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ETHNOMATHEMATICS: ARITHMETIC SEQUENCE PATTERNS OF MINANGKABAU CARVING ON SINGOK GONJONG

Muhammad Zia Alghar [1*], Elly Susanti [2], Marhayati [3]

[1,2,3] Magister Pendidikan Matematika, Universitas Islam Negeri Maulana Malik Ibrahim
Jalan Gajayana Nomor 50, Malang, Jawa Timur, Indonesia

e-mail: [1] muhammadzia1904@gmail.com

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*corresponding author**

Abstract

This study aimed to explore the arithmetic sequence pattern found in Minangkabau carvings mounted on singok gonjong. The method used is a qualitative method with an ethnographic approach. Data was collected by observation, interviews, literature studies, and documentation. The object of this study is Minangkabau carving on singok gonjong. The data obtained in this study came fromdirect observation, results of interviews with Minang carving craftsmen, documentation, and literature studies. The results showed three kinds of arithmetic sequence patterns in Minang carvings in singok gonjong. The first is the arithmetic sequence pattern on the saik galamai carving with formula $U_n = n$. The second is the pattern of odd and even arithmetic sequences on the sikambang manih carving wtih the odd formula $U_{(2n+1)} = 3n + 1$ and the even formula $U_{(2n)} = 3n$. The last is the pattern of odd and even arithmetic sequences on the combined engraving of saik galamai and sikambang manih wtih the odd formula $U_{(2n+1)} = 4n + 1$ and the even formula $U_{(2n)} = 4n$. The conclusion shows that the presence of patterns on the saik galamai carvings and sikambang manih carvings found on Singok Gonjong can be used as a preference for learning arithmetic sequences at school

Keywords: arithmetic sequence, ethnomathematics, sikambang manih carving, saik galamai carving

1. Introduction

Ethnomathematics is defined by d'Ambrosio (2001) as the mathematical practice of identifiable cultural groups and can be considered the study of mathematical ideas found in any culture. Furthermore, ethnomathematics is used to reveal the relationship between mathematics and culture. Thoughts about mathematics are not only found in formal classrooms but can be found in non-formal classrooms, such as in community culture in the form of objects or intangibles (Bustan et al., 2021; Suwarsono, 2020).

Ethnomathematics research is important to lead knowledge and practice of mathematics in culture in society towards formal education such as schools (Pais and Mesquita, 2013). Furthermore, ethnomathematics does not only reflect on the context of mathematics in the third world, but to bring out 'hidden mathematics' which may have been forgotten or to unfreeze the concept of mathematical thinking (d'Ambrosio, 2001; Gerdes, 2001).

Research on ethnomathematics has been widely carried out in previous studies, one of which is on the ornaments of traditional houses in an area (Ditasona et al., 2022; Fitriza, 2018; Nurhikmah et al., 2019; Utami et al., 2021). These studies provide an understanding that in traditional house ornaments, there are mathematical ideas that are found and applied to traditional houses.

One of the ornaments found in traditional houses is Minang carvings. Minang carvings are wood carvings with typical Minangkabau motifs. Isnan and Rohmiyati (2016) and Syafwandi and Zubaidah (2018) mention that Minang carvings not only function as aesthetics but also as a sign that the house owner is an economically capable person. In addition, the wood used for carving, choosing paint colors, and placing ornaments has its own rules and messages so that not just anyone can make Minang carvings. According to Joansa (2015), there are more than 70 types of Minang carvings have been identified. The Minang carvings can be grouped based on patterns, motifs, colors, and locations.

Some research on Minang carvings is still limited to classifying the types of carvings installed (Joansa, 2015; Prasetya and Adi, 2016). Furthermore, research that examines Minang carvings from a mathematical perspective is still minimal. Some ethnomathematics research on Minang carvings at gadang house is still limited to euclidean geometric shapes and geometric transformations. Therefore, the author feel the need to study Minang carvings from a mathematical point of view in more depth, namely by looking at the pattern of placement of Minang carvings in gadang houses.

Based on its location, Minang carving is usually applied to Minangkabau traditional buildings (gadang house), traditional halls, and household furniture such as cabinets, chairs, and the like. Minang carvings also found on windows, doors, poles, walls, and gonjong in the gadang house (Fitriza, 2018; Prasetya and Adi, 2016).

Gonjong is the roof part that tapers upwards in the gadang house. At the bottom of the gonjong is an area of the wall that supports the gonjong, known as singok gonjong. There are various variations of wood carvings that adorn singok gonjong. Generally, carvings on ssingok gonjong consist of carvings of sikambang manih and carvings of saik galamai. The installation of carvings on singok has its pattern, which is passed down from generation to generation from the carvers of each generation. (Fauziah and Niniwati, 2017; Isnan and Rohmiyati, 2016; Joansa, 2015).

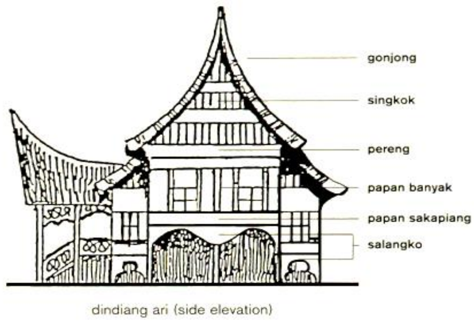


Figure 1. Parts of a gadang house
Source: Summerfield et al., (1999)

Figure 2. Saik galamai carving (left) and sikambang manih carving (right)

An arithmetic sequence is a sequence that has a constant difference between its terms. The order in an arithmetic sequence depends on the terms' general differences. Arithmetic sequences have the general form $U_n = a + (n-1)b$, where U_n is the n term, a is the first term, b is the difference, and n is the number of terms (Bartle and Sherbert, 2000; Bird, 2020; Rahmani-Andebili, 2021). The field observation results indicate carvings placement with a particular arrangement at each level. Thus, there is an arithmetic pattern Minang carvings on singok gonjong.

Figure 3. Some carvings on singok gonjong

Based on the description above regarding the relationship between mathematics and culture in Minangkabau carvings, this study aims to explore and analyze the concept of arithmetic sequences found in Minangkabau carving singok gonjong.

In Figure 4, it can be seen that there are two types of carvings on singok gonjong, namely sikambang manih and saik galamai carvings (which have galamai).

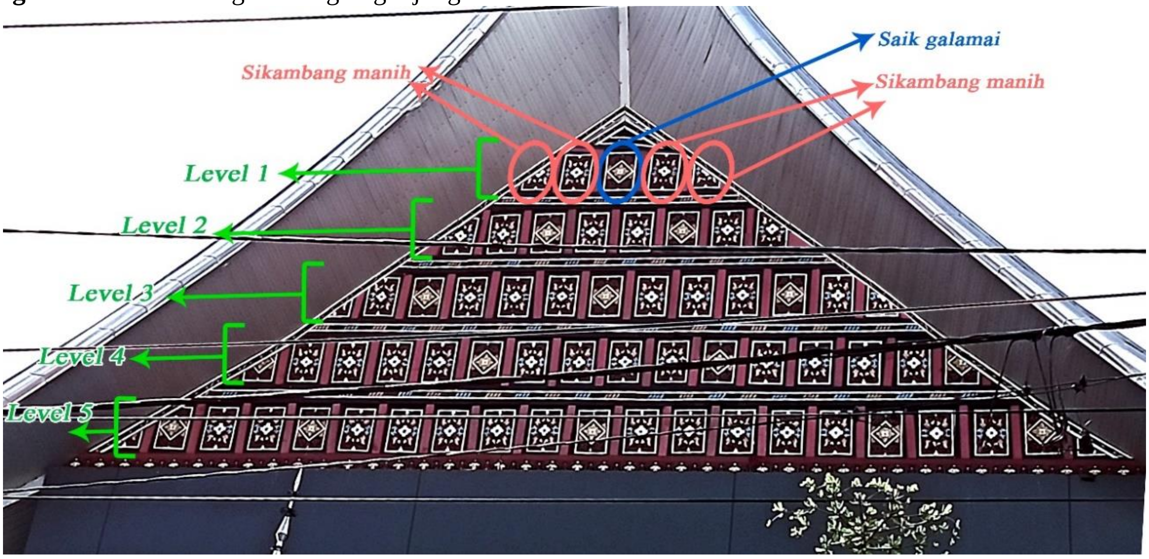


Figure 4. Carving on *singok gonjong* at the Pakan Labuah Village Office, Bukittinggi

2. Method

This study uses a qualitative method with an ethnographic approach. This approach was carried out by researchers coming to Minang carving places and conducting direct interviews with Minang carving craftsmen. The places used for the observation were the Pakan Labuah Village Office in Tigobaleh District and the Chan Umar Wood Craftsmen's Workshop in Pandai Sikek City, West Sumatra. The object of this study is Minangkabau wood carving on singok gonjong. Data collection techniques include observation, interviews, literature study, and documentation. Interviews were conducted by researchers with Mr. Beni, as a wood craftsman on Chan Umar's Minang carvings. The collected data is reduced and prioritized on the arithmetic sequence patterns of Minangkabau carvings in singok gonjong. Data triangulation techniques are used by researchers to check the validity of the data.

3. Result and Discussion

This section will explain the representation of Minang carvings in the Pakan Labuah Village Office and discuss the Minang carvings on the singok gonjong. On the singok gonjong there are five carvings levels, consisting of two types of Minang carvings.

There are five levels in the singok gonjong with Minang carvings. The researcher tries reconstructing Figure 4 to make it easier to observe the pattern.

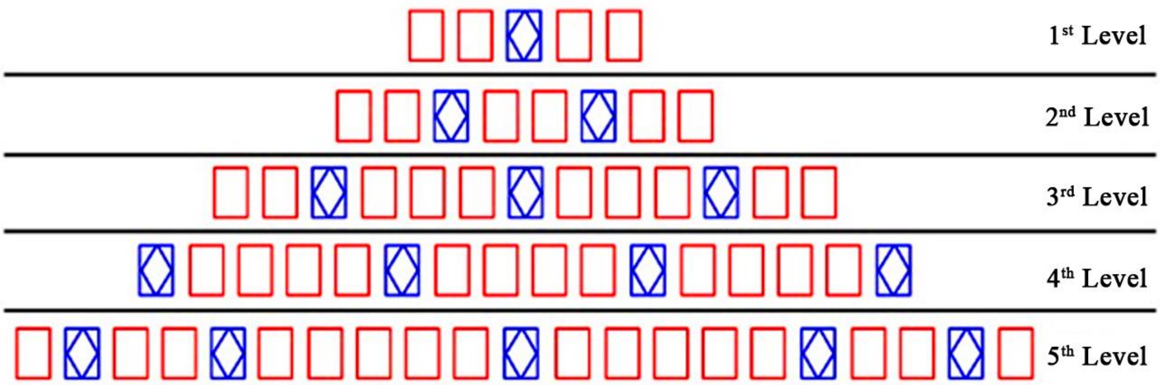


Figure 5. Representation of the carvings of saik galamai (blue) and sikambang manih (red) on singok gonjong

The results of the carving representation are shown in Figure 5, the blue color symbolizes the saik galamai carving, and the red color represents the sikambang manih carvings. Furthermore, on the first level, there are 1 blue engraving and 2 red engravings. The second level has 2 blue engravings and 6 red engravings. The third level has 3 blue engravings and 10 red engravings. The fourth level has 4 blue engravings and 12 red engravings. The fourth level has 4 blue and 12 red engravings. The fifth level, there are 5 blue engravings and 16 red engravings. Then the author represents the number of carvings in the following table.

Table 1. The number carvings of saik galamai, sikambang manih and a combination of both

Level	Number of Saik Galamai carving (Blue)	Number of Sikambang Manih carving (Red)	Number of Combined Engraving
1	1	4	5
2	2	6	8
3	3	10	13
4	4	12	16
5	5	16	21

In Table 1, it can be observed that there are arithmetic sequence patterns on the saik galamai carvings, sikambang manih carvings, and both carvings. Arithmetic patterns will be described in the following discussion:

3.1 Assessment Phase Results

In the saik galamai carving, there is an arithmetic sequence pattern. This is marked by the same difference in the saik galamai carvings on the first and second levels, second and third levels, third and fourth levels, and fourth and fifth levels. The difference is assumed to be s. Each level of carving is symbolized by Tk. The pattern can be represented in the following chart.

Level	Tk_1	Tk_2	Tk_3	Tk_4	Tk_5
Number of carvings	1	2	3	4	5
Difference (s)	1	1	1	1	

The difference between the number of engravings is same. In addition, Tk_2 is the sum of Tk_1 and the difference (s). Tk_3 is the sum of Tk_2 and the difference (s). Tk_4 is the sum of Tk_3 and the difference (s). The pattern can be represented in the following table.

Table 2. The arithmetic sequence pattern of saik galamai carving

Level	Number of Engravings	Number Pattern	The Formula for Arithmetic Sequence Pattern
1	1	1=1	U_1
2	2	$2 = 1 + 1 = 1 + (2 - 1) \cdot 1$	$U_2 = U_1 + (2-1) \cdot s$
3	3	$3 = 1 + 2 = 1 + (3 - 1) \cdot 1$	$U_3 = U_1 + (3-1) \cdot s$
4	4	$4 = 1 + 3 = 1 + (4 - 1) \cdot 1$	$U_4 = U_1 + (4-1) \cdot s$
5	5	$5 = 1 + 4 = 1 + (5 - 1) \cdot 1$	$U_5 = U_1 + (5-1) \cdot s$
n	U_n	$U_n = 1 + (U_{n-1}) = 1 + (n - 1) \cdot s$	$U_n = U_1 + (n-1) \cdot s$

Based on Table 2, it can be observed that the number of saik galamai carvings of the n^{th} level is as many as U_n pieces. So, the pattern obtained is

$$U_n = U_1 + (n - 1) \cdot s$$

Since U_1 has a fixed value of 1, and s is a fixed value of 1, then substitute U_1 and s with 1.

$U_n = (1) + (n - 1)(1)$
$U_n = 1 + (n - 1)$
$U_n = n$

So that the arithmetic sequence pattern for the saik galamai carving is obtained:

$U_n = n$

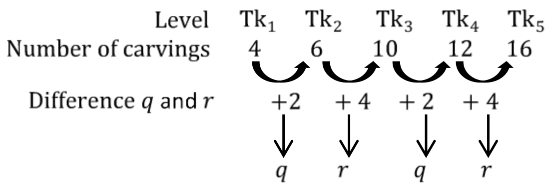
With

U_n is the number of engravings at the n level
n is the engraving level.

3.2 Arithmetic Sequence Pattern of Sikambang Manih Carving

On the sikambang manih carving, there is an arithmetic sequence pattern.

This is evidenced by the patterned differences in the saik galamai carvings in the first and second levels, second and third levels, third and fourth levels, and fourth and fifth levels. The difference is assumed to be q and r. The pattern can be represented in the following chart



As for the difference in the number of carvings, there are two kinds, namely the difference symbolized by r. In addition, the number of engravings in Tk_2 is the sum of the number of engravings in Tk_1 with a difference (q). Then the number of engravings in Tk_3 is the sum of the number of engravings in Tk_2 and the difference (r). Then the number of engravings Tk_4 is the sum of the number of engravings Tk_3 and the difference (q) and so on. The pattern can be represented in the following table.

Table 3. The arithmetic sequence pattern of sikambang manih carving

Level	Number of Engravings	Number Pattern	The Formula for Arithmetic Sequence Pattern
1	4	$4 = 4$	$U_1 = U_1$
2	6	$6 = 4 + 2$	$U = U_1 + q$
3	10	$10 = 6 + 4 = (4 + 2) + 4$	$U_3 = U_2 + r$ or $(U_1 + q) + r$
4	12	$12 = 10 + 2 = (4 + 2 + 4) + 2$	$U_4 = U_3 + q$ or $(U_1 + q + r) + q$ or $U_1 + 2q + r$
5	16	$16 = 12 + 4 = (4 + 2 + 4 + 2) + 4$	$U_5 = U_1 + r$ or $(U_1 + 2q + r) + r$ or $U_1 + 2q + 2r$
$2n + 1$	$U_{(2n+1)}$	$U_{(2n+1)} = U_{(2n)} + 4$	$U_{2n+1} = U_1 + \left(\frac{n-1}{2}\right)(q + r)$
2n	$U_{(2n)}$	$U_{(2n)} = U_{(2n+1)} + 2$	$U_{(2n)} = U_1 + \left(\frac{n}{2}\right)(q) + \left(\frac{n-2}{2}\right)(r)$

Based on table 3, it can be observed that the engraving at the n level for n odd values is as many as U_{2n+1} engravings. So, the pattern obtained is

$$U_{(2n+1)} = U_1 + \left(\frac{n-1}{2}\right)(q + r)$$

Since U_1 has a fixed value of 4, q has a fixed value of 2, and r has a fixed value of 4, then substitute the equation as follows.

$$U_{(2n+1)} = (4) + \left(\frac{n-1}{2}\right)(2 + 4)$$
$$U_{(2n+1)} = (4) + (n - 1)(3)$$
$$U_{(2n+1)} = 3n + 1$$

So that the arithmetic sequence pattern for Sikambang Manih carving for odd or odd n levels is

$$U_{(2n+1)} = 3n + 1$$

Table 4. The even-level arithmetic sequence pattern of sikambang manih carving

Level	Number of Engravings	Number Pattern	The Formula for Arithmetic Sequence Pattern
2	6	$6 = 4 + 2$	$U_2 = U_1 + q$
4	12	$12 = (4 + 2 + 4) + 2$	$U_4 = U_1 + 2q + r$
2n	$U_{(2n)}$	$U_{(2n)} = U_{(2n-1)} + 2$	$U_{(2n)} = U_1 + \left(\frac{n}{2}\right)(q) + \left(\frac{n-2}{2}\right)(r)$

As in Table 4, the number of engravings at the n level for the n even value is in U_{2n} pieces. So, the pattern obtained is

$$U_{2n} = U_1 + \left(\frac{n}{2}\right)(q) + \left(\frac{n-2}{2}\right)(r)$$

Since U_1 has a fixed value of 4, q has a fixed value of 2, and r has a fixed value of 4, then substitute the equation so that we get

$$U_{2n} = 4 + \left(\frac{n}{2}\right)(2) + \left(\frac{n-2}{2}\right)(4)$$

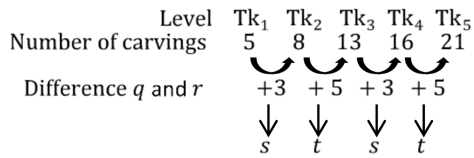
$$U_{2n} = 4 + (n) + (n - 2)(2)$$
$$U_{2n} = 4 + (n) + 2n - 4$$
$$U_{2n} = 3n$$

So that the arithmetic sequence pattern of sikambang manih carving for even or even n levels is

$$U_{2n} = 3n$$

3.3 Arithmetic Sequence Pattern of Saik Galamai and Sikambang Manih Carving

There is an arithmetic sequence pattern on the carvings of saik galamai and sikambang manih. That is evidenced by the patterned differences in the combined carvings in the first and second levels, second and third levels, third and fourth levels, and fourth and fifth levels. The difference is assumed to be s and t. The pattern can be represented in the following chart.



As for the difference in the number of carvings, there are two kinds of the same, namely the difference of three, which is symbolized by s, and the difference of five, which is symbolized by t. In addition, Tk_2 is the sum of Tk_1 with the difference (s). Then Tk_3 is the sum of Tk_2 and the difference (t). Then Tk_4 is the sum of Tk_3 and the difference (s), and so on. The pattern represented in the following table.

Table 5. The arithmetic sequence pattern of sikambang manih and saik galamai carving

Level	Number of Engravings	Number Pattern	The Formula for Arithmetic Sequence Pattern
1	5	$5 = 5$	$U_1 = U_1$
2	8	$8 = 5 + 3$	$U_2 = U_1 + s$
3	13	$13 = 8 + 5 = (5 + 3) + 5$	$U_3 = U_2 + t$ or $(U_1 + s) + t$
4	16	$16 = 13 + 3 = (5 + 3 + 5) + 3$	$U_4 = U_3 + s$ or $(U_1 + t + s) + s$ or $U_1 + 2s + t$
5	21	$21 = 16 + 5 = (5 + 3 + 5 + 3) + 5$	$U_5 = U_4 + t$ or $(U_1 + 2s + t) + t$ or $U_1 + 2s + 2t$
2n + 1	$U_{(2n+1)}$	$U_{(2n+1)} = U_{(2n)} + 5$	$U_{(2n+1)} = U_1 + \left(\frac{n-1}{2}\right)(s + t)$
2n	$U_{(2n)}$	$U_{(2n)} = U_{(2n+1)} + 3$	$U_{(2n)} = U_1 + \left(\frac{n}{2}\right)(s) + \left(\frac{n-2}{2}\right)(t)$

Based on table 5, the number of carvings of the n^{th} level for n odd values are in U_{2n+1} pieces. The following pattern can be this:

$$U_{(2n+1)} = U_1 + \left(\frac{n-1}{2}\right)(s + t)$$

Since U_1 has a fixed value of 5, s has a fixed value of 3, and t has a fixed value of 5, then the substitution of the equation is as follows.

$$U_{(2n+1)} = (5) + \left(\frac{n-1}{2}\right)(3 + 5)$$
$$U_{(2n+1)} = (5) + (n - 1)(4)$$
$$U_{(2n+1)} = 4n + 1$$

Table 6. The even-level arithmetic sequences pattern for carving sikambang manih and saik galamai

Level	Number of Engravings	Number Pattern	The Formula for Arithmetic Sequence Pattern
2	8	$8 = 5 + 3$	$U_2 = U_1 + s$
4	16	$16 = 13 + 3 = (5 + 3 + 5) + 3$	$U_4 = U_1 + 2s + t$
2n	$U_{(2n)}$	$U_{(2n)} = U_{(2n+1)} + 3$	$U_{(2n)} = U_1 + \left(\frac{n}{2}\right)(s) + \left(\frac{n-2}{2}\right)(t)$

As for Table 6, the number of engravings of the n level for n even value is as much as U_n pieces. The following pattern can be this:

$$U_{(2n)} = U_1 + \left(\frac{n}{2}\right)(s) + \left(\frac{n-2}{2}\right)(t)$$

Since U_1 has a fixed value of 5, s has a fixed value of 3, and t has a fixed value of 5, then the substitution of the equation is as follows.

$$U_{(2n)} = 5 + \left(\frac{n}{2}\right)(3) + \left(\frac{n-2}{2}\right)(5)$$
$$U_{(2n)} = 5 + \left(\frac{3n}{2}\right) + \frac{(5n - 10)}{2}$$
$$U_{(2n)} = 5 + \left(\frac{8n - 10}{2}\right)$$
$$U_{(2n)} = 4n$$

So, the arithmetic sequence pattern for Sikambang Manih and Saik Galamai carvings for even or even n levels is

$$U_{(2n)} = 4n$$

An arithmetic sequence was found based on the results of the exploration of Minang carvings on Singok Gonjong. That can be seen from the number of carvings on each level. The saik galamai carving has many carvings 1, 2, 3, 4, 5. The sikambang manih carvings have many carvings 4, 6, 10, 12, 16. The combination of the saik galamai and sikambang manih carvings has many carvings 5, 8, 13, 16 , 21. Exploration results show that there is regularity in the number of carvings at each level. This regularity characterizes an arithmetic sequence. An arithmetic sequence is a sequence with a constant difference. Arithmetic sequences have the pattern $a + b, a + 2b, a + 3b, a + 4b, \ldots\ a + (n-1)\ b$, with the general form $U_n = a + (n-1)b$ where U_n is the n term, a is the first term, b is the difference, and n is the number of terms.

Saik galamai carving on gonjong has an arithmetic sequence with the pattern $U_n = n$. So that the number of saik galamai carvings will always be the same as the level. Sikambang manih carvings have an arithmetic sequence of odd and even patterns. The odd pattern is $U_{(2n+1)} = 3n + 1$, while the even pattern is $U_{2n} = 3n$. That means that the number of carvings at each level of singok is different, but the difference between these differences has regularity. Meanwhile, the combination of saik galamai and sikambang manih carvings has an odd and even arithmetic pattern. The odd pattern is $U_{(2n+1)} = 4n + 1$ and the even pattern is $U_{(2n)} = 4n$. That means each level of carving on singok gonjong has a different number of carvings, but differences from one level to another have regularity.

Singok gonjong is part of the wall that supports the gonjong. The function of singok is not only as a support, but also as ventilation and decoration for the gadang house (Summerfield et al., 1999). Furthermore, the carvings on the singok represent the status of the homeowner and give a warm feel as welcomers (Prihatin et al., 2022; Putri et al., 2021). Therefore, the carvings that are installed are carvings of saik galamai and sikambang manih which have a certain meaning.

The carving of the sikambang manih is likened to a beautiful blooming flower (Joansa, 2015; Putri et al., 2021). Sikambang manih symbolizes the joy of the Minangkabau people in welcoming guests. Therefore, this motif is usually found in easily visible parts of the gadang house, such as singok gonjong (Hasan, 2004; Izzati et al., 2016; Summerfield et al., 1999).

The Saik Galamai motif is taken from the shape of a typical Minangkabau food, namely galamai, which is cut in the shape of a kite (Putri et al., 2021). Galamai is a typical food from West Sumatra which is made from rice, sugar cane, and coconut milk. Galamai is cut into rectangular shapes, as a sign of welcome to guests at traditional Minangkabau events. Furthermore, the Saik Galamai motif means thoroughness, wisdom, and prudence in dealing with various problems (Joansa, 2015; Putri et al., 2021).

In other words, the installation of the carvings of saik galamai and sikambang manih gives a deep meaning to the Minangkabau people. Sikambang manih signifies the friendliness and happiness of the homeowner in welcoming guests. Meanwhile, Saik galamai is a reminder for homeowners to always be careful and thorough in their actions. So that the two types of carvings are installed in a certain pattern to give a beautiful and meaningful nuance.

Thus, the placement of Minang carvings on Singok Gonjong has an arithmetic pattern. This is in line with the results of a research interview with Mr. Beni, a woodcarver from Chan Umar carving studio, who said that installing Minang carvings on gonjong is not simply installed, but requires certain rules. The rules also be different for each village. The various stages are needed before installation, starting from measuring the length and width of the gonjong, the area of singok, the type of carving, the number of levels, and so on.

4. Conclusion

Minangkabau carvings found on Singok Gonjong function as decoration, a philosophy of life, and Minangkabau cultural identity. There are two types of carvings on singok gonjong: carvings of saik galamai and carvings of sikambang manih. When studied mathematically, the installation of these carvings has an arithmetic sequence pattern. The results showed three kinds of arithmetic sequence patterns found in singok gonjong. The arithmetic sequence pattern of saik galamai carving has the formula $U_n = n$. The arithmetic sequence pattern of Saik Sikambang Manih carving has the formula $U_{(2n+1)} = 3n + 1$ and $U_{2n} = 3n$. Meanwhile, the arithmetic sequence pattern in the combination of saik galamai and sikambang manih carvings is $U_{(2n+1)} = 4n + 1$ and $U_{(2n)} = 4n$.

Furthermore, the existence of an arithmetic sequence pattern on Minang carvings in Singok gonjong can be used as a recommendation to be applied to the learning of arithmetic sequences at school. In addition, the results of this study can encourage further research to look at the patterns of arithmetic sequences or arithmetic series in other types of Minang carvings as well as in other parts of the gadang house.

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