COMPARING THE ACCURACY OF THE MODERN AND TRADITIONAL CALCULATION METHODS IN THE DETERMINATION OF PRAYER TIMES IN MALAYSIA

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Abstract

This article analyses and compares the traditional and modern calculation methods in determining the prayer times in Malaysia. Around 1800 A.D., prayer times were determined through the traditional method known as *rubu' mujayyab*. However, from the mid-19th century till today, the modern calculation method has replaced the traditional method. The traditional method is no longer used because it applied the general descriptive method which made the calculation slow as it took a longer time to use the *rubu' mujayyab* manual to calculate the prayer times. Though there are disadvantages in the traditional calculation method, the method should not be abandoned totally as there is research that doubts the accuracy of the results from the modern calculation method. Therefore, this research will analyse the data of prayer times that was accumulated between January to April 2011 by comparing between the modern and traditional calculation methods. The results showed that the traditional calculation method is more accurate and takes a more careful approach compared to the modern calculation method in the aspects of determining prayer times in Malaysia.

Keywords: *Rubu' mujayyab*, traditional calculation method, modern method, prayer times, general descriptive method.

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Introduction

Research on timekeeping has existed in the Arab world as early as 700 A.D. Research in this area was dominated by the Arab-Muslim scholars focusing on the three main aspects of Muslim acts of worship (*'ibadah*).

These three aspects are the daily prayers, the determination of the direction of the *qiblah* (direction of the Kaabah in Makkah – used for determining the direction to face when praying), and the determination of the beginning of the Islamic lunar month. There are several factors that led to the existence of research on timekeeping in the Arabic nations.

The assimilation of knowledge from the Greek and Indian civilizations is one of these factors. Arab scholars learnt physical astronomy, astronomical mathematics, trigonometry and geometry from the Greek civilizations.[1]

They learnt mathematical knowledge such as arithmetic, algebra, geography, decimals, and number

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[1] 'Ali 'Abdullah al-Daffa', *The Muslim Contribution to Mathematics* (USA: Humanities Press, 1977), 68- 69; Muhammad Adnan Bakhit, *History of Humanity* (Routledge: United Nations Educational, Scientific & Cultural Organization, 2000), 374; Howard R. Turner, *Science in Medieval Islam: An Illustrated Introduction* (USA: University of Texas Press, 1995), 64 & 65; Glen van Brummelen, *The Mathematics of the Heavens And The Earth: The Early History of Trigonometry* (New Jersey: Princeton University Press, 2009), 136.

theories from the Indian civilization.[2] Technology involving tools and equipment was also derived from the Greek[3] and Indian[4] civilizations. Through the assimilation of this knowledge, Arabic scholars successfully invented the world's first calculation method for prayer times known as *'ilm al-miqat*. This method was later disseminated to other parts of the Islamic world including the Malay Archipelago. This invention was the starting point for research on prayer timekeeping in Malaysia. Continuous researches finally lead to the invention of the modern calculation method that uses a formula to calculate the prayer times. This method later replaced the use of the traditional *'ilm al-miqat* method in Malaysia.

Methodology of Research

This research uses inductive analysis to analyse the data pertaining to the calculation of prayer times which have been gathered between the months of January and April 2011. The data is the calculation for the five compulsory daily prayer times of Zuhur, Asar, Maghrib, Isyak and Subuh, which numbers 600 data altogether. The prayer times were calculated using the traditional method which applies the *rubu' mujayyab*, and also using the modern calculation which applies the trigonometric formula. Both methods are different in the aspect of calculation concepts to verify the prayer times.

The area chosen for the calculation of prayer times is Kuala Lumpur with the latitude of 3° 9'. The latitude does not represent the single reference point station in the zone for the state of Kuala Lumpur. The latitude was also chosen without any ties to the current practice of time zones in Malaysia.

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[2] Regis Morelon, "General Survey of Arabic Astronomy," in ed. Roshdi Rashed, *Encyclopedia of The History of Arabic Science: Astronomy - Theoretical and Applied*, (New York: Routledge, 1996), 8; Nasim Butt, *Science and Muslim Societies* (Landon: Grey Seal Books, 1991), 85; Al-Birjandi, "Arabic Astronomy in Sanskrit," in ed. Takanori Kusuba & David Pingree, *Tadhkira II, Chapter II* (Leiden: Brill, 2001), 1; Adnan, *History of Humanity*, 374.

[3] David A. King, "Astronomical Instruments," in ed. M. J. L. Young et al., *Religion, Learning, and Science in the 'Abbasid Period* (United Kingdom: Cambridge University Press, 1990), 286.

[4] David A. King, "Astronomy," in ed. M. Zaki Kirmani & Singh, N. K., *Encyclopaedia of Islamic Science and Scientists* (Daryaganj: Global Vision Publishing House, 2005), 100; David A. King, "Islamic Astronomical Instruments and Some Examples of Transmission to Europe," in ed. Calvo, E. et al., *Shared Legacy: Islamic Science East and West: Homage to Professor J.M. Millas Vallicrosa* (Barcelona: University of Barcelona, 2008), 325.

The Calculation Concept in the Modern Method

The modern calculation method is the method currently used in Malaysia to determine prayer times. This calculation method uses the trigonometric formula with the assistance of computational technology such as calculator and computer to calculate prayer times. There are two methods that can be used to calculate prayer times, namely: (i) Calculation using the astronomical formula, and (ii) Calculation using that almanac data.[5] Even though these two methods are different, they still refer to the same trigonometric formula in the calculation of prayer times. The calculation that uses the astronomical formula takes into count the correlation of the number of days from the present date to the epoch date.[6] However, the calculation using the *falak* almanac depends on the data of the sun's ephemeris.[7]

With regards to the modern calculation method in Malaysia, the determination of prayer times is based on time zones, which are segregated based on the criteria set by the Department of Islamic Development Malaysia (JAKIM) in 1995 with the recommendation from the Technical Committee for the Hijrah Calendar. Three criteria have been set to segregate the zones in accordance with the tolerance times, which is two minutes, according to the western-most co-ordinate in each zone with its highest zone and the furthest island.[8] Based on these similar criteria, JAKIM has also fixed the size of the zones based on the time difference between the eastern and western zones that cannot exceed two minutes which is referred to as tolerance time.[9]

Regarding the calculation of prayer times of a zone, there are two concepts used in Malaysia. The first concept is the single reference point station which is used all over Malaysia except in the state on Kedah.[10] The second concept is the multi-point reference,

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[5] Baharrudin Zainal, *Ilmu Falak, Teori, Praktik dan Hitungan* (Kuala Terengganu: Kolej Ugama Sultan Zainal Abidin, 2003), 175.

[6] Otto Neugebauer, *A History of Ancient Mathematical Astronomy* (Berlin: Springer -Verlag, 1975), 1067.

[7] Susiknan Azhari, *Ensiklopedi Hisab Rukyat* (Yogyakarta: Pustaka Pelajar, 2008), 30.

[8] Md. Adnan Md. Daud, "Penyelarasan Waktu Solat di Malaysia" (paper presented at the Muzakarah Pegawai-Pegawai Falak Seluruh Malaysia, Hotel Seri Malaysia, Terengganu, September 8-12, 1999).

[9] Mohammad Saupi b. Che Awang, "Zon-zon Waktu Solat Yang Seragam dan Sistematik Bagi Seluruh Malaysia: Satu Cadangan" (paper presented at the Muzakarah Pegawai-Pegawai Falak Seluruh Malaysia, Hotel Seri Malaysia, Terengganu, September 8-12, 1999).

[10] Hardi Sadali (Pegawai Hal Ehwal Agama Islam Bahagian Falak dan Sumber Maklumat, Jabatan Mufti Pulau Pinang), in an interview with the authors, August 18, 2009.

which is used in the state of Kedah.[11] In the single reference point station, a reference station will be chosen and fixed in at a point in the western side. The location of the reference station is fixed in the western zone based on the concept of sunrise in the East and sunset in the West. Therefore, the sun is assumed to first rise in the eastern zones, and followed by the western zones. As such, the western zones will receive the sun a little later than the eastern zones. This means that the eastern zones would reach a prayer time before the western zones because the sun crosses the eastern zones earlier.

Hence, based on this calculation concept, the prayer times announced in any given zone is based on the calculation made by referring to the zone on the West, which is the single reference point station of the zone. Thus, the western area and the eastern area in the same zone will share the same prayer times.[12] For example, in the zone of the state of Penang (excluding Bukit Bendera), the reference station chosen for the calculation is situated in the western-most point, which is Pantai Acheh. As such, the prayer times for the entire area in the East and West of the zone of the state of Penang refers to the one calculated in Pantai Acheh.[13]

To illustrate an example, the Zuhur prayer time in Pantai Acheh in the zone of the state of Penang is from 1:02 p.m. to 4:30 p.m. Based on the *ihtiyati* concept, i.e. the two minutes difference, would indicate that the Zuhur prayer time in the eastern zones of Penang is from 1:00 p.m. to 4:28 p.m. Since the single reference point station is used, and the eastern area of the zone are in the time zone, the prayer times for the entire zone therefore would refer to the calculation at the single reference point station which is 1:02 p.m.

The prayer time calculation in the multi-point reference is different from the single reference point station. This is because the prayer times are not calculated based on a single point in the western zone. Rather, the prayer times are fixed based on the highest calculation result between the points in the zones in the state of Kedah. The reference points are chosen within the same time line. The time line is the line of the sun's journey which falls on the surface of the Earth every day. Apart from that, the time

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[11] Abdul Majid, *Waktu Ibadat dan Takwim: Kaedah dan Penggunaan Bagi Negeri Kedah Darul Aman* (Kedah: Annasyir Sdn. Bhd., 2007), 5.
[12] Mohammad Saupi, "Zon-zon Waktu Solat," 6.
[13] Sobri Mat Yasim (Assistant Falak Branch Officer, JAKIM research department) in an interview with the authors, November 10, 2009.

line is also the angle of the sun on the surface of the Earth.[14] The position of sunrise and sunset can be discovered more precisely through this time line. Multi-point reference is a calculation method that uses a special software known as *The Abdul Majid Software* which was developed by Abdul Majid Abdul Wahid, a Calendar Organiser in the state of Kedah Darul Aman. According to him, the software is programmed to automatically calculate the prayer times in the areas of the same time line. The time calculated which is the latest among the chosen points will be the determiner for the beginning of prayer times in the state of Kedah. The earliest time calculated among the chosen points, meanwhile, will be the determiner for the end of the prayer times in the state.[15]

The Calculation Concept in the Traditional Method

The traditional calculation method is a method that has been used to calculate the prayer times since the 18th century. The traditional calculation method was used in the Malay Peninsula through the teaching of the subject *'ilm al-miqat* in the traditional religious schools (*pondok*) as well as the roles played by the Malay *ulama* (religious scholars) who used this calculation method to determine the prayer times for the entire Malay Peninsula.[16]

The technique used in the traditional calculation method is different from the modern method. This is because the calculation is not in the form of a formula, but instead is in the general descriptive form[17] which is very much qualitative. Apart from that, the traditional calculation method depends on the use of the traditional *falak* equipment *rubu' mujayyab*[18] to calculate prayer times. The calculation cannot be carried out without this equipment. This is because the *rubu' mujayyab* is the main element used to gather the necessary data related to the sun to calculate the prayer times. The data regarding the sun are the declination value, height, radius and the position of the sun. Other than the *rubu' mujayyab*, the traditional calculation method also needs two

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[14] Abdul Majid bin Haji Abdul Wahid (The Calendar Organiser for the state of Kedah Darul Aman), in an interview with the authors, October 18, 2009.

[15] Abdul Majid, *Waktu Ibadat dan Takwim*, 8.

[16] Dato' Mursyid DiRaja Dato' Paduka Sheikh Abd. Majid bin Md. Noor (Committee Members of Fatwa Negeri Kedah Darul Aman), in an interview with the authors, October 18, 2009.

[17] Baharrudin Zainal, "Etnomatematik Dalam Ilmu Falak Alam Melayu" (PhD diss., University of Putra Malaysia, 2009).

[18] Hanafiah Abdul Razak (Assisstant Officer of Islamic Matters, Department of Mufti, Johor), in an interview with the authors, October 23, 2012.

schedules; the Earth schedule and the equation of time schedule. The degree of the position of the constellations can be determined with the information from the constellation schedule, and this information can also be used to discover the degree of the sun's position. Meanwhile, the schedule of the *ta'dil zaman* can be used to determine the degree of *zawal*, and it can be used to discover the real time of the sun's transit on the Meridian Line. Both these information are needed for the purpose of the calculation of prayer times using the traditional calculation method.

With regards to the calculation of prayer times, the traditional calculation method does not involve time zones. Hence, prayer times are calculated exclusively on the latitude of the given place, and does not share the prayer time with other places of other latitudes. For the latitude of other places, prayer times will be calculated based on the latitude of that place itself. Thus, the calculation for the prayer times differs from one place to another. The calculation concept used in the traditional calculation method guarantees the accuracy of prayer times because the calculated prayer times are based on the sun's position on that particular latitude.[19]

Analysis

This analysis of difference is carried out on the data of prayer times that have been gathered through the calculations using the traditional method and the modern method. The calculation concept that is used in the modern method refers to the single reference point station, while the concept in the traditional method uses the *rubu' mujayyab.*

The result shows that the calculation using the traditional method exceeds two minutes compared to the result of calculation using the modern method. The difference of two minutes was collected, and the average was estimated according to months from January 2011 to April 2011. The average of the difference of the data was estimated so as to make the data analysis easier. Then, the average value of deviation was calculated to determine the rate of error or difference that might exist in the average value. The lesser the value of deviation, the lesser the rate of error that exists in the calculation.

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[19] Hanafiah Abdul Razak.

Table 1

The Average Value and the Average Value of Deviation in the Difference of the Result of Calculation of Minutes in Prayer Times between the Traditional Calculation Method and the Modern Calculation Method from January 2011 to April 2011

Month	Contents	Zuhur	Asar	Maghrib	Isyak	Subuh
January	Average	2.516	3.23	2.742	2.258	2.710
	Average Deviation	0.531	0.501	0.768	0.479	0.504
February	Average	2.071	3.536	3.679	3.071	1.821
	Average Deviation	0.199	0.607	0.533	0.133	0.587
March	Average	2.452	3.871	3.581	2.677	2.321
	Average Deviation	0.495	0.514	0.820	0.741	0.633
April	Average	2.133	2.867	2.867	2.167	2.500
	Average Deviation	0.116	0.520	0.154	0.278	0.500

Table 1 shows the average and the average deviation value of minute difference obtained from the traditional calculation method and the modern method from January 2011 to April 2011. This value of minute difference shows the excess of minutes in the calculation result of the traditional calculation method compared to the modern calculation method. The average value of minute difference for Zuhur prayer time from January to April is between two to three minutes. For Asar, Isyak and Maghrib prayer times, the average value of minute difference is between two to four minutes each. For Subuh prayer time, the average value of minute difference is between one to three minutes. Meanwhile, the overall average value of minute difference is less than one minute. This value (less than one minute) shows that the calculated deviation is very little.

Based on the data above, the author summarises that one who prays according to the time that has been calculated based on the modern calculation method will pray a few minutes earlier compared to one who prays according to the time that has been calculated based on the traditional calculation method. Apart from that, one who prays according the time that has been calculated based on the modern calculation method will also lead by about one to two *rakaat* of prayer compared to one who prays according to the time that has been calculated based on the traditional calculation method (based on the opinion that the average rate of one *rakaat* of prayer is three minutes).[20]

It is the opinion of the authors that the situation of praying earlier according to the time that has been calculated based on the modern calculation method is dangerous. This is based on the research carried out by Abdul Halim which proves that the accuracy of the calculation of prayer times in the modern method is doubted because there exists a high degree of error in the result of its calculation.[21] This problem occurs not because of the use of the trigonometry formula in the calculation. Rather, this problem occurs because of the single reference point station concept that is in use currently. The concept of this single reference point sets a reference station that is in the western-most point of a given zone. Thus, the latitude and longitude of this station is entered in the formula for the calculation of prayer times to determine the Zuhur, Asar, Maghrib, Isyak and Subuh prayer times. Therefore, the areas in these zones will refer to the prayer times calculated based on the location of the reference station. Abdul Halim's study found that for all the prayer times, except the Zuhur prayer time, for almost every day all year long, there are locations where the time difference is more than two minutes and for the duration longer than half a year, there are locations with the difference of more than three minutes. For the Asar prayer in particular, there are times when the difference is almost four minutes. According to the data of the calculations, the difference is 120 to 224 seconds. For just three days in a year, the difference reaches the

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[20] Mohammad Saupi Che Awang and Muhamad Zakuwa Rodzali, "Waktu Solat Berasaskan Zon di Malaysia" (paper presented at the Astronomy Seminar in Conjunction of 20 years celebration of Malaysian Falak Syarie Association, Universiti Tenaga Nasional, Bangi, Selangor, July 13-14, 2007), 1.
[21] Abdul Halim Abdul Aziz, "Beberapa Isu Dalam Penghitungan Waktu Solat" (paper presented at the Astronomy Seminar in Conjunction of 20 years celebration of Malaysian Falak Syarie Association, Universiti Tenaga Nasional, Bangi, Selangor, July 13-14, 2007).

smallest value, 120 seconds (two minutes). On other days, it is longer than that; mostly three minutes.[22]

It can be deduced therefore that the time difference or the error that occurs to the result of the calculation of prayer times except Zuhur is about two to four times. The value of the difference or the error proves that the prayer times announced by the Mufti Departments all over the nation except for the state of Kedah is highly doubtable. In this case, the result of the calculation of prayer times using the traditional calculation method can overcome the time difference problem that occurs in the modern calculation method. This is because the result of the prayer time calculations in the traditional method for Asar, Maghrib and Isyak shows that there are up to four minutes of excess, while for Subuh shows that there are up to three minutes of excess. Since the traditional calculation method can overcome the problem of time difference, it can be argued that the traditional calculation method is more accurate compared to the modern calculation method.

Apart from that, the result of the calculation of prayer times in the traditional calculation method that exceeds up to four minutes if compared to the modern calculation method also shows that the result of calculation in the traditional calculation method is a lot more consistent to be used as the actual prayer time. In order to ensure that the prayer is really carried out within the actual prayer time, the traditional method of calculation is a lot more reliable.

Other than that, the result of the traditional method od calculation that shows excessive minutes also proves that the approach used by the early *ulama* was a cautious one in announcing prayer times. They wanted to be absolutely sure of the prayer times before they were announced to the *ummah* (community). Therefore, they took the approach of using the excessive few minutes to guarantee the accuracy of the prayer time and hence, making sure that the prayers carried out by the *ummah* is truly valid as they were done at the right time. As such, the cautious approach taken by the early *ulama* is an advantage in the calculation of prayer times because it guaranteed accurate results in the calculation of prayer times.

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[22] Abdul Halim, "Beberapa Isu."

Results and Discussion

The analysis above shows that the traditional calculation method is more accurate compared to the modern calculation method. This is because the result of the calculation is a few minutes ahead of the modern calculation method which is up to a maximum of four minutes. Apart from that, the traditional calculation method is guaranteed to be more accurate because of the approach towards to calculation method that uses a more cautious concept in the calculation of prayer times.

The modern method is exposed to inaccuracy because of the utilisation of the single reference point station in a particular zone in the calculation of a prayer time. The advantage of the calculation using the modern method is that it is faster compared to the traditional one. This is because the calculation is in the form of a formula and also uses the aid of a modern calculation tools and technology.

The traditional calculation method uses the manual *rubu' mujayyab*. The usage of the manual tool causes the process of prayer time calculation to take a longer amount of time. Though this method takes a longer period of time, the weakness can be overcome by using experts on the reading of *rubu' mujayyab*. This promises faster calculation process. Apart from that, *rubu' mujayyab* ought to be computerised so that the prayer times can be calculated with the aid of computer software. Thus, this will make the calculation process easier while making *rubu' mujayyab* more advanced in line with the progress of modern technology.

Conclusion

With regards to time difference that exists in the modern calculation method, the authors iterates that the single reference point station concept is not suitable to be applied in Malaysia because the inaccuracy in its calculation. A number of aspects must be revised in order to overcome the inaccuracy problem. Among the aspects to be revised include the zone size, finding the sun's ephemeris daily in the zone of prayer time, finding the line of the same prayer time, as well as not calculating the prayer times based only on a single latitude that represents many large districts.

Therefore, the authors conclude that the traditional calculation method is more accurate than the modern calculation method. The calculation concept in the traditional

calculation method ought to be applied where the prayer time is calculated for every latitude of locations. This would guarantee the accuracy of the prayer time at any given area.

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