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The Accuracy of Qibla Direction Applications Used by the Public

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Abstract

The Qibla direction is a fundamental concept in Islam, holding significant religious and spiritual importance, as it is the direction Muslims face during the five obligatory daily prayers towards the Holy Kaaba in Mecca. Beyond prayer, the Qibla also plays a role in various other daily activities, underscoring its importance in the lives of Muslims. Given the geographical diversity of the global Muslim population, this direction can vary based on one's geographical location. However, with the rapid development of technology, modern tools such as smartphone applications have made it easier to determine the Qibla direction. Despite their convenience, there remain concerns regarding the accuracy of these applications, which can vary due to differences in algorithms and data used. This study aims to assess the accuracy of the twenty most downloaded and highly rated Qibla direction applications available on the Play Store and App Store for Android and iOS. This study employed the theodolite method, which involves solar observations and surveying equipment to measure horizontal and vertical angles, thus accurately obtaining the Qibla direction of 292° 57' 44". This study found the differences in degrees between the actual Qibla direction, and the directions provided by five of ten Android and iOS applications. In conclusion, while most Android and iOS applications accurately provide the Qibla direction at 292 degrees, there are a few exceptions with minor variations. However, it is still functional as it falls within the allowed limits of degrees.

Keywords: Qibla Direction, Qibla Direction Applications, Accuracy, Android, iOS

Introduction

The Qibla, the direction in which Muslims turn while praying, is towards the Kaaba in Mecca and represents the oneness in the Muslim community. Theoretically, the Qibla direction is defined as the intersection point between the circle of the horizon and the great circle passing in the direction of our zenith and Kaaba in Mecca. It is technically a geodetic azimuth of the shortest distance connecting the Kaaba to anywhere on the Earth's surface. The importance of facing the Qibla is explained in the Qur'an in Surah Al-Baqarah, verse 149. Defining this direction is more accessible for Muslims in Mecca, while it is challenging for Muslims in other parts of the world. There are many ways to determine the Qibla, including the conventional

method of observing the position of the sun and the advanced techniques of using a mobile application. Nonetheless, accuracy is still essential, as researchers and even religious institutions such as the Malacca State Fatwa Committee pointed out.

The combination of advanced technology with religious beliefs has made the Qibla direction on smartphones important to Muslims globally. However, due to some incidences and criticism made by scholars and religious bodies such as Persatuan Falak Syarie Malaysia, there is doubt concerning the reliability of this method. These applications usually incorporate compass sensors, which are sensitive to magnetic interferences and could be inaccurate. This is because the Muslim community is not very knowledgeable about the use of technology to address its problems, let alone to use these technologies appropriately. Qibla direction applications on iOS devices face challenges related to accuracy, particularly in determining the precise direction of the Kaaba for prayers. (Niri et al., 2023).Some of these apps use augmented reality technology or solar guidance, but accuracy is always an issue that affects the users' satisfaction level and spiritual practice. It is important to note that the reliability of Qibla direction applications is essential to sustaining the faith and blending the religious orientation with the technology of the current world. Therefore, there is a pressing need for reliable Qibla direction applications that the Muslim community can trust.

This study aims to determine the accuracy of Qibla direction applications widely used by the public. The study has two primary objectives. The first is to analyse the reliability of twenty different Qibla direction applications from Android and iOS operating systems using the theodolite method, a surveying instrument for measuring angles. Secondly, the study seeks to compare the differences in the degree values between the actual Qibla direction observed through the theodolite and the Qibla directions indicated by the applications. By comparing the results, it will be possible to determine any deviations and, in general, evaluate the effectiveness and credibility of these popular smartphone applications for religious activities. The findings of this study will provide valuable insights into the accuracy of Qibla direction applications, thereby informing the public and contributing to the advancement of this field.

Literature Review

The Qibla is an Arabic word extracted from the root word, which means to face or turn toward. As a religious orientation, Muslims face the Qibla during prayers, which is directed towards the Kaaba located in Mecca. The Qibla direction also holds practical and religious importance for several other activities in Islam, including burial. (Saksono et al., 2018). Geographically, the Qibla means the direction towards the Kaaba from anywhere in the world, thus proving its relevance in the lives of Muslims. The Prophet Muhammad also stressed the importance of the Qibla in his preaching and provided examples reinforcing its importance in Islamic practice. Understanding the practical and religious importance of the Qibla direction is crucial for Muslims, as it enhances their connection to their faith and engages them in their religious activities (Fatwa et al., 2020).

The theodolite method for determining the Qibla direction is renowned for its precision and involves using the Sun's position, requiring an open area and skilled personnel. The theodolite, a precision tool for measuring angles in horizontal and vertical planes, calculates the angle between the Sun and the horizon, accurately determining the Qibla's

direction. This method references the Sun's azimuth angle at a specific time of day, with the Qibla's azimuth in Malaysia recorded between 291° and 293° (Mufti Wilayah Persekutuan, 2022). Spherical trigonometry is instrumental in calculating the azimuth of the Sun, and astronomers, including practitioners of astronomy, utilise this concept to determine the Qibla azimuth and direction precisely (Amree Ahmad, 2023; Ariffin & Arsad, 2022). The theodolite, integral to this process, measures the angle between the Sun and the horizon, facilitating high-accuracy Qibla direction calculation through the principles of spherical trigonometry (Saksono et al., 2018). The concept of the sun's azimuth angle and spherical trigonometry is shown in Figure 1.

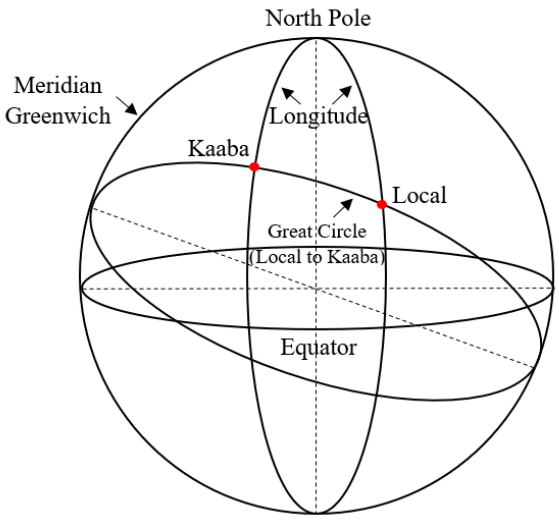

Figure 1 Concept of Spherical Trigonometry (Institut Tanah dan Ukur Negara, 2006).

As it is one of the most essential processes in Muslim practice, determining the Qibla direction involves the latitude and longitude of a particular area. The knowledge of the theoretical base and methods behind calculating the Qibla direction improves religious practices and compliance with Islamic guidelines, strengthening the feeling of Muslims' unity worldwide. This study involves the following calculation in Equation 1:

$$\tan \alpha = \frac{\sin \Delta\lambda}{(\cos \phi L \tan \phi M - \sin \phi L \cos \Delta\lambda)}$$

Equation 1

$$\alpha = 292° 57' 44''$$

Where,

ϕL = Latitude of the study area,
λL = Longitude of the study area,
ϕM = Latitude of Mecca, and
λM = Longitude of Mecca

Methodology

There are two techniques for finding the actual direction of the Qibla for Muslims: conventional and contemporary. This section will explain in detail how to determine the direction of the Qibla using the modern approach, which uses the total station tool. The methodology is simplified through a flowchart outlining a structured research process that compares the Qibla direction as determined by actual methods versus smartphone apps. The methodology of this study is divided into three phases, as shown in Figure 2.

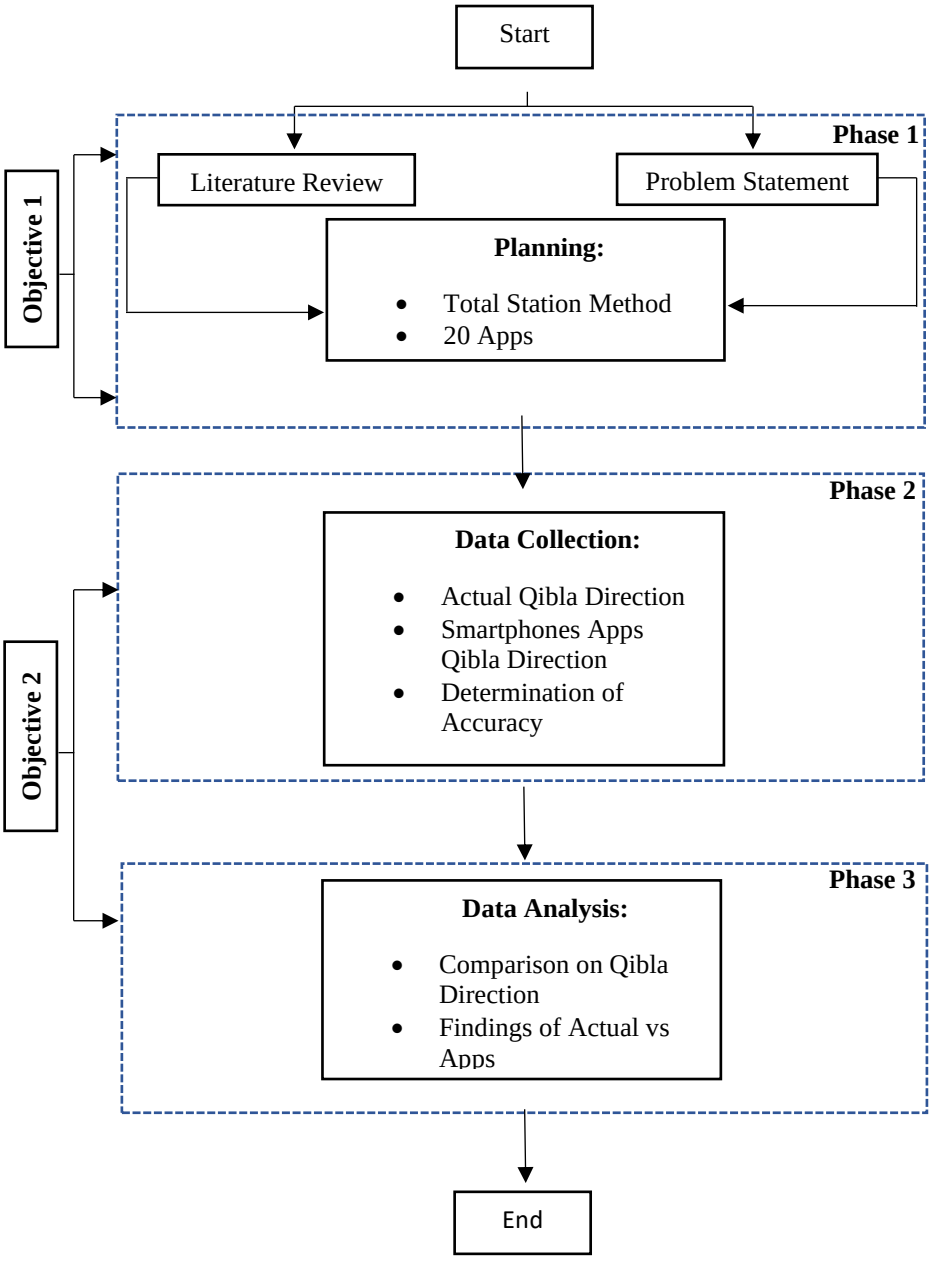

Figure 2 Flowchart of Methodology of the Study

Phase 1: Planning

The planning process starts with a systematic literature review to identify previous work, methodological approaches, and outcomes in determining the Qibla direction. This preliminary step aids in defining areas that may not be well understood and sets up the

framework for the research. Subsequently, a problem statement is developed to clearly define the research question or problem this study seeks to solve. The planning phase also outlines the specific methods for the study, using the total station method to determine the Qibla direction accurately and choosing twenty smartphone applications for comparison. This phase lays down the framework for the research by forming a plan on how the study will be conducted systematically and organised to prepare for the other phases to follow.

Phase 2: Data Collection

In the data collection phase, the Qibla direction is measured using the total station method (Figure 3), one of the highly accurate surveying techniques. Simultaneously, the Qibla direction shown by each of the twenty chosen smartphone applications is documented. This phase is essential as it involves collecting data to evaluate the effectiveness of the smartphone apps. The data from both the actual method and the apps are compared (Figure 4) and analysed to establish the apps' accuracy in directing the Qibla. Through this systematic data collection, the study can compare the correct Qibla direction to those offered by the apps.

Figure 3 Measuring and marking the Qibla direction using the total station method.

Figure 4 The comparison of an application on the actual Qibla direction

Phase 3: Data Analysis

The last step is to evaluate the data gathered and compare the Qibla directions computed by the actual method with those from the smartphone applications. This analysis assesses the degree of deviation and inaccuracy of the apps. This phase provides a comprehensive comparison that is be undertaken across three distinct categories: the total station method versus Android applications, the total station method versus iOS applications, and Android applications versus iOS applications. The findings of this study reveal which of the applications give acceptable directions in terms of the actual Qibla direction and, therefore, provide helpful information to those who require accurate apps for their religious practices. This phase is the final step of the research process in which all the information gathered is analysed and summarised in conclusion and recommendations.

Results and Discussion

This study section embarks on the crucial data analysis process to extract meaningful insights from the collected information. The focus is on comprehensively examining the results obtained from the total station method and the diverse Qibla direction applications. This analytical exploration will contribute to a nuanced understanding of the accuracy and reliability of Qibla direction applications, shedding light on their performance in the established total station method. Tables 1 through 3 show the outcomes of comparing three different categories.

Table 1
Comparison of the Actual Value of Qibla Direction and Android Versus iOS Apps

Name of Applications	Actual	Android	iOS
A		292°	292°
B		292°	292°
C		295 °	295 °
D	292°	292°	292°
E		295°	295°
F		292°	292°
G		292°	292°
H		295°	295°
I		295°	295°
J		295°	295°

Table 1 shows the results of the comparative analysis, showcasing the actual value of Qibla direction in degrees determined through the precise total station method alongside the Qibla direction values obtained from selected Android and iOS applications. Most analysed applications, such as A, B, D, F, and G, show a high level of accuracy, and the direction was virtually the same on both platforms. However, the angles of C, E, H, I and J all display a consistent discrepancy, indicating 295 degrees in Android and iOS systems, which is 3 degrees off from the actual Qibla direction. This suggests that the discrepancy is due to the applications, not the platforms. Users should be aware of these discrepancies and may need to verify the Qibla direction with multiple sources, mainly when using C, E, H, I and J.

Table 2
Comparison of the Actual Value of Qibla Direction and Android apps

Name of Applications	Actual	Android
K		292°
L		292°
M	292°	292°
N		292°
O		292°

Table 2 summarises observed Qibla direction readings from only the Android applications with the actual Qibla direction of 292 degrees. All the applications mentioned here, K, L, M, N and O, give the correct Qibla direction equal to 292 degrees, a figure obtained using the total station method. This shows a relatively high level of accuracy, and these Android applications would be deemed very dependable in proving the right Qibla direction. The high correlation shown in these applications further emphasises the usefulness and efficiency of these applications for Muslims who are in a dilemma on which direction to pray.

Table 3
Comparison of the Actual Value of Qibla Direction and iOS Apps

Name of Applications	Actual	iOS
P		292°
Q		292°
R	292°	292°
S		292°
T		292°

Table 3 shows the degree values of the Qibla direction from only iOS applications with the actual Qibla direction of 292 degrees. All the shown compasses of all five applications, P, Q, R, S and T, correctly depict the actual Qibla direction, reflecting the value of 292 degrees. This shows the high accuracy of all the tested iOS applications to ensure high integrity. Considering this, users of these applications can believe that the direction to the Qibla being indicated is accurate. The variations observed in these iOS applications show that the techniques are correct and that the developers can calculate the Qibla direction well using proper algorithms and data sets. The study generally indicates the reliability and accuracy of the Qibla direction from these iOS applications regarding degree values.

Conclusion

The findings of this study circulate on the accuracy and reliability of Qibla direction applications used by the public, highlighting their significance in the Muslim community. Concerning the Qibla direction, this study found that most Android and iOS applications offer correct information, including A to G and K to T, which indicates that the Qibla direction is at 292 degrees. Despite this, five applications, namely C, D, H, I and J, exhibited a 295-degree divergence from true north, which would require algorithm adjustments. In conclusion, most applications across both platforms were reliable and displayed the correct Qibla direction, signifying the utilisation of advanced technology to fulfil religious practices.

Recommendations

The analysis of Qibla direction values provided by various Android and iOS applications reveals a high level of accuracy in most applications, with a few showing slight differences. Hence, it is imperative to conduct further studies to strengthen the reliability and discuss the minor concerns found in this study. Thus, the following are the recommendations:

a) Conduct a thorough evaluation of the Qibla direction applications from Android and iOS platforms in various places, such as prayer rooms in malls, petrol stations and hotels, against theodolite method to determine how environmental factors, GPS reliability, and magnetic interferences affect the estimated Qibla direction values.
b) Evaluate the performance of Qibla direction applications from Android and iOS platforms across various types of terrain, such as urban areas, rural landscapes, and mountainous regions, against the theodolite method. Understanding how terrain influences accuracy can help optimise the applications for diverse environments.

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