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Exploring Geometric Concepts in the Medan Post Office through an Ethnomathematical Approach

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ABSTRACT

Geometry is often considered abstract and difficult to understand because it is rarely linked to real life and the surrounding culture. Therefore, a learning innovation is needed using the Medan Post Office. A culturally acculturated colonial heritage building studied in depth from an ethnomathematical perspective. This study aims to explore the cultural values and geometric concepts inherent in the architecture of the Medan Post Office using an ethnomathematical approach. It employs a qualitative ethnographic design, utilizing primary data from observations and interviews alongside secondary data from relevant literature; data analysis was conducted through reduction, presentation, and conclusion drawing. The findings reveal concepts of plane geometry (rectangles, squares, circles, semicircles, octagons, right-angled trapezoids, and isosceles triangles) and spatial geometry (pyramids, prisms, rectangular prisms, and cubes). The building embodies ethnomathematical elements resulting from the acculturation of local culture with colonial architecture, socio-historical functions, and environmental adaptation. This research enriches the study of cultural heritage ethnomathematics and offers potential as a resource for contextual, culture-based mathematics learning.

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1. INTRODUCTION

Mathematics is a crucial subject for developing students' logical, systematic, and critical thinking skills [1]. However, geometry is often perceived as difficult and abstract because instruction rarely links the material to real-life contexts or the surrounding environment [2]. To address this, instructional innovations that connect mathematical concepts with cultural realities are needed—one such method being the ethnomathematics approach. This approach presents mathematics as an integral part of community life, thereby making learning more meaningful and relevant [3].

The Medan Post Office, built in 1911, is a Dutch colonial heritage building designed by architect Ir. Simon Snuyf during the tenure of Resident J. Ballot [4]. Originally serving as a vital communication and logistics hub for the administration of Tanah Deli [5], the building remains standing strong today, serving as both a historical landmark and a public space in the city of Medan. Its architecture, a blend of European styles and elements of local wisdom, embodies a richness of form and mathematical calculation worthy of study through the lens of ethnomathematics.

D'Ambrosio first introduced ethnomathematics in 1977, defining it as mathematics practiced and developed by specific cultural groups in their daily lives [6]. Etymologically, the term comprises *ethno* (environment and cultural identity), *mathema* (understanding and learning), and *tics* (methods or techniques) [7]. This concept asserts that mathematics does not emerge in a vacuum but rather grows and evolves alongside the activities and needs of communities within their respective cultural contexts, as evidenced by the traditional calculation systems of the Minangkabau people [8]. Through ethnomathematics, students not only master the subject matter but also come to appreciate cultural diversity and cherish ancestral heritage [9].

Although many historical buildings hold great potential as resources for learning geometry, school instruction generally remains centered on textbooks and rarely utilizes objects from the surrounding environment. Meanwhile, the Medan Post Office, with its unique design and cultural acculturation, has not yet been thoroughly studied with respect to the geometric concepts embedded in it, nor have its associated cultural and philosophical values been examined in relation to the application of mathematical principles.

Various studies have demonstrated the presence of ethnomathematical elements in heritage structures. Agustin and Soebagyo [10] identified planar geometric shapes at the Walahar Dam; Putri and Zayyadi [11] identified concepts of plane figures, spatial shapes, and geometric transformations in historic Dutch-era houses; and Susanto et al. [12] documented the application of various geometric forms in the structure of Fort Van den Bosch. Overall, these studies indicate that colonial architecture was designed using systematic mathematical calculations. However, most existing research has stopped at identifying geometric shapes and has not yet delved deeper into their connections to cultural values or their application in classroom learning. Silviana et al. [13] and Fauziyah et al. [14] have suggested developing these research findings into learning materials to foster student appreciation for cultural heritage, yet such development and implementation remain very limited.

Based on existing literature, there is a research gap characterized by the following: (1) There is a lack of in-depth study specifically examining the ethnomathematics of the Medan Post Office a colonial building serving as a public facility that remains in active use today; (2) Ethnomathematical studies of heritage buildings generally fail to integrate the analysis of geometric concepts with philosophical values, socio-historical functions, and the building's environmental adaptation; and (3) There is no available reference directly linking the geometric findings of this building to mathematics learning needs in schools.

This research offers novelty in: (1) the object of study—the Medan Post Office—which has not been extensively researched from an ethnomathematical perspective; (2) the analytical approach, which combines the identification of geometric concepts with an exploration of cultural and philosophical values as well as the building's functions; and (3) the research contribution, specifically designed to serve as a contextual learning resource, distinguishing it from previous studies that generally focused solely on cataloging forms.

This study aims to explore the cultural and philosophical values, as well as the plane and spatial geometric concepts, embodied in the architecture of the Medan Post Office through an ethnomathematical approach.

From a theoretical perspective, this research enriches the body of knowledge, particularly regarding ethnomathematical studies of colonial heritage buildings in Indonesia. In practice, this finding encourages students to think logically and critically when applying mathematical concepts. It serves as a real, contextual, and innovative learning resource for teachers and students, boosting understanding of geometry while nurturing appreciation and responsibility for preserving local cultural heritage. Furthermore, the research broadens public understanding of the meanings and values embodied in the design of these iconic buildings in Medan.

2. METHOD

This study employs a qualitative approach aimed at understanding the meanings and phenomena under investigation, specifically, an exploration of ethnomathematical concepts within the architecture of the Medan Post Office. Given that the study focuses on an in-depth analysis of the building as a cultural artifact without involving the sustained participatory interaction with cultural groups characteristic of standard ethnographic research, an exploratory case study design was adopted. This design was selected to facilitate a thorough examination of the object's characteristics, values, and constituent elements through systematic observation, document analysis, and the investigation of its inherent cultural meanings and mathematical concepts [15].

The research was conducted at the Medan Post Office, located at Jalan Pos No. 1, Kesawan Urban Village, Medan Barat District, Medan City, North Sumatra Province. The research activities encompassed the entire process, from the planning and data collection stages to the compilation of the final report.

According to Surokim et al. [16], the research subjects are the parties who provide the necessary information. Participants in this study were selected using the purposive sampling technique; specifically, informants were chosen based on criteria requiring them to possess in-depth knowledge and understanding of the history, architecture, and cultural value of the Medan Post Office. Meanwhile, the research object of this study was the Medan Post Office building itself.

According to Nasution [17], the research data sources consist of primary and secondary data. Primary data comprises key information obtained directly through systematic observation of building elements and in-depth interviews with selected participants. Secondary data complements and reinforces the findings by drawing on sources such as scientific journals, history books, theses, technical documents, and other literature relevant to ethnomathematics and the architecture of the Medan Post Office.

Data collection was conducted using an integrated approach comprising three complementary methods to ensure valid and comprehensive data [18]: (1) observation to identify the geometric forms and structures of the buildings; (2) interviews to gather information on history, philosophy, and cultural values; and (3) documentation, including the collection of building photographs, location maps, and historical records. The instruments employed included interview guides, observation sheets, a camera for documentation, and field notes.

To guarantee the quality and trustworthiness of this qualitative research data, data validity checking is carried out through three triangulation techniques: source triangulation to compare information from various informants, method triangulation to verify data through different collection techniques, and theory triangulation to confirm findings with relevant theoretical perspectives.

Data analysis was performed systematically following the stages outlined by Witara et al. [19]: data reduction through the selection and simplification of relevant information; data presentation in the form of organized narrative descriptions; and conclusion drawing, which involved the formulation of findings that addressed the research objectives.

Throughout the process, research ethics principles were upheld by obtaining informed consent prior to data collection, protecting participants' identities, and ensuring that all participation was voluntary and in accordance with the regulations applicable at the research site.

3. RESULTS AND DISCUSSION

3.1. Results

3.1.1 Characteristics of The Research Subject

The subject of this study is the Medan Post Office, located at Jalan Pos No. 1, Kesawan Urban Village, Medan Barat District, Medan City, North Sumatra, and constructed in 1911 according to the design of architect Ir. Simon Snuyf, during the tenure of Resident J. Ballot, the building remains an active public space and a historical icon of Medan City, featuring an architectural style that blends Dutch colonial elements with local Malay cultural influences.

3.1.2 General Findings

Overall, the research findings indicate that the design of the Medan Post Office prioritizes not only service functionality and aesthetic appeal but also embodies philosophical values and the application of structured mathematical concepts. The findings are categorized into two main themes: cultural and philosophical values, and the geometric concepts applied to various building elements.

3.1.3 Findings by Theme

1) Philosophical and Cultural Value Aspects Of The Medan Post Office

The Medan Post Office building embodies the philosophical values of modern European architecture, reflecting the influence of European culture, particularly Dutch culture. This holds meaning for the building, where the dome-roofed structure serves as the main icon, symbolizing the centre and supervision, acting as the hub for all communication activities. The large pillar structures are identical in terms of strength, stability, and the impression of an official institution. Arch structures are widely used in doors and windows, which give an elegant, classic impression. The large window structures represent a tropical-climate strategy for ventilation and natural lighting, along with the pigeon ornament, one of the Dutch colonial architectural elements in the Dutch East Indies.

Figure 1. Medan post office building

In addition, the Medan Post Office building embodies philosophical values that reflect the influence of Malay culture, as seen in the post office building on the right side, which resembles a stilt house. According to Rukayah & Juwono (2018), Malay architectural buildings represent a form of adaptation to tropical environments and swampy terrain. In the case of this Medan Post Office building, there is no lower column section underneath the building, yet the presence of a second-floor section with a Walkway creates an impression similar to a stilt house. Furthermore, the dominance of arches within the Structural Architecture of the Medan Post Office shares similarities with the dominant arch interiors found in Maimun Palace.

Figure 2. Stilt House Concept

Based on observations and interviews, findings regarding the meanings embedded in the building's design include the following: the dome, as the highest element, symbolizes the center and authority while serving as a focal point for communication; the massive pillars represent strength, stability, and institutional stature; the building's composition adopts characteristics of traditional Malay stilt-house architecture; the arched forms of the windows and vents represent an adaptation to the tropical climate to optimize airflow and natural lighting; and the dove ornamentation symbolizes the building's primary function as a center for message transmission.

2) Mathematical Aspect Of The Medan Post Office

The mathematical aspect consists of building calculations and geometric concepts using tools such as measuring tapes, books, and pens. In addition, documentation results featuring mathematical aspects are used to strengthen the presented data by analysing the geometric concepts of the Medan post office building as an implementation of ethnomathematics. The following are the identification results of the mathematical aspects presented in the table below.

2.1. Dove Ornament

Figure 3. Dove Ornament

The wall ornament in the lobby area featuring a dove pattern is classified as a rectangle. A rectangle is a quadrilateral flat shape with two pairs of parallel lines of equal length and four right angles [20]. The formulas for the area and perimeter of a rectangle are: Area of a rectangle = Length x width, and Perimeter of a rectangle = 2 x (Length + width).

Geometry Application:

Given its length is 652 cm and its width is 42 cm. If the position of the rectangular ornament is rotated from its original horizontally elongated position to a vertically upright position, will the wall area covered by the ornament change? In your analysis, is the upright position still suitable and appropriate for wall decoration in the Post Office lobby? And what are the area and perimeter of the wall ornament in the post office lobby?

Answer:

The area does not change and will remain the same because the numbers are simply reversed; when multiplied, 652 cm x 42 cm yields the same result as 42 cm x 652 cm. However, for wall decoration, an upright vertical position is unsuitable because the lobby of the Medan Post Office is horizontally elongated; the ornament must also be installed horizontally to look neat and attractive. Therefore, the Dove ornament, as a symbol of message delivery, must also be installed horizontally, elongated to align with the room and appear neat and beautiful. And area = $652\ cm \times 42\ cm = 27.384\ cm^2$. Perimeter = $2\ (652\ cm + 42\ cm) = 1.388\ cm$. Thus, the resulting area and perimeter of the wall ornament in the post office lobby are 27.384 cm^2 and 1.388 cm.

2.2. Stained Glass Section Ornament

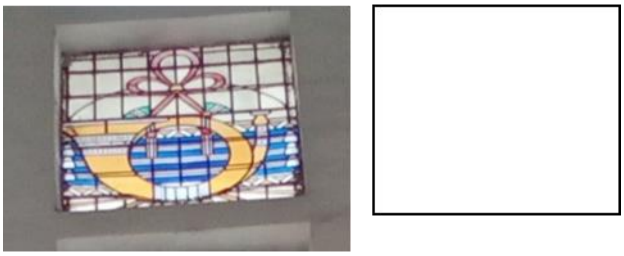

Figure 4. Stained glass section ornament

The ornament in the lobby area's stained glass is classified as a square. According to Makkullau [20], a square is a quadrilateral shape that has two pairs of parallel sides with equal lengths, and all of its angles are right angles. Based on the formulas for the area and perimeter of a square, the area is side x side. Perimeter = 4 x side.

Geometry Application

Given that the dimensions of the square ornament found in the stained glass are a vertical side of 48, and a horizontal side of 48 cm, If the management of Medan Post Office wishes to renovate the lobby area and plans to replace the stained glass with a new square glass whose perimeter is made twice the size of the original so that the decoration looks larger, will the required surface area of the new glass also automatically become exactly twice the original area? Provide your critical analysis! And what are the area and perimeter of the square ornament found in the stained glass?

Answer:

If the perimeter size is doubled, the area of the new stained glass does not double, but instead automatically becomes four times the original area. This happens because a two-fold change in the perimeter will cause the length of each side to double from 48 cm to 96 cm. When the new side dimensions are calculated using the formula 96 cm x 96 cm, the result is 9.216 cm^2 which is exactly four times larger than the initial area of only 2.304 $cm^{2.}$ Thus, this analysis proves that a linear increase in perimeter is not proportional to the increase in area. This geometric understanding is most important for the management of Medan Post Office, so they do not miscalculate the required amount of glass material during renovation. To Area **= s x s** = 48 cm x 48 cm = 2.304 cm^2 and Perimeter = $4 \times s = 4 \times 48\ cm = 192\ cm$. Thus, the resulting area and perimeter of the square ornament found in the stained glass are 2.304 cm^2 and a perimeter of 192 cm.

2.3. Yellow Dome Building Void

Figure 5. Yellow dome building void

The void in the yellow dome building is classified as a circular flat shape. A circle is a collection of points that are at an equal distance from a certain point [21]. The formulas for the area and circumference of a circle are: Area = πr^2 and circumference = $\pi \ x \ d$.

Geometry Application:

Given that at the edge of the golden-yellow dome void, there is a circular shape with a radius of 70 cm and a diameter of 140 cm. If the management of Medan Post Office wishes to install decorative lights exactly along the circumference of the golden-yellow dome void, and then they decide to expand the circular area of the dome until the radius becomes twice the original size so that the light emission is wider, will the length of the decorative light cable surrounding the dome also automatically become exactly twice the original length? Provide your critical analysis! And what are the area and circumference of the circular ornament found in the golden-yellow dome void?

Answer:

If the radius of the dome's circle is doubled (to 140 cm), the length of the decorative light cable along its circumference will automatically double from its original length. This happens because the circumference formula (K = 2πr) is directly and linearly proportional to the change in its radius (r), unlike the area formula, which increases quadratically. Therefore, this change in the circumference runs proportionally to its radius, allowing the management of Medan Post Office to immediately order a light cable twice without worrying about a shortage of materials. To Area = $\frac{22}{7} \ x \ 70 \ cm \ x \ 70 \ cm = 15.400 \ cm^2$ and Circumference = $\frac{22}{7} \ x \ 140 \ cm =$ 440 cm. Thus, the resulting area and perimeter/circumference from the edge of the golden-yellow dome void are a circular shape with an area of $15.400 \ cm^2,$ and a circumference of $440 \ cm$.

2.4. Arch Element Ornament

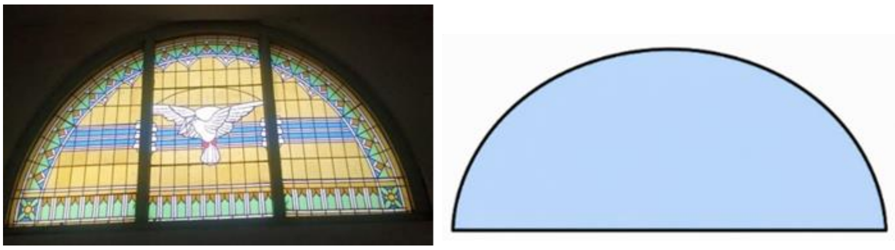

Figure 6. Arch Element Ornament

The ornament on the arch element is classified as semicircular. A semicircle is a part of a circle. The formulas for the area and perimeter of a semicircle are area $= \frac{1}{2}\ x\ \pi r^2$ and Perimeter = $(\pi\ x\ r) + $ d.

Geometry Application:

Given that the ornament on the semicircular arch element has a diameter of 292 cm. If the architect wants to create a new duplicate arch element that has a semicircular surface area twice as large as the original size above to be installed at the entrance gate, is it sufficient to simply double the diameter of the new arch from its original size to 584 cm? Provide your critical analysis! And what are the area and perimeter of the arch element ornament?

Answer:

If the diameter is changed to twice the size (584 cm), the area of the new arch does not double, but instead jumps to four times the original size. This occurs because the formula for the area of a semicircle is influenced by the squared value of the radius (r^2), so the increase in its area is exponential rather than linear. Therefore, if the architect only wants the area to be exactly twice as large, the diameter size must not be directly multiplied by two, but instead must be multiplied by the square root of two ($\sqrt{2}$). To Area $= \frac{1}{2}\ x\ \frac{22}{7} x\ 146^2 = 33.396{,}6\ cm^2$ and Perimeter = $(\frac{22}{7}\ x\ 146) + 292 = 750{,}86\ cm.$ Thus, the resulting area and perimeter of the arch element ornament are an area of 33.396,6 cm^2 and a perimeter 750,86 cm.

2.5. Yellow Dome Shape

Figure 7. Yellow dome shape

The octagonal dome is a polygon, which is a figure where the curve is closed, and all of its sides are bounded by straight lines [22]. The formulas for the area and perimeter of an irregular polygon are: Area of ABCDEFGHI = area of AIB + area of BIC + area of CID + area of DIE + area of EIF + area of FIG + area of GIH + area of HIA, and Perimeter of a polygon = side AB + side BC + side CD + side DE + side EF + side FG + side GH + side HA.

Geometry Application:

Given that the irregular octagonal dome has sides of 792 cm and 368 cm, as well as a height of 1.140 cm. If the management of Medan post office wishes to create a replica of the dome motif to be installed in a smaller exhibition room by cutting its length and width dimensions to exactly half of the original size, to 396 cm and 184 cm, will the wall surface area required to accommodate the new motif also automatically become exactly half of the original area? Provide your critical analysis! And what are the area and perimeter of the motif on the yellow dome building?

Answer:

If the length and width are cut in half, the area of the new motif does not become half, but instead shrinks drastically to one-fourth of the original area of 72.864 cm^2. This occurs because a linear change in the two dimensions of length and width will multiply the reduction of its area quadratically, ½ x ½ = ¼. Therefore, the relationship between downscaled sides is not directly proportional to their areas. Area = ABCDEFGHI = 451.440 cm^2+ 209.760 cm^2 + 451.440 cm^2+ 209.760 cm^2 + 451.440 cm^2+ 209.760 cm^2 + 451.440 cm^2+ 209.760 cm^2 = 1.515.104.870.400 cm^2. And perimeter = 792 cm + 368 cm + 792 cm + 368 cm + 792 cm + 368 cm + 792 cm + 368 cm = 4.663.296 cm.Thus, the resulting area and perimeter of the irregular octagonal dome are an area of 1.515.104.870.400 cm^2, and a perimeter of 4.663.296 cm.

2.6. Post Office Tower

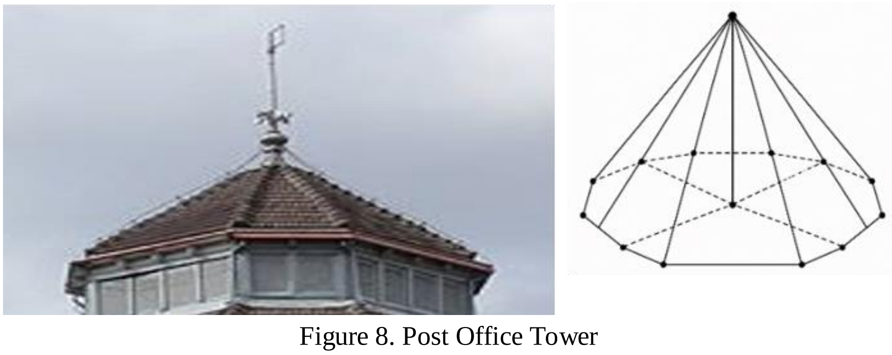

Figure 8. Post Office Tower

The tower is shaped like an octagonal pyramid. According to Makkullau [20], a pyramid is a three-dimensional shape bounded by a polygon-shaped base and several triangular vertical faces that meet at a single apex point. The formulas for the area and volume of the pyramid are: Prism surface area = base area + area of all vertical faces, and Pyramid volume = 1/3 x base area + prism height.

Geometry Application:

Given that the tower is shaped like a pyramid whose base is an irregular octagon, with base sides having 2 different measurements, 160 cm and 320 cm, and its vertical side is 230 cm. If, during the Post Office tower renovation, the management wants to downsize all the tower's base sides to half of their original size, to 80 cm and 160 cm, but the height of its vertical sides remains the same, will the total surface area of steel sheets required to cover the vertical faces of the tower also automatically decrease to exactly half? Provide your critical analysis! And what are the area and perimeter of the post office tower?

Answer:

If all the measurements of the base sides are cut in half, the total area of the tower's vertical faces will automatically also decrease to exactly half of the original area of 110.400 cm^2. This occurs because the formula for the area of a vertical face triangle ($L = ½ \times a \times t$), has a linear or directly proportional relationship with the measurement of its base length (a). Therefore, this change in the surface area of the pyramid's lateral area runs proportionally with the change in its base sides. Area = 2.862,167 cm^2 + (179.315,2 cm^2 + 77.926,4 cm^2) = 260.103,767 cm^2 and Volume = 1/3 x 77.926,4 cm^2 x 230 cm = 5.974.357,33 cm^3. Thus, the resulting surface area and volume of the post office tower are a surface area of 260.103,767 cm^2, and a volume of 5.974.357,33 cm^3.

2.7. Vestibule Column

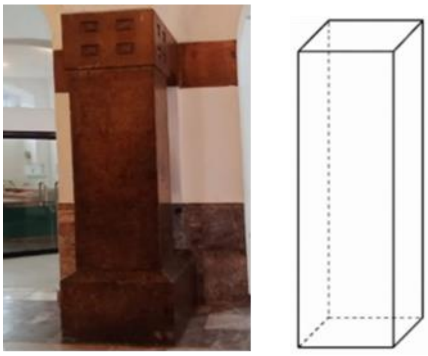

Figure 9. Vestibule Column

The vestibule column located in the lobby area is classified as a rectangular prism (cuboid). A rectangular prism is a three-dimensional shape whose opposite faces are congruent rectangles [23]. The formulas for the surface area and volume are: Surface Area = $2\ x\ (pl + pt + lt)$ and volume = p x l x t.

Geometry Application:

Given that the vestibule column has a length of 32 cm, a width of 48 cm, and a height of 173 cm. If, during the restoration of the post office lobby area, the architect decides to increase the height of the vestibule column to twice its original size, to 346 cm, while the dimensions of its base (length and width) remain the same, will the spatial volume occupied by the new column also automatically become exactly twice as much? Provide your critical analysis! And what are the surface area and volume of the vestibule column?

Answer:

If the height component of the rectangular prism column is doubled, the total volume of the column will automatically also increase to exactly twice the original volume of 531.456 cm^3. This occurs because the formula for the volume of a rectangular prism (V = p x l x t), has a linear or directly proportional relationship with the change in its height dimension (t). Therefore, this change in volume runs proportionally with the change in just one of its dimensions. To Area = 2 x (1.536 cm^2 + 5.536 cm^2 + 8.304 cm^2 = $30.752\ cm^2$. Volume = 32 cm x 48 cm x 173 cm = 265.728 cm^3. Thus, the resulting surface area and volume of the vestibule column are a surface area of 30.752 cm^2 and a volume of 35.550 cm.

2.8. Gable Vent Opening

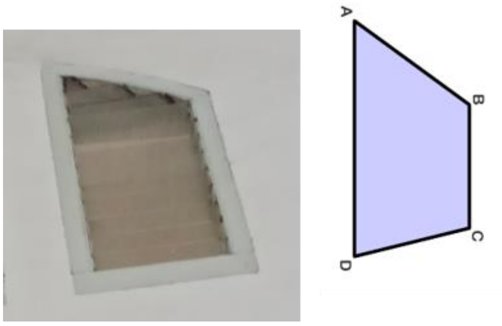

Figure 10. Gable Vent Opening

The gable vent opening is arch-shaped, and the section taken is a trapezoid. A trapezoid is a quadrilateral shape that has exactly one pair of parallel sides (Kartikasari, 2018). The formulas for the area and perimeter are as follows: Area = $\frac{1}{2}\ (a+b)x\ t$ and perimeter = AB + BC + CD + AD.

Geometry Application:

Given the bottom base side is 232 cm, the slanted side is 85 cm, and the height side is 72 cm. If, during the restoration of the post office vestibule room, the management wants to downsize the gable vent to half of its original size, with a base of 116 cm, a slanted side of 42.5 cm, and a height of 36 cm, will the open wall surface area for air circulation also automatically decrease to exactly half? Provide your critical analysis! What are the area and perimeter of the arch-shaped gable vent opening located in the vestibule room?

Answer:

If all linear dimensions are cut in half, the area of the vent opening does not become half, but instead shrinks drastically to one-fourth of the original size of 2.088 cm^2. This occurs because a linear change in the two dimensions of base and height will multiply the reduction of its area quadratically, ½ x ½ = ¼. Therefore, the reduction of the sides is not directly proportional to its area, so it is not crucial to miscalculate the adequacy of the air circulation volume in the vestibule room. To area $=\frac{1}{2}$ $(352{,}6)$x 72 =12.693,6 cm^2 and Perimeter = 232 cm + 72 cm + 120,6 cm + 85 cm = 509,6 cm. Thus, the resulting area and perimeter of the arch-shaped gable vent opening located in the vestibule room are an area of $12.693{,}6\, cm^2$ and a perimeter of 509,6 cm.

2.9. **Corridor Ornament**

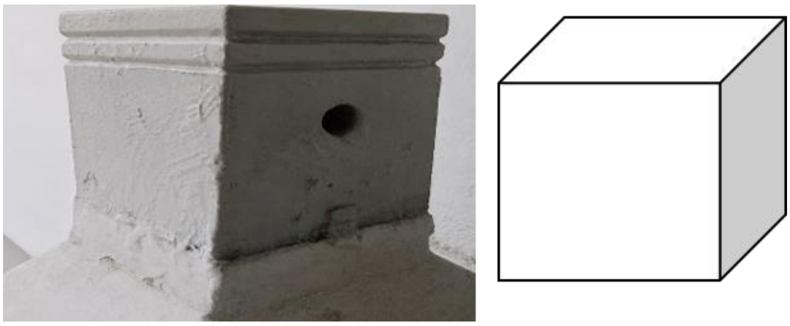

Figure 11. Corridor Ornament

The ornament on the corridor building is cube-shaped. According to Shadiq et al. [24], a cube is a three-dimensional shape where all of its faces are square-shaped, and it has 6 faces of equal size (congruent). The formulas for the surface area and volume of a cube are: Area of a Cube = 6 x side x side and Volume of a Cube = side x side x side.

Geometry Application:

It is known that the lower part of an ornament on a veranda building has equal sides, all measuring 15 cm. If, during the restoration process of the veranda from Medan Post Office, the management wants to order a replica of the ornament with the side lengths enlarged to twice their original size (30 cm), is it sufficient to provide twice the total amount of raw material needed to fill the solid volume of the new ornament? Give your critical analysis! And what is the surface area and volume of the lower part of the veranda building ornament?

Answer:

If the side length of the cube is multiplied by two, and is 30 cm, the volume of the required cement material does not double but instead surges eightfold from the original to 27.000 cm^3. This occurs because the formula for the volume of a cube is determined by the cubed value of its side, which is s^3, so that scaling up one linear dimension will multiply the volumetric effect exponentially ($2^3 = 8$). Therefore, the change in side length is not directly proportional to the change in its volume. The area = 6 x 15 cm x 15 cm=1.350 cm^2 and the volume = 15 cm x 15 cm x 15 cm = 3.375 cm^3. Thus, the resulting surface area and volume of the lower part of the veranda building ornament are a surface area of 1.350 cm^2 and a volume of 3.375 cm^3.

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2.10. Stair Handrail Ornament

Figure 12. Stair Handrail Ornament

The ornament on the stair handrail is shaped like a prism. A prism is a three-dimensional shape bounded by two congruent and parallel opposing base and top faces [25]. Surface area of a trapezoidal prism = area of a regular octagon, and the volume of the stair handrail ornament = volume of an octagonal prism.

Geometry Application:

It is known that a stair handrail ornament is shaped like an octagon, with a side length of 6 cm and a height of 10 cm. If, during the renovation of the post office stairs area, the management wants to order a cast concrete brick structure by extending the height of the stair handrail to twice its original size of 20 cm, while keeping the octagonal side length of 6 cm the same, will the total volume of the required cast concrete brick structure also automatically double exactly? Provide your critical analysis! And what are the surface area and volume of the stair handrail ornament?

Answer:

If the height component of the prism is doubled, then the total volume of the ornament will automatically increase to exactly twice its original size (2.496 cm^3). This happens because the formula for the volume of a prism, which is V = base area x height, has a linear or directly proportional relationship with its height dimension (t). Therefore, this change in volume runs proportionally to the change in just one of its dimensions. To area = 8x ($\frac{1}{2}$ x 6 cm x 5,2 cm) = 8 x 15,6 cm^2 = 46,8 cm^2 and Volume = 46,8 cm^2 x 100 cm = 468 cm^3. Therefore, the resulting surface area and volume of the stair handrail ornament are a surface area of 46,8 cm^2 and a volume of 468 cm^3.

2.11. Gable

Figure 13. Gable

A gable is defined as a front structure in the form of an isosceles triangle, a 2D shape. According to the GTK DIKDAS Team [26], generally, one side of the triangle is called the base. The formulas for the area and perimeter of a triangle are: Area of a triangle = ½ x base x height. Perimeter of a triangle = the sum of all its sides

Geometry Application:

It is known that a gable is shaped like an isosceles triangle, with a slanted side of 78 cm and a base side of 292 cm. Why is the aspect of equal length on both slanted sides, namely the symmetry of the gable, very important when viewed from the perspective of building structural stability and colonial aesthetics? And what are the area and perimeter of that isosceles triangle?

Answer:

The isosceles triangle shape ensures that the load from the roof is balanced and evenly distributed to the structural columns below, thereby preventing the risk of building cracks due to lopsided loading. From an architectural perspective, this symmetrical shape provides a sturdy, formal, and majestic visual impression, which is a key characteristic of the colonial building aesthetics of a post office. Therefore, the accuracy in choosing the type of triangle is not just for decoration, but rather a logical calculation for the sake of safety and structural beauty. To triangle area = $\frac{1}{2}\ x\ 146\ cm\ x\ 165{,}53\ \ cm$ = 12.083,69 cm^2 and triangle perimeter = 146 cm + 78 cm + $165{,}53$ cm = 389,53 cm. Therefore, the resulting area and perimeter of the curved gable vent opening located in the vestibule room are an area of $12.083{,}69\ cm^2$ and a perimeter of 389,53 cm.

In general, the pattern of geometric form application demonstrates a correspondence between the structure's characteristics and the requirements of structural function, aesthetics, and environmental adaptation.

3.1.4 Summary of Key Findings

Based on the analysis, it can be concluded that the architecture of the Medan Post Office systematically integrates concepts of planar and spatial geometry—concepts closely linked to philosophical values, cultural acculturation, the building's function, and adaptations to environmental conditions. These findings confirm the presence of rich and relevant ethnomathematical content, aligning with the research objectives.

3.2. Discussion

The research findings identify various geometric concepts in the architecture of the Medan Post Office, encompassing two-dimensional shapes such as rectangles, squares, circles, semicircles, octagons, right trapezoids, and isosceles triangles, as well as three-dimensional forms like pyramids, prisms, rectangular prisms, and cubes found in both structural and ornamental elements. The application of these forms goes beyond mere aesthetic considerations; rather, it results from a planning process that integrates technical calculations, building functionality, and adaptations to the cultural and environmental context, ensuring that each form has a clear meaning and purpose within the overall design.

These findings align with research by Agustin et al. [10] and Putri and Zayyadi [27], which reveals that Dutch colonial heritage buildings in Indonesia frequently incorporate geometric concepts and hold potential as representations of real-world objects in mathematics education. Like previous studies, this research identifies basic geometric forms and their associated symbolic meanings; however, it expands the scope of analysis by highlighting the acculturation of Malay architectural values and the characteristics of public service buildings that remain in operation today. Theoretically, these findings support the concept of ethnomathematics, which posits that mathematics evolves and is applied within cultural practices, and reinforce the view held by Suhartini et al. [28] regarding the effectiveness of culture-based approaches in creating meaningful learning experiences.

Practically, the results of this study can be utilized as contextual teaching materials for geometry, helping students understand abstract concepts through their surrounding environment while fostering an appreciation for local cultural heritage, as well as serving as a reference for historic building preservation efforts. This research is limited in scope to the analysis focusing on the identification of visual meaning and exploring the technical calculations of the design process, without testing its direct application in classroom learning. Therefore, future research is advised to develop these findings into tested learning devices and to explore other historic building objects in the North Sumatra region.

4 CONCLUSION

This study aims to explore the geometric concepts and cultural values embodied in the architecture of the Medan Post Office through an ethnomathematical approach. The findings reveal that the building incorporates various plane geometry concepts such as rectangles, squares, circles, semicircles, octagons, right trapezoids, and isosceles triangles as well as spatial geometry concepts, including pyramids, prisms, rectangular prisms, and cubes, within its structural and ornamental elements. The application of these forms represents an acculturation of local cultural values with colonial architecture, socio-historical functions, and intelligent environmental adaptation; specifically, the architectural characteristics of Malay stilt houses are evident in the building's side composition, the dome symbolizes a central communication hub, and the window and ventilation designs embody local wisdom in optimizing airflow and natural lighting for the tropical climate. These findings directly confirm the study's objective by revealing the close interconnection between mathematical principles and cultural significance within the building.

Theoretically, this study enriches the field of ethnomathematics by presenting empirical evidence regarding the integration of geometric concepts, cultural values, and architectural functions in colonial buildings that remain in use, while also complementing the literature on architectural acculturation in North Sumatra. Practically, the findings can serve as a resource for contextual mathematics learning and inform efforts to preserve and manage historic buildings in the city of Medan.

This study is limited in scope, focusing on the identification of forms and meanings without directly testing the application of the findings in educational settings. Therefore, future research is encouraged to develop teaching materials based on these findings and to further explore the technical and philosophical aspects of other historic buildings in the region.

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