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The contribution of mathematics to Islamic civilization: A historical study and its relevance in the modern era

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ABSTRACT

This article discusses the contribution of mathematics to the development of Islamic civilization from a historical perspective and its relevance in the contemporary context, especially in Indonesia. Using a critical review of scientific literature and relevant primary sources, this study evaluates the significant role of mathematics in shaping the social, religious, and economic systems of Muslims. Through figures such as Al-Khawarizmi, Al-Battani, and Al-Biruni, this article shows that mathematics is not only a tool for calculation, but also an instrument for upholding justice in inheritance (faraidh), sharia accounting, statistics on the welfare of the community, and measures and scales in muamalah. These concepts reflect the integration of reason and revelation in building a scientific and spiritual civilization. The relevance of these values in the modern era has been increasingly strengthened by the development of digital technology and the demand for a transparent and fair economic system. Therefore, synergy is needed between mathematics education and Islamic values as well as strengthening sharia-based digital research and applications to realize a Muslim society that is spiritually and scientifically advanced.

Keywords: Contribution, Mathematics, Islamic Civilization, Historical Study, Relevance.

1. INTRODUCTION

Mathematics is a branch of science fundamental to the development of various fields of science. In the context of Islamic civilization, mathematics is not only a tool for solving technical problems but also a force that underlies the scientific, technological, and cultural progress achieved by Muslims during the golden age (Harahap et al., 2024). From the 8th to the 13th centuries, the Islamic world experienced an intellectual heyday, in which Muslim scientists studied and developed mathematics at a very rapid pace. Their contributions to the development of mathematics not only had a major impact on Islamic civilization but also on world civilization (Samosir et al., 2025). The history of mathematics in Islamic civilization began with the translation of the works of Greek, Indian, and Persian scientists by Muslim scholars (Alkadafi et al., 2024). Al-Khawarizmi, known as the father of algebra, played a major role in developing mathematics at that time. His book, *Al-Kitab al-Mukhtasar fi Hisab al-Jabr wal-Muqabala,* became the main reference in the field of algebra and contributed to basic concepts used in modern mathematics. In addition, scientists such as Al-Battani and Omar Khayyam have also made major contributions to the development of trigonometry and number theory.

Mathematics studied and developed by Muslim scientists was not only limited to theory but also to its application in everyday life. In the field of astronomy, for example, the calculation of the positions of stars and the movement of planets is highly dependent on accurate mathematics. In the field of architecture, Muslim scientists have utilized the concepts of geometry and symmetry in designing magnificent buildings, such as mosques, palaces, and madrasahs (Alkadafi et al., 2024; Samosir et al., 2025). This shows that mathematics is not only an abstract science but also has a very concrete impact on building an advanced civilization. In addition, the contribution of Islamic mathematics is seen in the field of trade. With the development of international trade in the Islamic world, a more efficient accounting system is required. In this case, the Arabic numeral system adopted from India is helpful in simplifying calculations, replacing the more complicated Roman numeral system. The application of decimal numbers allows Muslims to conduct trade transactions more quickly and accurately, thereby accelerating economic growth (Nandita et al., 2024).

On the other hand, mathematics also plays an important role in Islam, especially in calculating time and direction. One of the most obvious examples is the determination of prayer times and the direction of the Qibla. Accurate calculations are required to determine the correct time to perform prayers and the correct direction to Kaaba in Mecca. This requires mastery of astronomy and mathematics, particularly in the fields of geometry and trigonometry (Asyatibi et al., 2023). The success of Muslims in developing mathematics and other sciences cannot be separated from the very strong scientific tradition of the golden age of Islam. During this period, many educational institutions such as Baitul Hikmah (House of Wisdom) in Baghdad became centers of research and development in science. Scientists worked collaboratively, shared knowledge, and produced various new discoveries that were passed on to the next generation (Alkadafi et al., 2024).

However, although Islamic civilization reached the peak of its glory in the field of science, especially mathematics, many of these contributions were forgotten or not widely known in the Western world until the Renaissance. At the time, the works of Muslim scientists were translated into Latin, and the knowledge contained in these works later influenced the development of science in Europe (Arrifada et al., 2016). Therefore, it is important to rediscover the contributions of Muslim scientists in the field of mathematics and to give due credit to their intellectual heritage. In addition, in the development of modern mathematics, we can still observe the application of many concepts discovered by Muslim scientists. Along with the rapid progress of technology and science today, it is important to recognize the great contributions that Islamic civilization has made in the field of mathematics (Munthe et al., 2024). Therefore, further study of the history of Islamic mathematics is relevant to enrich our knowledge and provide a broader perspective on the role of mathematics in building a progressive civilization.

As mathematics education continues to develop, especially in the context of Islamic education, it is important for the younger generation to study the history of mathematics in Islamic civilization and apply the basic principles discovered by Muslim scientists (Ruhiat et al., 2022). This will not only help in

the development of science but will also strengthen the understanding of the scientific values contained in the Islamic tradition. Thus, this article aims to reveal how mathematics plays a vital role in the advancement of Islamic civilization and to introduce the contributions of Muslim scientists who have enriched the world with their discoveries in the field of mathematics.

2. METHODOLOGY

In this study, the approach used was descriptive qualitative with theoretical study methods. This approach was chosen to explore in depth the contribution of mathematics to the progress of Islamic civilization by focusing on the analysis of existing literature as well as examining the theories that have been developed in the study of the history of Islamic mathematics. This study applies content analysis as a critical synthesis method to examine the literature on the contribution of mathematics to Islamic civilization. Content analysis allows researchers to systematically and objectively identify specific characteristics within a text. In this study, content analysis was used to reveal the dominant themes, recurring patterns, and conceptual constructs in historical and contemporary sources related to Islamic mathematics.

The analytical process involved several stages. First, literature familiarization was conducted by thoroughly reading selected texts from both classical and modern sources. These include works by historians of science, Islamic scholars, and educational researchers who explore mathematics in Islamic history and its relevance. Second, coding was applied to identify core themes, such as the role of mathematics in Islamic epistemology, the institutional development of scientific knowledge in the Islamic world, and the integration of Islamic mathematical heritage into modern education. The third stage is categorization, in which coded data are grouped into thematic clusters: (1) Historical Development of Mathematics in Islamic Civilization, (2) Key Muslim Mathematicians and Their Legacies, (3) Philosophical Foundations and Scientific Epistemology, and (4) the Relevance of Islamic Mathematical Thought in the Contemporary Era. These categories provide a structured framework to meaningfully interpret the literature.

This content-analysis approach strengthens the theoretical review by offering a systematic and reproducible synthesis of diverse scholarly perspectives. It also aligns with the tradition of Islamic historiography, which emphasizes contextualization and multi-perspective analysis. Using this method, the study not only reviews literature descriptively but also critically reconstructs the intellectual trajectory of mathematics within Islamic civilization, highlighting its ongoing significance.

3 RESULT AND DISCUSSION

3.1. Results

Table 1. Reference Selection Summary with Inclusion Criteria

Selection Stage	Number of Articles
Total articles initially collected	50
Articles included after applying inclusion criteria	33
Articles excluded due to:	
– Irrelevant to the core topic	8
– Not meeting scientific standards (e.g., blogs, etc.)	5
– Duplicates or overly similar content	3
– Missing abstract or unclear methodology	1
Total articles used in final analysis	**33**

Inclusion Criteria (see Table 1):

1. Publication Date: Articles published between 2022 and 2025.
2. Relevance: Directly discusses the history, development, and function of mathematics in Islamic civilization.

3. Source Type: Published in peer-reviewed journals or reputable academic repositories.
4. Language: Articles written in Bahasa Indonesia or English.
5. Clarity of Content: Must contain a clear abstract, methodology, and discussion section.
6. Accessibility: Full-text articles must be accessible for in-depth review.

The following Table 2 and 3 are the research results presented in table form, covering the main contributions of mathematics to Islamic civilization and its applications:

Table 2: Islamic Historiography and Its Modern Relevance

Historiographical	Historiographical Characteristics	Relevance in the Modern Era	Relation to the Development of Mathematics	References
Classical Islamic Period (750–1258 CE)	Focused on documenting Muslim scholars, integrating scientific work with Islamic values, as seen in works by Al-Tabari and Ibn Khaldun	Encourages reflection on Muslim scholars' contributions and revitalizes scientific heritage	Mathematics was applied in astronomy, architecture, and timekeeping for worship	Azhari (2022); Al-Haytham in Mahmudi (2023)
Bayt al-Hikmah Tradition	Synthesized Greek, Persian, and Indian sciences with Islamic values; development of logic and mathematics	Inspires interdisciplinary and transnational STEM models in Islamic education	Mathematics served as the foundation for advancements in optics, medicine, and engineering	Azmi (2024); Nasution (2022)
Islamic Rationalism & Philosophy (Al-Farabi, Ibn Sina)	Rationalism emphasized in historiography and scientific development, including logical deduction	Relevant to modern Islamic curriculum focused on logic and numeracy	Reinforced mathematics' role in developing scientific logic and research methodology	Shihab (2023); Asy-Syahrastani in Azhari (2022)
Ibn Khaldun's Social Historiography	Emphasized social dynamics, education, and transmission of knowledge	Provides a sociological framework for science education and cultural integration	Illustrates how mathematics evolved within administrative and social contexts	Nasr (2023); Ahmad (2024)
Modern Islamic Historiography (1900–Present)	Focuses on renewal (tajdid), reconstruction of Islamic knowledge, and integration with modern science	Forms the foundation for Islamization of science and integrative education	Mathematics is viewed as a neutral science that can be epistemologically and applicatively Islamized	Al-Attas in Rosyid (2022); Azra (2023); Rahman (2024)

Table 3. Review result of the main contributions of mathematics to Islamic civilization

No.	Contributions to Mathematics	Contribution Description	Implementation in Islamic Civilization	Reference
1	**Development of Algebra (Al-Khawarizmi)**	Al-Khawarizmi is known as the Father of Algebra, developing the basic concepts in algebra that are used today.	Algebra is used in mathematical calculations for astronomy, commerce, and architecture.	(Afliha, 2011; Dillon Perkasa et al., 2021; Hardika Saputra, 2024)
2	**Trigonometry Theory (Al-Battani)**	Al-Battani made major contributions to trigonometry, especially in the field of astronomy with improvements to the sine table.	Used to calculate star positions and planetary movements, as well as navigation.	(Harisman & Alya, 2024; Nawallia & Mishriya, 2024; Ruhiat et al., 2022; Sriyanto & Lindawati, 2021)
3	**Astronomy (Al-Biruni)**	Al-Biruni developed geometric and trigonometric concepts for calculating star positions, as	Used to calculate the direction of the Qibla and prayer times, as well as determining the times of Ramadan and Hajj.	(Ardi et al., 2016; Jannah, 2023; Kohar, 2018; Shapiee et al., 2022)

No.	Contributions to Mathematics	Contribution Description	Implementation in Islamic Civilization	Reference
		well as their influence on the Islamic calendar.		
4	**Social Statistics and Public Welfare**	Mathematics is used in the analysis of data on poverty, unemployment, and the social needs of the community.	Used to determine the targets of zakat-based community assistance programs or other religious social funds using a statistical and demographic approach.	(Afifah & Charisma, 2025; Khumaini & Apriyanto, 2018; Kusuma et al., 2024; Mabruroh, 2023; Maswar et al., 2022)
5	**Geometry and Symmetry (Islamic Architecture)**	The application of geometry and symmetry is very important in the design of Islamic buildings and mosques.	Used in designing mosques, palaces and historical buildings with beautiful symmetry.	(Arifin et al., 2025; Dinarti et al., 2024; Rahmah & Kusno, 2024)
6	**Accounting Mathematics (Islamic Trade)**	Mathematical concepts are applied in accounting systems and international trade transactions in the Islamic world.	Facilitating international trade transactions and financial administration.	(Azzura & Firdaus, 2024; Harisah & Sahi, 2022; Lamala & Domili, 2023; Latifah & Abdullah, 2023; Suarni & Sawal, 2020)
7	**Faroidh Science (Islamic Inheritance Science)**	Mathematics is used to calculate the inheritance share based on the provisions in the Qur'an and Hadith.	Fair distribution of inheritance to heirs according to sharia law, with fractional calculations and complex mathematical operations.	(Ayu et al., 2023; Huda & Mutia, 2017; Nuramalia & Rahmah, 2024; Nurjanah et al., 2025; Supriyadi, 2021; Ula et al., 2020)
8	**Measures and Scales in Transactions**	Mathematics is used to ensure fairness in buying and selling, such as size, volume, weight, and price.	Used in classical Islamic market, agricultural and trade transactions with the principles of honesty and justice based on the Qur'an (QS. Al-Mutaffifin: 1–3).	(Apriani & Amran, 2023; Muhammad et al., 2024; Nawallia & Mishriya, 2024; Setiawati et al., 2023)

3.2. Discussion

Based on the research results presented in the table, it can be concluded that mathematics plays a significant role in supporting the progress of Islamic civilization. Every contribution made by Muslim scientists, from Al-Khawarizmi with his algebra to Al-Battani and Al-Biruni with their contributions to astronomy, not only developed science, but also had a real impact on practical life. The application of these mathematical concepts is clearly visible in the social, economic, religious, and cultural life of Muslims at that time and had a major influence on Western civilization after being translated during the Renaissance.

3.2.1. Al-Khawarizmi's Development of Algebra: Foundations of Classical Mathematics and Relevance to Islamic Civilization

Muhammad ibn Musa Al-Khawarizmi (780–850 AD) was one of the most influential Muslim scientists in the history of the development of mathematics. He is widely known as the Father of Algebra because he wrote a monumental work that became the foundation for the modern algebra system: *Al-Kitab al-Mukhtasar fi Hisab al-Jabr wal-Muqabala* (The Book of Compendium of Calculations through Perfection and Balancing). In this work, Al-Khawarizmi not only classified and solved quadratic equations but also introduced a systematic method to solve mathematical problems that were applicable to various aspects of daily life and science of Muslims at that time (Afliha, 2011). The word al-jabr, from which the word "algebra" derives, refers to one of the important operations in equations: combining and moving terms from one side to the other. According to Afliha (2011), the algebraic system developed by Al-Khawarizmi did not rely on symbols used in modern notation but rather on a structured verbal and

descriptive approach. However, this system is very powerful for constructing a logical framework for thinking and is the basis for solving various forms of linear and quadratic equations.

Al-Khawarizmi's work was not merely an abstract theory, but had wide applications in social, economic, and religious life during the classical Islamic civilization. In the field of astronomy, algebra has been used to calculate the positions of stars and planets and to compile astronomical tables that are useful for accurately determining prayer times and the direction of the Qibla. Meanwhile, in the fields of trade and finance, the algebraic method is very helpful in calculating profits, distributing zakat, and developing a fair and systematic bookkeeping system (Dillon Perkasa et al., 2021). Additionally, the influence of algebra on Islamic architecture is significant. Precise and rational measurement techniques are needed for the construction of mosques, palaces, and city planning, all of which require high mathematical skills. Al-Khawarizmi acts as a link between abstract science and practical application, and bridges mathematics with the real needs of Islamic society. This connection reflects the spirit of Muslim scientists who not only pursue knowledge for the sake of knowledge but also for the welfare of the people. The discoveries and methods brought about by Al-Khawarizmi were later translated into Latin around the 12th century and used by European scientists such as Fibonacci. The term "algorithm" comes from the Latinized form of his name, "Algoritmi," which shows the great influence of Al-Khawarizmi in the development of modern computing (Saputra, 2023). It is no exaggeration to say that the foundation of today's digital technology has strong roots in the classical Islamic scientific tradition. According to Hardika Saputra (2024), Al-Khawarizmi's legacy is not only about methods but also about the philosophy of science based on order, logic, and service to the people. This is in line with the spirit of Islam as a religion that encourages the search for knowledge (*'ilm*) as part of worship. Therefore, learning mathematics, especially algebra, should be contextualized in Islamic values and Islamic intellectual history so that students not only understand the technicalities but also appreciate the noble values behind science.

In the contemporary context of Indonesia, strengthening the understanding of figures such as Al-Khawarizmi can motivate the younger generation of Muslims to develop their potential in mathematics and technology. Moreover, in the digital era, algebraic and algorithmic thinking skills are required for programming, big data, and artificial intelligence. Through history-based and value-based approaches, mathematics education can be an instrument of social and civilizational transformation. Therefore, the development of algebra should not only be remembered as part of history but also revived as part of a comprehensive education system. Historical studies of Al-Khawarizmi and his contributions must be integrated into school and college curricula and used as inspiration to develop contextual, inspiring, and Islamic mathematics learning strategies. Thus, Al-Khawarizmi's legacy will remain alive and relevant to today's Muslims.

3.2.2. Al-Battani's contribution to Trigonometry Theory and its Application in Islamic Civilization

Trigonometry is a branch of mathematics that plays a major role in the development of science, particularly in astronomy, navigation, architecture, and modern technology. One of the most influential figures in the development of trigonometric theory in the history of Islamic civilization is Abu Abdallah Muhammad ibn Jabir ibn Sinan al-Raqqi al-Harrani al-Battani (858–929 AD), better known as Al-Battani. He was an astronomer, mathematician, and physicist who made significant contributions to the development of trigonometric functions, especially tables of sines, tangents, and cotangents that were more accurate than those of his predecessors (Nawallia & Mishriya, 2024).

Al-Battani's main contribution to trigonometry was the systematic use of the sine and tangent functions in astronomical calculations, which had previously been dominated by the Ptolemaic geometric approach. He replaced the use of arc lengths with the numerical values of the trigonometric functions (sine and cosine) and compiled tables of the values of these functions with a high degree of precision. In his work, *Kitab al-Zij and* Al-Battani compiled tables of sines and tangents based on the division of a circle into 360 degrees and introduced spherical and plane trigonometric formulas to facilitate astronomical calculations (Ruhiat et al., 2022). In addition, Al-Battani is known for perfecting the model of the

movement of the sun and moon. He managed to calculate the tilt of the ecliptic with a result of 23° 35', which is very close to the results of modern measurements. His accuracy in calculating the tropical year and the motion of the sun's apses made his work an important reference in classical astronomy, even until the European Renaissance era. In this context, trigonometry not only plays a role as a calculation tool but also as a universal language in explaining the motion of celestial bodies and the structure of the cosmos (Sriyanto & Lindawati, 2021).

The practical application of Al-Battani's trigonometry in classical Islamic civilization is evident in various aspects of people's lives. One of them is to determine the direction of the Qibla (Qibla Determination), which requires high accuracy in measuring the angle between the geographical position of the Kaaba and the prayer location. Spherical trigonometric functions were used to calculate the direction of the Qibla from various parts of the Islamic world. In addition, the calculation of prayer times based on the height of the sun also involves tangent and cotangent functions, which are arranged in time tables used by muezzins and fuqaha (Harisman & Alya, 2024). Trigonometry has also become important in maritime and land navigation, especially during the period of Islamic trade and exploration expansion. Muslim scholars have used astrolabes and quadrants, whose working principles are heavily dependent on the understanding of spherical trigonometry. Shipping and trade from the Persian Gulf to the Indonesian archipelago, and even to Africa and Southern Europe, were carried out with the help of astronomical and trigonometric navigation. This shows how mathematical theories can drive the wheels of the economy and diplomacy of civilization (Nawallia & Mishriya, 2024).

Al-Battani's contribution has an important philosophical value for Muslims: that the pursuit of knowledge, including in the exact field such as mathematics, is part of worship. The approach of Muslim scientists, such as Al-Battani, strongly reflects the principle of Tawhid in science, where the order and laws of nature are a reflection of the order of Allah SWT's creation. Trigonometry, in this context, is not only a scientific tool but also a means to understand the greatness of God through the order of heavens and the earth (Ruhiat et al., 2022).

In the context of education in Indonesia today, understanding the history of trigonometry and the contributions of Muslim scientists such as Al-Battani is still very minimal. Harisman and Alya (2024) stated that understanding the history of trigonometry concepts for junior high school students is still low because the curriculum approach focuses solely on technical formulas without historical narratives. Introducing the contributions of figures such as Al-Battani can increase learning motivation, strengthen scientific-religious identity, and form a comprehensive understanding of the meaning of learning mathematics in Islam. Therefore, integrating the history of Islamic mathematics into trigonometric learning in schools and madrasas is a strategic step. In this way, students not only memorize sine and cosine formulas, but also understand their scientific background, their application in people's lives, and the spiritual values that accompany them. Education like this is more relevant and meaningful in building character, numeracy literacy, and love for the heritage of Islamic civilization. Ultimately, Al-Battani's legacy is that of Muslims and humanity. His scientific thinking and methods prove that Islamic civilization not only received knowledge from outside, but also developed and contributed it to the world. Studying and teaching trigonometry through Al-Battani's lens is a form of appreciation for the rich Islamic scientific tradition as well as a commitment to continuing it in the present and future.

3.2.3. Al-Biruni's Contribution to Astronomy: The Foundation of Astronomy and Its Relevance in Determining Muslim Worship

Abu Rayhan Muhammad ibn Ahmad Al-Biruni (973–1048 CE), known as Al-Biruni, was one of the most brilliant Muslim scientists in the history of Islamic civilization. He is widely known for his extraordinary contributions to astronomy, mathematics, physics, and geography, particularly in the development of astronomical science. One of Al-Biruni's most prominent achievements was his ability to integrate the concepts of trigonometry and spherical geometry into the calculation of star positions, planetary movements, and determination of important times in the Islamic calendar (Ardi et al., 2016). Al-Biruni's great work in the field of astronomy is recorded in various books, such as *Al-Qanun al-Mas'udi*,

which contains very accurate astronomical observation data, as well as a complete description of determining the latitude and longitude of a place, the position of celestial bodies, and the rotation of the earth. Al-Biruni was also known as one of the first scientists to openly state that the earth rotates on its axis, a revolutionary idea for his time (Jannah, 2023). He also measured the radius of the Earth using the shadow observation method in two different places, and the results were very close to modern measurements.

One of Al-Biruni's most practical contributions was his ability to calculate the direction of Qibla from various places in the world. Using spherical trigonometry, the angle between the meridian line and the direction of Kaaba was determined based on the latitude and longitude coordinates of a location. In practice, this method is important for determining the accurate direction of prayer, especially in areas far from Mecca. According to Shapiee et al. (2022) The method used by Al-Biruni became the basis for many modern applications, including digital compasses and GPS-based Qibla finder applications. In addition to determining the direction of the Qibla, Al-Biruni also played an important role in determining prayer times, which were highly dependent on the position of the sun in the sky. He formulated prayer times, such as Dhuhr, Asr, and Maghrib, using the angle of the sun's altitude, which is calculated using trigonometric formulas. This ability is important because the times of worship in Islam are astronomical and require high accuracy so that Muslims can carry out their religious obligations under the guidance of the sharia (Kohar, 2018). In addition to prayer, the Islamic calendar used to determine the beginning of Ramadan, Eid al-Fitr, and the implementation of the Hajj pilgrimage are also greatly influenced by the *hisab* (calculation) method developed by Al-Biruni. He compared the *hisab* and *rukyah* (crescent sighting) methods and offered a scientific approach by considering atmospheric factors, elevation of the place, and phase of the moon. This thinking shows that Al-Biruni was a critical scientist, opened to differences in methods, and combined an empirical approach with Islamic values (Jannah, 2023).

Al-Biruni's excellence lies in his multidisciplinary approach. He not only mastered astronomical theory but also geometry, pure mathematics, and natural philosophy. According to Ardi et al. (2016), he is known as a critical thinker who is able to ask fundamental questions about the nature of the universe and apply them to the practical needs of people. This style of thinking is worthy of emulation in the modern education world, especially in the curriculum of Islamic education and science in Indonesia. In the contemporary context, Al-Biruni's scientific legacy must be revived, especially in Islamic education and value-based mathematics and science learning. For example, the implementation of Islamic *astronomy-based project-based learning* can contextually integrate trigonometry, geography, and astronomy materials. Students can be invited to calculate the direction of the Qibla from home, determine prayer times using the sun's position, or create a simulation to determine the beginning of Ramadan based on astronomical data.

Moreover, introducing figures such as Al-Biruni in learning will foster a sense of pride in the heritage of Islamic knowledge and increase enthusiasm for learning science within the framework of spiritual values. This is important, considering the challenges of low numeracy and science literacy in the Indonesian education system, as reflected in the PISA results. Al-Biruni is a real example of the integration of faith, knowledge, and charity and has been successfully realized in the history of civilization (Kohar, 2018). Al-Biruni's contribution to astronomy and trigonometry proves that Islamic civilization is an integral part of the history of the development of global science. His scientific, systematic, and needs-based approach makes him an ideal model for a scientist: faithful, knowledgeable, and useful. It is time for Muslims, especially in Indonesia, to re-explore this treasure trove of knowledge and adapt it to contemporary life, for the revival of a civilization that is *rahmatan lil 'alamin*.

3.2.4. Social Statistics and the Welfare of the Community: The Role of Mathematics in the Distribution of Islamic Social Justice

Statistics, as a branch of modern mathematics, has become an important tool in social analysis, especially in terms of data-based decision-making to realize social justice. In the context of Islam, the application of statistics is not only technical but also part of the implementation of Sharia values, such as justice (*adl*), balance (*mizan*), and social concern (*ihsan*). One important area where Statistics play a major

role in the analysis of poverty data, unemployment, and the social needs of the community, which form the basis for the management of zakat, waqf, and other Islamic social funds (Afifah & Charisma, 2025). Zakat is a strategic financial pillar in Islam. However, the effectiveness of its distribution is highly dependent on the ability of zakat management institutions to accurately identify *mustahiks* (zakat recipients). Thus, the role of social statistics is crucial. Using descriptive and inferential statistical approaches, Zakat institutions can map poverty areas, calculate the welfare index of the community, and prioritize assistance based on valid and objective data (Maswar et al., 2022).

According to Khumaini and Apriyanto (2018), the use of statistical data to empower productive zakat funds allows a comprehensive evaluation of the impact of the zakat program. For example, longitudinal statistics can be used to measure changes in the economic status of *mustahiks* before and after receiving assistance. These results form the basis for improving targeted zakat distribution strategies, both in the form of consumption and productivity (micro-businesses, training, etc.). Kusuma et al. (2024) in his literature study show that statistics play an important role in overcoming unemployment, a crucial issue in contemporary Islamic society. With the analysis of labor market data, Islamic-based religious or government institutions can design skills training programs, scholarship programs, or entrepreneurship counseling in accordance with local demographic and economic characteristics.

From the perspective of the Qur'an, the use of science for social purposes, including statistics, has a strong foundation. Mabruroh (2023) explains that the Qur'an provides many verses about the importance of calculating, weighing, and paying attention to data in social and economic decision making (see *QS. Al-Mutaffifin: 1–3; QS. At-Taubah: 60*). Therefore, statistics in Islam are not only legal but also have the value of worship if used to improve welfare and eliminate poverty. Afifah & Charisma (2025) emphasizes that modern statistics can strengthen Islamic economic management, including in education, sharia investment, mosque budget planning and da'wah institutions, and evaluation of CSR programs based on Islamic values. By utilizing big data technology and geographic information systems (GIS), zakat institutions can compile village or RT-based poverty maps, create aid monitoring dashboards, and ensure transparency in the distribution of community funds in real-time. The concept of distributive justice in Islam is closely related to the statistical approach. When the distribution of wealth is unfair, the rate of economic inequality increases, which is contrary to *the maqashid sharia* (the main objective of sharia), especially in preserving wealth (*hifẓ al-mal*) and preserving lives (*hifẓ al-nafs*). Using statistical data, this inequality can be measured through indicators such as the Gini Ratio, the Human Development Index (HDI), and Multidimensional Poverty Index (MMI), all of which play an important role in formulating policies for the distribution of zakat and Islamic social assistance (Maswar et al., 2022). In addition, social statistics also functions as a monitoring and accountability tool in the management of community funds. Zakat distribution reports based on statistics can be an indicator of the success of amil institutions as well as a basis for accountability to the public and government. Thus, statistics encourage the birth of more professional, trustworthy, and value-based zakat management (Khumaini & Apriyanto, 2018).

In an educational context, the application of Islamic social statistics can be integrated into mathematics learning in schools and universities. For example, students can be invited to analyze local poverty data, create zakat distribution simulations, or compare the effectiveness of data-based aid programs. This approach, apart from increasing students' numeracy literacy, also forms social and religious characteristics that care about justice and welfare. Statistics in Islam are not just a technical tool, but also a strategic means for upholding social justice, empowering the people, and realizing shared prosperity. Therefore, it is important for Islamic institutions, educators and policy makers to integrate statistical approaches in social programs and da'wah, as part of scientific endeavors that are worth worship and benefit.

3.2.5. Geometry and Symmetry in Islamic Architecture: An Ethnomathematic Study of Beauty, Function, and Spirituality

Islamic architecture is a form of art and technology that not only displays physical beauty but also reflects religious values, cosmic philosophy, and mathematical order. One of the most prominent

characteristics of Islamic architecture is its intensive use of geometry and symmetry in the design of mosques, palaces, and historical monuments. This concept is not merely an aesthetic aspect, but is integrated with Islamic spirituality that emphasizes order, balance, and the oneness of God (*tauhid*) (Arifin et al., 2025). In this context, geometry, particularly flat shapes, spatial shapes, and repetition patterns (tesselation), have become the main basis in the design of ornaments and building structures. Rotational, translational, and reflectional symmetries are used to create infinite motifs such as mosaic tiles (*zellij*), carvings (*muqarnas*), and geometric calligraphy. As explained by Dinarti et al. (2024), mosque architecture is not just a physical building, but a manifestation of harmony between reason, art, and spirituality, all of which are represented through a mathematical approach.

Mosques, as the center of Muslim life, are often the main objects in the application of Islamic geometry. The shapes of the dome, tower, mihrab, and wall ornaments are the result of careful and symmetrical mathematical calculations. In an ethnomathematics study conducted by Arifin et al. (2025) in the Al-Mashun Grand Mosque in Medan, it was found that basic shapes, such as circles, octagons, and eight-pointed stars, were used repeatedly with rotation and translation patterns. These patterns not only decorate the building, but also represent perfection and infinity, which are symbols of divine nature. Furthermore, Rahmah & Kusno (2024) in his study of the Cheng Hoo Mosque in Purbalingga highlights the integration of Chinese cultural elements and Islamic geometric concepts in architectural design. The motifs used reflect the fusion of two traditions through mathematical media, making the mosque building not only a place of worship but also a space for cultural encounters. This strengthens the position of geometry as a bridge between religion, science and art.

Islamic architecture is unique in that each geometric design has a philosophical and theological meaning. For example, the eight-pointed star pattern is often interpreted as a symbol of the order of the cosmos and eight directions of heaven. Symmetry reflects the principles of balance taught in Islam. The never-ending patterns contain symbolic values about the eternity and oneness of God, as reflected in the doctrine of *Lailahaillallah* (there is no God except Allah), which also attempts to be reflected through visual harmony (Dinarti et al., 2024). The application of mathematics in Islamic architecture not only shows the technical capabilities of Muslims in the past, but also reflects the deep faith and worldview of Islam towards the universe. All calculations and designs are understood as a form of the contemplation of God's creation. Therefore, the construction of mosques is not performed carelessly but follows measurable scientific and artistic principles.

In the context of contemporary education in Indonesia, exploration of geometry and symmetry in mosque buildings can be used as a source of ethnomathematic-based learning. This has been done by researchers such as Arifin et al. (2025) and Rahmah and Kusno (2024), who emphasize the importance of linking mathematics learning with local wisdom and Islamic cultural heritage. With this approach, students not only learn formulas and forms, but also develop a historical, aesthetic, and spiritual understanding of mathematics. The application of ethnomathematics in the curriculum can simultaneously improve cultural literacy and numeracy at the same time. Through activities such as analyzing mosque floor motifs, calculating dome angles, or identifying symmetry in ornaments, students are invited to think critically while getting to know Islamic culture more deeply. This is in line with the vision of the Pancasila student profile and the religiosity-based character education in an independent curriculum. As a legacy of civilization, Islamic architecture teaches that mathematics is not just a technical tool but also part of art and an expression of spirituality. By reviving Islamic geometry-based learning, we not only preserve the scientific heritage of the past but also build a future that values the integration of science, faith, and art.

3.2.6. Accounting Mathematics in Islamic Trade: Instruments of Economic Rationality and Islamic Financial Ethics

The development of classical Islamic civilization includes not only religious knowledge and pure science but also practical fields such as trade, accounting, and financial management. Since the time of the Prophet and his companions, Islamic principles of finance have emphasized justice, transparency, and accountability. In this context, mathematics plays a strategic role in the development of the Sharia

accounting system and international trade transactions, which has helped Islamic civilization develop rapidly economically and politically across regions (Latifah & Abdullah, 2023). Mathematics in the Sharia accounting system are used to record, calculate, and manage all economic activities based on the principles of *halal* and *thayyib*. In international trade, recording debts and receivables, profit margins, profit-sharing ratios (*musyarakah, mudharabah*), and the accumulation of trade zakat requires a strong understanding of arithmetic, algebra, and data analysis. This can be seen in many trade records from the Abbasid era, when Muslims were actively involved in the trade from China to Andalusia (Lamala & Domili, 2023).

Azzura and Firdaus (2024) state that Sharia accounting also functions as a tool for economic and environmental sustainability, because its concept does not only pursue profit but also considers aspects of social and spiritual responsibility. For example, the depreciation value of goods, profit distribution, and management of productive waqf investments are conducted using a mathematical approach that considers long-term benefits. The calculation of the time value of money in the Sharia system also uses financial mathematics, although it lacks an interest system (riba). The Islamic accounting system rejects the manipulation of financial data and encourages transparency and honesty. Therefore, according to Harisah and Sahi (2022), the role of accounting in Islam is not merely a technical function but rather a part of Islamic business ethics. All recordings and calculations in *Muamalah* must be based on a straight intention, reflecting the values of *amanah* and *tawazun* (balance). In practice, the use of accounting mathematics strengthens commitment to justice in business contracts, both on a household scale and in sharia-based multinational companies.

Suarni and Sawal (2020) highlight that the role of accounting on a household scale is also important in Islam. Islamic family financial management involves needs-based budgeting, income expenditure bookkeeping, and monthly evaluations, all of which involve basic numerical logic and statistics. The growing use of Islamic financial applications shows that the mathematical approach to accounting is also penetrating domestic spaces, supporting microeconomic resilience amidst challenges of the times such as the pandemic. In terms of education and scientific methodology, Latifah and Abdullah (2023) emphasize the importance of mathematical approaches in Islamic economics and business, especially in formulating Sharia theories in the form of models that can be tested and analyzed. For example, the supply-demand curve model in Islamic microeconomics or the halal-haram utility function in consumer behavior can be explained mathematically to be more measurable and can be compared scientifically with the conventional economic system.

In international trade, the Islamic documentation and audit system uses a double-entry bookkeeping system, which is known to have developed in the Islamic world before being adopted by the Western world. In this system, each transaction is recorded in two accounts, which requires understanding of the ratios, percentages, and balances. With this approach, Muslim businessmen in the classical era were able to expand their trade networks to East Africa, India, and Southeast Asia through a solid and scientific administration system (Lamala & Domili, 2023). Accounting mathematics is also used in the management of modern Islamic Financial Institutions (LKS), such as Islamic banks, Islamic cooperatives, and Islamic microfinance institutions. Calculation of murabahah margins, mudharabah profit-sharing ratios, and ijarah installment simulations require precise mathematical algorithms and logic to comply with Sharia principles and do not cause *gharar* (uncertainty) or *dzulm* (injustice) (Azzura & Firdaus, 2024).

The integration of Islamic mathematics and ethics through accounting reflects the integral approach between faith and science, which is a characteristic of Islamic epistemology. Therefore, in higher education, especially in Islamic accounting or Islamic economics study programs, it is very important to teach applied mathematics within the framework of *maqashid sharia* so that students are not only able to calculate profits but also understand the social responsibilities behind it. Mathematics in Islamic accounting and trade are rational instruments that do not conflict with Islamic spiritual principles. It is precisely through an honest, transparent, and accountable mathematical approach that Muslims can build an economic system that is just, sustainable, and oriented towards the welfare of the community. This is part of the legacy of Islamic civilization that must be revived in the educational, economic, and financial governance systems of today's people.

3.2.7. Faraidh Science and Mathematics: Divine Justice in the Distribution of Inheritance Based on Rational Calculation

The science of Faraidh or Islamic inheritance science is one of the very specific branches of science in Islamic law. This science is explicitly discussed in the Qur'an, especially in Surah An-Nisa verses 11, 12, and 176, as well as in the hadiths of the Prophet ﷺ. The specialty of the science of faraidh lies in the integration of the rules of revelation (*nash syar'i*) and mathematical logic, making it a unique branch of science because it demands religious understanding and advanced arithmetic skills (Huda & Mutia, 2017). In the science of faraidh, the division of inheritance to heirs is performed using mathematical fractions, such as 1/2, 1/4, 1/8, 2/3, 1/3, and 1/6. The determination of this portion is based on kinship, gender, and the presence of other heirs. This process involves fractional arithmetic operations, LCM, FPB, and reconciliation of excess or deficient portions, known as *the 'aul* (downward adjustment) and *radd* (upward adjustment) methods (Nurjanah et al., 2025).

As explained by Ayu et al. (2023), inheritance calculation is not only a matter of mathematics but also the intersection between Sharia law and state law, especially in cases of inheritance of adopted children or children from adultery. In such cases, mathematics is still used to calculate the proportion of inheritance if it is permitted by positive law, even though rights may differ from the provisions of sharia. Nuramalia and Rahmah (2024) emphasize that the science of inheritance should be taught early in Islamic education because it is an important tool in maintaining the fairness of the distribution of family wealth after the testator dies. In addition, learning Faraidh can train complex arithmetic and systematic thinking skills, especially by solving inheritance cases using the *Syajaratul warits* diagram (inheritance tree), inheritance matrix, and proportional portion reduction techniques. The science of faraidh also reflects Islam's high appreciation of mathematics, as can be seen from the Prophet ﷺ's explicit command that his companions study it. In the hadith narrated by Ibn Majah it is stated: "*Study the science of faraidh and teach it to others. Indeed, it is half of the knowledge and will be forgotten*." This shows that Faraidh science is a form of science that must be preserved as part of Islamic scientific heritage (Supriyadi, 2021). The use of mathematics in inheritance becomes more complex when the number of heirs increases or when inheritance rights overlap. In such situations, mathematical solution models are required, such as distribution tables, rounding, calculating the difference in parts, and using digital algorithms. Therefore, Nurjanah et al. (2025) proposed that faraidh learning be combined with information technology using spreadsheet-based software or digital faraidh applications to help understand the accuracy of calculations.

Ula et al. (2020) also highlighted that inheritance is inseparable from the social and psychological aspects of the family. Therefore, accurate and fair calculations based on mathematics are important for avoiding conflicts between families. In this context, mathematics functions as a tool for resolving conflicts and guaranteeing justice in line with the *maqashid sharia* in safeguarding property (*hifz al-mal*) and safeguarding descendants (*hifz al-nasl*). Learning the science of inheritance also strengthens the integration of mathematics lessons and Islamic Religious Education in schools. As explained by Nuramalia and Rahmah (2024), the application of Faraidh science in learning allows teachers to develop a cross-subject approach (interdisciplinary learning), which teaches students to calculate while understanding the values of justice, family, and social responsibility.

Furthermore, with the advancement of technology and high social mobility today, mathematics-based inheritance science needs to be developed in contemporary contexts, such as digital inheritance, stock ownership, and inheritance zakat, all of which require precise calculations based on Sharia principles. Heirs need to understand this concept to avoid getting caught up in practices that deviate from Islamic law and have the potential to harm certain parties. Thus, Faraidh science is not just a ritual of dividing wealth, but is a reflection of the Islamic family financial system based on knowledge, justice, and mathematical logic. Strengthening the learning and application of this science is a form of conservation of Islamic intellectual heritage and an innovation in Islamic education based on the integration of naqli-aqli science.

3.2.8. Measures and Scales in Muamalah: Mathematical Foundations in Upholding Islamic Economic Justice

The concept of justice in Islam is not only applied in the fields of worship and social ethics but also in real terms in economic and muamalah practices, especially in the system of weights and measurements. In the Qur'an, justice in measuring and weighing receives special attention, as stated in Surah Al-Mutaffifin verses 1–3: "*Woe to those who cheat in weights and measures, namely those who, when they receive a measure from others, they demand it in full, and when they measure or weigh for others, they reduce it*." (QS. Al-Mutaffifin: 1–3). This verse is the normative basis for an honest and fair Islamic economic system in which mathematics plays a central role as a measuring tool to uphold justice in transactions. In the context of the history of Islamic civilization, various units of length (*dhira'*), weight (*ratl*), volume (*sa' and mudd*), and time (sa'at) have been standardized through scientific principles based on mathematical logic (Nawallia & Mishriya, 2024).

According to Setiawati et al. (2023), justice in measurement and weight is not merely a moral command but also an important instrument in creating market confidence, maintaining economic stability, and preventing fraud (*gharar*) in trade. Therefore, Muslims since the time of the Prophet ﷺ have developed a precise measurement system. Determining the ratio or ratio between units, such as 1 mudd = ¼ sa' or 1 ratl = ± 0.51 kg, is a real form of the application of quantitative mathematics in economic activities. Furthermore, in contemporary practice, cases of rounding off scales, for example, as discussed by Muhammad et al. (2024) in a study on modern laundry franchise services, show a deviation in the value of justice if rounding is done unilaterally without agreement. In a review of *fiqh muamalah*, such practices are considered a form of *tadlis* (hidden fraud). Therefore, the accuracy of the weight or volume calculations and the precision of the measuring instruments are part of the direct implementation of Sharia principles. Apriani and Amran (2023) explain that in Islamic economics, every business actor is required to ensure the accuracy of measuring instruments, and even in Islamic history, the caliphs have assigned *qadhi hisbah* (market supervisors) to ensure the honesty of traders in weighing and measuring. This is where it is seen that mathematics in the measurement system does not stand alone but is integrated with business ethics and Islamic regulations. Muslim scientists in the Middle Ages, such as Al-Khazini and Al-Karaji, have also developed measuring devices based on the principles of physics and mathematics. They calculated the density and volume of objects using the theory of proportion and ratio, which was then used in the trade of precious metals, spices, and agricultural products. This is an example of how applied mathematics in scales became part of the scientific and advanced Islamic economic system (Nawallia & Mishriya, 2024).

In the context of current education and community development, it is important for Muslims to understand that violations of the accuracy of measurements are violations of religious principles and social ethics. By integrating mathematics learning with religious values through the theme of measurements and scales, teachers can instill the concepts of honesty, responsibility, and justice in learning activities; for example, in the topics of measuring weight, volume, and fractions. In today's digital era, the use of automatic sensor-based measurement technology, digital scales, and POS (Point of Sales) systems in modern markets must also be monitored in terms of their halalness and accuracy. The potential for errors or digital manipulation can become a loophole for injustice, if not handled with accountability. Therefore, the principle of "*waufuu al-kaila wa al-mizan bi al-qisth*" (QS. Al-An'am: 152) perfecting measurements and scales with justice remains relevant as an ethical and mathematical foundation in the Islamic digital economy. Thus, mathematics in the system of measurements and scales is not just a technical tool, but also a main pillar in realizing social justice and economic blessings in Islamic transactions. Justice in the scales is a real manifestation of a Muslim's faith in economic interactions, showing that Islam does not separate worldly calculations from everyday responsibility.

4. CONCLUSSION

Mathematics has made a profound contribution in shaping just scientific and civilized Islamic civilization. Starting from the development of algebra by Al-Khawarizmi, the theory of trigonometry by

Al-Battani, astronomy by Al-Biruni, to practical applications in the science of faraidh, sharia accounting, social statistics, and the system of measurements and scales in muamalah, all show that Islam does not separate rational science and spiritual values. Mathematics in Islam is not just a tool for calculating, but becomes a pillar in implementing the principles of justice (*al-'adl*), balance (*al-mizan*), and responsibility (*amanah*) in every aspect of people's lives.

Integration between mathematics education and Islamic values in educational institutions, both formal and informal, is needed to form a generation that is intellectually intelligent and spiritually ethical. In addition, the development of Islamic digital technology, such as faraidh applications, zakat calculators, and Sharia accounting systems, needs to be continuously supported so that people can apply Islamic mathematical principles practically in contemporary life. Cross-disciplinary research between mathematics, Islamic studies, and technology is also important for strengthening the role of mathematics in building a progressive Islamic civilization in Indonesia and the world.

Ethical Approval
Ethical approval was not required for this study.

Informed Consent Statement
This research did not require informed consent.

Author Contributions
Conceptualization, BG., and MN; methodology, BG., and NW; collecting data, BG., and NW; formal analysis, BG., and NW; resources, BG.; writing the original draft, NW., and BG; writing the review and editing, NW.

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