Al-Munawwar Mosque Ternate is located  $0^{\circ} 2' 55.17''$  east of the midtown point.

Because the distance of the coordinate point used does not exceed  $0^{\circ} 15'$  from the midpoint or about 27.75 kilometers, the difference in the calculation results remains in the range of 1 minute.

**Table 5.** Single Frequency Distribution Table from the Results of Comparison of the Initial Calculation of Prayer Time with the Coordinate Points of the Grand Mosque and Islamic Guidance

Difference	Frequency
+1 minute	50
-1 minute	51
<b>Total</b>	<b>101</b>

From the table above, it can be seen that the difference in the difference in calculation results is still in the same range, which is less than 1 minute to more than 1 minute. However, the number of differences decreased to 11.2%. This shows that the calculated prayer time is included in the prayer time range that uses the middle coordinate point. This calculation can also cover a larger area, up to 27.75 kilometers to the west if the difference increases by 1 minute, and to the east if the difference decreases by 1 minute.

If the results of the two comparisons above are combined, a total of 136 results of the initial calculation of prayer times are found that are different from the results of the calculation of the Islamic Guidance. The results of the calculation using the coordinate

points of the mosque show similarities with the Islamic Guidance 36 times. On the other hand, the calculation results using the middle coordinate point only have similarities with Islamic Guidance 21 times. This shows that the calculation with the coordinate point of the great mosque is more accurate than the calculation using the middle coordinate point of a city or district. Therefore, the use of coordinate points obtained through geolocation techniques can be used to determine the beginning of prayer times.

#### **D. Conclusion**

The geolocation-based early prayer time calculation program is designed based on the formula for calculating the beginning of prayer time listed in the book *Ephemeris Hisab Rukyat 2024* using a *Spreadsheet* from Microsoft Excel to produce a simple, practical, and accurate calculation of prayer times. The program utilizes geolocation techniques to determine specific locations based on latitude and longitude coordinate points. This study tested the program with a sample of 15 regions in Indonesia, calculated on the 15th of every month throughout 2024 with two approaches, namely using the central coordinate point of the city or district to compare the calculation results with the Islamic Guidance and using the coordinate point of the great mosque in the city or district. Of the 900 samples, it was found that 11.2% of the results showed a difference in the range of less than or more than 1 minute, since the value of the coordinate points of the great mosque used did not exceed the distance of  $0^{\circ} 15'$  from the central coordinate point (about 27.75 kilometers). This distance is the factor causing the difference in results of 1 minute in the upward rounding process in the initial calculation of prayer time listed in the book *Ephemeris Hisab Rukyat 2024* before the addition of *ihityat*. This difference is relatively small because the value only ranges from less than 1 minute to more than 1 minute, so this geolocation technique-based early prayer time calculation program can be used in determining the beginning of prayer time effectively with accurate results.

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