Carrying Javanese Local Wisdom In Mathematical Model

by Ngadiman Ngadiman

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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.

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, Jemuah, Setu, Ahad, Senen,* and *Slasa*. The *pancawara* cycle starts with *Wage*. The *pancawara* days then are *Kliwon*, *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 Kliwon* (Thursday *Kliwon*) 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*, *Jimawal*, *Je*, *Dal*, *Be*, *Wawu*, and *Jimakir*. Each year consists of 12 months called as *Sura, Sapar, Mulud, Bakda Mulud, Jumadilawal, Jumadilakir, Rajab, Ruwah, Pasa, Sawal, 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 last 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,

Sura 2nd, *Sura* 3rd and so on until 29/30 *Rayagung*. Afterwards, it comes back to 1 *Sura* which constitutes the new year.

In *Aboge* calendar, the number of days in one *windu* is (354 x 8) + 3 = 2,835 days, and the number of *selapanan* cycles in one *windu* is 2,835 : 35 = 81 *selapanan* cycles. Furthermore, the number of days in one *kuruf* is (354 x 120) + 45 = 42,525 days or 1,215 *selapanan*s.

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):

$$A-1554=8p+j \tag{1}$$

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):

$$((H+512)-1554)=8p+j \tag{2}$$

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: $1951-1554=8p+j \Leftrightarrow 397=(8\times 49)+5$. 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 $((1439+512)-1554)=8p+j \Leftrightarrow 397=(8\times 49)+5$. 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):

$$A=H+512 \tag{3}$$

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):

$$H-2=8p+j \tag{4}$$

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

$$((H+512)-1554)=8p+j \Leftrightarrow H-((130\times 8)+2)=8p+j \Leftrightarrow H-2=8\times(130+p)+j \Leftrightarrow H-2=8k+j$$

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 $1439-2=8p+j \Leftrightarrow 1437=(8\times 179)+5$.

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 Jimkirjege* (*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* Sukemi 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 *Aboge* 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 tahun* for *pancawara* 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 formulaed 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 *pancawara* days is 5, 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):

$$t_s + b_s = 7p + j_s \tag{5}$$

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

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

$$t_p + b_p = 5p + j_p \tag{6}$$

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 *pancawara* 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:

$$t_s + b_s \equiv 7p + j_s \Leftrightarrow 4 + 2 \equiv 7p + j_s \Leftrightarrow 6 \equiv (7 \times 0) + j_2 \Leftrightarrow j_s = 6$$

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

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

The remaining amount after division $j_p = 3$ suggests it *Legi* day in *pancawara* 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

$$t_s + b_s + (d-1) = 7p + j_s \tag{7}$$

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

$$t_p + b_p + (d-1) = 5p + j_p \tag{8}$$

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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