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Mathematics on Cirebon Woven Fabric with Lanang Motifs

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ABSTRACT

This study aims to know the mathematical elements in the lanang motif woven fabric, construct a mathematical model on the increasingly lanang patterned weaving, and construct a new mathematical model for the new lanang motif woven fabric. The data was obtained in the form of qualitative data using interview data collection techniques, observations, documentation and field notes with data analysis, namely domain analysis, taxonomic analysis, component analysis and theme analysis. The results showed that the lanang-patterned woven fabric has geometric shapes, namely pentagons, rhombuses and triangles, to make pentagons, rhombuses and triangles using a pattern formed from small polygons called a rhombus-shaped unit lattice. The mathematical model used in this research is the matrix; to create a pentagon requires a matrix of order 103 × 210, to form a rhombus requires a matrix of order 103 × 338, and to develop a triangle involves a matrix of order 103 × 348. These patterns can create new designs by manipulating the rows contained in the matrix owned by each shape.

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1. INTRODUCTION

According to James [1], mathematics is the science of logic regarding shapes, arrangements, quantities, and concepts that relate to each other in large numbers, divided into three fields, namely geometry, analysis and algebra. Mathematics is a branch of science because mathematics can be used in various fields such as biology, physics, and mathematics. According to Trianawaty Anwar [2], mathematics is one of the basic sciences that has an essential role in everyday life and the development of science and technology.

The role of mathematics in human life and technological development is found in the education, economic and cultural sectors. According to Mulyasa [3] states, when

viewed in the education sector in the 2013 curriculum that mathematics is a compulsory subject that must be followed by students even as a National Examination at all levels of education from elementary school (SD), junior high school (SMP), and High School (SMA). However, teaching mathematics in schools only provides formulas, making students bored and dizzy having to memorize these formulas. This happens at almost all levels of education experience. One of them is like the editor in an online news media stating that there are students who think math is complicated and that students who have just heard about it are already afraid [4]–[8] . Mathematics can provide humans with reasoning systematically and critically and increase creativity. These thoughts help humans develop human thinking patterns and human attitudes when interacting [9]–[13]. For example, when people study mathematics, students are expected to be able to absorb the existing information and think whether the information is following facts or just information that is just an illusion.

The role of mathematics in the economic sector is needed as entrepreneurs must calculate the losses and profits for their business to help the economic sector. The role of mathematics in the cultural sector is like making ancient building architectures and designing images in a community skill. It has a historical value that is thick with the culture of having geometric shapes and a pattern made of mathematical models.

Koentjaraningrat [14] states that culture comes from Sanskrit, namely Buddayah, which is the plural form of buddhi (mind or reason) defined as things related to mind and reason. In English, culture is called culture, which comes from the Latin word colere, which means to cultivate or work. Widagdo [15] states in his book that culture results from the human mind achieving the perfection of life. Everything created by humans, concrete and abstract, is culture.

People do not realize that a preserved culture has the science of mathematics. Mathematics in culture is called ethnomathematics. Mathematics in a culture is the development of mathematics. One of the mathematical sciences in culture is woven cloth. Budiyono [16] revealed that weaving is a technique in making cloth which is made with a simple principle, namely by combining yarn lengthwise (warp) and transversely (weft) using traditional tools called non-machine looms, shortened to (ATBM).

Cirebon is an area in Indonesia that makes two types of woven fabric motifs, one of which is lanang motif woven fabric. The lanang motif woven fabric is a woven fabric used for men because, in this lanang motif, the length of the woven fabric made is only about

1.2 meters; with this length, this woven fabric can only be used as a sarong for men, and this lanang motif does not have threads gold in the motif. This lanang motif is called tajung woven fabric or lurik fabric in its place of origin, Palembang, West Sumatra. This statement is the same as in Salim's research [17] regarding the headgear woven fabric, which states that the cape woven fabric is one of the woven fabrics that does not use gold thread for male sarongs.

The lanang-patterned woven fabric has mathematical elements such as geometry in the shape of a pentagon, quadrangle and triangle, making a mathematical model for crossing two threads, namely an elongated thread (warp) and a transverse thread (weft), so that it becomes a lanang-patterned woven fabric and manufacture a new motif derived from lanang-patterned woven fabric by exchanging rows and unit grids. This problem is exciting to be raised in a study that the researcher will do, namely, wanting to link culture in the form of woven fabric crafts with mathematics, geometry, and mathematical models.

2. METHOD

The type of research used in this research is descriptive qualitative research. The descriptive method is data collected by qualitative methods in the form of words, pictures, and not numbers and then explained so that it can be described. Researchers go into the field, study a process or natural discovery, and record, analyze, interpret, report and draw conclusions from the process. This descriptive research is not intended to test specific hypotheses but only describes "what is" about analyzing mathematical elements in the woven fabric. This descriptive research aims to make a systematic, factual and accurate description, picture, or painting of the facts, characteristics and relationships between the phenomena being investigated.

Before conducting research, researchers must determine in advance what types of data are needed to be related to the research. 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. Such as visual data in the form of photographs of woven fabrics, then focused on the crossing pattern between two longitudinal and transverse threads so that they become motifs on woven fabrics. Besides that, it can also be in the form of written data from interviews with resource persons who know about the object, namely woven fabrics. The data collection techniques used in this study were interviews, documentation methods, observations, and field notes.

3. RESULTS AND DISCUSSION

3.1. Mathematical Model on Lanang Patterned Woven Fabric

The mathematical model is to describe a narrative in mathematical form by being given a symbol. The elaboration process is called modelling or modelling, which is nothing but a thought process [18]. The mathematical model used by the researcher is the matrix. Purwanto [19] states that the matrix is a line of elements in the form of a rectangular number. Matrix is a structured collection of numbers placed in rectangular rows and columns and is bounded by two square brackets [20]–[23]. The matrix is a series of elements in the form of numbers placed in rectangular rows and columns bounded by two square brackets. The number of rows and columns determines the form of the matrix.

The mathematical model in the image on the lanang-patterned woven fabric is the pentagon, the rhombus, and the triangular elements. The model that will be made is a matrix with elements of one (1) and zero (0); the researcher uses element one (1) because the thread that is transverse in the position above the thread is elongated while the element is zero (0) because it is symbolized as the thread that is transverse in the position under the elongated thread. After getting the mathematical model, the researcher also got a pattern for making this lanang woven fabric motif.

In order to better understand the longitudinal (warp) thread, what is the position of the thread and what is the transverse (weft) position of the thread on the woven fabric, the researcher illustrates the image as follows:

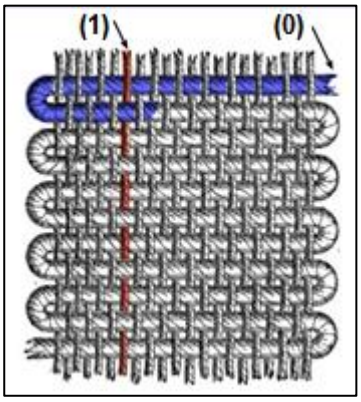

Figure 1. Woven Fabric Embroidery

Figure 1 shows that code (1) is the position of the longitudinal thread (warp), and code (0) is the position of the transverse thread (weft). Determining the number of longitudinal and transverse threads of the craftsman requires careful calculations so that the results of the woven fabric are satisfactory as desired. The calculation of yarn for the manufacture of woven fabrics plays a vital role because the results obtained may be unsatisfactory in calculating more or less yarn.

1. Pentagon element

   The pentagon elements on the lanang motif can be seen below:

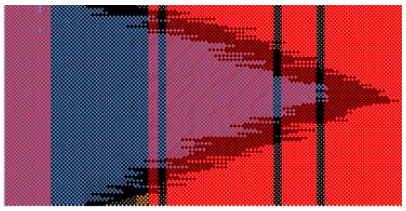

Figure 2. Pentagon elements

Making a pentagon element requires 103 transverse threads and 210 longitudinal threads. The lanang motif is a rectangle, with element one (1) as a thread coloured blue and black, while element zero (0) is a thread coloured red and black. The following is a mathematical model of thread embroidery so that it becomes a motif that resembles a pentagon:

Row 1

[**1**01010101010101010101010101010101010101010101010101010101010101010
101010101010101010101010101010101010101010101010101010101010101010
10101010101010101010101010101010101010101010101010101010101010101010
1010101]

Row 2

[01010101010101010101010101010101010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010101
0101010]

And so on until row 103. If these matrices are combined into one matrix and implemented in excel, it will become a matrix of order 103 x 210 with elements one (1) and zero (0) will be the image according to the motif of this woven fabric.

Here is the picture::

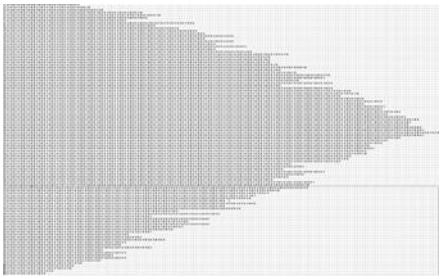

Figure 3. Pentagon element

If the elements in the matrix are coloured with the colours described above, then the result will look like in figure 2.

2. Rhombus Element

The rhombus elements in lanang woven fabric can be seen below:

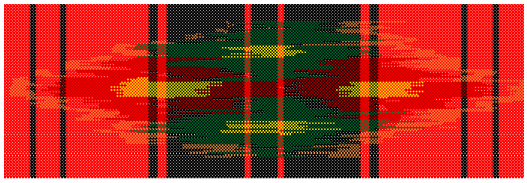

Figure 4. Rhombus Element

The rhombus element to make it must require 103 transverse threads and 169 longitudinal threads. This rhombus element one (1) is coloured with yellow, green and red, while element zero (0) is coloured with red and black. The following is a mathematical model of thread embroidery so that it becomes a motif that resembles a rhombus:

Row 1

[10101010101010101010101010101010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010
10101010101010101010101010101010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010
10101010101010101010101010101010101010101010101010101010101010101
010101]

Row 2

[01010101010101010101010101010101010101010101010101010101010101010
10101010101010101010101010101010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010

10101010101010101010101010101010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010
101010]

And so on until line 103, if implemented in excel, it will form a matrix. The matrix on the elements of the rhombus unit combined into one matrix will become a matrix of order 103 x 338 with elements one (1) and zero (0) will be the image according to the motif of this woven fabric.

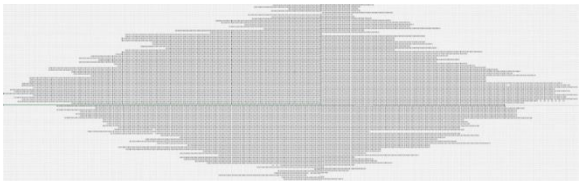

Figure 5. Rhombus element

If the elements in the matrix are coloured with the colours described above, then the result will look like in figure 4.

3. Triangle Element

The Triangle Element on lanang woven fabric can be seen below:

Figure 6. Triangle element

Triangle to make it must require 103 threads across and 348 threads lengthwise. The mathematical model in a triangular matrix has elements one (1) coloured in blue, black and red, while elements zero (0) are coloured in black and red. The following is a mathematical model of thread embroidery so that it becomes a motif that resembles a triangle:

Row 1

[01010101010101010101010101011010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010
10101010101010101010101010101010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010
10101010101010101010101010101010101010101010101010101010101010101
01010101010101010101010101010101010101010101010101010101010101010
10]

Row 2

[**1**0101010101010101010101010101010101010101010101010101010101010101
0101010101010101010101010101010101010101010101010101010101010101
1010101010101010101010101010101010101010101010101010101010101010
0101010101010101010101010101010101010101010101010101010101010101
1010101010101010101010101010101010101010101010101**1**01010101010101
01]

And so on up to row 103; if it is poured into excel, it will form a matrix. The matrix on the triangular elements combined into one matrix will be a matrix of order 103 x 348 with elements one (1) and zero (0) will be the image according to the motif of this woven fabric. Here is the picture:

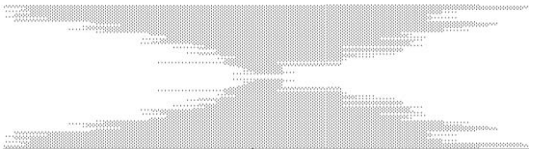

Figure 7.

If the elements in the matrix are coloured with the colours described above, then the result will look like in figure 6.

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3.2. Modify the matrix of the elements that have been formed to produce a new model

The creation of a new model made of pentagons by manipulating the row exchange in the matrix. The rows that are swapped, namely from lines 1 to 47, are swapped with lines from 48 to 103 and lines 48 to 103 are swapped with lines 1 to 47 so that it will become the image:

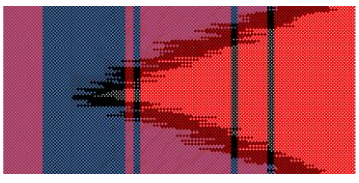

Figure 8. New Motif Made of Triangle Pattern Manipulation

In addition, the rhombus can be manipulated its matrix by swapping rows. The rows that are swapped are from rows 1 to 51 and are swapped with rows from 52 to 103 and vice versa so that it will become the image:

Figure 9. New Motif Made of Rhombus Pattern Manipulation

Alternating rows can manipulate the matrix in the triangular elements. The rows that are swapped, namely from the 1st to the 53rd row, are swapped with the 54th to 103rd rows and vice versa so that it will be in the following form:

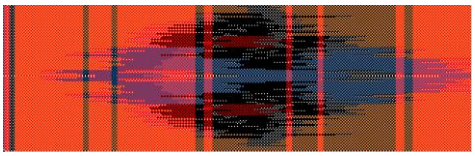

Figure 10. New Motif Made of Triangle Pattern Manipulation

3.3. Discussion

Lanang patterned woven fabric is a culture that is in the community. Especially in the Cirebon area, woven fabrics existed in 1947; that in 1947 there were Cirebon people who became woven fabric craftsmen in Karangsari Village Blok Kelebakan. Meanwhile, those who produce woven fabrics in Kertasari Village, Gombang Block, Weru District, and Cirebon Regency from 1950 to 2018 still survive. Lanang-patterned woven cloth is one of the products he makes.

The woven cloth with the lanang motif is a woven cloth that men only use because this woven cloth does not use a gold thread and is not made as a scarf. The colours in the lanang-patterned woven fabric have a particular meaning in everyday life. The red colour has the meaning of courage which is contained in the historical story of the courage of the figures and soldiers of war; the green colour has the meaning of fertility and the wealth of natural products contained in fertile and natural conditions [24]–[28]. Rich in natural products, the colour yellow has the meaning of openness and warmth contained in the social life of the people who are relatively open and build togetherness with other people, and black colour has the meaning of the socio-cultural life of the people who still maintain a mystical side to their traditional forms of belief [29].

The researcher found the main shapes contained in the lanang-patterned woven fabric, namely pentagon elements, rhombus elements and triangular elements; the three forms were only repeated in one woven fabric on the basis that the researchers focused on the three shapes, namely pentagon elements, rhombus elements and triangular elements. Each

element is contained in a unit lattice to form its elements, such as a pentagonal element contained in a rhombus-shaped unit lattice as much as 3,141 having the properties of one-time rotation of 180°, vertical shift and reflection about the y-axis. This rhombus element is filled by a unit lattice of 3,486, which has the property of rotation of 180°, experiencing sideways or horizontal displacement and reflection on the x-axis. The triangular elements are filled by 3,645 unit grids having 360° rotation, horizontal shift and reflection about the x-axis.

The process of making woven cloth still uses traditional tools. The artisans use a thread arrangement technique to make lanang-patterned woven cloth using traditional tools. In the process of making woven fabrics, the threads extend in a parallel position, but when pulled to each other, the position of the longitudinal threads will be above and below so that when the transverse thread is inserted into the longitudinal thread, there will be an embroidery process, this results in the display of threads, and the transverse threads pinched each other. When the longitudinal and transverse threads are pinched together, they form a woven fabric. The researcher numbered one (1) and zero (0) to better understand it. Numbering one (1) is the transverse thread above the transverse thread, and the numbering zero (0) is below the transverse thread.

Each pattern that resembles a pentagon, rhombus and triangle is made using a mathematical model in the form of a one (1) and zero (0) element matrix. To form a pentagon element pattern, 103 rows of colourful transverse threads are the shape of a pentagon and 210 columns of longitudinal threads of only one colour. Forming a rhombus element pattern requires 103 rows of colourful transverse threads that are rhombus shapes and 338 columns of longitudinal threads of only one colour. Another part to form a triangular element pattern requires 103 rows of colourful transverse threads that are triangular shapes and 348 columns of longitudinal threads of only one colour.

The unit grid is a small part of the polygon. Polygons are points connected so that their shape resembles a flat shape. Based on the explanation above, there is mathematics in the lanang patterned woven fabric, namely unit lattice, geometry and a mathematical model in the form of a one (1) and zero (0) element matrix. This explains that mathematics can be integrated with culture in the community, which is called ethnomathematics [30]–[34]. Each pentagon pattern, rhombus and triangular element can be made into new patterns and produce new shapes. From new patterns made from woven patterns with a lanang pattern, artisans can make various patterns

4. CONCLUSION

Based on the description of the data analysis and discussion and the results, it is concluded that the mathematical elements contained in the lanang-patterned woven fabric are geometry and crystallographic groups. The geometry is like a pentagon pattern consisting of a unit lattice which is a crystallographic group in the form of a rhombus as many as 3,141 having a rotational property of 180° and a shift towards up or down with a reflection about the y-axis. The rhombus consists of a rhombus-shaped unit lattice of 3,486, which has a rotational property of 180° and a sideways shift with a reflection on the x-axis. It resembles a triangle consisting of a rhombus-shaped unit lattice of 3,645, having a rotational property of 360° and a shift towards up or down with a reflection on the y-axis.

The matrix model to form a pentagon requires 103 rows of transverse threads and 210 columns of longitudinal threads. To make a rhombus, you need 103 rows of transverse threads and 338 columns of longitudinal threads. To form a triangle requires 103 rows of transverse threads and 348 columns of longitudinal threads.

The new model is created by swapping rows in the matrix. The rows swapped in the matrix to make a pentagon, namely from rows 1 to 47, are swapped with rows from 48 to 103. The rows swapped in the matrix to make a rhombus are from rows 1 to 51, with rows from 52 to 103. The rows swapped in the matrix to make a triangle from rows 1 to 53 are swapped with rows from 54 to 103.

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