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Ethnomathematics Based Exploration of Geometric Concepts in Cirebon Rattan Crafts

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ABSTRACT

This study aims to identify and describe the mathematical concepts embedded in Cirebon's traditional rattan crafts and to examine their potential use as contextual resources for mathematics learning. Using a qualitative method with an ethnographic approach, data were collected through direct observation of rattan craft production and semi-structured interviews with local artisans. The analysis revealed several geometric concepts present in the motifs and construction processes of rattan crafts, including reflection and translation properties in transformation geometry, rectangular forms in weaving patterns, and measurement principles applied in determining the dimensions of rattan furniture components. These findings show that cultural artefacts contain rich mathematical structures that can support contextual and meaningful learning. The novelty of this study lies in its systematic ethnomathematical exploration of rattan craftsmanship in Cirebon, an area not previously examined in existing ethnomathematics literature and in demonstrating how these cultural practices can serve as conceptual bridges for introducing abstract mathematical ideas to students. This study offers a new perspective on integrating local cultural knowledge into mathematics education, thereby strengthening the relevance of mathematics to students' real-world experiences.

1. Introduction

Mathematics, as mandated in Law No. 20 of 2003 Article 37, is a compulsory subject at the elementary and secondary levels in Indonesia and plays an essential role in developing students' reasoning and problem-solving abilities. However, mathematics is often perceived as abstract, leading many students to struggle in understanding concepts presented during classroom instruction (Dunlosky et al., 2013) These difficulties are exacerbated by the dominance of conventional teaching practices that limit students' opportunities to explore mathematical ideas through meaningful contexts (Sowanto, & Mulyadin, 2019; Yaniawati et al., 2019). Consequently, teachers are required to adopt more innovative pedagogical approaches that support students' conceptual understanding and engagement in learning (Tanudjaya & Doorman, 2020; Singer et al., 2015).

One promising approach is ethnomathematics-based learning, which connects mathematical concepts with cultural practices familiar to students (Budiarto et al., 2019; Mania & Alam, 2021). Ethnomathematics provides opportunities for learners to explore and interpret mathematical ideas embedded in cultural artefacts, enabling them to better grasp abstract concepts through contextual experiences (Herawaty et al., 2019). Prior studies indicate that ethnomathematics can improve students' mathematical understanding, communication, and reasoning by linking formal mathematics to real-world cultural settings (Orey et al., 2014).

In Indonesia, one cultural product with strong pedagogical potential is traditional rattan craftsmanship. Rattan, a vine from the Palmae family (Rambey et al., 2021; Szczepanowska, 2018), is abundant in regions such as Cirebon, West Java, where communities, particularly in Tegalwangi village are well known internationally for their woven rattan furniture and decorative products. Beyond its cultural and economic value, rattan craftwork incorporates structured patterns, proportions, and geometric forms that naturally reflect mathematical concepts.

Despite its rich mathematical potential, previous ethnomathematics studies in Indonesia have predominantly focused on cultural practices such as weaving (Quraisy, 2025; Fitriyah et al., 2025), batik motifs (Prahmana & D'Ambrosio, 2020; Hidayati et al., 2025), traditional houses (Afriyanto et al., 2024; Ambarawati et al., 2025; Ahmad & Ashari, 2024), and local games (Aritonang, 2025), while systematic exploration of the mathematical structures in Cirebon rattan crafts remains largely absent from existing literature. The extensive body of ethnomathematics research in Indonesia has documented mathematical concepts in various cultural artifacts, including the geometric transformations found in Yogyakarta batik patterns (Prahmana & D'Ambrosio, 2020), the architectural mathematics of Rumah Gadang (Afriyanto et al., 2024; Naibaho et al., 2025) the symmetry patterns in silk woven sarongs (Quraisy, 2025) and the geometric elements in mosque ornaments (Purniati et al., 2022; Siregar, 2025). However, comprehensive analysis of Sundanese ethnomathematics reveals that while there has been significant research on various cultural practices, certain domains remain underexplored (Lidinillah et al., 2022).

Moreover, although many studies promote the use of cultural artifacts in mathematics education (Yuntawati & Aziz, 2025; Sulistiawati et al., 2025), few investigations explicitly analyze how the geometric characteristics and measurement principles in rattan craftsmanship can be transformed into contextual learning resources for school mathematics. Research has demonstrated that traditional cultural objects contain rich mathematical concepts that can be integrated into educational settings (Maba, 2025), yet the specific application of these findings to curriculum development and classroom implementation requires more systematic investigation (Sunzuma & Maharaj, 2019; Kyeremeh et al., 2025).

This gap is important because rattan craftsmanship contains repetitive patterns, symmetry, transformations, and proportional measurements, concepts central to the school mathematics curriculum (Quraisy, 2025; Nazahra & Astutiningtyas, 2025). Studies on similar traditional crafts have revealed that geometric concepts such as symmetry (reflection, rotation), transformation (translation), and basic geometric shapes are embedded in cultural artifacts (Quraisy, 2025; Fitriyah et al., 2025). The architectural analysis of traditional buildings has shown that cultural objects incorporate diverse geometric representations, including spatial forms, flat shapes, symmetry, patterns, proportions, and geometric transformations (Afriyanto et al., 2024; Ambarawati et al., 2025). Understanding these mathematical elements provides a foundation for teachers to design learning activities that bridge abstract concepts with students' lived experiences (Naibaho et al., 2025; Maba, 2025).

Research on traditional Indonesian cultural practices has consistently demonstrated that mathematical concepts, particularly in geometry, arithmetic, and transformation, are embedded in various cultural expressions. These include angles, symmetry, rotation, reflection, coordinate geometry, as well as patterns related to mathematical sequences and geometric relationships (Endilina, 2025). The integration of such cultural elements into mathematics education has been shown to improve students' understanding of geometric concepts contextually and applicatively (Siregar, 2025).

2. Research Methodology

This study employed a qualitative research design using an ethnographic approach to explore the mathematical concepts embedded in traditional Cirebon rattan crafts. Ethnography is appropriate for this study because it enables researchers to understand cultural practices directly within their natural context and to interpret the meanings behind the artefacts and activities of a particular community (Hameed, 2020; Umbara et al., 2021). Since rattan craftsmanship is a culturally embedded practice transmitted across generations, an ethnographic lens allows for an in-depth examination of the mathematical structures inherent in its production processes.

2.1 Research Site and Participants

The research was conducted in Tegalwangi Village, Cirebon Regency, the centre of rattan craftsmanship in West Java. This site was selected purposively due to its long-standing reputation as a rattan production hub and its variety of woven motifs that reflect strong geometric characteristics. Participants consisted of several experienced rattan artisans who were selected through purposive sampling. Selection criteria included:

(1) having at least five years of experience in rattan crafting,
(2) being actively involved in producing motifs and furniture, and
(3) willingness to participate in interviews and observations.

These criteria ensured that participants possessed culturally embedded knowledge relevant to identifying mathematical concepts in rattan designs.

2.2 Data Collection Techniques

Data were collected through three primary ethnographic techniques (Aveling et al., 2015):

1. Participant Observation
   The researcher observed artisans' crafting processes directly, including measuring materials, shaping motifs, and assembling rattan furniture. Detailed field notes and photo documentation were taken to capture geometric patterns, symmetry, transformations, and proportions visible in craftmaking.
2. Semi-Structured Interviews
   Interviews were conducted with artisans to obtain explanations of motif construction, measurement techniques, decision-making processes, and cultural meanings associated with rattan patterns. The interview structure allowed flexibility to pursue emerging insights while maintaining consistency across participants.
3. Artifact Analysis
   Several rattan products and motifs, including Ceplok Geometric motifs, Gedhek Cross motifs, and rattan chair components were examined to identify recurring mathematical structures such as reflection, translation, square shapes, and proportional measurements.

These three data sources enabled the triangulation of findings to enhance validity.

2.3 Data Analysis Procedures

Data analysis followed an ethnographic analytical framework consisting of the following stages (Aveling et al., 2015):

1. Domain Analysis: Identification of broad cultural domains related to rattan craftsmanship, such as weaving patterns, measurement processes, and motif construction.
2. Taxonomic Analysis: Classification of mathematical elements within each cultural domain, such as symmetry types, transformation properties, geometric shapes, and proportional measurement rules.
3. Componential Analysis: Comparison of different motifs and crafting techniques to distinguish nuances in their mathematical structures (e.g., differences between translational and reflective patterns).
4. Theme Construction: Integration of analytical results into overarching themes that describe how mathematical ideas are manifested in rattan craftsmanship and how these concepts can be connected to classroom mathematics learning.

Validity was ensured through method triangulation (observation, interview, artefact analysis), source triangulation (multiple artisans), and ongoing member checking, where artisans were asked to confirm the accuracy of interpretations drawn from the data.

3. Finding

Rattan craftsmanship is a long-standing cultural practice in Tegalwangi Village, Cirebon, where artisans work collaboratively in home-based workshops passed down through generations. Crafting activities are not merely economic tasks but embody a shared cultural identity. These social dynamics shaped the way artisans construct motifs, maintain precision, and preserve stylistic traditions, providing a rich context for identifying embedded mathematical concepts. Based on observations and interviews, several mathematical structures were found in rattan craftsmanship, manifested through motif construction, pattern repetition, and measurement techniques.

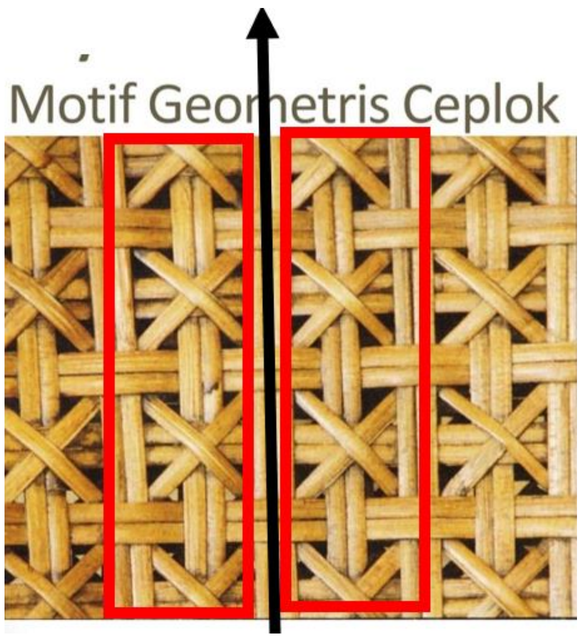

Figure 1. The ceplok geometric rattan motif

Figure 1 illustrates the Ceplok geometric motif commonly produced by artisans. Field observations revealed that the motif is constructed by ensuring balance between the left and right sides, reflecting an intuitive understanding of symmetry. One artisan explained:

> *"Kalau bikin motif Ceplok itu harus benar-benar seimbang kiri dan kanan. Kalau satu sisi beda sedikit saja, nanti motifnya kelihatan miring. Jadi kami selalu cek pantulannya, apakah sama bentuknya."* (Artisan A, Interview)

This statement demonstrates that artisans employ implicit knowledge of reflection symmetry, even though they may not use the corresponding mathematical terminology. Their emphasis on balance and mirrored positioning aligns with the mathematical definition of reflection as a transformation producing a mirror image across a line of symmetry. In addition to the nature of reflection, these motifs also have translational properties, as shown in Figure 2.

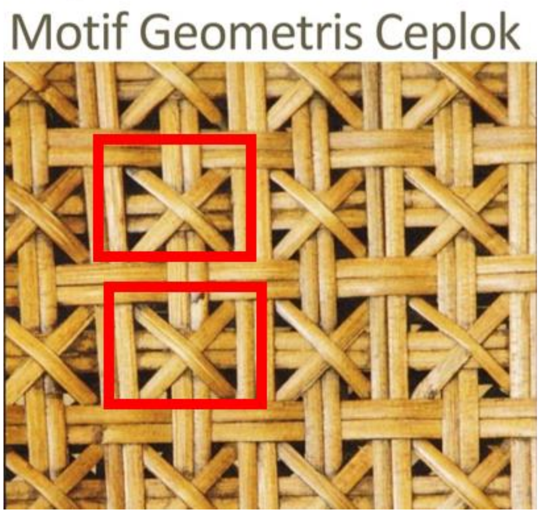

Figure 2. Translational properties of rattan motifs

In Figure 2, it can be seen that there is a concept of transformation geometry, namely translation properties. In translational properties, it can be sheared and does not change shape and size, but there is a change in position. In addition, on other motifs such as the Gedhek Cross Rattan Motif.

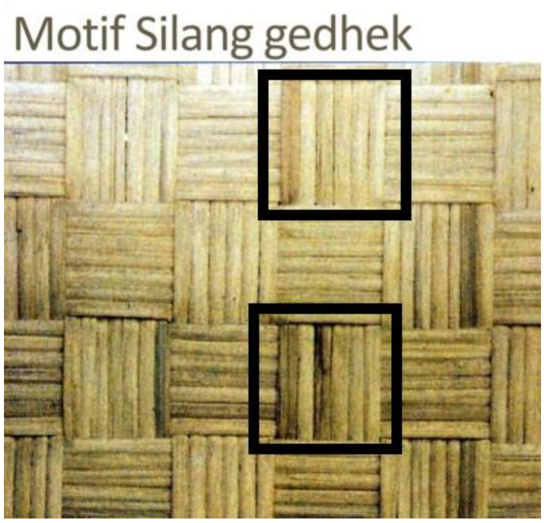

Figure 3. Gedhek cross rattan motif

Similarly, the Gedhek cross motif (Figure 3) embodies translational patterns. During interviews, artisans described the process of repeating woven strands at consistent distances:

> *"Pola silang itu tinggal diulang saja, maju satu garis, ulang lagi. Ukuran dan jaraknya jangan berubah, biar hasilnya lurus dan seragam."* (Artisan B, Interview)

This practice reflects the core concept of translation, where shapes are shifted without altering size or orientation. The artisans' focus on maintaining equal spacing reinforces the mathematical principles of congruence and uniform displacement along a defined direction.

Beyond motifs, mathematical concepts also appear in the structural components of rattan furniture. Figure 4 shows a typical rattan chair, which requires precise measurement to maintain shape and stability. Observations showed artisans frequently performing comparative measurements using visual alignment and proportional reasoning. One artisan elaborated:

> *"Kalau diameter besinya beda sedikit, nanti bentuk kursinya tidak simetris. Ukuran rotan yang dipakai juga harus sesuai. Biasanya kami pakai hitungan perbandingan supaya tiap bagian pas dan seragam."* (Artisan C, Interview)

This remark highlights artisans' reliance on proportional reasoning, especially when determining appropriate diameters and maintaining uniformity across multiple components. The craftsmanship process thus inherently involves mathematical ideas of ratio, measurement precision, and geometric consistency.

Figure 4. Rattan chair

During observations, artisans often compared two rattan strands by aligning them side-by-side and adjusting thickness or length until they achieved uniformity. This practice parallels mathematical concepts of equivalence, scale, and linear measurement. Although informal, these procedures demonstrate culturally embedded mathematical strategies consistent with real-world mathematical modelling. As an example, in the manufacture of Rattan Chairs, there are measurements, namely the thickness of the diameter of the iron legs of the chair in the size of each part must be the same. For example, an iron frame with a diameter of 1.5 cm and a thickness of 1.5 mm on the iron. Likewise, for the rattan, the diameter of the rattan used, for example, is 20 cm to 22 cm. For decoration, use rattan jawit with a diameter of 0.8 cm and the number of decorations must be the same on each chair. Therefore, when making rattan handicrafts, it is not arbitrary to have a size; it must have the appropriate size.

To support contextual mathematics education, the mathematical structures found in rattan craftsmanship were systematically mapped into potential classroom activities (Table 1). These include identifying axes of symmetry, constructing translational patterns, calculating perimeter and area of woven squares, and evaluating proportional relationships in craft components. These activities align directly with conceptual understanding required in transformation geometry and measurement topics.

Table 1: Mathematical concept summary and classroom integration

Concept	Mathematical Definition	Classroom Activity	Assessment Example (With Rubric)
Reflection	A transformation that produces a mirror image across a line of symmetry.	Students trace the Ceplok motif and draw its line of symmetry on grid paper.	*Task:* Identify and draw the axis of symmetry. Rubric: Correctly drawn line (2 points), proper justification (1 point).
Translation	A movement of an object without changing its shape or size.	Students create translational patterns from the Gedhek motif using square grids.	*Task:* Determine the direction and distance of the translation. Rubric: Correct direction (1 point), correct distance (1 point), explanation (1 point).
Square Shape	A quadrilateral with equal sides and four right angles.	Students measure rattan patterns to form squares and calculate their area.	*Task:* Compute area and perimeter. Rubric: Correct formula (1 point), correct calculation (2 points).
Proportion/Measurement	A ratio comparing quantities to maintain uniformity in design	Students calculate ratios between rattan sizes used in a product.	*Task:* Check if two components are proportional. Rubric: Correct ratio (2 points), explanation (1 point).

These findings demonstrate that mathematical concepts, reflection, translation, geometric shapes, and proportions are embedded naturally within the craft-making process and can be translated into classroom learning contexts. The ethnomathematical elements found in rattan crafts correspond to the framework of PISA (Programme for International Student Assessment), which focuses on students' abilities to formulate, employ, and interpret mathematical concepts in real life contexts (Batiibwe, 2024).

1. In the formulate process, students identify geometric structures and symmetry found in local rattan motifs.
2. In the employ stage, they apply mathematical reasoning through measuring, constructing patterns, and determining transformations.
3. In the interpret phase, they relate the outcomes to real-world cultural artifacts, reinforcing mathematical literacy and contextual understanding.

These findings are also aligned with the National Mathematics Competency Standards set by the Ministry of Education and Culture (Kolar & Hodnik, 2021), which emphasize contextual problem solving, reasoning, and the application of mathematical concepts in daily life. There are mathematical concepts based on several explanations regarding rattan motifs and measurements in the manufacture of rattan crafts. It can be seen through measuring techniques and motifs on the rattan, such as geometry transformation, reflection and translation properties, and rectangular shapes. The mathematical concepts found in rattan crafts can be applied in learning mathematics at school. Teachers can use it as teaching material for learning mathematics so that students can know the mathematical concepts contained in the culture in their environment.

4. Discussion

In the concept of transformation geometry, teachers can implement transformation material that explains the nature of reflection and translation or shift (Prahmana & D’Ambrosio, 2020; Endilina, 2025; Noerhasmalina & Khasanah, 2023). Research demonstrates that geometric transformation concepts, including reflection, rotation, and translation, are embedded in various cultural artifacts and can be effectively utilized in mathematics education (Prahmana & D’Ambrosio, 2020; Endilina, 2025). Studies on traditional Indonesian cultural practices have revealed that transformation geometry concepts are naturally present in batik motifs, traditional dances, and other cultural expressions, providing authentic contexts for mathematical learning (Endilina, 2025; Noerhasmalina & Khasanah, 2023).

The abstract nature of mathematics can be linked to contextual problems. The integration of ethnomathematics approaches addresses the challenge of making abstract mathematical concepts more accessible to students by connecting them to familiar cultural contexts (Sunzuma & Maharaj, 2019). Research indicates that geometry teaching should connect to learners' cultural backgrounds and environments, which is consistent with the social constructivist theory of learning. This approach emphasizes using relevant, everyday cultural activities that learners are familiar with, making mathematics more meaningful and engaging (Sunzuma & Maharaj, 2020). According to existing elements of mathematical literacy, there are aspects to the mathematical process: formulate, employ, and interpret (Jatnika et al., 2025). Mathematical literacy is an essential ability that students must possess and will affect other skills in learning mathematics (Ibrahim & Wahid, 2025). The integration of cultural elements into mathematics learning helps students relate abstract mathematical ideas to their everyday environment, enhancing their mathematical literacy and problem-solving capabilities (Susanti et al., 2025).

Furthermore, the implementation of ethnomathematics in geometry learning has been shown to strengthen students' cultural identity and positive attitudes towards mathematics (Jatnika et al., 2025; Pardimin & Supriadi, 2025). Teachers hold positive perceptions toward the use of ethnomathematics in geometry learning, reflected in aspects including awareness, prior exposure, evaluation of instructional design and implementation, practical use in teaching, and student assessment (Pardimin & Supriadi, 2025). Culturally responsive pedagogy supports the development of more inclusive and identity-affirming mathematics education (Zainovi et al., 2025).

The results of this study also found a mathematical concept, namely a flat shape like a square. In the formulating process, students can recognize a flat form. In the employing process, students can complete solutions related to rectangular shapes from real-world contexts. In the interpretive process, students can double-check whether or not they are correct in solving the solutions used in these problems. Research on ethnomathematics exploration of traditional games has revealed mathematical concepts in the form of flat shapes, congruence, number comparisons, and relations, demonstrating how cultural artifacts can serve as effective learning resources for geometric concepts (Syarmadi & Izzati, 2020).

Studies on batik motifs have consistently shown that geometric concepts such as plane geometry, symmetry, similar and congruent shapes, and arithmetic concepts in the form of ratios are embedded in traditional cultural patterns (Hidayati et al., 2025). These findings support the notion that cultural artifacts contain rich mathematical content that can be systematically explored and integrated into formal mathematics education. The geometric transformations found in various Indonesian batik motifs, including translations, reflections, dilations, and rotations, provide concrete examples of how abstract mathematical concepts manifest in cultural practices (Novikasari & Febriana, 2024).

With innovation in the ethnomathematics-based mathematics learning process in rattan crafts, it can be used as a solution or bridge for students in learning abstract mathematical concepts. Ethnomathematics contributes to the world of education, especially in learning mathematics. The process of learning mathematics from traditions and culture happens around students. Therefore, with ethnomathematics, students can have contextual mathematical knowledge, making it easier to understand mathematical concepts (Wibawa et al., 2025).

Research demonstrates that ethnomathematics studies how individuals or groups within a culture comprehend, express, and apply the concepts and customs of their culture, providing a theoretical framework for understanding mathematical thinking in cultural contexts. The systematic integration of indigenous mathematical concepts in Indonesian traditions has shown that cultural practices contain sophisticated mathematical understanding that can enhance formal mathematics education (Wibawa et al., 2025). Furthermore, studies indicate that school mathematics needs to be reconnected with the reality of human life so that students can easily understand mathematics and use it to solve various daily life problems (Permita et al., 2022).

The exploration of mathematical concepts in traditional crafts, such as the Gringsing batik motif in Javanese culture, has revealed that ethnographic methods can effectively uncover the mathematical structures embedded in cultural artifacts (Permita et al., 2022). This approach allows educators to develop culturally responsive teaching materials that bridge the gap between abstract mathematical concepts and students' lived experiences (Permita et al., 2022). The integration of local cultural elements into mathematics learning has been shown to enhance student engagement and understanding while preserving cultural heritage (Hidayati et al., 2025; Novikasari & Febriana, 2024).

5. Conclusion

This study examined the mathematical concepts embedded in traditional Cirebon rattan craftsmanship using an ethnographic approach. Through participant observation, semi-structured interviews, and artefact analysis, the research identified several underlying mathematical structures, including reflection and translation in woven motifs, square and other geometric shapes, and proportional reasoning applied in the construction of rattan furniture components. These findings demonstrate that mathematical thinking is naturally integrated into artisanal practices, even when not expressed using formal mathematical terminology.

The study provides a theoretical contribution by offering the first systematic ethnomathematical exploration of rattan craftsmanship from Cirebon, an area underrepresented in existing ethnomathematics literature. The integration of artisans' perspectives and cultural practices into the analysis highlights how mathematical ideas emerge organically within traditional craftwork. This strengthens the argument that cultural artefacts serve as rich sources of informal mathematical knowledge and reinforces the ethnomathematics premise that mathematics exists and functions within cultural systems.

In practical terms, the mathematical elements identified in rattan motifs and crafting processes have strong potential for use as contextual resources in mathematics education. By mapping these cultural structures to classroom activities, such as analyzing symmetry, constructing translational patterns, calculating geometric measures, and evaluating proportional relationships, the study offers concrete pathways for teachers to connect abstract mathematical concepts with students' real-world experiences. Such connections align with national curriculum expectations and international frameworks such as PISA, which emphasize formulating, employing, and interpreting mathematics in meaningful contexts.

Despite its strengths, this study has several limitations. The ethnographic observations involved only a limited number of artisans within a specific village, which may not fully represent variations in rattan crafting across the broader Cirebon region or other cultural contexts. In addition, the study focused on identifying conceptual mathematics rather than implementing and evaluating the use of rattan-based activities in actual classroom settings. Future research could expand the participant base, incorporate comparative studies with other cultural artefacts, or conduct classroom interventions to investigate the effectiveness of culturally grounded mathematical learning activities.

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