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Macan Ali In The Cirebon Glass Painting: The Study Of Ethnomathematics

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ABSTRACT

The research objectives are: 1) Knowing the history and development of the macan Ali and the typical Cirebon glass painting. 2) Knowing the mathematical elements in the typical Cirebon Ali macan glass painting. The research method used by the researcher is descriptive qualitative research with interview data collection techniques, observations, documentation and field notes. The research results are the history of the macan Ali, which means the association of the Cirebon indigenous people who are great linuhung or holding fast to the belief of an almighty god. The mathematical element found in the macan Ali is the golden ratio worth 1.618... . The Golden Ratio used by the researcher is the Golden Rectangle and the Golden Ellipse. First, there are 3 Golden Rectangles on the two macan eyes, the front and back legs of the macan Ali and the formation of the tail pattern and the overall macan Ali's difference of 0.155 and 0.164. Then, 1 Golden Ellipse is found in the formation of the Ali macan body. Meanwhile, in typical Cirebon glass paintings, there are elements of transformation (Reflection, Translation, Dilation, and Rotation), namely, reflection or reflection on the making of the macan ali pattern in glass media, translation and rotation on the mega cloudy carving, and dilatation on the wadasan carving. From this research, it is hoped that this will provide readers with insight and knowledge regarding the typical Cirebon macan ali glass painting and the mathematical elements contained in it and can preserve the art, culture, and history through the typical Cirebon macan ali glass painting.

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1. INTRODUCTION

Mathematics is a basic science that has an essential role in education. Mathematics can make reasons for students to be able to train students in critical, logical and systematic thinking. Suherman [1] says that mathematics is the science of logic about form,

arrangement, quantity, and concepts in large numbers divided into three fields: algebra, analysis, and geometry. That is, mathematics is a science that contains logic where we are brought to know what is called form, arrangement, quantity, and concepts that are interconnected by numbers divided into three fields: algebra, analysis, and geometry.

The role of mathematics is widely used in our daily lives, for example, in the fields of education, economy, and culture. The role of mathematics in the field of culture is used as a concept or part of the creation of building architecture, form or motif used in a particular community skill. If seen, the culture in the community has values and history that arise through forms and mathematical concepts such as geometry, flat shapes, spatial shapes and patterns made from a mathematical model—no exception with the culture in Indonesia.

Indonesia is a country that has a wide variety of cultures, from Sabang to Merauke. Every place or region in Indonesia must have a different custom or culture for each region. For example, the arts of painting, batik, dance, etc [2]–[6]. Culture is a habit that contains elements of essential and fundamental values that are passed down from generation to generation. The habits carried out cannot be separated from applying mathematical concepts, thus providing unique and varied results. People do not realize that from the forms of cultural products that exist, especially in Indonesia, such as art, building forms, carvings, and jewellery that are preserved, they have mathematical knowledge so that mathematics is part of culture and history [7].

Mathematics contained in culture is called ethnomathematics. Ethnomathematics is mathematics applied by specific cultural groups, groups of workers or farmers, children from certain classes of society, professional classes and so on [8]. Ethnomathematics in Indonesia is not a new science but has been known since the introduction of mathematics itself. It is just that the discipline itself was realized after several scientists introduced names for students. Through ethnomathematics, mathematics learning is introduced through local traditions and culture, which are still practised and recognized by specific communities. Ethnomathematics was first pioneered or introduced by D'Ambrosio, a Brazilian mathematician, in 1977. According to D'ambrosio [9], mathematics is practised among cultural groups identified as ethnic, national communities, labour groups, and children of specific age groups and Professional classes.

One of the mathematical sciences in culture is glass painting. According to one glass painting artist, Dian Mulyadi, glass painting is a painting rich in colour gradations

and harmonization of decorative nuances and displays ornaments or decorative motifs of Mega Mendung and Wadasan, we know as batik motifs. It takes a long time to learn because it paints the picture upside down on a slippery object.

Since ancient times, glass painting has been known as a medium for Islamic da'wah in the Cirebon area. Historically [10]–[14], the glass painting came with the development of Islam in the Cirebon area. One of the ways to place glass paintings in Cirebon people's homes is as the presMacan that shows that the owner of the house is a devout person, usually in the form of glass paintings depicting mosques or Arabic calligraphy paintings [15], [16]. Another religious-magical function is glass painting which is used as a repellent against reinforcements [17]. Generally, Macan Ali's painting is used.

The Macan Ali painting has a motif or design in the form of Arabic calligraphy writing [17], [18], which can be written in Latin "Laa ilahaa illallaah", which means there is no god but Allah. According to its development, the macan ali glass painting is the most popular in Cirebon. Not only that, but the Macan ali glass painting is also an attraction for tourists to visit Cirebon who want to know the history of the Macan Ali and buy a typical Cirebon glass painting with the macan ali theme.

However, the macan ali painter generation has almost become extinct over time. The factor that almost made the successor of the glass painter almost extinct was the means that were not available by the city government to preserve this culture. The rapid development also makes the millennial generation now prefer things related to technology rather than gaining knowledge through art. Now, the remaining generation of glass painters also often makes glass paintings with more modern themes such as floral, plant, or classical ornaments on glass media.

The disappearance of this generation of glass painters in Cirebon is since many children of the current generation prefer to use or study gadgets rather than participate in learning about the history and arts of their respective regions. Of course, this dramatically affects the influence of the preservation of culture and art in Cirebon, which has now begun to be eroded by modern times. On this basis, the researcher can develop research related to the glass painting of the Macan Ali through aspects or elements of mathematics. The element of mathematics can also make someone's interest in studying mathematics more innovative and fun by applying the mathematical element to the Macan ali found in the typical Cirebon glass painting.

This research is exciting to discuss because we know that only a few artists or glass painting artisans know about making the macan ali symbol pattern applied from a mathematical point of view. This problem relates to culture in the form of the macan ali symbol in glass painting with mathematics so that the culture owned by the Cirebon people can still exist and be explored more deeply later.

2. METHOD

The research method used is descriptive qualitative research because this research explores the mathematical knowledge contained in glass painting and determines the pattern of depiction in determining the macan ali motif in glass painting. Before conducting research, researchers must determine in advance what types of data are needed to be related to the research. Various research data sources can be used to obtain the necessary data. Based on the data source, data collection can be done using primary and secondary sources.

Primary data is obtained by researchers directly without going through intermediaries, namely by interacting or communicating directly. The primary data in this research are visual data and written data. Visual data in the form of photographs of Macan Ali paintings then focused on the patterns applied in making paintings on glass objects, namely macan ali glass paintings. At the same time, the written data is the result of interviews with resource persons who know about the object, namely the glass painting of the Macan Ali.

Secondary data is a data source that does not directly provide data to researchers, such as documents or through other people's intermediaries. Researchers took data through source books, articles, and writings related to ethnomathematics and glass painting to complement the data with relevant literature studies.

3. RESULTS AND DISCUSSION

3.1. History and Development of Glass Painting Macan Ali Cirebon

Macan Ali is one of the distinctive themes in Cirebon glass painting and has long been known by the traditional Cirebon community. At first, the Macan Ali was known as a mystical Macan owned by the Padjajaran kingdom during the Hindu period, which was later adapted by the Islamic Cirebon sultanate. The form of the Macan Ali also followed Islamic rules at that time, which changed the shape of living things into Arabic calligraphy arrangements. The form of the Macan Ali is believed to contain Arabic calligraphy sentences whose contents are 2 (two) sentences of the creed, namely the Shahadah of Tauhid and the Creed of the Prophet or what is also called Kalimursyadah. The Macan Ali is a symbol of the struggle of the Cirebon people from ancient times until now. Macan Ali has the philosophical meaning of MA (Masyarakat Adat/Indigenous People), CAN

(Caruban Nagari), and Ali (Agung Linuhung). The Cirebon indigenous peoples' associations are great linuhung or cling to the belief of an almighty god.

Figure 1. Macan Ali and Macan Ali Painting

Macan Ali began to be made not only as a symbol or Cirebon flag, but over time, crafts such as glass painting entered the late 19th to 20th centuries AD. Glass painting is a blend of art, philosophy, and industry [19], [20]. Macan Ali is one of the most famous motifs or themes in Cirebon. Macan Ali was formed with a calligraphy arrangement that allegedly reads Laa Ilaha illallaah. The Macan Ali theme is widely used in traditional Cirebon art, such as banners, batik, sculptures in the palace gardens, tlawungan, and glass paintings.

In the macan ali painting, there is a form of calligraphy which is strongly suspected of reading the sentence "Laa Ilaha Ilallah", which has different characteristics in each hermitage or sultanate in Cirebon, including, Kasepuhan, Kanoman, Kacirebonan, and Kaprabonan. The glass painting of the Macan Ali itself is described as a painting with a meaning where humans must always hold fast to the creed and make the glass a reflection of human life which adheres to the creed in everyday life.

In the painting with the theme of Macan Ali, the primary form of Arabic calligraphy that forms it does not change, only the processing differences in the primary colour, head shape, and decorative forms in the calligraphy [21], [22]. The primary colour on Macan Ali's body is variations in each painting made by artisans. A visible difference is also found in the processing of the shape of the head of the Macan Ali. For example, in Rastika's work, the shape of the head tends to be more rounded; in the works of Halimi Husnan and Ade Supriadi, the shape of Macan Ali follows the shape of the head on Macan Ali, and the wall decoration is made of leather.

Table 1. Visual of Macan Ali Painting

No	Macan Ali Visualization	Distinctive Features / Origin
1		Kacirebonan
2		Kasepuhan
3		Kanoman
4		Kaprabonan

Table 1 above shows similarities and differences from the macan ali painting. The similarity found in the glass painting of the Macan Ali are found in the following sections:

1. The four motifs or characteristics of a hermitage lie in the shape of the Macan Ali, which looks like a sitting Macan.
2. The four motifs have a macan ali flag or banner as troops in each hermitage or sultanate in Cirebon.
3. The four motifs, when measured using the golden ratio, are the same size, only slightly different in the colours and clothes are worn by Macan Ali.

While the differences found by researchers in the glass painting of the Macan Ali are in the following sections:

1. The macan ali motif in each sultanate or hermitage has different clothes and colours to characterize a particular sultanate or hermitage.

2. In terms of glass painting, Macan Ali is usually made differently, such as: using megamendungdecorations, wadasan or using both according to the painter's wishes.

3.2. Mathematics on Macan Ali glass painting

The painting of Macan Ali, typical of Cirebon, is one of the themed glass paintings or Macan Ali motifs. The glass painting of the Macan Ali is seen from ethnomathematics, namely paintings or works of art related to the Golden Ratio approach. The Golden Ratio is known as Golden Number, Golden Proportion, Golden Mean, Golden Section, Divine Proportion, or Divine Section [23]. The Golden Ratio is a unique number approximately 1.618 in value and is denoted by the Greek letter (φ, pronounced phi). The golden ratio is commonly found in geometry, design, art, architecture, and even natural forms. An interesting thing about the golden ratio is that this ratio is considered a comparison that produces beautiful geometric shapes.

If it is calculated using proportions, the value is close to the number 1: 1.618, and there is a geometric construction in it to separate one line segment into many parts where the ratio value or comparison of the long line is compared to the short line (b) compared to the longest line (a). so the formula for the golden ratio is φ=b/a. The Golden Ratio has been used since classical times in various applications, namely in the fields of art, architecture, and spirituality, because of its perfect approach (beauty), which directly and indirectly touches the sides of divinity as something that cannot be doubted.

The glass painting of the Macan Ali is an artificial work or craftsman used by the artist (human) as an art form to interpret the two shahada sentences on the motif of the macan ali painting into a glass medium. The creed is a sentence that states the great sentence to Allah SWT and His messenger as a guide for humanity in everyday life by sticking to the creed. The macan ali painting based on the golden ratio is the Macan Ali painting at the Kasepuhan palace as the research sample.

The researcher found the point contained in displaying the pattern of the macan ali painting by using the golden ratio measurement, which can produce an aesthetic value in the macan ali painting. The researchers determined the golden ratio to determine the proper measurement and the value of beauty in Macan Ali. Researchers chose the Golden Rectangle and Golden Ellipse to determine the measurement pattern on the macan ali painting.

1. Golden Rectangle

The golden rectangle is a unique ratio or proportion [23]–[26]. The particular proportion is obtained by dividing the line segment into two segments or lines so that the ratio for the whole line, AB, is the longest part while AC is part of the longer ratio, and the shortest part is CB. The ratio of many squares forms a golden ratio or golden section rectangle; among the many squares, it forms a rectangle which produces a golden ratio of 1.618181819.

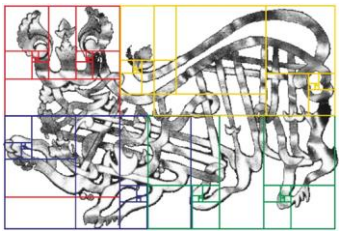

Figure 2. Golden Rectangle Macan Ali

From figure 2 above, there are four golden section rectangles, where each rectangle has an aesthetic value to the beauty of the macan ali painting. The following is the result of applying the golden section rectangle to each part of the Macan shape to form an aesthetic value in the Macan Ali painting, namely:

a. Golden Rectangle on Macan Ali Head (Figure 2, red line)

Based on the results of the researcher's analysis of the golden section rectangle, which was applied to the formation of the eyes of the Macan Ali, it was determined through certain distances and observations. According to the golden section rectangle theory, determining the value of a golden section by calculating φ=A/B=B/C=C/D=1,618, Provided that the numerator is greater than the denominator or the length is greater than the height according to rectangular rules or characteristics. The following are the measurement results of A = 5.71 cm and B = 3.58 cm using the golden section theory: φ=A/B=15.02/9.28=1,618.

The calculation results above show that the values of A and B compare 1.618 or the golden ratio. The formation of the golden section rectangle pattern focuses on an aesthetic value in the form of the right eye and left eye found in the glass painting of the Macan Ali. In terms of works of art, according to the painter with the glasses of the Macan Ali in the painting of the Macan Ali, the palace of Kasepuhan, it means that there is always someone watching over our every behaviour, both good and bad.

b. Golden Rectangle on Macan Ali's Feet (Figure 2, blue line)

Based on the results of the researcher's analysis of the golden section rectangle, which was applied according to the theory of the golden section rectangle, measurements were made using values of A = 15.02 cm and B = 9.28 cm to produce the following golden ratio φ=A/B=15.02/9.28=1,618

The results of the calculations above show that the values of A and B have a comparison of a golden ratio value. That is, the formation of the golden section rectangle pattern produces an aesthetic value for the two front legs of Macan Ali which has the value or meaning of a sitting Macan.

c. Golden Rectangle on Macan Ali's Tail (Figure 2, yellow line)

Based on the results of the researchers' analysis of the golden section rectangle, which was applied according to the golden section theory, the measurements were carried out using the values of A = 18.52cm and B = 10.44 cm, which could produce the following golden ratio φ=A/B=18.52/10.44=1,773

The calculation results above show that the values of A and B have a difference of 0.155 from the golden ratio. That is, the formation of the golden section rectangle pattern is not far from the results of the calculation of the golden ratio to produce an aesthetic value of beauty in forming the tail up to the tip of the tail, which is circular above the Macan Ali's body.

2. The golden ellipse

The golden ellipse is determined based on the calculation of the golden rectangle, where the ellipse is formed through the proportions formed by the rectangle [27]–[31]. To determine the golden section of the ellipse, you must first find the appropriate comparison proportion that produces the golden ratio in the calculation of the golden rectangle. According to [32], the golden ellipse has a slightly smaller major to minor axis ratio to define the ellipse better. Green's statement means that the ratio from the largest to the smallest has a significant value or role in determining the value of an ellipse comparison to produce a golden ratio of 1.618.

According to the golden section theory, the following formula is used to determine the value of the golden section ellipse:

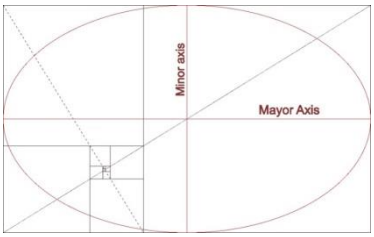

Figure 3. Golden Ellipse [33]

The analysis results show that the golden ellipse on the Macan Ali is found on the body part formed by the patterned golden ellipse to determine the body of the Macan Ali following the beauty of the animal's body shape in the painting. The following is the measurement pattern made by the researcher through specific observations to determine the size that is following the golden section theory formula:

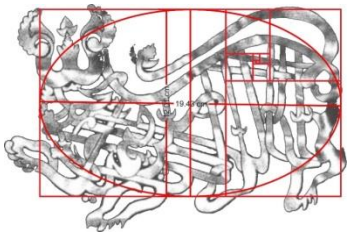

Figure 4. The Golden Ellipse Measuring Pattern on Macan Ali

The calculation results using the golden section ellipse theory are based on the determination of the largest (major) and smallest (minor) lines:

$$\varphi = \frac{A}{B} = \frac{19.44}{12.01} = 1{,}618$$

From the results of the above calculations, it is evident that measurements through observations at a certain distance produce a golden ratio value of 1.618 in the pattern of formation of a golden ellipse that produces the body of a Macan Ali. Forming a pattern using a golden section ellipse can produce the value of beauty in the shape of the Macan Ali's body so that it determines the aesthetic value of beauty. If you pay attention to the shape of the Macan Ali's body, which is decorated with calligraphy-like woven but random, it can be interpreted that in ourselves as humans, we must hold fast to the two sentences of the creed.

Meanwhile, the part that characterizes the Cirebon glass painting with the Macan Ali motif is usually decorated with carvings such as Mega Mendung and Wadasan in each of his paintings. In these characteristics, the researcher puts the concept of transformation (reflection, translation, and rotation) in the typical carvings of Cirebon glass painting.

a. Reflection

Cirebon's typical glass painting in its manufacture has a reverse painting technique. If the art of painting, in general, is painting by adjusting the position of the image, it is different from glass painting which uses reverse painting techniques so that the resulting image follows what the author wants. This technique makes glass painting look like it has the property of reflection or reflection where glass media is used as a vertical line to create a clear image through the reverse technique of glass painting. This makes the concept of reflection in the manufacture of glass painting.

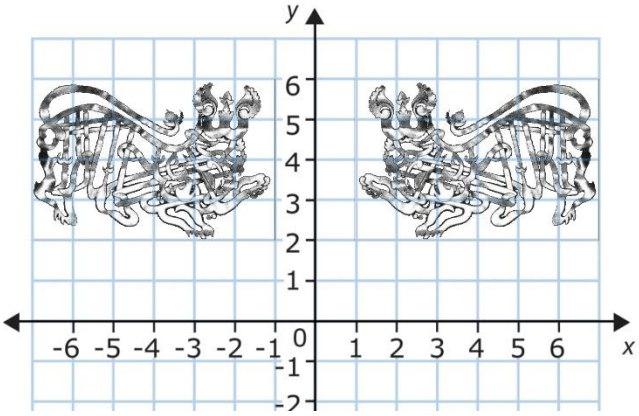

Figure 5. Reverse Painting

b. Translation

The creation of a typical Cirebon glass painting is identical to the megamendungdecoration. The researcher explored the shape of the megamendungusing the concept of translation in the typical Cirebon Macan ali painting. In figure 6, the concept of translation or shift occurs in the megamendungdecoration, which shifts from decoration a to decoration a'.

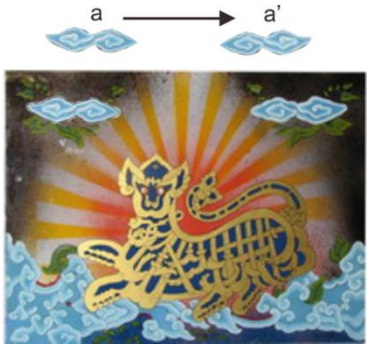

Figure 6. Megamendung Translation Concept

c. Rotation

The concept of rotation or rotation in the form of megamendung and wadasan decorations is found in the typical Cirebon Macan ali glass painting..

Figure 7. Rotation Concept

From Figure 7 above, it can be seen that Megamendung A1 is the result of the 180^{o} rotation of Megamendung A.

Based on the explanation above, it is clear that the Macan Ali painting was created through particular proportions that make the aesthetic value or the beauty of the Cirebon typical Macan ali glass painting become a unique beauty for art connoisseurs. The concept or element of mathematics found in the culture that develops through the arts in society is what makes mathematics a science that can be applied to many fields, and mathematics related to the culture or arts of this society is called ethnomathematics. The golden ratio pattern formed in the Macan Ali and the concept of transformation of the characteristics of Cirebon glass painting.

4. CONCLUSION

Based on the description of the data analysis and discussion and the results, it is concluded that the Macan Ali is a symbol or flag of the pride of the Cirebon people, born in the 13th century AD. The Macan Ali became a famous motif in glass painting in the 19th to 20th centuries AD. The glass painting of the Macan Ali means holding fast to the two sentences of the creed with the glass as a reflection of human life who holds fast to the creed.

The mathematical element contained in the Macan ali painting is the golden ratio or particular proportion, which is used to measure the pattern of formation of the beauty of a painting by producing a value of 1.618. At the same time, the typical Cirebon Macan ali glass painting lies in carvings such as Mega Mendung and Wadasan. Megamendungand insightful contain elements of transformation (reflection, translation, and rotation). The concept of reflection or reflection in making glass paintings, translation or shift in Mega

Mendung carvings, dilation or enlargement of Wadasan carvings, and rotation or rotation of Mega Mendung carvings in Cirebon Macan ali glass paintings.

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