

Ethnomathematics on Sundanese belief symbol

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Ethnomathematics is the activity of mathematics in popular culture. The activity is patterned, structured and has a form in everyday life and has become a belief that is ingrained in the form of local wisdom. Symbols and the benchmark are the basic references that are measured mathematically and seen when applied to the Sundanese belief symbol. This research seeks to uncover mathematics regarding the Sundanese belief symbol using the qualitative method with descriptive analysis and an archaeological approach.

Key words: *Sundanese Belief Symbol, Mathematics*

Introduction

In human civilization, mathematics is the knowledge that is inseparable from cultural development. Mathematics was created from a culture (Ambrosio, 2001) and on the other hand as a tool in problem-solving (Sukirwan et al., 2017; Sukirwan, 2018). Those two perspectives have different explanations, but amalgamate in the context of anthropology, mathematics and mathematical models in the form of a new study, ethnomathematics (Rosa and Orey, 2013).

Ethnomathematics is a complex and dynamic representation that illustrates the influence of the culture against the application of mathematics in the community (Barta and Shockey, 2006). Linkages between the two then give the implications on how mathematics is transformed into different cultural systems. This provides a more open space to lift culture in the study of ethnomathematics and mathematical education (Balamurugan, 2015; Matang, 2002). Although mathematics became the main approach in explaining the ethnomathematics that arises, the conclusions drawn from this study are basically very open, especially in a multicultural context in which the main conclusion is directed at how research on culture is carried out (Zhang and Zhang, 2010; Ariyani & Daryanto 2018).

This study aims to reveal the ethnomathematics on the Sundanese belief symbol that reveals the behavior of Sundanese tribes in keeping the culture of local wisdom. The symbol of the unique nature of the Sundanese culture refers to the Sundanese identity inherent in activities of daily living. It is not just on personal identity, but the implications of the Sundanese cultural symbol effect on place of residence, life partner and also daily activities. The Sundanese belief symbol later became principal to the Sundanese living in living the life as a whole person; of them become good, keeping good relations with each other, maintaining the sustainability of nature, maintaining the balance of nature, as well as devoutness and obedience to the rules of custom.

Some studies of the Sundanese have revealed the daily activity of the Sundanese relating to the practice of math. Studies conducted by Muhtadi et al (2017) reveal how ethnomathematics works in estimating, measuring, and making patterns. Estimating, for example, is used to estimate the volume of wood, stone, or sand in units *kibik* (1 *kibik* = 1 m³). Measuring units of length used in the (*sajengkal*, *sadepa*, *sahasta*, *satampah*, *sadim*); unit area (*sabata*, 1 *bata* = 14 m²); unit of volume (*sadam*, *sakojong*, *satelebug*). Patterns used in determining patterns of webbing which are known by the term *pihuntuan* pattern. Another study done by Abdullah (2017) about ethnomathematics from the perspective of Sundanese culture, is concerned with uncovering the symbols measurement in units of length, width, height, area, volume, and time. The second study is exploratory, exposing the Sunda tribal habits in running math activities performed in everyday life. Customs ethnomathematics basically is part of local wisdom applied based on the symbols of the culture and growth in an environment of Sundanese. However, the research did not explain in detail about how cultural symbols affect individual Sundanese. Therefore it could not show identity or Sundanese identity itself. In addition, there are the symbols of the culture and beliefs which are very influential on behavior and local Sundanese wisdom. Furthermore, it is very interesting to study Sundanese belief symbols which is closely associated with mathematics.

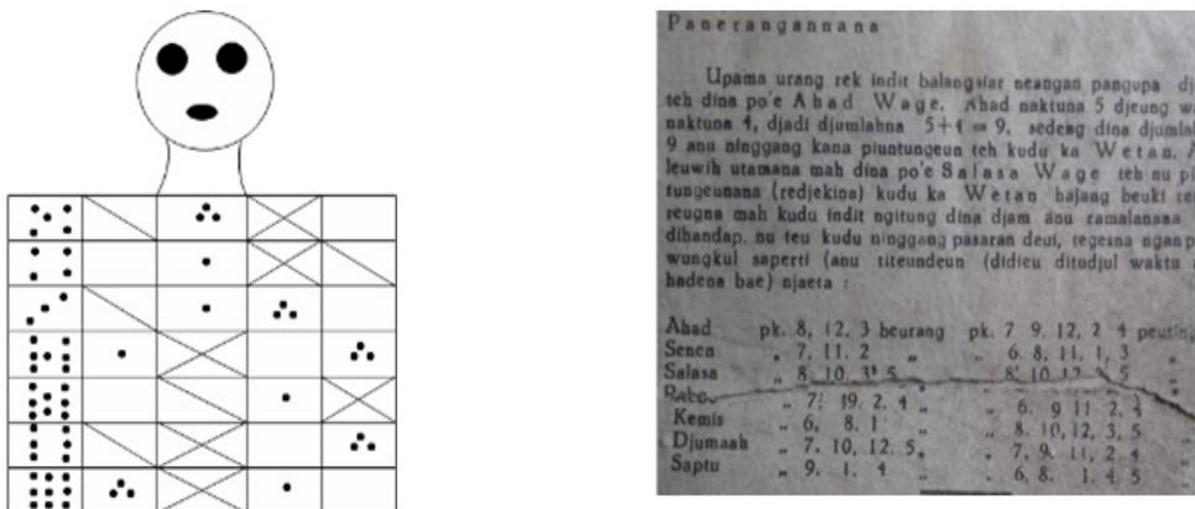
A cultural symbol that appears regarding Sundanese belief (Sundanese belief symbol) is the manifestation of local wisdom in maintaining the balance of nature. This symbol has long been there and worn since the days of "*Sunda Buhun*" until now, and is scattered in the region of West Java. At the time of the "*Sunda Buhun*", specifically the era of the ruling Kingdom of Galuh Pakuan, King Wastukancana Niskala between 1348 AD - 1475 AD (Septiani, 2016), there is a Sundanese belief symbol on the cubes '*kolenjer* [calendar]' which serves to determine the time for farming and harvest seasons. The Sundanese belief symbol is written in the form of a dot on the middle of the square image on the stone. Though already mixed with large holes, some signs of this dot are clearly visible and are believed to be a "benchmark" symbolising the number.

Figure 1. Manuscripts of Sundanese belief symbol on the stone (Source: <http://www.pikiran-rakyat.com>).



The next development of the Sundanese belief symbol is in the form of benchmarks that symbolise figures no longer written in stone, but written on top of wood termed *tunduk*. Up to now, the symbol of trust has been in the form of writings published in "*paririmbon*".

Figure 2. Manuscripts of Sundanese belief symbol on the *tunduk* and *paririmbon*.



There are manuscripts of the Sundanese belief symbol of numbers which are a benchmark. On the *tunduk*, the numbers are represented by dots which are made using a scratch knife or skewer tools such as a nail. Representation of these dots can be identified as the natural numbers, i.e.: 1, 2, 3, 4, 5, 6, 7, 8, and 9. These numbers are unique and connect one condition to other conditions. The connectivity of these conditions indicates the existence of mathematical activity. This is more clearly seen on *paririmbon* by the existence of mathematical activity, such as operations of addition, subtraction, multiplication, and

division. Its uniqueness that results from the activity of mathematics then generates new benchmarks that followed and became the principle of local wisdom.

Thus there are two interesting questions that need to be investigated. First, how mathematics is carried out on the Sundanese belief symbol, and second, the influence of ethnomathematics applied to the Sundanese belief symbol on the Sundanese community local wisdom.

Method

This research focuses on the activity of ethnomathematics using the qualitative method with descriptive analysis and an archaeological approach (Alangui, 2001; Barton, 1996). The ethnomathematics activity was examined from Sundanese culture activity (inherent in everyday life) to determine the benchmark numbers that became a symbol of the belief of Sunda.

The primary research data was obtained through the interview against the perpetrators of the culture. The perpetrator is the Sundanese culture which occupies a large area of West Java, Indonesia. However, because not all perpetrators of the culture understand Sundanese belief symbol ethnomathematics, the primary sources in this study was the perpetrator of environmental culture in the life of the Sundanese regarded as Sunda. Location research was in the Cigorowong, Village Sukasetia, district Cisayong, Tasikmalaya district of West Java Province, Indonesia. The primary source was the Sunda at that location, namely, Mr. Darmini and Mr. A. Warma. For the complete interview, data was collected through manuscripts, documents from the primary sources, observation, field notes, photo and video recording. The research was completed between January - March 2018. In terms of data collection, researchers acted as an instrument of research. The data analysis used the ethnographic approach, i.e. the link between culture and mathematics. As the alternative, a mathematical concept was used to elaborate the symbols arising from the activity of ethnomathematics.

Result and discussion

Sundanese belief symbol

Sunda belief basically arises from the philosophical life of the Sundanese. There is an expression in the Sundanese language called the *babasan, cunduk waktu nu rahayu, ninggang mangsa nu sampurna, niti wanci nu mustari, nincak mangsa nu mustika*. This language can be interpreted as the time anticipated, just in time, being in safety and happiness. With that philosophy, everything must be taken into account appropriately in order to survive. According to the beliefs of the Sundanese, each time (number of times) contains the consequences. This belief was later symbolised by the number of benchmarks, including the

numbers 3, 5, and 6. The meaning of this number can be seen from the following interview excerpt:

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Researcher : What is the meaning of the number 3, Sir?
Mr. Warma : Number 3 means: body first, soul second, third treasure.
Researcher : Mean?
Mr. Warma : A body without the soul does not mean; the soul without treasure can't anything.
Researcher : Not understand.
Mr. Warma : At least if it falls on the criteria of the soul, it's not a loss, especially if the entry criteria treasure.

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Researcher : If number 5, what does that mean?
Mr. Warma : The first *hakul pati*, both *hakul miskin*, third *hakulah*, fourth *hakul kaya*, fifth *hakul raja*.
Researcher : What is its purpose?
Mr. Warma : Usually used for someone who wants to run for office, so the ruler or someone who wants to buy something valuable.

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Researcher : So number 6, what does that mean?
Mr. Warma : Well that is used if one wants to travel or relocate the residence, avoiding *kala leutik* (small barrier).
Researcher : Meaning?
Mr. Warma : Remember the proverb, impaled spikes; the first on earth, both above, third in the east, fourth in the south, fifth in the west, sixth in the north.
Researcher : How is it used, Sir?
Mr. Warma : You must know *naktu* days, *naktu dawuh*. Already known, isn't it?
Researcher : Already from Mr. Darmini.

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Excerpts from the interview above provide illumination about the meaning of benchmark numbers 3, 5, and 6. This connection with the benchmark numbers today is called *naktu*. *Naktu* on the day of the benchmark is hereditary and knowledge should be memorised; to proponents of Sunda to record it in the horns and *paririmbon*. An overview of the *naktu* benchmark can be listened to in the passage of the interview here:

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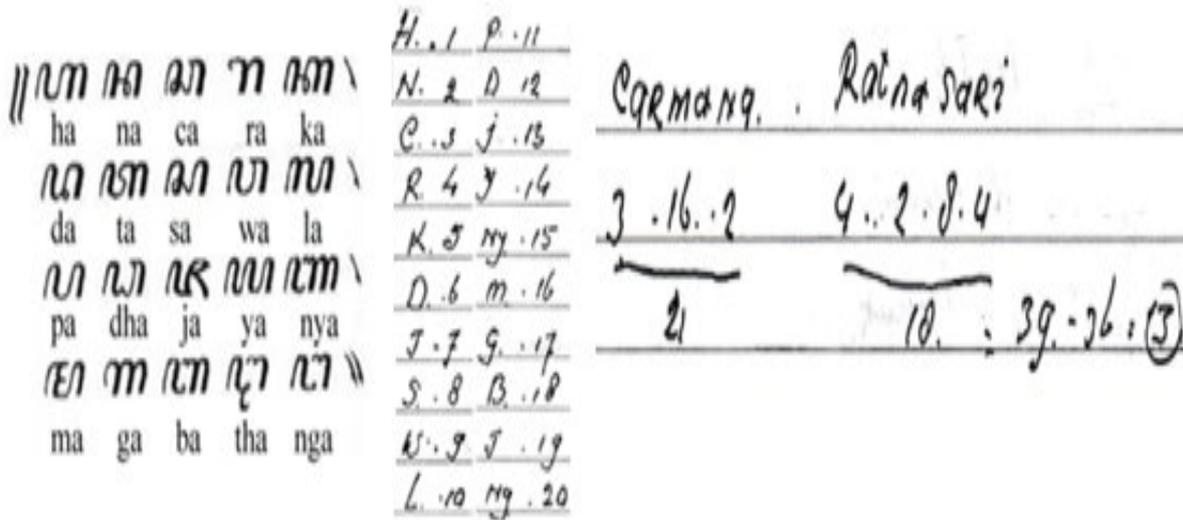
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Researcher : Try uncle, what does *naktu* mean ?
 Mr. A. Darmini : *Naktu* means the benchmark numbers, take a look from the horns [while taking the horn and show it to the researchers.]
 Researcher : Try to explain uncle ?
 Mr. A. Darmini : Try to see these dots [pointing sign dot on horn]. Starting from the *naktu* of Sunday 5; Monday 4; Tuesday 3; Wednesday 7; Thursday 8; Friday 6; and Saturday 9.
 Researcher : If *naktu dawuh*?
 Mr. A. Darmini : *Naktu dawuh*, there is *manis* 5; *pahing* 9; *pon* 7, *wage* 4; and *kliwon* 8.

Sundanese belief symbol and local wisdom

The local wisdom that emerges from the Sundanese belief symbol can be traced to the Sunda people's identity. This identity is associated with the name, place of residence, life partner, and day-to-day activities. Identification on this identity is based on the *naktu* day and Sundanese script *hanacaraka*, and boils down to the benchmark numbers 3, 5, and 6.

Figure 3. Manuscripts *Hanacaraka* and symbol of identity



Sundanese script *hanacaraka* sequence is composed starting from 1 to 20. These sequences are used in determining the number for a person's name or the name of a spouse, such as Carmana and Ratnasari. The following interview excerpt gives an overview of mathematical activity on behalf of a person or a couple.

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- Mr. Warma : For example, Carmana, consider: $C = 3$; $M = 16$; and $N = 2$.
- Researcher : Yes, Sir. But why are the letters A and R not counted?
- Mr. Warma : Letter C life [that is, in the phrase of one CAR, C as a benchmark], R is not counted, dead. How many, 3 add 16 add 2? So 21. Well, this is a good result.
- Researcher : Why?
- Mr. Warma : Just try counting, $21 - 9 - 12 = 6 = 3$, the remaining three means of treasure. Nice name Carmana was born Tuesday, the life (good luck) of treasure.
- Researcher : Why can fathers guess the day of inception of Tuesday?
- Mr. Warma : Because of the letter C is equal to 3, three was *naktu* today Tuesday. Well, now his partner Ratnasari, $R = 4$; $N = 2$; and $S = 8$; what is the number?
- Researcher : 18.
- Mr. Warma : Okay, try with a total of Carmana, so 18 to 21 is equal to 39, took 36 the remaining 3, good. Now total with birthdays respectively.
- Researcher : Ratnasari means R, equals 4, *naktu* Monday. Means 39 added 4 add 3, so 46.
- Mr. Warma : 46 minus 21, so 25; subtract 12, so 13; subtract 9, so 4; subtract 3, so the rest of 1.
- Researcher : Why were the results not so good?
- Mr. Warma : No problem, then total the (accumulated) with the name of the village. Therefore, do not forget to choose the right place to live in number?
- Researcher : If like that, Sundanese is not rash to seek shelter? This is resulting in the Sundanese could further spread to everywhere.
- Mr. Warma : Like that. If we know the matter, we would not be rash in undertaking life.
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The above interview excerpt illustrates that ethnomathematics activity is going on when operating the *naktu* benchmark numbers and also the arrangement of numbers on a revised *hanacaraka* script. Meanwhile, the benchmark number 3 is a target if it is associated with the concept of mathematics of modulo. The concept has been applied to find the remainder of modulo results for those who are later reconciled with the meaning of benchmark 3; body, soul, and treasure.

The interesting findings from benchmark 3 are the implications of the results for mobilising against the local wisdom. As reflected in the interview, the rest of the results for 3 will affect the pattern of life of the Sundanese. Regardless of the number of symbols against confidante Sundanese and also the context of rationality, the implication of the Sundanese belief symbol impacts on at least two things; first, prudence in life; both equalization. Caution implies carefulness and maturity in the act; when this is achieved, the attitude and behaviour towards

nature around will be kept. Equalisation in this context is the spread evenly. Since Sundanese should affiliated calculations on the residence, then the spread of Sundanese will be occurred. On the benchmark number 5 and number 6, the rest of the quotient of two numbers. This is a target that is sought to be matched with the meaning of each number on both the benchmark numbers. Excerpts of the interview below provide ways in which the Sundanese people find the rest of the quotient of the number 5 and number 6.

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Mr. Warma : For example, if you want to nominate a leader; this year is the year of Za, the *naktu* 7; the name Carmana, want to nominate themselves to become regent.

Researcher : Means 7 add 21 to 28.

Mr. Warma : Yes, 28 minutes 25 get the rest of 3; the possibility is not so.

Researcher : Means, if the benchmark 6; for example, March 25, 2017.

Mr. Warma : See the Hijri calendar, now it's the 25th.

Researcher : 25 minus the 24, remaining one; the danger is in the Earth; what does that mean?

Mr. Warma : Yes, you can't travel everywhere and must not do damage on Earth.

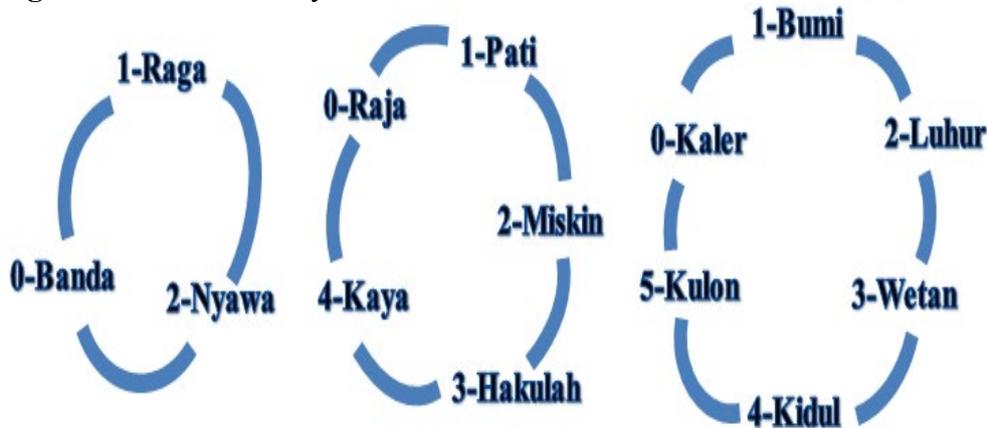
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Based on an excerpt of the interview above; local wisdom arising on the symbol number 5 or number 6 more to the thoroughness in the act. At a time when the rest of division 1 in the benchmark 6; the means is *kala* or danger existing on earth. Sunda people are clever to keep a respectful attitude towards nature and not cause destruction of nature. Local wisdom of the Sundanese basically arises from individual awareness of maintaining good relations between their fellows and also with the surrounding natural environment. Nevertheless, life in modern Sundanese, especially for perpetrators of the Sundanese culture that understand the philosophy of numbers; interpret the numbers as *ugeran*; not to act rashly or without a basis of calculation.

Mathematical model of Sundanese belief symbol

Based on mathematical activities practiced in the benchmark of numbers 3, 5, and 6; the rest of each group of benchmark numbers is basically determined by the sequence of numbers which are cyclic. Suppose to number 21 in the benchmark 3; that means back to zero after the number 3 or 7 rounds; then the number 28 in the benchmark 5, back to number 3 after 5 rounds. Similarly, the number 25 in the benchmark 6, back to number 1 after 6 rounds. Cycle numbers from each benchmark numbers can be illustrated in the following figure.

Figure 4. The rotation cycle numbers on the benchmark numbers 3, 5, and 6.



To determine the rest of the division at each group of benchmark numbers, presented here are the stages of mathematical activity in each group of benchmark numbers, numbers 3, 5 and 6.

a. On the number 3

On the activity of the resulting summation ethnomathematics number 46.

Step-1: $46 - 21 = 25$ or can be written $46 - 7.3 = 25$

Step-2: $25 - 12 = 13$ or can be written $25 - 4.3 = 13$

Step-3: $13 - 9 = 4$ or can be written $13 - 3.3 = 4$

Step-4: $4 - 3 = 1$ or can be written $4 - 1.3 = 1$

b. On the number 5

The resulting ethnomathematics activities on the summation of the number 28, so $28 - 25 = 3$ or may be written $28 - 5.5 = 3$

c. On the number 6

On the activity generated ethnomathematics summation of number 25, making it $25 - 24 = 1$ or can be written $25 - 6.4 = 1$

Refer to understanding modulo (Andreescu and Andrica, 2009; Coppel, 2009), an operation that involves integers m, a, b where $b/a-m$ and $m \neq 0$, written $a \equiv b \pmod{m}$. In other words $a \equiv b \pmod{m}$ where $a = mq + b$, with $0 \leq b < m$. Some properties relating to the understanding, are:

1. m/a means $\exists q \in \mathbb{Z}$ such that $a = mq$ (Divisibility definition).
2. $m/a - b$ means $\exists q \in \mathbb{Z}$ such that $a - b = mq$ (Division).
3. Because $a - b = mq \Leftrightarrow a = mq + b$ then apply $a \equiv b \pmod{m}$ and $0 \leq b < m$ (Modulo).
4. $a \equiv b \pmod{m}$; $b \equiv c \pmod{m}$; $c \equiv d \pmod{m}$, then $a \equiv d \pmod{m}$ (Transitive).

Based on the notion of modulo and division properties, then the activity ethnomathematics on benchmark numbers 3, 5, and 6 can be explained as follows.

a. On the number 3

- $46 - 21 = 25 \Leftrightarrow 46 - 7.3 = 25$ or $46 \equiv 25 \pmod{3}$
- $25 - 12 = 13 \Leftrightarrow 25 - 4.3 = 13$ or $25 \equiv 13 \pmod{3}$
- $13 - 9 = 4 \Leftrightarrow 13 - 3.3 = 4$ or $13 \equiv 4 \pmod{3}$
- $4 - 3 = 1 \Leftrightarrow 4 - 1.3 = 1$ or $4 \equiv 1 \pmod{3}$

Thus $46 \equiv 1 \pmod{3}$

b. On the number 5

$$28 - 25 = 3 \Leftrightarrow 28 - 5.5 = 3 \text{ or } 28 \equiv 3 \pmod{5}$$

c. On the number 6

$$25 - 24 = 1 \Leftrightarrow 25 - 6.4 = 1 \text{ or } 25 \equiv 1 \pmod{6}$$

Suppose P is the result of calculations based on the benchmark *naktu* and/or the number of *hanacaraka* and s is the remainder of division by the benchmark numbers 3, 5, or 6, then $\exists q \in \mathbb{Z}$ such that:

- $P \equiv s \pmod{3}$ where $P = 3q + b$, with $0 \leq b < m$.
- $P \equiv s \pmod{5}$ where $P = 5q + b$, with $0 \leq b < m$.
- $P \equiv s \pmod{6}$ where $P = 6q + b$, with $0 \leq b < m$.

Conclusion

It is concluded that the activity of mathematics in the Sundanese belief symbol is the interconnectedness between the benchmark numbers, especially *naktu* and benchmark of the Sundanese script and Javanese script. It is also through a specific number modulo operation on (3, 5, 6), the rest of the quotient between the benchmark numbers implies identity in determining the name, place of residence, life partner, as well as the activities of everyday life. It is highlighted that the influence of the Sundanese belief symbol ethnomathematics on Sundanese culture formed a local wisdom in maintaining the balance of nature which is manifested in an attitude of full calculation in taking action, keeping good relations with others, maintaining relationships with nature, and equitable spread of the population.

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