Carrying Javanese Local Wisdom In Mathematical Model

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Abstract. People of Cikakak Traditional Village, Wangon District, Banyumas Regency, Central Java Province are known as the followers of Islam Aboge (Alif Rebo Wage). Their religious holidays such as the beginning of fasting month (Ramadan) and Eid al-Fitr are determined based on the rules they have been using so far, namely Month Code or Sandi Bulan and Year Code or Sandi Tahun. This research is conducted using literature study method and field study in the form of interview with respondents. This research aims at producing a mathematical model which matches the function of these two codes. The results obtained are five mathematical equations to determine the names of year, saptawara and pancawara days for the 1st day of each month, and saptawara and pancawara days for other dates.

1. Introduction

In Javanese calendar, it has been in the fourth kuruf [1], i.e. Asapon (Alif Selasa [Tuesday] Pon) kuruf. However, many Javanese people still continue to use the third kuruf, i.e. Aboge (Alif Rabu [Wednesday] Wage). Kuruf itself is a cycle which lasts for 120 years with each year consisting of 354 (short year) or 355 days (long/leap year). In this time interval there are 45 leap years (wuntu years).

Aboge calendar is a Javanese one, beginning since the 1st day of Sura 1555 Javanese Calendar. The difference is that Aboge calendar ceases at the third kuruf and Javanese calendar keep on continuing to the next kuruf. This calendar which is used by Aboge people who implement Islam in their own way. The Aboge calendar is still used by Islam Aboge followers who live in Cikakak Village, Wangon District, Banyumas Regency. Aboge calendar is used for two matters, namely religious and traditional celebrations.
or ceremonies. For these people, Aboge calendar is everlasting and eternal thus it will never reach the next kuruf [6].

Syahrin, Turmudi and Puspita [9] have presented the results of their study on the implementation of Aboge calendar in Keraton (Kingdom) Kasepuhan, Cirebon. According to Syahrin, Turmudi and Puspita [9], this Aboge calendar is used only for celebrations of traditional nature such as new year commemoration on the 1st day of Sura (1 Muharram), Muludan (12 Rabi’ al-awwal), Nisfu Sha’ban, Panjang Jimat (12 Mulud), jamasan (purification) of royal coach Singa Barong (Sura 5th), and Caos (hospitality) tradition with the Sultan (King) of Kasepuhan. The people of keratons use Javanese calendar only for tradition purpose, but people in Cikakak uses Aboge calendar for two functions, tradition and religion [2, 3, 4, 5].

To determine the time for a celebration to be held, Aboge people in Cikakak has developed a knowledge known as Sandi Bulan (Month Code) and Sandi Tahun (Year Code). In this article, a mathematical model will be made. This model will have a function which matches these two codes.

2. Methods
This research is conducted using literature study method and field study in the form of interview with respondents. Many of the literature used in this research are historical archives. One respondent who still understands the Aboge calendar i.e. Mbah (grand father) Sukemi is a subject in this research.

3. Result and Discussion
3.1 Constituents of Aboge Calendar
Aboge Calendar is built by several elements such as (1) name of saptawara days, (2) name of pancawara days, (3) name of selapanan days, (4) names of year which form a windu (8-year) cycle, (5) names and date of month, and (6) the existence of short and long years. Like any other calendars, Aboge calendar also has year number and every year number has its year name. In Aboge as well as Javanese calendars, other than the 7-day (called as saptawara) and 5-day (called as pancawara or pasaran) cycles, there is also an 8-year cycle (called sewindu). The combination of 7- and 5-day cycles results in a cycle which lasts for 7 x 5 days or 35 days. This cycle is called selapan or selapanan [7, 8].

The saptawara cycle starts from Wednesday. The saptawara days then sequentially are Thursday, Friday, Saturday, Sunday, Monday and Tuesday. After Tuesday, it comes to Wednesday again. In Javanese, the week consists of such days as Rebo, Kemis, Jemawat, Setu, Ahad, Senen, and Slasa. The pancawara cycle starts with Wage. The pancawara days then are Klion, Legi, Paing and Pon in sequence. After Pon it comes back to Wage. The combination of saptawara and pancawara days which results in selapanan cycle starts from Rebo Wage (Wednesday Wage), Kemis Klion (Thursday Klion) and it ends in the 35th day, i.e. Selasa-Pon. The next day is Rebo-Wage (Wednesday Wage) again.

One windu cycle which lasts for eight years begins with Alif year. Hence, in Aboge Calendar, its first year is Alif, the first saptawara day is Rebo (Wednesday) and the first pancawara day is Wage, thus Aboge which stands for Alif Rebo Wage. The meaning contained in the term Aboge is that the new year falls in the 1st day of Sura (first month) of Alif year on Rebo Wage. Each year in one windu year is called in sequence as Alip, He, Jimawat, Je, Dal, Be, Wawu, and Jimakir. Each year consists of 12 months called as Sura, Sapor, Mulud, Bakda Mulud, Jumadiulawal, Jumadilakir, Rajah, Ruwah, Pasa, Saval, Apit, and Rayagung. The odd-number months consist of 30 days, and the remaining have 29 days. The number of days in a year is 354. The year consisting of 354 days is called short year (common/wastu).

In the sewindu cycle which lasts for eight years, there are three long year (leap/wuntu), they are 2nd, 5th and 8th years or the He, Dal and Jimakir years. The leap year has 355 days. The 1 day addition is made to the last month hence the Rayagung month has 30 days. Thus, the Aboge calendar starts from Sura 1st,
Aboge year name, let us assume calendar, it turns out 1439 Hijri coincides 1951

Why is the cycles in one year. Hence, the different yet equivalent formula from equation (2). The said formula is given in equation (4):

Syahrin, Turmudi and Puspita (2015) give a model of determining the year name in Aboge calendar. The derivation of equation (2) to equation (4) is

Currently, it is 1952 Javanese year. One year before is 1951. Since Aboge calendar is none other than the Javanese calendar created by Sultan (King) Agung Hanyokrokusumo, then Aboge calendar year number is the same as that Javanaese calendar.

3.2 Determining Year Name

If the Aboge calendar has reached 1951, then what is the year name? To determine the year name, subtract the year with 1554 and the result is divided by 8. If the remaining number is 1, then the year name is Alif. If the remaining number after subtraction is 2, then the year name is He, and so forth. This remaining number after subtraction is called as jejem. This way, then 1951 is the Dal year.

Why is the sekaten of 2017 which is also the year 1951 in Javanese calendar a Dal year? To determine a year name, let us assume A is the year number in Javanese or Aboge calendar. The year name in Aboge calendar is jejem (remaining amount after division) j which fulfills the equation (1):

\[ A - 1554 = 8p + j \]  

(1)

If what is known is the year number in Hijri calendar (H), then the year name in Aboge calendar is jejem (remaining amount after division) j which fulfills the equation (2):

\[ ((H + 512) - 1554) = 8p + j \]  

(2)

with p is non-negative integer and jejem j = 1,2,3,4,5,6,7,8 respectively state the year names Alip, He, Jimawal, Je, Dal, Be, Wawu, and Jimakir. Please note that the remaining amount after division (jejem) in Javanese calculation concept is never 0. In Javanese philosophy, 0 is a death number which needs to be avoided. This is different from modulo in mathematics which may have a remaining amount of 0. For example, for the year number in Aboge calendar 1951, from equation (1) its year name is: 1951 – 1554 = 8p + j ⇔ 397 = (8 × 49) + 5. This calculation gives a result p = 49 and jejem j = 5 hence the year 1951 is a Dal year.

Furthermore, suppose the year number in Hijri Calendar is 1439, then with equation (2) the year name is ((1439 + 512) – 1554) = 8p + j ⇔ 397 = (8 × 49) + 5. The remaining 5 is a jejem and it indicates the Dal year. Hence, the Aboge year which coincides with 1439 Hijri is a Dal year. Looking at the Christian calendar, it turns out 1439 Hijri coincides 1951 Aboge year, and it falls in 2017. The conversion of Hijri to Aboge calendars fulfills the equation (3):

\[ A = H + 512 \]  

(3)

Syahrin, Turmudi and Puspita (2015) give a model of determining the year name in Aboge calendar using different yet equivalent formula from equation (2). The said formula is given in equation (4):

\[ H - 2 = 8p + j \]  

(4)

The derivation of equation (2) to equation (4) is

\[ ((H + 512) - 1554) = 8p + j ⇔ H - ((130 × 8) + 2) = 8p + j ⇔ H - 2 = 8 × (130 + p) + j ⇔ H - 2 = 8k + j \]

Using equation (4) the same result is obtained, i.e. the jejem for 1439 year number in Hijri calendar is equal to 5, hence 1439 H is a Dal year. The calculation is 1439 – 2 = 8p + j ⇔ 1437 = (8 × 179) + 5.
3.3 Determining Day Name for the 1st day of Sura

From the previous calculation example, it is found that the Aboge year number 1951 is a Dal year. So, what day is the 1st day of Sura in the Dal year of 1951? One of public figures who still understands the Aboge calendar is Mbah (Grand Father) Sukemi (figure 1 left side). From him, we obtain a code which serves as a key to understanding the Aboge calendar. The code consists of eight subcodes and called as Year Code or Sandi Tahun. We still cannot comprehend many of the knowledges Mbah Sukemi has given. One of them is the Aboge Calculator (figure 1 middle and right side).

Figure 1. Respondent: Mbah (grand father) Sukemi and Aboge calculator (Photo: Private Collection)

Year Code: Aboge (Alif Rebo Wage), Hadpona (He Ahad Pon), Jimwaljepon (Jimawal Jemuah Pon), Jesaing (Je Slasa Paing), Daltunis (Dal Setu Manis), Bemisnis (Be Kemis Manis), Wanenwon (Wawu Senen Kliwon), and Jinkirjege (Jimakir Jemuah Wage). These subcodes mean the 1st day of Sura of Alif year falls on Wednesday Wage hence Aboge (Alif Rebo Wage). Likewise, the 1st day of Sura of He year falls on Ahad (Sunday) Pon. This can be figured out from the He Ahad Pon coding, abbreviated as Hadpona. Hence, since the Aboge year 1951 is a Dal year, then the celebration of new year on the 1st day of Sura falls on Setu/Saturday Manis, deriving from the coding Daltunis (Dal Setu Manis).

One of the Year Code uses is to determine when the holiday Eid al-Fitr is. The key used is: ”The day is the same, yet its pasaran is the next one,” just as Mbah Sukemi explains. It means the Eid al-Fitr will fall on the same day as the 1st day of Sura, yet its pasaran day shifts to the next one. Thus, the 1st day of Shawwal of Alif year will fall on Wednesday Kliwon. For 1951 in Aboge calendar, the Eid al-Fitr holiday of the 1st day of Shawwal will fall on Saturday Paing.

In addition to those subcodes, there is another code which explains the day name on the 1st day of each month. The code consists of 12 subcodes and named Month Code or Sandi Bulan. In this code, the first syllable shows the month name of 12 months in Aboge calendar. The second syllable is the code for saptawara day name with 1 meaning Wednesday and so on. The third syllable is a code for pasaran (pancawara) day names with 1 means Wage and so forth. In Javanese, the sequence from 1, 2, 3, 4, 5, 6 to 7 is ji, ro, lu, pat, ma, nem, tu.

These subcodes have the following meanings: Ram-ji-ji means the 1st day of Sura of Alif year falls on Rebo Wage. Par-lu-ji means the 1st day of Sapar of Alif year falls on Jumat Wage, and so on hence the 1st day of Shawwal of Alif year is coded as wal-ji-ro or the Shawwal 1st of Alif year falls on Wednesday Kliwon. This result confirms what Mbah Sukerni explains, i.e. that the 1st day of Shawwal will fall on the same day and the next pasaran from the 1st day of Sura.

Meanwhile, for 1951 year which is a Dal year, the 1st day of Sura falls on Setu (Saturday) Manis, hence the 1st day of Shawwal will fall on Setu Paing. In a Dal year, the Ram-ji-ji code means the 1st day of Sura falls on Setu Manis which matches the Daltunis (dal setu manis) code. This means that the first 1 is Setu and the second 1 is manis. As a result, the Shawwal 1st will fall on Wal-ji-ro or sawal-1-2 hence Shawwal 1st falls on Setu Paing.
3.4 Transformation of Local Wisdoms into Mathematical Model
These local wisdoms turn out having mathematical nature. From the year code with its eight subcodes, each subcode can be coded with numbers. The above Calendar begins with Sura 1st on Wednesday Wage hence Wednesday, Thursday, Friday, Saturday, Sunday, Monday and Tuesday are coded 1, 2, 3, 4, 5, 6 and 7. Likewise, Wage, Kliwon, Manis, Paing and Pon are coded 1, 2, 3, 4 and 5. Using this codification, the Year Code can be stated as Alif 1-1, He 5-5, Jimawal 3-5, Je 7-4, Dal 4-3, Be 2-3, Wawu 6-2, and Jimakir 3-1. The first numbers in these codings are then named jejem tahun for saptawara days and the second numbers are called jejem bulan for saptawara or pasaran days.

Month Code: Ram-ji-ji, Par-lu-ji, Lud-pat-ma, Walud-nem-ma, Diwal-tu-pat, Dikir-ro-pat, Jab-lu-lu, Ban-ma-lu, Don-nem-ro, Wal-ji-ro, Dah-ro-ji, and Jah-pat-ji

Furthermore, also formulised is jejem bulan for saptawara days, i.e. 7, 2, 3, 5, 6, 1, 2, 4, 5, 7, 1 and 3 respectively for such months as Sura, Sapar, Mulud, Bakda/Sawal Mulud, Jumadilawal, Jumadilakir, Rajab, Ruwah, Pasa, Sawal, Apit, and Rayagung. Jejem bulan for saptawara days is 5, 4, 4, 3, 3, 2, 2, 1, 1, 5 and 5, sequentially for the same order of months.

Suppose the jejem tahun and jejem bulan for saptawara days are $t_s$ and $b_s$. The saptawara day name for the 1st day is jejem (remaining amount after division) $j_s$, which meets the equation (5):

$$t_s + b_s = 7p + j_s$$

with $j_s = 1, 2, 3, 4, 5, 6$, and 7 respectively for Wednesday, Thursday,..., Tuesday.

Using the same method, the saptawara day name for the 1st day is jejem (remaining amount after division) $j_p$, which meets the equation (6):

$$t_p + b_p = 5p + j_p$$

with $j_p = 1, 2, 3, 4$, and 5 indicating Wage, Kliwon, Legi, Paing and Pon.

Equation (5) is a mathematical model for saptawara day name on the 1st day of all months and in each year name. Equation (6) is a mathematical model for saptawara day name on the 1st day for all months and in each year name. For example, the day name on the 1st day of Sapar of Dal year is:

$$t_s + b_s = 7p + j_s \Leftrightarrow 4 + 2 = 7p + j_s \Leftrightarrow 6 = (7 \times 0) + j_s \Leftrightarrow j_s = 6$$

The remaining amount after division $j_s = 6$ suggests it is Monday in saptawara cycle, and

$$t_p + b_p = 5p + j_p \Leftrightarrow 3 + 5 = 5p + j_p \Leftrightarrow 8 = (5 \times 1) + j_p \Leftrightarrow j_p = 3$$

The remaining amount after division $j_p = 3$ suggests it is Legi day in saptawara cycle. Thus, the 1st day of Sapar of Dal year will fall on 6-3 day or Monday-Legi. Now, what is the day name on the 12th day of Rajab of Be year? Equations (5) and (6) can only be used to determined the day name on the 1st day of Rajab of Be year. To determine the day name on other dates than the 1st, equations (5) and (6) need to be modified to equations (7) and (8) as follows:

Suppose the jejem tahun and jejem bulan for saptawara days are $t_s$ and $b_s$. The saptawara day name for the $d$ th day is jejem (remaining amount after division) $j_s$, which meets the equation

$$t_s + b_s + (d - 1) = 7p + j_s$$

Using the same way, the saptawara day name for the 1st day is jejem (remaining amount after division) $j_p$, which meets the equation

$$t_p + b_p + (d - 1) = 5p + j_p$$

Using equations (7) and (8), the day name on the 12th day of Rajab of Be year is $((2+2)+(12-1))$ modulo 7 = 15 modulo 7 = 1 and $((3+2)+(12-1))$ modulo 5 = 16 modulo 5 = 1. Hence, the 12th day of
Rajab of Be year is Wednesday Wage. For the same date and month yet different year, then the year name is also different. For example, the 12th day of Rajab of Wawu year, it will fall on 1+11 modulo 7 or 5 (Sunday) and 4+11 modulo 5 or 5 (Pon). Thus, the 12th day of Rajab of Wawu year falls on Sunday Pon. In the calculation of Islam Aboge community which is based on equations (7) and (8), the 10th day of Besar of the Dal year 1951 falls on 7+9 modulo 7 or 2 (Thursday) and 3+9 modulo 5 or 4 (Paing). Thus, the Eid al-Adha in the Dal year 1951 falls on Thursday Paing.

4. Conclusion and Suggestion

The people of Cikakak Village have developed knowledge to determine the day name on each date for a year. The first step is determining the day name on the new year the 1st day of Sura which is done using the Year Code. The second step is determining the day name on other dates using the Month Code. The Aboge calendar construction using the Year and Month Codes can be modeled mathematically. The first step is determining the year name using equation (1). The second step is determining the saptawara and pancawara day names for the 1st day of all months using equations (5) and (6). The third step is determining the saptawara and pancawara day names for the \( d \) th day in all months using equations (7) and (8).

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