


Mizwala Qibla Finder: Modern Innovations in Qibla Direction Determination

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Article Info	ABSTRACT
<p>Article History Received 01-12-2025 Revision 15-12-2025 Accepted 25-12-2025</p> <p>Keywords: Mizwala Innovation Qibla</p>	<p>Determining the direction of the Qibla is an important aspect of astronomy that continues to undergo methodological and instrumental developments. One of the latest innovations is the Mizwala Qibla Finder, an instrument designed to determine the direction of the Qibla with an accurate astronomical and geodesic approach without relying on magnetic fields. This article discusses the history of mizwala's development, the fundamental theories that underlie its working principles, and its practical application in the field. The measurements show that the mizwala can provide precise results, with very small deviations compared to those of astronomical azimuth calculations. This innovation emphasizes the importance of integrating modern technology with the tradition of Islamic astronomy to maintain the accuracy of Muslims' direction of worship across various places.</p> <p>This is an open-access article under the CC-BY-SA license.</p> 

I. Introduction

Determining the direction of the Qibla is one of the essential aspects of astronomy, with ritual, geographical, and astronomical dimensions. The Qibla is the main direction for Muslims in performing prayer, so the accuracy of its determination significantly affects the validity of worship [1]. In the modern context, various methods and instruments have been

developed to achieve higher precision, ranging from shadow methods, theodolites, and compasses to digital technologies such as GPS and mobile applications [2]. However, among these modern devices, there is also a tool that seeks to return the principle of qibla measurement to a classical astronomical approach, but with a strong geometric component.

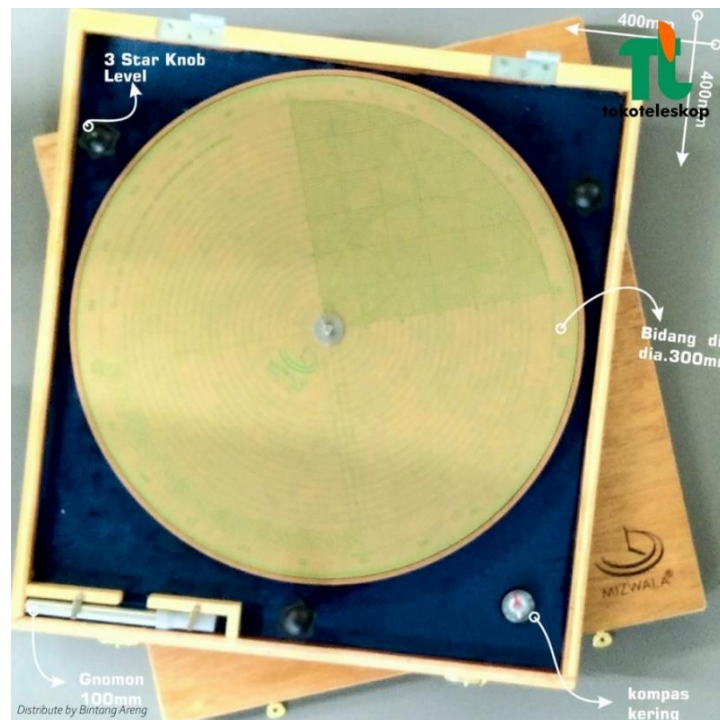


Figure 1. Parts of Mizwala Qibla Finder

The Mizwala Qibla Finder is a reconstruction of the classic *istiwa'* and sundial principles, but redesigned to be easier to use and more precise, as shown in Figure 1. This innovation was born from Hendro Setyanto's experience providing training on determining the qibla direction to Congress participants, during which many had difficulty understanding the theory behind sundial use. To overcome the understanding gap, Hendro modified the sundial by adding a sheet of paper that was rotated according to the angle value of the shadow. This simple experiment later became the forerunner of the Mizwala Qibla Finder. This tool uses the principles of sundial geometry (the Sun's shadow) to determine the direction of the Qibla with high accuracy, without electricity, GPS, or an internet connection [1]. By using the Sun's azimuth and the orientation of the gnomon's shadow at a given time, Mizwala allows users to determine the direction of the Qibla in real time [3].

In its development, Mizwala not only serves as a measuring tool but also as an interactive learning medium for understanding basic concepts of positional astronomy, such as azimuths, the apparent motion of the Sun, and the geometry of the celestial sphere. This tool is designed to be compatible with various latitudes in Indonesia and can be used at any time when the Sun is visible, unlike the Rashdul Qiblah method, which only occurs twice a year [4]. Based on the Sun's azimuth and the calibration of the Kaaba's direction, Mizwala provides stable, accurate measurement results, making it one of the local astronomical instruments that has received wide attention in the world of hisab-rukyat [1].

In addition to its practical value, Mizwala demonstrates the dynamics of Indonesian astronomy's increasingly creative and innovative development. It is a concrete example of how Islamic astronomical instruments can continue to develop without abandoning the roots of the classical scientific tradition [5]. The use of Mizwala in field educational, research, and qibla direction verification activities affirms its position as a modern astronomical instrument that is relevant, cost-effective, easy to produce, and capable of educating the public about the relationship between natural phenomena and worship practices [6].

Thus, research on the Mizwala Qibla Finder is essential to examine its historical development, the astronomical theories that underlie it, and its effectiveness and accuracy in measuring the direction of the Qibla across various locations. This study is expected to enrich the literature on local astronomical instruments and to contribute to the development of qibla direction-determination methods in Indonesia.

II. Method

This study uses a qualitative-descriptive approach combined with a simple experimental field test. This approach was chosen to describe the mizwala instrument's theoretical characteristics and to assess its accuracy in measuring the direction of the Qibla. The research stage begins with a literature review, namely the exploration of various scientific sources on the history of mizwala's development, the basic principles for determining the direction of the Qibla, and the theories of geodesy and astronomy that underlie it. The literature studied includes publications from ICOP, LAPAN, and several contemporary astronomy journals.

Next, a theoretical analysis was carried out, namely the elaboration of the working principle of mizwala based on the azimuth formula of the direction of the Qibla derived from the geometry of the celestial sphere. This analysis aims to confirm the connection between astronomical theory and the design of the mizwala apparatus, which operates based on the Sun's position and geographical coordinates. The next stage is field tests, conducted at several observation points, including in the Medan City area and its surroundings. Each point was measured using a Mizwala tool and compared with the results of the calculation of the astronomical qibla azimuth based on ephemeris data and GPS coordinates. The measurement process is carried out when the gnomon's shadow is clearly visible on the mizwala, especially during sunny weather around local noon.

The measurement data were then analyzed by comparing the deviation between the Qibla direction from the mizwala result and the theoretical result. The difference value, in degrees, is recorded to assess the tool's accuracy and consistency. This approach allows researchers to evaluate Mizwala's performance empirically while describing its potential applications in field qibla direction calibration and in astronomical education.

III. Results and Discussion

The development of astronomy in Indonesia has made significant progress, with the emergence of various instrument innovations that facilitate the observation and measurement of the direction of the Qibla. One of these innovations is the Mizwala Qibla Finder, a Qibla direction-finder based on the Sun's shadow, developed by Indonesian astronomer Hendro Setyanto [3].

The background to Mizwala's emergence began with Hendro's experience training participants at the Nahdlatul Ulama Congress, especially during the session on determining the direction of the Qibla using sundials. In this activity, Hendro found that many participants had difficulty understanding the geometric theory of the Qibla direction because the explanation based on the Sun's shadow was considered too abstract. To bridge the gap between theory and practice, he modified the sundial by placing a piece of paper over its plane, then rotating it while marking the angular position of the Sun's shadow. This simple

experiment marked the birth of a new tool he named Mizwala Qibla Finder, which means "direction-finding tool" [7].

In its development, Mizwala has proven able to address two needs at once: technical needs as an accurate measurement tool for the direction of the Qibla, and educational needs as a medium for learning observation-based astronomical concepts. It represents a continuation between the classical Islamic astronomical tradition, which has long used the principle of the Sun's shadow (such as the *istiwa'* stick and astrolabe), with modern scientific approaches based on spherical geometry and spherical trigonometry [8].

Mizwala Theory and Working Principle

Theoretically, the working principle of the Mizwala Qibla Finder is rooted in the geometry of the celestial sphere and spherical trigonometry, which are the primary bases in astronomical determination of the direction of the Qibla [1]. The direction of the Qibla is determined by calculating the azimuth of the Qibla (A), which is the angle between the geographical north direction and the direction of the outline towards the Kaaba in Makkah. The standard formula used in Equation (1):

$$\tan(A) = \frac{\sin(\Delta\lambda)}{\cos(\phi) \tan(\phi_k) - \sin(\phi) \cos(\Delta\lambda)} \dots (1)$$

With a caption:

A = azimuth of the Qibla,

ϕ = latitude of location,

ϕ_k = latitude of the Kaaba (21°25' N),

$\Delta\lambda$ = the longitude difference between the location and the Kaaba.

The formula shows that the intersection of the horizon plane determines the direction of the Qibla with a large circle connecting the observer's position to the Kaaba. In the context of using Mizwala, the azimuth result is translated into a physical form: a Qibla Line drawn on

the flat plate of the tool. This tool consists of a horizontal plate with a gnomon (vertical needle) and an azimuth scale from 0° to 360° . When in use, the Mizwala is placed on a flat plane and illuminated by sunlight. The shadow of the gnomon will form on the plate, and when it is aligned with the calibrated Qibla direction line, the position indicates the correct direction of the Kaaba [9].

The astronomical principles applied to Mizwala are similar to the concept used to measure the direction of the Qibla through the phenomenon of Rashdul Qiblah, when the Sun is directly above the Kaaba (May 21–28 and July 15–18 each year) [10]. However, the Mizwala's advantage was its ability to imitate the principles of Rashdul Qiblah at any time, as it used the Sun's azimuth, calculated from the time and location coordinates.

In addition, the Mizwala is designed to be adaptable to a wide range of geographical latitudes. At the bottom of the device is a latitude adjuster to set the angle of view for the apparent motion of the Sun in each region. Thus, the tool can be used throughout Indonesia, from Sabang to Merauke, with minimal measurement deviation. In field practice, the Mizwala Qibla Finder is used according to a systematic, straightforward procedure. First, the user determines the geographic coordinates of the measurement location (latitude and longitude) using GPS or digital maps. Second, the Mizwala plate is adjusted to these coordinates so that the Qibla line corresponds to the calculated azimuth value of the Kaaba. Third, the tool is placed in a location exposed to direct sunlight, and the gnomon's shadow is observed at a specific time. When the shadow is aligned with the direction of the Qibla, then the position indicates the direction of the Kaaba astronomically [11].

Based on the results of field tests conducted by researchers at the Astronomical Science Observatory of the University of Muhammadiyah North Sumatra (OIF UMSU), the deviation from the measurement results of the Qibla direction with Mizwala to the results of astronomical calculations is in the range of $\pm 0.2^\circ$ to $\pm 0.5^\circ$, much more precise than the use of magnetic compasses which are often affected by magnetic field disturbances [12]. These results show that Mizwala can produce measurements equivalent to those of optical devices, such as theodolites, in terms of directional accuracy.

In addition to its technical functions, Mizwala also plays a vital role in education and falak literacy. This tool is used in practicum activities, workshops, and training on Qibla direction determination for students and the general public. Through Mizwala, participants can learn directly about the apparent motion of the Sun, geographical orientation, and the relationship between astronomical theory and Muslim worship. Furthermore, Mizwala also has potential for application in astrotourism and the preservation of Islamic astronomical culture, as it represents the heritage of Islamic science adapted to contemporary needs. In the context of astronomy in Indonesia, Mizwala symbolises the independence of local Muslim scientists in developing observation-based astronomical instruments relevant to the challenges of the times.

The results of the Qibla direction measurement using the Mizwala Qibla Finder show excellent accuracy, with deviations ranging from $\pm 0.2^\circ$ to $\pm 0.5^\circ$ compared to the astronomical azimuth calculation. This value indicates that this tool can achieve accuracy close to that of an optical theodolite, which is commonly used by official institutions such as the Hisab and Rukyat Agency of the Ministry of Religion to calibrate the direction of the Qibla. With a low level of deviation and consistent yield stability, Mizwala has proven to be an effective practical tool as well as a scientific instrument for Qibla direction determination in the field.

From an astronomical perspective, this high accuracy is due to the Mizwala working principle, which uses the Sun's position as a directional reference rather than the Earth's magnetic field. Magnetic compasses, which are widely used by the community, are susceptible to local disturbances such as magnetic anomalies, metal in the area, or electromagnetic interference. Under such conditions, the deviation in direction can reach 2° – 6° . On the other hand, because Mizwala is based on the Sun's geometric position and the Kaaba's azimuth, the measurement of the Qibla direction is more stable, independent, and aligned with the global astronomical coordinate system.

Theoretically, Mizwala also showed how the geometry of the celestial sphere could be translated into a precise yet straightforward tool. The relationship between the latitude, longitude, and the position of the Sun is directly visualized by the gnomon's shadow. Thus, Mizwala integrates the concept of spherical trigonometry into an easy-to-understand practice

of visual observation. This approach aligns with the principles of contextual astronomical education, which emphasize teaching astronomical concepts through empirical and demonstrative methods. Methodologically, Mizwala offers an essential alternative for Indonesian academics and practitioners of astronomy [8]. On the one hand, this tool bridges the gap between the hisab (calculation) method and the rukyat (observation) method. Hisab provides precise mathematical results, but they are not easy for the general public to understand visually. Meanwhile, Mizwala offers an observational approach based on hisab theory, which can be directly verified in the field. Thus, it becomes an integrative medium between theory and practice, as well as between scientific and religious approaches.

In addition, from the epistemology of astronomy, the Mizwala Qibla Finder can be seen as a form of revitalization of classical instruments, given a new lease of life within a modern frame of mind. Hendro Setyanto did not simply imitate the sundial principle but reconstructed it by adding an angle system and latitude calibration, making it relevant across various geographical areas of Indonesia. This innovation demonstrates the ability of local astronomical scientists to continue the Islamic scientific tradition, adapting it to the needs of the times. In line with King's view [13], the progress of Islamic astronomy throughout history has always been marked by Muslim scientists' ability to combine empirical observations and geometric rationality into a methodological unity.

From the application's perspective, Mizwala's existence also has a positive impact on education and the dissemination of astronomical science. OIF UMSU, for example, has used this tool in various educational and public observation activities, such as Qibla direction training, rukyat workshops, and astrotourism activities based on Islamic astronomy literacy [14]. This activity is not only focused on measuring the direction of the Qibla, but also aims to increase public awareness of the regularity of the celestial system and the relationship between natural phenomena and religious practices. Thus, Mizwala serves as a means of scientific literacy and spiritual reflection, two critical aspects of contemporary Islamic epistemology.

Practically, Mizwala is also very promising as a tool for verifying the direction of the Qibla in remote areas. Because it does not rely on electricity or GPS signals, it is suitable for

field activities in areas without digital infrastructure. Its portability and affordability make it an alternative instrument that educational institutions or Islamic mass organizations can mass-produce. In addition, since its working principle is based on the Sun's shadow, the tool can operate year-round on sunny days. In the realm of research, Mizwala offers opportunities to develop mathematical models and simple optics-based technologies. The integration of these tools with digital astronomical data, such as ephemeris tables or the application of the Sun's position, can improve the efficiency and accuracy of measurements.

Thus, the Mizwala Qibla Finder is not only a tool for measuring the direction of the Qibla but also an essential symbol in the scientific journey of Indonesian astronomy. He emphasised that scientific innovation can arise from practical needs while remaining grounded in a strong theoretical framework. In the context of contemporary Islamic science, Mizwala represents the spirit of integration between revelation and ratio, tradition and innovation, and scientific observation and deduction, a hallmark of philosophical epistemology that remains relevant today.

IV. Conclusion

This study confirms that the Mizwala Qibla Finder, developed by Hendro Setyanto in Indonesia, is one of the innovations in modern astronomical instruments that successfully combines astronomical theory with the practice of observing the Qibla direction in a simple yet precise manner. Starting with a sundial reconstruction experiment to address the difficulties of Qibla direction training, Mizwala evolved into an efficient, portable, and accurate astronomical tool. Theoretically, Mizwala operates on the principles of celestial geometry and spherical trigonometry, using the Sun's position as a reference for the Kaaba's orientation. Using the calibrated azimuth line on the tool plate, the user can determine the direction of the Qibla by observing the gnomon's shadow. This method has been shown to produce minimal deviations from astronomical azimuth results, ranging from $\pm 0.2^\circ$ to $\pm 0.5^\circ$, allowing it to be scientifically aligned with optical devices such as theodolites. In addition to its practical value, the Mizwala Qibla Finder also reflects the integration between Islamic scientific traditions and modern scientific approaches. Hendro Setyanto's innovation shows

that the development of astronomy does not rely solely on digital technology but can also grow from local creativity, grounded in empirical observation and a deep understanding of astronomical principles. With high accuracy, ease of use, and substantial educational value, the Mizwala Qibla Finder deserves to be used as a standard instrument for measuring and verifying the direction of the Qibla in Indonesia. Furthermore, this tool has the potential to serve as a model for the development of simple optics-based astronomical instruments relevant to Islamic astronomy research, astronomical education, and future religious astrotourism activities.

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