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ETHNOMATHEMATICS IN ARCHITECTURE: EXPLORING GEOMETRY AND PATTERNS IN THE WE TENRI OLLE TOMB

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ABSTRACT

This study explores the application of ethnomathematics in the We Tenri Olle Tomb, located in Pancana Village, Barru Regency, South Sulawesi. The study aims to identify mathematical concepts, particularly geometry, embedded within the tomb's architectural elements. Using a qualitative descriptive method, data were collected through direct observation and literature review. The results show that the tomb's design reflects the application of planar geometry concepts, such as rectangular walls, and spatial geometry, such as a semi-spherical dome. Geometric transformations, including reflections on walls, translations in floral patterns, and rotations in window designs, were also identified. The tomb design embodies the dynamic cultural acculturation between the local Bugis culture and European colonial influences while symbolizing the diplomatic relationship between the Tanete Kingdom and the Netherlands. This study contributes to ethnomathematics by connecting cultural heritage with mathematical concepts and providing insights for developing culture-based mathematics education to enhance students' understanding of geometry and appreciation for local traditions.

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1. INTRODUCTION

Ethnomathematics, a term derived from three Greek roots—techné (technique, art, skill), mathemá (understanding, explanation, learning), and ethno (a group in the same natural and socio-cultural environment with compatible behaviors)—focuses on the ways cultural groups develop techniques for measurement, calculation, inference, comparison, and classification throughout history [1]-[4]. These mathematical practices enable communities to model and make sense of their natural and social environments [5][6]. [1] defines ethnomathematics as a program that generates new knowledge by observing the entire society, including its cultural dimensions, and by considering its members' traditions and aspirations. It emphasizes that every culture has its own distinct methods of understanding and interacting with the world, reflected in its mathematical techniques and practices.

In education, the integration of ethnomathematics has been shown to significantly enhance students' mathematical learning [7]. Study suggests that incorporating cultural contexts into teaching not only improves students' conceptual understanding but also increases their motivation and engagement [8][9][10]. Furthermore, ethnomathematics fosters critical thinking, problem-solving abilities, and an appreciation for local culture [11][12][13]. By linking abstract mathematical concepts with cultural contexts, this approach strengthens students' understanding, encourages active problem-solving, and facilitates improved communication skills [5][12][14][15]. Moreover, ethnomathematics has been found to increase students' interest in mathematics, enriching their learning experiences and making the subject more relevant to their lives [8][9][16]. Thus, ethnomathematics has the potential to enhance mathematics education holistically, promoting conceptual understanding, cognitive skills, intrinsic motivation, and heightened student interest.

Over the past decade, researchers have extensively explored the application of ethnomathematics in various cultural contexts. [17] investigated Akan ethnomathematics in Ghana, focusing on its application in teaching mensuration and geometrical concepts within the secondary school curriculum. Their study revealed various Akan ethnomathematical processes embodied in artifacts, buildings, and tools that support the teaching of geometric and mensuration topics, including applications of the pi (π) concept in ethno-technology. While Owusu-Darko et al. concentrated on curriculum implementation and pedagogical strategies, our research extends beyond educational applications to examine the inherent mathematical principles in historical architecture as cultural expressions. Additionally, where their work recommended integrating ethnomathematics into curriculum implementation, this study provides a concrete case analysis that could serve as educational material for such integration.

[16] explored the importance of developing and implementing mathematics curricula that integrate cultural and folkloric elements from students' daily lives and society. Their research specifically examined geometric patterns in Bedouin embroidery as a cultural vehicle for mathematics education, discussing the essence of the ethnomathematics approach and its importance in mathematics education. Their work emphasized how cultural values, traditions, and symbols manifest in all aspects of society, including education. While Fouze & Amit focused on curriculum development and the theoretical importance of cultural integration in mathematics education, our research provides an empirical analysis of a specific cultural monument, offering practical content that could be incorporated into such curricula. Furthermore, where their work examined domestic folk art (embroidery), this study investigates monumental architecture, representing a different scale and context of mathematical expression in cultural artifacts.

In the Indonesian context, ethnomathematics has been explored in various cultural and architectural domains, though with notable differences in approach and focus compared to this study. [18] investigated the geometric concepts of squares, triangles, and circles in the traditional architecture of the Balla Lompoa house in South Sulawesi, employing a qualitative ethnographic approach. Their work, while regionally relevant to our research, focused on residential architecture rather than funerary monuments, which involve different cultural symbolism and mathematical principles. Furthermore, while they examined indigenous architectural forms, this study explores a monument that represents cultural fusion between European architectural styles and Bugis cultural elements, providing insights into mathematical adaptations across cultural exchanges.

[19] examined ethnomathematics in the design of traditional Indonesian houses, focusing primarily on structural patterns and spatial organization. Their methodology involved visual analysis similar to ours, but they did not explore the historical and cultural context as deeply. Our research builds upon their approach by incorporating historical documentation and cultural significance into the analysis, providing a more comprehensive understanding of how mathematics, culture, and history intersect in architectural design.

[20] explored the cultural representation of the Bugis people in Barongko cake, demonstrating how ethnomathematics extends beyond architecture into cultural artifacts. While their research shares our focus on Bugis cultural expressions, they examined culinary traditions rather than architectural monuments. This difference in material focus allows our research to complement theirs by expanding the ethnomathematical understanding of Bugis culture across different domains of cultural heritage.

[4] analyzed mathematical patterns in Yogyakarta batik, focusing on symmetry and geometric transformations. Their work shares our interest in pattern analysis but differs in application context and cultural region. While they examined two-dimensional textile patterns, our research investigates three-dimensional architectural structures, requiring different analytical approaches and revealing distinct mathematical principles. [21] studied ethnomathematics in Sundanese community activities, taking a broader ethnographic approach than our architectural focus. Their work examined mathematical practices embedded in daily activities, while our research concentrates on mathematical principles preserved in enduring cultural monuments.

Internationally, [22] examined the geometric patterns of Chinese Tulou architecture, offering insights into the application of ethnomathematics in traditional building design. Their research employed a similar methodological framework to ours but in a different cultural and architectural context. While they focused on communal residential structures with circular layouts emphasizing social organization, this study examines a funerary monument with European architectural influences, highlighting the mathematical principles underlying cultural adaptation and historical commemoration.

Despite this rich body of research, there is a notable gap in the literature regarding the application of ethnomathematics in tomb architecture, particularly in the case of the We Tenri Olle Tomb in South Sulawesi. Previous studies have predominantly focused on residential architecture (as seen in [18][19][22]), cultural artifacts (such as [20] work on Barongko cake and [4] research on batik patterns), or community practices (as exemplified [21] study of Sundanese activities), with limited attention to funerary monuments that often represent significant cultural and historical heritage. Additionally, while researchers like [17] and [16] have emphasized educational applications of ethnomathematics, few have conducted in-depth analyses of monuments representing cross-cultural influences and historical transitions.

The We Tenri Olle Tomb, located in Pancana Village, Barru Regency, South Sulawesi, serves as a testament to the cultural fusion and local wisdom of the Bugis people. The tomb, with its distinctive European-style architecture, honors Tenri Olle (also known as Siti Aisyah We Tenri Olle), a Bugis queen who ruled the Tanete Kingdom from 1855 to 1910 [23], [24]. As a leader who reigned for 55 years, she left behind a significant cultural and historical legacy. The unique architectural design of the tomb provides a rich opportunity for analysis from an ethnomathematical perspective that has not been explored in previous research. This study aims to uncover the hidden mathematical elements embedded in the tomb's architecture, revealing how these elements reflect the local wisdom and cultural identity of the Bugis community.

The novelty of this research lies in the object under study—namely, the tomb—and the analytical approach that connects architectural elements with mathematical concepts such as plane figures, solid figures, and geometric transformations like translation, reflection, and rotation. Translation refers to the shifting of elements without altering their shape or size, reflection to the flipping of elements over an axis of symmetry, while rotation refers to the turning of elements around a central point. These three concepts are relevant for analyzing the structure of the tomb in relation to the alignment and symmetry embedded within it. Additionally, this research also highlights aspects of cultural identity and local heritage integrated into the physical structure of the tomb, making it a medium for reflecting cultural values that can be bridged through mathematics learning based on local wisdom.

By investigating the ethnomathematics of the We Tenri Olle Tomb, this study seeks to identify and describe the mathematical values within its cultural elements. This exploration not only connects students with their local culture but also enhances their conceptual understanding of mathematics, fostering greater engagement and motivation for learning. Furthermore, this study contributes to the broader field of ethnomathematics by extending its application to historical monuments with complex cultural significance, demonstrating how these structures can serve as repositories of mathematical knowledge and cultural identity.

2. RESEARCH METHODS

This study employed a qualitative descriptive approach [25] to explore the application of geometric concepts, including planar and spatial geometry, as well as geometric transformations such as symmetry, translation, and rotation, in the architectural structure of Siti Aisyah We Tenri Olle's tomb in Barru Regency, South Sulawesi. This approach was selected for its capacity to provide rich, contextual interpretations of complex cultural and mathematical phenomena embedded in architectural heritage. The study focused on identifying and analyzing planar and spatial geometry elements, as well as geometric transformations such as symmetry, translation, and rotation present in the tomb's structure.

Data were collected through a combination of literature review and direct observation. The literature review provided a theoretical foundation by synthesizing academic journals, books, and relevant scholarly articles, which helped to explore the use of geometric elements in traditional architecture and their links to local cultural values. Meanwhile, direct observation involved a visit to the We Tenri Olle Tomb to study its architectural form and structure firsthand, focusing on geometric elements such as rectangular walls, circular ornaments, and semi-spherical forms. During the site visit, photographic documentation was carried out using a digital camera, manual sketches were made in notebooks, and a structured observation sheet was used to guide the identification of specific geometric features and patterns. The observation focused on both macro structures (e.g., overall layout, dome design) and micro elements (e.g., ornaments, carvings, and decorative symmetry).

Visual documentation, including photographs and sketches, was used to capture detailed observations of these features, alongside the geometric transformations evident in symmetry, translation, and rotation across various architectural motifs. In accordance with the characteristics of qualitative research, the researcher acted as the main instrument in the data collection process [25][26]. This role required the researcher to observe, interpret, and analyze data based on direct interaction with the research site and context. An observation sheet served as a supporting research instrument, helping to systematically record the presence of geometric elements and transformations.

The data analysis technique used followed a descriptive qualitative, using inductive reasoning to identify recurring patterns and categorize geometric features based on their shapes, functions, and cultural meanings [25][26]. Triangulation was carried out by comparing the findings from field observation with existing literature to ensure the validity of the data [27]. This analysis highlighted planar elements such as rectangular walls and circular ornaments, as well as spatial elements such as the rectangular base and semi-spherical dome. Additionally, the study examined the application of geometric transformations, including reflective symmetry in floral patterns, translations in wall designs, and rotational symmetry in the tomb's window and ornamentation.

In the final phase, we described the ethnomathematical values embedded in the tomb's geometry, exploring how these elements reflect the local wisdom of the Bugis community. For instance, symmetry patterns were found to symbolize harmony and balance, while rotational patterns represented cultural dynamism. This analysis offered valuable insights into the relationship between mathematical concepts, architectural structures, and cultural heritage, with implications for integrating these ideas into culture-based mathematics education [2][28].

3. RESULTS AND DISCUSSION

This study aimed to explore the application of mathematical concepts, particularly geometry and symmetry, in the architectural design of Siti Aisyah We Tenri Olle's Tomb, located in Pancana Village, Tanete Rilau District, Barru Regency, South Sulawesi. Through a combination of observations and literature review, the study revealed how mathematical principles, especially geometric and symmetrical thinking, are embedded in the tomb's architectural design. These mathematical concepts are not only fundamental to the tomb's aesthetic appeal but also serve as powerful symbols of Bugis cultural identity.

The analysis emphasized the dominant geometric elements found in the structure, including planar forms, spatial shapes, and transformation patterns. Although some features relating to rays, parallel lines, and line intersections were also identified, these were not prioritized in the current analysis and are acknowledged as areas for potential future exploration.

3.1 We Tenri Olle Tomb

The We Tenri Olle Tomb, while primarily serving as the resting place for the Queen of Tanete, also symbolizes the strong diplomatic and historical ties between the Tanete Kingdom and the Netherlands (see **Figure 1**). The tomb's architectural design, influenced by European styles, incorporates local cultural elements, particularly in the inscriptions and tributes that honor the Queen's pivotal role in Tanete's history. This combination of foreign and indigenous elements is significant when viewed through an ethnomathematical lens. The tomb's form and structure demonstrate how geometric principles and symmetrical thinking are not only aesthetic tools but also markers of cultural and political meaning.

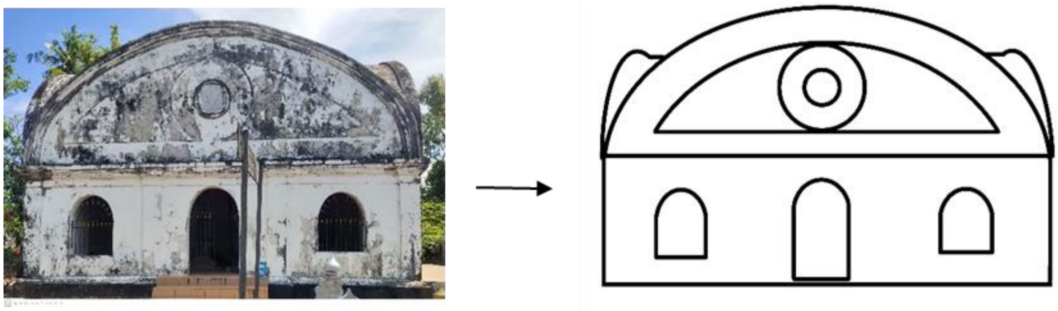


Figure 1. The We Tenri Olle Tomb

The tomb's design, characterized by a semi-spherical dome and intricate ornamentation, reflects the royal authority of the Queen. The dome shape, a prominent feature in the tomb, serves as a symbol of both colonial influence and local architectural traditions. In South Sulawesi, domed structures are often associated with the tombs of kings or Islamic leaders. The dome in the We Tenri Olle Tomb is emblematic of this local architectural tendency to adopt foreign building styles as a status symbol and to symbolize political alliances, particularly with the colonial government [12]. The inclusion of European architectural elements such as arched windows and doors further underscores the cultural acculturation between the Bugis community and the Dutch during the early 20th century. This blending of European and Bugis architectural styles demonstrates how mathematical concepts, especially symmetry and geometry, serve not only as design principles but also as cultural symbols that reflect the complex social and political dynamics of the time.

The semi-spherical dome, with its precise curvature, mirrors the symmetry seen in various cultural artifacts and architectural forms within South Sulawesi. The symmetry within the tomb, from the alignment of the dome to the decoration of its walls, echoes the Bugis cultural affinity for balance and harmony. The application of geometric principles like reflection and rotational symmetry in the design of the tomb aligns with local traditions that view symmetry as a symbol of stability and order. These principles, while mathematical in nature, transcend aesthetic values, integrating deeper cultural meanings associated with social harmony, royal authority, and political diplomacy.

While the We Tenri Olle Tomb stands as a monument to both local and foreign cultural influences, it also embodies a complex narrative of diplomatic and social exchange. The adoption of European architectural elements, such as the dome and arched windows, is a direct reflection of the political relationship between the Bugis community and the Dutch colonial government. These architectural choices were not simply aesthetic preferences but were deeply intertwined with the cultural and political realities of the time, acting as symbols of the Queen's role in Tanete's history and her relationship with the colonial authorities.

Despite the tomb's status as a protected cultural heritage site, detailed information regarding its construction and the full scope of its cultural significance remains limited. This study highlights the importance of further exploration into the architectural and ethnomathematical aspects of such heritage sites, as they offer valuable insights into the interplay between culture, mathematics, and history. Future studies should focus on uncovering more about the specific mathematical techniques used in the tomb's design and how these techniques reflect broader cultural practices and beliefs within the Bugis community.

3.2 Planar Geometry Concepts in the We Tenri Olle Tomb

The architectural design of Siti Aisyah We Tenri Olle's Tomb showcases the application of various planar geometry concepts, particularly through its shapes and structures. These include rectangular walls, semi-circular domes, and full circular elements in the roof. These geometric forms are essential in achieving visual balance, structural stability, and symbolic meaning, which are integral to the tomb's design.

3.2.1 Rectangular Walls

The walls of the tomb are composed of rectangular shapes, a fundamental geometric form characterized by two pairs of parallel sides where opposite sides are equal in length (see **Figure 2**). Rectangles, as one of the most basic two-dimensional shapes, offer both visual and structural stability to the building. In architectural design, rectangles are often used to create well-organized spaces that enhance the symmetry and proportionality of the structure.

Geometrically, a rectangle is a planar figure where all angles are right angles (90°), which contributes to the building's orderly and balanced structure. The regularity of the rectangular shape helps reinforce the symmetry of the tomb's design, aligning with the Bugis cultural values of balance and harmony.

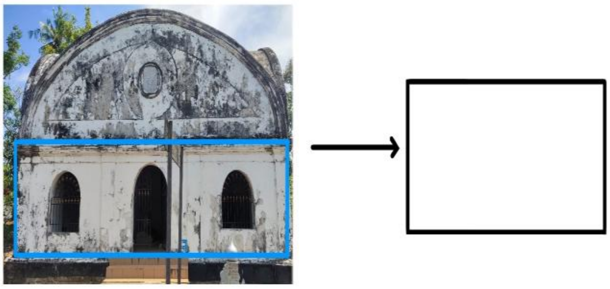


Figure 2. Rectangular Walls in the We Tenri Olle Tomb

Mathematically, the area and perimeter of the rectangular walls can be calculated using the following formulas:

$$A = l \times w$$

Where:

A = Area of the rectangle

l = Length

w = Width

$$P = 2(l + w)$$

Where:

P = Perimeter of the rectangle

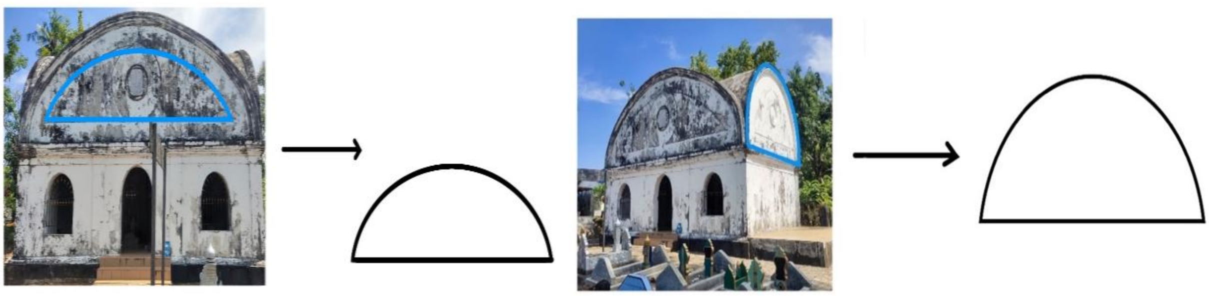
l = Length

w = Width

These geometric properties are crucial for understanding the proportions and design efficiency of the tomb's architectural elements.

3.2.2 Semi-Circular and Circular Roof Elements

The roof of the We Tenri Olle Tomb incorporates semi-circular and full circular elements, which are essential to the overall architectural harmony (see **Figure 3**). A semi-circle is geometrically formed by dividing a full circle into two equal, symmetric parts, and its elegant curvature complements the straight lines of the rectangular walls, creating a smooth transition between the building's vertical and horizontal elements. Although not all parts of the roof are semi-circular, the combination of semi-circles and full circles contributes to the overall balanced and symbolic aesthetic of the tomb's architecture.



(a) **(b)**

Figure 3. (a) Semi-Circular and (b) Circular Roof Elements in the We Tenri Olle Tomb

This curved form not only enhances the visual appeal of the tomb but also symbolizes the connection between the earthly realm and the spiritual, with the semi-circle often representing wholeness and unity. The geometric characteristics of the semi-circle and the full circle are integral to understanding the tomb's architectural and symbolic values.

3.2.3 Full Circular Elements

In addition to the semi-circular shapes, full circular elements are also prominently featured in the roof's design, especially at the front of the building (see **Figure 4**). Circular ornamentation is used in various decorative features, including engravings that combine Dutch Latin characters and Bugis Lontara script. The inscription, "WE TENRI OLLE, DATOE TANETTE, VAN 1856–1910, COMMANDEUR ORANJE NASSAU RIDDER N LEEUW," underscores the fusion of Bugis and Dutch cultural influences. This blend reflects the adaptive nature of the local community, preserving their cultural identity while incorporating foreign elements.

Figure 4. Full Circular in the We Tenri Olle Tomb

Geometrically, a circle is defined as the set of all points in a plane that are equidistant from a central point **[29]**. A full circle is a perfect planar shape, where each point on its circumference is equally distant from the center, symbolizing completeness and continuity.

The mathematical formulas for the area and circumference of a circle are:

$$A = \pi r^2$$

Where:

A = Area of the circle

π = 3,14 or $\frac{22}{7}$

r = Radius

$$C = 2\pi r$$

Where:

C = Circumference of the circle

π = 3,14 or $\frac{22}{7}$

r = Radius

3.3 Doors and Windows Combining Rectangles and Semi-Circles

The doors and windows of the We Tenri Olle Tomb feature arched tops that form semi-circles, a characteristic element of European architectural influence (see **Figure 5**). These arched openings demonstrate the integration of local Bugis culture with Dutch architectural elements, reflecting the cultural fusion in the early 20th century. The combination of rectangular and semi-circular shapes in the tomb's doors and windows exemplifies the use of design principles that merge geometric elements to achieve both functional and aesthetic harmony.

Rectangular shapes, being parallelograms with right angles **[29]**, provide structural stability and a sense of order. In contrast, the semi-circular arches introduce a flowing, organic form that contrasts with the rigidity of the rectangles, softening the architectural design. The union of these two geometric forms in the doors and windows creates a balanced, harmonious aesthetic that reflects both the influence of European design and the local Bugis approach to symmetry and proportion.

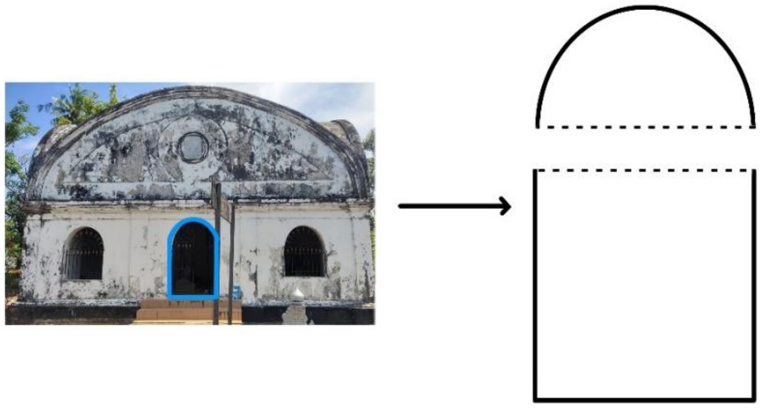


Figure 5. **Doors and Windows Combining Rectangles and Semi-Circles in the We Tenri Olle Tomb**

Mathematically, the combination of rectangular and semi-circular elements in the doors and windows can be analyzed to understand the geometric properties involved. The circumference of the arched portion (semi-circle) is half the circumference of a full circle, and the vertical sides of the door or window correspond to the sides of the rectangular component. The semi-circular arch's circumference is half of the circumference of a full circle, which is given by: $C\ curved = \frac{1}{2}(2\pi r) = \pi r$, where: r = Radius of the semi-circle. The circumference of the vertical sides $= l + w + w = l + 2w$. The total circumference of the shape is the sum of the curved side and the vertical sides: $C = \pi r + p + 2l$. Thus, the radius $r = \frac{1}{2}\ p$. Substituting this into the equation results in:

$$C = \frac{1}{2}\pi l + l + 2w$$

$$C = \frac{l}{2}(\pi + 2) + 2w$$

Where:

C = Total circumference of the shape

π = 3,14 or $\frac{22}{7}$

l = length

w = width

3.4 Spatial Geometry Concepts

The architecture of Siti Aisyah We Tenri Olle's Tomb combines various geometric forms, with a rectangular base resembling a cuboid. The roof structure consists of a curved dome resembling a semi-cylinder, creating a monumental and symmetrical impression for the overall tomb structure (see Figure 6). The dome of the tomb, which reflects European architectural characteristics, illustrates the transformation of Tanete kings' tombs during the 20th century, influenced by political relations with the Dutch government.

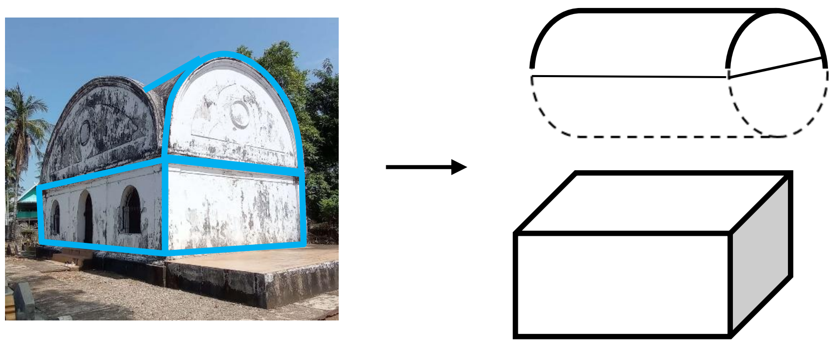


Figure 6. **Structure Composition Using a Cuboid and Half-Cylinder in the We Tenri Olle Tomb**

In mathematics, a cuboid is a three-dimensional solid figure with six rectangular faces, where opposite faces have the same dimensions. In the We Tenri Olle Tomb, the rectangular base resembling a cuboid provides an organized spatial layout. Visually, the cuboid imparts a sense of stability and simplicity to the building.

The semi-spherical dome on the tomb's roof is a form resembling a cylinder, a three-dimensional shape with two circular bases and a curved lateral surface connecting the bases. These two shapes, although derived from simple geometric concepts, are combined in the tomb's design to create a harmonious, strong, and majestic impression, which characterizes the tomb’s architecture.

Mathematically, the combination of a cuboid and a half-cylinder roof in the structure can be analyzed to understand the geometric properties involved. The volume of the structure consists of two main parts: the volume of the cuboid and half the volume of a cylinder. The volume of the cuboid is given by: $V_{cuboid} = l \cdot w \cdot h$, and the volume of the half-cylinder (roof) is half of the volume of a full cylinder, given by: $V_{roof} = \frac{1}{2}(\pi \cdot r^2 \cdot h)$, where: r = radius of the cylinder. The diameter of the cylinder is equal to the width of the cuboid, which means: $r = \frac{1}{2} \cdot w$. Substituting this into the formula results in:

$$V = l.w.h + \frac{1}{2}\left(\pi\left(\frac{1}{2}w\right)^2 h\right)$$

$$V = l.w.h + \frac{1}{2}\left(\frac{\pi w^2 h}{4}\right)$$

$$V = l.w.h + \frac{\pi w^2 h}{8}$$

Where:

V = Total volume of the structure

π = 3.14 or $\frac{22}{7}$

l = length of the cuboid

w = width of the cuboid (and diameter of the cylinder)

h = height of both the cuboid and the cylindrical roof

3.5 Geometric Transformation Concepts

Transformation geometry provides a fundamental approach to understanding the spatial relationships within geometry [30]. This branch of mathematics studies the manipulation of geometric shapes through transformations such as translation, reflection, rotation, and dilation. These principles can be observed within the architectural elements and decorative motifs of Siti Aisyah We Tenri Olle’s Tomb, where various geometric transformations are intricately woven into the design.

3.5.1 Translation

Translation refers to a geometric transformation that moves an object from one position to another without altering its shape or orientation. This transformation is the result of two reflections along parallel lines, and conversely, two parallel reflections produce a translation [30]. In the tomb’s architecture, the concept of translation is clearly demonstrated in both structural and decorative elements (see Figure 7).

Figure 7. Translation in the We Tenri Olle Tomb Windows and Doors

For example, the tomb's windows and doors feature vertical iron bars arranged parallel to each other, with uniform spacing. Additionally, along the edges of the tombstone, repetitive floral motifs create a pattern that repeats at consistent intervals (see **Figure 8**). These motifs, according to Ashari **[31]**, serve a semi-sacred function and are common in the tombs of Bugis kings. These repeated patterns, such as *Sulapa Eppa*, *Bunga Tanri, Belo-Belo Cidu,* and *Bunga Parenreng*, are often categorized as decorative or filler motifs and appear on various tomb structures including tombstones and covers.

Figure 8. Translation in the Edge of the Tombstone

The repetition of these patterns without alteration in size or shape, along with their consistent intervals, exemplifies the principle of translation in geometric transformations. These elements showcase a deliberate application of symmetry and regularity in the design, reinforcing the tomb's aesthetic and symbolic coherence.

3.5.2 Reflection (Symmetrical Reflection)

Symmetrical reflection, a transformation that creates a mirror image of an object across an axis of reflection, is prominently featured in the architectural design of the We Tenri Olle Tomb complex in Barru Regency. In this transformation, each point of the object is reflected across a line, such that every corresponding pair of points lies equidistant from the axis of reflection **[29]**.

Figure 9. Reflection in the Headstone of Siti Aisyah We Tenri Olle Tomb

The headstone of Siti Aisyah We Tenri Olle, one of the five tombs in the complex, is a prime example of symmetrical reflection (see **Figure 9**). The tomb features floral and calligraphic motifs that are mirror images of one another. The calligraphy on the headstone, which reads: *"Oh God! I am not a dweller of heaven, but I cannot endure the fires of Hell. Therefore, show me repentance (forgiveness) and forgive my sins, for indeed, You are the Most Forgiving of great sins,"* highlights the strong Islamic influence within Bugis culture.

This use of symmetry extends to the other tombs in the complex. Each headstone exhibits mirrored geometric motifs, emphasizing a visual harmony that reflects the cultural values of the Bugis community, such as balance, unity, and spiritual reverence. According to Ashari **[31]**, these motifs, including *Sulapa Eppa*, *Bunga Tanri*, and various forms of calligraphy (shahada, dhikr, *Ismul Jalalah*, and prayers), carry sacred meanings, enhancing the spiritual significance of the tombs.

3.5.3 Rotation

Rotation is a geometric transformation that involves turning an object around a fixed point by a specified angle. This transformation produces a symmetrical pattern by rotating each point of the object by a fixed angle about a central axis **[30]**. At Siti Aisyah We Tenri Olle's Tomb, radial symmetry is evident in the iron ornaments at the tops of the windows, which are arranged to resemble sun rays (see **Figure 10**). These patterns can be interpreted as the result of rotational symmetry, where the ornaments are evenly distributed around a central point, creating a balanced and cohesive design.

Figure 10. Rotation in the Windows of Siti Aisyah We Tenri Olle Tomb

This rotational symmetry is not merely an aesthetic choice; it adds a sense of dynamism and visual order to the structure, contributing to the overall harmonious impression of the tomb's architecture. The rotational transformation further reinforces the theme of balance and symmetry, which are central to the cultural and architectural significance of the tomb complex.

4. CONCLUSION

This study aimed to uncover the mathematical concepts embedded in the We Tenri Olle Tomb's architecture and how these elements reflect the cultural identity of the Bugis people. Through detailed analysis of geometric shapes, spatial structures, and transformations—such as reflections, translations, and rotations—this research demonstrates that the tomb's design is not only a product of aesthetic and structural considerations but also a cultural artifact rich in mathematical meaning.

The findings directly address the research objectives by showing that mathematical reasoning is visibly expressed through both the physical form and symbolic function of the tomb. Elements like rectangular walls, circular ornaments, and the semi-cylindrical dome exemplify the integration of local wisdom and foreign influence, especially from European architecture, into a coherent structure that embodies symmetry, harmony, and cultural diplomacy.

By highlighting these relationships, the study contributes to the growing body of ethnomathematics research, expanding its scope to include tomb architecture—an underexplored domain. Furthermore, this research underscores the value of incorporating cultural heritage into mathematics education, thereby fostering students' conceptual understanding and cultural awareness. Future studies are encouraged to delve deeper into additional geometric elements not fully explored here, such as rays, parallel lines, and intersections, to enrich our understanding of the interplay between mathematics and cultural expression.

AUTHOR CONTRIBUTIONS

Muhammad Ammar Naufal: Conceptualization, Data curation, Formal analysis, Methodology, Project administration, Supervision, Validation, Writing - Review and Editing. Ja'faruddin: Conceptualization, Methodology, Supervision, Validation. Satrina: Conceptualization, Data curation, Methodology, Project Administration, Resources, Visualization, Writing - Original Draft, Writing - Review and Editing. Lhenny Ardillah Latif: Conceptualization, Data Curation, Methodology, Project administration, Resources, Visualization, Writing - Original Draft, Writing - Review and Editing. Gita Eka Novianti: Conceptualization, Data Curation, Project Administration. Risaldi: Conceptualization, Data Curation, Project Administration. Fadhel Muhammad: Conceptualization, Data Curation, Project Administration. Muhammad Nasiru Hassan: Supervision, Validation. All authors discussed the results and contributed to the final manuscript.

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CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest related to the research presented in this manuscript. This includes any financial relationships with the government that may have a direct or indirect interest in the research findings. They are committed to maintaining the integrity of the research process and ensuring that the findings are presented without bias.

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