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Etnomathematics: exploration sanitary industry center of Malang

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A B S T R A C T
This study aims to explore the mathematical elements contained in the center of the sanitation industry in Malang City. The Sanitary Industry Setra is in the form of flower pots, gravestones, tombstones, fountains, hand washing stations, chairs, and so on. The object is an object of exploration based on an ethnomathematical point of view. This study uses a qualitative approach to the type of ethnographic research. The subjects in the study were sanitary ware craftsmen in the Karangbesuki area of Malang City. The subject is experienced and has a fairly large turnover. Data collection techniques in the study were carried out by observation or direct observation in the field, interviews, and also by studying literature. This research will provide evidence that without realizing it, people have applied the concepts of comparison, calculation and mathematical measurement in creating an object of crafts that have been carried out since ancient times. The mathematical implementation carried out by craftsmen produces crafts in the form of spatial geometric shapes such as: blocks, tubes, half balls, and others. In creating craft objects, researchers also found the concept result from geometric transformations such as: of translation, rotation, and also reflection on some of the crafts produced.

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1. INTRODUCTION

Mathematics is closely related to everyday life in various aspects. One field that uses mathematics is an art that is realized in the form of crafts (Sari 2018). The craft in question is various forms of varied objects such as crafts, weaving, painting, etc. The production of these crafts is not only seen as a hobby, habit, and side job, but over time and with high market demand, producing handicrafts has now become the main livelihood for some people in certain areas. The area where most of the residents use handicrafts as a family income is the Karangbesuki area. Karangbesuki is one of the villages in the Malang area, Sukun District, Malang City. This village consists of nine RW (Rukun Warga) and 79 RT (Rukun Tetangga) (Puspasari dkk. 2019). Karangbesuki is an area in the city of Malang, where most of its residents have a livelihood as craft art craftsmen in the form of sanitation.

Karangbesuki Village has been a center for the sanitation industry since the 1980s. Previously, this industrial center was an area dominated by pottery artisans. Over time, it shifted a little into flower pot crafts, tombstones, pillars, etc. Finally, the area developed into a center for the Sanitary

Industry. The main characteristic of an industrial center is the growth of clusters that produce fairly similar products (Rustantono 2021). This Sanitary craftsman makes handicrafts with several mixtures using traditional methods without the help of machines. Artisans get expertise autodidactically and from generation to generation by seeing firsthand and practicing directly with other artisans. Starting from this hereditary expertise, it can make the region a thriving industrial center. It can be seen by establishing several UDs, such as UD. Putra Dasrim, UD. Mother's Prayer, UD. Darmo Putra, IT Sanitary, UD. Bakri Darmo Putra, UD. Pendowo, UD Darmos Putro, UD Manunggal.

Making crafts also combines elements of art that are developed and realized in the form of works like sanitary ware. The attractiveness is so high that handicrafts from this industrial area are increasingly in demand by the wider community, not only from the local area but throughout Indonesia. Such rapid development shows that, in the end, the handicrafts of the Karangbesuki area become the hallmark of the region. If observed in more detail, it turns out that making sanitary ware in the Karangbesuki area cannot be separated from mathematical concepts from the manufacturing process to finishing.

In this craft, there is one mathematical topic, namely geometry. However, there are other mathematical elements or topics to be found in crafts. Geometry is one of the fields in mathematics that investigates points, lines, planes, and spaces and their properties, measurements, and relationships with one another (Nur'aini dkk. 2017). In learning mathematics based on an environmental approach (ethnography), geometry has a role in helping students think logically and concretely. The lack of an environment-based approach used by teachers during the mathematics learning process resulted in students' perceptions that geometry material was complex. At the same time, concept learning should be applied simultaneously with concrete forms around us with ethnomathematics.

According to D'Ambrosio (1984) in (Sopamena 2018), Ethno-mathematics is one of the fields of mathematics that considers a cultural consideration, where mathematics emerges with an understanding of reasoning and the mathematical system it uses. Borba (1997) in (Supiyati, Hanum, dan Jailani 2019) also describes ethnomathematics as how people use certain cultural concepts of mathematics to understand relational and spatial aspects of their lives. According to (Wurdani dan Budiarto 2021), ethnomathematics is a form of study of mathematical practice that can be associated with a group of cultures or activities of a particular society. According to E.B Tylor in Ratna, (2005) defines culture as all human activities, including knowledge, belief, art, morals, law, customs and other habits (Ratuanik dan Kundre 2018). There are six basic mathematics activities: counting or counting, measuring, designing, playing, explaining, and determining locations.

According to (Shokib 2019) , elements of culture that are universal and are referred to as the principal of every culture are: 1. Tools and equipment for human life, for example; clothing, housing, household appliances and so on. 2. Livelihood systems and economic systems, for example; agriculture, plantation, animal husbandry, production system. 3. The social system, for example; kinship, marriage system, inheritance system. 4. Language as a means of communication, both oral and written. 5. Science. 6. Arts, for example; sound, visual and motion art. 7. Religious system. Some areas studied in this ethnomathematics are temples and inscriptions, pottery and traditional tools, local units, batik and embroidery motifs, and traditional games. The ethnomathematical objects can be in the form of traditional games, traditional crafts, artifacts, and activities in the form of culture (Wardani dan Budiarto 2022). Thus, it can be concluded that ethnomathematics is a science used to understand mathematical concepts adapted

from culture. So with ethnomathematics, geometry material can be implemented directly in everyday life.

Ethnomathematical research conducted by (Hardiarti 2017), obtained the results that the mathematical concept found in the Muaro Jambi temple in the form of the concept of a flat quadrilateral in several parts of the temple consisting of a square, rectangle, parallelogram, trapezoid, and irregular quadrilateral. Then the research conducted by (Abdullah 2020), shows that the decoration on the Yogyakarta cultural heritage building contains the concept of geometric transformation which includes translation (shift), reflection (reflection), rotation (turn), and dilation (multiplication). Research conducted (Radiusman dkk. 2021), Found that not only religious elements but also mathematical elements in the Great Mosque of Demak in the form of geometry and transformation concepts. In contrast to the previous research, the object of handicraft producers, which is the center of the industry and a source of livelihood, is the main attraction for exploring mathematical concepts. It is based on the form of craft which is a mathematical form and dimensional space. Research conducted (Nur Alvian dkk. 2021). shows that there are elements of mathematics (ethnomathematics) in the Sumur Gumuling Tamansari building, namely the concepts of rectangles, pentagons, rhombuses, triangles, circles, and the combined concept of a flat rectangular structure with a half circle. In this case it can be said that mathematics enters all aspects of life including cultural buildings.

Based on the description above, the research aims to explore the mathematical elements that exist in the handicrafts in the Karangbesuki area as a center for the sanitation industry. Exploration is done by looking at the production process to produce handicrafts.

2. METHOD

The research was conducted using a qualitative approach with an ethnographic design. The research object was carried out at the sanitary craft center in the Karangbesuki sub-district area, Malang City. Data collection techniques were carried out by directly observing production activities, conducting interviews with craft business owners, and documenting the entire production process. This observation was carried out directly in 2 industries, namely UD. Manunggal and UD. Darmo Putro. The interview was conducted with Mr. Subiantoro as the owner of the UD industry. Manunggal and Mr. Eka Candra as owners of UD. Darmo Putro in the RW.02 area, Karangbesuki Village, Malang City.

The data obtained during interviews and observations will then be analyzed qualitatively and described in descriptive form. The instruments used in this research include: interview guide and observation guide. The stages of this data analysis technique include data reduction, data presentation, and also conclusions. At the data reduction stage, important things or information will be selected from the results of interviews and observations and then presented descriptively. Overall, the data will be presented in descriptive form.

3. RESULTS AND DISCUSSION

The sanitation industry is one of the potentials of Karngbesuki Village. The superior products produced from the sanitation industry are generally in the form of flower pots, gravestones, tombstones, fountains, sinks, mosque domes, pillars, and others. Each sanitary ware has a different shape and motif. The type of interest also varies depending on the conditions. Like in the month of Ramadan, gravestone sanitation is in great demand. There are also various finishings, the most dominant of which is using black paint as a finishing touch. However, some use the finishing touch in the form of ceramics.

With the times' development and buyers' increasing interest in this sanitary industry, new ideas and innovations have emerged. It will lead to more and more variety of industrial products to be marketed. For example, in the current pandemic era, every entrepreneur is competing to make a sink innovation for washing hands which is currently very much needed. It is intended to attract buyers.

The situation can be seen in the surrounding settlements that still use goods from the village's sanitation industry, such as flower pots, sinks, and road gates. The materials used to make these items are the same as those used to make other industrial products. The materials are cement, sand, and mountain ash. All the materials used are straightforward to get around the factory. Most of the time, the process of making this sanitary ware already has its mold, but some do not make it without a ready-made mold from scratch. Every day, the manufacturer of the sanitary industry directly from the factory can make more than five crafts depending on the size of the craft, the drying time, and the order. If the order is large, usually in one day, artisans can make more than ten crafts. The daily production process starts at 08.00 – 16.00 WIB.

In making the sanitary industry, several stages must be carried out. First, prepare tools and materials. The materials used are cement, sand, mountain ash, and water with a predetermined ratio. The water used here is sufficient to form a dough that has been determined. Second, prepare a mold which is usually divided into two, which will later be joined together with a rope to glue. Third, put the finished dough to the inner edge of each mold with a predetermined thickness. Fourth, unite the mold with a rope. Fifth, let it dry a little. Sixth, remove the mold from the inside. Seventh, with the result that is still half wet, dried by using the sun. That way, at this stage of drying, weather significantly affects that stage.

After being completely dry, the sanitary ware will be painted according to the innovations of the artisans, but some are left untouched, such as house pillars. Usually, the house's pillars will be painted when installed as the foundation of the building. In this manufacturing process, it can be seen that the biggest obstacle is the drying process, which depends on sunlight.

Based on the research results, it can be obtained ethnomathematics in the activities of the Sanitary Industry Center, namely counting, counting, and measuring activities. This counting activity occurs when artisans determine the ratio of materials to a mixture of cement, sand, and mountain ash. The counting activity here can be seen in determining the thickness of the sanitary ware, which depends on the size of the sanitary ware to be produced. The measuring activity can be seen when the artisans determine the diameter or size used to make sanitary ware.

It was making dough from raw materials using different ratios. If we use a ratio of 1: 2: 1, it means using One sack of cement, Two sacks of sand, and One sack of mountain ash. If we use a ratio of 1: 3: 1, it means using One sack of cement, Three sacks of sand, and one sack of mountain ash. These comparisons are only used for one time of making sanitary ware. It also applies to its multiples.

In the measuring activity, it appears when the craftsman determines the diameter or size that will be used to make sanitary ware. The craftsman uses existing molds if an artisan only makes sanitary ware for general sale. However, if the artisans make sanitary ware according to the order, the artisans must measure it first. Here, artisans measure by using a tool like a meter. For the comparison of the size of the base and cover, the artisans do not have a standard size because all of them are by the types that will be made. It also applies to the height of the sanitary ware, which does not have a specific standard for measuring.

Ethnomathematics can also be seen in the forms of sanitary products that use geometric concepts. The shapes produced in this industry are various, such as blocks, hemispheres, tubes,

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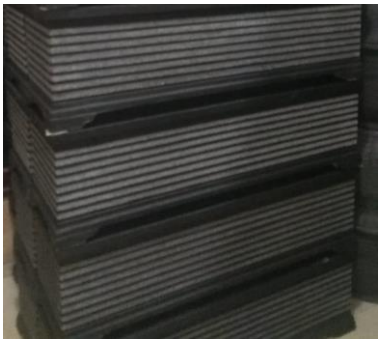
etc. (can be seen in table 1). This geometric concept can also be seen in some of the motifs produced in the sanitary craft, which can be seen in table 2 below:

Table 1. The Relationship between Sanitary and Spatial Building

 Figure 1	• Visible elements of building blocks • The formula for the surface area of a cuboid: • $Lp = 2(pl + pt + lt)$ • Volume of the beam formula: • $V = p\ x\ l\ x\ t$
 Figure 2	• Seen elements of a semi-spherical space • The formula for the surface area of a hollow half sphere: Lp = $2\pi r^2$ • Hemispheric volume: V = 2/3 πr^3
 Figure 3	• Visible elements of building a tube space without a lid • The formula for the surface area of a cylinder:Lp = πr (r + 2t) • Tube volume: V = $\pi r^2 t$
 Figure 4	• Visible elements of a flat square shape • The formula for the area of a square: L = s x s • The formula for the perimeter of a square: k = 4 x s

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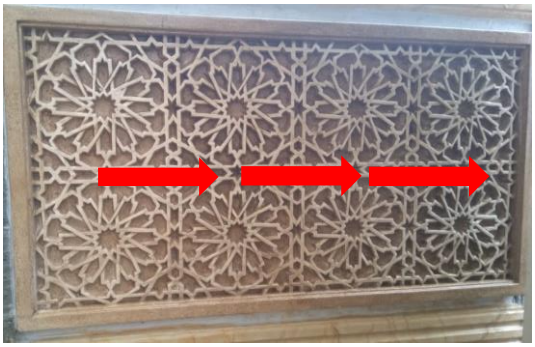
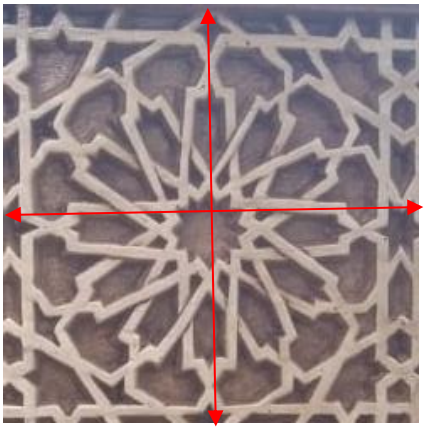
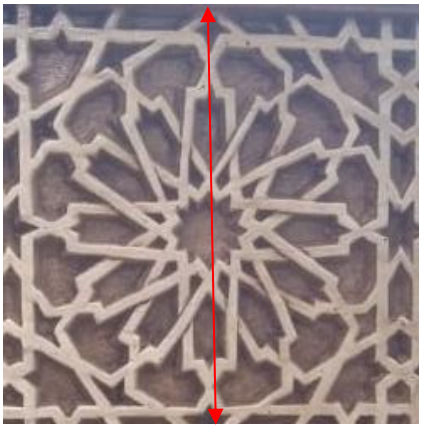
The results of sanitary crafts are generally made as a flat wake or space. It can be said to be a flat shape because some handicrafts have lengths, widths, and diameters. It can be said to be a form of space, too, because some handicrafts have length, width, and height, which are one of the characteristics of building space.

Table 2. The Relation of Motifs in Sanitary to Geometry Transformations

 Figure 1  Figure 2  Figure 3	• In Figure 1, it can be seen that the motif on the sanitary ware has a translation concept • In Figure 2, it can be seen that the motif on the sanitary ware has the concept of rotation • In Figure 3, it can be seen that the motif on the sanitary ware has the concept of reflection

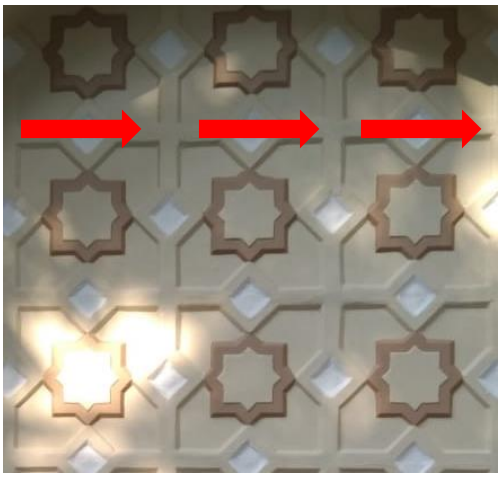


Figure 1

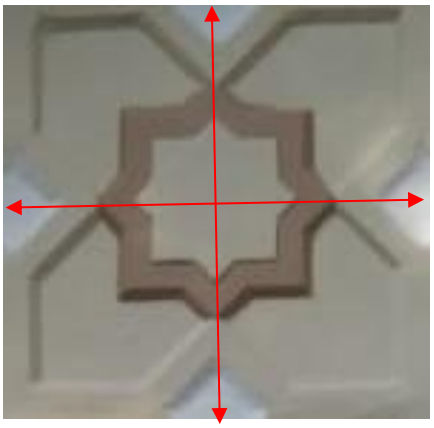


Figure 2

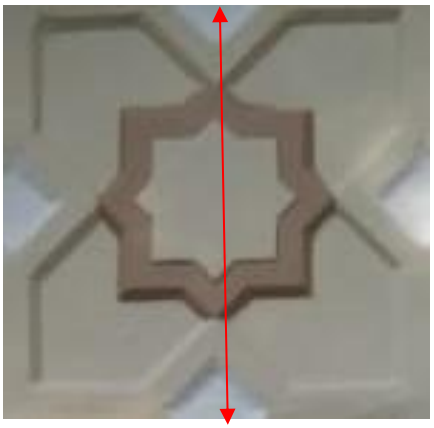


Figure 3

- In Figure 1, it can be seen that the motif on the sanitary ware has a translation concept
- In Figure 2, it can be seen that the motif on the sanitary ware has the concept of rotation
- In Figure 3, it can be seen that the motif on the sanitary ware has the concept of reflection

Geometric transformations in sanitary ware can be seen in the form of shear (translation), reflection (reflection), rotation (rotation), and dilation. The concept of translation is used in shifting existing patterns or patterns to a specific position. It can be seen in table 2 above, which contains several results of sanitary ware that apply the concept of translation. The concept of

reflection used in this craft can be seen in making patterns or patterns. Artisans only need to make one motif, which will later put the motif to the other side and later become a complete motif. The next concept is the concept of rotation which can be seen in table 2 above.

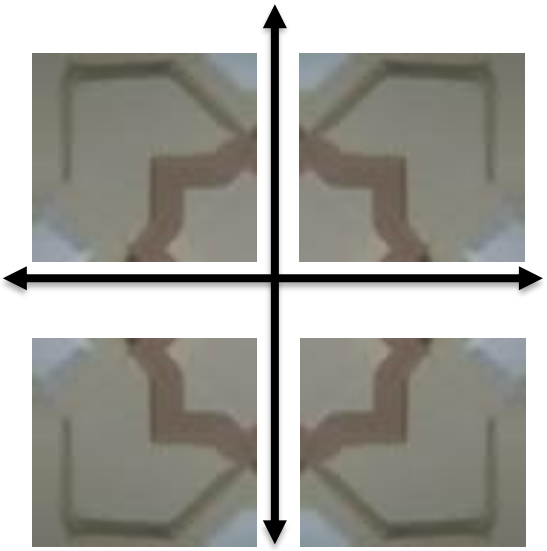


Figure 1. The Result of the reflection of the motif

In addition to the concepts of flat shapes, spatial shapes, and geometric transformations, the research results also show the concept of fractions. The concept of fractions is usually taught since elementary school by linking the concept to everyday life or the life around it. The application of the concept of fractions in this sanitary ware lies in the motif, which can be divided equally, and is seen in Figure 2.

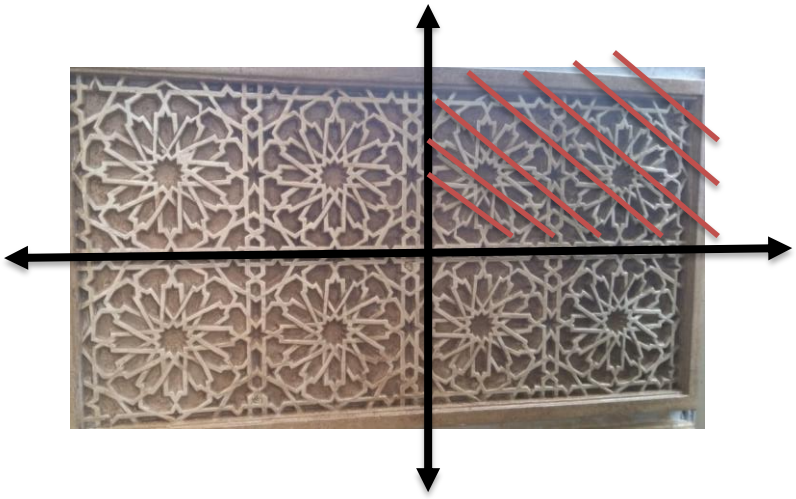


Figure 2. Concept of Fraction in one of the motifs

The concept of congruence is also seen in the results of sanitary crafts. Two flat figures or spatial figures are said to be congruent if the two plane figures have corresponding sides of equal length and angles of equal size (Kholil, 2020). This concept is seen in the pattern of motifs on sanitary ware, which have similar shapes and sizes. It can be seen at the gate when entering the area of the Karangbesuki sanitary industrial center, Malang City, in Figure 3.

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Figure 3. Congruence concept in RW-Gate

This study found four mathematical activities in the center of the sanitation industry, such as comparisons, spatial concepts, transformation geometry, and congruence. These results are in accordance with research conducted by Suryandari dkk. (2018) that the mathematical concepts that emerged in the ethnomathematics exploration of bayat pottery include: the concepts of straight comparison, number sequences, equality, conformity, and space. These ethnomathematical findings can be continued for further research and can also be used for the development of learning tools on comparative materials, geometric shapes, transformations, and congruence. The results of this exploration can be used as a source of innovative culture-based learning in learning so that students will better understand the implementation of mathematical concepts in everyday life (Kristanti, Rofiki, dan Masamah 2022). This is in accordance with the results of research by (Sumiyati, Netriwati, dan Rakhmawati 2018) which confirms that the use of geometry learning media developed based on ethnomathematics has an effect on students' mathematical critical thinking skills. The same thing was also conveyed by Richardo, dkk (2019) that ethnomathematics in the Yogyakarta context is valid, practical, and has the potential to measure critical thinking skills. Apart from that, the results of this research can also be used as a source for learning mathematics, especially material on geometric shapes and transformation geometry (Fajriah dan Suryaningsih 2021).

4. CONCLUSION

This study found some ethnomathematical elements in the sanitation industry center. Ethnomathematics in this counting activity appears when artisans determine the ratio of materials for a mixture of cement, sand, and mountain ash. The counting activity here can be seen in determining the thickness of the sanitary ware, which depends on the size of the sanitary ware to be produced. The measuring activity can be seen when the artisans determine the diameter or size used to make sanitary ware. In addition, this center for the sanitation industry also contains geometric concepts, which include fractions, comparisons, congruences, spatial structures, and

transformation geometry.

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