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# Ethnomathematical Exploration of Kasepuhan Palace Architecture: Geometry, Symmetry, and Cultural Values in Mathematics Learning

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**ABSTRACT**

The Kasepuhan Cirebon Palace is one of the historical sites that still stand in Cirebon City and reflect the local community's cultural heritage, including ethnomathematical practices embedded in daily life. This study aims to analyse the ethnomathematical aspects of the Kasepuhan Palace as a source of contextual mathematics learning. This qualitative research employed an ethnographic approach and was conducted in the Pekalipan area of Cirebon City. The data were collected from a building complex (Keraton Kasepuhan), and one informant was selected based on their role as cultural custodians (Abdi Dalem). Data collection techniques included observation, interviews, and documentation. The findings suggest that the architectural structure, floor patterns, and carved ornaments of the Kasepuhan Palace incorporate various mathematical concepts, including geometry, angles, symmetry, and measurement. These concepts appear in the spatial layout, pillar arrangement, and shapes such as rectangles, triangles, cuboids, limas, and tubes. The study suggests that incorporating the ethnomathematical elements of the Kasepuhan Palace into mathematics learning can enhance students' understanding of geometric concepts while fostering their appreciation for local cultural wisdom. However, this study is limited to one palace complex and a small number of informants; future research could expand to other historical sites or compare multiple palaces to enrich the ethnomathematical analysis.



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## 1. INTRODUCTION

Mathematics is often portrayed as an exact science, abstract and independent of social and cultural context. This view makes mathematics seem rigid and difficult to comprehend, especially when presented in an abstract, formal learning context. As a result, many students struggle to see the relevance of mathematics because it feels detached from their everyday experiences. In response to these challenges, ethnomathematical approaches offer an alternative that links mathematical concepts to local cultural contexts. According to Putra and Prasetyo, ethnomathematics is the study of how a cultural community understands and applies mathematical ideas in everyday life, including in traditional arts, architecture, and crafts [1]. By treating culture as a source of mathematical meaning, ethnomathematics helps bridge formal concepts with lived practices. This approach opens up opportunities to create mathematics learning that is more contextual, meaningful, and respects local wisdom [2], [3], [4], [5], [6], [7], [8].

Globally, the contextualization of mathematics learning is increasingly recognised as an effective strategy in improving students' numeracy literacy [9]. Organisations such as the OECD encourage strengthening the connection between mathematics learning and the real world so that students can develop critical thinking and *problem-solving* skills more holistically [10]. Research by Rawat and Nagaraju shows that integrating ethnomathematics into mathematics curricula can increase student engagement by linking learning to their cultural context [11]. Therefore, contextual learning is not only about using "real-life examples," but also about using contexts that are meaningful to students' identities and communities. Thus, the integration between local culture and mathematics education is not only relevant in the Indonesian context but also in line with the direction of global education reform in the 21st century.

On the other hand, the application of ethnomathematics in Indonesia is still dominated by cultural objects such as batik motifs [12], traditional houses [13], and traditional games [14]. At the same time, the study of architecture as a source of mathematical learning, especially in school geometry materials, remains very limited. One of the cultural objects that is rich in mathematical elements but rarely explored is the Kasepuhan Palace in Cirebon. As a historical relic, this palace combines Javanese, Islamic, Chinese, and European cultures, reflected in its architectural structure, floor patterns, and carved ornaments featuring geometric shapes, including rectangles, triangles, squares, circles, and cylinders. The concepts of angle and symmetry are also evident in the arrangement of tiles and pillars, as well as in the layout of the space. Because geometry learning relies heavily on visualisation and spatial reasoning, architectural features like these provide a particularly strong context for classroom learning. However, as far as the researcher is concerned, no studies have been found that specifically utilise the architecture of the Kasepuhan Palace as a source of mathematics learning, particularly in geometry education in schools. This indicates a significant research gap in the use of cultural sites as a context for learning mathematics.

This study employs a descriptive-qualitative approach, incorporating observation techniques and visual documentation of architectural elements and ornaments within the Kasepuhan Palace. The focus of the study is on analysing the geometric shapes of planes and spaces, symmetrical patterns, and angular structures that are explicitly present in building design. This technique is used to identify mathematical patterns in cultural contexts, as has been applied in other ethnomathematical studies [15]. Accordingly, this research is directed at identifying and describing the mathematical concepts embedded in selected architectural elements of the Kasepuhan Palace and explaining their potential use as contextual resources for teaching geometry. The novelty of this study lies in the use of the Kasepuhan Palace as a source of mathematics learning that has not been extensively researched before. This research also emphasises the importance of integrating mathematics education with cultural preservation, so that students not only understand the formal concepts of mathematics but also appreciate the rich mathematical heritage of our ancestors. Accordingly, this research is directed at identifying and describing the mathematical concepts embedded in selected architectural elements of the Kasepuhan Palace and explaining their potential use as contextual resources for teaching geometry.

## 2. METHOD

This research employs a descriptive-qualitative approach with an ethnographic orientation. According to Spradley [16], ethnography focuses on describing cultural elements to understand how local communities interpret their environment. This approach was chosen to identify and describe the mathematical concepts embedded in the architectural structure of the Kasepuhan Palace. In this study, the ethnographic orientation is reflected in the effort to interpret architectural forms not only as physical objects, but also as cultural artefacts whose meanings are understood by the local community. The subjects of this research consisted of a former Abdi Dalem (a court official), chosen for his extensive knowledge of historical architecture and the symbolic meaning of the palace. The informant was selected purposively because the research required contextual explanations of the function, history, and cultural symbolism of architectural elements that could not be obtained through observation alone. In addition to the informant, the palace environment and its architectural objects served as the primary sources of visual data for identifying mathematical patterns.

Data were collected through direct observation, semi-structured interviews, and visual documentation of selected architectural elements, such as the pavilion (pendopo), gates, halls, and carved ornaments. These elements were chosen because they prominently display symmetrical patterns, geometric shapes, and recurring structural motifs relevant to ethnomathematical analysis. Observation was conducted to record the structures' visible characteristics (forms, patterns, layouts, and proportions), while interviews were used to confirm the names, functions, and cultural meanings of the observed objects. Visual documentation (photographs and sketches) was used to support more accurate identification of geometric and spatial features during the analysis stage.

Data analysis was conducted in several stages. First, all observation notes, interview transcripts, and documentation were openly coded to identify recurring mathematical features. Second, the codes were grouped into categories, including shape, symmetry, angles, size, and spatial arrangement. Third, thematic interpretation was conducted to reveal how these categories manifested in the palace's architectural design. This analytical process reflects contemporary ethnographic procedures that emphasise systematic coding and interpretive synthesis. To maintain analytic consistency, the coding results from each data source were compared to ensure that identified mathematical concepts were supported by more than one form of evidence.

Ethical procedures were followed throughout the research. The researcher obtained official permission from palace authorities, ensured the anonymity of informants, and adhered to cultural protocols when entering restricted areas of the palace. This included respecting access restrictions, maintaining appropriate conduct during documentation, and ensuring that no cultural meanings were misrepresented in reporting. The credibility of the findings was strengthened through triangulation of sources, methods, and expert confirmation, as well as through comparisons of data from observations, interviews, and visual recordings. These procedures ensured the credibility and cultural sensitivity of the research. Through these steps, the study aimed to produce findings that are both methodologically trustworthy and respectful of the cultural context in which the mathematical ideas are embedded.

## 3. RESULTS AND DISCUSSION

### 3.1 RESULT

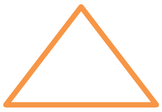
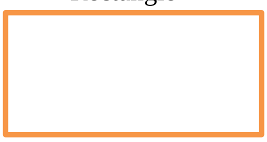
Based on observation and analysis, various ethnomathematical concepts were identified within the architecture of the Kasepuhan Palace. Overall, the findings are organised into three main aspects: (1) geometry of planes and spaces, (2) angle concepts in architectural elements, and (3) symmetry in building structures and ornamentation. Here is a description of the findings on each building:

#### 3.1.1 Geometry of Planes and Spaces

**Prabayaksa Ward**

Prabayaksa Ward is one of the main buildings in the Kasepuhan Palace complex, which has high historical and cultural value. The Prabayaksa Ward was the main building where the Sultan received guests and presided over deliberations; "having a height of 100 cm from the ground level is a manifestation of the King's authority as the highest figure in the social structure of the Palace" [17]. From a geometrical standpoint, the façade and structural composition of this ward display multiple plane figures that can be used to introduce basic concepts of area and perimeter (Table 1).

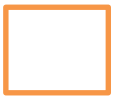
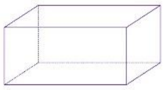
Table 1. Ethnomathematics of Prabayaksa Ward

| Picture | Geometric Shapes | Information |
|---|---|---|
|  Picture 1. Prabayaksa Ward | Triangle  Trapezoid  Rectangle  | • Triangle: A triangle is described as a three-sided flat shape. $L = \frac{1}{2} \times alas \times tinggi \quad K = a + b + c$ <br>• Trapezoid: Has exactly one pair of parallel sides. $L = \frac{1}{2} \times (a + b) \times tK = a + b + c + d$ <br>• Rectangle: Build a rectangular flat that has two pairs of parallel sides, each with equal length, and all four corners are right angles. $L = p \times l$ $K = 2 \times (p + l)$ |

**Jinem Ward**

The Jinem Ward is one of the important buildings in the Kasepuhan Palace complex, which has high historical, cultural, and social functions. The Jinem Ward was used as a reception room for courtiers and guests of honour before being received in the Prabayaksa Ward; "This space is in front of the main ward and serves as a transit point for royal guests" [17]. The observed elements in this area emphasise both plane geometry (square) and solid geometry (rectangular prism/cuboid), as evident in the building parts and supporting structures (Table 2).

Table 2. Ethnomathematics of Jinem Ward

| Picture | Geometric Shapes | Information |
|---|---|---|
| <br>Picture 2. Jinem Ward | Square<br><br>Cuboid<br> | • Square: A type of rectangle that has four sides of equal length, two pairs of parallel sides, and right angles. $L = s^2$<br>$K = 4 \times s$<br>• Cuboids: Build a 3D space with 6 rectangular sides, each of the same size. The cuboid has 12 ribs, 8 corner points, and 6 side planes.<br>$V = p \times l \times t$ |

**The Great Ward of the Lord**

The Great Ward of Panembahan is the main room of the kingdom, which functions as the seat of the Sultan and the implementation of sacred events; "The Great Ward of Panembahan was built one meter higher than the Prabayaksa ward as the throne of Gusti Panembahan" [17]. The dominant plane figure identified in the layout and structural lines of this ward is the rectangle, which appears consistently in several architectural segments (Table 3).

Table 3. Ethnomathematics of the Great Ward of the Lord

| Picture | Geometric Shapes | Information |
|---|---|---|
| <br>Picture 3. The Great Ward of the Lord | Rectangle<br> | Rectangle: Build a rectangular flat that has two pairs of parallel sides, each with equal length, and all four corners are right angles.<br>$L = p \times l$<br>$K = 2 \times (p + l)$ |

**Pancaratna**

Pancaratna or West Paseban, used by palace officials to witness activities in the front square; "Palace officials used this building to witness activities in the front square" [18]. The visual structure of Pancaratna features trapezoidal and rectangular forms,

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especially in the roof and wall segments, which can be mapped to plane-geometry concepts (Table 4).

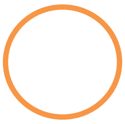
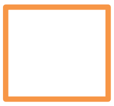
Table 4. Ethnomathematics Pancaratna

| Picture | Geometric Shapes | Information |
|---|---|---|
| <br>Picture 4. Pancaratna | Trapezoid<br><br>Rectangle<br> | • Trapezoid: The length of the trapezoid has exactly one pair of parallel sides.<br>$L = \frac{1}{2} \times (a + b) \times t$<br>$K = a + b + c + d$<br>• Rectangle: Build a rectangular flat that has two pairs of parallel sides, each with equal length, and all four corners are right angles.<br>$L = p \times l$<br>$K = 2 \times (p + l)$ |

## Red Brick Fence

The Red Brick Fence at the Kasepuhan Palace serves as a barrier between the palace's inner area and the outside world. The Red Brick fence that surrounds the palace complex "shows the influence of Majapahit architecture with red brick material without stucco as a symbol of strength and immortality" [17]. In addition to its cultural meaning, the fence ornaments exhibit repeated plane figures that can be identified as circles, rhombuses (rhombus), and squares (Table 5).

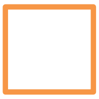
Table 5. Ethnomathematics Red Brick Fence

| Picture | Geometric Shapes | Information |
|---|---|---|
| <br>Picture 5. Red Brick Fence | Circle<br><br>Rhombus<br><br>Square<br> | • Circle: As a set of points that are equally distant from the centre.<br>$L = \pi r^2$<br>$K = 2\pi r$<br>• Rhombus: It has all four sides of equal length, as well as two perpendicular diagonals.<br>$L = \frac{1}{2} . d_1 \times d_2$ $K = 4 \times s$<br>• Square: A type of rectangle that has four sides of equal length, two pairs of parallel sides, and right angles. $L = s^2$<br>$K = 4 \times s$ |

## Stone Gilang

Batu Gilang is one of the important elements of the Kasepuhan Cirebon Palace's environment, with substantial historical and symbolic value. These stones are square or rectangular and are made of finely carved natural stone, generally placed in open areas near the Prabayaksa Ward or at strategic points within the palace, where they are often used for important ceremonies or meetings. Batu Gilang serves as a temporary seat or throne for royal figures and guests of honour during traditional activities. The geometric identification in this object is straightforward, focusing on square and rectangular faces that can support introductory lessons on plane figures (Table 6).

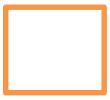
Table 6. Ethnomathematics of Stone Gilang

| Picture | Geometric Shapes | Information |
|---|---|---|
| <br>Picture 6. Stone Gilang | Square<br><br>Rectangle<br> | • A square is a type of rectangle that has four sides of equal length, two pairs of parallel sides, and right angles. $L = s^2, K = 4 \times s$<br>• Rectangle: A rectangle has all four sides of equal length, as well as two perpendicular diagonals. $L = \frac{1}{2}.d_1 \times d_2 \quad K = 4 \times s$ |

## Lingga and Yoni Stones

The Lingga and Yoni stones at the Kasepuhan Palace in Cirebon are symbols of cultural heritage that reflect the spiritual and philosophical values of past peoples. Batu Lingga and Yoni show "the remnants of the influence of Hindu culture before Islam came to Cirebon and symbolise the balance of the universe" [17]. From the perspective of solid geometry, the Lingga component can be associated with a cylindrical form, while the base elements include plane geometry, such as squares (Table 7).

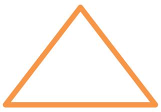
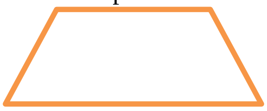
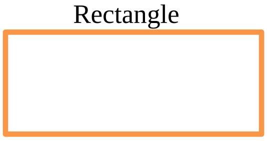
Table 7. Ethnomathematics of Lingga and Yoni Stones

| Picture | Geometric Shapes | Information |
|---|---|---|
| <br>Picture 7. Linogga and Yoni Stones | Tube<br><br>Square<br> | • A tube is a three-dimensional structure with two identical circular sides as a base and a lid, and one curved side as a blanket. These two circles are parallel and connected by a curved plane that forms the surface of the Volume Formula tube.$V = \pi r^2 t$<br>• Square: A type of rectangle that has four sides of equal length, two pairs of parallel sides, and right angles. $L = s^2$<br>$K = 4 \times s$ |

## Siti Hinggil

Siti Hinggil, meaning high ground, functions as an official ceremony place and a symbol of the Sultan's authority; "Siti Hinggil is in a higher land order as a symbol of the spirituality of power" [18]. From the perspective of solid geometry, the Lingga component can be associated with a cylindrical form, while the base elements include plane geometry, such as squares (Table 7).

Table 8. Ethnomathematics Siti Hinggil

| Picture | Geometric Shapes | Information |
|---|---|---|
|  Picture 8. Siti Hinggil | Triangle  Trapezoid  Rectangle  | • Triangle: A triangle is described as a three-sided flat shape. $L = \frac{1}{2} \times alas \times tinggi$ $K = a + b + c$ <br>• Trapezoid: Has exactly one pair of parallel sides. $L = \frac{1}{2} \times (a + b) \times t$ $K = a + b + c + d$ <br>• Rectangle: Build a rectangular flat that has two pairs of parallel sides, each with equal length, and all four corners are right angles. $L = p \times l$ $K = 2 \times (p + l)$ |

### 3.1.2 The Concept of Angles in Architecture and Ornamentation

**Entrance to the Barong Lion Museum**

Table 9. Ethnomathematics of the entrance of the Barong Lion Museum

| Picture | Corner | Information |
|---|---|---|
|  Picture 9. Entrance to the Barong Lion Museum  Picture 10. Roof  Picture 11. Arch Over Door |  Picture 12. Buffer  Picture 13. Box Frame on Door | • The Taper Corner is a triangular roof at the top of the door (the top of the triangle). <br>• A pointed corner that is inside the arch above the door. <br>• The right angle is between the roof support and the wall. <br>• The frame of the box on the door is angled at right angles. |

The entrance to the Barong Lion Train Museum becomes the main access to the magnificent train storage room; "This train has the heads of dragons, birds, and elephants, indicating cultural acculturation" [17]. Angle concepts were identified through the roof form, the arch above the door, the supporting elements, and the door frame details (Table 9), showing that angle recognition can be grounded in real architectural parts rather than abstract diagrams.

**Heritage Museum Entrance**

This door serves as the gateway to the museum, which houses various heirlooms from the Kasepuhan Palace, including keris, spears, armour, and other spiritual relics. It is strategically located and decorated with symbols of majesty and the Cirebon people's belief in heirlooms as sacred ancestral heritage. In this entrance, the angle concept is most visibly represented through the pointed roof components and the rectangular doorway construction (Table 10).

Table 10. Ethnomathematics Heritage Museum Entrance

| Picture | Corner | Information |
|---|---|---|
|  Picture 14. Heritage Museum Entrance |  Picture 15. Small Roof Parts  Picture 16. Entrance | • The small roof sections on the left and right sides of the building, which resemble a pointed triangle, are pointed corners. • All rectangular entrances have right angles. |

**The Gate of the Lord**

Panembahan Gate is a sacred boundary between public space and the inner area of the palace; "The function of the gate is as a boundary marker and entrance to the sacred space" [19]. The gate structure exhibits clear perpendicular relationships between vertical pillars and horizontal components, corresponding to right angles in plane geometry (Table 11).

Table 11. Ethnomathematics of the Gate of the Lord

| Picture | Corner | Information |
|---|---|---|
|  Picture 17. The Gate of the Lord |  Picture 18. Gate Corner | In the pillars and vertical structures of the gates, they most likely form a right angle (90 degrees) with the gate's horizontal part. |

### 3.1.3. Symmetry in Building Structures

**The Side Door of the Throne**

The Sultan or officials use the side door of the throne to enter the main room without going through the public lane; "to be limited access as a symbol of power and hierarchical order" [17]. The symmetry observed in this door is primarily reflective (mirror) symmetry along a vertical axis, visible in the arrangement of windows and ornaments (Table 12).

Table 12. Ethnomathematics On the Side of the Throne

| Picture | Symmetrical | Information |
|---|---|---|
| <br>Picture 19. The Side Door of the Throne | <br>Picture 20. Door Symmetry | • Each door leaf has three glass windows, whose sizes and vertical positions are similar and symmetrical about the centerline.<br>• Above the door is a small glass panel with carved metal or wood decorations, also symmetrically arranged.<br>• The pattern of flowers and leaves in the carvings also shows reflective symmetry in the centre of the panel. |

**The Gate of Siti Inggil**

The Siti Inggil Gate, in the form of a bendar temple, shows the unity of Hindu-Buddhist elements in Cirebon's Islamic architecture; "This gate in the form of a Bendar temple is the entrance to Siti Hinggil which is considered sacred" [18]. The observed symmetry of this gate is again reflective symmetry, where the left and right sides mirror each other across a vertical midline (Table 13).

Table 13. Ethnomathematics of the Siti Inggil Gate

| Picture | Symmetrical | Information |
|---|---|---|
| <br>Picture 21. The Gate of Siti Inggil | <br>Picture 22. Gate Symmetry | • This gate has vertical mirror symmetry.<br>• If a straight line is drawn in the middle of the gate gap (from bottom to top), the left and right sides appear symmetrical.<br>• That is, the shape, size, and ornaments on the left side are mirror reflections of those on the right side (although there is a small quantity of natural wear and tear that makes them not entirely identical).<br>• This type of symmetry is also called vertical axial symmetry. |

**White Tiger Tail Statue**

These two statues of white tigers are placed in the palace's front area as symbols of strength, vigilance, and the palace's spiritual guardianship. The white tiger, also known as Maung Bodas, is a symbol closely related to Prabu Siliwangi, the ancestor of the kings of Cirebon, and is an icon revered by the community. In terms of form, the paired placement of the statues supports a bilateral (left–right) symmetry reading, especially when considered relative to the central axis of the front area (Table 14).

Table 14. White Tiger Tail Ethnomathematics

| Picture | Symmetrical | Information |
|---|---|---|
|  Picture 23. White Tiger Tail Statue |  Picture 24. Symmetry of White Tiger Tail Statue | In the concept of geometry, there are seven types of mirroring concepts, including reflection on the x-axis, y-axis, y-line = x, y-line = -x, x = h, y = k, and point (0.0)<br><br>This study uses the idea of reflection symmetry to describe the observable mirror-like balance in the statue arrangement. |

## 3.2 DISCUSSION

The findings show that the structure and ornaments in the Kasepuhan Palace not only have aesthetic and symbolic value, but also reflect explicit mathematical concepts. Based on the results, these concepts include plane geometry (triangles, trapezoids, rectangles, squares, circles, and rhombuses), solid geometry (rectangular prisms/cuboids and cylinders), angle concepts (acute/pointed angles and right angles), and symmetry (primarily vertical reflective symmetry). These mathematical ideas were identified across multiple architectural components, including wards/buildings, gates, fences, stone artefacts, museum entrances, and statues, indicating that mathematical representations are widely embedded in the palace environment.

The Prabayaksa Ward exemplifies the application of geometric concepts in traditional Javanese architecture, which draws on traditional elements and integrates spiritual and political values. The concept of a "luminous and protected holy place" in the name of Prabayaksa reflects a mathematical understanding of sacred spaces with special proportions that create a spiritual atmosphere [20]. In line with the findings, the Prabayaksa Ward displays clear plane-figure compositions—particularly triangles, trapezoids, and rectangles—visible in the façade and structural arrangement, which can be connected to core geometry topics such as area and perimeter. This aligns with research demonstrating that palace architecture incorporates mathematical concepts integrated with local cultural values [21]. A similar dominance of rectangular forms was also observed in the Great Ward of Panembahan, suggesting consistency in how space and authority are represented through proportional and geometric layouts within the palace complex.

The Jinem ward exhibits the phenomenon of cultural acculturation, as reflected in the application of mathematical concepts. The blend of local styles with foreign influences, evident in the marble floors and white walls adorned with European-style ceramics, demonstrates the integration of concepts from two different architectural traditions, characterised by symmetry and geometric patterns. This aligns with research on cultural acculturation in the palace's architectural design, which shows that the meeting of Javanese and European cultures produces a unique mathematical expression [21]. Empirically, the Jinem Ward findings highlight both square forms (plane geometry) and cuboid/rectangular prism forms (solid geometry), which appear in architectural parts and can support learning about 2D–3D relationships, faces, edges, vertices, and volume. This strengthens the interpretation that acculturation is not only visible in ornament style but also in the repeated use of structured geometric patterns that can be formalised in mathematical language.

The square or rectangular Gilang stone exemplifies the application of basic geometric concepts in ceremonial funerary structures, serving as a functional seat while also conveying the symbolic values of perfection and stability in Javanese philosophy. The regular selection of geometric shapes reflects an understanding of harmony and balance in traditional architectural design [22]. Consistent with the results, Batu Gilang predominantly presents square and rectangular faces, making it a concrete example of how basic plane geometry can be introduced through culturally meaningful artefacts. Beyond Batu Gilang, other palace features also reinforce this pattern: the Red Brick Fence displays repeated circle, rhombus, and square motifs, while the Lingga–Yoni stones combine a cylinder form with square elements, together broadening the range of geometric representations available for learning. Likewise, Siti Hinggil exhibits triangles, trapezoids, and rectangles, confirming that multiple plane figures recur across different sites within the complex.

This demonstrates that mathematics plays a crucial role in shaping the beauty and resilience of traditional structures. Thus, the Kasepuhan Palace can serve as an authentic ethnomathematics learning resource, enriching mathematics learning materials and instilling a love for local culture. This approach aligns with the spirit of the Freedom of Learning, which encourages meaningful, context-based learning. In addition, the results on angle concepts—identified at the entrances of the Barong Lion Museum and the Heritage Museum (acute/pointed and right angles) as well as at the Panembahan Gate (right angles formed by perpendicular structures)—show that angle recognition can be taught using real architectural references. The symmetry findings (e.g., vertical reflective symmetry on the Side Door of the Throne and the Siti Hinggil Gate, and bilateral balance suggested by the paired White Tiger statues) also provide clear contexts for teaching reflection symmetry through observation and simple axis-drawing activities. Therefore, the palace environment offers a coherent set of contexts for teaching geometry topics (2D shapes, 3D solids, angles, and symmetry) while simultaneously supporting cultural appreciation and preservation goals.

### 3.3 IMPLEMENTATION

The implementation of ethnomathematics in mathematics education can be realised through the integration of local cultural elements, such as architecture, traditions, and cultural products of the Kasepuhan Palace of Cirebon, into the contextual learning process [23]. Based on the results of this study, the palace provides concrete objects that represent plane geometry (triangles, trapezoids, rectangles, squares, circles, and rhombuses), solid geometry (cuboids/rectangular prisms and cylinders), angle concepts (acute/pointed and right angles), and symmetry (mainly vertical reflective symmetry). For example, teachers can use symmetrical patterns and shapes in space on palace gates or ornaments to explain the concepts of geometry and transformation, making mathematical material not only abstract but also meaningful and relevant to students. In practice, a lesson can begin with photos or short observation tasks of Prabayaksa/Jinem wards and the Red Brick Fence, followed by student activities to classify shapes, identify angle types, and draw symmetry axes on selected motifs. The benefits of this integration include improved problem-solving skills, increased learning motivation, and character development, fostering a love for students' local culture [24]. This is because students are invited to connect formulas and geometric properties to visible forms in their own cultural environment, rather than solely through decontextualised diagrams.

However, this study has limitations: most studies are still based on single-case studies or literature reviews, have not been conducted as quantitative experiments, and involve learners in learning design to a minimal extent [25]. In addition, the findings in this study are descriptive (identifying and mapping concepts), so they have not yet measured the direct impact on students’ learning outcomes in classrooms. For this reason, *future research* recommendations include conducting multisite field research (e.g., across various palaces or local traditions), using quasi-experimental methods to measure mathematical learning outcomes, and designing collaborative learning that allows students to participate in cultural observation. Future studies may also develop and test specific learning scenarios, such as: (1) geometry worksheets using the Prabayaksa façade for area–perimeter problems, (2) solid-geometry tasks using the Jinem ward to identify faces–edges–and vertices and compute volume, and (3) transformation activities using the Siti Hinggil gate and throne side door to explore reflection symmetry.

The practical implication is that teachers need to be trained in simple ethnographic observation and in developing teaching materials (modules or Learning and Knowledge Systems, LKS) based on local culture, accompanied by guidance on exploring local cultural structures, such as palace architecture, as a medium for geometry learning. Teacher preparation can include (a) how to select cultural objects that clearly display mathematical features, (b) how to translate observations into learning objectives and activities, and (c) how to design assessment rubrics that evaluate both conceptual understanding and students’ ability to interpret cultural artefacts mathematically. This strategy aligns with the spirit of the Independent Curriculum, which emphasises relevance, context, and grounding in local wisdom, thereby supporting the simultaneous strengthening of students' understanding of concepts and cultural identities [23]. Thus, the Kasepuhan

Palace is positioned not only as a research object but also as a practical and adaptable learning resource for geometry teaching in schools.

## 4. CONCLUSION

This study revealed that the architecture of the Kasepuhan Palace incorporates a variety of ethnomathematical concepts, including flat buildings and spatial structures such as triangles, trapezoids, squares, rectangles, cuboids, tubes, and other geometric elements, as well as right angles, tapering corners, and concepts of reflective symmetry and axial symmetry. The existence of these concepts is not only symbolic and aesthetic; it is also practical. However, it can also serve as a meaningful and contextually relevant medium for mathematics learning, in line with the spirit of the Independent Curriculum, which emphasises the importance of local wisdom in education. The implementation of ethnomathematics enables students to understand the material more concretely and in a way that is relevant to their environment, thereby strengthening the nation's appreciation for culture. However, this study has limitations: it employs a descriptive case study approach in a single location, lacks quantitative analysis or field experiments, and involves minimal student involvement in the cultural exploration process. Therefore, advanced research is recommended using a quasi-experimental design or classroom action to test the impact of cultural integration on learning outcomes, expand the scope to other local cultural areas, such as palaces or traditional houses across various regions, and actively involve students in the collection and analysis of cultural data. The practical implication is that mathematics teachers need to be equipped with skills in simple ethnographic observation and the development of learning media such as modules, worksheets, or teaching aids based on local cultural elements so that mathematics learning not only strengthens the mastery of concepts, but also builds students' identity and love for their own culture.

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