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ETHNOMATHEMATICS IN SASAKNESE ARCHITECTURE

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Abstract

This research is aimed to explore the cultural elements especially in *Sasak* architectures in Lombok Island such as a home living (Bale), worship building (masjid), lumbung (*sambi*) in ethnomathematics point of view. This research uses qualitative approach with cognitive (anthropology cognitive). The interviewees are the experienced custom leader and humanists who has conducted the research on *Sasak* society. Meanwhile, the data collection method used the participant, observation and documentation. Data analysis on this research is not only based on the researcher is interpretation but also the idea structure of the society. This research shows the evidence of sensitivity on the use of numbers practiced by *Sasak* ancestor long time ago in doing the measurement using their anthropometric ability (Ethnomathematics). The architecture products of *sasak* society also describe that *sasak* society is more focus on the process than the final products itself which describes the consistency in conducting role and cultural device which control the desire of individual construction.

Keywords: Ethnomathematics, Architecture, *Sasak* Society

Abstrak

Kajian ini bertujuan untuk mengekplorasi unsur-unsur budaya khususnya pada arsitektur masyarakat suku *sasak* di Lombok seperti rumah hunian (*bale*), bangunan tempat ibadah (*masjid*) dan lumbung padi (*sambi)* dalam sudut pandang etnomatematika.Kajian ini menggunakan pendekatan kualitatif dengan model etnografi (*anthropology cognitvef).*informan yang digunakan adalah para pemangku adat dan budayawan-budayawan yang sudah memiliki pengalaman dalam melakukan penelitian-penelitian tentang budaya masyarakat *sasak.* Sedangkan teknik pengambilan data menggunakan pengamatan berperan serta (*participant observation)* dan dekomentasi. Analisis data dalam penelitian ini tidak didasarkan semata-mata pada interpretasi peneliti tetapi merupakan susunan pikiran dari anggota masyarakat yang dikorek keluar oleh peneliti. Kajian ini mengungkap bukti kepekaan terhadap angka yang dipraktikkan oleh nenek moyang masyarakat suku *sasak* sejak dahulu, dalam hal melakukan pengukuran yang menggunakan kemampuan antropometris (etnomatematika). Produk-produk arsitektur tradisional masyarakat suku *sasak* ini juga menggambarkan bahwa tradisi masyarakat *sasak* itu lebih mementingkan suatu proses diatas produk akhir yang ingin dihasilkan yakni tergambarnya masyarakat yang selalu konsisten dalam menjalankan peran dan piranti adat yang mengatur hajat membangun dari masing-masing individu didalamnya.

Kata kunci: Etnomatematika, Arsitektur, Masyarakat

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Culture is a typical way for humans to adapt themselves to the environment, while mathematics is realized because of human activities. It is in line with the phrase Freudenthal, "mathematics as a human activities" (Gravemeijer & Terwel, 2000). Next, Suhirman (2001) defines mathematics as the science of form, structure, quantity and other related concepts with large numbers divided into three fields, namely algebra, analysis and geometry. Meanwhile, according to Abdurrahman (2003) states that mathematics is a direction to find answers to problems faced by human beings, a way of using information, using knowledge of form and size, using knowledge about counting and thinking in man himself view and use relationships.

Mathematics and Cultural Products

Mathematical and cultural integration means contextual and realistic mathematics. Various cultural products of our ancestors reveal artistic creativity that contains mathematics, for example in carved ornaments and architectural forms in traditional houses containing three-dimensional geometric formations (Kucuk, 2013). Likewise found by Nasir and Cobb (2007) and Orey (2000) that mathematical contextualization has been described as identification of mathematics that is practiced and developed in different cultural groups. So also stated by (Rius, 2000; Rosa & Orey, 2007) stating that if mathematics is seen as a cultural construct, then it is cultural development.

Orey (2009) stated that mathematics in various cultural contexts confirms this as a demand. Cultural products in the form of artifacts such as traditional buildings are given the opportunity to be developed through mathematical thinking. Mathematical creative thinking that is integrated with culture can also arise in economic behavior. The concept of calculating mathematics through a linear program to determine the critical point as well as meeting several variables becomes a solution when many needs must be met but funds are limited. Mathematical calculations here are an alternative problem solving. Humans appear to fulfill their creativity needs with limited funds. For that it is clear that mathematics is the product of the human mind.

Ethnomathematics

Ethnomathematics is a field study. D Ambrosio (1990) defined ethnomathematics as a very broad term that refers to the socio-cultural context including language, jargon, symbols, behavior and myths. In line with this definition, Orey (2003) explained ethnomathematics to explain, and understand the world to manage problems faced by people, a larger humanitarian problem. More specific again D Ambrosio (1993) stated that the mission of the ethnomathematics program is to recognize that there are different ways of doing mathematics where different cultures can negotiate in practicing mathematics. Furthermore, Borba (1997) described ethnomathematics as a way in which people use certain cultures in mathematical concepts in dealing with relational and spatial aspects in their lives. Thus, ethnomathematics emerges as a new category in the conceptual discourse of mathematics education and as an interaction between mathematics and culture.

One of the objectives of mathematics learning is to prepare students to use mathematics and mathematical mindset in everyday life (Soedjadi, 2000). According to Barta and Shockey (2006) ethnomathemathic is a complex and dynamic representation that describes the influence of cultural use of mathematics in its application. In mathematics learning in schools so far students still consider that mathematics is difficult, too abstract, many formulas and so on, this is because the mathematics learning in school is too formal and not in accordance with what is experienced by students in everyday life. Bandeira and Lucena (2004) investigated mathematical ideas and practices obtained by members of the vegetable farming community in the Northeast region of Brazil. They learn the mathematical concepts used by farmers to harvest, produce and commercialize vegetables. They

found that the specific mathematical knowledge produced by farmers differed from the mathematical knowledge obtained in academic settings. Therefore, more researches are needed to explore the cultures that exist around us to find concrete mathematical concepts so that the concepts can be applied in school math learning.

From some of these opinions, it appears that in math learning at school there is a tendency that to explore the initial knowledge of students should begin by associating formal mathematics with the experience of students in everyday life. Therefore, in this study focused on exploring and exploring more about the customs (customs) of *sasak* community related to the calculation, measurement, modeling, designing especially related to the traditional buildings of Sasaknese society. According to Rosa and Orey (2016), ethnomathematics is the application of math skills, ideas, procedures, and practices applied in the past by members of certain cultural groups in different contexts, which are often used today in today's context. It is hoped that based on the findings of this study can be a reference for teachers and observers of mathematics learning in order to create textbooks and use local culture as a source of learning mathematics in schools, so that learning math is more interesting and meaningful for students.

METHOD

The research method used in this study was a qualitative approach with the model of ethnography (anthropology cognitive) (Spradley, 1987). A new ethnography that focuses its efforts to discover how people organize their customs in mind and then use them in life. Informants used are the custom leader and cultural observers who already have experience in conducting research on the culture of the *sasak* community. While the data retrieval technique using participant observation and documentation. The analysis in this study is not only based solely on the interpretation of the researcher but also the composition of the idea of members of the community who are scraped out by the researchers, who then use four stages in analyzing the data such as an anarchic domain, taxonomic analysis, component analysis and theme determination.

RESULTS AND DISCUSSION

Architecture is an art and technique of designing and building and can be associated with construction (Irawan, 2016). The basic concept of *sasak* community building is a residential building called "bale" (house of residence), building of worship place "mesigit" (ancient mosque), and building of food store "granary" (sambi) is basically the same as Austronesia building in general which has a construction with poles and wooden beams both on the coast to the mountains. This spread leads to the emergence of vernacular structures that incorporate mound patterns with the construction of poles and beams according to the natural challenges encountered.

- House of Residence (*bale langgak*)

  The house in the *sasak* language called "bale" is a space that is occupied as a residence settled hereditary in the hope of obtaining serenity, tranquility and welfare of the birth and the mind. Home is one of the embodiment of cultural products and the development of human civilization (Fathurrahman, 2016). Spatial and home structures characterize the sociological dimension that reflects the social fabric of its supporting society. Classes and social functions in society are two elements that affect the shape, structure, and naming of space and home. *Gedeng* mention for the house of the nobles, cottage (*bale jamaq*) for ordinary people and bale bonter and mountain bale rate occupied by the religious teacher, village chief and the nobles. As for the concept of *sasak* architecture development always depart from *pemole* and *semaiq* concept which is then applied based on *sasak* custom system in example system of value, social, ritual and technical system.

- *Bale Jamaq*/*Bale Tani*

  The concept of *bale tani* is built in accordance with the environment generally on the slopes of the hill; this bale has a roof of the back and side almost touching the ground and made with a slope that can launch the fall of rain water. Framework of the roof is made higher because basically this roof also functions to form space, because generally the bale tani wall is relatively low in example about 2 meters while the floor (floor) the *dalem* is higher than the *ampik*.

  Space and function of this farm bale is divided into three spaces namely *bale dalem*, *dalem bale* and *ampik*. *Bale dalem* serves for the bedding of girls and *dalem bale* to store food and *ampik* divided into 2 *ampik belo* (long) and *ampe konteq* (short) which each function long *ampik* to place doing productive things like weaving and weaving while the short *ampik* is used for the boys resting place. All shapes can be seen in Figure 1.

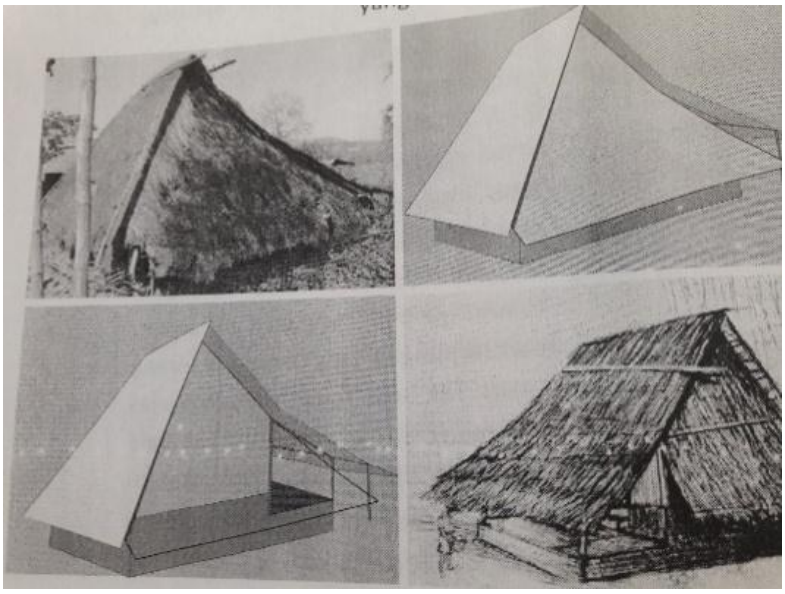

Figure 1. *Bale Jamaq/Bale Tani* (Photo Source: *Museum Provinsi NTB*)

- *Bale Bonter*

The concept of *bale bonter* is a residence for the citizens who have the function and status of the middle nobility, this building is made to be more authoritative than *bale jamaq* with symbols such as peduncles and the use of *jejait* on the frame. *Bale bonter* construction is more robust compared to other bale-bale poles and blander-blander and its doors use carvings. *Bantaran* (foundation) *bale bonter* built rather high so that built steps (steps) made of soil. In general, this type of house is equipped with a six (*berugaq bertiang* six) or *bale jajar* also called *bencingah.* Space and *bale bonter* functions have in common with the *bale jamaq* that is applying the concept of *dalem bale*, *dalem bale* and *ampik* that can be seen in Figure 2.

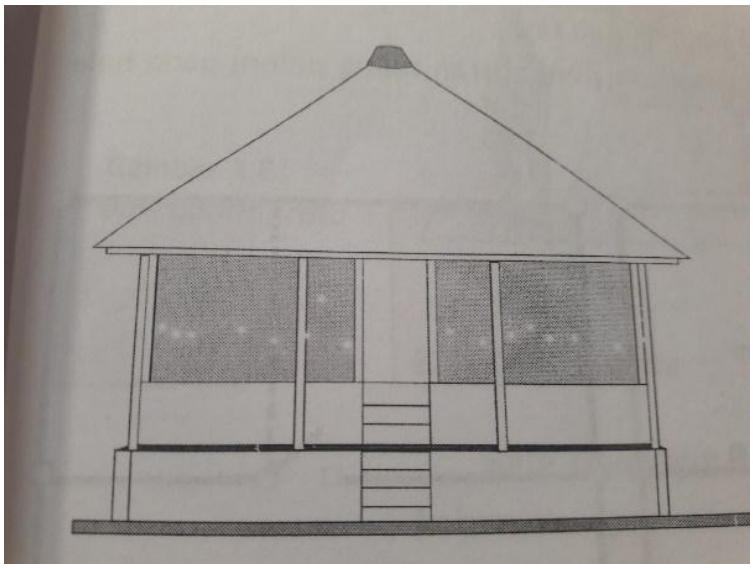

Figure 2. *Bale Bonter* (Photo Source: *Museum Provinsi NTB*)

- *Bale Gunungrate*

Bale gunungrate does not vary much with the *bale bonter*, both materials and construction. There is little difference in the shape of the roof. Construction of bale mountain roof rate using *tunjeng* and *bumbungan* generally decorated with carvings this hole usually has a length of 2 meters is used as a pedestal four pieces *ujuk-ujuk* same length. This type of building has a wall of yard so everyone who wants to enter it does not apply haphazardly. They will maintain the attitude or etiquette, especially because of the gate to the yard. The *Bale Gunungrate* and its sketch can be seen in Figure 3.

Figure 3. *Bale Gunungrate* and *Bale Gunungrate* sketch (Photo Source: *Museum Provinsi NTB*)

- Building for worship *(Mensigit)*

  One component of traditional architecture that has a long history in Lombok is the architecture of the mosque. Not because the quantity has reached hundreds of thousands, until Lombok dubbed the island of a thousand mosques but because of the historical aspect and function of the mosque as a traditional icon, almost certainly there is a site of a mosque or ancient mosque that serves as a center of civilization.

  The building of the mosque uses the pattern of the mound foundation with the low pillars and walls and the towering roof extends downward as if it were almost touching the ground, so everyone who will enter must be in a downcast position. The size of the customary mosque is generally 7 x 7 meters or 9 x 9 meters on the floor, in the middle of the mosque space, stands 4 main pillars that directly into a crown pole or cone. Around the wall is built 20 poles tied with *gelampar* components and *jejait* using a system of *purus* (knockdown) and wooden pegs of roofing materials are usually made of reeds and some are using bamboo, and the roof is mounted through the wall about one meter above the floor, so people enter the mosque should bow down. Downward attitude is interpreted as a form of homage to the mosque or the people in it. Mosque buildings are usually placed in separate locations separated from housing or settlements (Figure 4).

Figure 4. Ancient mosque of *bayan*

- Granary /*sambi*

Setia Sopandi (2013) identifies *sasak* granary building technology in Lombok dating from 3500 years BC. *Banguanan* barn consists of two parts, namely the top and bottom which each has its own function of the top serves as a place to store the rice so that it is made closed. This upper space is formed by the roof with a symmetrical dome pattern if viewed from the front and rear. At the bottom consists of four poles with the arrangement in a clockwise direction, ranging from *nyake*, teacher, *pendite*, and *kire*. The illustration can be seen in Figure 5.

Above the four pillars are formed *jelepeng* which serves to prevent rats rose into the barn through the pole, in addition to increase the beauty. Above *jelepeng* is placed coral reef-shaped place where laying *gelampar* bottom that serves as a base with foot footprint women (*selampak nine*). The form of a granary developed by the *sasak* community is called "*mekadal meteng*" which in *sasak* society symbolizes the frugal attitude (frugal). The location of the granary in the yard is always in the right position of the house, as a sign of appreciation for the rice that is the fortune of the God.

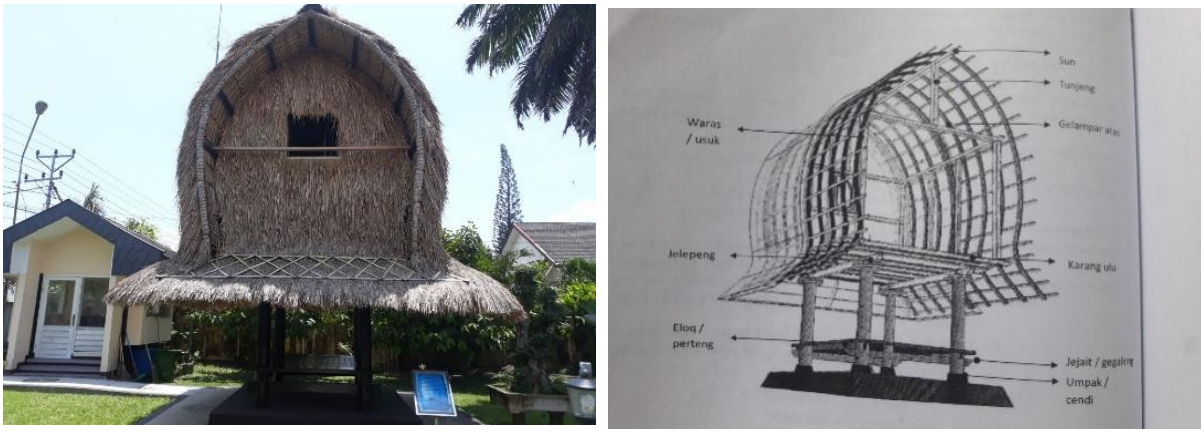

Figure 5. Granary *(sambi)*

The concept of mathematics in the cultural architecture of the sasak society

There are some concept of mathematics in the cultural architecture of the *sasak* society, such as measuring and measurement, designing, and geometric form. The explanation of the concept explained in the following.

- Measuring and measurement

In forming *sasak* community building structures, there is a feature known as "sikut/elbow" which means size, but in this case size is not related to length, width and height (numerical), but also relates to elbow time, elbow space and elbows ramon. Elbow length corresponds to the length to the power (north), width towards the andang and mudi (front - behind), high elbows associated with the nature of the building is determined by the size of the owner of the building

while the elbow time related to the start building. All of these elephants are termed anthropometry (a measure that refers to the size of a human body).

The use of the concept of size (elbow) in determining the size of buildings in the community *sasak* use some terms in accordance with what will be measured.

1. *Elbow size*: the size of the construction of a house that refers to the size of the human body known as anthropometry, this measure consists of *seperunjung*, *sedepa*, *sejengkak*, *sekepal*, *sehasta*, and *senyari* (Figure 6).
2. *Elbow andang*: measurement to ensure the accuracy of direction that refers to the environmental layout, the accuracy of the determination of the direction of doors and windows tailored to the comfort and security of the inhabitants of the house.
3. *Time elbow*: precise time planning measurements to construct buildings such as houses, mosques, barns or other buildings.
4. *Elbow of space*: measurements related to the position of the planned room and determine the proper position to be made the core room in accordance with the traditional buildings that apply in the community.
5. *Elbow of ramon*: This elbow is used to select the right building material and placed in the right position especially wood and bamboo materials.

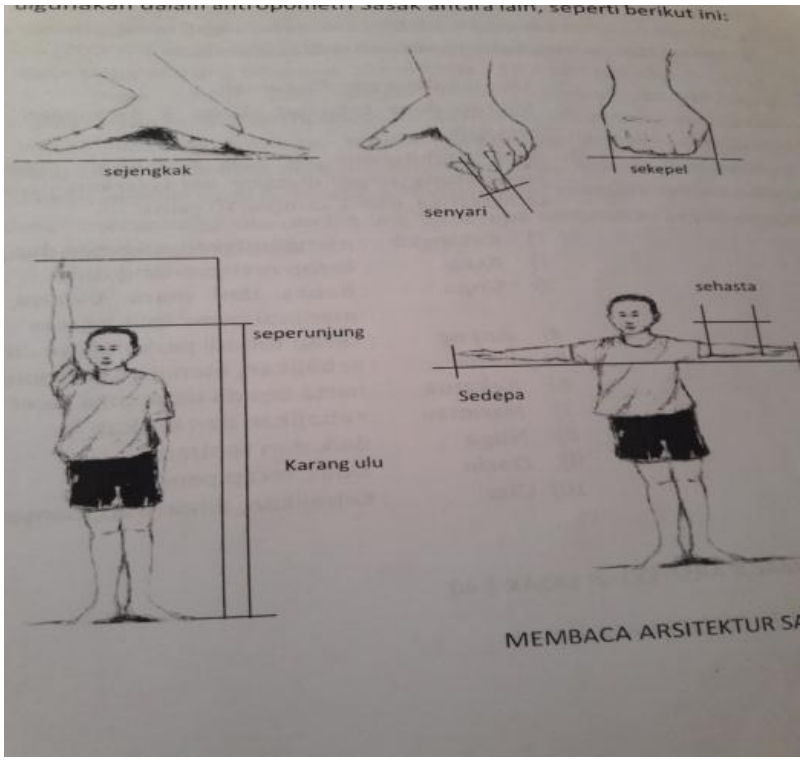

Figure 6. *Sasak* anthropometry size.

- Designing

Sasak community activities related to the designing in the activities of building design such as establishing houses of residence, places of worship, and buildings related to the social life. In implementing the values that must be upheld in designing or planning development, the *sasak* community realize the four basic concepts those are:

1. *Semaiq*, not excessive in accordance with the needs so that the main size used is the size of the owner.
2. *Hardened* (sturdy), logical in applying the correct structure concept
3. *Pantes* (ethical), meets standards of decency
4. *Solah* (aesthetic) satisfies the owner's heart and others who see it.

- Geometric form

Geometry form that exists in the construction of buildings founded by *Sasak* community. It can be seen in Table 1.

Table 1. Mathematics concept and its application in *Sasak'* building ornament

No.	Mathemacics Concept	Building Ornament
1	Angle	Angle is at every house, mosque, and *lumbung*
2	Triangle	Pieces of houses and mosques
3	Square/rectangle	There are on the walls of houses and base od *lumbung* .
4	Symmetry	Spaces of *dalem bale*, domes of *lumbung*.
5	Reflection	There are carvings on the door of the house and the gate of *rumah gunung rate*
6	Trapezium	Walls of *rumah gunung rate*
7	Circle	Baseboard/barn beam
8	Prismatic	Roof of houses/*bale tani*, *bale bonter* and *bale gunung rate*.
9	Parallel	Walls of house and mosque
10	Cylinder, beam, and cut cone	*Jelepeng lumbung*, pillar of house and lumbung
11	Wave shaped sinusoide $Y= a \cos (x - \alpha)$ $Y= a \sin (x - \alpha)$	Roof of *lumbung*
12	Pyramid	Palate of mosque

CONCLUSION

The *sasak* architecture has different construction and ornamentation designs to present a functioning and beautiful building. In addition, the shape of a unique model is geometrically shaped. Inadvertently the *sasak* community has been practicing mathematics in everyday life, visible from the shape and model of the building which has the pattern, angle, building space, angle, triangle, square, cylinder, prism and circle. In addition the form and function of various kinds of buildings and public spaces that contain noble values. This study shows that the architecture of the *sasak* community has a taste, finesse and awareness of servant hood in maintaining the cultural customs inherited by their ancestors, and it is evident that the *sasak* people have sensitivity to the numbers and mathematical calculations practiced by ancestors since time immemorial.

The ethnomathematics practiced by the *sasak* community is evident from the methods of measuring, designing and building forms that exist in *sasak* culture. Therefore, through studies more focused on extracting data related to customs that contain mathematical concepts so that the findings obtained can be implemented in learning mathematics in schools, so that school mathematics learning is more interesting, fun, and not too abstract because the context is directly related to everyday life found in their own culture.

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