Engineering Drawing of Cirebon *Gunungan* Puppet Shape through Ethnomathematics

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ABSTRACT

Cirebon Gunungan Puppet is one of the gunungan puppet figures that has shape characteristics in the Java region. Gunungan puppet is a puppet figure whose presence is considered important in every puppet show. Therefore, these puppet figures are often reproduced to meet the needs of puppet show. However, knowledge of the gunungan puppet preparation is still limited to traditional knowledge that is less understandable by today's younger generation who need more objective and systematic knowledge. Therefore, this study aims to compose knowledge of gunungan puppet with a focus on composing engineering drawings in the Cirebon gunungan puppet shape through ethnomathematics. The method used in this study is qualitative with an experimental approach. The theory used to support the achievement of this gunungan puppet engineering drawing is ethnomathematics. The composition of the Cirebon gunungan puppet engineering drawings produced three stages, that are the base grid system that determined through ethnomathematical ratio, the contour base that resulting from the arrangement of triangle, circle, and square shape, and the outline shape that resulting from drawing the outline from the geometric shape arrangement to create the Cirebon gunungan puppet shape. The results of this research are expected to be a reference for learning traditional art and design objectively and systematically, especially in the creation of Cirebon mountain puppets.

INTRODUCTION

Puppet is a traditional art that has *adi luhung* (high culture) value as a result of community culture. However, the art tradition is currently experiencing a crisis of knowledge construction. Puppet knowledge initiated by predecessors which was then maintained and preserved by the older generation at this time is not systematically arranged while the younger generation who are currently, that are generation Y and Z, are a generation that develops through knowledge systematically constructed through formal education (Limelta & Paramita, 2020, p. 26). Generation Y is basically still experiencing the rise of physical shadow puppet show. This generation is also called the millennial generation because it was born at the same time as the development of digital media (Christiani & Ikasari, 2020, p. 85). Therefore, this generation has also witnessed that shadow puppet show have existed regularly in digital media that are aired nationally, especially on commercial television. However, the development of technology, in addition to national political factors, and so on, the Z generazi has begun to distance itself from shadow puppet show.

Puppet knowledge has been focused on aspects of performing arts and literature. As for the aspect of fine art, puppet knowledge that has been constructed includes aspects of crafts,

known as tatah (inlaid) and sungging (coloring), which from these two things are inseparable from puppet sketches. However, puppet knowledge sketching is still limited to puppet figures. Knowledge that has not been well constructed is *gunungan* puppet. Although basically every mpu (maestro) of puppet art understands correctly and tries to transfer his knowledge to his students. Knowledge of *gunungan* puppet is often emphasized by adapting from previous *gunungan* puppet artifacts, both through mutrani and tedhak methods (Pramudita et al., 2022: 194).

Gunungan puppet is one of the puppet figures that has a special shape. Therefore, this puppet is classified as a wayang morgan (Sunarto, 1997, p. 118). The special shape of the *gunungan* puppet can be seen in the shape contour, that are the pucukan (cone) at the top, genukan (convex) in the middle, and lengkeh (concave) at the bottom, and has a symmetrical principle on both sides. Although in general, *gunungan* puppets have the same form principle, each puppet type and shadow puppet development area has different characteristics of *gunungan* puppets. One type of puppet and development area that has the form of *gunungan* puppets characteristics is the *gunungan* puppet that developed in Cirebon, and *Tatar Sunda* (Sundanese Region) in general.

Cirebon is an area that became the starting point for the development of puppet in Sundanese Region. The development of puppet in Cirebon is thought to have been brought along with the spread of Islam during the Sunan Gunung Jati period (Masroer Ch.Jb., 2015, p. 46; Rohmah et al., 2021, p. 55). Therefore, it is not surprising that Javanese *gunungan* puppets, both Gapuran (gate type form) and Blumbangan (pond type form) types are still often found in shadow puppet shoe that developed in Cirebon. However, in the development of shadow puppets in Cirebon, there are forms of *gunungan* puppets that have different characteristics from Javanese mountain puppets (Nurin et al., 2019: 34).

Figure 1. Cirebon Gunungan Puppets variety
(Doc. Photos by Nugraha, 2015 (left); Karsa, 2016 (middle);
Museum Wayang Indonesia, 2023 (right))

The characteristics of Cirebon *gunungan* puppets can be seen from the filling and shape. The *gunungan* puppets in figure 1 are various forms of *gunungan* puppets found in Cirebon, that are on the left is the gununan puppet known in the western Cirebon region or called the kulonan style, the middle of the eastern region or wetanan style, while the right is from keraton style. The filling found in the Cirebon *gunungan* puppets from top to bottom consist of tree of life, ponds, garuda birds, god of ganesha, tigers, and wadasan (rocks). Nurin et. all. (2019, p. 34) reveals that the Cirebon *gunungan* puppet which has a point of view in the

form of Ganesha filling, as shown in figure 1, is often referred to as the Ganesha *Gunungan* Puppet. In addition, Koesoemadinata (2013, p. 147) also revealed that *gunungan* puppet with Ganesha filling is referred to as *Gunungan* Jaler (male type form). As for the shape aspect, although Cirebon *gunungan* puppets have different characteristics from the characteristics of Javanese *gunungan* puppets, there has been no research that reveals it. Therefore, this study seeks to reveal the characteristics of the Cirebon mountain puppet shape and its engineering drawings.

Previous research that raised the Cirebon *gunungan* puppet was a study conducted by Nurun Ala Nurin et. all. (2019), that the identity of Sundanese can be seen from the visual symbols of *gunungan* puppet. This study strengthens the assumption that Cirebon *gunungan* puppets have different characteristics from Javanese mountain puppets. Another research on Cirebon mountain puppets was conducted by Ian Perasutiyo et. all. (2022), that the Cirebon *gunungan* puppet with the Ganesha type has a shape that matches the golden ratio. This research strengthens the assumption that Cirebon *gunungan* puppets have objective potential that can be used as capital in the composition of engineering drawings. In addition, there is also a *gunungan* puppet research that focuses on engineering drawings, conducted by Pandu Pramudita, et.all (2022b) with a focus on Surakarta *gunungan* (kayon) puppet materials and uses the golden ratio which then becomes a guideline in the composition of *gunungan* puppet engineering drawing steps. The focus of this research is how to compose engineering drawings of Cirebon *gunungan* puppets through mathematical aesthetics, especially using ethnomathematics. This research is expected to be an asset for the younger generation as learning material on how to draw *gunungan* puppet, especially Cirebon *gunungan* puppet which is more objective and systematic without deviating from the aesthetics of Sundanese which is the basic value of Cirebon shadow puppets.

METHOD

The research method used is qualitative with an experimental approach. Dharsono revealed that experimentation is an artist or designer's activity in carrying out a creative process with steps that include experimenting with alternative materials, techniques, tools, and arrangements (Dharsono, 2016, pp. 46–47). The experimental approach in this study is controlled through the following steps; 1) measuring the Cirebon *gunungan* puppet artifacts with an ethnomathematical approach, 2) determining the comparison of ethnomathematical measurement results in Cirebon *gunungan* puppets, 3) simulating the grid system on digital *gunungan* puppet images, 4) determining the layout of the Cirebon *gunungan* puppet shape as a basis for patterns, 5) determining the steps of Cirebon *gunungan* puppet engineering drawings. This research is also supported by opinions from experts and practitioners of shadow puppets, especially *gunungan* puppets, including: Ki Bambang Suwarno, Ki Junaidi, and Ki Thuthun, which practically provide the basics in making *gunungan* puppets traditionally. However, in this study, the information from the informants was then reprocessed into objective and systematic knowledge through the composition of engineering drawings of *gunungan* puppets, especially Cirebon *gunungan* puppets.

The object of this research material is the Cirebon *gunungan* puppet which is documented secondarily from the Indonesian Puppet Museum and some artist. The collection of Cirebon puppets at the Indonesian Puppet Museum located in Jakarta is quite representative used as data. At this point, documentation is indeed obtained secondarily because of limited access to documentation directly with good quality. The observation of Cirebon *gunungan* puppet material is still carried out directly by visiting the location of the Indonesian Puppet Museum.

RESULT AND DISCUSSION
The Shape Pattern of Cirebon *Gunungan* Puppet

The contour of the *gunungan* puppet shape is basically considered a non-geometric shape because it is considered to adapt a form of natural objects. The contour of this puppet is perceived with various forms of natural objects, such as mountain, mosque domes, and human hearts stillations (M. N. Huda & Saddhono, 2017, p. 139; Sabdho & Basir, 2014, p. 2; Solichin et al., 2019, p. 191). Although the contour shape is distilled from an object, the relatively firm contour look leads to the perception that the eye perceives as a certain geometric shape. Nurin et. all. (2019, p. 35).revealed that the contours of mountain fields generally have a pentagonal base shape. However, due to the force on the contour expression, the basic shape of this pentagon can no longer be used as a justification, and even the *gunungan* shape is no longer composed of a single shape but of several shapes.
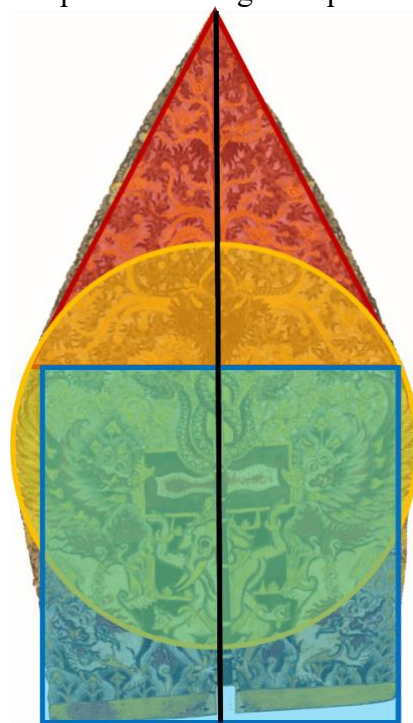

Figure 2. Cirebon Gunungan Puppets Shape Composition (Doc. Illustration by Researchers, 2023)

Illustration of the Cirebon *gunungan* puppet shape composition presented in figure 2 it is known that the puppet shape is composed of isosceles triangles at the top, circles in the middle, and squares at the bottom. The impression that arises on the layout of the Cirebon *gunungan* puppet shape is sturdy. This is because, even though the bottom is square, but because the middle is a circle so that the convex shape (*genukan*) does not seem so prominent. The three arrangements of the Cirebon *gunungan* puppet shape basically adapt Sundanese aesthetics contained in three expressions, that are *buana nyuncung* which is symbolized by a triangular plane, niat kudu buleud which is symbolized by a circle field, and hirup kudu masagi which is symbolized by a square field (Jamaludin, 2021, pp. 77–78). The arrangement of triangles, circles, and squares then becomes the next capital to be used as a guideline for the composition of Cirebon *gunungan* puppet engineering drawings.

The Size Ratio of Cirebon *Gunungan* Puppets through Ethnomathematics

The size of *gunungan* puppets basically cannot be determined modernly in units of meters, centimeters, or up to millimeters. Although Ki Thuthun (interview, August 2023) revealed that if the *gunungan* puppet is measured so the unit used should be reach millimeters. However, he also added that even that cannot be a guideline. Ki Junaidi (interview, August 2023) revealed that the size in the world of puppetry according to oral traditions passed down from previous artists using hands, for example the screen used as a puppet show area as wide as the puppeteer hand stretch or called sakdepa (one fathom). Ki Bambang Suwarno (interview, August 2023) asserts that the height of *gunungan* puppet should ideally be patang kilan (four spans). He then added that this shows that the size of the shadow puppet cannot be pegged or set because it should follow the puppeteer posture. Therefore, the measurement of *gunungan* puppet in this study does not use formal measuring techniques that use 'western' units or known as standard units, such as meters, centimeters, or millimeters, but uses non-standard units, especially ethnomathematics.

Ethnomathematics is a calculation method used by local communities as a guide in producing cultural artifacts. Ubiratan D'Ambrosio (1985, p. 44) reveals that ethnomathematics allows for a calculation method used by society that is different from that taught in formal schools. By other academics, ethnomathematics is understood as a way of calculating used by society in everyday life traditionally to account for an object or even a state in a certain way (Abroriy, 2020, p. 183; Fitriani et al., 2019, p. 95; Hardiarti, 2017, p. 100; N. Huda et al., 2023, p. 3; Purnama et al., 2022, p. 159; Zayyadi, 2017, p. 35). However, although the calculation method is understood as a system of knowledge for primitive societies, it has a universal and apriorical (Ascher & Ascher, 1986, p. 140; Gerdes, 1994, p. 19). The universal of ethnomathematics is understood that every society can use the same way. As for apriorical in ethnomathematics, it is understood that the measuring scale carried out does not deny the importance of mass industry but the need for every society that applies it.

Calculations through ethnomathematics carried out by the community often do not use measuring instruments that have a fixed scale because the tools used are taken from natural units. One of the measuring instruments used as a measurement scale is hands, such as span, cubits, and so on. Marshall Clagett (1999, p. 1) revealed that in the history of Egyptian civilization, there were small-scale measurements using the human body, especially hands, among others: cubit arm, palm, spawn, and finger. The comparative scale found in the human body has a balance of proportion with the world expressed by Leonardo da Vinci in his work Vitruvian Man. Vadstrup (2021, p. 152) reveals that through Vitruvian Man, da Vinci shows that there is an ideal comparative relationship between microcosm and macrocosm. The comparative scale that shows conditions in balance with nature by Leonardo Fibonacci is called the golden ratio (Dunlap, 1997, p. 135; Meisner, 2018, p. 12). The golden ratio itself has a series of calculations, including: 1, 1, 2, 3, 5, 8, 13, 21, etc., which at the same time creates ideal comparisons, such as 1: 1, 2: 1, 3: 2, 5: 3, 8: 5, etc. (Koshy, 2019, p. 4; Meisner, 2018, p. 44). This is evidenced by Meisner when applying the golden ratio to finger objects contained in da Vinci's painting entitled John the Baptist shown in figure 3. In other words, the use of human body parts for measurement purposes can be recognized because they have an ideal comparison.
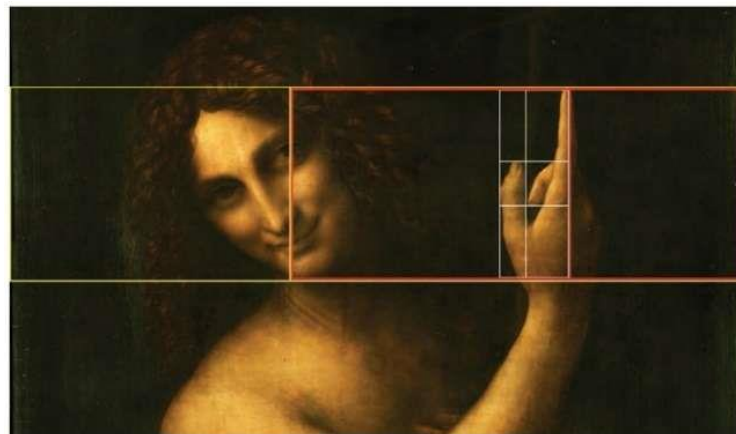
Figure 3. Finger proportions in Leonardo da Vinci's painting of "John the Baptist"
(Doc. Scan by researchers from Mesiner, 12: 2008)

Ethnomathematics, as explained earlier, has a universal nature. Although Egyptian civilization is understood to have existed much more time and place than Java, similar measurements as expressed by Clagett were also made by Javanese. Ki Bambang Suwarno and Ki Junaidi revealed that there are five units that are generally used as measurement guidelines in the world of puppetry, including: *nyari*, *teba*, *cengkah*, and *kilan*. *Nyari* is a unit of measurement using finger as illustrated in figure 4 point a. Teba is a unit of measurement using the palm as illustrated in figure 4 point b. *Cengkah* is a unit of length calculated from the stretch of the tip of the thumb to the tip of the index finger as illustrated in figure 4 point c. *Kilan* is a unit of length calculated from the stretch of the tip of the thumb to the tip of the little finger as illustrated in figure 4 point d.
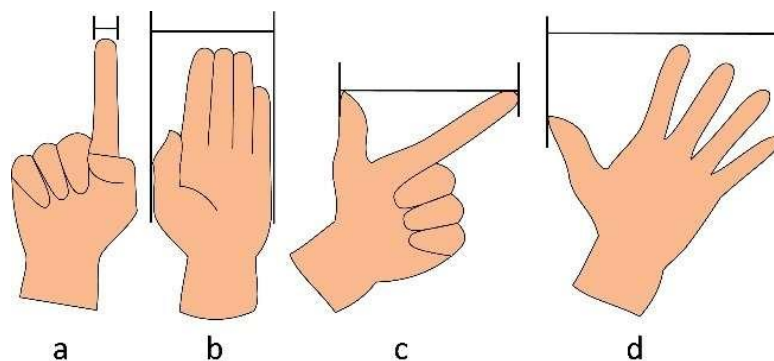

Figure 1. a) Nyari, b) Teba, c) Cengkah, d) Kilan (Doc. llustration by researchers, 2023)

The comparison between *sak nyari* (one finger) to *sak kilan* (one span) is relatively consistent. Just as the finger in Egyptian is considered a single digit, the palm is 4 digits (Clagett, 1999, p. 8), so in the comparison of *nyari* to *kilan* also uses *nyari* as a starting guideline as illustrated in figure 5. *Sak nyari* = 1 digit, *rong nyari* = 2 digits, and *telung nyari* = 3 digits. The ratio between *nyari* (finger) and *teba* (palm) is *sak teba* (one palm) equal to 2 times *telung nyari* (three fingers) or 6 digits. The comparison between *teba* (palm) and *cengkah* is that *sak cengkah* (one cengkah) is the same as *sak teba* (one palm) plus *telung nyari* (three fingers) or 9 digits. The ratio between *cengkah* and *kilan* (span) is that *sak kilan* (one span) is equal to *sak cengkah* (one *cengkah*) plus *telung nyari* (three fingers) or 12 digits. In other words, if *sak nyari* (one finger) is the initial comparison to reach *telung nyari*

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(three fingers), then the unit of measure above *telung nyari* (three finger) is calculated based on its multiple.

Sak Kilan	1	2	3	4	5	6	7	8	9	10	11	12
Sak Cengkah	1	2	3	4	5	6	7	8	9			
Sak Teba	1	2	3	4	5	6						
Telung Nyari	1	2	3									
Rong Nyari	1	2										
Sak Nyari	1											

Figure 2. Digits ratio in small-scale Javanese Ethnomathematics (Doc. llustration by researchers, 2023)

The *gunungan* puppets size generally uses *kilan* (span) and *teba* (palm). Ki Bambang Suwarno (interview, August 2023) revealed that the height of the *gunungan* puppet is four adult span (*patang kilan*). Based on these clues, it was found that the average height of the *gunungan* was four adult span (*patang kilan*) with a width of two span (*rong kilan*) plus one adult palm (*sak teba*). The comparison of the size of the height and width of the *gunungan* puppet is then used as a guideline to determine the comparison of the shape of the Cirebon *gunungan* puppet shape.

The Engineering Drawing of Cirebon *Gunungan* Puppet Shape
The engineering drawing of the *gunungan* puppet field is a detailed arrangement to form the *gunungan* puppet shape by placing points and lines precisely and measurably through certain comparisons. Pramudita et.all. (2022b, pp. 135–139) revealed that the engineering drawing of the *gunungan* puppet shape has three stages, including: base grid system, contour base, and shape outline.

The base grid system is a guideline in the form of an arrangement of horizontal and vertical lines formed from certain ratio results to determine the points that will be placed in the constituent areas of the *gunungan* puppet shape. The ratio used to form the base grid system is obtained from the basis that the height of the *gunungan* puppet is *patang kilan* (four span). The width of the *gunungan* puppet is *rong kilan* (two span) more *sak depa* (one palm). Therefore, figure 4 illustrates a scale of *patang kilan* (four span) up, while to the side, both right and left each are *sak kilan* (one span) more *telung nyari* (three fingers).
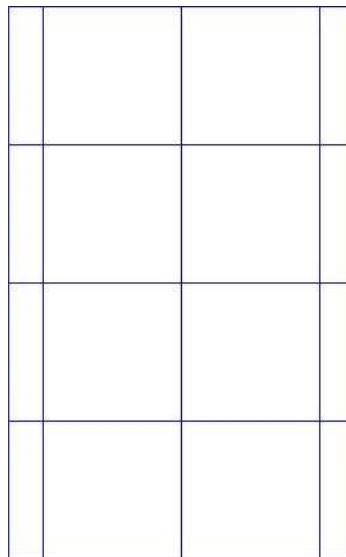
Figure 3. Wayang *Gunungan's* Base Grid System (Doc. llustration by researchers, 2023)

The next step is to determine the contour base of the Cirebon *gunungan* puppet. The first step is to create a *Genukan* (Convex) circle. In figure 7 it has been illustrated that the diameter of the circle is obtained from the width of the comparison, that is, the *rong kilan* (two span) is more *sak depa* (one palm). The center point of the circle is determined from the intersection between the vertical axis line and the horizontal line formed from a square plane with the length of the sides of the *rong kilan* (two span) more *sak teba* (one palm) placed on top.
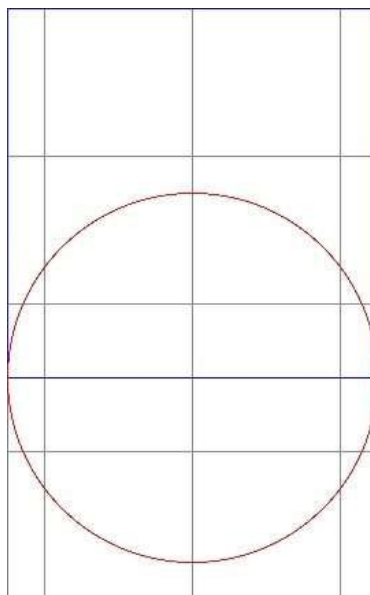

Figure 4. Making of *Genukan* Circle (Doc. Illustration by researchers, 2023)

The next step is to determine the lengkeh (concave) area. As illustrated in figure 2 that the bottom area the Cirebon *gunungan* puppet, which is the lengkeh area, is a square area. Therefore, the *lengkeh* area is a square area whose sides are determined to be half of the height of the *gunungan* puppet. If the height of the mountain puppet is *patang kilan* (four span) then the length of the sides of the square is *rong kilan* (two span).
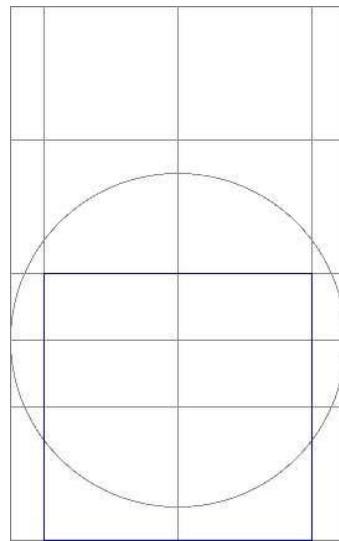
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Figure 5. Determining the *Lengkeh* Area (Doc. Illustration by researchers, 2023)

The *lengkeh* area is not enough to make a square area at the bottom but also needs a connecting line between the genukan circle and the lengkeh square. Technically, to connect the two areas requires an open curved line. However, to get the results correctly, it takes the right technique in making the curved line, that is by making a circle on the outside that creates a negative area. Figure 9 illustrates that the diameter of the circle made is as wide as the diameter of the *genukan* circle. The center point of the negative circle is sak *kilan* (one span) outward and *limang nyari* (five fingers) upward.
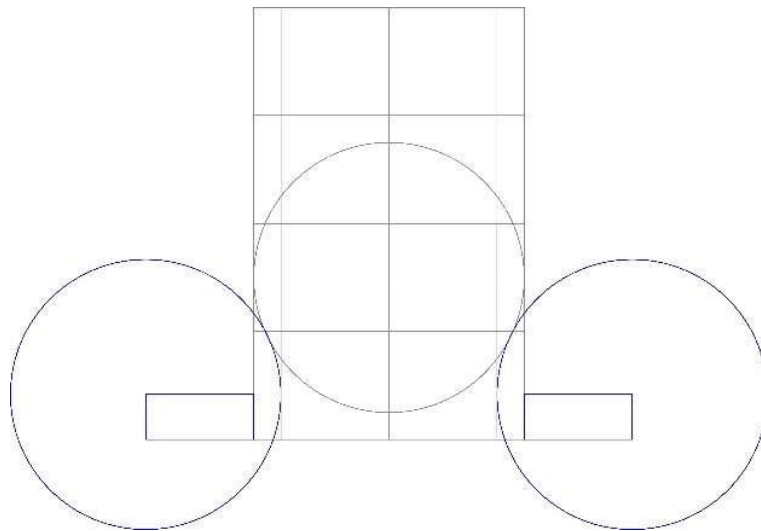

Figure 6. *Lengkeh* Curved Making (Doc. Illustration by researchers, 2023)

The *lengkeh* area is closed with curved corners which at the same time form a *palemahan* area. Curved corners are created using the circles shape. Basically, this curved angle does not include the shape structure part. However, the majority of angular shapes on the curved part towards the *palemahan* are in the form of curved expressions although they are often found also in pointed features, or so small the shape of the curved that it seems pointed. The curved corners are made using circles as illustrated in figure 10 with the diameter of the *rong nyari* (two fingers).
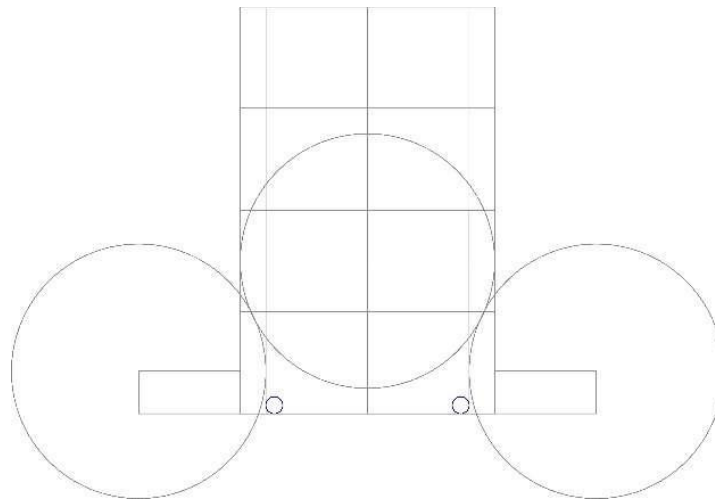

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Figure 7. *Palemahan* Curved Making (Doc. Illustration by researchers, 2023)

The final step at the contour base stage is the creation of a cone in the pucukan area. The *pucukan* area is formed from the triangle shape. However, the lower angle of the triangle shape is determined from the confluence of the horizontal lines of the square top extended to the intersection of the circle line. Thus, the triangle shape as illustrated in figure 11 is formed from the topmost axis point drawn to the intersection between the circle and the top line of the square, both on the left and right sides.
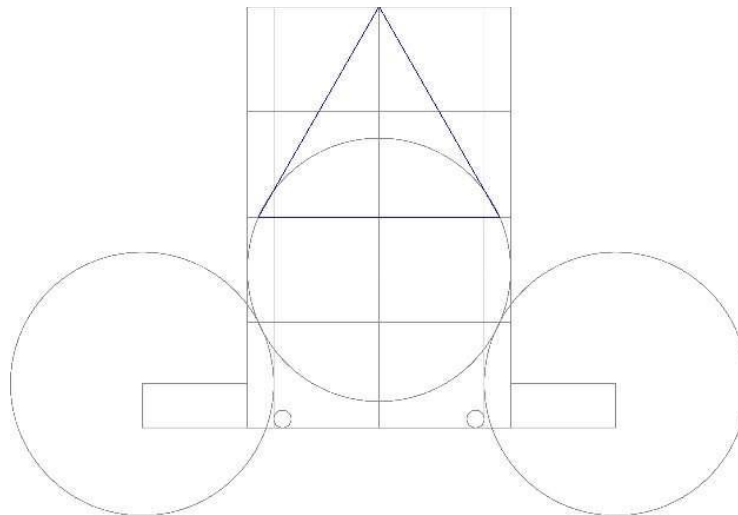

Figure 8. *Pucukan* Cone Making (Doc. Illustration by researchers, 2023)

The last stage in the *gunungan* puppet engineering drawing is the outline shape. Outline shape is the creation of an outline as illustrated in figure 12, which connects between the edges that close each other from the arrangement of shapes to create a new shape, that is the *gunungan* puppets shape.
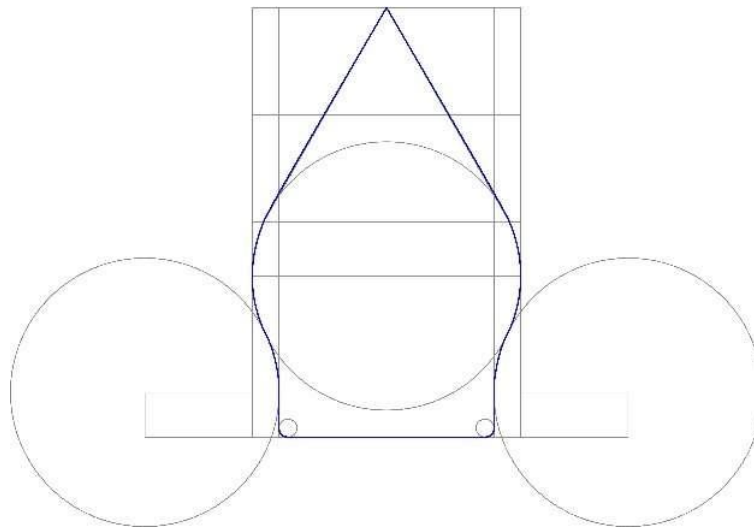
Figure 9. Outline Shape Making (Doc. Illustration by researchers, 2023)

The Composition Validation of Engineering Drawing Cirebon *Gunungan* Puppet

The outline shape of the cirebon *gunungan* puppet produced from the engineering drawings is then crossed with the Cirebon *gunungan* puppet image. This is done basically not part of the steps of the *gunungan* puppet engineering drawing but part of a research experiment, that is a validity test to determine the suitability of the *gunungan* puppet shape to reach as close as possible to the image of the Cirebon *gunungan* puppet. Figure 13 shows the results that there are parts of the *gunungan* puppet image that are not covered by the outline shape of *gunungan* puppet from the engineering drawing. This happens because of three factors, including the artifact condition, the shooting angle, and the composition of engineering drawings process.

Figure 10. Comparison Results of Engineering Drawings with Cirebon *Gunungan* Puppet Image (Doc. Illustration by researchers, 2023)

The artifact condition is intended as a factor derived from the material condition of the Cirebon *gunungan* puppets. *Gunungan* puppets are often understood as puppet figures that have a special shape that seems to have a symmetrical impression between the two sides. However, the reality of *gunungan* puppets is often found that the right and left sides are basically not exactly symmetrical. Symmetry is an impression that appears because the right

and left sides have similar shapes, as well as the fill. This asymmetry can occur due to three conditions, the first can start from the sketch or corekan (scribble) process, that is when the image of the *gunungan* puppet is traced onto the leather sheet, the second can be caused by the craft process, precisely during the inlaid process which may occur inconsistencies in carving tools so that it has an impact on reducing the puppets volume, and third can occur due to natural material processes, Where as the skin ages there can be a shrinkage.

The shooting angle is intended as a technical factor in taking *gunungan* puppet documentation which is then used as visual data. In this case, basically it takes sufficient photographic knowledge to get images that represent the posture of the *gunungan* puppet itself. The representation of the posture of *gunungan* puppet means that the suitability of the posture of *gunungan* puppet in reality and recorded in the image. This can be achieved with the condition that the *gunungan* puppet position is stuck standing perfectly upright and the camera position is right in the ready to highlight from the middle side and needs to be assisted by supporting tools so that the camera does not wobble easily. However, sometimes the field conditions, and the photographic ability of the photographer are not in accordance with the provisions resulting in distorsion in the posture of the *gunungan* puppet.

The composition of engineering drawings process is intended as a technical factor in the process of determining points and drawing lines. This process can occur due to adjustments caused by material factors, such as in reality it is not symmetrical so that in the process of compose engoneering drawings made symmetrical, or also from the results of image documentation so that the same action is taken. In addition, differences in point determination and line drawing can occur due to parallax, which is an error in the use of tools caused by limited eye capabilities. Therefore, to minimize the presence of this parallax, the process of complie engineering drawings is determined through digital methods, that is with the help of design software. The software used in the process of composing the Cirebon *gunungan* puppet engineering drawings uses Adobe Illustrator CC 2019.

CONCLUSIONS

Cirebon *gunungan* puppets have shape characteristics compared to *gunungan* puppets from Java. The shape characteristics of this *gunungan* puppet can be seen from its shape which is composed of isosceles triangles in the pucukan (cone) section, circles in the genukan (convex) section, and squares in the *lengkeh* (concave) and palemahan (bottom) section. The arrangement when the geometric sahpe gives a solid impression on the *gunungan* puppet posture. In addition, these three shape are also a representation of Sundanese aesthetics consisting of buana nyuncung, *niat kudu buleud*, and *hirup kudu masagi*. However, the comparison between the height and width of the Cirebon *gunungan* puppet ethnomatically basically has no difference from the Javanese mountain puppet, which is *patang kilan* (four span) height with *rong kilan* (two span) width more than sak teba (one palm). Ethnomathematics is the basis of measurement that has a subjective as well as objective nature, where each artist can create a size that suits the size of his posture but still has the same form of *gunungan* puppet posture because the basis of comparison is fixed. The engineering drawings of Cirebon *gunungan* puppets are arranged in three stages, that are the base grid system that resulting from ethnomathematical comparisons, the contour base that resulting from the placement of three geometric shapes, and the outline shape that resulting from drawing the outline from the arrangement of geometric shapes to create the Cirebon *gunungan* puppet shape. However, the results of the composition of engineering drawings have deviations from the reality form of Cirebon *gunungan* puppets caused by material condition, shooting angles, and the composition of engineering drawings process.

ACKNOWLEDGMENTS

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