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Geometric Analysis of Pahudu Andung (Human Motif) In Pahikung Woven Cloth From East Sumba

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ABSTRACT

This study aims to explore and document the mathematical concepts (ethnomathematics) contained in the *Pahudu Andung* motif (human motif) on the *Pahikung* woven cloth typical of Melolo, East Sumba. Through an ethnographic approach, this study explores the cultural, historical, and technical dimensions of the motif's creation, which have been passed down through generations. Data were collected through participatory observation, documentation, and in-depth interviews with three expert weavers (tenabi) in the Umalulu region. The results show that the *Pahudu Andung* motif is not merely a decorative element, but rather a visual representation rich in the geometric concepts of transformation and plane shapes. Ethnomathematic analysis identified the application of the principle of bilateral symmetry (reflection) in the body structure of the motif, translation in the repetition of the "X" pattern, and dilation (scale) in the rhombus shape. In addition, the use of basic geometric shapes such as a trapezoid as a foundation, a rectangle on the trunk, and a rhombus on the head with precise acute-angled details was found. This study concludes that local weavers have intuitively applied complex geometric concepts in preserving the philosophical values of victory and strength through woven art.

1. Introduction

Sumba's woven fabrics are traditionally decorated with elaborate designs and ornamental motifs set in harmonious compositions(Wicaksono, 2022). The woven cloth is made of two pieces (lirang, half a piece) separately woven and then joined and sewn to form one piece(Anas, 2007). Lines are important in a composition because they create area and shape. The decorative motifs shown are arranged symmetrically in the composition to achieve harmony. The traditional woven fabrics, particularly the lau pahikungu, reflect the identity of women(Gajjala et al., 2022). Besides these functions, woven fabrics also perform other important functions in the life of the Sumbanese, such as religious, social and economic aspects. These are traditional clothing, funeral wrappings, burial goods, symbols of family ties, assets, exchange tools, gifts and decorative materials(Lestari et al., 2023)

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The wide variety of motifs is explained by the fact that each tribe has its own characteristic features, and there are no two the same, both in terms of coloring and each image. In that way, the meaning of preserving the sacredness of the woven fabric is very meaningful, especially for the people of East Sumba. The strength of East Sumba woven fabric is not only on the uniqueness of its design which is full of decorative symbols with social and religious significance or the very attractive natural color scheme but also on the production process that involves the soul of the weaver which can be complete in months of work with extraordinary patience and perseverance(Budiati et al., 2023)

One of the most prominent symbolic patterns in woven textiles of East Sumba is the Pahudu Andung (human motif) that tells the story of human life in the era of intertribal conflicts and the time of ancient kingdoms. The Andung (skull tree) symbolizes heroism, victory and the remembrance of ancestral spirits in this motif, and the tree of life symbolizes continuity, fertility and the interconnectedness of human existence. The motif not only has philosophical meaning but also expresses complex geometric principles inherent in the traditional art of weaving. The structure is defined by reflection symmetry attained by a balanced arrangement of bilateral tree forms and translational symmetry realized by repeated placement of figurative elements on the textile surface, which results in harmonious visual rhythm. Moreover, the fractal nature of branches and ornamental skulls organized recursively, as well as the proportional spatial relationships, indicate that traditional weavers unconsciously used advanced geometric reasoning while at the same time safeguarding their cultural legacy (Sari et al., 2021). These mathematical structures reveal that indigenous artisans possess a rich mathematical knowledge embedded in their cultural practices.

The mathematical sophistication of the Pahudu Andung motif is highly relevant to the current problems of mathematics education in Indonesia. Even with the curriculum reforms, mathematics is still taught as abstract procedures and symbolic manipulations that are often disconnected from students' sociocultural experiences(Astika Wanhar et al., 2026). So, many students consider mathematics as a lonely and difficult subject, which is not much related to everyday life. Ethnomathematics offers a pedagogical framework to fill this gap by incorporating indigenous cultural knowledge with formal mathematical concepts(Kabuye Batiibwe, 2024). Ethnomathematics contextualizes geometrical concepts within culturally meaningful artifacts, such as traditional woven textiles, to promote conceptual understanding, reinforce cultural identity, and improve students' engagement and motivation in mathematics learning(Pratama & Yelken, 2024). This view sees local cultural products as not only artistic expressions, but also authentic learning resources that link school mathematics and community knowledge(McCurdy, 2025).

The cultural context of this study is in Umalulu, locally called Tana Umalulu, a historically important area in East Sumba, East Nusa Tenggara Province, Indonesia(Gamage et al., 2021). The region was called Tanah Melolo (Melolo Kingdom) during the Dutch colonial administration, and today it is part of the Umalulu District of East Sumba Regency. The area is marked by rolling hills, large savannas and soils that are relatively infertile and restrict agricultural productivity. However, the perennial Umalulu River has been the traditional basis for human settlement, agricultural activities and the growth of local communities along its banks. The livelihood of the people is mainly based on rain-fed agriculture, primitive irrigation, livestock and traditional handicrafts. One of the economic activities is the Sumba woven textiles production which plays a significant role not only as a household income source but also as a means of transferring Sumba's cultural values, local knowledge and traditional skills from one generation to another. Thus the textile becomes a cultural artifact of importance, embodying mathematical ideas, artistic expressions and local wisdom at the same time.

Using an ethnographic qualitative research design, this research examined the mathematical knowledge contained within these cultural artifacts. Ethnography is especially suitable because it allows researchers to understand mathematical practices in the natural setting of a culture through an intense involvement with the participants and their daily activities . Data were collected through participant observation of the weaving process, in-depth interviews with expert weavers, and documentary analysis of woven textile artifacts and their associated cultural records(Risku et al., 2022).

These complementary sources generated rich descriptive data, such as field observations, participants' narratives, and visual documentation of the weaving patterns. The data analysis involved iterative coding, thematic interpretation, and cultural contextualization to identify the embedded mathematical concepts in the weaving motifs. This ethnographic approach emphasizes the importance of immersion in the community and experiential understanding so that researchers are able to see mathematical knowledge as embedded in cultural practice rather than as abstract, decontextualized concepts. Thus, the study provides a holistic account of the preservation, transmission and embodiment of indigenous geometric reasoning in the traditional weaving culture of Umalulu.

2. Metodology

This study utilized a qualitative descriptive research design to explore and document ethnomathematical concepts in pahikung (songket weaving) practices at the Melolo weaving center. A qualitative approach was considered appropriate because it allows for an in-depth understanding of cultural knowledge, traditional craftsmanship and the mathematical principles embedded within indigenous practices in their natural context. The descriptive design enabled the researchers to systematically identify, interpret and explain mathematical elements expressed in the weaving process without intervening in the social and cultural context(Hsieh & Shannon, 2005).

Data were collected using several qualitative techniques to ensure richness and triangulation of data. First, non-participant observations were conducted to examine the phases, patterns and methods of pahikung weaving. Special attention was paid to the processes of motif construction, pattern repetition, symmetry formation, practices of counting, and spatial arrangements that may reflect mathematical concepts. Second, in-depth semi-structured interviews were conducted with tenabi (expert weavers) who had a lot of knowledge and experience in traditional weaving practices. Interviews were conducted to explore the cultural meanings of weaving motifs, traditional measurement systems, pattern-making procedures and cognitive processes in weaving activities. Third, artifact documentation was done by collecting and analyzing photographs, sketches, and samples of woven products in order to identify the geometric shapes, transformations, ratios, and other mathematical patterns present in the textile designs(Roulston & Choi, 2017).

The participants were purposively selected based on their experience as tenabi, who were known by the local community as experienced pahikung weavers. The study was conducted with ten expert weavers who provided detailed perspectives on the technical and cultural aspects of the weaving tradition. Data collection continued until sufficient data was collected to provide a rich understanding of the mathematical phenomena embedded in the weaving practices(Creswell et al., 2007).

Table 1. Ethnographic Model of Pahudu Andung Interview Instrument

Stages	Indicators	Sub Indicators	Data Collection Methods	Data Subjects
Descriptive Interview	Culture and History	The origin of the human motif (Andung) in Melolo	Interview	Weaver
		The symbolic and philosophical meaning of motifs for indigenous peoples	Interview	Weaver
		When is cloth with the Andung motif usually used?	Interview	Weaver
	Preparation and Materials	Availability of raw materials (thread, natural/synthetic dyes).	Observation	Availability of materials
		Rituals or taboos during the process of weaving the Andung motif.	Interview	Weaver
Structural Interview	(Tools and Competencies)	Tools (sticks/wooden slats) for forming human motifs.	Documentation	Availability of tools
		Competence/expertise of weavers in Pahudu technique.	Observation	Hikung Process
	Geometry Process (Anatomy)	Stages of the Pahudu hikung technique in forming human anatomy.	Interview	Weaver 1
		Precision and accuracy of shape (Symmetry, Points, Lines)	Observation	Student
Contrast Interview	Products and Aesthetics	The aesthetics and final details of the Pahudu Andung motif.	Documentation	The final result of Pahudu Andung
		Technical constraints, obstacles, and solutions in motif precision	Interview	Weaver
	Economic Value	Economic value and marketability of fabrics in local/global markets.	Interview	Weaver

3. Results

3.1. Descriptive Interview

a. The Origin of the Human Motif (Pahudu Andung) in Melolo

Based on the results of interviews with Weavers 1 and 3 (NMR and NK) (15/03/2026), they stated that Pahudu Andung (human motif) comes from our ancestors if there is a traditional house where the house has a symbol or motif of andung placed on the roof of the house. Weaver 2 (HNB) (15/03/2026) stated that Pahudu andung berasal dari sebuah sebuah kuburan dari kuburan tersebut there are carvings in the shape of humans, eyes and noses, so the weavers are creative in forming motifs from these carvings.

Fig.1. Interview with Weaver 1

Fig.2. Interview with Weaver 2

Fig.3. Interview with Weaver 3

b. The symbolic and philosophical meaning of motifs for indigenous peoples

Based on the results of the interview with weaver 1 (NMR) (03/15/2026) stated that the symbol of Pahudu Andung is a symbol of victory for the past community in war as well as a sign of the tribe, in the era of inter-tribal war (marapu), the victory of a village is marked by bringing home the enemy's head as spoils of war. Weaver 2 (HNB) stated that pahudu andung has the meaning of courage in war. Weaver 3 (NK) (03/15/2026) stated that pahudu andung has the meaning of strength to protect the area for example traditional houses that have andung symbols and also this andung house was made so that it would not be lost from generation to generation.

c. When is cloth with the Andung motif usually used

Based on the results of interviews with weaver 1 and weaver 2 (NMR) (15/03/2026), it was stated that cloth with the andung motif is usually used to wrap corpses as burial provisions and is used at traditional events such as belis.

d. Availability of Raw Materials (yarn, natural/synthetic dyes)

Based on the results of interviews with weaver 1 and weaver 2 (NMR) and HNB) stated that the availability of raw materials such as thread usually uses pamawang tawalah thread (white thread) and for coloring usually uses kombu and wora. This applies to original sarongs, while kloss thread which does not require coloring is usually used for ordinary sarongs.

Fig.4. Tawalah thread

Fig.5. Tawalah thread (white thread)

Fig.6. Kloss thread

e. Rituals or taboos during the process of weaving the Andung motif

Based on the results of interviews with weavers 1 and 2 (NMR, HNB) (03/15/2026) stated that in the past before making andung motif cloth there was always a ritual in the form of mbola Pahappa (a place for betel/areca nut) which was always kept near the thread as a solution when taking the wrong thread when hikung (songket) but now it is rarely done. Weaver 3 (NK) (03/15/2026) stated that rituals such as keeping pahappa (betel/areca nut) near the thread so that when pamening the thread does not jump.

Fig.7. Mbola Happa

3.2 Structural Interview

a) Tools (sticks/wooden slats) for forming human motifs

Based on the documentation results (15/03/2026) tools such as sticks (ri kalanda), wooden slats (palambang) in making pahudu andung are available.

Fig. 8. Alat bantu

b) Competence/Expertise of Weavers in Pahudu Technique

Based on the results of observations made on weaver 2 (HNB) (15/03/2026), it appears that she is very skilled in the process of weaving pahudu andung (songket).

Fig. 9. The process of making the hikung (songket)

c. Stages of the Pahudu nose technique in forming human anatomy

Based on the results of an interview with weaver 1 (NMR) (15/03/2026), he stated that the stages in the pahudu andung hikung (songket) process start from the right side of the motif and then continue with counting the threads according to the shape of the motif.Berdasarkan hasil wawancara dengan bapak penenun 1 (NMR) (15/03/2026) menyatakan bahwa tahapan dalam proses hikung (songket) pahudu andung dimulai dari sisi kanan motif kemudian dilanjutkan dengan penhitungan benang sesuai dengan bentuk motif.

Fig.10. Stages of the hikung pahudu andung technique

d. Precision and accuracy of shape (Symmetry, Points, Lines)

Based on the observation results (15/03/2026) it can be seen that in Pahudu Andung (human motif) there are several geometric elements including a solid basic flat shape; starting from the very bottom, there is a wide trapezoid shape that symbolizes the foundation or ground where life rests. From there, grows the main trunk and vertical branches in the shape of a rectangle that gives the impression of stability, strength, and the relationship between the earth and the sky. The most striking element is the Rhombus shape that resembles a head or skull at each end of the branch. In Sumba culture, this shape symbolizes the eye or consciousness, which is emphasized by the use of acute angles (less than 90 degrees) at each meeting point, giving a sharp and authoritative character.

The beauty of this motif lies in its mathematical regularity. Through the principle of Bilateral (Reflective) Symmetry, this fabric demonstrates the balance of the cosmos where the left and right sides are identical mirror images separated by a central axis. Furthermore, there is a dynamic translation or shift in the pattern, as in the "X" motif and the small rhombuses that are repeated vertically with precise spacing. The entire composition is unified by the woven texture that forms Parallel Lines horizontally, creating visual harmony. Use of Scale or Dilation pada bentuk belah the from the large one as the center of attention to the small one as the filling detail, shows how complex the geometric thinking of the Sumba weavers is in creating a symbol of balance and majesty.

Basic Planar Shape
Stem: Rectangle

Bilateral Symmetry (Reflective)

Translation (Pattern Shift)

Tip: Rhombus	Balance and Harmony	Repeat of the X and Small Rhombus Patterns
		
Acute Angle Detail at the intersection of diagonal lines	**Parallel Lines** Consistent horizontal weave texture	**Scale (Dilation)** S1: Top S2: Side

Fig.11. Geometry Analysis of Pahudu Andung

3.3 Contrast Interview

a. Aesthetics and final details of the Pahudu Andung motif

Based on the documentation results (15/02/2026) the aesthetics or final result of the pahudu andung looks attractive and clear.

Fig.12. Final result of the pahudu andung

b. Technical constraints, obstacles, and solutions in motif precision

Based on the results of interviews with weavers 1, 2 and 3 (NMR, HNB and NK) (15/03/2026), it was stated that there were several obstacles and technicalities in the pahudu andung hikung (songket) process, such as errors in taking the thread when counting and damage to the stick, such as breaking and coming loose from the thread. Nilai ekonomi dan daya jual kain di pasar lokal/global. Based on the results of interviews with weavers 1, 2 and 3 (NMR, HNB and NK) (15/03/2026), it was stated that there were several obstacles and technicalities in the pahudu andung hikung (songket) process, such as errors in taking the thread when counting and damage to the stick, such as breaking and coming loose from the thread.

4. Conclusion

Typical ethnographic research uses three types of data collection: interviews, observations, and documents. This pairing produces three types of data: quotations, descriptions, and document excerpts, resulting in one product: a narrative description or narrative. Closed-mindedness, personal experience, and active involvement, not just observation, by the observing ethnographer are crucial components of this study. Ethnographers often collaborate with people from diverse fields. Their research may focus on a particular topic or field, a combination of historical methods, observation, and interviews, or an in-depth study of culture and language.

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