

MATHEMATICAL APPLICATION IN DETERMINING QIBLA DIRECTION OF TAMHIDI CENTRE UNIVERSITI SAINS ISLAM MALAYSIA (USIM) BY USING SPHERICAL TRIGONOMETRY

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Abstract

The direction of the Qibla is the direction of the city of Makkah which is one of the legal conditions for performing prayer. Spherical trigonometry a branch of Mathematics plays a critical role in determining the direction of Qibla. This paper presents a trigonometry formula to calculate the direction of Qibla at the Tamhidi Centre at Universiti Sains Islam Malaysia (USIM). The calculated value of the Qibla azimuth of Tamhidi Centre, USIM is $292^{\circ}35'44.44$ (from the north).

Keywords: Direction of the Qibla, Spherical Trigonometry, azimuth

INTRODUCTION

All this time, mathematics is considered an abstract, theoretical science and only contains formulas that do not seem to intersect with the reality of life. It is the basic science of the development of science (basic science) and is very useful. In terms of worship, mathematics has an important role, for example in terms of prayer which is not separated from the number of rak'ahs and order, prayer time, determination of the day in terms of obligatory and circumcised fasting, determination of the minimum limit of zakat (nisab), and its distribution. The role of mathematics related to prayer is to determine the early prayer time and the direction of Qibla. Most of the Malaysian community consists of Muslims. Certainly, in terms of prayer, the direction of the qibla is the most important thing that cannot be ignored because facing the qibla is one of the valid conditions of prayer. For a Muslim who lives in a certain place, it is not difficult to determine the direction of the Qibla, but when he is far away it may be difficult to determine the direction of the Qibla when he wants to pray.

The problem experienced now is to determine the direction of the Qibla towards the Kaaba. Therefore, trying to find the direction of Qibla is worship and at the same time a challenge in science and technology. The direction of the city of Mecca can be known from the surface of the earth, by doing some calculations, given that every point on the earth's surface is on the surface of the sphere, then Qibla direction calculation can be done with one of three spheres (sphere trigonometry).

Based on the description, this paper discusses "Mathematical Applications in Determining Qibla Direction of Tamhidi Centre Universiti Sains Islam Malaysia (USIM) by using Spherical Trigonometry". Until then to formulate the problem in this regard is: "What is meant by the direction of Qibla" and "How is the application of spherical trigonometry in determining the direction of the Qibla?". The purpose of writing is to know the meaning of the direction of the Qibla and to know the application of the sphere trigonometry in determining the Qibla direction. The limitation of the discussion is only discussed trigonometric formulas used in spherical trigonometry (spherical trigonometry) and the formula to determine the direction of Qibla.

LITERATURE REVIEW

There have been several studies related to the determination of qibla direction including by Muhammad Izdihar Afiq Nor A'zlan & Ahmad Azhan Hamizon(2019) discussed the determination of the direction of qibla using mathematical calculation methods. In these studies, two methods have been compared, are spherical trigonometry method and the vector calculus method to see which method is the best for existing data. The results by using both the spherical trigonometry method & vector calculus method are 290.8611 and 290.8967 respectively. So both methods can be used to find the direction of qibla. Another study by Maftukhah, Nurissaidah Ulinuha, Mohammad Hafiyus sholeh and Wika Dianita(2018) discussed the analysis and implementation of haversine formulas in determining qibla direction by using Spherical Trigonometry in Indonesia. The results show that by descending definitions of haversine, rules of cosine in spherical triangles, addition and multiplication rules on trigonometry and the circumference of the spherical triangle, the qibla direction can be determined.

Refer to the research by Herlina Ahmad, Febryant, Muthmainnah, Ahmad Al Yakin, and Sukadji Sarbi(2018) in The Analysis of Student Error in Solve the Problem of Spherical Trigonometry Application, the most common error made by the student is the misconception of the concept. 59.09% come from the test to calculate the direction of qibla and 68.18% from the test calculate the distance between 2 countries. The student made a mistake because of a lack of understanding of the correct concept in solving the matter of calculating the distance between two countries and the spherical triangle formula to solve the problem of calculating the direction of qibla.

According to previous research, trigonometry is a scientific method in mathematics that can be used to determine the direction of qibla. Studying the spherical trigonometry application needs students to memorise the formula and understand the concept so that students do not often make mistakes in solving the problem.

NAQLI ELEMENTS IN DETERMINING QIBLA DIRECTION

Through surah Al-Baqarah: verse 149 in the Al-Quran has explained the movement of the direction of the Muslim Qibla from Jerusalem to the Kaaba. In addition, the same thing can also be seen in surah Al-Baqarah: verse 150. An example of a verse from surah Al-Baqarah: is verse 149 which means:

"And from wherever you come out, turn your face towards Masjidil Haram. Indeed, the provision is really something that is right from your Lord. And God doesn't forget what you did."

(Surah al-Baqarah: 149)

While the argument from the hadith of Rasulullah S.A.W means:-

From Abu Hurairah r.a said: Rasulullah s.a.w said. "When you want to pray, complete ablution, then face the Qiblah, then Takbir".

(Narrated by Bukhari & Muslim)

Based on the arguments above, it has been clearly explained that the right condition for a person to pray is to face the Qiblah.

TAMHIDI CENTRE ISLAMIC SCIENCE UNIVERSITY OF MALAYSIA (USIM)

Tamhidi Centre Universiti Sains Islam Malaysia (USIM) is one of the Matriculation/Foundation level study centres chosen by SPM/Equivalent graduates to continue their studies. It is located in Nilai Negeri Sembilan, Malaysia.

SPHERICAL TRIGONOMETRY

Trigonometry is a branch of mathematics that explains the comparison of the length of the right triangle named sinus, cosinus, and tangent. Spherical trigonometry is a part of trigonometry that deals with the relationship between the sides and angles of spherical triangles. Spherical trigonometry can be applied in determining the Qibla direction. To get the appropriate Qibla direction is used Figure 1 below:

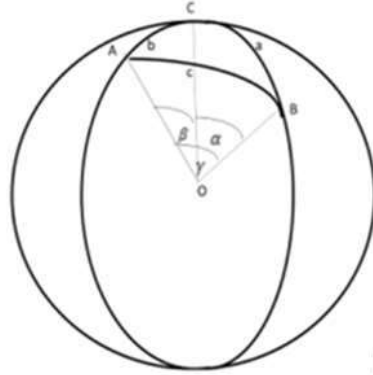


Figure 1. Spherical Trigonometry

From Figure 1 above, it can be known that the spherical triangle of ABC has lengths a, b, and c as well as angles $\angle CAB$, $\angle ABC$, and $\angle BCA$.

1. Point A refers to Makkah city as the centre of Qibla direction with specific latitude (ϕ) and longitude (λ), furthermore that can be written as ϕ_A and λ_A . Meanwhile, point B is the Tamhidi Centra USIM that will be calculated in the Qibla direction with specific latitude (ϕ) and longitude (λ), furthermore, that can be written as ϕ_B and λ_B .

2. Spherical triangles of ABC has sides whose length are a, b, and c. The length of each side can be determined by using these formulas:

$a = 90^\circ -$ the latitude of the Tamhidi Centre USIM that will be calculated in its Qibla direction $= 90^\circ - \phi_B$

$b = 90^\circ -$ the latitude of Makkah $= 90^\circ - \phi_A$

$C =$ the difference between the longitude city that will be calculated in its Qibla direction and Makkah ($\lambda_A - \lambda_B$)

So, the formula to determine the Qibla direction is:

$$\text{Cotan } B = \frac{\sin a \cotan b}{\sin C} - \cos a \cotan C$$

We will use this formula in the part of the calculation of the Qibla direction.

Trigonometry science is taught in college, with no exception at Universiti Sains Islam Malaysia (USIM). The students in USIM can determine the Qibla direction of some locations if they understand the application of spherical trigonometry.

CALCULATION OF QIBLA DIRECTION

The spherical Trigonometry calculation method was used to find the Qibla Direction for the Tamhidi Centre Nilai Negeri Sembilan. To find Qibla's direction, we need to know the value of latitude and longitude Tamhidi Centre USIM Nilai and Mecca.

Tamhidi Centre USIM Nilai Latitude $\hat{\varnothing}t : 2^{\circ} 59' 22.09''$

Tamhidi Centre USIM Nilai Longitude $\wedge t : 101^{\circ} 47' 1.86''$

Mecca Latitude $\hat{\varnothing}m : 21^{\circ} 25' 25''$

Mecca Longitude $\wedge m : 39^{\circ} 49' 39''$

* The Latitude and Longitude of Mecca are fixed (Siti Faizah (2018)).

* Local Latitude and Longitude Tamhidi Centre USIM Nilai can be found on the application USIM Mobile Staff.

Formula finding value of a :

$$\tan a = \frac{\sin (\wedge t - \wedge m)}{\tan \hat{\varnothing}m \cos \hat{\varnothing}t - \sin \hat{\varnothing}t \cos (\wedge t - \wedge m)}$$

$$\begin{aligned} \sin (\wedge t - \wedge m) &= \sin (101^{\circ} 47' 1.86'' - 39^{\circ} 49' 39'') \\ &= 0^{\circ} 52' 57.32'' \end{aligned}$$

$$\begin{aligned} \tan \hat{\varnothing}m \cos \hat{\varnothing}t &= \tan 21^{\circ} 25' 25'' \cos 2^{\circ} 59' 22.09'' \\ &= 0^{\circ} 23' 30.61'' \end{aligned}$$

$$\begin{aligned} \sin \hat{O}t \cos (\hat{A}t - \hat{A}m) &= \sin 2^\circ 59' 22.09'' \cos (101^\circ 47' 1.86'' - 39^\circ 49' 39'') \\ &= 0^\circ 1' 28.3'' \end{aligned}$$

$$\begin{aligned} \tan a &= \frac{0^\circ 52' 57.32''}{0^\circ 23' 30.61'' - 0^\circ 1' 28.3''} \\ &= \frac{0^\circ 52' 57.32''}{0^\circ 22' 2.31''} \\ &= 2^\circ 24' 10.28'' \\ a &= \tan^{-1} 2^\circ 24' 10.28'' \\ &= 67^\circ 24' 15.53'' \end{aligned}$$

$$360^\circ - 67^\circ 24' 15.53'' = 292^\circ 35' 44.4''$$

Qibla azimuth of Tamhidi Centre USIM Nilai = $292^\circ 35' 44.4''$ (from north).

BENEFIT TO UMMAH

The application of spherical trigonometry is able to assist people to determine and make certain of the Qibla direction, especially for people who study or work at Tamhidi Centre to perform prayers as they will be at the location throughout the day. Furthermore, students from Tamhidi Centre can apply their theoretical knowledge learnt during lectures to determine the Qibla direction. This effort ensures the integration of knowledge of Naqli and Aqli in their curriculum, hence making them Muslims who have the ability to involve science and technology in Islam. Using the spherical trigonometry method will also provide Muslims with the best calculation method needed to find the direction of qibla.

CONCLUSION

Spherical trigonometry is used to determine the direction of Qibla at Tamhidi Centre USIM Nilai Malaysia. We need to know the value of latitude and the longitude of the city of Mecca and Tamhidi Centre USIM Nilai, Malaysia first before we substitute into the spherical trigonometry formula. Hence, we calculate and find out the value of Qibla azimuth of Tamhidi Centre USIM Nilai = $292^\circ 35' 44.44''$ (from the north).

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