NOTASI : Jurnal Pendidikan Matematika
e-ISSN : 2988-5908 **Vol. 4, No. 3, Hal. 150-157, September 2026**

Application of geometric concepts in the architecture of palembang limas houses: An ethnomathematical study

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Abstract

Rumah Limas is a traditional house of the Palembang community, South Sumatra, whose name derives from its roof shape resembling a truncated pyramid. This study aims to identify and analyze the geometric concepts embedded in the architectural structure of Rumah Limas and to examine its relevance for culture-based mathematics learning, known as ethnomathematics. The method used is descriptive qualitative research with a literature study approach, reviewing and synthesizing findings from journal articles, architectural archive documents, and official cultural sources related to Rumah Limas and other Indonesian traditional houses. Data analysis used domain and taxonomic analysis techniques commonly applied in ethnomathematics research, supported by source triangulation. The results show that the structure of Rumah Limas contains at least six categories of geometric shapes, namely truncated pyramids and isosceles trapezoids on the roof, triangles on the roof truss, rectangular prisms on the tiered house body, rectangles in the floor plan, prisms or cylinders on the supporting pillars, and reflective symmetry on the ornaments. These findings are consistent with previous ethnomathematics research on other traditional houses in Indonesia. This study concludes that Rumah Limas has great potential as a contextual geometry learning resource that enriches students' understanding while preserving local wisdom.
Keywords: ethnomathematics, geometry, Limas house, traditional architecture, contextual learning.

How to cite: Mensia. (2026). Application of geometric concepts in the architecture of palembang limas houses: An ethnomathematical study. *Jurnal Notasi*, 4(3), 150-157. https://doi.org/10.70115/notasi.v4i3.715

Received: 23 Juli 2026 | Revised: 13 Agustus 2026
Accepted: 14 September 2026 | Published: 30 September 2026

Introduction

Mathematics is often perceived as an abstract discipline that is disconnected from students' everyday experiences, making it challenging for learners to develop meaningful understandings of mathematical concepts, particularly in geometry. Geometric concepts such as plane figures, solid figures, symmetry, proportions, angles, and spatial relationships are frequently introduced through formal definitions, formulas, and symbolic representations. Although these approaches are essential for developing mathematical knowledge, they may not always enable students to recognize how mathematics is embedded in their surrounding environment. Connecting mathematical concepts with familiar cultural practices and objects can provide opportunities for students to construct more meaningful relationships between formal mathematics and their lived experiences. From this perspective, ethnomathematics offers an approach to mathematics education that examines mathematical ideas, practices, and reasoning within specific cultural contexts (D'Ambrosio, 2001; Rosa & Orey, 2011). Rather than treating mathematics exclusively as a body of abstract knowledge, ethnomathematics recognizes that mathematical thinking also emerges through everyday activities, traditional craftsmanship, architecture, artistic practices, and community-based knowledge systems (Ascher & D'Ambrosio, 1994; Gerdes, 1999).

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The theoretical foundations of ethnomathematics are closely related to the recognition that mathematical knowledge develops within particular social and cultural environments. Bishop (1988, 1991) emphasized the relationship between mathematics education and cultural practices, highlighting the importance of understanding mathematical activity within its broader social context. Similarly, Rosa and Orey (2011) argued that ethnomathematics can connect school mathematics with students' cultural experiences, helping make mathematical learning more relevant and meaningful. This perspective does not imply that culturally embedded mathematical practices should replace formal mathematical knowledge. Instead, cultural practices can serve as starting points for identifying, representing, and formalizing mathematical relationships. In geometry education, for example, the design of traditional buildings can provide observable examples of geometric forms, spatial arrangements, measurement, symmetry, proportional relationships, and transformations. Gerdes (1999) demonstrated how geometric ideas embedded in cultural artifacts and artistic practices can be explored to develop mathematical reasoning at different educational levels. Therefore, ethnomathematics provides a conceptual framework for examining traditional architecture not merely as a cultural artifact but also as a potential resource for mathematical investigation and instruction.

Traditional Indonesian architecture represents a particularly valuable context for ethnomathematical research because the country's cultural diversity is reflected in the structural designs, spatial organization, decorative patterns, and construction practices of its traditional houses. These architectural forms demonstrate how communities organize space, select proportions, arrange structural components, and develop construction techniques in response to cultural values and practical requirements. Previous studies have identified mathematical concepts in several traditional Indonesian buildings. Susanto et al. (2022), for instance, explored geometric elements in the Joglo Sinom Limas traditional house, identifying concepts such as plane geometry, solid geometry, symmetry, similarity, congruence, and geometric transformations. Sari et al. (2022) examined the traditional Tanean Lanjang settlement in Madura and identified geometric concepts alongside cultural values associated with kinship, household harmony, and social relationships. Meyundasari et al. (2024) also investigated geometric concepts in the architecture of Istana Dalam Loka in West Nusa Tenggara, demonstrating the potential of traditional architecture to provide contextual examples for geometry learning. These studies indicate that mathematical ideas can be identified within architectural structures while also recognizing the cultural meanings associated with those structures.

Research on other traditional houses further demonstrates the diversity of mathematical concepts embedded in Indonesian architectural heritage. Studies of traditional Komering houses have identified geometric forms in roofs, walls, stairs, and decorative elements, including triangles, rectangles, trapezoids, circles, and cuboids (Agustian et al., 2025). Research on the Bola Pa'borongan traditional house of the Kajang community has similarly identified relationships involving lines, angles, plane figures, solid figures, and geometric transformations (DS et al., 2025). Studies of Tongkonan architecture in Tana Toraja have also explored the geometric elements and cultural meanings represented in traditional building structures (Hasnia et al., 2025). Beyond traditional houses, research on the architecture of Ijo Temple has demonstrated how cultural heritage can be investigated through geometric principles and

subsequently connected to mathematics learning (Carla et al., 2024). Collectively, these studies suggest that traditional architecture provides opportunities to explore mathematical concepts through direct observation, measurement, visual representation, and mathematical modeling. Nevertheless, each architectural tradition has distinctive structural characteristics and cultural meanings, requiring context-specific analysis rather than assuming that findings from one building can be directly generalized to another.

One traditional building that merits particular attention is the Limas House, a traditional dwelling associated with the Palembang community in South Sumatra, Indonesia. The house is characterized by its distinctive roof structure, which is commonly described in terms of a pyramidal or truncated-pyramidal form. Beyond its physical appearance, the Limas House represents an important component of Palembang's cultural heritage, reflecting architectural knowledge, construction practices, spatial organization, and cultural values passed down across generations. Its structural components provide potential opportunities to investigate mathematical concepts, including geometric shapes, angles, measurements, scale, proportion, and spatial relationships. In this context, the Limas House can be understood as an architectural artifact in which practical construction decisions can be examined through formal mathematical concepts. Such an investigation is consistent with the ethnomathematical perspective that mathematical knowledge can be identified and interpreted through culturally situated practices (D'Ambrosio, 2001; Rosa & Orey, 2011).

Previous research has begun to document the mathematical potential of the Limas House. Lisnani et al. (2022), in their ethnomathematical study of the Limas House at the Balaputera Dewa State Museum in South Sumatra, identified mathematical elements associated with measurement, geometry, and angles, alongside cultural, historical, and philosophical dimensions. Their findings demonstrate that the Limas House can be examined from multiple perspectives, connecting its architectural features with mathematical knowledge and local cultural heritage. Cahyani et al. (2025), in their exploration of Limas Houses in Anyar Village, South Sumatra, identified mathematical concepts associated with geometry, algebra, trigonometry, scale, proportion, and roof inclination. More specifically, Febriani and Efriani (2025) investigated the application of Varignon's theorem to the floor-plan structure of the Limas House, demonstrating how an architectural representation can be used to examine relationships between the midpoints of a quadrilateral and the resulting parallelogram. Adinda and Arifin (2025) also explored the relationship between the Limas House floor plan and the Pythagorean theorem through a geometric representation involving the Garfield trapezoid. These studies demonstrate that the mathematical potential of the Limas House extends beyond identifying familiar shapes to include the examination of geometric relationships and the application of formal mathematical theorems.

Despite these contributions, further investigation is needed to develop a more systematic understanding of the geometric concepts represented in the architectural structure of the Limas House. Existing studies have explored selected mathematical features, particular architectural locations, or specific theorems. However, a comprehensive classification of its geometric elements across different architectural components—including plane geometry, solid geometry, angular relationships, measurement, proportional relationships, and geometric transformations—remains an important area for further investigation. This need is consistent with broader reviews of ethnomathematics research, which indicate that cultural artifacts can

support the exploration of multiple mathematical topics but require careful translation into mathematically coherent learning experiences (Nursanti et al., 2024; Rasyidin & Nur, 2024). Moreover, the identification of geometric forms alone does not necessarily establish the mathematical relationships underlying an architectural structure. A more systematic investigation should distinguish between visual resemblance and mathematically justified relationships, ensuring that interpretations of architectural features are supported by appropriate definitions, measurements, and calculations.

A further consideration concerns the distinction between recognizing geometric forms and quantitatively analyzing their mathematical properties. For example, identifying a roof section as a trapezoid is only an initial step. A more detailed analysis may examine its parallel sides, angles, height, area, symmetry, and relationships with other structural components. Similarly, a roof that resembles a truncated pyramid can provide a context for examining cross-sectional dimensions, surface area, volume, and proportional relationships, provided that the relevant dimensions and geometric assumptions are established. Illustrative calculations can therefore help clarify how mathematical concepts are derived from architectural observations rather than merely assigning mathematical labels to cultural objects. Such an approach is consistent with research that applies formal geometric reasoning to traditional architectural structures, including the investigation of Varignon's theorem in the Limas House floor plan (Febriani & Efriani, 2025). By combining architectural observation with mathematical representation and quantitative analysis, ethnomathematical research can provide a more rigorous account of the relationship between cultural knowledge and formal mathematics.

The educational relevance of such an investigation is supported by research emphasizing the value of culturally contextualized mathematics learning. Rosa and Orey (2011) explained that connecting school mathematics with students' cultural and everyday experiences can help make mathematical concepts more meaningful. Similarly, Brandt and Chernoff (2014) discussed the importance of ethnomathematics in mathematics classrooms, particularly its potential to connect mathematical learning with cultural contexts. Acharya et al. (2021) also examined mathematics educators' perspectives on the cultural relevance of school mathematics, highlighting the importance of considering learners' cultural environments when developing mathematics curricula. In the Indonesian context, Nursanti et al. (2024) reviewed research on ethnomathematics-based learning and identified several mathematical competencies and content areas that can be addressed through culturally grounded approaches, including geometric visualization, mathematical communication, critical thinking, and problem-solving. These perspectives suggest that the Limas House may provide a meaningful context for learning geometry by enabling students to identify mathematical relationships in a recognizable cultural artifact, formulate questions, perform measurements, construct representations, and evaluate mathematical claims.

Nevertheless, the educational implications of ethnomathematical research should be developed carefully. The presence of geometric concepts in traditional architecture does not, by itself, demonstrate that using the architecture in classroom instruction will improve learning outcomes. Instead, the identified concepts provide a foundation for developing learning activities, instructional materials, and mathematical modeling tasks that can subsequently be evaluated in educational settings. For example, students could investigate the geometric forms of selected architectural components, compare the dimensions of different structural elements,

calculate areas or volumes using explicitly stated assumptions, and examine whether observed shapes satisfy particular geometric properties. Such activities can support the transition from concrete cultural observations to abstract mathematical representations. They may also create opportunities for students to appreciate local cultural heritage while developing mathematical understanding. This perspective positions ethnomathematics as a resource for instructional design rather than assuming that cultural relevance automatically guarantees educational effectiveness.

Based on this background, the present study aims to identify and systematically classify the geometric concepts embedded in the architectural structure of the Palembang Limas House, quantitatively analyze selected mathematical relationships through illustrative calculations, and examine the relevance of the findings for developing ethnomathematics-based geometry learning in schools and higher education. The study focuses on connecting observable architectural features with mathematically justified concepts, including plane geometry, solid geometry, angular relationships, measurement, proportion, and geometric transformations where supported by the evidence. By extending previous explorations through a systematic classification and quantitative examination of selected features, this research seeks to contribute to the documentation of Palembang's architectural heritage and the development of culturally contextualized mathematics learning resources. The expected contribution is a clearer account of how the mathematical properties of the Limas House can be interpreted through formal geometry while maintaining an appreciation of its cultural significance.

Method

This study employed a qualitative descriptive design using a literature review approach (*library research*) grounded in the ethnomathematics framework. This approach was selected because the study aimed to describe and analyze mathematical phenomena embedded in cultural artifacts, specifically the Limas House, through a synthesis of secondary data from previous ethnographic studies rather than direct primary field observations.

Data were collected through documentation, involving the identification and examination of national scientific journal articles on the ethnomathematics of traditional houses, particularly the Limas House, published between 2015 and 2025. The sources also included archival documents on traditional South Sumatran architecture and credible official cultural resources. These materials comprised ethnomathematics journal articles reporting geometric concepts and findings from previous observations, architectural records describing the structure and materials of the Limas House, and articles from media outlets and official cultural websites providing contextual, historical, and philosophical information about the house.

Data analysis followed procedures commonly used in ethnomathematical research. First, domain analysis was conducted to classify the structural and ornamental elements of the Limas House into general categories. Second, taxonomic analysis was used to break down each domain into more specific subcategories of geometric shapes. Third, componential analysis was conducted to associate each identified geometric shape with relevant mathematical concepts. Finally, cultural theme analysis was performed to interpret the philosophical meanings underlying the selection of particular geometric forms within the cultural context of the Palembang community.

To enhance the credibility of the findings, source triangulation was employed by comparing the identification of geometric concepts in the Limas House across multiple literature sources. The findings were also compared with patterns identified in studies of other traditional houses across the Indonesian archipelago to provide cross-validation.

Results and Discussion

Based on domain and taxonomic analyses of various literature sources, six major categories of architectural components in the Limas House were identified, each incorporating specific geometric concepts. The main roof incorporates a truncated square pyramid (frustum), isosceles trapezoids, and isosceles triangles. Specifically, two triangular surfaces are located at the front and rear, while two trapezoidal surfaces extend along the left and right sides, meeting at the roof ridge. These findings are consistent with Lisnani (2022), who identified isosceles trapezoids and a square pyramid in the Limas House at the Balaputera Dewa Museum. A summary of the findings is presented in Table 1.

Table 1. Identification of Geometric Concepts in the Structure of the Limas House

Architectural Component	Geometric Concepts	Description of Findings
Main roof	Truncated pyramid, isosceles trapezoids, isosceles triangles	Two triangular surfaces (front and rear) and two trapezoidal surfaces (left and right) meet along the roof ridge.
Roof frame (trusses)	Right triangles, diagonal lines	Inclined wooden beams form triangular support structures that bear the weight of the roof tiles.
Main body of the house (*kekijing*)	Rectangular prisms arranged in tiers	The floor consists of multiple levels, with a height difference of 30–40 cm between successive levels.
Supporting pillars	Elongated prisms or cylinders	Vertical pillars stand perpendicular to the ground and measure approximately 1.5–2 meters in height.
Floor plan	Rectangle	The overall building footprint is rectangular.
Ornaments (*simbar* and *melati*)	Reflectional symmetry	The ornaments are arranged symmetrically about the central axis of the roof.

To clarify the quantitative application of these geometric concepts, illustrative calculations were performed using standard mathematical formulas. The roof inclination angle was calculated using the trigonometric ratio of the roof height to half the base width. For example, if the height of the central roof section is 3 meters and half the base width is 2 meters, the inclination angle is approximately 56.3°. This represents a relatively steep angle, which is consistent with the design principle of facilitating rainwater runoff in tropical climates.

The roof surface area, comprising two trapezoidal surfaces and two triangular surfaces, can be calculated using the standard formulas for the areas of trapezoids and triangles. The volume of the space beneath the truncated-pyramid roof can be calculated using the frustum

volume formula, where the height of the frustum and the areas of its lower and upper parallel surfaces are known. Meanwhile, the length of an inclined wooden beam in the roof truss can be calculated using the Pythagorean theorem, with the vertical height and horizontal distance serving as the two perpendicular sides of a right triangle.

To further strengthen the validity of the findings, the geometric concepts identified in the Limas House were compared with findings from ethnomathematical studies of several other traditional Indonesian houses, as presented in Table 2.

Table 2. Comparison of Geometric Concepts in the Limas House and Other Traditional Indonesian Houses

Traditional House (Location)	Dominant Geometric Concepts	Source
Limas House (Palembang)	Truncated pyramid, trapezoid, rectangle, cylinder	Lisnani (2022); Cahyani et al. (2025)
Rumah Gadang (Minangkabau)	Triangles (gonjong roof), parabolic curves, rectangles	Jurnal Analisa (2019)
Joglo House (Ponorogo)	Pyramids, squares, rectangular prisms, lines of symmetry	JPPGSD Unesa (2020)
Tongkonan House (Toraja)	Triangles, curves, rectangles, geometric transformations	Jainuddin et al. (2022)
Bola Pa'borongan House (Kajang)	Squares, triangles, trapezoids, rectangular prisms, pyramids, cubes	DS et al. (2025)
Saoraja House (Bugis, Pinrang)	Triangles, circles, trapezoids, pyramids, cylinders, prisms	Exploration of the Bugis Saoraja Traditional House (2024)

This comparison indicates that, although each traditional house has distinctive architectural features reflecting its geographical conditions and cultural philosophy, common patterns can be identified. Triangles, rectangles, and trapezoids are prominent plane shapes, while pyramids, prisms, and rectangular prisms frequently appear as solid geometric forms across the traditional Indonesian houses examined.

The finding that the roof of the Limas House resembles a truncated pyramid is consistent with Lisnani's (2022) study, which identified a square pyramid and isosceles trapezoids in the Limas House at the Balaputera Dewa Museum. The truncation of the pyramid's apex along the roof ridge, where the *Simbar* and *Tanduk Kambing* ornaments are placed, represents more than a structural design choice. It also carries philosophical significance as a symbol of human limitations in relation to the Creator. This finding highlights the principle that, within ethnomathematics, geometric forms cannot be separated from the cultural meanings and values of the communities that create them. This characteristic distinguishes ethnomathematics from conventional Euclidean geometry, which is generally treated as culturally neutral.

Variations in roof inclination, with a gentler slope at the front and a steeper slope in the central section, as also reported in Cahyani et al.'s (2025) ethnomathematical exploration of the Limas House, suggest that the Palembang community has intuitively applied trigonometric

principles to address practical problems. These design features help facilitate the runoff of heavy tropical rainfall and reduce the risk of water seeping into the wooden structure. This phenomenon supports the argument that formal mathematical concepts, including the tangent function and angles of elevation, have been applied empirically in traditional communities long before they were systematically formulated in formal education. This is a defining characteristic of ethnomathematics, which D'Ambrosio (2001) describes in terms of mathematics embedded in cultural practices.

The proportionally decreasing levels of the *kekijing* floor structure, together with the reflectional symmetry found in *Simbar* ornaments and *Melati* carvings, indicate the application of similarity and geometric transformation principles. Similar patterns have been identified in ethnomathematical studies of other traditional houses, including the symmetrical carvings of the Tongkonan House in Toraja (Jainuddin et al., 2022) and the Bola Pa'borongan House of the Kajang community (DS et al., 2025). The consistency of these findings across different traditional houses suggests that symmetry and similarity serve both aesthetic and structural functions in traditional Indonesian architecture and are not restricted to a single cultural region.

This study reinforces previous research suggesting that traditional architecture has considerable potential as a source of contextual geometry learning. Unlike conventional geometry instruction, which often presents abstract concepts disconnected from students' experiences, an ethnomathematics approach based on the Limas House enables students to explore truncated pyramids, trapezoids, similarity, and the Pythagorean theorem through tangible cultural objects that are socially and culturally meaningful. Nevertheless, this study has limitations because it relies entirely on a literature review without direct field observations or interviews with craftspeople or descendants of the Limas House tradition. Consequently, the geometric calculations presented are illustrative and intended primarily for pedagogical purposes. Further research should verify these calculations through direct field measurements and additional empirical investigation.

Conclusion

Based on the analysis and discussion, it can be concluded that the architectural structure of the Palembang Limas House incorporates at least six categories of geometric concepts: truncated pyramids and isosceles trapezoids in the roof, triangles in the roof trusses, rectangular prisms or prisms in the tiered main structure, rectangles in the floor plan, prisms or cylinders in the supporting pillars, and reflectional symmetry in the ornaments. These findings are consistent with previous ethnomathematical studies examining both the Limas House and other traditional Indonesian houses. These geometric concepts serve not only structural and aesthetic functions but also carry philosophical meanings that reflect the cultural values of the Palembang community. Therefore, the Limas House can serve as an effective contextual learning resource for teaching geometry through an ethnomathematical approach at various educational levels.

Future research should involve direct field observations, measurements, and interviews with Limas House craftspeople to empirically verify structural dimensions and roof inclination angles. Further studies could also develop these findings into instructional modules or worksheets for ethnomathematics-based geometry learning at the elementary and secondary school levels, as well as supplementary materials for geometry courses in mathematics education programs.

Author Contributions

Mensia contributed to the conceptualization of the study, formulation of the research objectives and scope, and identification and collection of relevant literature on Palembang Limas House architecture and geometric concepts from an ethnomathematical perspective. The author also contributed to source selection and review, domain and taxonomic analyses, and synthesis of the findings concerning the representation of geometric concepts in the structural and ornamental elements of the Limas House. In addition, the author prepared the initial manuscript, interpreted the findings regarding the relevance of the Limas House as a contextual geometry learning resource, and revised and edited the manuscript to produce the final article.

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