Ethno-modelling as a Glocalization Process of Understanding Vernacular Architecture: The Case of the Kajang Padati Gadang House in Padang City, Indonesia

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Received	Accepted	Published
28.12.2023	23.02.2024	29.02.2024

https://doi.org/10.61275/ISVSej-2024-11-02-35

Abstract

Ethnomodelling can be considered as an association between ethno-mathematics and mathematical modelling which allows us to experience different realities in a particular culture. A lot of tacit knowledge contained in the Indonesian culture is only understood as part of tradition, especially in the form of vernacular architecture. In fact, this knowledge can become material for development in the field of praxis, which plays a role in enriching the repertoire of contemporary architecture. Thus, ethno-modelling is seen as a way of facilitating the understanding of cultural components through the modelling process involving three cultural approaches: local, global, and glocal. Thus, ethno-modelling research provide insights into various locally developed tacit knowledge so that they can be understood explicitly.

This study explores the mathematical knowledge developed through the dynamics in vernacular architecture in Indonesia. It examines the case of Minangkabau traditional architecture, Kajang Padati Gadang House, and analyzes their vernacular house forms. Through the ethno-modelling approach, the object is descriptively studied from its physical and non-physical aspects.

The findings show that there are various kinds of translation processes that can understand how Minangkabau people who live in Padang City can respond to various forms of adaptations through their architecture.

Keywords: Ethno-modelling, Vernacular architecture, Tacit-to-Explicit knowledge.

Introduction

Padang City is one of the urban areas that has a diverse population with various ethnicities and cultures, including the Minangkabau ethnic group, known for their traditional houses called Rumah Gadang. According to Aryanti et al. (2022), Padang is an area resulting from Manaruko (land clearing for new settlement) located outside the Minangkabau homeland (darek). Consequently, Minangkabau people who live in the Padang city have their own typology of *Rumah Gadang* known as *Rumah Gadang Kajang Padati* (RGKP).

RGKP exhibits several differences compared to Rumah Gadang Bagonjong found in the darek (mountainous regions of Minangkabau). The most significant difference in RGKP is found in its roof shape. This type of Rumah Gadang features a roof similar to a curving pedati roof. As Rullis et al. (2018) explain, this type of roof is also referred to as gonjong tak sampai. Initially, these houses used rumbia (sago palm) leaf as the roofing material. However, as time progressed, corrugated iron roofing has started to be used. Initially, corrugated iron was used only on the roof edges, resulting in differing rust patterns across the entire roof. In Refisrul & Arios (2021), this type of roof is referred to as atap bakolam. Additionally, the nomenclature of this Rumah Gadang often depends on the number of columns used in the structure of the house. According to Setijanti et al. (2012), coastal Minangkabau communities tend to be more open and practical, thus RGKP buildings are not heavily laden with symbolism and prioritize functionality.

Currently, there are several RGKP buildings that still stand and are well-maintained. However, as noted by Elfendes (2017), there are also many RGKP structures that have undergone changes in the meanings of their spaces, have been abandoned, or even demolished. These conditions can lead to the loss of knowledge about the modeling of RGKP buildings.

This research offers a novel exploration in the field of Ethnomodelling, focusing on RGKP as its subject, with the hope of enriching the body of knowledge on Ethnomodelling within the context of vernacular architecture in Indonesia. The aim of the research is to understand the modeling of RGKP buildings in the city of Padang through an ethno-modeling approach, in more detail its objectives are as follows:

1. To identify and documenting architectural aspects of RGKP,
2. To analyze the modelling of RGKP through emic, etic, and ethnomathematic perspectives, and
3. To interpret the ethno-modelling of RGKP.

Theoretical Framework

The study of ethnomodeling is a methodological approach representing a practical application of ethnomathematics that introduces a cultural perspective to a modeling concept (Rosa & Orey, 2010). This approach aims to identify and describe mathematical practices within a specific cultural context. Therefore, ethnomodeling translates relationships and regularities, creates schemes, formulates, and visualizes problem situations in the local community from the real world into academic mathematical concepts through mathematization (Rosa & Orey, 2012).

Ethnomodeling is an intersection of three research fields: ethnomathematics, cultural anthropology, and mathematical modeling. Figure 1 illustrates how ethnomodeling intersects these three research areas.

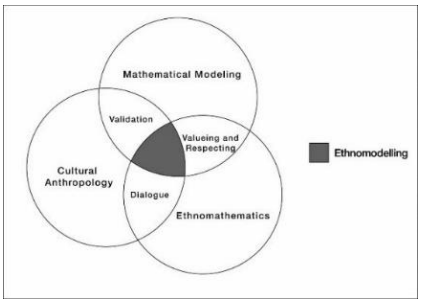

Fig. 1: Diagram of Ethnomodelling
Source: Author

Orey & Rosa (2015) delineate ethnomathematics as an art and technique that evolves across diverse cultural (ethno) and linguistic backgrounds, aiming to scrutinize the social, cultural, environmental, political, and economic conditions (mathema). In this context, ethno refers to specific groups identified through cultural symbols, codes, myths, and everyday reasoning.

The intersection between ethnomathematics and mathematical modeling lies in appreciating pre-existing knowledge and traditions to translate and evaluate issues through the elaboration of mathematical models in specific contexts. Additionally, the overlap between ethnomathematics and cultural anthropology involves local knowledge of a cultural group to address their issues and contexts. This also takes the form of knowledge built across time and generations closely tied to history, social dynamics, culture, and the natural environment (Rosa & Orey, 2010). According to Eglash et al. (2006), cultural anthropology is always associated with the translation of cultural perspectives (emic and etic). The use of ethnomathematical modelling techniques forms a connection between the local conceptual framework and mathematical ideas related to global design through translation. Therefore, this relationship can be termed as ethnomodeling because it resembles the action of translating mathematical modeling.

The emic perspective represents the viewpoint held by a cultural group, closely related to cultural values, philosophy, social dynamics, and history. According to Rosa & Orey (2018), the construction of the emic perspective represents descriptions and analyses deemed appropriate by the local community. Validation of emic knowledge is associated with the consensus of the local community.

On the other hand, the etic perspective represents the viewpoint held by individuals outside the local cultural group, also known as the academic perspective. The etic construction involves the explanation, description, and analysis of ideas, concepts, procedures, and mathematical practices expressed in conceptual categories and schemes. This construction must be precise, logical, comprehensive, replicable, and independent (Rosa & Orey, 2018). Thus, researchers must be aware of the distinction between the emic and etic perspectives in the context of ethnomathematics.

The glocal approach, encompassing emic-etic and dialogical process, embodies a continuous interplay between globalization (etic) and localization (emic). This interaction provides perspectives in which both approaches contribute valuable insights regarding the same phenomenon. According to Rosa and Orey (2019), it involves a blending, mixing, and reciprocal exchange among participants, adapting the two approaches. One component specifically involves the voices of local culture members, encompassing their systems of values and everyday mathematical practices. The intention is to empower members of non-dominant cultures to have more influence over the representation of their own mathematics and science

Review of Literature

Vernacular architecture can be interpreted as a local expression of human life through the design of buildings that align with local traditions and conditions (Rapoport, 1969; Oliver, 2006). Numerous studies have explored Rumah Gadang Kajang Padati (RGKP), including research by Rullis et al. (2018), identifying RGKP in the city of Padang as traditional architectural structures. Rullis observed the characteristics of RGKP in terms of roof form, facade structure, spatial layout, and ornaments, highlighting the specific uniqueness of form, function, and interior spatial design. Refisrul et al. (2021) explore the analogy between the names and meanings of spaces in RGKP and the traditional *Bagonjong* houses. Meanwhile, Setijanti (2012) assert that RGKP, originally a traditional Padang house known as Rumah Gadang Bagonjong, has undergone a shift towards Vernacular Architecture. This transformation is associated with various changes and simplifications of symbols inherited from Rumah Gadang Bagonjong to RGKP. Thus, RGKP can be interpreted as both vernacular and traditional architecture. While conducting research on the vernacular

architecture and RGKP, it is essential to consider the perspective presented by Brown and Mauldin (2012). According to Brown and Mauldin (2012), researching vernacular architecture is synonymous with studying 'traditional buildings,' seen as authentic architectural products of a specific location that have evolved in form over time. They contend that vernacular architecture, embodied in traditional buildings, exhibits a close relationship between form and function, influencing design considerations (Brown and Mauldin, 2012).

Essentially, vernacular buildings have consistently served as a means to construct locally in response to the culture, social aspects, and microclimate of a specific region. (Yousuf, 2011). In this connection, Setijanti et al. (2012) assert that the design and layout of traditional houses in Padang are strategically optimized to leverage the specific features of the tropical wet climate, aiming to provide comfortable living spaces. The authors propose that the orientation of Rumah Gadang Kajang Padati (RGKP) structures enables the maximal penetration of sunlight. In a congruent perspective, Aryanti (2019) highlights the significance of optimal sunlight ingress facilitated by the specific orientation of RGKP buildings.

Furthermore, Yusran et al. (2021) have carried out ethno-modelling of the Atag building in the Ajung village, Jember, East Java, and indicate that Atag is a vernacular building that combines typical shapes, materials and construction systems to optimize tobacco drying. Materials sourced from the surrounding environment are assembled into a construction that aligns with local conditions and the user needs. Moreover, the availability of materials is considered to have been mathematically optimized in its construction, spatial arrangement, and relational aspects. The use of ethno-mathematical processes in calculating the analysis demonstrates that the treatment during the drying process is conducted while taking into account the roof angle's ability to optimize space, respond to rain, internal air circulation, and the efficiency and effectiveness of the tobacco drying process (Yusran, 2021).

Similarly, the findings of the research conducted by Hildayanti & Sahabudin (2023) on the tectonics of the tongkonan house represent a form of local wisdom in the Toraja community. The connection system and layered posts minimize the possibility of the building collapsing due to strong winds.

According to Setijanti et al. (2012), the application of stacked gable in the RGKP is considered to optimize the exchange of air between the exterior and interior parts of a building. This assertion can be strengthened through computational fluid dynamics (CFD) simulations. In this regard, Amri et al. (2017) utilize CFD to analyze the influence of wind pressure on roof inclination. CFD simulations can generate diagrams illustrating the magnitude of wind pressure on an object. Consequently, CFD can also be applied in research related to fenestration (openings). This aligns with Feng's statement (2021) that the design of fenestration systems has been a central theme in the construction community for many years. Nevertheless, recent advancements in system simulation and computational science have introduced a new perspective in the examination of fenestration systems. Vernacular houses heavily rely on natural ventilation to optimize thermal comfort. Similarly, Yusran and Citraningrum (2013) indicate that the Laika House, owned by the Tolaki ethnic group residing in the Southeastern part of Sulawesi island, provides excellent thermal comfort due to the presence of Orini and Powire. Orini and Powire serve as elements of cross-ventilation that ensure optimal air circulation and thermal comfort inside the Laika House.

Ethno-modelling research can also employ a proportion-based approach. Proportion refers to the harmonious relationship between various elements, emphasizing size, scale, and visual balance. This concept is crucial for creating aesthetically pleasing and balanced designs (Ching, 2007). Prananto (2010) adopts a similar concept. Proportion refers to the relationships between the whole and its parts, logical connections, necessary relationships characterized in such a way that they

simultaneously satisfy the mind and the eye. Sani et al. (2015) says that proportions in the form of ratios are used as a reference for comparing the detailed elements within the traditional *Bola Soba* house in Watampone City. The fundamental principle of size applied in the proportional system of the Bola Soba building is the *Sulapa Appa* element. This reflects a complete unity between the philosophy of the ideal perfection of life and the application of a four-sided form within a house. In line with that, Yusran et al. (2022) have also utilized a tracing method to document the facades of traditional Bugis houses. Traditional Bugis houses feature structural elements, such as horizontally arranged timber in the gables roof, also known as *Timpak Laja*. Typically, Bugis society regards *Timpak Laja* as a symbol of the owner's status. Buildings with a greater number of *Timpak Laja* are associated with nobility and royalty, and vice versa. However, etically, this structure serves as a reinforcement for the span of the roof structure.

Research Methodology

This research employs a descriptive qualitative method. Primary data is directly obtained from the research subjects through observation, interviews, and documentation. Three RGKP buildings located in Koto Tangah, Kota Padang (Figure 2) were examined. These subjects were selected using purposive sampling techniques, which is a non-random sampling method in which the researcher selects specific identities within the sample (Lenaini, 2021). The specific criteria possessed by the subjects include being long-standing structures, still inhabited and well-maintained, experiencing minimal changes in their form, and representing the typologies of RGKP. According to Dhasmayzal, et al. (2022), RGKP has a relatively similar form, which is related to the cultural determination of RGKP typology based on the number of *tiang* (columns).

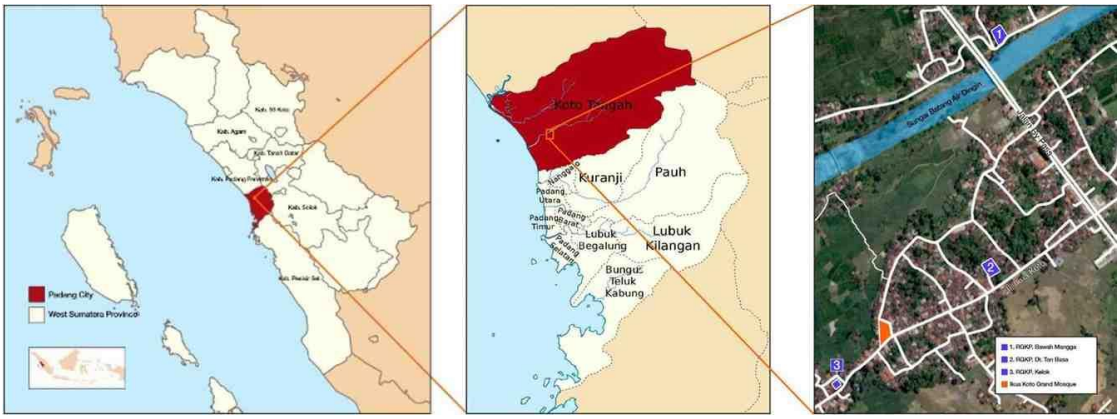

Fig. 2: The location of research objects
Source: Author

Data collection has been carried out by conducting physical observations on RGKP. This involves observing the entire building, including its orientation, form, and appearance. Following this, meticulous documentation and metric measurements are performed, cross-validated with traditional anthropometric methods. Measurements commence with the building's footprint, encompassing the distance between column axes. Elevation measurements involve determining column heights from the foundation. For interior assessments, column height is combined with stage or floor elevation. Finally, detailed measurements of each structural element are conducted.

Interviews were conducted with both the residents of the house and relevant experts to gather information about RGKP that cannot be directly observed during the initial assessment. The obtained interview data includes the historical background of RGKP, the history of specific RGKP used as research subjects, cultural values associated with the structure and construction processes of RGKP, as well as cultural values related to the use or function of RGKP.

The collected data is used as a reference in the process of redrawing the research object. The results of this redraw are subsequently analyzed descriptively through an ethno-modeling strategy. Data and information related to RGKP are comprehended from emic, ethical, and ethno-mathematical perspectives.

The emic perspective is a viewpoint held by a cultural group. This perspective is closely related to cultural values, philosophies, social aspects, and history. The emic description of RGKP represents descriptions and analyses considered appropriate by the local Minangkabau ethnic group. In contrast, the etic perspective is a universal viewpoint of the global community. This description is related to the natural ventilation system and utilizes climate data from Padang City obtained from the weatherspark.com website. Local knowledge, such as the form of the Singok roof, is validated using Computational Fluid Dynamics (CFD) simulations with Autodesk CFD application.

Ethno-mathematics is employed within the ethno-modeling approach to elaborate on the mathematical forms and calculations in RGKP. The results of the redraw are analyzed using ethno-mathematics. The ethno-mathematical approach used is related to the *Jangka* unit, which is an anthropometrical traditional unit used in the design of Rumah Gadang (Fitriza et al., 2019). Ethno-mathematical analysis emphasizes the proportions and ratios of RGKP, including *lanjar*, building height, and roof shape. The analysis results are then translated to describe the use of mathematics in addressing the challenges and housing needs of the Minangkabau Padang community. Subsequently, the three descriptions – emic, etic, and ethnomathematical – are interpreted to discover the modeling aspects of RGKP.

Findings and the Discussion

1. Case Studies

a. RGKP Bawah Mangga

RGKP Bawah Mangga is located on Koto Tuo Street, Ikua Koto, Koto Tangah, Padang City (Figure 3). This house is inhabited by the Balai Mansiang clan. Based on an interview with its caretaker, Mrs. Izur, the house is estimated to be around 200 years old. Initially, this building was intended for a *Kaum Saparuik* (matrilineal family consists of three generations). RGKP Bawah Mangga is named so because there used to be a large mango tree that shaded this building. The building is oriented towards the southeast and is parallel to the Batang Air Dingin River. This building has four *ruang* and five *lanjar*. The rooms in this house consist of *langkan*, *ruang tapi*, *ruang tangah*, and *bilik*. Additionally, there is a kitchen at the back of the main building.

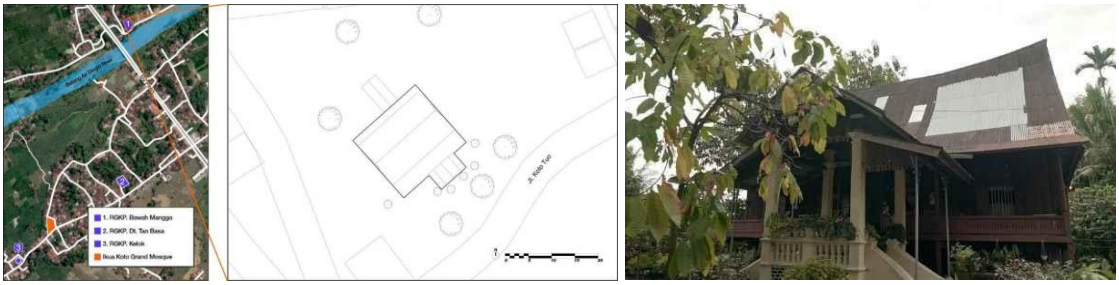

Fig. 3: RGKP Bawah Mangga
Source: Author

b. RGKP Datuak (Dt.) Tan Basa

This RGKP is located on Ikua Koto Street, Koto Panjang, Ikua Koto, Koto Tangah, Padang City (Figure 4). Based on an interview with its caretaker, Mr. An, the building was constructed between the late 18th and early 19th centuries. This Rumah Gadang belongs to the Datuak Tan Basa family of the Koto clan. RGKP was intended for a *Kaum Saparuik* (matrilineal family consists of three generations). The building is oriented towards the southeast, parallel to the Batang Air Dingin River. It comprises four rooms and four lanjar. The rooms in this house consist of *langkan*,

ruang tangah (*tapi*), *ruang dalam* (*tangah*), and *bilik*. There is an extension building for the kitchen at the back.

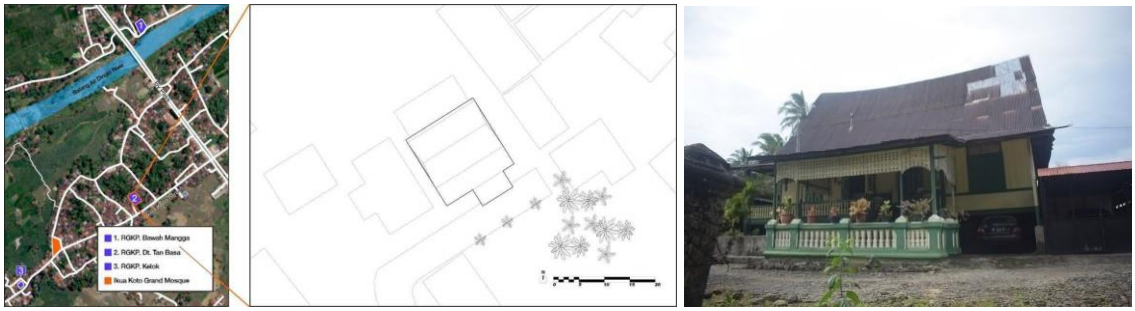

Fig. 4: RGKP Datuak (Dt.) Tan Basa
Source: Author

c. RGKP Kelok

RGKP Kelok is located on Ikua Koto Street, Koto Panjang, Ikua Koto, Koto Tangah, Padang City (Figure 5). This Rumah Gadang was constructed around 1930 and is owned by the Koto clan. The house is named Rumah Gadang Kelok after the name of the first-generation woman who inhabited it, Mrs. Kelok. Initially, RGKP was intended for the nuclear family of Mrs. Kelok. The building is oriented towards the southeast, parallel to the Batang Air Dingin River. This house has three *ruang* and three *lanjar*. The rooms in this house consist of *langkan*, *ruang tangah*, and *bilik*.

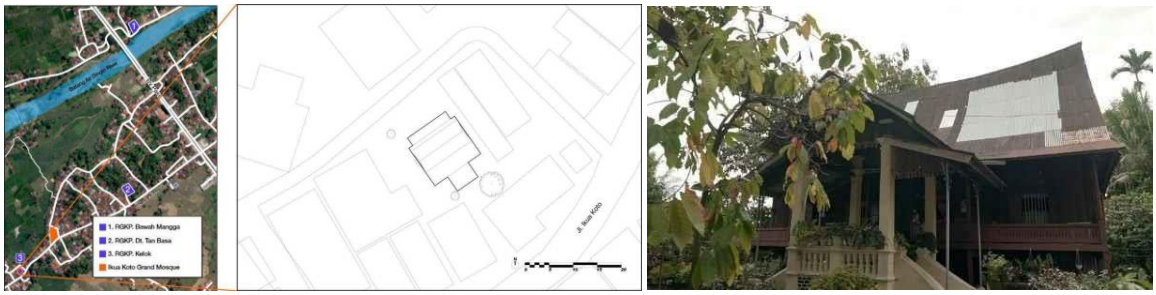

Fig. 5: RGKP Kelok
Source: Author

2. Emic Description of Rumah Gadang Kajang Padati (RGKP)

RGKP is estimated to have existed since the migration of inland (*darek*) Minangkabau communities to the Padang region. In the daily life of the community, this house is often referred to as Rumah Gadang because its role extends beyond being just a residence; it also serves as a venue for traditional ceremonies. Typically, the house consists of several rooms, namely *langkan* (a veranda for receiving guests), *ruang tapi* (a space for conducting traditional ceremonies), *ruang tangah* (a transitional space before entering the bilik), and *bilik* (rooms for female family members). These rooms are arranged sequentially from the front to the back, following the lanjar of the house. *Lanjar* is a spatial module from front to back, while the spatial module from left to right is called *ruang*. Figure 6 illustrates the layout of the three RGKP objects, showing the *ruang* and *lanjar*, along with their respective meanings. RGKP Kelok has fewer l*anjar* with smaller dimensions. Consequently, the second and third *lanjar* in this house are open spaces without partitions, serving as both *ruang tapi* and *ruang tangah*.

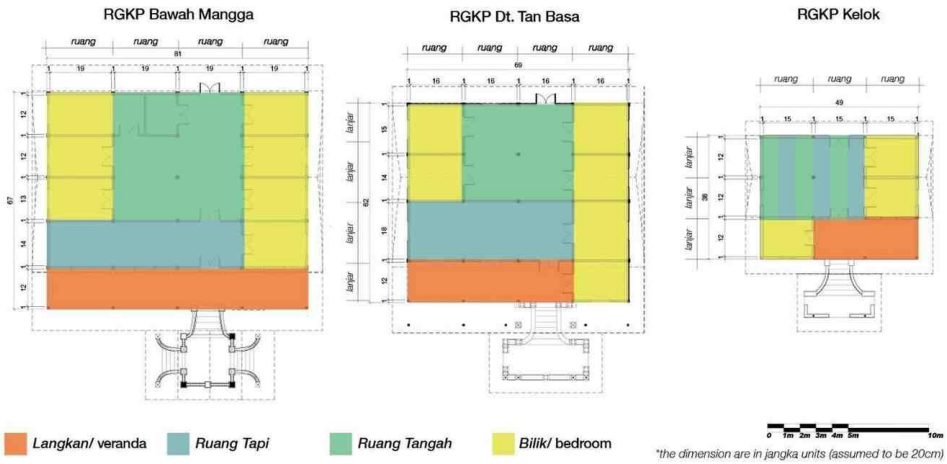

Fig. 6: Plan of RGKP
Source: Author

RGKP is divided into three parts: the head, body, and legs. In Minangkabau culture, the head section is referred to as *Atok* (roof). The body part is called *Dindiang* (wall). Meanwhile, the lower part of the house is known as *Kolong* (understage). Figure 7 provides a visual representation of an RGKP object, illustrating its various components.

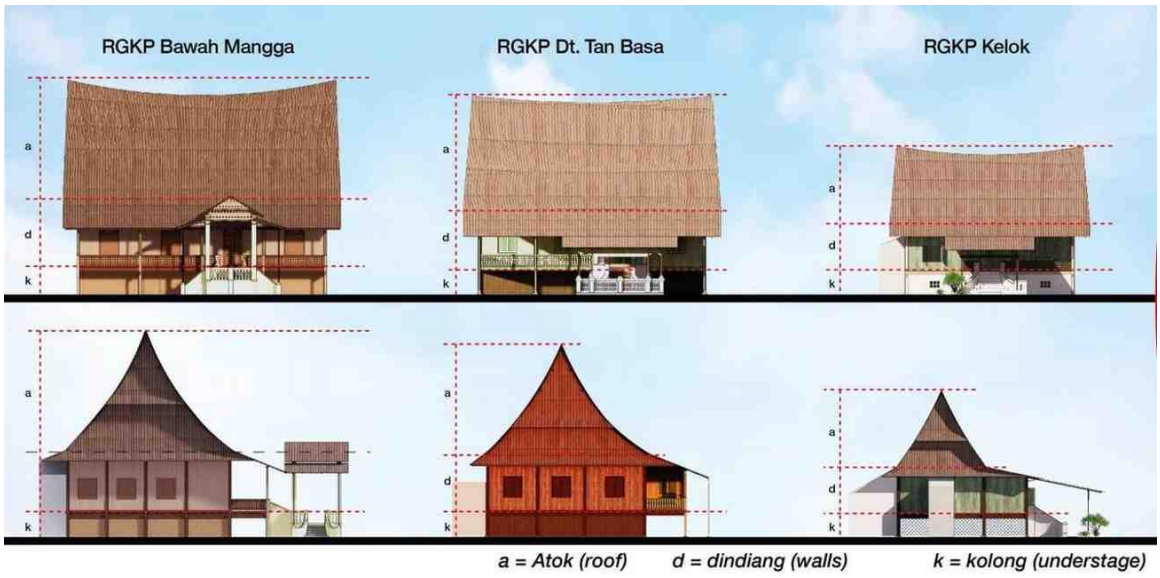

Fig. 7: Building parts of RGKP
Source: Author

RGKP takes the form of a stilted house with a wooden frame structure system. This structural system does not use nail connections but relies on a system of dowel and pin joints. RGKP stands on a foundation called *batu sandi*, which consists of flat stones. During the construction process, these flat stones are placed after the central structure of the building is connected. The structure is then leveraged onto these flat stones. According to Setijanti et al. (2012) and Couto (2013), RGKP's structure is composed of modular elements (*jarek*) connected by *palanca* (lower beams) and *paran* (upper beams) (Figure 8). The number of jarek arrangements influences the number of rooms in a Rumah Gadang, typically ranging from four to five *jarek*. *Jarek* consists of *tiang* (columns) connected by *rasuak* (beams). The number of posts in jarek determines the *lanjar* a Rumah Gadang will have. In general, RGKP *jarek* typically have four to six posts. The outermost columns are often ornately carved and smaller in size, serving to support

the *barando/langkan* roof. Meanwhile, the interior posts of the building support the overall roof structure, often made from massive, non-straight, and crooked wooden posts, known as *tonggak bengkok*. If the number of interior posts is even, there will be a *tiang gantuang* (hanging column) in the middle of the *jarek* to support the roof ridge. *Jarek* directly supports the roof structure, which consists of *kasau* (rafter) and *lae* (purlin). There is *balok bubuang* (ridge beam) on the central column.

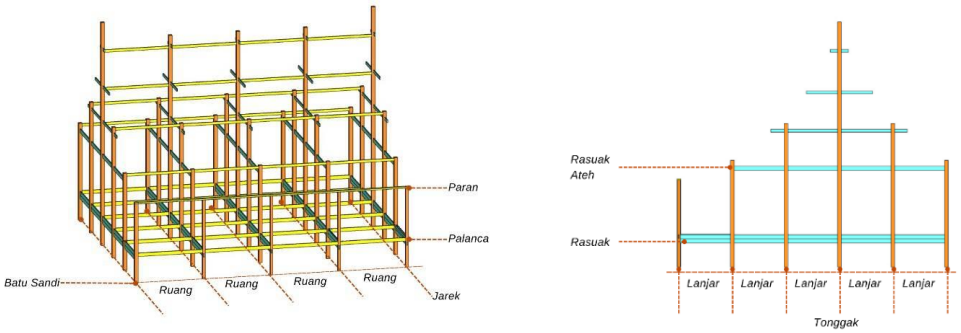

Fig. 8: Jarek structural system in RGKP
Source: Author

Based on an interview with Mr. Dasrul Mangkudum Sati, Chair of the Palito Nyalo Minangkabau Traditional Arts and Culture Group, the RGKP construction uses traditional Minangkabau measurement units. The unit of measurement commonly used is the palm span (*jengkal*), based on the length of the tip of the thumb to the tip of the little finger of the *Mamak Kapalo Warih* (traditional leader) of the clan (matrilineal line). This measurement system is used as the basis for sizing the RGKP. Besides, the measurements of RGKP are also based on the function of the space. *Ruang Tapi* usually has larger *lanjar* than other due to the function of the *Ruang Tapi* as a place for traditional and religious ceremonies. The room's measure is calculated from the width of the people when sitting opposite each other plus the width of the dish during the ceremony. Meanwhile, the *Ruang Tangah* and *Bilik* have smaller *lanjar* dimensions because it used as bedroom, and *Langkan/Barando* has the smallest *lanjar* dimensions due to its function for receiving guests and relaxing only.

The determination of the number of lanjar and rooms in RGKP is closely related to the generations of the family residing in the house. RGKP inhabited by *saparuik* families (three generations in a matrilineal context) tends to have more *lanjar* and *ruang*. For example, RGKP Bawah Mangga has 4 *ruang* and 5 *lanjar*, while RGKP Dt. Tan Basa has 4 *ruang* and 4 *lanjar*. In contrast, RGKP Kelok which is inhabited by the nuclear family, has only 3 *ruang* and 3 *lanjar*, which is fewer. This difference is associated with the function of RGKP as intended for daughters. Each daughter residing in RGKP has her own *bilik* (bedroom). Typically, these *bilik* are located in *lanjar* after the *ruang tapi*. Therefore, RGKP designed for *saparuik* families requires additional *lanjar* to meet this need.

The roof of RGKP has a shape resembling the roof of a *padati* or *pedati*, which is a traditional vehicle pulled by water buffalo. According to the interview with Mr. Dasrul, this roof represents a transition of tightened *gonjong* roof shape, resulting in a higher ridge and improved rainwater drainage. This transformation also gives rise to the curved ridge of the RGKP roof, which is not as extreme as the Rumah Gadang with a *gonjong* roof. The Rumah Gadang *gonjong* roof has a *singok* consisting of solid and carved panels. However, RGKP features a *singok* composed of stacked roof elements resembling a louvers structure (Figure 9).

Fig. 9: *Singok* in RGKP's gable roof
Source: Author

3. Ethic Description of RGKP

Ethic description is the description and analysis of mathematical idea knowledge, practices, procedures, and concepts expressed within a conceptual framework by scientific observers. Tacit knowledge demonstrates that local knowledge within a community aligns with globally developed scientific knowledge

The RGKP roof comprises a combination of a flat roof and a sloping roof (Figure 10). The flat roof covers the areas of *ruang tapi*, *ruang tangah*, *and bilik* and can be referred to as the primary roof of the building. Meanwhile, the sloping roof is present on the overhangs as well as the *langkan* roof. The *singok* (gable) of the primary roof is not a continuous part of the building's side wall; instead, it is an open section covered by a multi-tiered roof arrangement forming a kind of louver. This roof takes the form of a sloping roof consisting of the upper part and the lower part.

Fig. 10: Parts of RGKP roof
Source: Author

According to Amri (2017), roofs with sharp angles have a high drag coefficient because the sharper the angle of a building's roof, the larger the surface area directly exposed to the wind. Figure 11 illustrates the results of Computational Fluid Dynamics (CFD) simulations conducted on the RGKP model, where wind speed in the simulation is indicated by a color spectrum. When the color approaches red, it signifies higher wind speeds at that point, and vice versa. The simulation results demonstrate that the use of an open and tiered *singok* (roof gable) in the building can enhance air ventilation, reducing the wind pressure on the roof while decreasing the indoor room temperature. Conversely, CFD simulations on RGKP with a closed and solid *singok* show a greater wind pressure effect and reduced indoor air exchange.

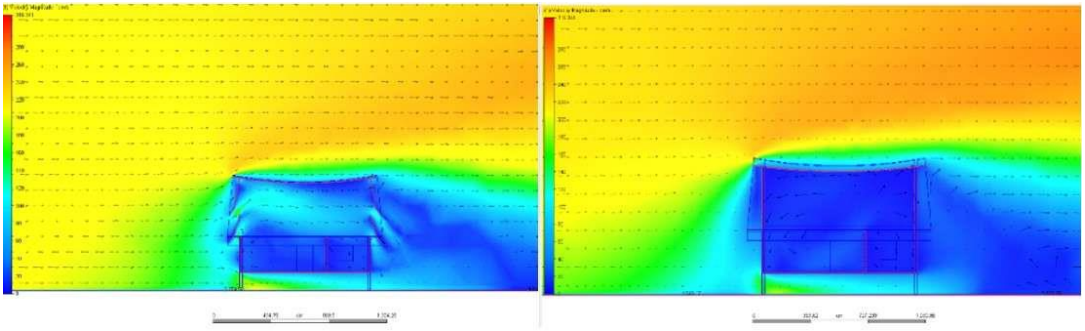

Fig. 11: CFD simulation results on RGKP
Source: Author

4. Ethnomathematics Description of RGKP

Ethnomathematics is an art and technique that has evolved within societies of diverse cultural backgrounds. Ethnomathematics can also be broadly interpreted in the socio-cultural context, including language, jargon, symbols, behaviors, and myths. Ambrosio (1993) explains that the purpose of ethnomathematics is to understand the numerous mathematical practices carried out by different cultures to address their needs and challenges.

As a traditional house, RGKP serves not only as a residence for resting and accommodating living space but also for conducting traditional and religious ceremonies. Based on an interview with Mr. Dasrul Mangkudum Sati, RGKP has varying dimensions of *lanjar*. The differences in *lanjar* dimensions are determined by the spatial functional requirements of each *lanjar*. The *lanjar* with the most significant dimension is the one occupied by the *ruang* tapi. RGKP modeling employs a *jangka* unit. This unit is an anthropometric measurement that varies for each individual. In this study, the *jangka* is assumed to be 20cm in metric units.

The *lanjar* of the *ruang tapi* has a minimum dimension of 13 *jangka*, consisting of 8 *jangka* for seating face-to-face and 3 *jangka* for the *jamba* or meal during traditional ceremonies (Figure 12). This dimension is based on the seating configuration during traditional ceremonies and can be formulated as $2x+y$, where x represents the width dimension of a person while sitting cross-legged, and *y* represents the dimension of the *jamba* or food tray used in the ceremony. Figure 12 shows the dimensions of the *ruang tapi* in each research object. RGKP Bawah Mangga and RGKP Dt. Tan Basa have *ruang tapi* dimensions of 13.5 *jangka* (270cm) and 17.5 *jangka* (350cm), respectively. The *ruang tangah* and *ruang tapi* in RGKP Kelok have dimensions of 24 *jangka.*

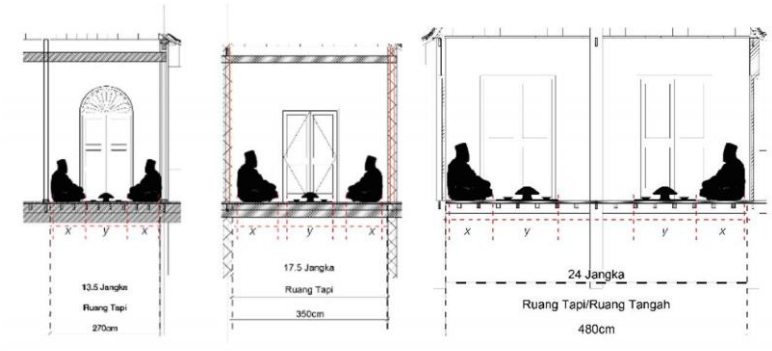

Fig. 12: *Lanjar ruang tapi* in RGKP
Source: Author

Each part of RGKP is proportionally determined by the height of the roof (*atok*) (Figure 13). RGKP Bawah Mangga has dimensions of *atok* (*a*) 41 *jangka*, dindiang (*d*) 20 *jangka*, and *kolong* (*k*) 9 *jangka*, resulting in a ratio of $a : d : k = 4.5 : 2.5 : 1$. Meanwhile, RGKP Dt. Tan Basa has dimensions of a 34 *jangka*, b 17 *jangka*, and k 8.5 *jangka*, resulting in a ratio of $a : d : k = 4 :$

2.05 : 1. RGKP Kelok has dimensions of a 22 *jangka*, b 14 *jangka*, and k 7 *jangka*, resulting in a ratio of a : d : k = 3.2 : 2 : 1. Based on the dimensions and ratios of the building parts in the research objects, it can be concluded that the roof of RGKP is the part with the largest dimensions, with the proportion $a > d + k$.

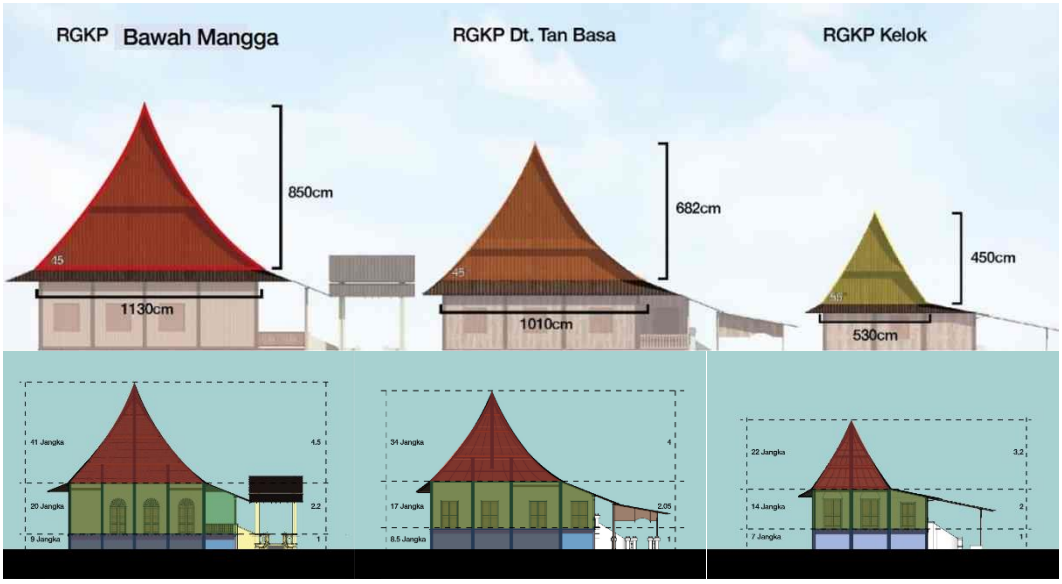

Fig. 13: Building parts ratio
Source: Author

5. The Interpretation of Three Aspects of Ethnomodelling

The modeling of RGKP is based on the needs and challenges of the Minangkabau community in the city of Padang. RGKP modeling begins with *jarek*, which is a longitudinal structural module composed of *tiang* (columns) and *rasuak* (beams) made of wood. The number of columns in a jarek is adjusted according to the requirements of *lanjar*. The determination of the number of columns follows the formula *n*+1, where *n* represents the number of *lanjars*. Meanwhile, the number of *lanjars* in RGKP ranges from 3 to 5, depending on the spatial requirements.

The width dimensions of *jarek* are related to the height of the building's roof. The roof height is determined by subtracting the width of *langkan* from the width of *jarek*. The roof's shape is derived from two curves bounded by the dimensions of the total number of lanjars in the building. These jareks are then arranged horizontally to form rooms, with the arrangement of jareks based on the required number of rooms in RGKP. The *singok* (gable) part of the RGKP roof is designed with openings to maximize natural ventilation and reduce wind-induced pressure. This design principle can be applied in contemporary contexts to contextualize RGKP. Figure 14 illustrates the stages of RGKP modeling.

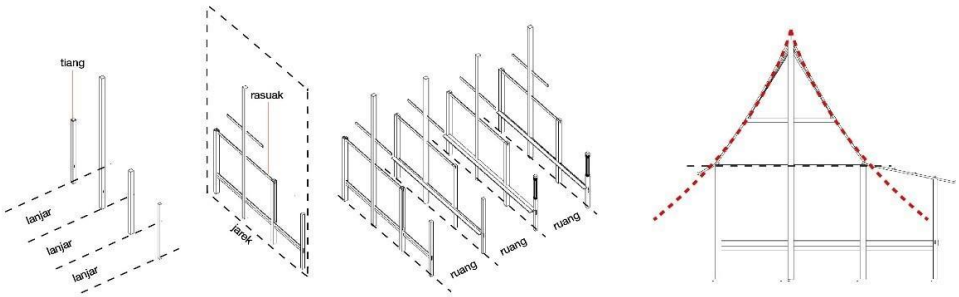

Fig. 14: Modeling of RGKP
Source: Author

Conclusions

Rumah Gadang Kajang Padati (RGKP) represents a specific subtype of the traditional Minangkabau house known as Rumah Gadang, which is found in the coastal areas of West Sumatra that has a variety of unique features. Based on the ethnomodeling analysis strategy, the following conclusions have been deduced:

- The structure of RGKP consists of a modular framework known as *jarek*. *Jarek* comprises column elements called *tiang* connected by beams known as *rasuak*. The determination of the number of columns in a *jarek* is related to the required number of *lanjar* (living spaces) (*lanjar*+1). The horizontally arranged *lanjar*s form the spatial dimensions.
- The number of *lanjar* and *ruang* in RGKP is determined by the count of female family members who occupy the house. This can be observed through the number of *bilik* (bedrooms) in RGKP. RGKP Bawah Mangga and RGKP Dt. Tan Basa have more *bilik* compared to RGKP Kelok because RGKP Kelok was initially intended for the first and second generations (mother and her children) of a family. In contrast, RGKP Bawah Mangga and RGKP Dt. Tan Basa are Rumah Gadang designed for a *saparuik* family (three generations).
- The dimensions of *lanjar*, aside from *langkan*, in RGKP affect the height of the main roof known as kajang *padati* roof. The height of the roof in RGKP has a smaller ratio to the width of lanjar.
- The height of the RGKP roof influences the overall roof height. In each research object, it was found that the roof-to-wall (a) ratio is larger than the sum of the wall and base (d+k), resulting in a > d+k.
- The main roof of RGKP is fundamentally formed by two mirrored curves. RGKP with smaller dimensions and fewer *lanjar*, such as RGKP Kelok, has a slenderer roof shape with sharper angles. Conversely, RGKP Bawah Mangga and RGKP Dt. Tan Basa have broader and flatter roof shapes.
- RGKP features a *singok* or gewel roof with openings resembling louvers. These louvers are formed by two-tiered sloping roofs. This type of *singok* (gewel) roof allows cross-ventilation and helps reduce the risk of structural damage caused by wind pressure on the roof.

This study understand the ethno-modeling of RGKP. The existence of RGKP enables meticulous and comprehensive collection of physical data. However, cultural knowledge about RGKP is predominantly transmitted orally. At present time, there is a scarcity of individuals possessing detailed knowledge in this regard.

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