Learning geometry of plane and space through *Timor Tengah Selatan* culture

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Abstract. Mathematics learning is inseparable from local culture. In the local culture in *Timor Tengah Selatan* regency, there are geometric shapes of plane and spaces contained in local buildings or customs. The habit of measuring gardens. The habit of making roofs and fences is a form of Geometry. This research aims to examine the geometrical shapes contained in traditional houses, LOPO. The research was conducted at Benteng None. The type of this research is qualitative research. The data collection method uses observation and interview techniques. Data were analyzed by data reduction, data presentation, data verification and conclusion. The results showed that there were several Geometry shapes of plane and space at Benteng None, *Timor Tengah Selatan* Regency.

1. Introduction
Ethnomathematics is a study of the differences in the way people solve mathematical problem and practical algorithm based on the mathematical perspective of society itself. Ethnomathematics refers to various forms of mathematics as consequences that are embedded in cultural activities. In this perspective, Orey [1] asserts, "Ethnomathematics may be characterized as a tool for acting in the world" and as such, provides insight into the social role of mathematics in the academic area. Ethnomathematics refers to mathematical concepts embedded in cultural practices and recognizes that all cultures and all people develop unique methods for understanding and changing the reality of cultural community [2,3].

Ethnomathematics illustrates the mathematical perspective of validating and determining the whole society experience in mathematics which shows that mathematical thinking is compatible with people's lives. Further proof, Orey [1] stated that "the paradigm that different cultures use or work with unique interactions between languages and their environmental culture". D'Ambrosio [4] considers that in the Ethnomathematics view, mathematical thinking is developed in different cultures depending on the problems determined through the cultural perspective.

Ethnomathematics refers to mathematical concepts embedded in cultural practice and recognizes that all cultures and all people develop unique method to understand and to change the reality of own society [3,5,6]. It also recognizes that this method of cultural accumulation is involved in a constant, dynamic, natural evolution and growth.

Indonesia is a large country that is very rich in culture. One of the interesting things is the culture of the people in the central part of Timor Island, *Timor Tengah Selatan* Regency, East Nusa Tenggara Province, Indonesia [7]. Therefore, the researcher wants to study about Ethnomathematics in the community at *Timor Tengah Selatan* Regency.

2. Method
This study is qualitative [7]. In this case descriptive study is related to the shapes of Geometry that exist within the ethnic Timor Tengah Selatan. This study was conducted in the cultural tourism area Benteng None in Timor Tengah Selatan. The subject of this study is the ethnic culture of Timor Tengah Selatan contained in the form of a traditional house, LOPO at the tourism area Benteng None.

The variables in this study are Geometry flat plane and space, curved sides in the traditional house LOPO. The observations relate to the geometrical forms of the flat plane and space that exist in the ethnic Timor Tengah Selatan, especially in the traditional house, LOPO. Data collection used is documentation, observation, and interviews [7]. Documentation consist of photos of traditional houses there. Observations were carried out on the shapes of Geometry that existed in the ethnic Timor Tengah Selatan, traditional house of LOPO. Guidelines for observation related to Geometry forms on LOPO traditional houses at Benteng None.

There are two types of interviews used in this research, namely: standardized interview with interview guidelines and unstandardized interview without using interview guidelines and questionnaire. Interview guidelines relating to the geometry of LOPO buildings. Researchers determined the "key informant", the officer who guarded at the tourism area Benteng None. Triangulation used is source triangulation, technique triangulation and time triangulation. Activities in data analysis are: data reduction, data display and data verification (data verification).

3. Result and Discussion
The tourism object area of Benteng None is located in West Amnuban District in the Nule village. The tourism object area of Benteng None is estimated to be 800 years old (eight centuries). The Geometric shape found on the outside of the Benteng None is a circle. The shape of a circle appears on the fort fence. Building a fence follows the shape of LOPO inside of Benteng None. Because the basic form of LOPO is a circle, the fence is also in the form of a circle with its center, the center of the LOPO itself. The center of the LOPO is obtained by determining the intersection between the diagonal poles forming the square shaped LOPO. Geometry plane on the inside of a circle that appear consist of square, rectangle and circle and the geometric space consist of cubes, tubes and cones.

There are many measurements used in the people of Timor Tengah Selatan, including the size of the weight, length and size of a particular collection [8]. These measurements are very relative, because they are very varied and depend on other variables. These measures were passed down from their ancestors.

People there use a measure derived from their ancestors. The measurement used is "Depa" or "Jengkal", size for length. The unit of length is "Depa". The size of this "Depa" is based on the length from the tip of the finger of the left hand to the tip of the finger of the right hand, when the hand is stretched. The size of "Depa" is very relative, because it depends on the length of each hand. The size of "Depa" cannot be used as a standard one length measure. In addition to the "Depa" size, a "Jengkal" size is also used based on the length from the tip of the thumb to the tip of the little finger, when the palm of the hand is stretched to the maximum. This size is used when people need a size that is not too long. The size of the "Jengkal" is very relative, because it really depends on the length of one's finger. The size of the "Jengkal" for people with long fingers is different from the size of "Jengkal" for people whose fingers are not long. Thus, the size of the "Jengkal" cannot be used as a standard measure of length. But the people of Timor Tengah Selatan do a job using that size.

Budiarto [8-10] stated that mathematical concepts that emerge in various cultural outcomes of community groups indicate that there has been a relationship between mathematics and culture. Through Ethnomatematics, culture can be seen in a mathematical perspective. From the results of an interview with the "Key Informant" called "Jupir" that in building of LOPO supporting poles in the Benteng None, the “Jengkal” size was used.
Based on Figure 1, the metric between the two supporting poles is ten "jengkal". Each “Jengkal” is estimated at 20 cm. So that the metric between the two supporting poles is around 2 meters. LOPO means "Lumbung" which is a house or a place to store the harvest. From the LOPO structure it can be seen that there is a part for storing crop yields namely at the top of the LOPO. But there is a LOPO that is used as a traditional house in Timor Tengah Selatan Regency. There are two traditional houses, namely LOPO (see Figure 2) and Rumah Bulat (Ume Kbubu) (see Figure 3). LOPO is used by men to store harvests or is used for traditional meetings or gatherings or sitting for "makan sirih". “Makan sirih” likes eating a traditional snack.

Figure 2 shows that the roof of LOPO at Benteng None is made of “alang-alang”, with the floor made of piles of natural stone as high as one meter. In the center there are four pillars supporting the house. These four pillars relate to the beliefs of the people of Timor Tengah Selatan about the four cardinal points (North, South, East and West). Although technically, these four supports are sturdy in supporting a building when compared to one buffer, two supports or three-three supports. Rumah Bulat (Ume Kbubu) [8]. The roof of “Rumah Bukat” is made of “alang” grass and directly to the ground and only has one door to enter and exit the room.
Figure 3. Rumah Bulat (Ume Kbubu)

This house is used by women to cook or "roasting", mothers who have just finished giving birth. The custom in ethnic Timor Tengah Selatan is that a mother who has finished giving birth must be roasted, so that health and fluids in the body that cause the disease can be lost. In Dawan tribe, it is called: SE'I. At first time, LOPO was formed with one pole like an umbrella. Building LOPO with four supporting poles (see Figure 4), starting with one supporting pole (T1). After determining one supporting pole, the second supporting pole (T2) will be made. The second supporting pole is ten "Jengkal" from the first supporting pole. Likewise, making a third support pole (T3) and fourth support pole (T4). The distance between the first and second supporting poles and the second and third supporting poles and the distance of the third supporting poles and the fourth supporting poles is always the same, which is ten “Jengkal”. So that the position of the four pillars is square.

Figure 4. Position of the Supporting Pole and LOPO center

People at Timor Tengah Selatan do not know square. However, this form is used as a standard for building LOPO. The distance between poles is 10 Jengkal (10 x 20 cm = 200 cm = 2 meters). If it is square, then each corner of the square is 90°. It is estimated that the square angle is 90°. The magnitude of the angle is determined based on feeling. The large angle was told by ancestors. Furthermore, by using a rope or other object, a diagonal line is drawn (a connecting line between two non-adjacent angles). The second diagonal intersection is made the midpoint. This midpoint is used as the center of LOPO and to get the top of LOPO. The LOPO peak projection must be exactly at the center of the LOPO. LOPO center means that all sizes must start from this LOPO center. The LOPO circle is based at the center of this LOPO. Then the distance between the bottom of the LOPO with the flat part on the pole is also the same, namely 10 Jengkal = 2 meters. In the flat part is made of blocks that occupy the four poles. Then arranged wood with the same size. Thus, the basic form of LOPO is actually a CUBE.
LOPO poles are taken logs from the forest, so that Geometrically, the logs are tubular (Figure 5). Intake of these logs from certain types of plants. Not all plant stems can be used as LOPO support poles. The type of stem of this plant is also determined from generation to generation, with the help of traditional leaders who can communicate with ancestors. If it is wrong to determine which tree trunks are used as poles, then the ancestors will be angry and have consequences for the surrounding community.

There are three shapes of circles. The first circular form, on the outside of LOPO, is a log of stones that are used as shields against enemies. This circle is centered on the center of LOPO. The second circle form, is at the top of the LOPO pole. The LOPO pole is located at the center of the circle (see Figure 6). This circle is made of wood which is about 5 cm thick. So, in one LOPO there are four circles on the supporting pole. This circle has two functions. The first function of the circle is to prevent mice from jumping to the top of the LOPO, because the top of the LOPO is used to store food in the form of rice or corn from their crops. The second function is to save "Sirih and Pinang" which will be used in traditional meetings at the LOPO.

The triangle is part of a square. Thus, if there is a square in LOPO, then there is also a triangle shape. But in this case only isosceles right triangle. The form of an isosceles triangle appears on the LOPO pole. This means that it can be seen that there are several triangles formed from the poles.

The Geometrical shape of the tube appears on the four support poles (see Figure 7). The support pole is a solid tube. It is estimated that the diameter of this tube is about one “Jengkal” or 20 cm. However, from the story of the people of Timor Tengah Selatan, that a pole was obtained from a piece of wood. The sticks get to the top, the smaller (the diameter). So, it is more correct to say that the cone-shaped pillar is beheaded. Because there is almost no difference between the diameter of the top and bottom diameter. Even if there is a difference, it is close to one or two millimeters. For the people of Timor Tengah Selatan, it is not a problem with the cylinder or cone-beheaded, but it is a log.
Cones in the form of LOPO occur as a result of a shrinking circle. Actually, LOPO is not conical. This is because the LOPO roof does not form a flat surface, but a curved surface [11]. However, with the process of Geometric idealization, the LOPO is seen as a cone. Thus, the cone area and volume calculation are an approach in calculating the LOPO surface area and volume. Following this, the cone model from LOPO.

If you pay attention to the shape of the LOPO (see Figure 8 and Figure 9), it can be said that the Geometrical shape of the LOPO is close to the conical shape. The center of the conical base circle is the center of the LOPO obtained by obtaining a diagonal square intersection. If a line is drawn from the center of this circle, the top of the LOPO is obtained. Thus, making LOPO roof should lead to the peak of LOPO.

4. Conclusion
Geometry shapes are contained of LOPO, traditional house at Timor Tengah Selatan Regency. In the shape of this building, there are Geometry plane and Geometry space. The Geometry plane are: circle and square and the Geometry space are: cubes, beams, cones and tubes.
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