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Exploration of Ethnomathematics in Traditional Houses of Papuan People

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ABSTRACT

Ethnomathematics serves as a bridge between history and culture with mathematics, playing a crucial role in recognizing that various cultural activities lead to different mathematical concepts. This study aims to describe the historical, philosophical, and mathematical concepts embedded in traditional Papuan houses, including Honai, Kaki Seribu, Rumah Pohon, and Rumsram. The research was conducted at the Papua Ethnic House Tourism and Cultural Park using a qualitative descriptive research method based on ethnography. Data were obtained through observation, interviews, and documentation, and analyzed using data reduction, data presentation, and data verification techniques. The results showed that traditional Papuan houses integrate mathematical concepts in their structure and design, such as: (1) The Honai house adopts a cylindrical and conical shape for space efficiency and durability; (2) The Kaki Seribu house highlights symmetrical patterns in its numerous supporting pillars, reflecting adaptation to the surrounding environment; (3) The Rumah Pohon applies principles of proportion and stability to ensure safety from external threats; (4) The Rumsram house represents the Biak people's connection to maritime culture while demonstrating geometric principles in its trapezoidal and rectangular structures. In addition to mathematical aspects, traditional Papuan houses contain philosophical and historical values that strengthen local cultural identity. Further research will focus on developing and testing Papuan culture-based mathematics learning models. For example, creating didactic designs that use the Honai House concept to teach geometric shapes (cylinders and cones) or the Thousand-Legged House to teach symmetry and patterns. The effectiveness of these models in enhancing student understanding and interest could be the focus of testing. Practical applications include creating textbooks, modules, learning videos, or even interactive apps that showcase traditional Papuan houses as a medium for learning geometry, patterns, and measurement.

Keywords: ethnomathematics; historical and philosophical aspects; mathematical concepts traditional papuan houses

INTRODUCTION

Mathematics is a discipline that studies the concepts, structures, and relationships contained in numbers, space, and patterns (Fakhri Auliya et al., 2022). This discipline covers various fields such as arithmetic, geometry, algebra, statistics, and analysis. Mathematics is often used in other sciences such as technology, economics, and various other fields to solve problems and make decisions (Handayani & Irawan, 2021). However, although mathematics has extensive uses and benefits and influences development and change, this science tends to be disliked and avoided because of its difficulty and abstraction (Simanjuntak, 2022). Moreover, if these concepts are not related and not in line with activities in real life. This view often arises among students at every level of education. The reason is, they are often only required to answer mathematical problems without having an understanding of real applications in everyday life, forcing students to

learn concepts abstractly can cause stress in learning. Therefore, an educator must be able to determine the appropriate approach so that learning objectives can be achieved better (Rohmaini et al., 2020).

Mathematics learning should start with contextual problems experienced by students, or at least start with something they can imagine and feel (Fakhri Auliya et al., 2022). D'Ambrosio (1985) stated that mathematics is essentially a technology that develops symbolically in cultural skills and activities. Mathematics is also the result of cultural activities based on social and environmental activities that are considered in accordance with the concept of mathematics. Mathematics is a form of culture and is integrated into every activity of society(Santos & Prudente, 2022). Mathematics and culture are two things that are interrelated. Mathematics and culture are both related so that they cannot be separated in daily activities. However, because there is still a view that mathematics and culture are not related. So a study must be carried out that discusses the relationship between mathematics and culture. The study of mathematics that discusses this culture is called ethnomathematics (Sudirman et al., 2020).

Ethnomathematics is the study of certain patterns or distinctive colors of mathematics that exist and develop in society. Ethnomathematics plays a very important role in connecting the preservation of culture and local wisdom with technological advances through science. Not only does it reveal the relationship between mathematical concepts and cultural practices, ethnomathematics also shows how mathematical understanding develops contextually in a society (Mania & Alam, 2021). D'Ambrosio (1985) explains that ethnomathematics is the study of how certain cultural groups develop and use mathematical concepts and practices in their lives. Each community has its own way of applying mathematical principles, both in traditional measurement systems, geometric patterns in art and architecture, and in calculation strategies that are passed down from generation to generation (Fachrur et al., 2021). Thus, ethnomathematics can be a bridge between academic concepts and real experiences of society, so that mathematics learning becomes more contextual and meaningful.

Therefore, ethnomathematics plays a very important role in education, especially in improving students' understanding of mathematical concepts through exploration of local culture. Ethnomathematics is also one of the best choices for mathematics teachers by linking local culture so that Mathematics Learning can be useful in a cultural environment. There are six universal mathematical activities found in every culture, namely counting, measuring, designing, explaining, discovering, and playing. By integrating mathematical elements that have long existed in people's lives, students can more easily understand abstract concepts by linking them to real experiences (Deda et al., 2024). This not only increases appreciation for cultural heritage but also encourages the preservation of traditions through a science-based approach. Therefore, research in the field of ethnomathematics is important to identify and document various forms of application of mathematics in community culture, including in the construction of traditional Papuan houses. Previous ethnomathematics research has also indirectly described the cultural richness in Indonesia, one of which is the activities and culture of indigenous peoples on the island of Papua.

The preservation of the uniqueness of Papuan traditional houses is the main reason for conducting this research. This is because the shape and characteristics of Papuan traditional houses are very geometric, simple, and have deep meaning. The traditional houses observed not only have rich historical and philosophical values, but also show the application of interesting mathematical concepts in their architecture and construction. Various elements such as building structures, geometric patterns, traditional measurement systems, and proportions and symmetries used by Papuans in building their traditional houses are evidence that mathematics has long been present in their lives intuitively. This experience encouraged the author to Investigate further into the relationship between culture and mathematical concepts in the construction of Papuan traditional houses, so that it can be a source of contextual and culture-based learning. This research is also a suitable idea to overcome various problems and challenges in learning mathematics by making culture the object of learning.

RESEARCH METHODS

The research method used in this study is descriptive qualitative with an ethnographic approach. This research was conducted in 2024 at the Papua Ethnic House Tourism and Culture Park located on Jalan Baru Jl. Raya Aimas-Klamono No.km.21, Malawili, Kec. Aimas, Sorong Regency, Southwest Papua, 48916.

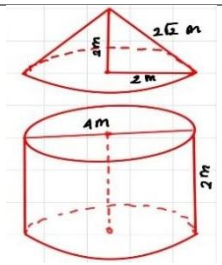
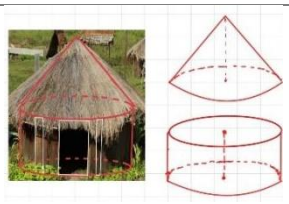
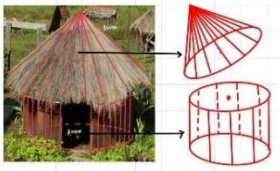
The sampling technique used purposive sampling and it was decided that the owner and manager of the tourism and cultural park "Papua Ethnic House" as the subject of the study. While the object of this study is the collection of traditional houses in the Papua Ethnic House which includes: honai houses, centipede houses, tree houses, and rumsram houses..

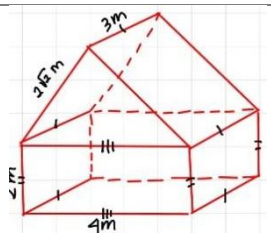
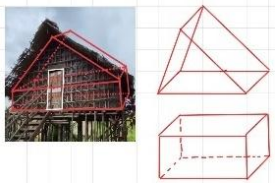
The data sources used in this study are primary data and secondary data. Primary sources are obtained by observing objects and interviewing subjects. While secondary sources are obtained based on documentation. This study uses Miles and Huberman's qualitative data analysis techniques, namely data reduction, data presentation, and verification.

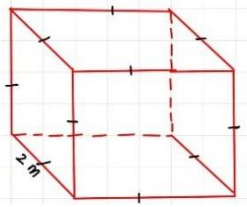
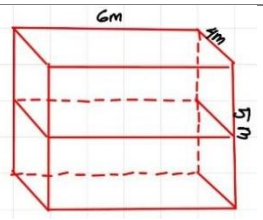
RESULTS AND DISCUSSION

Based on the results of the research that have been analyzed, several important findings were found covering historical, philosophical, and mathematical concept aspects identified in each traditional house studied. The historical aspect includes the background, origin, and development of traditional houses in the context of the local community's culture. The philosophical aspect describes the values, symbolic meanings, and cultural messages contained in each architectural element of the traditional house. Meanwhile, the mathematical concept aspect includes geometric patterns, size comparisons, symmetry, and measurement principles that appear in the building structure. All of these findings have been systematically arranged based on their respective categories and presented in the following table to facilitate understanding and further analysis.

Table 1. Data Analysis Results

No.	Aspects of Findings	Description	Drawings/Sketches of Mathematical
1.		**Honai House**	
	a) Background of the house	Honai House is a traditional house of the Dani tribe from the Baliem Valley, Papua. Built according to the cold climate of the highlands.	
	b) Function of the house.	As a residence for adult men and a center for customary discussion	-
	c) Philosophical	Symbolizes warmth, unity and family.	-
	d) House structure	Circular in shape with wooden walls and a conical roof made of straw.	-
	e) Materials:	Local wood, bamboo and straw.	-
	f) Measurement techniques	Using body measurements (height, footsteps).	-
	g) The size of the house	Is 4 meters in diameter and 4 meters high.	
	h) Geometric elements	Circular base, cylindrical base, and conical roof.	
	i) Symmetry pattern	Infinite rotational symmetry in the shape of a cylindrical circle.	
2)		Rumah Kaki Seribu	
	a) Background of the house	Typical stilt houses of the Arfak tribe in the Arfak Mountains, Manokwari.	
	b) Function of the house.	A dwelling that is resistant to floods and wild animals.	-
	c) Philosophical	Symbolizes strength and	-

		protection.	
	d) House structure	Rectangular in shape with wooden pillars with a leaf roof.	-
	e) Materials:	Wood, bamboo, rattan, and leaves.	-
	f) Measurement techniques	Using the length of the wood and the stride of the foot.	-
	g) The size of the house	4 meters long, 3 meters wide and 5 meters high.	
	h) Geometric elements	The rectangular base forms a block, the triangular roof forms a triangular prism, and the stairs form a right triangle.	
	i) Symmetry pattern	The rectangular base forms a block, the triangular roof forms a triangular prism, and the stairs form a right triangle.	
3)		Rumah Pohon	
	a) Background of the house	The traditional house of the Korowai tribe is built high in the trees.	
	b) Function of the house.	The traditional house of the Korowai tribe is built high in the trees.	-
	c) Philosophical	A symbol of the close relationship between humans and nature and resilience.	-
	d) House structure	A stilt house 8-12 meters high with tree trunks as the main foundation.	-
	e) Materials:	Wood, rattan, and dry leaves.	-

	f) Measurement techniques	Using tree height or wood length.	-
	g) The size of the house	Length and width 2 meters, height 5 meters.	
	h) Geometric elements	The square base forms a cube, the triangular roof forms a triangular prism.	
	i) Symmetry pattern	Reflection symmetry in wall design.	
4)		Rumah Rumsram	
	a) Background of the house	The traditional house of the Biak tribe is inspired by the shape of a boat.	
	b) Function of the house.	A place for young people to study and discuss.	-
	c) Philosophical	Symbolizes maritime tribal identity, a symbol of knowledge and education.	-
	d) House structure	Rectangular in shape with a steep roof like an upside-down boat.	-
	e) Materials:	Coconut wood, rattan, and dry leaves.	-
	f) Measurement techniques	Based on the length of the wood and adjusted to the size of the boat.	-
	g) The size of the house	Length 6 meters, width 4 meters, height 5 meters.	

h) Geometric elements	The rectangular base forms the beam and the roof is trapezoidal.	
i) Symmetry pattern	Reflective symmetry in wall and door design.	

The discussion of this research is in the form of history and meaning of traditional houses of Papuan society and a description of mathematical values, especially in the concept of geometry and measurement. The study of history and philosophy as well as mathematical concepts in traditional houses of Papuan society is as follows:

History and Philosophy of the Honai Traditional House

Honai is a traditional house of the Dani tribe in the mountains of Wamena, Papua, which is designed to protect its inhabitants from extreme cold temperatures. In addition to being a place to live, Honai also functions as a gathering space for men to discuss and rest. This house symbolizes unity, protection, and family togetherness, with a circular shape that reflects harmony and a conical roof that symbolizes resilience. The circular shape makes it windproof, while the conical roof helps rainwater flow and distributes the load evenly, increasing the strength of the building. The main materials are wood for the walls and straw for the roof, which functions as a natural insulator to keep it warm at night and cool during the day. The compacted earthen floor also helps maintain the room temperature. In its construction, the Wamena people use traditional measuring instruments such as stride length and height. This technique reflects local skills that have been passed down from generation to generation (Hendriyanto et al., 2023).

History and Philosophy of the Kaki Seribu Traditional House

Rumah Kaki Seribu is a typical stilt house of the Arfak tribe in Manokwari which has many supporting pillars to protect it from wild animals. This stilt design reflects the community's adaptation to the environment as well as the values of resilience and togetherness. Its multi-pillar structure makes the house more stable and supports air circulation. The main materials consist of wood for the walls and pillars, sago leaves or rumbia for the roof, and rattan as a binder. In its construction, the community uses the length of steps or rope as a measuring tool to determine the height of the pillars and the structure of the house (Magauay, 2023).

History and Philosophy of Rumah Pohon

Rumah Pohon is a traditional house of the Korowai tribe built on trees or using high poles as protection from wild animals and threats from other tribes. This house symbolizes

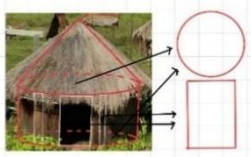
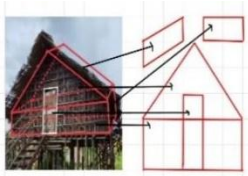
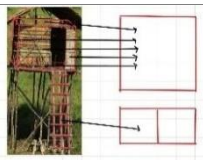
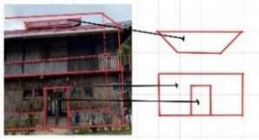
the courage and adaptation of the community to the forest environment where they live. Access to this house uses a ladder or rope that can be pulled for safety. Trees function as the main pillars, but in ethnic houses, the pillars are replaced by long wood. The main materials consist of wood and rattan for the structure, and dry leaves for the roof. In its construction, the community uses the length of wood or rope to determine the height of the house and the strength of its pillars (Tereshkina et al., 2015).

History and Philosophy of the Rumsram Traditional House

Rumsram is a traditional house of the Biak tribe that functions as a place to learn customs, arts, and prepare young people to become leaders. This house is a symbol of cultural preservation with a roof shaped like an inverted boat, reflecting the relationship of the Biak people with the sea and sailing. The structure is rectangular with a steep roof to speed up the flow of rainwater and strengthen the building. This house has two floors as a gathering space for Biak men. In ethnic houses, Rumsram functions as a museum and souvenir shop. The main materials consist of wood and bamboo for the walls, and leaves or zinc for the roof. The size of the roof follows the natural proportions of the traditional boats of the Biak people (Mallqui, A. O., & Chávez, 2021).

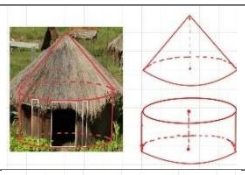
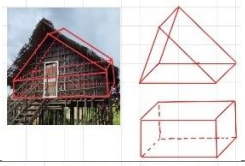
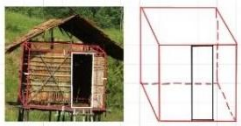
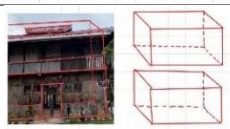
Concept of Geometry of Plane Buildings

Tabel 1. Flat Building Concept in Papuan Traditional Houses

No.	Findings	Sketch
a)	The circular and rectangular flat shapes are visible in the base structure, doors, and honai house.	
b)	The triangular flat shape is visible on the roof of the millipede and the rectangle on the walls.	
c)	The flat square shape is visible on the wall surface and the rectangle on the roof surface of the tree house.	
d)	Trapezoid The isosceles trapezoid shape is seen in the shape of the roof of the rumsram and the rectangles on the walls and doors.	

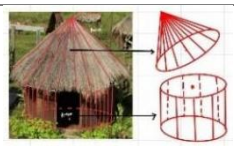
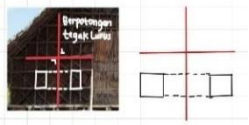
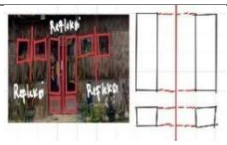
The Concept of Geometry of Spatial Buildings

Tabel 2. The Concept of Spatial Building in Papuan Traditional Houses

No.	Findings	Sketch
a)	Build a cylindrical and conical space on the base structure and roof of the Honai house.	
b)	Build triangular prism and cuboid spaces on the roof and base structure of the millipede house.	
c)	The cube-shaped structure is found in tree houses.	
d)	Build a block space on the structure of a rumsram house.	

Concept of Geometric Transformation

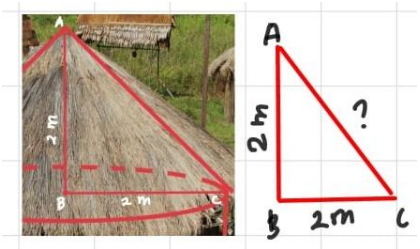
Tabel 3. The Concept of Geometric Transformation in Papuan Traditional Houses

No.	Findings	Sketch
a)	The concept of infinite rotation on the basic structure of a cylinder and a conical roof.	
b)	The concept of reflection is found in the design of the walls of the centipede house	
c)	Reflection concept in tree house roof design	
d)	The concept of reflection in the design of the walls and doors of the Rumsram house	

The concept of the Pythagorean Theorem

a) The concept of the Pythagorean theorem is found in the roof structure of a Honai house to find the slope of the Honai roof or what is called the length of the painter's line with the following calculation:

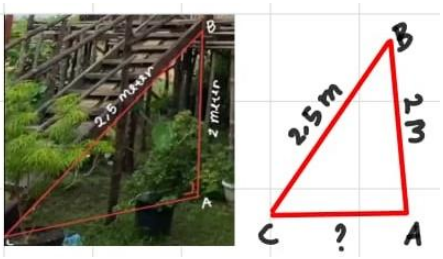
$$AC^2 = \sqrt{AB^2 + BC^2}$$
$$AC^2 = \sqrt{2^2 + 2^2}$$
$$AC^2 = \sqrt{4 + 4}$$
$$AC^2 = \sqrt{8}$$
$$AC^2 = \sqrt{4.2}$$



$AC = 2\sqrt{2}\ m$

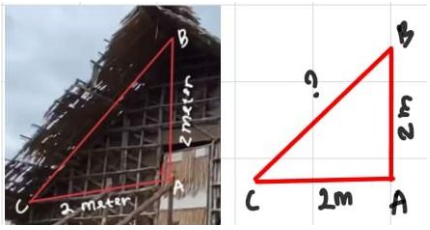
b) The concept of the Pythagorean theorem is also found in the structure of the stairs of a millipede house and based on the available measurement information, the distance between the stairs and the support pillar can be determined as follows:

$$AC^2 = \sqrt{CB^2 - BA^2}$$
$$AC^2 = \sqrt{2{,}5^2 - 2^2}$$
$$AC^2 = \sqrt{6{,}25 - 4}$$
$$AC^2 = \sqrt{2{,}25}$$
$$AC = 1{,}5 \text{ m}$$



c) Another concept of the Pythagorean theorem is found in the roof structure of a millipede house to find the slope of the roof of the house with the following calculation:

$$CB^2 = \sqrt{CA^2 + AB^2}$$
$$CB^2 = \sqrt{2^2 + 2^2}$$
$$CB^2 = \sqrt{4 + 4}$$
$$CB^2 = \sqrt{8}$$
$$CB^2 = \sqrt{4.2}$$
$$CB = 2\sqrt{2}\ m$$



CONCLUSION

Based on the results of the research that has been conducted, several conclusions can be drawn. This study successfully identified mathematical elements found in Papuan traditional houses, especially honai, millipedes, tree houses, and rumsram. These elements include aspects of geometry, measurement, and aesthetics that show cultural diversity and the application of mathematical concepts in the lives of Papuan people. The structure and form of traditional houses also reflect strong cultural values, such as togetherness, sustainability, and the relationship between humans and nature. This study shows that these values are relevant in mathematics learning, especially to improve students' understanding of the practical application of mathematics in everyday life. So that the ethnomathematics approach can be one strategy to increase students' interest in learning mathematics, especially by using the local cultural context as a relevant and interesting learning medium.

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