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Explored Ethnomathematics on Silahisabungan Monument

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Abstract

Ethnomathematics is one technique that explains the various cultural contexts associated with mathematics applied by a particular community. SilahiSabungan Monument is a monument that holds significant meaning for the Toba Batak community in North Sumatra, Indonesia. Through an ethnomathematical approach, this research explored and analyzed the relationship between the symbols and forms found at SilahiSabungan Monument with underlying mathematical concepts. The research method used was qualitative research. The results of this study indicate that the shapes and symbols at SilahiSabungan Monument are related to concepts of plane geometry. For example, shapes like rectangles, trapezoids, and others on the monument can be connected with concepts of plane geometry. This demonstrates the richness of mathematical knowledge within Toba Batak culture. This ethnomathematical exploration provides a deeper understanding of the relationship between culture and mathematics in the context of the SilahiSabungan Monument. This research makes an important contribution to expanding the insights and understanding of researchers and the community about ethnomathematics and the importance of preserving and respecting cultural heritage and traditional knowledge. Further exploration of ethnomathematics at SilahiSabungan Monument can provide new perspectives in understanding and appreciating the cultural and mathematical diversity in Indonesia.

1. Introduction

Mathematics is a foundational science in various fields of study. Its role in everyday life is crucial for both human existence and scientific advancement. In education, mathematics is encountered from basic to higher levels, from elementary to university education. Education and culture are two inevitable elements of daily life because culture is a complete and inclusive entity that applies to society, while education is a fundamental need for everyone in society (Febriana et al., 2022). Mathematical concepts are arranged sequentially, with each concept building upon the previous one. Mathematical concepts consist of geometry, congruence and similarity, as well as measurement concepts. Mathematical concepts found in society can be utilized as knowledge to study mathematics within a cultural context (Rakhmawati, 2016).

Indonesia is renowned for its cultural richness, which is a heritage that must be preserved by future generations to ensure the continuity and preservation of its inherent wisdom. Education and culture are inseparable. Nowadays, mathematics can be learned in various ways, not only through textbooks and teachers but also through culture. Culture significantly influences how students perceive things, including understanding mathematical concepts. Culture is the evolving way of life of a region or group that is passed down through generations (Salim, 2016). Culture illustrates the identity of a nation. It can influence an individual's behavior and plays a significant role in the development of individual understanding (Utaminingsih, 2014).

Culture consists of various systems such as religious, political, architectural, artistic, customary, clothing, and linguistic systems, which are inseparable elements of culture. Cultural heritage is classified

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into immovable cultural heritage and movable cultural heritage (Mardika, 2019). Monuments are structures built to commemorate events or incidents from the past and hold significant historical value. One of the monuments in Dairi Regency is the Raja SilahiSabungan monument. It is located in Silalahi Nabolak Village, Silahisabungan District, Dairi Regency. Dairi Regency is currently one of the tourist destinations in North Sumatra.

In the context of mathematics education, cultural values can be transformed into learning activities, one of which is ethnomathematics (Ratriana et al., 2021). Ethnomathematics is the mathematics used within certain ethnic groups, social classes, occupational classes, and other cultural institutions. Mathematics learning associated with culture is known as ethnomathematics. Ethnomathematics serves to express the relationship between mathematics and culture (Martyanti & Suhartini, 2018). The application of ethnomathematics in learning shows that students learn contextually, where they learn directly from real-life situations (Dahlan & Permatasari, 2018). By applying ethnomathematics in mathematics education, it is expected that students will have a better understanding of mathematics and the culture around them, allowing teachers to instill cultural values in their students (Fauzi & Setiawan, 2020).

Ethnomathematics is a branch of mathematics education that connects mathematics with the culture in which students live. In ethnomathematics, students are not only encouraged to develop mathematical skills but also introduced to cultural elements, such as the Silahisabungan monument. Therefore, ethnomathematics is considered highly relevant for current lessons as it can motivate students to learn mathematics. Hence, in this study, ethnomathematics focuses on exploring the elements of plane geometry in the Silahisabungan monument.

Plane geometry, also known as two-dimensional geometry, deals with figures that have only area and perimeter. Types of plane geometry figures include circles, triangles, squares, trapezoids, parallelograms, rectangles, rhombuses, and kites. Euclid, an ancient Greek mathematician known as the father of geometry, discovered the concepts of geometry. His work "The Elements" is a highly influential geometry book in the history of mathematics, serving as a reference until the 20th century (Busrah, 2021). Some types of plane geometry figures include triangles, squares, rectangles, circles, trapezoids, parallelograms, rhombuses, and kites.

Silalahi Monument is a significant monument for Toba Batak community in North Sumatra, Indonesia. It serves as a symbol of cultural identity and rich history for the local community (Atrea, 2018). However, there have been few studies that explore and analyze Silalahi Monument from the perspectives of mathematics and culture through an ethnomathematical approach. In the context of Silalahi Monument, the forms found within the monument have the potential to contain deep mathematical knowledge. For example, the triangular shapes found in the monument. Additionally, other forms may also reflect mathematical concepts such as plane geometry.

It is important to explore the forms of the Silalahi Monument from an ethnomathematical perspective because this can provide new insights into the wealth of mathematical knowledge within Toba Batak culture. This research can also help in preserving and respecting the cultural heritage and traditional knowledge associated with the Silalahi Monument. In the context of mathematics education, exploring ethnomathematics at the Silalahi Monument can make a significant contribution to the development of a more diverse and inclusive curriculum. By expanding understanding of mathematical concepts within culture, it can create more relevant and engaging learning experiences for students (Purba, 2022).

Therefore, this study aims to explore and analyze the geometric shapes found in Silalahi Monument through an ethnomathematical approach. It is hoped that this research can provide a deeper understanding of the relationship between culture and mathematics, as well as contribute to the preservation of cultural heritage and the development of more holistic mathematics education. The research method used in this study is qualitative. Data collection techniques employed by the researcher include observation, documentation, and interviews with the surrounding community. In this paper, the author will provide a detailed explanation of the research methodology used, the findings of the research, and the implications of this study for the development of mathematics education and cultural preservation. It is hoped that this research can provide new insights and motivate further research in the fields of ethnomathematics and traditional knowledge.

Figure 1. Silahisabungan Monument

This research was conducted to explore SilahiSabungan Monument in depth by applying the concept of ethnomathematics. In this case the researcher seeks to describe the real form of SilahiSabungan Monument building with the concept of mathematics as a learning resource for students so that learning is not only learned in class but can also be learned outside of school, especially at Silahisabungan Monument.

2. Methods

The method used in this study was qualitative research. The approach employed by the researcher was ethnography. The definition of qualitative research is research that uses scientific methods to articulate a phenomenon by explaining the data and facts obtained using words comprehensively about the research subject (Habsy, 2017). Ethnographic approach is a study of a tribe or nation obtained based on field research conducted by researchers and aims to explain a culture from the perspective of the inhabitants of that area (Pahleviannur et al., 2022).

The data collection techniques used in this study include observation, interviews, and documentation. Data analysis in this study involves data reduction, data presentation, and drawing conclusions. The analysis technique involves describing the shapes of the buildings at Silalahi Monument and linking them to mathematical concepts present in the shapes of Silalahi Monument. The researcher only focuses on explaining the concepts of plane geometry in Silalahi Monument buildings.

3. Results & Discussions

Based on the results of exploration conducted at Silalahi Monument by observation and documentation, researchers found various objects that can be used as mathematical objects. The symbols and shapes contained in Silalahi monument express the concept of flat geometry.

Monument or *Tugu* Silalahi or known as *Tugu* & *Makam Raja* Silahisabungan (TUMARAS) which was inaugurated on November 23 to 27, 1981 by all Pomparan Raja Silahisabungan. On November 24, 1981 in Tumaras, much of the history and tarombo of Opung Silahisabungan was written, all over Indonesia and even the world where all descendants of Opung Silahisabungan are oriented to Tarombo in Silalahi Nabolak as the basis for their partuturan to all descendants of Opung Silahisabungan. Where the eldest is called *Pak Tua* (old father) by his younger siblings and the smallest is called *Pak Uda* (*bapa uda*/*anggi doli*) by the older brother.

Silahisabungan monument was built against the backdrop of problems that occurred among the Silahisabungan generation. So that Turpuk Kings in Silalahi Nabolak have the intention to build Silahi Sabungan Monument so that all Silahi Sabungan can live in peace and the generations who are overseas can make pilgrimages and know their ancestral lands, and can build kinship between existing clans. This Silahi Sabungan monument is not used as a tourism site because it is devoted to pilgrimage and

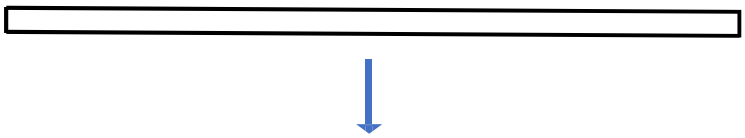
remembering the ancestral lands of fellow Silahi Sabungan clans, therefore there is no inauguration from the culture and tourism office.

The King of Silahi Sabungan monument is often visited by students to conduct research on the silahi sabungan monument, and many also associate this silahi sabungan monument to be a topic in the student's final project. Usually Silahisabungan monument is visited by visitors who want to make a pilgrimage on holidays and during the Silahi Sabungan monument party. The meaning contained in the illustrations on the Silahi Sabungan monument is none other than as a unifying symbol and identity symbol for all descendants and as a place for pilgrimage as atribute to the ancestors of Silahisabungan clan.

One of the interesting aspects of Silahisabungan Monument is the geometric symbolism contained in it. The structure of this monument contains various geometric shapes such as triangles, circles and rectangles. Each geometric element has a deep symbolic meaning in the beliefs and culture of Batak people. Ethnomathematics on Silahisabungan Monument is also manifested through the use of numbers and patterns. The number of stairs, the number of steps, and even the intricate carving patterns all have mathematical connotations that are important to the Batak people. The numbers used in the construction of these monuments often have deep cultural and spiritual significance. This Silahisabungan monument expresses the concept of flat geometry. Here are some objects that express the concept of flat geometry as follows.

3.1. Explored on the Stairs of Silahisabungan Monument

Figure 2. Front of Silahisabungan Monument



In Figure 2, on the front side of Silahisabungan Monument, there are steps that have the geometric concept of a rectangle. A rectangle is a four-sided flat shape that has two pairs of parallel sides of equal length and four right angles (90 degrees). In this case, the mentioned steps have a rectangular shape, which means the length and width of the steps are different. Steps are the part of the staircase placed between two floors or surfaces with different heights. These steps are located at the front of Silahisabungan Monument.

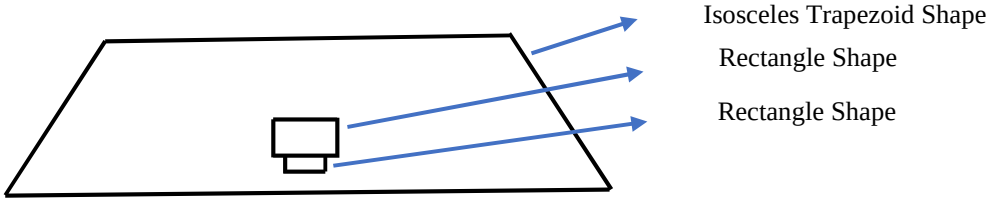
This explored relates to how these steps function in facilitating access to the monument. It may involve researching the number of steps, the height of the steps, and how they are designed to ensure accessibility for visitors with various needs. Rectangular steps have two main dimensions: length and width. Length refers to the horizontal measurement of the steps, while width is the vertical measurement. Understanding the proportion between length and width is important to determine the balance and stability of the steps.

The ratio between the length and width of the steps can vary depending on the design and structural requirements. This ratio can affect the level of comfort when using the steps as well as the steps' ability to support weight. In addition to length and width, the angle of inclination of the steps is also an important factor. The optimal angle of inclination allows easy and safe access to higher places. The height of each step also needs to be considered to ensure comfort during use. The number of steps in a rectangular staircase

also affects the overall slope of the stairs and the distance between each step. This is important to maintain user safety and ensure the stairs are easy to use (Setiawan, 2020).

3.2. Explored of Hadap Tao Silalahi's 1st Side Section

Figure 3. Hadap Tao Silalahi 1st side section



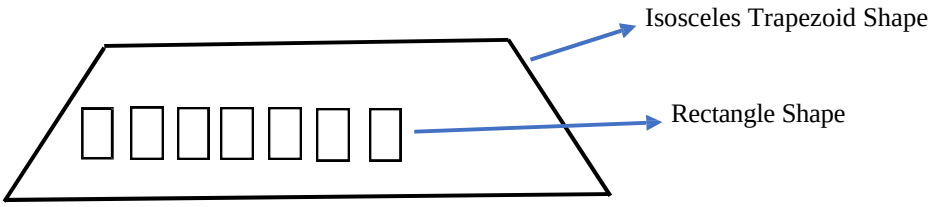
In Figure 3, the 1st side of Hadap Tao Silalahi has the concept of flat geometry, namely there is an isosceles trapezoidal shape and a rectangular shape. Trapezoid is a two-dimensional flat shape consisting of four sides, are two parallel sides that are not equal in length and two parallel sides and two other sides. According to the nature of the trapezoidal alignment, there are two assumptions about the trapezoid. An isosceles trapezoid is a trapezoid that has a pair of ribs that are equal in length and on the sides it also has a pair of parallel ribs. An isosceles trapezoid has one folding symmetry and no rotary symmetry. In the context of the image of the 1st side of Hadap Tao Silalahi, there is a trapezoidal shape with two hypotenuse that have the same length.

Isosceles trapezoids are rarely used in architecture to provide visual variety in building design. The isosceles trapezoid is more commonly used in math or geometry as a flat building concept (Wulandari, 2017). In architecture, isosceles trapezoids are not often used because the shape tends to be less structurally stable than other geometric shapes such as rectangles, triangles, or circles. Architects are more likely to use more structurally stable geometric shapes for building design to ensure the safety and stability of the building (Nugroho & Iyati, 2021).

However, the isosceles trapezoid can still be used in architectural design when combined with appropriate structural elements or supports to increase its stability. However, its use to provide visual variety to building designs is not as common as other geometric shapes.

3.3. Explored Hadap Ruma Parsaktian 2nd Side Section

Figure 4. Hadap Ruma Parsaktian 2nd Side Section

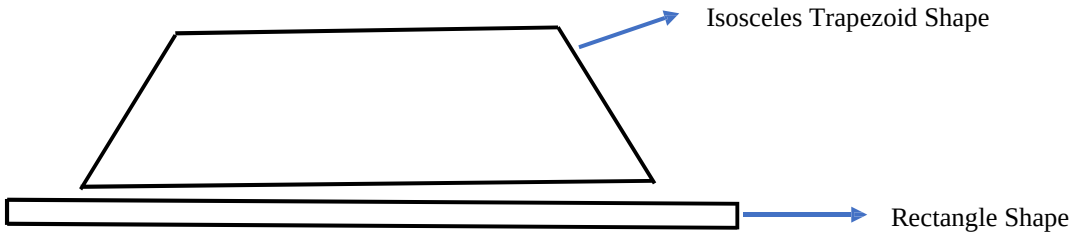


In Figure 4, Hadap Ruma Parsaktian 2nd Side Section there are flat geometric shapes, namely, isosceles trapezoidal shapes and rectangular shapes. The isosceles trapezoidal shape is found in the shape of the silahisabungan monument and the rectangular shape is found in the object above the heads of the seven women. Thus, it can be seen that the design of the silahisabungan monument has different geometric elements, giving the structure visual and aesthetic complexity.

A trapezoid is a two-dimensional flat shape consisting of four sides, two parallel sides that are not equal in length and two parallel sides and two other sides. According to the nature of the trapezoidal alignment, there are two assumptions about the trapezoid. An isosceles trapezoid is a trapezoid that has a pair of ribs that are equal in length and on the sides it also has a pair of parallel ribs. An isosceles trapezoid has one folding symmetry and no turning symmetry.

3.4. Explored Hadap Juma Dabdab 3rd Side Section

Figure 5. Hadap Juma Dabdab 3rd Side Section



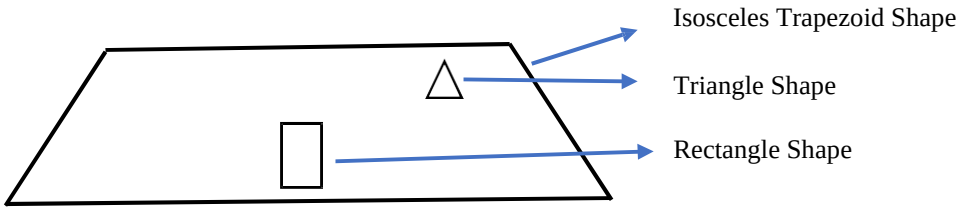
In Figure 5, Hadap Juma Dabdab 3rd side section there are flat geometric shapes, namely, isosceles trapezoidal shapes and rectangular shapes. The trapezoidal shape is found on the Silahisabungan monument and the rectangular shape is found on the steps leading to the 3rd side of Silahisabungan monument.

The isosceles trapezoidal shape is found on the structure of Silahisabungan monument. An isosceles trapezoid has two pairs of parallel sides with two equal opposite angles. In this context, the top or main structure of the monument forms an isosceles trapezoid, giving dimension and visual complexity to the

design of the monument. And the rectangular shape is found on the steps leading to the 3rd side of Silahisabungan monument. Rectangles have two pairs of parallel sides and all four corners are right angles. In this case, the rectangular steps provide access to the 3rd side of the monument, while also providing a geometric element that is consistent with the overall design. Thus, two forms of flat geometry, the isosceles trapezoid and the rectangle, are present on Hadap Juma Dabdab 3rd side section of Silahisabungan monument, giving visual and structural beauty to the design of the monument.

3.5. Explored Hadap Nauli Basa 4th Side Section

Figure 6. Hadap Nauli Basa 4th Side Section



In Figure 6, the 4th side of Hadap Nauli Basa there is a flat geometric shape, namely in the shape of the Silahisabungan monument building in the form of an isosceles trapezoid, on the carving of the fourth side there is a triangular roof shape of a traditional house, and on the carving of the 4th side which describes the descendants of Raja Silahisabungan in the form of a rectangle.

First, the isosceles trapezoid on the silahisabungan monument building. An isosceles trapezoid is a flat shape that has two pairs of parallel sides, where one of the pairs has the same length. In this case, the Silahisabungan monument features an isosceles trapezoid shape. The top or main structure of the monument forms an isosceles trapezoid. This gives the overall design of the monument the same dimension and unique visual characteristics as before.

Secondly, the triangular shape in the carving on the fourth side resembles the roof of a traditional house. A triangle is a flat shape with three sides and three angles. Two sides of the triangle can be parallel, and one of its angles is smaller than 90 degrees. In the carving on the fourth side, there is an image of a traditional house roof shaped like a triangle. This traditional house roof has a triangular shape with two sides possibly parallel to the sides of the trapezium on the SilahiSabungan monument. This represents a traditional architectural element carved to reflect local cultural heritage and history.

Thirdly, the rectangular shape in the carving on the fourth side depicts the descendants of Raja SilahiSabungan. A rectangle is a flat shape with two pairs of parallel sides of different lengths, and all four angles are right angles. In the carving on the fourth side depicting the descendants of Raja Silahisabungan, there is a rectangular shape. This rectangle may symbolize the stability and strength of the descendants in preserving their cultural heritage and history.

Therefore, the fourth side of Hadap Nauli Basa of Silahisabungan monument displays various geometric shapes, namely an isosceles trapezium in the monument's structure, a triangle in the carving representing the traditional house roof, and a rectangle in the carving depicting the descendants of Raja

Silahisabungan. Each of these geometric shapes contributes to the uniqueness and beauty of the overall design of Silahisabungan monument.

This research focuses on analyzing the geometric structure of Silahisabungan monument, including discussions on its shapes, sizes, and proportions. Through measurements and geometric analysis, researchers can identify patterns or mathematical ratios underlying the construction of the monument.

Furthermore, this research highlights the role of mathematics in the construction of Silahisabungan monument. This includes the use of mathematical calculations to determine dimensions and proportions, the application of geometry in arranging structural elements, and the implementation of mathematical principles to ensure the stability and resilience of the monument.

Another report on ethnomathematics, such as the study by Zayyadi, (2018), focuses more on analyzing geometric patterns and the use of symmetry, while in the case of the SilahiSabungan monument, the research may focus more on analyzing geometric structures and the use of mathematics in monument construction. The goal remains the same: to introduce and understand mathematical concepts through local culture.

Pratiwi & Pujiastuti (2020) report on marble games involves players arranging marbles on a flat surface with specific patterns, such as triangle formations, circles, or other symmetrical patterns. Marble games often involve simple counting, such as the number of marbles each player has or the score obtained when a marble enters a hole.

In contrast, the report by Fajriyah (2018) highlights the importance of linking mathematical concepts with cultural contexts to enhance understanding and application. By understanding mathematical concepts in a cultural context, mathematical literacy can be improved because students will be better able to relate these concepts to real-world situations.

Based on the findings of the research, the development of learning materials that integrate ethnomathematical concepts such as Silahisabungan monument can be pursued. These materials can be designed to introduce students to mathematical concepts through a rich cultural context, thereby enhancing student interest and engagement in learning. The research results can also be used to enrich the mathematics curriculum with discussions on ethnomathematics. This may involve blending elements such as history, culture, and local traditions into mathematics education, allowing students to understand and appreciate the cultural contributions to the development of mathematical concepts.

From the points discussed above, the researcher acknowledges certain limitations in this study. Therefore, the researcher has several recommendations for future research to address these limitations. First, there is no specific discussion regarding the significance of certain numbers or geometric patterns in Batak culture within the design of the SilahiSabungan monument. Second, there is no specific explanation about the analysis of mathematical calculations used by architects or builders to ensure the stability and beauty of the structure.

4. Conclusion

In this study, the geometric shapes found in Silahisabungan Monument were examined using an ethnomathematical approach. The results indicate that Silahisabungan Monument contains geometric structures that encompass the shape, size, and proportions of the monument. Through measurement and geometric analysis, researchers can discover mathematical patterns underlying the construction of the monument. The study also highlights the role of mathematics in the construction of Silahisabungan Monument, such as determining dimensions and proportions, using geometry in the arrangement of structural elements, and applying mathematical principles to ensure the stability and durability of the monument.

Based on the findings of this research, the researcher has several recommendations for future research to address the limitations of this study. First, it may be beneficial to investigate the mathematical symbolism contained within the design and structure of Silahisabungan Monument. For example, whether there is the use of specific numbers or geometric patterns that have special meaning or significance in Batak culture. Second, further research could examine the construction calculations used in the construction of Silahisabungan Monument. This research could involve a detailed analysis of the mathematical calculations used by architects or builders to ensure the stability and beauty of the building structure.

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