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Bugis ethnomathematics: Exploration of the *sulapa eppa walasuji* motif as a source of learning mathematics

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Abstract

Mathematics has historically been integrated into everyday life, and Indonesia's cultural heritage, such as the *walasuji* of the Bugis community, provides a valuable context for learning. This study explores activities involving mathematical concepts found in the making of *walasuji*. A descriptive qualitative method with an ethnographic approach was used. Data were collected through observation, documentation, and interviews. The findings reveal that making *walasuji* involves mathematical concepts such as translation, reflection, rotation, and straight-line equations, offering potential as contextual learning resources in schools. Additionally, the *sulapa eppa walasuji* motif embodies character values manifested in humans, namely intellectuality (*acca*), courage (*warani*), honesty (*lempu*), and wealth (*sugi*), referred to as *sulapa eppa na taue* (the philosophy of a quadrilateral human). Integrating cultural artifacts like *walasuji* into mathematics learning can enhance students' engagement, cultural awareness, and critical thinking skills. This research implies that future mathematics education should incorporate elements of local wisdom to create meaningful, relevant, and culturally responsive learning experiences, aligning mathematics more closely with students' everyday realities and cultural identities.

Keywords: Bugis culture; cultural motifs; ethnomathematics; mathematics education

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Introduction

Mathematics is commonly presented in schools as a subject detached from cultural contexts and everyday life (Hendriana et al., 2019; Pathuddin et al., 2023; Rosa & Orey, 2011). This approach unintentionally fosters the perception that mathematics is challenging. Findings from the International Assessment Mathematics in Indonesia Program indicate that Indonesian students struggle with comprehending and applying mathematical concepts to real-life problem-solving tasks (Rastuti & Prahmana, 2021; Wagner et al., 2018). The core issue lies in the mechanical nature of mathematics instruction, where formulas are taught straightforwardly without linking them to students' daily experiences.

To address the challenges in mathematics education in Indonesia, transformative efforts are necessary to connect mathematics with students' real-life experiences and cultural backgrounds. Ethnomathematics, introduced by D'Ambrosio (2016) in response to the overly mechanistic nature of mathematics education, offers a potential solution. This approach bridges the gap between mathematics and societal realities, which has long existed due to rigid, decontextualized formal education (Busrah & Pathuddin, 2021; Maryati & Prahmana, 2019; Risdiyanti, Prahmana, & Shahrill, 2019). Ethnomathematics integrates traditional knowledge and cultural practices with mathematical concepts, aligning them with the socio-cultural contexts in which they develop (Bishop, 1994; Hendriana et al., 2019; Prahmana & D'Ambrosio, 2020). By reconstructing mathematics to reflect diverse cultural perspectives, ethnomathematics promotes critical thinking, democratic reasoning, and tolerance for different ideas during the learning process (Pathuddin et al., 2021; Santos, 2019; Suherman et al., 2021). Thus, ethnomathematics serves as an innovative approach to making mathematics more relevant to students' daily lives, enhancing their engagement, fostering a deeper appreciation for the subject, and stimulating creativity through cultural connections.

Indonesia, with its rich and diverse cultural heritage, has the potential to enhance its mathematics education system by integrating mathematical learning with students' real-life experiences and cultural backgrounds (Muhtadi et al., 2017; Nayazik, 2024; Prahmana et al., 2021). Various cultural elements across Indonesia can serve as contextual foundations for teaching mathematics, including those found in Wajo Regency. This region offers numerous cultural artifacts and traditions that can be explored, such as traditional house architecture, local pastries, mosques, silk sarong patterns, and ceremonial elements like *walasuji* in wedding rituals. Several studies have documented mathematical concepts embedded within the cultural practices of South Sulawesi communities (Qastarin & Siagian, 2019; Rumi, 2017).

Several prior studies have investigated the challenges students face in grasping geometric transformation concepts, applying relevant principles, converting problems, solving mathematical tasks, and addressing word problems linked to real-life situations (Maulani & Zanthy, 2020). Additionally, geometric transformation serves as a fundamental concept essential for understanding other topics, such as the volume of rotating objects, relations, and functions(Sundawan, 2018; Umbara et al., 2023). Meanwhile, ethnomathematics studies have also explored cultural practices related to traditional ceremonies. For example, Pathuddin et al., (2021) examined the ethnomathematics of the Barongko cake in Bugis wedding traditions as a mathematics learning resource. Similarly, Prahmana et al., (2021) Prahmana, discussed the use of the pranatamangsa system and birth-death ceremonies in Yogyakarta to contextualize mathematics learning. These studies demonstrate that traditional cultural practices, including those in wedding ceremonies, can serve as rich sources for ethnomathematics exploration and offer valuable opportunities for contextual mathematics education.

Although walasuji is commonly found in Bugis wedding processions and symbolizes core values such as intellectuality (*acca*), courage (*warani*), honesty (*lempu*), and wealth (*sugi*) (Abdollah & Sulo, 2018; Hasbi et al., 2021; Syarif et al., 2018), no previous studies have specifically explored the mathematical concepts embedded within the *sulapa eppa* motif of *walasuji*. Existing research has primarily focused on the cultural, philosophical, and symbolic meanings of *walasuji*, without investigating its potential as a source of contextual mathematical learning. This creates a significant gap in the literature, particularly regarding the integration of ethnomathematical elements into mathematics education. The widespread recognition of *walasuji* among the Bugis community, including students, offers a unique opportunity to contextualize mathematical concepts such as geometric transformations and straight-line equations. Therefore, this study aims to fill this gap by examining the mathematical aspects of *walasuji* weaving techniques, contributing both to the ethnomathematics discourse and to the development of effective mathematics learning trajectories based on local wisdom.

Methods

This study employed a qualitative research methodology with an ethnographic approach. Ethnography was used to describe cultural practices and understand a way of life from the perspective of those within the culture (Spradley, 2007). This approach aligned with the objective of the study, which was to explore activities that incorporated mathematical concepts in the process of making walasuji. The research was conducted in three sub-districts in Wajo Regency—Tanasitolo, Majauleng, and Belawa—located in South Sulawesi Province, Indonesia. These areas continued to preserve the tradition of walasuji weaving, especially during wedding ceremonies.

The research process was carried out in several steps. First, a preliminary study was conducted through library research to gather information regarding walasuji and its cultural significance. Second, informants were selected using purposive sampling, focusing on traditional craftsmen who possessed extensive experience and authority in walasuji making. Three informants were chosen: H. Andi Makkarodda (Tanasitolo), H. Bakri (Majauleng), and H. Wellang (Belawa). The number of informants was limited because these individuals were recognized experts and were among the few remaining traditional walasuji artisans.

Third, data collection was conducted through three techniques: (1) observation, using a structured observation sheet designed to record the walasuji making activities, the tools and materials used, and the identification of mathematical elements such as shapes, patterns, proportions, and measurements; (2) semi-structured interviews, guided by an interview instrument consisting of open-ended questions aimed at exploring the techniques, symbolic meanings, and mathematical concepts embedded in the walasuji weaving process; and (3) documentation through photographs, sketches, and video recordings of the walasuji crafting activities and finished products.

The observation sheet focused on several elements, including the identification of geometric shapes (rectangles, rhombuses), symmetry patterns, proportional relationships, use of measuring tools (appang), and the presence of mathematical transformations such as translation, rotation, and reflection in the motifs. Meanwhile, the interview guide included questions about the historical background of walasuji, cultural philosophies, craftsmanship techniques, the use of measurements and proportions, and the transmission of traditional knowledge across generations.

Interviews were conducted in the Bugis language to ensure effective communication and obtain deeper insights, given that it was the mother tongue of the informants. All interviews were audio-recorded, and key points were documented. To ensure data validity, a triangulation technique was applied by cross-checking the results of interviews, observations, and documentation. In addition, member checking was conducted by validating the interpreted information directly with the informants.

Finally, the collected data were analyzed through several stages: data reduction by selecting and summarizing relevant information; domain analysis to identify primary domains related to mathematical activities; taxonomic analysis to classify specific activities based on their mathematical concepts; and interpretation by linking empirical findings with relevant theoretical frameworks. The final findings were presented thematically to illustrate the connection between mathematical concepts and traditional cultural practices in walasuji making.

Results

Walasuji making technique

The process of making *walasuji* involves specific tools, materials, and techniques that reflect the local knowledge, skills, and values of the Bugis-Makassar community. The tools used include a machete (*parang*) for splitting and carving, a saw (*gergaji*) for cutting bamboo, a small sharp knife (*tobo'*) for refining certain parts, and a chisel (*pahat)* for making holes in the bamboo. The primary materials consist of mature, straight, and green bamboo, rattan for binding, and bamboo pegs for securing the structure. The making of *walasuji* follows a mathematical approach, as seen in the *sulapa eppa* concept, which translates to a rhombus shape. This shape aligns with the traditional weaving patterns found on *walasuji* walls, characterized by parallel sides, equal-length edges, and perpendicular diagonals. The weaving process usually begins one to two weeks before a Bugis-Makassar wedding, with the number of artisans involved varying depending on the family's social status. The division of labor includes individuals assigned to cutting bamboo, splitting it into strips, refining the strips, and assembling the design. Artisans create different motifs, with smaller, intricate designs typically reserved for higher social classes, while simpler patterns are made for the middle class due to their easier and faster production.

Figure 1. The process of making *walasuji*

The *walasuji* weaving technique requires precise skills and an understanding of bamboo properties. According to cultural expert and artisan H. Andi Makkarodda, the number of bamboo strips used in the weaving process historically signified social status. For instance, nobility used three parallel bamboo strips arranged in a way that symbolized leadership and protection, while commoners used two strips, and enslaved individuals did not use *walasuji* at all. The arrangement of bamboo colors, such as cream, green, and yellow, further reflected social hierarchy. The meticulous weaving process involves diagonal patterns with precisely spaced gaps, forming symmetrical rhombus or square shapes. Despite the absence of standardized measuring tools, artisans rely on their instincts and experience to determine the appropriate dimensions, ensuring that the design harmonizes with the house’s structure.

The craftsmanship of *walasuji* incorporates mathematical reasoning, particularly in estimating measurements, aligning patterns, and ensuring proportional balance. Artisans acquire their skills through observation and practice, as described in interviews where traditional knowledge is passed down from older generations. The mathematical aspects of *walasuji* making align with the principles of ethnomathematics. These skills are evident in assessing bamboo quality, calculating the required number of strips, positioning structural elements, and weaving the final design. This demonstrates how traditional weaving practices not only preserve cultural heritage but also integrate mathematical thinking into indigenous craftsmanship.

Geometric pattern of the *sulapa eppa* motif on *walasuji*

Translation is the movement of an object from one location to another in space without changing the shape or orientation of the object. In translation, each point of the object moves in the same direction by a certain distance (vector u). The result is an object that remains the same size and shape. The following is a picture of the geometric pattern of the sulapa eppa walasuji motif on a cartesian diagram using the geogebra application.

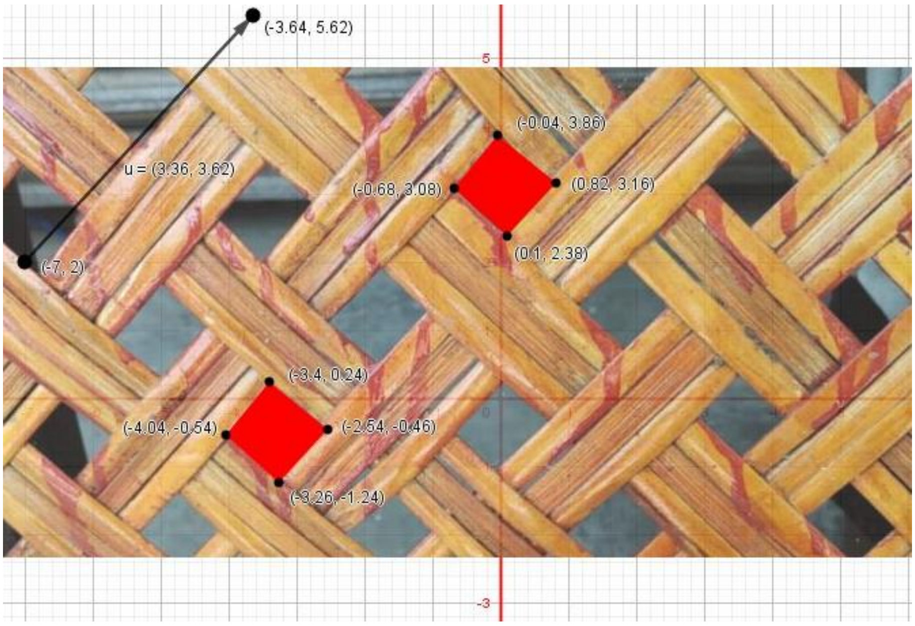

Figure 2. Representation of the concept of translation in *walasuji*

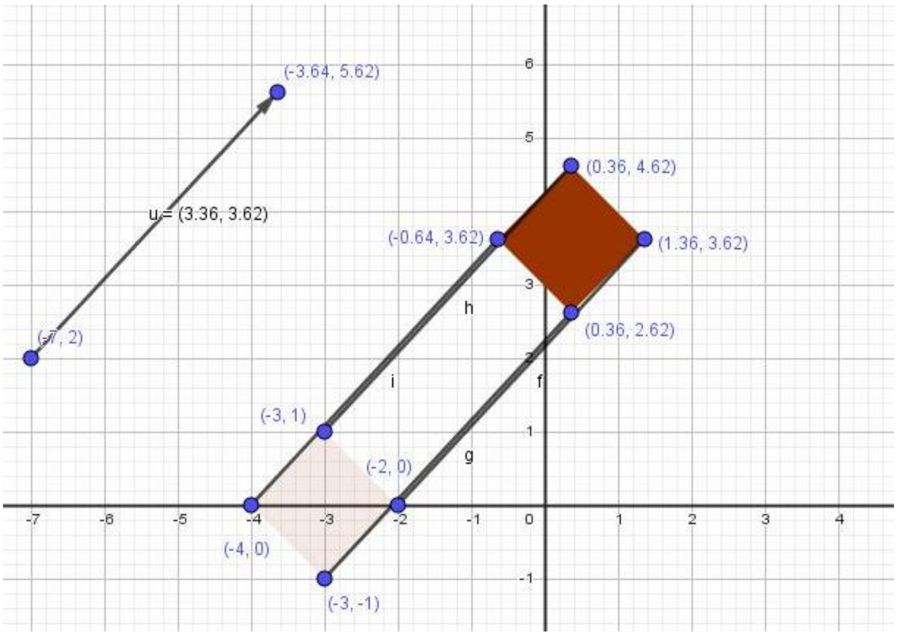

Figure 3. Redesign of *sulapa eppa walasuji* motif with translations to vector $u = (3.36, 3.62)$

Based on Figure 3, it can be seen that the geometric pattern of *the sulapa eppa* motif in *walasuji* is in accordance with the concept of transformation geometry where the pattern is formed from the result of translation to the u vector of (3.36, 3.62). For the size of the shape *of the sulappa eppa* in walasuji to have the same size, the craftsmen use *appang*. As Mr. HW said that:

> *Supaya padai loppona sulapa eppana walasujie ipakengngi appang, nareko tipuni sulapa eppana ipatamanni appang, narekko engka sulapa eppa iya denulle tama appangnge igeserei salimana gangkanna tama appangnge,*

Based on the results of the interview, it can be interpreted that the craftsman uses *appang*, which is made of a board used to measure so that the size of *the eppa sulappa* in *walasuji* is the same. For the calculation of Translation in Transformation Geometry with the u vector, the following formula can be used:

$$A\ (x, y) \xrightarrow{T=\frac{a}{b}} A'(x + a, y + b)$$

In the above redesign, the concept of geometry in the form of a rhombus with points, points, points and points will be translated with vector lengths can be completed as follows:$A\ (-3, -1) B\ (-2, 0) C\ (-3, 1) D\ \ (-4, 0) u = (3.36, 3.62)$

$$A\ (-3, -1) \xrightarrow{T=\frac{3.36}{3.62}} A'(-3 + 3.36, -1 + 3.62)$$
$$= A'(0.36\ , 2.62)$$
$$B\ (-2, -0) \xrightarrow{T=\frac{3.36}{3.62}} B'(-2 + 3.36, 0 + 3.62)$$
$$= B'(1.36\ , 3.62)$$
$$C\ (-3, -1) \xrightarrow{T=\frac{3.36}{3.62}} C'(-3 + 3.36, 1 + 3.62)$$
$$= C'\ (0.36\ , 4.62)$$
$$D\ (-3, -1) \xrightarrow{T=\frac{3.36}{3.62}} D'(-4 + 3.36, 0 + 3.62)$$
$$= D'(-0.36\ , 3.62)$$

This result shows that the shadow of the translated point is equal to the size of the starting point, so the shape of the transformed object will be the same size. In reflection, each point on the original object is reflected or reversed to the other side of the line or plane. The result is an object that remains the same shape but can have opposite orientations. The following are some images of the representation of the concept of reflection on the geometric pattern of *the sulapa eppa walasuji* motif using the geogebra application.

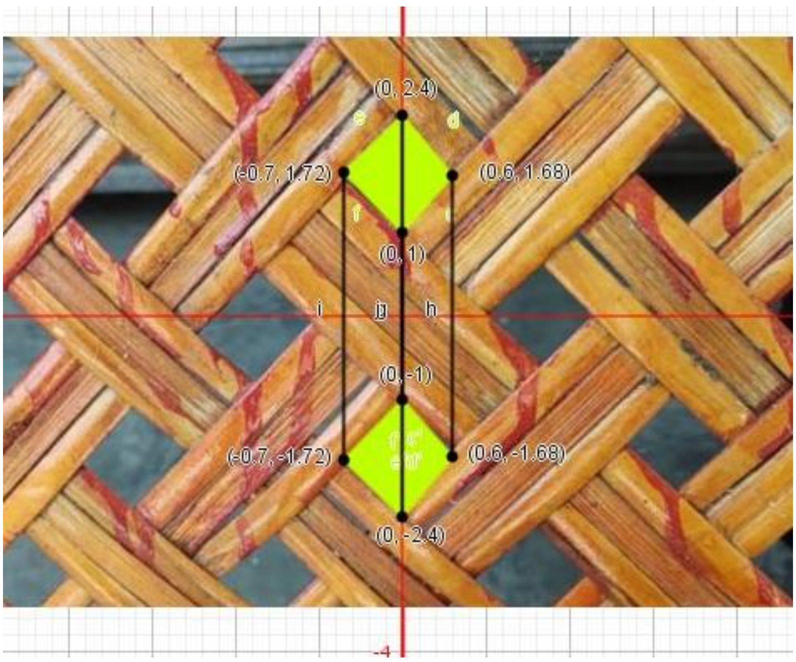

Figure 4. Representation of the concept of reflection on *walasuji* on the x-Axis

Based on Figure 4 there is a point that is reflected on the x-axis, then:$B\ (x, y)$

$$x' = x$$
$$y' = -y$$
$$The\ equation\ can\ be\ written\ in\ the\ form:$$
$$\boldsymbol{x' = 1.x + 0.y}$$
$$\boldsymbol{y' = 0.x + (-1).y}$$
$$or\ in\ matrix\ form:$$
$$\begin{pmatrix} \boldsymbol{x'} \\ \boldsymbol{y'} \end{pmatrix} = \begin{pmatrix} \boldsymbol{1} & \boldsymbol{0} \\ \boldsymbol{0} & \boldsymbol{-1} \end{pmatrix} \begin{pmatrix} \boldsymbol{x} \\ \boldsymbol{y} \end{pmatrix}$$

Rotation is a transformation that involves rotating an object around a specific point referred to as the center of the angle. The angle of rotation is expressed in degrees or radians and can be counterclockwise (positive) or clockwise (negative). The result of rotation is an object that remains the same size and shape, but changes in orientation.

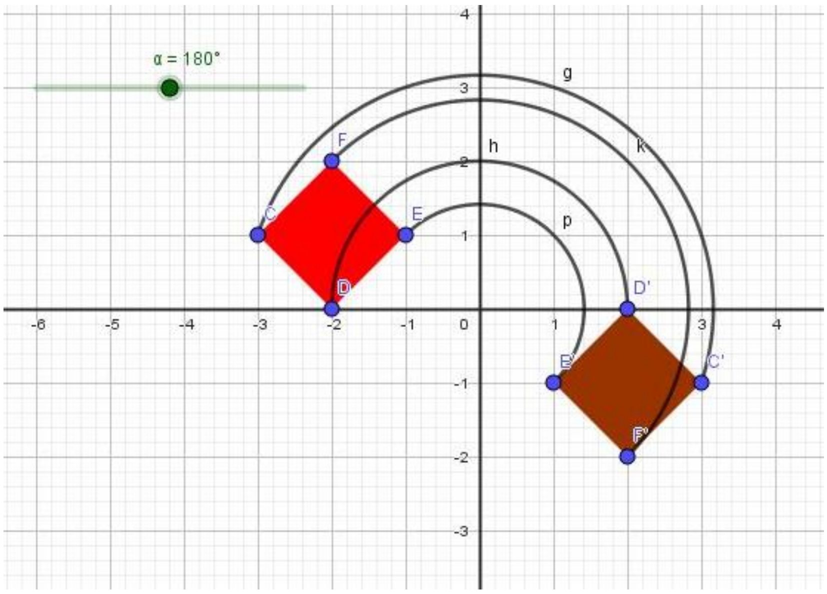

Figure 5. Redesign of the *Sulapa Eppa Walasuji Motif* with Counterclockwise rotation 180°

Based on Figure 5 there are points B, C, D, and E that are rotated as far 180°as counterclockwise. From the results of the rotation, the shadows of points C, D, E, and F are obtained.

$$x' = x\ cos\ \theta - y\ sin\theta$$
$$y' = x\ sin\ \theta + y\ cos\ \theta$$
$$in\ matrix\ form:$$
$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} cos\ \theta & -sin\theta \\ sin\ \theta & cos\ \theta \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}$$

The general form of a straight line equation is or , this equation has a gradient = $ax + by + c = 0\ ax + by = cm - \frac{a}{b}$. Bamboo slats that are woven diagonally with a certain amount of distance so that they will create symmetrical holes between the webbing in the form of a rectangle or rhombus to form a straight line equation.

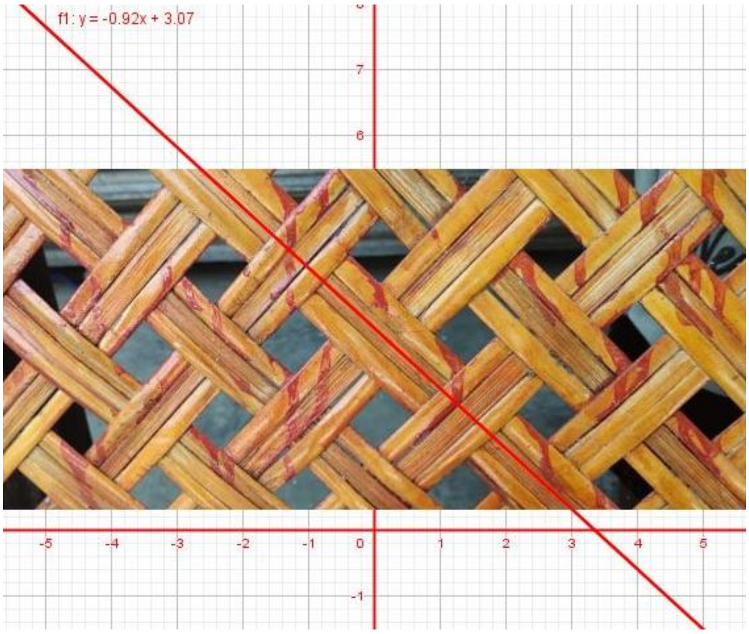

Figure 6. Representation of the concept of a straight line in *walasuji*

In Figure 6, it can be seen that the line equation formed is, this line equation has a gradient m = -0.92. One of the properties of a gradient is that a line with a negative gradient will slope to the left. The straight line equation formed on $y = -0.92\,x + 3.07$ *the walasuji* forms parallel lines.

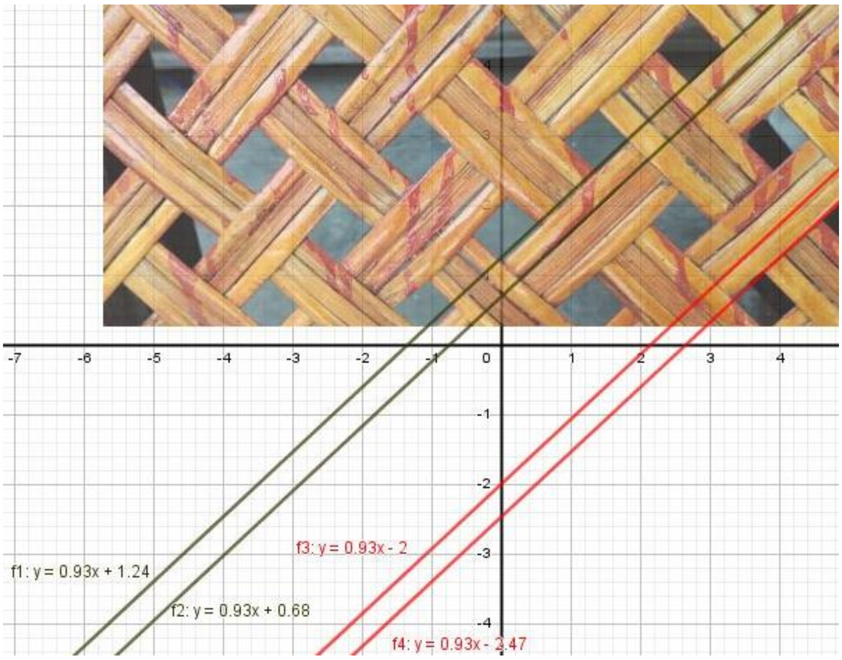

Figure 7. Representation of parallel concepts in *walasuji*

Several parallel lines are formed, each with an equation:

$$f_1: y = 0.93x + 1.24$$
$$f_2: y = 0.93x + 0.68$$
$$f_3: y = 0.93x - 2$$
$$f_4: y = 0.93x + 2.47$$

The above equation shows that the gradient value for the parallel lines is 0.93. This is in accordance with the concept of gradients in the straight line equation that if it is known that the lines are parallel to each other, then the gradient must be the same. In addition to forming parallel lines, in walasuji lines can also be formed that intersect perpendicularly.

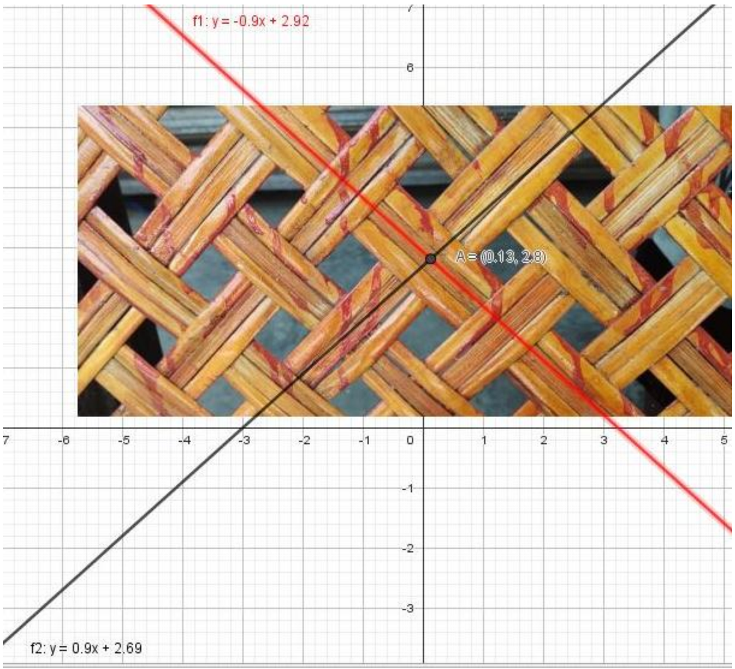

Figure 8. Representation of the concept of intersecting lines in *walasuji*

Based on the Figure 8, the equation of lines that intersect perpendicularly is:

$$f_1\!: y = -0{,}9x + 2{,}92$$
$$f_2\!: y = 0{,}9x + 2{,}69$$

The equation has gradient values, y_1 = and = . Based on the concept of perpendicular line gradients, the product of the perpendicular line gradient is -1 or $-0{,}9y_2 0{,}9m_1 x\ m_2 = -1$.

The philosophy of *sulapa eppa walasuji*

The Bugis-Makassar people generally know *sulapa eppa walasuji* as a symbol depicted through lines that are interconnected with four points in the form of a rectangle. *Sulapa eppa walasuji* is also the basic form of the Lontara script, namely the letter "*sa*" which is in the shape of a rhombus with four sides which makes *sulapa eppa walasuji* known as the fruit of the intellectual property, beliefs and culture of the Bugis-Makassar people (Hasbi et al., 2021).

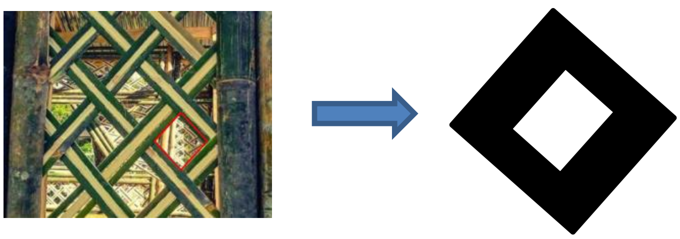

Figure 9. *Sulapa Eppa Walasuji* bamboo weaving and illustration of the *Sulapa Eppa Walasuji* Symbol from the *Lontara* Script *"Sa"*

The Figure 9 shows the process of the letter "*sa*" (from the *lontara* script), which is taken from the symbol of *sulapa eppa walasuji* (woven bamboo made for Bugis community rituals), which has four corners containing the values of belief of the Bugis-Makassar community. This *walasuji* is the forerunner of the lontara script. Because there were no pens, pencils and other types of writing instruments. This *Lontara* script was initially used to write government and social regulations. The manuscript was written on lontar leaves using sticks or kalam made of coarse palm fiber.

So, at first, Bugis literature was written on *lontar/siwalan* sheets; the collection of writings was then called *lontara*. *Lontara* presents sacred literature in the form of mythological beliefs and mantras. Then, there was also the development of literary works characterized by worldly life. This is based on the development of *lontara* and the behavior of the community and its culture. About the creation of sound signs called *lontara aksara*, there is an assumption that this comes from the beliefs and mythological views of the Bugis people, who consider this universe as sulapa' eppa' walasuji.

The symbol "*sa*" should symbolize the microcosm or *sulapa eppa' na taue* (rectangle of the human body). So the upper part of the letter/letters symbolizes the position of the head. On the right and left are the hands, and on the bottom end are the feet. This letter also symbolizes sewwa, which is the mouth or the place where the sound comes out of the head. Because everything comes from the mouth, it is expressed as sadda or sound. The sounds then had meaning (symbol).

Sulapa eppa walasuji is also depicted as a human body, which is commonly referred to as the human body square (*Sulapa eppa na taue)* as shown in the picture below.

Figure 10. *Sulapa Eppana Tawwe*

The philosophy of sulapa eppa is also manifested in humans, often referred to as *sulapa eppa na taue* (the philosophy of a four-sided human). In *lontara*, four characteristics are mentioned, namely sulapa' eppa' which must be possessed by every good leader. A good leader candidate must not only be seen from his hereditary factors but must also have intellectuality (*acca*), courage (*warani*), honesty (*lempu*), and wealth (*sugi*). Totality is also seen in everyday expressions which indicate that humans can be perfect or have *sulapa eppa*, if he can bind his partner in a marriage, and in Bugis beliefs about it only if you are assigned to be a leader, then you must have *sulapa eppa*.

Discussion

The technique of making *walasuji* reveals that this cultural practice reflects the deep local knowledge, craftsmanship skills, and cultural values of the Bugis-Makassar community. The use of specific traditional tools and materials, transmitted across generations, highlights the importance of maintaining cultural heritage in strengthening communal identity, in line with Geertz's (1973) view of culture as a system of inherited conceptions expressed through symbolic forms. Furthermore, the findings demonstrate that the walasuji making process is not merely technical but incorporates complex mathematical thinking, particularly in the application of geometric transformations such as translation, reflection, and rotation.

This is consistent with D'Ambrosio's (2016) theory that mathematics in traditional cultures not only serves practical needs but also embodies philosophical and symbolic meanings. The transformation geometry found in the *sulapa eppa* motif, when analyzed through the Cartesian coordinate system using the GeoGebra application, exhibits a structured mathematical regularity. This confirms Edwards and Penney's (2007) assertion that geometric transformations preserve the basic size and shape of objects during movement, even within traditional art forms.

In comparison to previous studies, most research, such as Abdollah & Sulo, (2018) and Mattulada, (1985), primarily emphasizes the symbolic and philosophical dimensions of *sulapa eppa* in Bugis culture. Similarly, Syarif et al., (2018) focused on *sulapa eppa* as the philosophical basis of Bugis traditional architecture, without exploring its mathematical dimensions. Meanwhile, research by Pathuddin et al., (2021) and Busrah & Pathuddin, (2021) identified mathematical practices within traditional food-making processes, but not in ritual artifacts like walasuji. Thus, this study offers a new contribution by systematically analyzing the embedded mathematical structures within walasuji, demonstrating how indigenous craftsmanship inherently applies mathematical concepts without formal education or modern measuring tools.

Theoretically, this research strengthens the ethnomathematics perspective by providing empirical evidence that traditional artifacts embody abstract mathematical principles. The crafting of *walasuji* represents an applied form of transformation geometry and measurement, indicating that cultural practices naturally integrate mathematical reasoning as part of problem-solving and aesthetic design. This supports the view of Bishop, (1994) and Rosa & Orey, (2011) that mathematics is a universal activity deeply rooted in human culture, manifested through practices such as designing, building, and patterning.

The implications of this study are significant for both cultural preservation and education. It demonstrates the potential for integrating local cultural practices into mathematics education curricula, promoting contextual learning that connects students' cultural backgrounds with mathematical concepts. Incorporating *walasuji* into learning trajectories could enhance students' understanding of geometry through culturally relevant examples, as advocated by Prahmana et al., (2021) in ethnomathematics-based education models. Furthermore, for artisans, recognizing the mathematical elements in their work could foster a deeper appreciation of traditional practices and encourage innovations that maintain cultural authenticity while improving craftsmanship efficiency.

Conclusion

This study reveals that the process of making *walasuji* integrates mathematical concepts such as translation, reflection, rotation, straight-line equations, and geometric patterns, reflecting the cultural intelligence of the Bugis-Makassar community. The sulapa eppa philosophy embedded in *walasuji* symbolizes key human traits — intellectuality (*acca*), courage (*warani*), honesty (*lempu*), and wealth (*sugi*) — demonstrating a deep connection between mathematics, culture, and leadership values in Bugis society. These findings highlight the potential of traditional cultural practices as rich sources for understanding and applying mathematical concepts in everyday life. Integrating cultural artifacts like *walasuji* into mathematics education can foster student engagement, cultural awareness, and critical thinking. However, the study's limitations include the small sample size and the lack of quantitative modeling of the mathematical patterns. Future research should explore broader regional practices, apply quantitative methods, and develop ethnomathematics-based learning materials to promote culturally responsive mathematics education.

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Conflicts of Interest

The authors state that there are no conflicts of interest concerning the publication of this manuscript.

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Author Contributions

Andi Aras: Conceptualization, writing - original draft, editing, and visualization; **Nasruddin:** Review and editing; **Fawziah Zahrawati B.:** Validation, deep review, and supervision. **Syahrul:** Review and editing.

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