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Ethnomathematics of *Pananrang*: A guidance of traditional farming system of the Buginese community

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Abstract

Culture plays an essential role in the emergence and development of mathematics; hence, both are inseparable. Mathematics emerges from the daily activities of a group of people, and although its concepts have been applied traditionally since time immemorial, it has not reached the level of formal usage. One cultural activity involving mathematical concepts is the use of *Pananrang* in determining the right farming seasons despite not having a formal education. Therefore, this research explores mathematical concepts in *Pananrang*, which are used as a reference for the Buginese community's farming system. This is qualitative research comprising an ethnographic approach with data collected through literature research and interviews with informants with expertise in *Pananrang*. The results showed that the community used mathematical concepts, such as multiplication, addition, and modular arithmetic, to determine the proper farming seasons. These outcomes can be socialized and used as a contextual learning resource.

Keywords: Buginese, Congruence, Ethomathematics, Modulo, *Pananrang*

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Mathematics and culture are still often regarded as two unconnected factors. This is because mathematics is perceived as a neutral, abstract, and culturally independent discipline often excluded from social values (Maryati & Prahmana, 2019; Rosa & Orey, 2011). The assumption that this subject is a science with absolute truth makes it to be considered unrelated to cultural and social realities (Karnilah & Juandi, 2013; Prabawati, 2016). Mathematics is an essential aspect of culture that emerges from daily activities, hence it both are inseparable (Ergene et al., 2020; Maryati & Prahmana, 2019).

One form of community culture that can be explored is related to mathematical ideas, activities, and procedures integrated into people's life. This exploration is called ethnomathematics, which studies the relationship between mathematics and culture (Izmirli, 2011; Rosa & Orey, 2010). In addition, it can also be interpreted as mathematics practiced in daily life by some groups of people (Matang, 2002). Ethnomathematics is a branch of science that studies the relationship between mathematics and relevant socio-cultural contexts and helps show how mathematical-concept is produced, transmitted, and disseminated in systems of cultural diversity (Zhang & Zhang, 2010). It also acts as a bridge that can connect the preservation of culture and local wisdom with advances in technology and art through science (Nur et al., 2020; Pathuddin & Raehana, 2019).

Indonesia is an archipelagic country whose territory stretches from Sabang to Merauke, and this geographical condition makes it the largest multicultural nation in the world (Nurcahyono, 2018; Utami et al., 2019). This provides a better opportunity to implement cultural integration into mathematical learning to make it more fascinating and fun (Lidinillah et al., 2022). In addition, the association of mathematical learning with culture in the surrounding environment will add insight and introduce the values of local wisdom for teachers and students (Sugianto et al., 2019).

Mathematical concepts that emerge in culture have been widely studied with the slow eradication of its paradigm unrelated to culture. Currently, many ethnomathematical research aimed to determine the interaction between mathematics and culture. In Indonesia, ethnomathematics research evaluated many sectors. Several studies have shown mathematical concepts in the traditional calendar system, such as the Balinese, which found the least common multiple in their calendar system (Suarjana et al., 2014). In addition, arithmetical concepts were found in the Javanese calendar system (Agustina et al., 2016). Ethnomathematics is also used to determine good days in Javanese and Sundanese culture as well as to accomplish various activities such as weddings, agriculture, search for goods, birth and death ceremonies (Abdullah et al., 2019; Imswatama & Setiadi, 2017; Nisa et al., 2019; Prahmana et al., 2021; Ramli, 2021; Setiadi & Imswatama, 2017; Suraida et al., 2019). Furthermore, it is implemented by the Cigugur community to predict good days in farming (Umbara et al., 2021).

Presently, research on ethnomathematics in Buginese culture is limited, specifically in determining the best time to carry out farming activities. This is important because Buginese is the tribe with the largest population in South Sulawesi, where most people's livelihoods are farming. It makes South Sulawesi one of the largest rice-producing regions outside Java, significantly contributing to rice production in Indonesia (Rezky & Alam, 2019). The Buginese community still combines modern and traditional knowledge as references in farming (Tahir et al., 2019). One of the cultural heritages used as a reference by the Buginese community in various activities is *Pananrang*. For Buginese farmers, *Pananrang* plays an essential role in their farming activities. It is indigenous knowledge about farming procedures, cropping season cycles, climate change, good plants to plant in certain seasons, and predictions of pest attacks (Kamaluddin et al., 2016). Hence, it is used by most Buginese farmers as a source of information in making decisions regarding their agricultural land (Kamaluddin et al., 2016). It is a form of local wisdom that is still preserved with numerous benefits and positive values despite the advent of technology (Hafid, 2018). However, these activities are not only able to preserve tradition but also hone critical and mathematical thinking skills. Mathematical concepts can be found in *Pananrang*, and its application has not yet reached the level of formal mathematics, despite its long usage. Some *pappanarang* who have not even taken formal education can apply mathematical concepts well, which shows that no matter how primitive a community group is, they will always use mathematics in their life (Pathuddin et al., 2021). Therefore, this research aims to determine the use of mathematical concepts to analyze the good time in farming based on *Pananrang*.

This research makes it possible to generate new knowledge from the perspective of mathematics, mathematics education, and culture. From a mathematical perspective, this research seeks to encourage the creation of new knowledge in the form of a mathematical model based on *Pananrang*, which is expected to facilitate the Buginese community in determining the best time for their agricultural activities. In mathematics education, this research seeks to reveal ethnomathematics in the Buginese culture that can be integrated into formal mathematics learning, especially in higher education. Furthermore, from a cultural perspective, this research can help preserve traditions and cultural heritage that are almost extinct, considering that the number of *Pappananrang*, a term for people who have expertise in *Pananrang*, is currently decreasing. In general, this research can contribute to cultural preservation by bearing new generations of *Pappananrang* who are more modern with the provision of formal mathematical knowledge learned in educational institutions, which is then applied to the local community's culture.

METHODS

This qualitative research was carried out using an ethnographic approach. Ethnography is a research approach to describe a culture (Spradley, 2016). The main goal of ethnography is to understand a way of life from the point of view culture's members (Windiani & Rahmawati, 2016). It is in line with the aim of this study, which is to understand the cultural activities contained in *Pananrang* and determine the meaning of these activities for proper analysis of the ethnomathematics. This research was conducted in Baranti District, Sidenreng Rappang (Sidrap) Regency, because it is one of the agricultural centers in South Sulawesi and Baranti district that produces the largest rice yields. In addition, the Sidrap community still uses the *Pananrang* tradition to determine the right farming season. This can be seen by the invitation of *Pappananrang,* to take part in the *tudang sipulung,* which is held yearly (Dollah, 2016).

This research design was developed using four general questions, which are the core of ethnographic principles, namely "*Where is it*?", "*How does it look*?", "*What is it*?", and "*What does it mean*?" (Prahmana & D'Ambrosio, 2020; Utami et al., 2019). It is presented in Table 1.

Table 1. Ethnomathematical research design

General Questions	Initial Answers	Starting Point	Specific Activity
Where is it?	In the activities of farming carried out by the Buginese community in Sidrap Regency, there are mathematical practices.	Culture	Reviewing references containing *Pananrang* and conducting an interview with the informant with his knowledge and abilities.
How does it look?	Investigate aspects of the farming process of the Buginese community related to mathematical concepts.	Alternative thinking	Investigating aspects of the farming process of the Buginese community related to mathematical concepts.
What is it?	Evidence	Philosophical mathematics	Identify the characteristics of the farming activities of the Buginese Sidrap community related to mathematical concepts. It is shown that farming activities in the Buginese community have mathematical concepts that can be seen from the elements of knowledge used in daily life.
What does it mean?	The significant value of culture and mathematics.	Anthropology	Describe the relationship between science and culture. Describe the mathematical concepts found in the farming activities of the Buginese community.

Data were collected through literature research by searching various references related to *Pananrang*, such as the book by Abd. Halim Baco contains the *Pananrang* manuscript regarding good times to start agricultural activities and the procedures for determining these times, as well as by interviewing informants. The informant interviewed was Puang Lasi, a *Pappananrang* who is still active in the Sidrap regency. Informants were selected by seeking information from several local residents regarding people who are experts in *Pananrang*. From the information, researchers were directed to meet Puang Lasi. Most community members come to Puang Lasi to ask about a good time to start essential activities such as farming. In this study, Puang Lasi was the only informant interviewed because, in Baranti District, where the researchers' collected data, no other *Pappananrang* could be found. The interview used the Bugis language because it is the informant's first language, while Indonesian is the second language. Therefore, the informant is more fluent in Bugis. Two of the three researchers are natives who grew up in the research location and can speak Bugis fluently. Nevertheless, the researchers were still accompanied by local residents to strengthen the understanding of the interview results and interpretations. During the interview, everything disclosed by the informant was recorded to obtain more accurate information. In addition, essential information related to the research objectives was written.

Credibility is one of the criteria for the validity/trustworthiness of data in qualitative research (Guba, 1981; Lincoln & Guba, 1986). To ensure the credibility of the data in this study, the researchers carried out four processes. Firstly, the researchers conducted a member-check on the data obtained from the book containing the *Pananrang* manuscript that is written in the *Lontara* script. The process of reading and interpreting the manuscript was initially carried out by the researchers. However, some words or sentences are poorly understood. In this case, the researchers involved the local residents in checking the validity of the data and providing reinforcement for the data correctness that had been collected. Secondly, the research team conducted intense discussions to ensure the consistency of the research questions with the findings. Thirdly, researchers extend the time and the research process to obtain more accurate data and strengthen the interpretations of the research results. Finally, triangulation was conducted. The triangulation carried out in this study was time triangulation. The researchers confirmed the data that had been previously obtained at different times. There were three interviews, five months from the first to the second, followed by four months from the second to the third. After the three interview processes, the researchers concluded that the data had reached its saturation, marked by the consistency of the interview results.

After obtaining valid data, the next step is data analysis through the data collection and reduction by sorting and summarizing the relevant ones for meaningful information. After the data reduction stage, domain analyses were carried out to obtain an overview of the data needed to answer the research focus. Meanwhile, taxonomic analysis was carried out by describing these categories in more detail based on the mathematical concepts in determining farming time. At this stage, the essential domains and sub-domains were explored by matching them with library materials to gain a deeper understanding. The last step is data presentation and the analysis results, which describe the relationship between mathematical concepts and the process of determining farming time.

RESULTS AND DISCUSSION

In the Bugis language, the term *Pananrang* comes from the word "*tanra*" which means sign or marker. Therefore, *Pananrang* has the meaning of a "sign or marker" of events related to agricultural activities.

It contains a method for predicting the weather, one of which is for agriculture. Predictions are based on local weather within eight years (Yusmar, 2008). This research showed that each community in a particular area in South Sulawesi has a different *Pananrang* due to its varying characteristics. Furthermore, two types of *Pananrang* obtained from the manuscript written by Abd Halim Baco and Puang Lasi were evaluated. *The pananrang* by Puang Lasi was passed down from one generation to another without formal documentation.

Determining Good Year for Farming

Data regarding the determination of good years for farming were obtained from the *Pananrang* manuscript in the book "*Agi-Agi Ritaneng Iyato Riduppa*" by Abd. Halim Baco. This book is not the result of research but is a guide in determining the right time to start farming activities based on the *Pananrang* manuscript, passed down from generation to generation. The book is written using the *Lontara* script, the traditional Buginese script. Based on the contents of the book, it was found a description of the process of determining the timing of farming through mathematical calculations. However, it is still traditional and has yet to reach the level of formal mathematics in the form of a mathematical model. The results showed that the Hijri year is critical as a marker in predicting events and determining the agricultural activities to be carried out in subsequent years. *Pananrang* uses an eight-year cycle known as *sipariyama*, and each is named using Arabic letters with a Buginese dialect. The years of s*ipariyama* and their characteristics are presented in Table 2.

Table 2. The years of *Sipariyama* and their characteristics

Year's Name	Predictions and Characteristics
Taung Alipu (ا)	• It is predicted that there will be numerous rainfalls within a short period. • There will be many floods with an abundant yield of rice and other crops. • In the Sipariayam cycle, this year is the best year for farming
Taung Ha (ه)	• It is predicted that there will be much rain with an inadequate yield of rice and fruit. • Cold air and many emerging diseases.
Taung Jim (ج)	• It is predicted to have enough rain with limited wind. • Several fruit plants, but the grains of rice are less dense and imperfect.
Taung Zai (ز)	• This year is predicted to have a long rainy season even until harvest, with strong winds and many flooding. • Many rat attacks and medium to low rice yields.
Taung Daleng Riolo (د)	• Moderate rain with winds and abundant crop/fruit yields. • The yield of rice decreased due to numerous hollows. • The weather is hot and suitable for planting corn.
Taung Ba (ب)	• The rainy season is predicted to be short, with limited flooding. • Rice plants are often failed with moderate fruit yields. • The corn yield is good. • The crawl plant, such as sweet potato, watermelon, and pumpkin, grow rapidly. • Hot air and the results of woody plants are not very good. • Many terms are given to this year, such as the year of pigs, fish, corn, rat, etc.
Taung Wau (و)	• This year, rainfall is usually high, with many flooding, cold weather, and rats attacking the crops. • Many emerging diseases.
Taung Daleng	• This year, it is predicted to have a short rainy season, fewer floods, and cold weather.

Rimonri (ر)	• The wind is weak, but in some cases, when it is strong, it can cause many damages. • Rice yield can be good, but it could also fail.

Explanation of the procedure for determining the year of *sipariyama* based on the book by Abd. Halim Baco can be seen in Figure 1.

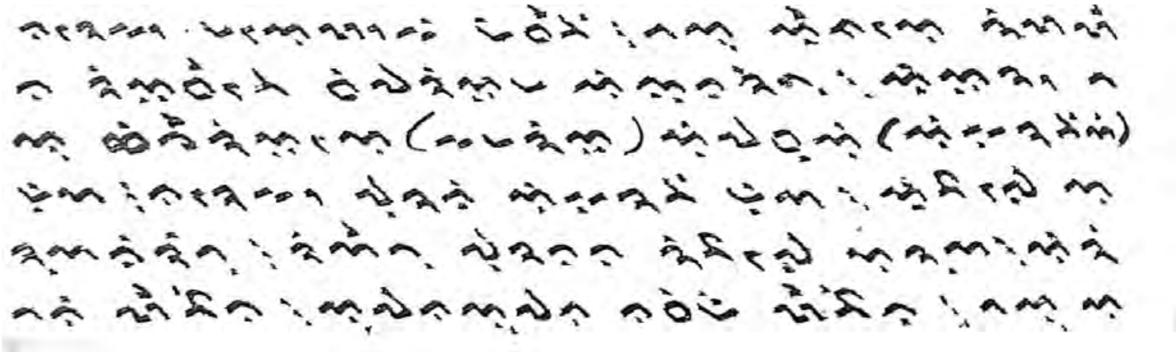

Figure 1. Determination of year names in *Sipariyama* in the *Pananrang* manuscript

The information in Figure 1 is written using the *Lontara* script. The transcription of the *Lontara* script into Latin can be described as follows.

Narekko maeloki missengngi taung engkae rilalenna riyasengnge sipariyama iyaniaritu iyaro taung Hijriyah e (Kamariyah) ipassui (ikurangiwi) dua. Narekko purani ikurangi dua, ibage aruwani ritu. Riwettu purana na ibage aruwa, iritani lebbinna.

English translation.

If we want to know the year's name in *sipariyama*, that is by removing (subtracting) the Hijriyah (Kamariyah) year by two. After subtracting by two, divide by eight. After dividing by eight, look at the remainder.

From the manuscript, we found that the *sipariyama* year can be determined by subtracting the Hijri year by two and then dividing the result by eight. The remainder of the division is used to name the farming year. For instance, when one, two, three, four, five, six, and seven are left, it becomes *Taung Alipu*, *Taung Ha*, *Taung Jim*, *Taung Zai*, *Taung Daleng Riolo*, *Taung Ba*, and *Taung Wau*. However, in situations where the result of the calculation is completely divided without a remainder, that year is named *Taung Daleng Rimonri*. Year names in s*ipariyama* in the *pananrang* manuscript can be seen in Figure 2.

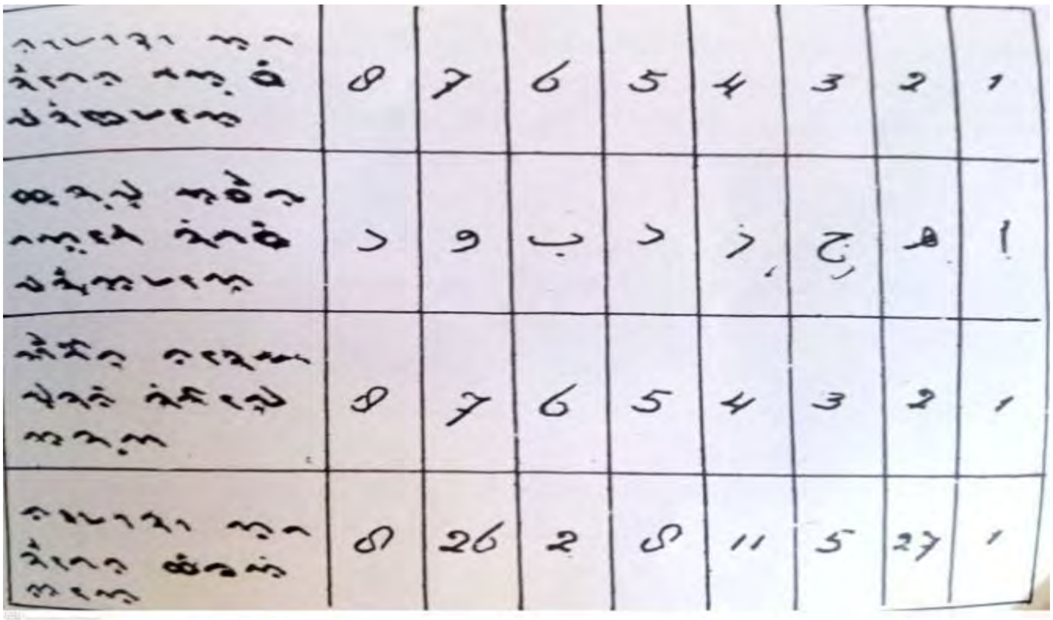

Figure 2. Year names in *Sipariyama* in the *Pananrang* manuscript

The transcription of the *Lontara* script into Latin in Figure 2 can be described as follows.

Line 1: *Nomoro' attarettena taung sipariyamae*
Line 2: *Hurupu' asenna taungnge ri tassipariyamae*
Line 3: *Lebbinna narekko purani ri bage aruwa*
Line 4: *Nomoro' attarettena hijaiyae*

English translation,
Line 1: The number symbol of *sipariyama*
Line 2: The Arabic symbol of *sipariyama*
Line 3: The remainder, after dividing by eight
Line 4: The number symbol of the Arabic alphabet

The explanation of Figure 2 is presented in Table 3.

Table 3. Relationship between remainder of division and year name

The Reminder of Division	Year Name
1	Alipu
2	Ha
3	Jim
4	Zai
5	Daleng Riolo
6	Ba
7	Wau
0 or 8	Daleng Rimonri

From the results of this research, information showed that the determination of the year in *sipariyama* contains the following mathematical concepts.

Modular Arithmetic

Definition:

Let a integer and m integer be greater than zero. The operation $a \ mod \ m$ gives a remainder when a is divided by m. In other words, $a \ mod \ m = r$ such that $a = mq + r$, where $0 \leq r < m$.

Let $a = Hijri \ Year - 2$, based on the closure property of integers under subtraction:

Hijri Year $\in Z$ (1)

$2 \in Z$ (2)

From Equations (1) and (2), it can be concluded that $a \in Z$ and reciprocally, $8 \in Z$. Therefore, because $a \in Z$ and $8 \in Z$, based on the definition, the determination of the year in *sipariyama* can be stated as follows:

$a \ mod \ 8 = r$, such that $a = 8q + r, 0 \leq r < 8$ (3)

Where:

r =remainder of division

$a = Hijri \ Year - 2, a \in Z$

q = quotient

The following is an example of determining the year in *sipariyama*:

When this year is 1443 H, then the following is obtained:

$a = 1443 - 2$

$a = 1441$

Substitute a into equation (3):

$a \ mod \ 8 = r$

$1441 \ mod \ 8 = 1$ or can be written $1441 = 8.180 + 1$

It can be seen that the result of the division has a remainder of 1, meaning that the year 1443 H coincides with the year of Alif or *Taung Alipu* (ا). Therefore, based on *Pananrang*, it can be predicted that it is the best year for farming.

Some other examples of using modular arithmetic to determine the year in *sipariyama* are presented in Table 4.

Table 4. Examples of modular arithmetic to determine the year in *Sipariyama*

Hijri Year	a (hijri year – 2)	$a \bmod 8 = r$ $(a = mq + r)$	Year Name
1443	1443 – 2 =1441	1441 mod 8 =1 Since there *q* = 180 such that 1441 = 8.180 + 1	*Taung Alipu* (ا)
1444	1444 – 2 = 1442	1442 mod 8 =2 Since there *q* = 180 such that 1442 = 8.180 + 2	*Taung Ha* (ه)
1445	1445 – 2 =1443	1443 mod 8 =3 Since there *q* = 180 such that 1443 = 8.180 + 3	*Taung Jim* (ج)
1446	1446 – 2 = 1444	1444 mod 8 = 4 Since there q = 180 such that 1444 = 8.180 + 4	*Taung Zai* (ز)
1447	1447 – 2 = 1445	1445 mod 8 =5 Since there *q* = 180 such that 1445 = 8.180 + 5	*Taung Daleng Riolo* (د)
1448	1448 – 2 = 1446	1446 mod 8 =6 Since there *q* = 180 such that 1446 = 8.180 + 6	*Taung Ba* (ب)
1449	1449 – 2 = 1447	1447 mod 8 =7 Since there *q* = 180 such that 1447 = 8.180 + 7	*Taung Wau* (و)
1450	1450 – 2 = 1448	1448 mod 8 =0 Since there *q* = 181 such that 1448 = 8.180 + 0	*Taung Daleng Rimonri* (د)

Furthermore, while two integers a and b have the same remainder when divided by a positive number m, it means that a and b are congruent modulo m. The determination of the *sipariyama* year also corresponds to the congruence of integers.

Congruence of Integers

Definition:

When m is a positive integer, then a is congruent to b modulo m (written $a \equiv b \ (mod\ m)$) if and only if m divides $(a-b)$ or $m|(a-b)$.

In other words, $a \equiv b(mod\ m)$ if only if $a = mk + b$, because $m|(a-b)$, meaning there exists an integer k such that $a - b = mk$ which has the same meaning as $a = mk + b$.

Theorem 1:

When $a \equiv r(mod\ m)$ with $0 \leq r < m$, then r is called the smallest remainder of a modulo m.

In determining the year in the *sipariyama* cycle, Equation (3) is obtained, which can also be written in the congruence relation as follows:

$$a \equiv r\ (mod\ 8) \quad (4)$$

Where:
$a = Hijri\ Year - 2$
r = the smallest remainder

Example:
When this year is $1444\ H$, then based on Table 4, the following is obtained:

$$a = 1444 - 2$$
$$= 1442$$

Therefore, it can be written in the form of congruence as in Equation (4) as follows:

$$1442 \equiv 2\ (mod\ 8)$$

Since $8|(1442 - 2)$ or $8|(1440)$.

Note that from the calculation results, a remainder of 2 was obtained, which means the year $1444\ H$ is good for farming, although the previous year was better.
The integer congruence can also be used to predict the next *Sipariyama* year.
Theorem 2:

If $a \equiv b\ (mod\ m)$ and $c \equiv d\ (mod\ m)$, so $a \pm c \equiv b \pm d\ (mod\ m)$

Example:
When this is the Ha year, what is the possible outcome of agricultural yields in the next 9 years?
The calculations in Table 4 can also be used as a reference for predicting subsequent years.
Based on Table 4, year H coincides with the year 1444 H, which has a remainder of 2, hence, it can be written as follows:

$$1442 \equiv 2(mod\ 8)$$

The next 9 years can be written into a congruence relation as follows:

$$9 \equiv 1(mod\ 8)$$

Therefore, based on Theorem 2:
When $1442 \equiv 2(mod\ 8)$ and $9 \equiv 1(mod\ 8)$,
$1442 + 9 \equiv 2 + 1\ (mod\ 8)$
$\equiv 3\ (mod\ 8)$

From the calculation above, it can be seen that the remainder is 3, meaning the next 9 years will be the year of Jim, as shown in Table 3. Therefore, it is predicted that the rice grains are less dense, with low yield, while other plants and fruits grow well.

Determining Good Month for Farming

Data regarding the determination of a good month for farming is obtained from *Pananrang*, which Puang Lasi uses. The following excerpt from an interview illustrates the mathematical concept of determining a good month for farming. Interviews were conducted on Saturday, July 23rd, 2022.

Researcher : "How to know the best time to start working in the rice fields?"

Informant : "The 7 *Pananrang*s, namely *Orong Porong*, *Wara-Wara*, *Tanrae*, *Manue*, *Watang Patae*, *Walue*, and *Tekkoe* have made different predictions on the right planting season".

Researcher : "Then how do we know that we are currently at a certain *Pananrang*?"

Informant : "The present season is *Pananrang Lautang*, which consists of 8 days with three *sub-categories,* namely *Watang Patae*, *Walue*, and *Tekkoe*. Yesterday was the first day of *Watang Patae*, hence, we count eight days from Tuesday, which is followed by *Walue*, then *Tekkoe*. After the three *Pananrang* Lautang passed, the *Orong Porong* season begins."

Researcher : "Does it means that *Orong Porong* is the starting point for one to count? How many days does each *Pananrang have*?"

Informant : "*Orong Porong* consists of 22 days, followed by *Wara-Wara,* which also has same number of days. However, *Wara-Wara* is the most dangerous time because it causes severe damages to crop. This is followed by *Pananrang Tanrae* which has 36 days, then *Pananrang Manue* with 29 days. After that is *Watang Patae* with 8 days, *Walue* with 8 days, and finally *Tekkoe* with 8 days. After Tekkoe, one cycle of *Pananrang* is finished."

Researcher : "When one cycle is finished, what's next?"

Informant : "We start again from the beginning with *Orong Porong*. This is different from the *Lontara*, whose time and characteristics are fixed. For example, this year, the first day for *Orong Porong* fell on April 1st, therefore, it is not used as a reference that every year it must fall on 1st of April, rather we must always count."

Researcher : "Ok, is it because in one cycle of *Pananrang*, the number of days is not up to 365 days?".

Informant : "Correct. *Orong Porong*, *Wara-Wara*, *Tanrae*, *Manue*, *Watang Patae*, *Walue and Tekkoe* have 22, 22, 36, 29, 8, 8 and 8 days, culminating in 133 days in one cycle".

Researcher : "It means that one *Pananrang* cycle only covers approximately 4.5 months of the year.

Informant : "Yes, it is true".

From the interview results above, one cycle is divided into seven *Pananrang* consisting of 133 days, which means one period covers approximately 4.5 months of the year. A mathematical model is obtained to determine the number of days per *Pananrang* as follows:

$$7n + 1, \qquad n = 1,3,4,5 \tag{5}$$

For $n = 3$, obtained the number of days *Orong Porong* and *Wara-Wara*

For $n = 5$, obtained the number of days *Tanrae*

For $n = 4$, obtained the number of days *Manue*

For $n = 1$, obtained the number of days *Watang Patae*, *Walue*, and *Tekkoe*. These three *Pananrang* are also known as *Pananrang lautang*.

Note: In equation (5), there is no $n = 2$ because, for $n = 2$, it is obtained 15, and it cannot show one of the seven types of *Pananrang*.

The following is a continuation of the interview to obtain more information on the best time to start planting rice.

Researcher : "From the seven *Pananrang* mentioned earlier, what is the prediction of rice growth, and which is the best planting season?"
Informant : "When we plant rice during *Orong Porong*, it is usually fertile with many tillers although the grain is usually not full. In *Wara-Wara*, the rice ten to experience numerous diseases, while during *Tanrae*, and Manueits growth is healthy and clean. Well, the three *Pananrang* Lautang, usually enter the disease season, thereby making the growth of rice massosoang."
Researcher : "What is *massosoang*?"
Informant : "*Massosoang* means that rice growth is uneven, some in good, bad, and diseased conditions."

From the interview results, information is obtained about an excellent time to start agricultural activities. The details of each *Pananrang* and the characteristics of rice growth in each *Pananrang* is presented in Table 5.

Table 5. *Pananrang* and Their Characteristics

***Pananrang* Name**	**Number of Days**	**Rice Growth Characteristics**
Orong Porong	22	The growth of rice is fertile, but the rice grains are not full
Wara-Wara	22	Many diseases in rice
Tanrae	36	The rice is healthy
Manue	29	The rice is healthy and clean
Watang Patae	8	Uneven rice growth
Walue	8	Uneven rice growth
Tekkoe	8	Uneven rice growth

Based on Table 5, it is known that the best month to start planting rice is during *Tanrae* and *Manue*. As in determining the *sipariyama* year, there is also the concept of modulo in determining the beginning of the start of the day in each Pananrang,

Suppose:
d_1 = Number of days in *Orong Porong*
d_2 = Number of days in *Wara-Wara*
d_3 = Number of days in *Tanrae*
d_4 = Number of days in *Manue*
d_5 = Number of days in *Watang Patae*
d_6 = Number of days in *Walue*
d_7 = Number of days in *Tekkoe*

Therefore, the beginning of the start of the day on one *Pananrang* is the remainder of the previous number divided by seven. Mathematically, it can be written as follows:

$$r = (\sum_{i=1}^{n-1} d_i) mod\ 7 \quad (6)$$

Example:
When Friday is the beginning of *Orong Porong*, the first day to start *Watang Patae* is determined as follows:
Because *Watang Patae* is the fifth *Pananrang* ($n = 5$), then do the addition up to the number of the fourth *Pananrang* ($n - 1$).

$$r = \left(\sum_{i=1}^{n-1} d_i\right) mod\ 7$$
$$= (d_1 + d_2 + d_3 + d_4)\ mod\ 7$$
$$= (22 + 22 + 36 + 29) mod\ 7$$
$$= 109\ mod\ 7$$
$$= 4$$

Because the remainder of the calculation above is 4, so the fourth day after Friday is the start day of *Watang Patae,* which is Tuesday.

This research shows that *Pananrang*, one of the references in the traditional agricultural system of the Buginese community, is closely related to the mathematical model. This mathematical model includes the concepts of multiplication and addition, modular arithmetic, and congruence of integers. The results indicated that the Buginese community has applied mathematical concepts without formal education in determining the farming season. This means that mathematics relates to the environment and cultural values (Palinussa, 2013). In line with this, ethnomathematics is present to draw it closer to reality and people's perceptions.

The findings in this research are related to preliminary research, which found that several ethnic groups in Indonesia can apply ethnomathematics adequately. Therefore, it needs to be socialized and used as a contextual learning resource. The Javanese can apply Arithmetic concepts to their calendar using several mathematical concepts such as numbers, sets, modulo, and the patterns (Agustina et al., 2016). It is also used to conduct the weton tradition for the bride and groom (Zahira et al., 2022). The Sundanese used mathematical concepts to count the good days in marriage, such as the modulo 5, addition, division, and line segments (Maryani et al., 2022). The concept of algebra is also found in the Baduy community calendar system, and it is expected to change students' perspectives from the assumption that mathematics is difficult but rather interesting and very closely related to daily life (Putri & Pujiastuti, 2022). Lastly, the Baduy applied the concepts of numbers and sets in the Javanese and Sundanese alphabets, modulo arithmetic in determining auspicious days to travel and start work, and algebraic concepts for days to get married (Imat, 2020).

Preliminary research on the ethnomathematical exploration research of several cultures in Indonesia (Abdullah et al., 2019; Imswatama & Setiadi, 2017; Nisa et al., 2019; Prahmana et al., 2021; Ramli, 2021; Setiadi & Imswatama, 2017; Suarjana et al., 2014; Suraida et al., 2019) have been conducted using different objects. However, this research examined the mathematical concepts in a Buginese culture, which were rarely explored. Like other tribes, such as the Javanese, Sundanese, and Balinese, the Buginese is also rich in culture. This means that further research can be conducted on Buginese ethnomathematics.

The mathematical model found in this study can be a starting point for changing traditional mathematics in *Pananrang* into formal mathematics by bringing these concepts into mathematics learning in the classroom. In higher education, these findings are closely related to number theory material which is a branch of pure mathematics that studies numbers, number properties, and the relationship between numbers, especially those related to integers such as modular arithmetic, base numbers, congruence, and congruence applications (Hartati, 2020). Thus, the findings of this study can be implemented in learning number theory contextually so that students are expected to gain a better understanding because the source of learning comes from their environment.

The use of *Pananrang* as a reference for the traditional farming system of the Buginese community, which is still preserved today, is an implementation of religious teachings that were brought and polished into the tradition, which then gave rise to social and cultural values. Some of the socio-cultural values in *Pananrang* include *manini*, *mappikkiri*, *manyameng ati*, and justice (Gunawan, 2014). *Manini* (caution) means that determining a good time in farming is the implementation of carefulness in starting activities. The value of *mappikkiri* means thinking, which means that the Buginese people always think and carefully plan before starting activities so that the maximum results can be achieved. Furthermore, *manyameng ati* (peace) means that the Buginese community must be able to find peace of mind before and after carrying out activities. Lastly, the value of justice means that the Buginese people believe that all members of society have the right to enjoy the produce of the land (Halim et al., 2017). Concerning mathematics learning, the teachers are not only transferring the mathematical concepts obtained at *Pananrang* but are also expected to be able to instill these values in students. Hence, they can appreciate and recognize their cultural roots, so one of the goals of ethnomathematics is to restore the nature of science to gain peace and maintain the ethics of using mathematics to humanize humans (Risdiyanti & Prahmana, 2020) can be realized. Thus, the findings in this study are expected to provide motivation and inspiration for students to preserve *Pananrang* as indigenous knowledge by instilling a desire within them to help the Buginese farming community around them for humanitarian purposes.

Indirectly, the findings of this study can bear new generations of *Pappananrang* who not only understand mathematical concepts, but also can use it wisely to assist the Buginese community in determining the best time to start farming activities. The understanding gained by the younger generation is more than just a traditional understanding but has reached the level of formal mathematics. Finally, these findings can also be implemented in computer science learning through ethnocomputing by directing students to design software applications to determine the excellent time to start farming activities so that students can reconfigure the relationship between culture, mathematics, and technology.

CONCLUSION

In conclusion, *pananrang* is one of the Buginese community's local wisdoms, which guides in determining the best farming seasons. This research showed two processes for determining when to start agricultural activities, namely the year and the month. The community uses the sipariyama cycle, an eight-year period that evaluates the remainder of the division to obtain the concept of modulo 8. For a good month to start planting rice, 7 *Pananrang* are used, each with a different number of days. The number of days can be calculated by multiplying the number 7 by one of 1, 3, 4, or 5, then adding the result to 1. Furthermore, determining the starting day of a *Pananrang* using a mathematical model with modulo 7. This research also showed the richness of Buginese culture, which contains mathematical concepts that can be used in learning, specifically in number theory material such as integer division, modulo, and congruence. The results are expected to inspire educators to apply culture in learning mathematics.

Furthermore, this study is limited by determining the good year and months for farming, hence subsequent studies must determine the mathematical concepts required for auspicious days to enrich references in contextual mathematics learning. It is also necessary to collaborate with researchers from several fields of science, such as informatics engineering to provide in-depth research on *Pananrang* and create a web/android application as a form of cultural preservation in the digital era while making it easier for people to determine the best time to start agricultural activities.

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