DEVELOPMENT OF MEASUREMENT SYSTEM IN PAYANGO (A TRADITIONAL BUILDING PLANNING SYSTEM) TO MEASURE COMPLEX BUILDING SHAPES

[1]Abdi Gunawan Djafar, [2]Ernawati, [3]Khalih Trumansyahjaya, [4]Niniek Pratiwi, [5]Nurrizka Febriany Ramdhani

[1]the Architectural Engineering Department, Faculty Of Engineering, Gorontalo State University, Indonesia.

[2]the Architectural Engineering Department, Faculty Of Engineering, Gorontalo State University, Indonesia.

[3]the Architectural Engineering Department, Faculty Of Engineering, Gorontalo State University, Indonesia

[4]the Architectural Engineering Department, Faculty Of Engineering, Gorontalo State University, Indonesia.

[5]student Of The Architectural Engineering Department, Faculty Of Engineering, Gorontalo State University, Indonesia.

Abstract

Payango is a traditional building planning system in Gorontalo which consist of: defining the building measurement unit, determining the size of a building, determining the orientation of the building, determining the position of doors and windows, and etc. Defining the measurement unit and determining the size of the building is the first step to be done which will also affect the other steps. To define the measurement unit, one fathom long of bamboo or wood stick is needed, then remove one-third long of the stick, the remaining two-third then is used as the measurement unit. The stick is then divided into 8 segments and marked. Each of the segments named as follows: Grace, Ill-fated, Reward, Loss, Give birth, Death, Age, and Scorched. The odd segments are favorable because they have good meaning, and it is believed will bring good fortune to the building owner, while the even segments have bad meaning. The building's length and width should be on the odd segments, as to prevent bad luck happened to the building's owner. The odd number of things is a characteristic of Gorontalonese architecture. The one who will measure or do the *payango* is called *ta momayango*, mostly men in their 50s. In the development of contemporary architecture, the building shapes becoming more complex and challenging for *ta momayango* to measure them. This article discusses the steps to measure in *payango*, the principle of measuring in *payango*, and the development of *payango* by making mathematical model and with the help of a procedural modelling software to measure the complex floorplan shapes. This research seek to help the work of *ta momayango*, and conserving one of Gorontalonese culture.

Key words: Reinvention, Measurement System, Local Tradition, Gorontalo

Introduction

Payango is a word from Gorontalo language which means 'measure'. The verb form, *momayango*, means to determine and to put the measure on something which about to be built. While *ta momayango*, (literally means the one who measure) is the expert in *payango* who will define the measurement unit and determine the building size. As a profession, *ta momayango* could be related to architect, since the ability to plan a building.

Practically, it is already a custom for Gorontalonese to *payango* every single building they will build. House, mosque, shop, and even a well need to be measured using *payango* rules. The locals believe that every construction will affect the owner/the user's life, and therefore measurement be the decisive factor whether the building will give a good influence or a bad influence. *Payango* has been practiced since Islam arrived in Gorontalo. It is a tradition that still well practiced and conserved by the natives [Ernawati, 2017].

Eventhough the word *payango* means measure, *payango* itself is not only about the measurement process, but also encompasses the process of determining the building's height (stilt, wall, and roof), orientation of the building, position of doors and windows along the perimeter wall, size of the doors and windows, the first and the last foundation to be built, and position of the roof's tie beams. *Payango*

will firmly decide the building's construction, hence *payango* could be named as a traditional building planning system.

Before the construction begin, the building owner need to hold a discussion between the elders, the ulama, and the village/town leader to make agreements on the construction time and preparation of everything needed in the construction process. At the agreed time, *payango* begins. The measurement process started with making a template using a stick of wood or bamboo. The length of the stick should be one fathom long, the same length as the building owner's fathom. One-third long of the stick is then cut and removed. The remaining two-third is used as the building measurement unit. The stick is then divided into 8 segments and marked (see figure 1). Each of the segments named as follows: Grace, Ill-fated, Reward, Loss, Give birth, Death, Age, and Scorched. On the odd segments are grace, reward, give birth, and age. These segments are favorable because they have good meaning, and it is believed will bring good fortune to the building owner, while the even segments have bad meaning. The building's length and width should be on the odd segments, as to prevent ominous event for the property and the owner's future.

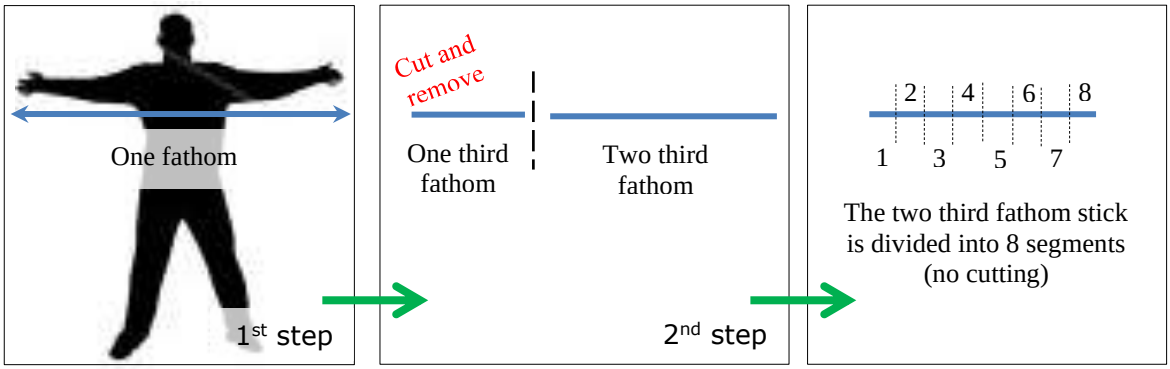

Figure 1. Process of making the template to measure building.

It is believed that each segment in the *payango* template will give predispose to the building owner as the given name. For instance if the building owner seek to get and feel virtue from the God, the building's size should be on the grace segment. If the building owner wanted to get good fortune and wealth, the building's size should be on the reward segment. If the building owner hope to get offspring, the building's size should be on the give birth segment. If the building owner wanted to live-long in age, the building's size should be on the age segment. Commonly, *payango* can also be done not only to a residential building, but also to a public building like places of worship, offices, hospitals, shops, and markets. There are proper segment for certain type of building. The places of worship's size should be on the grace segment. The shops size should be on the reward segment. The maternity ward's (in a hospital) size should be on the give birth segment. The emergency room's (in a hospital) size should be on the age segment. Each of the segment could related to any building type and its function.

The fathoms of two people are needed to *payango* a building. The template in setting the length of the house would be made by measuring the husband's fathom, while the template to measure the width of the house would be made by measuring the wife's fathom. It implies that in the past a house is owned by a married couple, or to build a house people should get married beforehand. Nowadays *ta momayango* allowed a single person to *payango* his/her house using only his/her own fathom to make the template and use that one template to measure both the length and the width of the house. For a government building, since fathoms of two people is needed, the head of the government's fathom is used to create the template for specifying the length. Meanwhile in measuring the construction's width, the template is made by using the vice head of the government's fathom [Usman, 2017].

The length of one's fathom is relatively the same as one's height (if the ape index equals to 1). The template itself is small, only two third of one's fathom. While the building's size is always longer than the template. So, in the building measurement process, the template needs to be moved several times from one edge until it reached the other edge of the planned size.

The owner might have a planned building dimension, but the size needs to be evaluated by *payango* to see whether the planned building size will be on the good segments (the odd numbers) or the bad segments (the even numbers). Therefore, if the planned building size is on the even segments of the template, then he should change the planned size to be on the closest odd segment (if he would like to make a slight change) or to a specific odd segment he would like. For example if the planned building size is on the scorched segments, then the owner should change the planned size to be on the age segment (reducing the planned size by 1 segment) or to be on the grace segment (adding the planned size by 1 segment), see figure 2.

It is common for the owner and *ta momayango* to set the *Payango* on the construction site. *Payango* traditionally not integrated yet in the planning process. If someone wants to take *payango* into consideration in building something, he should ask the help of *ta momayango* beforehand. *Ta momayango* would come to the construction site and give advice and instructions to the building owner. Integrating *payango* into the planning process should be done to avoid any miscoordination between the building owner, the consultant, and *ta momayango*, especially if the building is planned to follow the *payango* rules. Nowadays the building planning process adopt modern technology, as a result the building has become more developed and more complex. Therefore *payango* -a traditional building planning system- should also make use of the technology, and develop to meet the challenges of contemporary architecture. Development of *payango* is needed so it would be more applicable, not considered as outdated or irrelevant with contemporary architecture. By doing so, *payango* would still be practiced, and finally conserving one of the Gorontalonese cultural heritage.

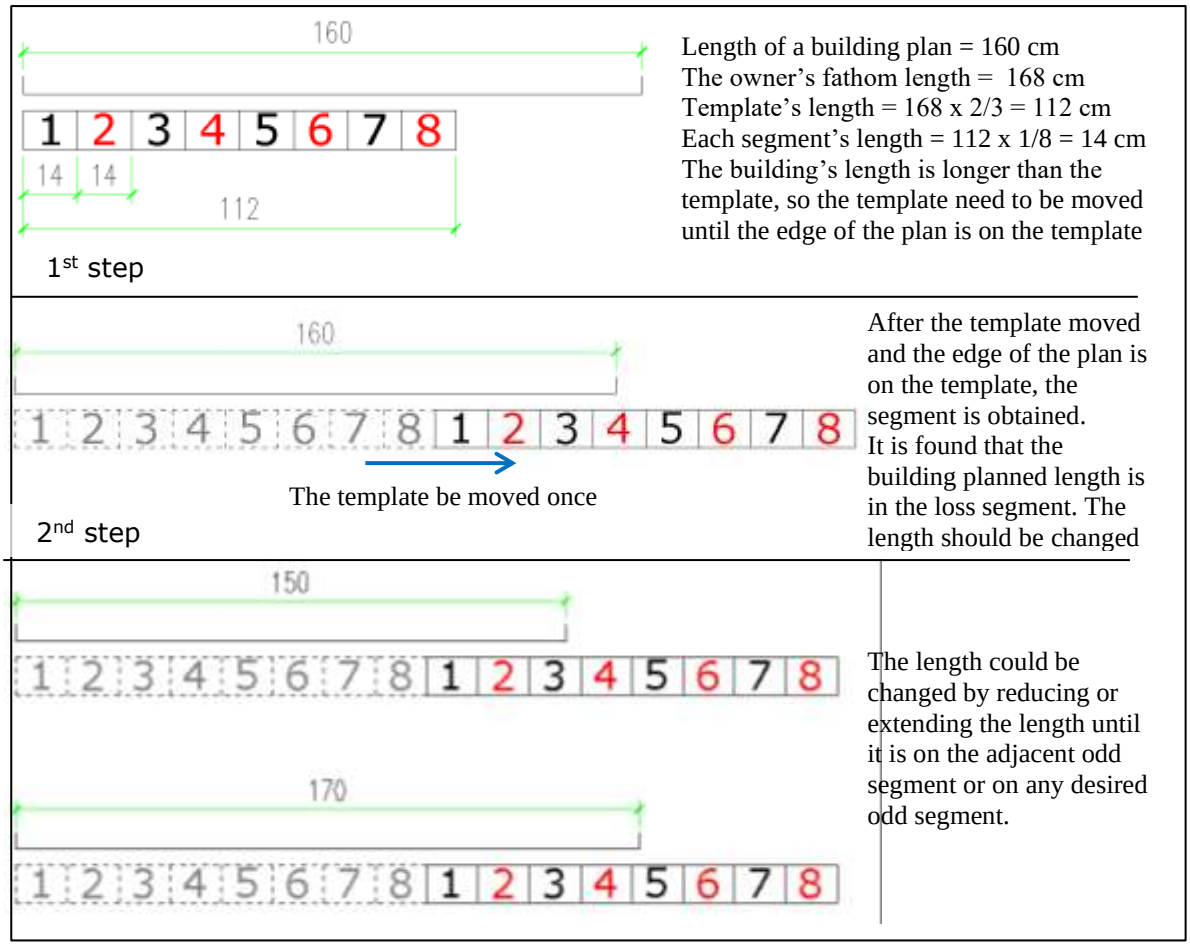

Figure 2. Process of evaluating the planned length using a template.

Development of Measurement System in Payango

Among the other steps in *payango*, determining the size of the building is the first and important step. The other steps of *payango* like determining the position of doors and windows, determining the first foundation to be built and etc, will adjust to the determined building dimension. Since the old time, the buildings floorplan in Gorontalo were built in a rectangle shaped plan. It is explaining why the length and width of the building become the only measured size. These days, building floorplans were made by combining basic shapes, using dynamic lines, and etc. In the near future, these complex shaped buildings may be built in Gorontalo and there may be possibility that *payango* rules will be applied on them. The complexity in shapes become a challenge to be measured only by using two parameters: length and width. It will also become a difficult work for *ta momayango* to measure them alone. Therefore the measurement system in *payango* should be developed by using modern technologies.

A rectangle floorplan is a simple shape, but two rectangles which arranged like in figure 3a would be a complex shape. The shape cannot be considered as an entity and simultaneously measuring the combined length and width, because there are large areas outside the building that would be counted as the areas inside the influence of *payango*. Instead, the shape should be counted as 2 entities and measure the length and width of each shape (see figure 3b). Thus measuring this complex shape is twice the work compared to the simple one.

A well, as a water resource that could influence many people's life, should also be measured using *payango* rule. Circle shaped well can be measured by the diameters. So the length and width of the shape which should be measured are the 2 diameters of the circle (see figure 3c). Therefore, we can apply *payango* measurement not only to shapes which made of straight lines but also for the curved lines. The 2 diameters of the circle will actually create an area of imaginary square outside the circle and some area outside of the circle will also be influenced by the *payango*. The writer proposes the area outside of the circle as the maximum area which is allowed for a complex shape to be measured using *payango* rule.

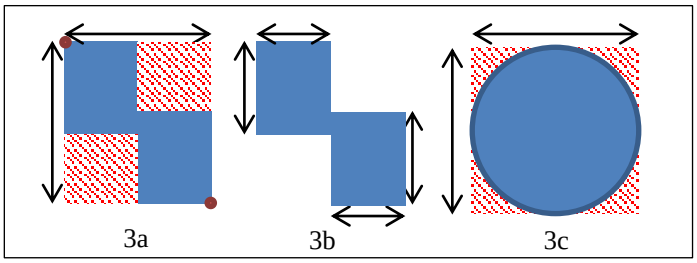

Figure 3. *Payango* rules in measuring complex floorplan shapes.

A calculation can also be made to determine on which segment will the building planned length be, by making a formula which associate the planned length and the fathom length. By using this formula, the building owner could find out whether his building will be on the good segment or the bad segment, therefore he can evaluate and make necessary revision to the establishment plan. The formula will be very helpful especially to be applied in the case of a large scale and complex shaped building which has numerous sides and difficult to be measured by *ta momayango*. Using this formula in evaluating a building size will be the first step on integrating *payango* in the building planning process.

Methods

An interview with the expert in *payango* (*ta momayango*) is conducted before the research begin. By listening to his experiences on measuring buildings, it was found out that measuring non-residential buildings which are large and complex shaped is more difficult than simple shaped residential building. Integrating *payango* in planning process should also be done so that architects could put *payango* into consideration in building design.

This research seeks to solve the problems of measuring a complex shape and integrating *payango* into the planning process. By determining a standard on whether a complex shape could be measured just like a simple shape or should it be separated into several parts and measure each of them, it is

expected that *payango* measurement system could be used to measure any complex building shapes. Integrating *payango* into the planning process would be done by making mathematical model to produce formula which would be used to determine the building size and also evaluate any planned size. A procedural modelling software would be used to visualize the application of formula.

Results and Discussion.

Measuring complex shape

Payango rule in measuring a circle is the same as measuring a square. Therefore the influence of *payango* on a circle shaped floorplan will be as large as the square and some areas outside the circle will also take into account. These areas outside of the circle are proposed as the maximum area which is allowed for a complex shape to be measured using *payango* rule. If the diameter of a circle is a, then the area of the circle is $\frac{\pi a^2}{4}$, and the area of the square outside the circle is a^2. Area outside of the circle is = $a^2 - \frac{\pi a^2}{4} = 0.215a^2$. With a^2 is also the area of any square or rectangle outside the complex shape to be measured. The value itself could be rounded down to $0.2a^2$. Example of determining whether a parallelogram shaped floorplan could be measured like a square/rectangle or should be separated into several shapes is given in figure 4.

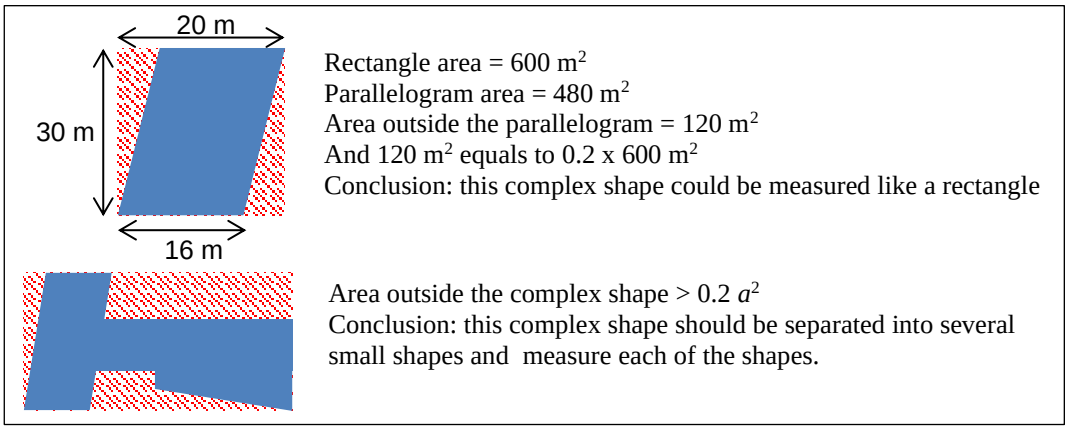

Figure 4. Measuring complex shapes

Payango Mathematical Model

Template's length, and the segment's length is derived from the fathom's length. The relation between them is shown in the table 1:

Table 1. Relation between fathom's length, template's length, and the segment's length

Name	Rule	Length
Fathom's length	The owner's fathom length	x
Template's length	Two third of fathom's length	$\frac{2}{3}$ x
Segment's length	One eigth of template's length	$\frac{1}{12}$x

The length of each segment measured from the starting point is shown in figure 5.

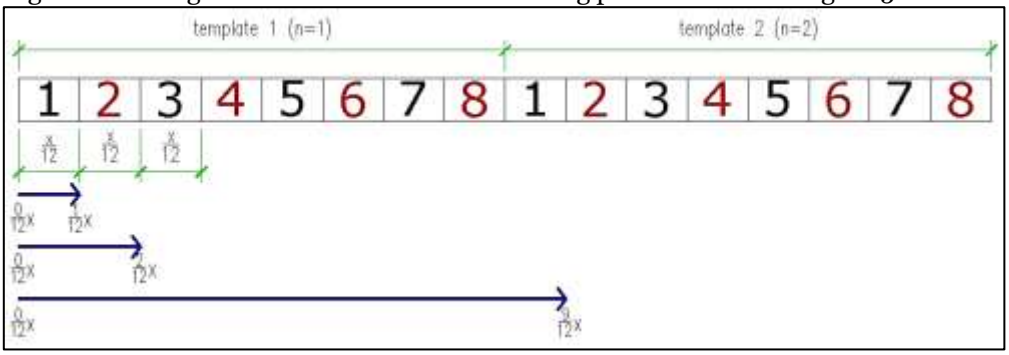

Figure 5. Mathematical model of *payango* measurement.

For the grace segment in template 1 (n=1) could be described as $\frac{0}{12}x < grace < \frac{1}{12}x$, while the grace segment in template 2 (n=2) could be described as $\frac{8}{12}x < grace < \frac{9}{12}x$. Then for any template (n), the grace segment could be described as $\frac{(n-1)8+0}{12}x < grace < \frac{(n-1)8+1}{12}x$. The formula could then be rewritten as $\frac{(n-1)8+c}{12}x$, with *c* signifies the lower and upper limit of a segment. The value of *c* is as follows:

Table 2. Value of *c*

Lower limit	Segment	Upper limit
0	Grace	1
1	Ill-fated	2
2	Reward	3
3	Loss	4
4	Give birth	5
5	Death	6
6	Age	7
7	Scorched	8

For example, a man with a fathom of 168 cm (x = 168 cm) would like to build a 600 cm long house. We'll determine whether the planned length will be on a good segment or the bad segment. Based on the fathom's length, the template length will be $\frac{2}{3}$ x 168 cm = 112 cm, and each of the segment's length is $\frac{1}{12}$ x 168 cm = 14 cm. Divide the planned length by the segment's length and we'll get 42.8, round it down and we'll get 42, which means the planned length is on the even segment (the good segment). Divide the planned length by the template's length and we'll get 5.35, round it up and we'll get 6, which means the planned length is on the 6th's template (n=6). To determine what segment the planned length is, put the value of the n, the x, and the planned length in the equation:

$$\frac{(n-1)8+c}{12}x = The\ planned\ length$$
$$\frac{(6-1)8+c}{12}168\ cm = 600\ cm$$
$$((5)8+c))14\ cm = 600\ cm$$
$$40 + c = 42.85$$
$$c = 42.85 - 40$$
$$c = 2.85$$

Round down and round up the value of *c* above and we'll get 2 and 3 respectively. The lower limit is 2 and the upper limit is 3, which means the planned length is on the reward segment.

The formula could be used on application such as spreadsheet processing program and a procedural modelling software. The later program could provide visualization of any changes within the planning process which is more helpful than the spreadsheet processing program. The other steps in payango such as determining the position of doors and windows, and the first and the last foundation to be built, can also be worked and visualized using this program. Development of *payango* will ease the work of *ta momayango* and help architects integrating its rule in planning process.

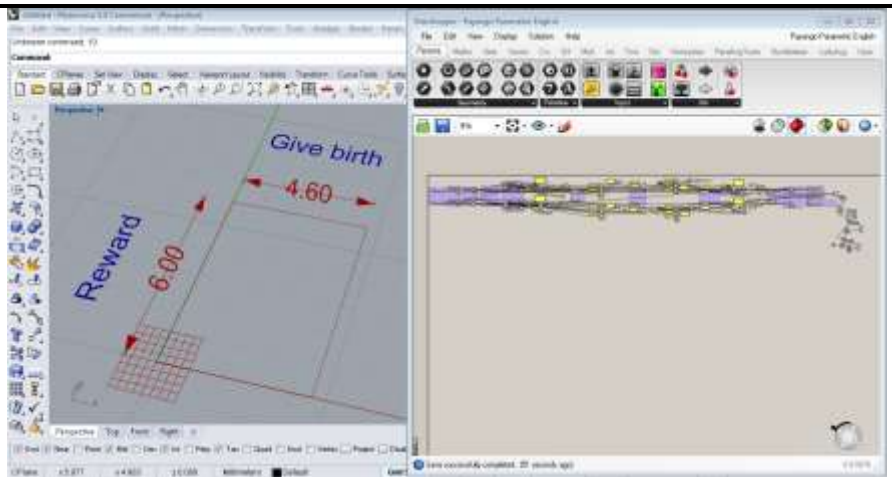

Figure 6. Applying the formula in a procedural modeling software.

Conclusions

Efforts in preserving local wisdoms could be done in many ways. Development of measurement system in *payango* is an effort to make *payango* more understandable by common people, and applicable by architects. The study proves that *payango* could adapt to the current development and should not be left behind. It is clear that *Payango* is a local wisdom that shows the uniqueness of Gorontalonese architecture.

Acknowledgements

This study is supported by the Gorontalo Adat Council.

References

1. Usman, DK. Personal interview. 21 April 2017.
2. Ernawati, *et al.* (2017). Penerapan Tradisi "Payango" pada Rumah Tinggal Masyarakat Gorontalo sebagai Upaya Pelestarian Budaya Lokal. In *Online Proceedings of Seminar Heritage Cirebon 2017*. Halaman A 033-040. Cirebon, West Java: Seminar Heritage Cirebon 2017.