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AN ETHNOMATHEMATICS STUDY ON RUMAH KELANTAN TIANG 12

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Abstract: *This study investigated the ethnomathematical dimensions of the traditional rumah Kelantan Tiang 12, a distinctive symbol of Malay architectural heritage in Kelantan, a state on the east coast of Malaysia. Framed within the lens of ethnomathematics, the research examined how mathematical knowledge is woven into the design, construction and cultural meaning of the house. A qualitative methodology was adopted encompassing field observations, architectural measurements, photographic documentation and a review of relevant literature. The findings revealed a rich presence of mathematical concept: geometric forms in floor layouts and roof structures, proportional systems derived from traditional units of measurement and symmetrical arrangements that reflect balance and harmony. The twelve central pillars were found to embody both structural necessity and cultural symbolism, representing stability, identity and continuity of tradition. This study concluded that master builders applied mathematical reasoning intuitively, transmitted through generations of practices rather than formal instruction. By uncovering these embedded mathematical elements the research contributes to the preservation of Malay cultural knowledge while also demonstrating the potential of ethnomathematics to enrich mathematics education through culturally grounded learning experiences.*

Keywords: *Rumah Kelantan Tiang 12, Ethnomathematics, Malay design, vernacular Architecture, Geometry In Malay Culture*

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Introduction

Ethnomathematics as conceptualized by D'Ambrosio (1985), examines the interplay between mathematical ideas and cultural practices, this perspective emphasizes that mathematical knowledge is not confined to formal education but it is embedded within daily practices, artifacts and architectural traditions. Subsequent scholarship underscores the relevance of Ethnomathematics in uncovering indigenous knowledge systems and situating mathematics within culturally meaningful contexts (Barton, 2008; Rosa&Orey, 2016).

Within the Malay cultural landscape traditional architecture serves as a living record of cultural identity ,craftmanship and mathematical reasoning . in Kelantan ,one of the most distinctive vernacular structures is Rumah Tiang 12 characterized by its twelve primary pillars, symbolic spatial arrangements and intricate decorative motifs (Abdullah et al 2021; Othman, 2014).Traditional Malay builders constructed these houses without nails, relying instead on tanggam and pasak joinery systems, demonstrating a form of mathematical and engineering ingenuity (Said & Kamaruddin, 2010).

Despite considerable research on the cultural and historical significance of Rumah Tiang 12 (Nasir, 1985; Othman and Shuaib, 2013; Harun and Ibrahim, 2011), relatively little scholarship has explored its mathematical dimensions. Master's level studies (Othman, 2014) and journal publications (Othman & Shuaib, 2013) have outlined the spatial and Islamic cultural symbolism of the house, while digital preservation efforts such as Muti Akita have focused on heritage conservation (Zulkifli et al., 2024). However, these contributions stop short of analyzing the implicit mathematical reasoning embedded in its design.

Accordingly, this study investigates the ethnomathematical principles present in the design and construction of the Rumah Kelantan Tiang 12 by identifying and interpreting the geometric and spatial logic in its architectural features. The research aims to bridge the gap between indigenous construction knowledge and formal mathematical discourse, contributing both to heritage preservation and the enrichment of mathematics education.

The study of Rumah Kelantan Tiang 12 is significant to ethnomathematics and mathematics education because it connects cultural practices with mathematical ideas in a meaningful, real-world context. From an ethnomathematics perspective, the house exemplifies how mathematical thinking is embedded in cultural artifacts. The Tiang 12 (12-pillars) structure reflects concepts such as symmetry, proportion, spatial organization, and measurement. The layout of the pillars, the geometry of the roof, and the modular construction techniques all demonstrate how local builders applied mathematical reasoning informally, knowledge passed down through generations.

In terms of mathematics education, this study provides a culturally relevant teaching tool by using the house to teach geometry, ratios, and spatial reasoning. This approach promotes appreciation of local heritage while learning mathematics and supports more inclusive teaching methods where students see their own culture reflected in the curriculum. Such representation can motivate students and challenge the perception that mathematics is disconnected from everyday life.

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Overall, the significance of this study lies in bridging cultural knowledge and formal mathematics, enriching both the understanding of mathematics as a human activity and its educational practice.

Literature Review

Ethnomathematics: Conceptual Foundations

The concept of ethnomathematics, first introduced by D'Ambrosio (1985), emphasizes the study of mathematical ideas embedded within cultural practices, knowledge systems, and everyday activities. Unlike conventional mathematics education, which prioritizes universal abstraction, ethnomathematics situates mathematical reasoning within socio-cultural contexts, revealing diverse forms of numeracy, measurement, and spatial reasoning. Gerdes (1996) later expanded this framework by demonstrating that cultural artifacts such as weaving, design, and architecture embody complex mathematical concepts that, while not always formally codified, are functionally sophisticated. Rosa and Orey (2016) further argue that ethnomathematics provides a bridge between cultural identity and mathematical literacy, offering a platform to valorize indigenous knowledge systems in contemporary education.

Ethnomathematics and Architecture

Architecture has long served as a fertile domain for the exploration of ethnomathematics. Barton (2008) highlighted how spatial design and proportional systems convey mathematical narratives within cultural frameworks. Similarly, studies across Asia and Africa (Gerdes, 1996) show that vernacular structures incorporate tacit geometric knowledge, symmetry, and modularity. In the Malay world, architectural traditions employ proportional rules and symbolic geometry that reflect both practical needs and metaphysical beliefs (Nasir, 1985; Ahmad, 1999). These practices demonstrate how cultural values are translated into architectural form through measurable design choices.

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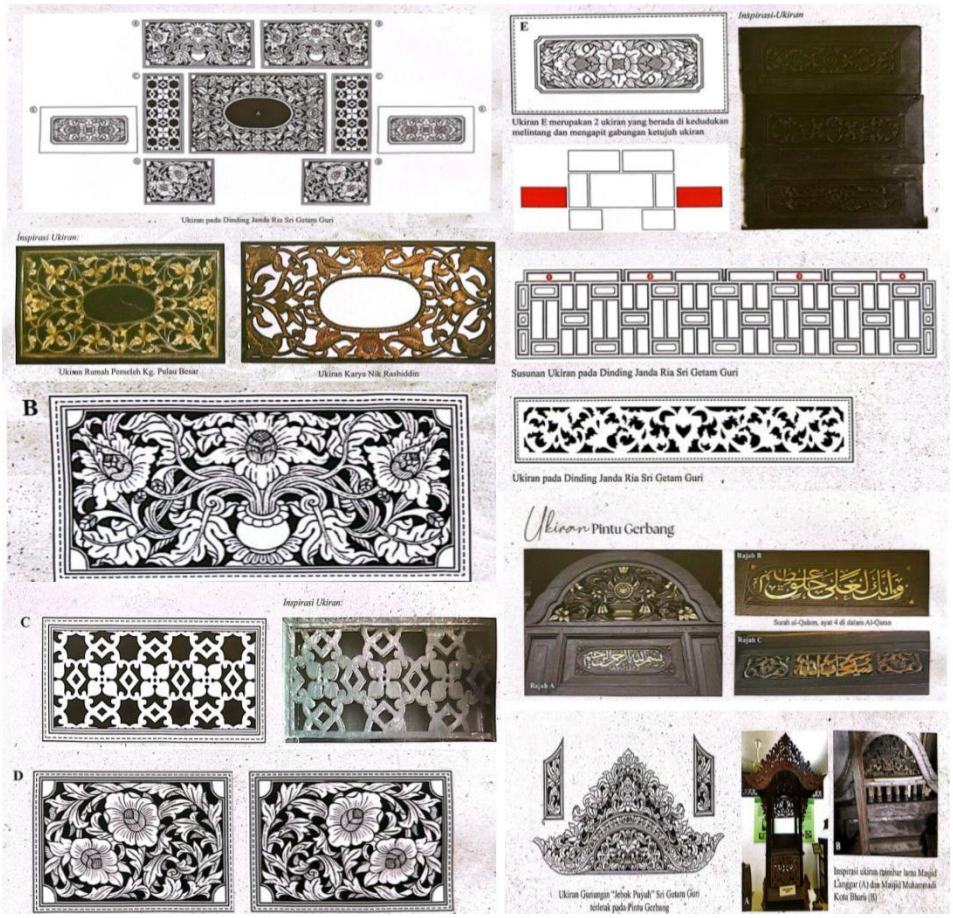

Figure 1 Architectural Design On Rumah Kelantan Tiang 12

The Traditional Malay House in Kelantan

The Malay house, particularly in Kelantan, represents a distinct architectural identity characterized by elevated timber structures, decorated carvings, and functional spatial organization. Nasir (1985) provides one of the earliest systematic classifications of traditional Malay houses, emphasizing typologies such as Rumah Bujang, Rumah Tiang 12, and Rumah Tiang 16. Harun and Ibrahim (2011) examined the spatial structure and environmental elements of Kelantanese houses, highlighting their adaptive design in response to climate, social organization, and Islamic values. More recently, Said and Kamaruddin (2010) noted that timber carvings and motifs not only reinforce aesthetic identity but also reflect embedded geometric principles.

The Rumah Tiang 12, in particular, occupies a special position in Kelantanese heritage. As Othman (2014) and Abdullah et al. (2021) explain, its twelve-post structure serves both as a physical framework and a symbolic marker of status, craftsmanship, and mathematical order. The arrangement of posts, proportional ratios of rooms, and modular expansions reveal mathematical reasoning inherent in construction practices. Othman and Shuaib also highlight how the spatial arrangement reflects Islamic values of privacy, hierarchy, and communal interaction, further linking architectural space to cultural epistemology.

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The relationship between ethnomathematical categories and Malay architectural practices in Rumah Kelantan Tiang 12 can be understood as a convergence of culturally embedded numerical, spatial, and proportional systems expressed through vernacular design. Ethnomathematics frames mathematics not as abstract computation but as knowledge encoded in cultural practices such as counting, measuring, designing, and spatial organization. The use of anthropometric measurements, proportional reasoning, and rule-based construction methods demonstrates embodied forms of mathematics, where builders rely on inherited knowledge rather than formal calculation.

Intersection of Ethnomathematics and Rumah Tiang 12

The study of Rumah Tiang 12 through an ethnomathematical lens reveals how mathematics is intricately embedded in architectural heritage. Rahman and Aziz (2024) demonstrated that documenting Rumah Tiang 12 via digital exhibitions requires careful attention to its proportional rules, symmetry, and geometric ornamentation, which embody tacit mathematical knowledge. At the same time, Projek Travel provides accessible accounts showcasing how the house reflects unique cultural and spatial principles that are easily recognizable to the public. Together, these studies illustrate that Rumah Tiang 12 is not merely a physical structure but also a repository of mathematical reasoning, cultural symbolism, and ecological adaptation.

While previous works have explored the architectural and cultural significance of Rumah Tiang 12, relatively few studies have systematically analyzed its mathematical dimensions within the framework of ethnomathematics. Most architectural scholarship focuses on typology, ornamentation, and cultural symbolism (Nasir, 1985; Harun & Ibrahim, 2011), while ethnomathematics research in Malaysia remains more general in scope (Barton, 2008; Rosa & Orey, 2016). This study seeks to bridge that gap by offering an ethnomathematical interpretation of Rumah Tiang 12, thereby contributing to both architectural heritage studies and mathematics education.

Methodology

The focus of this study is to explore how mathematical concepts such as geometry, proportion, symmetry, and measurement are embedded in the traditional architecture of Rumah Kelantan Tiang 12. Accordingly, this study adopts a qualitative ethnographic approach grounded in the theoretical framework of ethnomathematics (D'Ambrosio, 1985). A house known as Rumah Kelantan Tiang 12, located at Jalan Bayam, Kota Bharu, Kelantan, was purposefully selected for the study.

Data collection methods included field observations, interviews, and document analysis. Observations focused on architectural features such as the placement of pillars, roof angles, and spatial layout. Interviews were conducted with traditional builders to explore themes such as traditional measurement systems, symbolic meanings, and construction methods. The data were thematically analyzed with an emphasis on mathematical aspects such as proportion, conversion, and measurement. Additionally, blueprints, manuscripts, and previous studies were reviewed to support and triangulate the primary data.

Trustworthiness was ensured through data triangulation, member checking, and the use of a reflexive journal to manage researcher bias.

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Findings and Discussion

The findings of this study reveal that Rumah Kelantan Tiang 12 is not merely a physical structure but a manifestation of indigenous mathematical thinking interwoven with cultural values, functionality, and aesthetic sensibilities. These results align with the ethnomathematics framework, which posits that mathematical ideas are embedded in cultural practices and expressed through context-specific forms (D'Ambrosio, 1985).

Figure 2 Rumah Kelantan Tiang 12

Rumah Kelantan Tiang 12 is a house that has 12 uncut wooden pillars and the structure is installed in the ground up to the top of the ceiling.

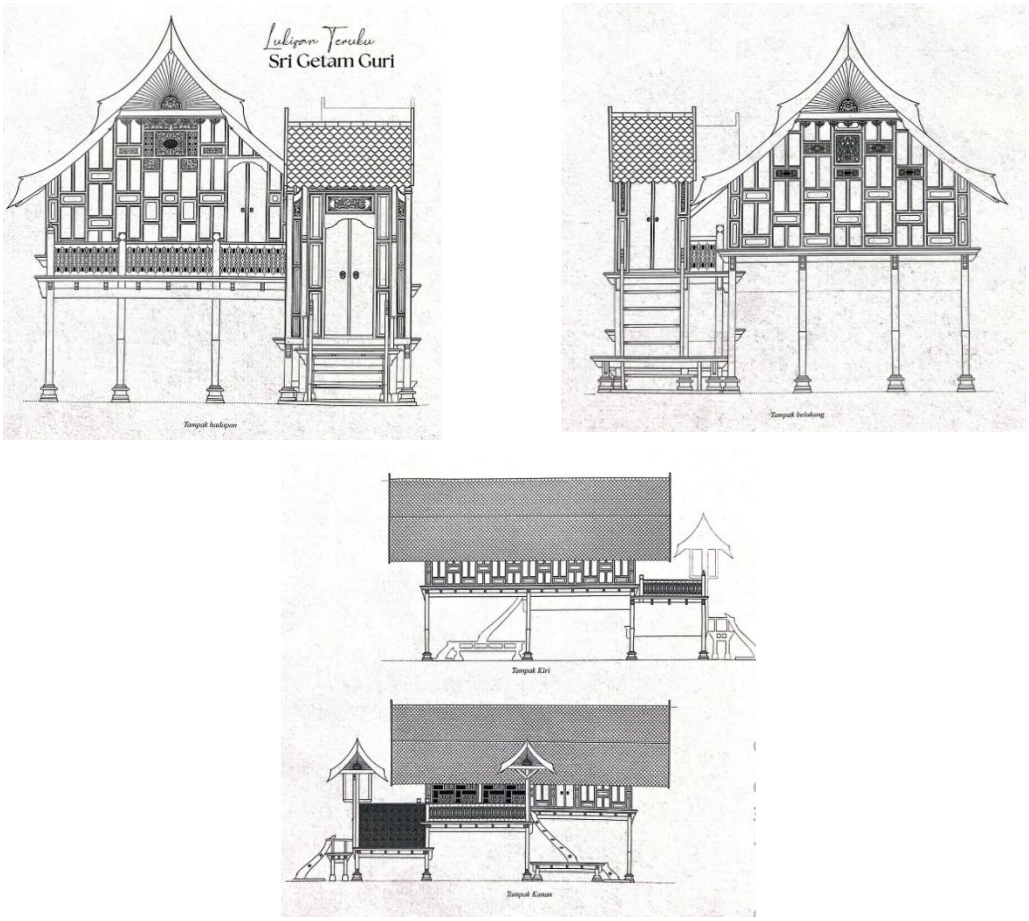

Figure 3 The Front and Back Illustration of Rumah Kelantan Tiang 12

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The above mentioned illustrations showed the front and back drawing of Rumah Kelantan Tiang 12.

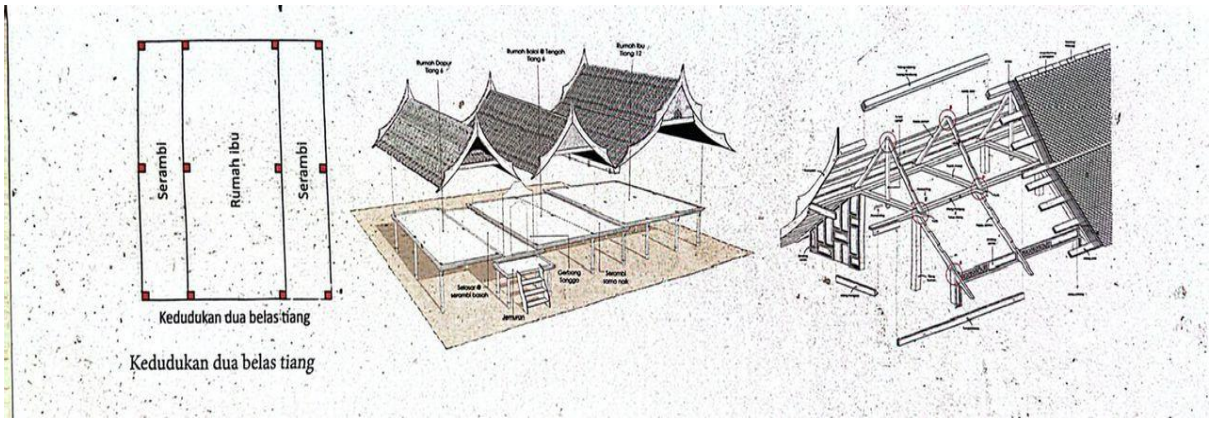

Figure 4 The Layout Plan of Rumah Kelantan Tiang 12

The layout plan of Rumah Tiang 12 is divided into seven distinct spaces: Rumah Ibu (the living area), Rumah Balai (the guest living area), Rumah Dapur (the kitchen), Selasar (uncovered passage), Jemuran (yard), and Telaga Langit (air well).

Rumah Ibu, or the living area, serves as the core of the Rumah Tiang Dua Belas design and is considered the main family living space. Its floor level varies and is built higher than the other parts of the house. Rumah Balai functions as a space for daily activities, such as weaving mats. Rumah Dapur, located at the back of the house, is divided into two sections—one for cooking and the other for dining.

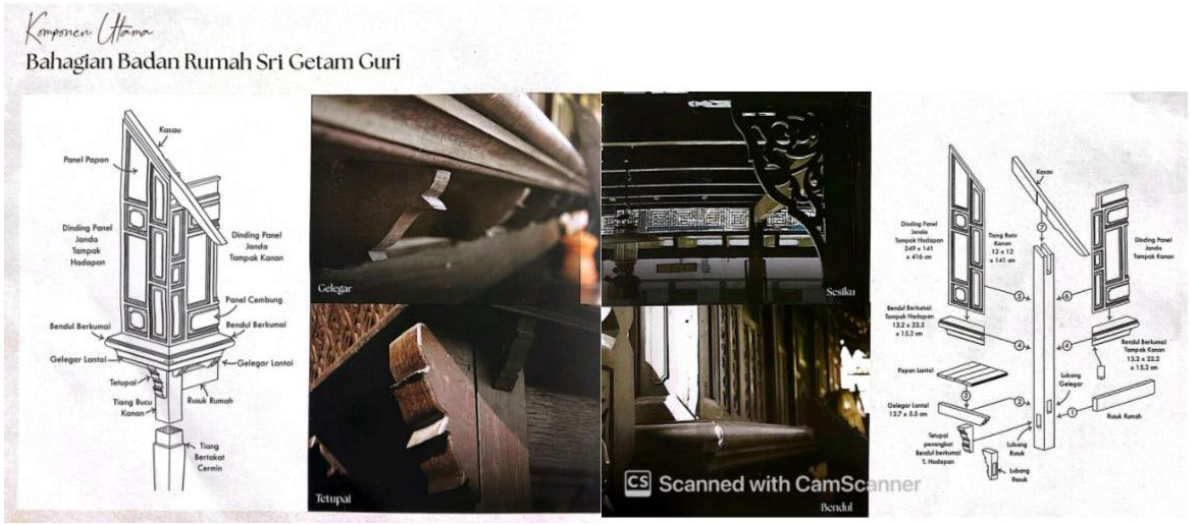

Figure 5 The Body of Rumah Tiang 12 and Its Measurement

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The use of traditional, body-based units of measurement such as depa, jengkal, and hasta demonstrates a contextual and experiential understanding of space and scale. Although these units are non-standardized, they reflect a consistent internal logic that has been applied across generations of builders. In traditional Malay measurement systems, 1 jengkal is approximately 22 cm, 1 depa is about 175 cm, and 1 hasta is equivalent to 45 cm. Accordingly, the conversion formula from centimeters to jengkal is expressed as:

jengkal = cm ÷ 22

For example, the dimensions of a tiang 12 (pillar), measured at 12 cm × 12 cm × 141 cm, can be converted into jengkal as follows:

12 ÷ 22 = 0.55 jengkal, and 141 ÷ 22 = 6.41 jengkal.

Thus, the overall dimensions become approximately 0.55 × 0.55 × 6.41 jengkal.

Similarly, a floor joist measuring 12.7 cm × 5.5 cm converts to approximately 0.58 × 0.25 jengkal. When further converted into depa, this becomes approximately 0.073 × 0.031 depa. For the window panel wall (dinding panel janda), with dimensions of 249 cm × 141 cm × 416 cm, the measurements convert to approximately 5.53 × 3.13 × 9.24 hasta.

In the case of the pagar musang (fox fence), a height of 33 inches is equivalent to approximately 4.2 jengkal. The spacing between each element, ranging from 6 to 8 inches, converts to approximately 0.76 to 1.02 jengkal.

The pemeleh typically measures between 2.5 to 4 meters in length, which corresponds to approximately 5 to 8 hasta. Its height ranges from 10 to 15 cm, equivalent to about 0.22 to 0.33 hasta, and its thickness generally follows similar proportions.

These findings support earlier studies (Gerdes, 1994; Barton, 2008), which argue that mathematical cognition can be embodied and informal while still remaining systematic. For instance, the estimated floor dimensions of 21 hasta by 6.5 hasta demonstrate the application of consistent proportional reasoning.

Moreover, the geometric layout—characterized by rectangular room divisions, parallel structures, and right angles—suggests a spatial intelligence that closely aligns with principles found in Euclidean geometry. Although traditional builders may not conceptualize their work using formal mathematical terminology, their practices clearly reflect practical applications of mathematical reasoning.

The consistent use of ratios in room dimensions, pillar spacing, and ceiling height indicates an implicit understanding of proportion and scale. These ratios serve both functional and aesthetic purposes, contributing to ventilation, structural integrity, and visual harmony. This balance between utility and beauty exemplifies the holistic design approach inherent in Malay vernacular architecture. Such proportional reasoning parallels concepts taught in formal mathematics education, including scale, ratio, and spatial reasoning.

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Furthermore, the presence of symmetry, tessellation, and repetition in decorative elements reflects a deep cultural appreciation for order and balance, reinforcing the integration of mathematical principles within traditional architectural expression.

Conclusion

Rumah Kelantan Tiang 12 represents an important architectural heritage of Kelantan when examined through the lens of ethnomathematics. The findings reveal a rich presence of mathematical concepts embedded within its structural design, particularly through the use of traditional measurement units such as jengkal, depa, and hasta. The geometric layout of the house is predominantly rectangular, with dimensions often expressed using depa and hasta.The wall element, known as janda berhias, features rectangular panels arranged both vertically and horizontally, while the carved decorations incorporate curved forms organized in deliberate and structured patterns. Similarly, the roof, constructed using singgora tiles, demonstrates the use of curved forms in its architectural profile.

It is important that this expertise is preserved and passed on to younger generations to ensure the continuity of these skills. Further research should also be conducted on various types of Rumah Kelantan to deepen our understanding of the mathematical and cultural knowledge inherited from the ancestors of Kelantan, as well as to enrich the appreciation of those interested in the history and heritage of this remarkable state.

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