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The *kayon* ideal shape: mathematical aesthetic on the *kayon* figures

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ABSTRACT

The *kayon* figure is a traditional artefact in the shadow puppet form, which has features in its shape, so this figure is often utilized as the basis for a branding design to give an Indonesian identity. However, the *kayon* shape does not have enough explanation to be recognized as a geometric shape. This makes some people have an ethnocentric stigma against this figure utilizes. This research aims to explain the *kayon* shape using mathematical aesthetics to obtain objective results. The golden ratio with experimental methods is the theory to analyze the *kayon* shape. The structure and size data of *kayon* shapes were obtained from observing 25 *kayon* figure artefacts of Surakarta-style shadow puppets. The main structure of the *kayon* figure consists of the *pucukan* (the top part), the *genukan-lengkeh* (the middle part), and the *palemahan* (the bottom part). The *kayon* shape size ratio guide is obtained from the phi value in the golden ratio number pair with the formula $\varphi 1<n=\varphi 2$. The engineering drawing of *kayon* shape is carried out in three steps, consisting of the base grid system, the base layout *kayon*, and the *kayon* shape outline. This study concludes that the *kayon* ideal form is created from a 13:7 ratio. The contribution of this research is useful to be the basis for determining the aesthetics of *kayon* figures (*wanda kayon*), as a guide for the creation of *kayon* figures, and as an academic appreciation that the *kayon* shape is a geometric shape originating from Indonesia.

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1. Introduction

Indonesians, some time ago, were rowdy about the pros and cons of changing the halal logo into the *kayon* or *gunungan* shape. This logo change is based on the head decree of BPJPH No. 40/2022. The *kayon* figures utilized by the Indonesian government began in 1978 as an image on the side of the Rp100,- coins, Figure 1. In addition to the national scope, the *kayon* figures shape is also used as the logo of international events such as the 11th ASEAN Para Games and G20 events. The debate about the *kayon* figure shape use cannot be separated from the ethnocentrism stigma by the Indonesian people who consider that the puppet shadow figure uses Javacentric. When reviewed from various cultural artefacts in Indonesia, the *kayon* figure is an artefact that has a basic shape that can be used in various designs, one of which is a logo. However, neither the Indonesian elite nor the intellectuals are aware of the feature of this figure shape. Therefore, the study of the *kayon* figures' shape is important to be raised to find and explain the *kayon* shape as a geometric shape originating from Indonesia. *Kayon* is a shadow puppet figure that we first see when the shadow puppet show begins with a position embedded in the middle of the screen or *kelir*. This figure can be found in all types of shadow puppets, both *Purwa*, *Madya*, *Klitik*, *Gedog*, *Revolusi*, and other types of shadow puppets; even *Golek* puppet also uses *kayon* figures in the shadow puppets form. The shadow puppet styles development in

various regions shows differences in visual form, including *kayon* figures. The *kayon* figure's shape is mostly in the form of a mountain shape stylisation, which tapers upwards although there are differences in the shape and the form of the ornament used as a characteristic. The *kayon* of the Surakarta style is larger, and looks more beautiful and full (*ngrawit*) than the Yogyakarta style, which is smaller and simpler, and other *kayons* such as Cirebon, Pasundan, and Bali, which are even smaller in size [1].

The *kayon* figure was first created by Sunan Kalijaga to complement the *purwa* shadow puppet that has been composed of a *beber* puppet to a shadow puppet that we see today [2]. The creation of this figure coincides with the creation of other puppet equipment such as *gedebog pisang* (banana tree trunks), *blencong* (oil lamp), and *kotak* (wooden box) [3], [4]. The event was marked by a *sengkalan* (Java Chronogram) that reads *Geni Dadi Sucining Jagad,* which refers to the year 1522 AD. Susuhunan Paku Buwana II (PB II) when making *Wayang Krucil* also created a *kayon* figure whose contents also formed a *sengkalan*, that is *gapura lima retuning bumi* which refers to 1739 AD [5], [6]. The *kayon* figure shape created by Sri Sunan Kalijaga is then often referred to as *Kayon Blumbangan* or *Kayon Alas-Alasan,* while the *kayon* figure created by Sri Susuhunan Paku Buwana II is referred to as *Kayon Gapuran*. The *kayon* figure has a relatively upright symmetrical shape with a pointed top which is a stylisation of the mountain shape so commonly referred to by the term '*Gunungan*' [7], [8]. The form of this figure shape cannot be identified singularly with the expression of a certain geometric plane as it is classified in the *puppet morgan*. At least, the *kayon* shape is arranged from the combined shape, consisting of the triangle at the top, the ellipse at the centre, and the trapezoid at the bottom [9]. According to Gleadall, the field is divided into mathematically created geometric shapes and freely created non-geometric shapes [10]. In other words, the *kayon* shape is still considered a non-geometric shape because this shape no one has been able to explain its formation mathematically. On the other hand, the many variations in the *kayon* figures shape also give rise to differences in the *kayon* shape it uses. The differences in these shapes include the size of each *kayon*. Therefore, there is a need for a study of the *kayon* shape.

Fig. 1. Various Utilization of Kayon Figure Shape

Ahmadi, who claims that the *Kayon Blumbangan* figure has a chubby shape, so it is called *Kayon Wadonan*, and the *Kayon Gapuran* figure has a slender shape, so it is called *Kayon Lanangan*, is one of the studies that address *kayon* figures and the Surakarta Style purwa shadow puppet shape [11], In his research, Ardhi revealed that every innovation in the *kayon* figure creates a unique arrangement of forms and that the *kayon* figure's shape is based on the works of Bambang Suwarno [12]. The face form, neck propensity, shoulder position, hull propensity, and clothing idea are all examples of the *Wanda* aesthetic found in *wayang kulit* fine art [13]; according to Subiyantoro, the *kapangan*, the head and facial position, the clothing and attributes, and the figure colour all contribute to the aesthetics of the shadow puppet shape appearance [14]. Research on the form of the *kayon* shape has never existed before. Therefore, this research focuses on the study of the *kayon* shape, especially on the Surakarta-style shadow puppet *kayon* figure shape. This study aims to find the *kayon* shape ideal form. The *kayon* ideal shape is useful to be the basis for determining the aesthetics of *kayon* figures, as a guide for the creation of kayon figures, and as an academic appreciation that the *kayon* shape is a geometric shape originating from Indonesia.

2. Method

This research uses qualitative methods with an experimental approach. According to Mace, experiments are the activities artists and designers engage in as part of the creative process. These activities include trying various objects, methods, tools, and configurations [15]. The creating experiment on the *kayon* ideal shape was carried out by drawing engineering methods. Drawing engineering is a way of drawing an object through certain systematic steps. Drawing methods used include manual drawing and digital images. The data used is primary data from the observation results on 25 *kayon* figures of the Surakarta Style shadow puppet. The Surakarta style scope of the 25 *kayon* figures includes the Kasunanan Surakarta Palace sub-style, the Pura Mangkunegaran Palace sub-style, and the People's sub-style, both Sangkrah, Klaten, Wonogiri, and Sragen. The *kayon* figures are obtained from the collections of Ki Bambang Suwarno, Ki Purbo Asmoro, and Ki Sarwanto, which are puppet masters of Surakarta-style shadow puppetry. The measuring instrument used is a ruler with units reaching millimetres. The tools used for the drawing experimentation of the *kayon* figures shape include F4 block millimetres, pencil, compass, ruler, arc, drawing pens, and computers—the application used for digital drawing *kayon* figures in Adobe Illustrator CC 2019. Figure 2 is an experimental flowchart for technically creating *kayon* drawings.

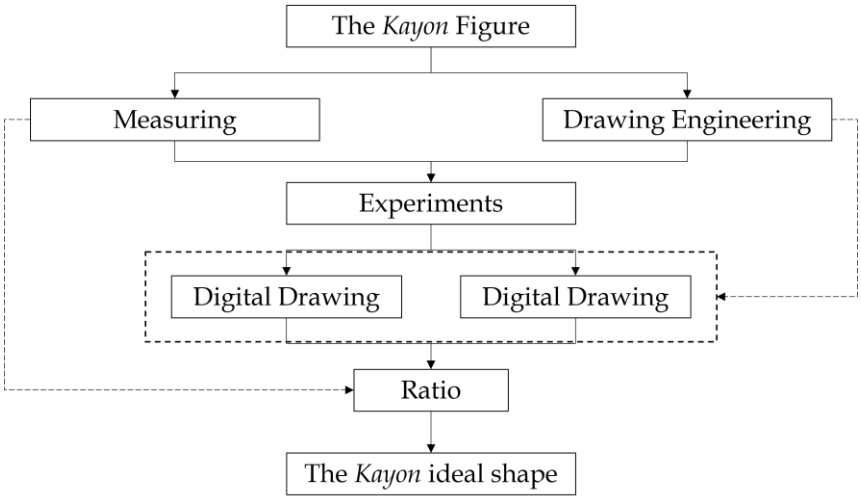

Fig. 2. The Experimental for Technically Kayon Drawings

3. Results and Discussion

The *kayon* shape discussion begins by identifying the *kayon* shape structure to obtain the figure's main form. Identification is continued with the shape measurements results in explanation as the basis for calculating the ideal ratio. The ideal ratio is determined through golden ratio calculation. Next, the drawing engineering steps explanation as a guideline for the *kayon* shape drawing. Finally, the experimental results explanation of creating the *kayon* shape through manual and digital drawing methods.

3.1. The Structure of *Kayon* Shape

The shape structure of each *kayon* figure consists of *pucukan* that have a conical shape, *genukan* which has a convex shape, and *lengkeh* which has a concave shape, see Figure 3. Meanwhile, *palemahan* shows four varieties, including *palemahan* which is in the form of a long shape, *palemahan* which is only a *umpak*, *palemahan* which consists of the long shape and *umpak*; and *palemahan,* which is formed from a combination of the long shape and the *umpak*. Ghefra clarified that not all *kayon* figures have the *umpak*, which is the *palemahan* component in the small protrusion form in the centre [16]. The *umpak* existence is a shape variety produced by the artist's creativity and consciousness to provide additional construction power to *kayon* figures when used in the shadow puppet show. In other words, *umpak* is not the *kayon* figure's main part, so it is not included as one of the *kayon* shape structures. Here is presented an image of the *kayon* shape structure.

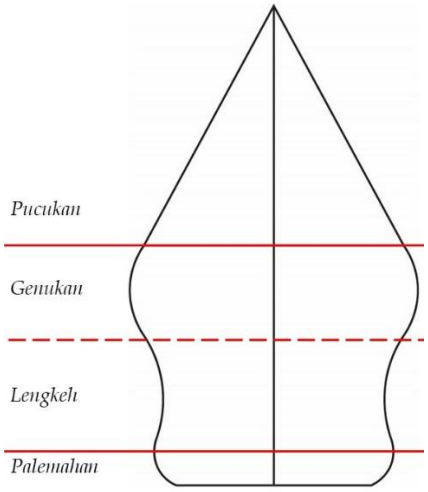

Fig. 3. The Structure of *Kayon* Shape

3.2. The Kayon Shape Size

The *kayon* figure size is a mathematical dimension obtained from measuring the height and width of the *kayon* figure. This measurement does not aim to find the shape extent but is limited to knowing the comparison dimensions between height and width. The diverse contour realities of *kayon* figures require guidelines to determine the parts that need to be measured. The *kayon* parts that need to be measured include height, the *genukan* width, the *lengkeh* width, and the *kayon* midpoint width. Here is presented the image of the points used as guidelines for measuring *kayon* figures, see Figure 4.

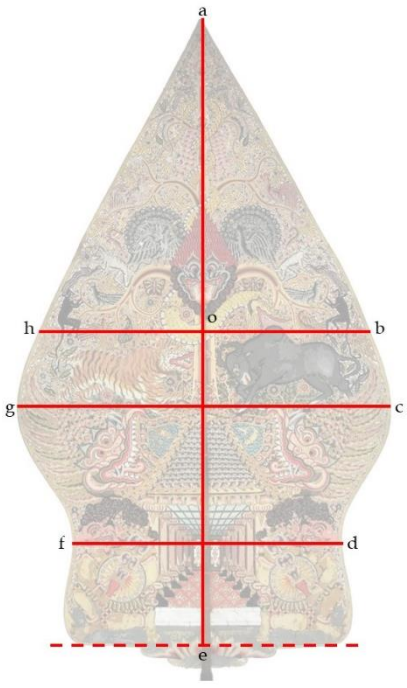

Fig. 4. The Measuring Points of *Kayon* Shape (Kayon Gapuran Kyai Kobar figure, created by Ki Bambang Suwarno, Photo and Modification by Pramudita, 2021)

The *kayon* figure height is determined from the length of point 'a' to 'e'. The 'a' point is the top point on the *pucukan*. The 'e' point is the bottom point of the *palemahan* part drawn in a straight line from the top point. However, based on the results of the observation, there is a reality of the *palemahan* part contour shape in the form of a *umpak*. This variety will give a difference in the guidelines for measuring the *kayon* figure's height if they are determined based

on the *palemahan* bottom point. Therefore, the bottom measurement point is based on the *palemahan* horizontal line drawing that forms a long shape. If the *palemahan* part used in the *kayon* figure only shows the *umpak,* then a straight line draw is placed on the border between the *lengkeh* and *umpak* part, as shown above. The *kayon* figure height is symbolized by the formula.

$$t_{fk} = \overline{ae}. \quad (1)$$

The making result the *kayon* figure height is then determined by the midpoint marked by the 'o' point, that is, the point that divides exactly between the *kayon* figure height of the top and bottom. The *kayon* figure midpoint is known from the horizontal line that passes through the *kayon* figure midpoint. The point that is the *kayon* midpoint wide border on the right is marked with 'b' point while the point that is the border on the left is marked with 'd' point. The *kayon* figure's midwidth is symbolized by the formula

$$l_{fk} = \overline{boh}. \quad (2)$$

The *genukan* width is determined from the horizontal line length on the *genukan* outermost shape. The outermost point that is the right *genukan* width border is marked with 'c' point while the outermost point on the left is marked with 'g' point. The *genukan* width is symbolized by the formula

$$l_g = \overline{cg}. \quad (3)$$

The *lengkeh* width is determined from the horizontal line length on the *lengkeh* innermost shape. The innermost point that which is the right-width border, is marked with 'd' point, while the innermost point on the left is marked with 'f' point. The *lengkeh* width is symbolized by the formula

$$l_k = \overline{df}. \quad (4)$$

Table 1 is presented the *kayon* figures size recapitulation, both *Kayon Blumbangan* and *Kayon Gapuran*.

Table 1. The *Kayon* Shape Size Recapitulation

Kayon Figure	t_{fk} (cm)	l_{fk} (cm)	l_g (cm)	l_k (cm)
Figure 1	77.9	42.3	48.0	33.2
Figure 2	81.6	43.1	49.5	36.8
Figure 3	77.3	38.6	47.8	36.4
Figure 4	85.0	48.3	55.0	38.6
Figure 5	98.1	57.9	65.8	44.8
Figure 6	86.6	49.4	61.1	36.9
Figure 7	86.0	43.1	52.6	39.0
Figure 8	82.9	41.0	50.4	36.0
Figure 9	84.0	41.7	50.4	37.9
Figure 10	83.3	39.6	49.8	37.5
Figure 11	76.0	38.3	48.0	34.4
Figure 12	76.9	39.6	44.4	34.3
Figure 13	81.7	42.7	48.7	35.5
Figure 14	75.2	40.3	44.8	36.6
Figure 15	86.4	45.9	56.0	40.9
Figure 16	87.2	44.3	52.9	39.5
Figure 17	85.7	43.4	51.8	39.3
Figure 18	84.0	41.9	51.6	39.2
Figure 19	87.1	42.1	51.2	37.9
Figure 20	85.9	41.6	50.2	38.7
Figure 21	854	46.0	54.0	41.2
Figure 22	85.3	42.8	50.4	38.2
Figure 23	85.6	38.3	49.4	36.5
Figure 24	80.8	41.5	49.4	37.9
Figure 25	85.7	45.4	52.4	38.6

3.3. The *Kayon* Shape Ideal Ratio

The *kayon* ideal ratio is the ratio used as a guideline for the *kayon* shape size and drawing. The theory used to analyze the *kayon* shape ratio is the golden ratio which is based on mathematical aesthetics. The golden ratio symbolized by "φ" (phi) is a perfect ratio revealed by Leonardo Fibonacci [17]. Ibrahim states that the golden ratio is a balance at the same time [18]. In particular, Richard A. Dunlap states that a golden ratio is an irrational number defined $(1+\sqrt{5}):2$ [19]. The formula then creates an arithmetic series consisting of 1, 1, 2, 3, 5, 8, 13, 21 [19]. In the Fibonacci series, the ratios of numbers in each pair are sequentially convergent on phi, such as 1/1, 2/1, 3/2, 5/3, 8/5, etc., and when reaching the fortieth number, the resulting ratio matches phi up to 15 decimal places that are 1.618033988749895 [19]. The ideal ratio determination is obtained from the ratio between height and width, both the mid-width, the *genukan* width, and the *lengkeh* width. The decimal number used in the *kayon* figures measurement is one number behind the comma (0.0). This is based on the fact that the measuring instrument that is generally used in Indonesia is a maximum of up to a millimetre (mm) unit while the unit to be used is a centimetre (cm) so that numbers can only be known to a maximum of up to one number behind the comma. As for the phi value from the ratio calculating result using three numbers behind the comma (0.000). The following is presented as the *kayon* shape ratio value recapitulation: *Kayon Blumbangan* and *Kayon Gapuran*. See Table 2.

Table 2. The *Kayon* Shape Ratio Value Recapitulation

Kayon Figure	$t_{fk}:l_{fk}$	$t_{fk}:l_g$	$t_{fk}:l_k$
Figure 1	1.842	1.623	2.346
Figure 2	1.893	1.648	2.217
Figure 3	2.075	1.676	2.201
Figure 4	1.820	1.598	2.277
Figure 5	1.694	1.491	2.190
Figure 6	1.814	1.466	2.428
Figure 7	2.077	1.702	2.295
Figure 8	2.076	1.688	2.364
Figure 9	2.082	1.722	2.290
Figure 10	2.174	1.729	2.296
Figure 11	1.984	1.583	2.209
Figure 12	1.942	1.732	2.242
Figure 13	1.913	1.678	2.301
Figure 14	1.866	1.679	2.055
Figure 15	1.956	1.604	2.196
Figure 16	2.063	1.728	2.314
Figure 17	2.085	1.747	2.303
Figure 18	2.124	1.725	2.270
Figure 19	2.140	1.760	2.377
Figure 20	2.125	1.761	2.284
Figure 21	1.930	1.644	2.155
Figure 22	2.100	1.784	2.353
Figure 23	2.295	1.779	2.408
Figure 24	2.014	1.692	2.206
Figure 25	1888	1.635	2.220
Average	**1.999**	**1.675**	**2.272**

The ratio in the golden ratio is simply a numbers pair obtained from the convergent sequence; that is, in the first level, it is a 1:1 ratio, but in the next level, it is the ratio of the sum of the two numbers with the number there behind the previous one, see Table 3. The ratio from the 9th level onwards has a values consistency up to 3 decimal places. Regardless of the value above the 9th level, the result of the comparison between the *kayon* height and width shows a ratio value close to the value of the 2nd level golden ratio, which is 2:1, and the ratio of the *kayon* height and the *genukan* width is close to the value of the 4th level golden ratio of 5:3. The ratio between the *kayon* height and the *lengkeh* width has a value greater than the largest value of the golden ratio. Thus, the ratio is approached to the value of the 2nd level, which is 2:1. Thus, in determining the ideal *kayon* shape has two ratio guidelines, namely the ratio of 2:1 to determine

the smallest width while the 5:3 ratio to determine the largest width of the *kayon* figure. The ratios of 2:1 and 5:3 are not the main ratio guidelines in the *kayon* ideal shape creation.

Table 3. Ratios and Values on the Golden Ratio

Level	Ratio	φ Value
1	1 : 1	1.000
2	2 : 1	2.000
3	3 : 2	1.500
4	5 : 3	1.667
5	8 : 5	1.600
6	13 : 8	1.625
7	21 : 13	1.615
8	34 : 21	1.619
9	55 : 34	1.618
Etc.	Etc.	1.618

The two ratios as the upper guidelines are; first, the smallest limit of *kayon* width guided from the mid-width with a ratio of 2:1 and the broadest guideline *kayon* which is guided from the *genukan* width with a 5:3 ratio; secondly, the middle position and the culmination of the *genukan kayon*. If the 2:1 ratio is symbolized by φ1 and the 5:3 ratio is symbolized by φ2, then the *kayon* shape ratio can be formulated as φ1<n=φ2. The 5:3 ratio is used as a fixed ratio of the outermost border of the *kayon* ideal shape, especially in the shape width part, to obtain the shape consistency and make it a guideline in determining the *kayon* figure width. The *kayon* ideal shape concept creation uses the ratio result that is within a range greater than the 2:1 ratio and equal to the 5:3 ratio. The ratios to be experimented with are determined by the formula.'

$$n = (2x - 1) : x \tag{5}$$

Table 4 is presented a table of the ratio calculating results using the formula with x determined from 1 to 9.

Table 4. Ratio Calculation Results

x	2x-1	n	Value
1	1	1: 1	1.000
2	3	3: 2	1.500
3	5	5 : 3	1.667
4	7	7: 4	1.750
5	9	9: 5	1.800
6	11	11: 6	1.833
7	13	13: 7	1.857
8	15	15: 8	1.875
9	17	17: 9	1.889

Based on the table above, if it is known that φ1<n=φ2, and the values φ1 = 2,000 and φ2 = 1.667, then the resulting ratio of x=1 and x=2 does not meet the value criteria. The value of n that meets the value criteria is produced from x which is in the range of 4 to 9, while at x = 3 is equal to φ2, which is the widest limit. Thus, basically, the experiment of making the *kayon* ideal shape was carried out with six types of ratios, that are 7:4, 9:5, 11:6, 13:7, 15:8, and 17:9. However, this experiment will be narrowed down by using two ratios found in the middle of the six ratios, that are the ratios of 11:6 and 13:7. It was decided to narrow down the possibility of a shape form that is too small because it is close to φ1 as well as too wide because it is close to φ2 (see Figure 5).

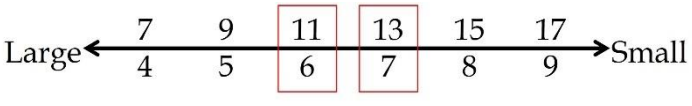

Fig. 5. Ratio Determination through Count Series

3.4. The Kayon Shape Engineering Drawings

The creation of the *kayon* ideal shape uses the same drawing engineering steps. The steps are described as follows in Figure 6.

- Creating axis lines as *kayon* height guidelines (t_{fk}).
- Make the height line a guideline for the *Kayon* Midwidth (l_{fk}) and the *Genukan* Width (l_g).

a. If the *Kayon* Midwidth ratio is 2:1 (φ_1) then the length of the Mid width of *Kayon* is obtained by the formula:

$$l_{fk} = t_{fk} \times \varphi_1 \text{ atau } l_{fk} = \frac{t_{fk}}{2}. \quad (6)$$

b. If the *Genukan* Width ratio is 5:3 (φ_2) then the length of *Genukan* Width is obtained by the formula:

$$l_{fk} = t_{fk} \times \varphi_2 \text{ atau } l_g = \frac{(t_{fk} \times 3)}{5}. \quad (7)$$

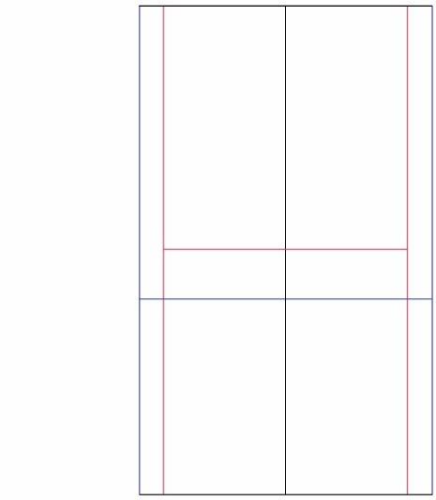

Fig. 6. 1st and 2nd step result

- Creating a height line used as a guideline for creating a *kayon* ideal shape with width is obtained from the formula. The result can be seen in Figure 7.

$$l_x = t_{fk} \times n. \quad (8)$$

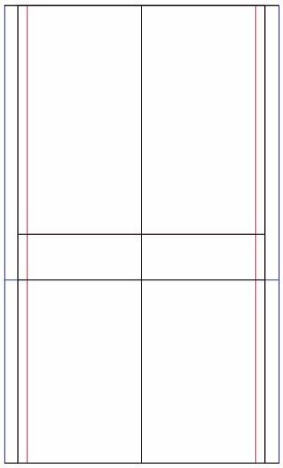

Fig. 7. 3rd step result

- Between the *Kayon* Height (t_{fk}) and the predetermined width (l_x) will form a rectangle shape. Continue by dividing the rectangle into three levels which will make the rectangle into 64 parts. Up to this stage, it is referred to as the *Base Grid System*, which is an arrangement of vertical and horizontal lines used as a guideline in line drawing, see Figure 8.

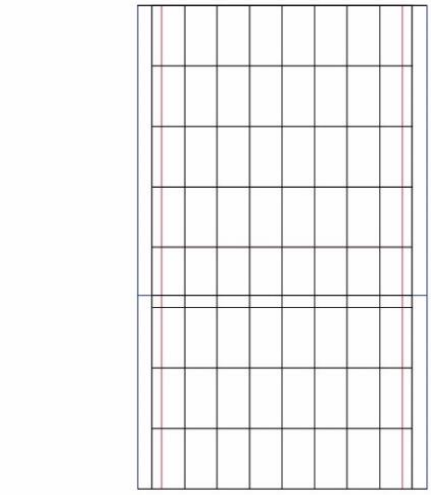

Fig. 8. 4th step result

- The *pucukan* line is created by drawing a line from the top of the axis to the two intersection points (right and left) between the height line of the predetermined rectangle shape with the *Kayon* Midwith (t_{fk}). The pulling of the *pucukan* line and the *kayon* mid-width line will form an isosceles triangle that becomes the *pucukan kayon* shape area, see Figure 9.

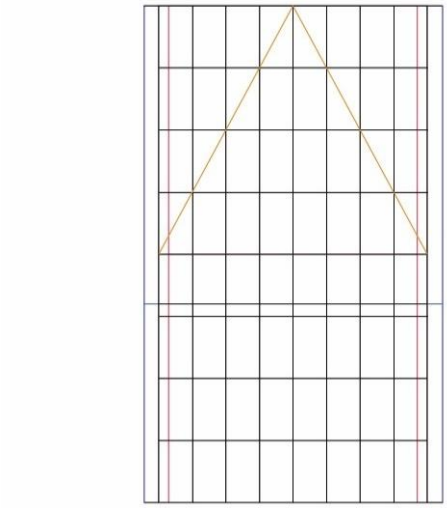

Fig. 9. 5th step result

- The curved line that becomes the *genukan* shape is made from a circle that has the centre being on the *Genukan* line width (l*g*). The circle is determined from the following:
  a. The intersection point between the *pucukan* line and the *kayon* mid-width line is simulated with the symbol 'a'.
  b. The intersection point between the *pucukan* line and the *genukan* width line is simulated with the symbol 'b'.
  c. The intersection point between the high line and the *genukan* width line is simulated with the symbol 'c'.

d. Then the circle centre point, which can be simulated with the symbol 'o', which is on the *genukan* width line, is obtained from the length summation of the 'b' to 'c' points and the length of 'a' to 'c' points drawn horizontally from the 'c' point, which can be symbolized by the formula.

$$o = \overline{bc} + \overline{ac}. \tag{9}$$

e. The determination of such a central point is calculated from 'b' point.
f. The circle radius length is obtained from the length of the 'o' to the 'a' point, or it can be symbolized by $r = \overline{oa}$. See Figure 10 and Figure 11.

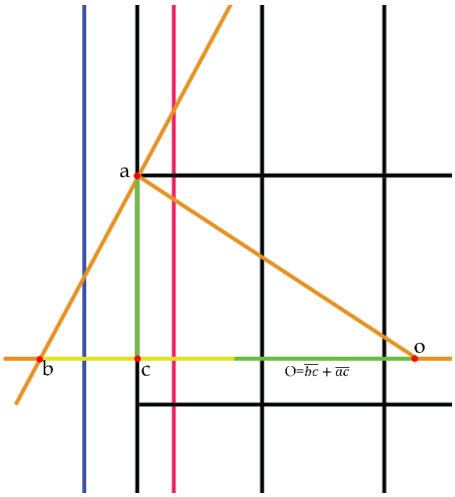

Fig. 10. Steps to set the centre point of *Genukan* circle

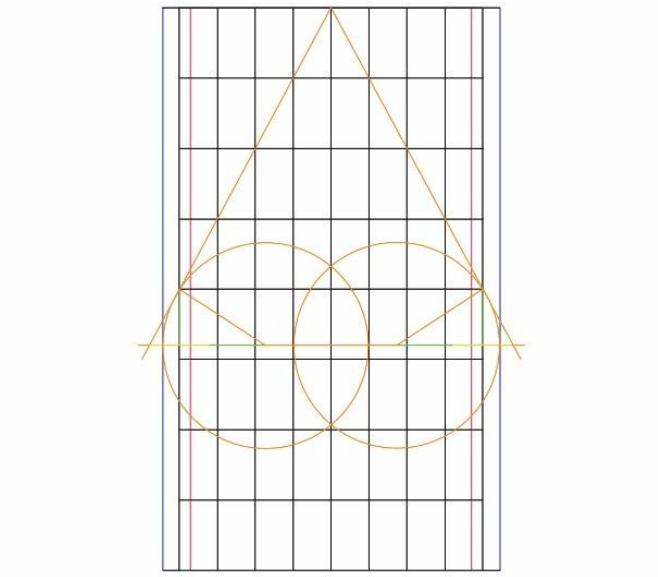

Fig. 11. 6th step result

- The *lengkeh* curved line is determined in the following way (see Figure 12, Figure 13, and Figure 14):

a. The intersection point between the bottom the *lengkeh* circle and the high line is simulated with the symbol 'a'.
b. Draw a line from the top of the axis to the bottom corner.
c. The intersection point between the *pucukan* lines of the axis to the corner with a horizontal line intersecting 1/64 of the square is simulated with point 'b'.

d. If the length of 'a' to 'b' becomes the circle radius length, then when the circle is made at 'a' and 'b' points on the outer side, it will get a meeting point that will be used as the circle centre point to form a *lengkeh* curve.

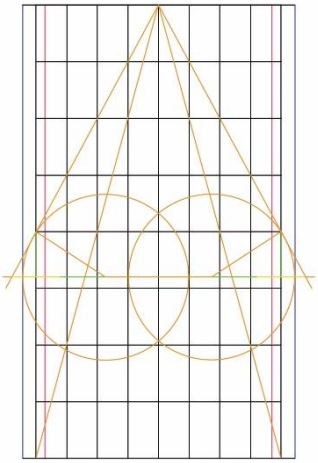

Fig. 12. 7th step result, b point

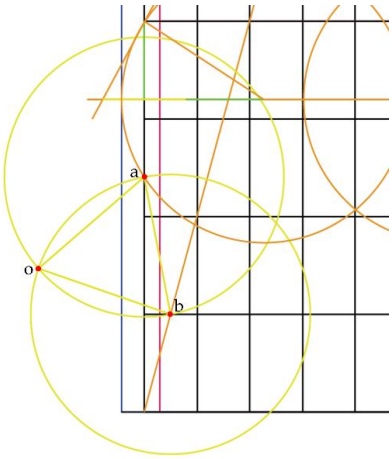

Fig. 13. Steps to set the centre point of *Lengkeh* circle

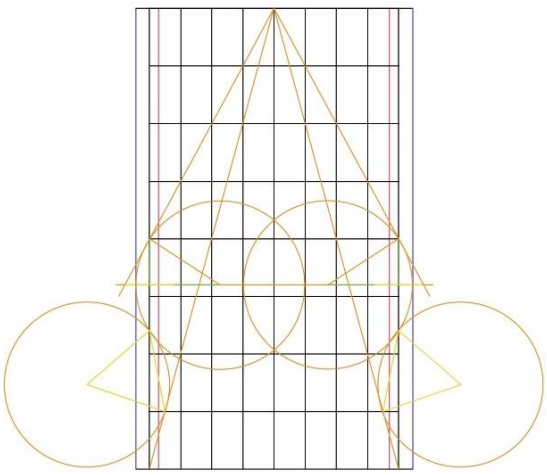

Fig. 14. 7th step result

- The *palemahan* curved line is determined in the following way (see Figure 15 and Figure 16):
  a. The intersection point between the axis top lines to the corner that with a horizontal line intersecting 1/64 rectangle is simulated with 'a' point ('b' point in creating the *lengkeh* becomes point an in creat the *palemahan*).
  b. The intersection point between vertical lines intersecting 1/64 rectangle with the bottom the *kayon* width line simulated with 'b' point.
  c. The intersection between the diagonal lines from 'a' to 'b' points with a diagonal line of 1/64 rectangle simulated with the symbol 'c'.
  d. The length between 'b' to 'c' points is used to determine the centre point and radius of the *palemahan* circle.
  e. If the length 'b' to 'c' points becomes the circle radius length, then when the circle is made at points 'a' and 'b' points, on the inner side, it will get a meeting point that will be used as the circle centre point to form a *palemahan* curve.

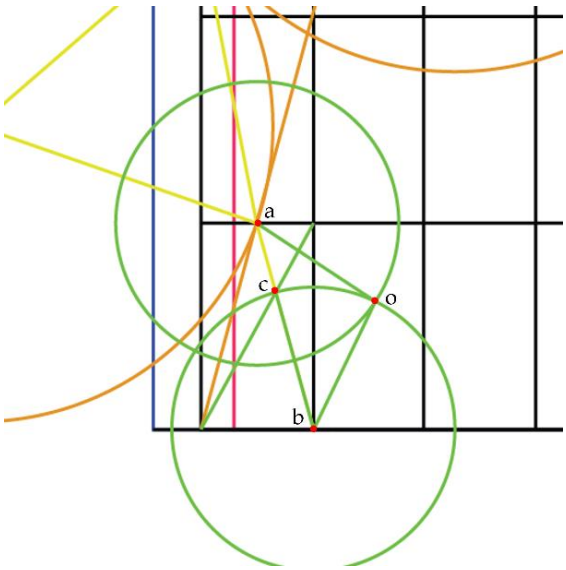

Fig. 15. Steps to set the *Palemahan* circle centre point

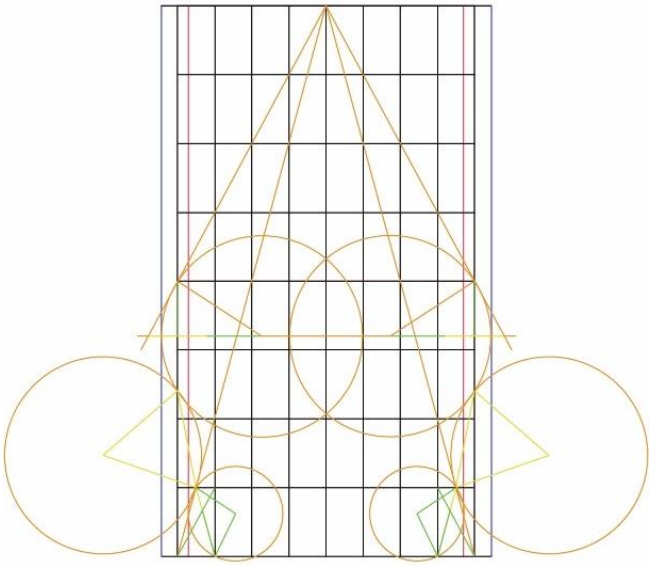

Fig. 16. 8th step result

- Make the *palemahan* line on the lower side the shape closing line. The *palemahan* line is a line resulting from the draw between 'b' point in the creation of the *palemahan* circle centre on the right and left. Up to this stage, it is referred to as the *Kayon* Contour Base, see Figure 17.

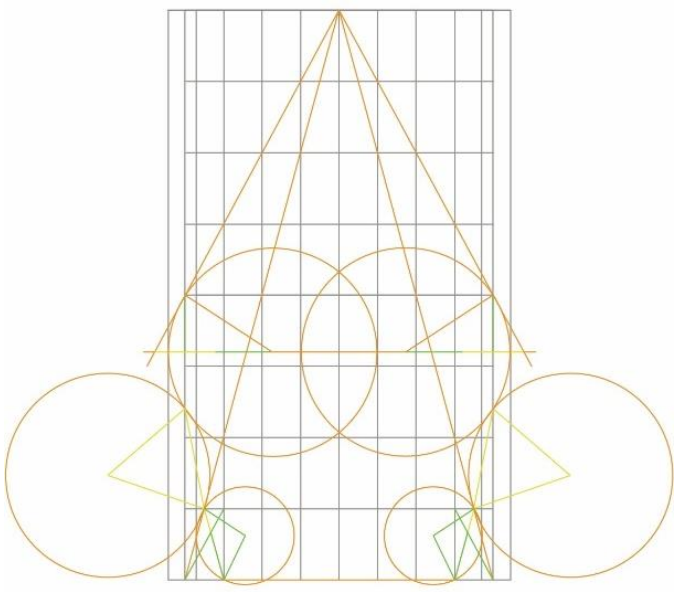

Fig. 17. 9th step result

- Creating outlines to form the *kayon* ideal shape. This stage is called the *Kayon* Shape Outline; see Figure 18.

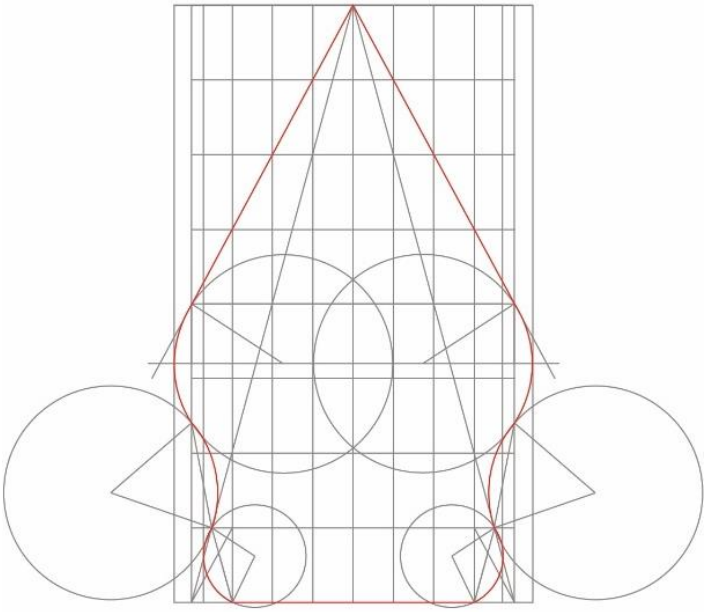

Fig. 18. 10th step result

3.5. The Kayon Shape Eksperimental Result

The experiment of the *kayon* ideal shape making was carried out with the drawing techniques described above. In addition to using two ratios from the previous calculation results, which are 11:6 and 13:7 ratios, this experiment also used manual drawing (Figure 19) and digital drawing (Figure 20). The equipment used to draw the *kayon* ideal shape manually includes F4 millimetre block paper, pencil, compass, ruler, arc, and drawing pen—using millimetre block paper to assist in determining the size precisely. The software used to draw

the *kayon* ideal shape digitally is *Adobe Illustrator CC 2019*. Here are the results of *kayon* shape manual and digital drawings.

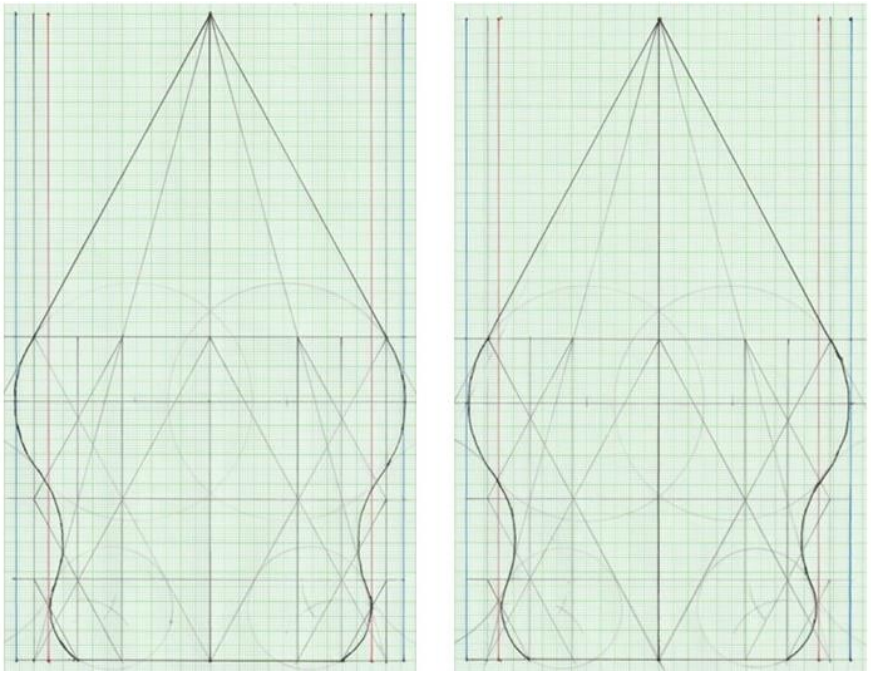

Fig. 19. The manual drawing results of *kayon* shape with 11:6 (left) and 13:7 (right) ratios

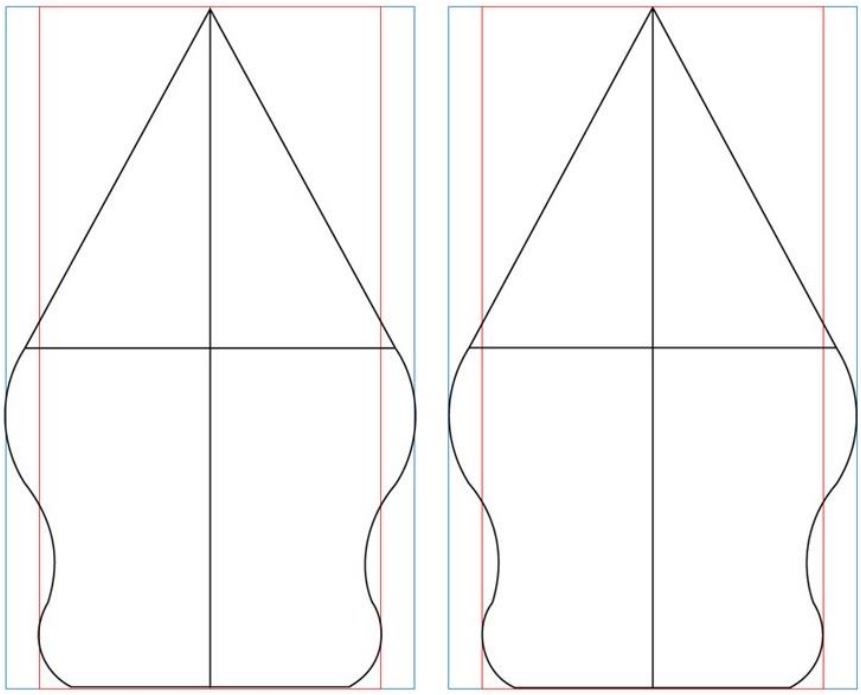

Fig. 20. The digital drawing results of *kayon* shape with 11:6 (left) and 13:7 (right) ratios

The experiment of the *kayon* shape creation using the 11:6 and 13:7 ratio, both manually and digitally, showed different results. The manual creation of the *kayon* shape shows that the 11:6 ratio has the *genukan* exact width at a 5:3 ratio, while the 13:7 ratio indicates the *genukan* width is less than the 5:3 ratio. As for the digital creation of the *kayon* shape shows that the 13:7 ratio (Figure 21) has the *genukan* exact width at a 5:3 ratio, while an 11:6 ratio indicates the *genukan* width more than the 5:3 ratio.

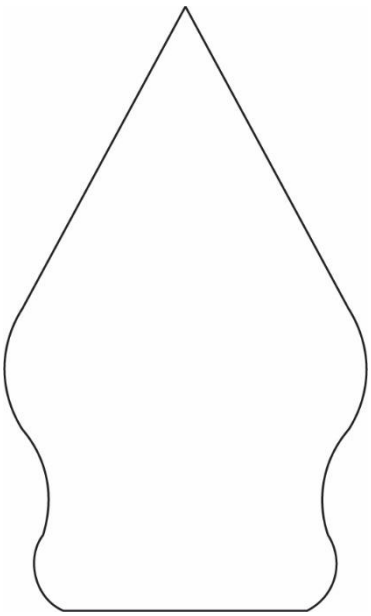

Fig. 21. The *Kayon* Ideal Shape with 13:7 Ratio (BIK137)

The parallax effect, which is an error in tool use brought on by a limited vision function and results in errors in measuring results, angles, or object accuracy [20], [21], is what causes the outcomes difference between the construction of *kayon* shapes using manual and digital methods. This happens mainly in compass use, which is when the needle is placed in the same hole so that it enlarges the hole marks on the paper and affects the size created. In addition, the points placement and the line drawing can shift even if it is only a few millimetres and have an impact on the parallax occurrence. Parallax can also happen in the *kayon* shape digital drawing that is at when the point placement and the outlines drawing. However, digital methods can minimise parallax because the work uses more precise number measurements than manual methods. Therefore, the *kayon* ideal shape is decided from the digital drawing results in a 13:7 ratio, which will hereinafter be called by the abbreviation BIK137.

4. Conclusion

The *kayon* shape structure is formed from three rows, among others: a narrowed straight contour at the top called the *pucukan*, a curved contour with a convex and concave shape in the middle called the *genukan-lengkeh*, and a curved contour towards straight with a long shape form below called the *palemahan*. The phi golden ratio value used as a guideline for the *kayon* shape ratio is obtained by the formula $\varphi_1<n=\varphi_2$. The shape experiment was then carried out using two ratios, including 11:6 and 13:7 ratios. The *kayon* shape drawing technique is carried out through three steps: the base grid system, the *kayon* layout base, and the *kayon* shape outline. The experiment continued using *kayon* two drawing methods: manual and digital. This research resulted in that the *kayon* ideal shape was obtained from drawing techniques with a 13:7 ratio. The results of this study are expected to explain and confirm the *kayon* shape as a geometric shape originating from Indonesia on the basis that the *kayon* shape can be explained through mathematical measurements. In addition, the results of this study are also expected to be a guide for creating a work of art and design that provides an Indonesian identity.

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