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A Fractal Dimensional Analysis of Vernacular House Façades in Indonesia: *Rumah Gadang* and *Uma*

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Abstract

Vernacular house façades have distinct visual characteristics as a reflection of the factors that influence vernacular architecture, one of which is how the locals perceive and interpret aesthetics. This study attempts to quantitatively examine the aesthetic qualities of the façades of two vernacular houses, namely *Rumah Gadang* from West Sumatra, western Indonesia, and *Uma* from Sumba Island, eastern Indonesia. Both have very different geographical conditions, cultural, and historical backgrounds. The fractal dimension analysis is used by breaking down the façade into 5 layers of architectural attribute; silhouette, main tripartite, structure, façade components, and material texture. Using the box-counting method, it is known which layer is the biggest contributor to the visual complexity of the façades. Based on the calculations, it is concluded that there are differences in the degree and proportion of visual complexity in the case of the two houses. The façade of *Rumah Gadang* has higher visual complexity than *Uma*. Material texture is the most dominant contributor to visual complexity of both houses. In *Rumah Gadang*, the façade components greatly contribute to visual complexity, while in *Uma* the silhouette has a big influence. This finding can be attributed to the way the homeowners place importance on the façade and the house in its respective social system, or even the development of civilization behind the two houses. It is also found that subjective-qualitative visual observation and philosophical approach do not always correspond with the result of mathematical calculation.

Keywords: *façade*; *fractal analysis; fractal dimension; Indonesian vernacular house; rumah gadang; uma; visual complexity.*

Introduction

Among the many vernacular houses in various parts of Indonesia, *Rumah Gadang* and *Uma* are two that stand out visually; *Rumah Gadang* with a striking curved roof and *Uma* with a towering roof. Both are located in two contrasting corners of Indonesia, *Rumah Gadang* is in the western part of Indonesia, specifically on the island of Sumatra, while *Uma* is located in the eastern part on an island called Sumba.

In line with their distant locations, these two vernacular houses have very different historical and geographical backgrounds. The existence of *Rumah Gadang* is based on Minangkabau culture which adheres to custom and is based on Islamic teachings (Hasan, 2007), set in a tropical rainforest and hilly area. *Uma* is built in Sumbanese culture which is based on a belief in an ancestor named *Marapu* (Reny, Subroto, & Saifullah, 2018) that affect the layout and shape of the house (Irwanuddin, 2018). Sumbanese still shows the practices of megalithic civilization (Handini, 2019). *Uma's* setting is in a limestone hilly area with a savanna climate with low rainfall (BPS Kabupaten Sumba Barat, 2020).

Both houses are positioned as family heirlooms. The site where *Rumah Gadang* stands is called

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heirloom land (*tanah pusaka*). The house itself is also often referred to as an heirloom (*pusaka*). Inside the house, various heirlooms, symbols of greatness and objects for traditional ceremonies are stored (Syafwan, 2016). *Uma* also has certain parts that are treated as heirlooms or used to store heirlooms used in ceremonies. In some cases, the entire *Uma* is even treated as an heirloom called *Uma Pamali* (forbidden house), which can only be accessed by the leader (Adon & Renda, 2022).

The visual characteristics of *Rumah Gadang's* façade have been described by many researchers, including a curved roof with several pointy ends, a stilt base, an elongated façade, floor leveling, and stairs (Agus, 2006; Hasan, 2007; Rini, Numan, & Idham, 2021). Likewise, *Uma's* visual characteristics such as a stilt base, low bamboo walls, small openings, the climbing ladder, and wide sloping roof with a tower in the center have been widely discussed (Nurdiah & Hariyanto, 2013; Irwanuddin, 2018; Reny, Subroto, & Saifullah, 2018). However, the existing explanations are mostly qualitative in nature. These visual characteristics have not been studied in a mathematically measurable way.

This study aims to analyzes the visual characteristics of the façades of two vernacular houses quantitatively using the fractal dimension analysis method. Fractal dimensional analysis was carried out by slicing the façade into 5 layers of architectural attributes: silhouette, main tripartite, structure, façade components, and material texture. Through the box counting method, it will be known which layer is the biggest contributor to the visual complexity of the façades.

This study is not intended to relate formal visual complexity to cultural or historical context. However, it is possible to link them indirectly.

Literature Review

1. The importance of façade in Indonesian vernacular house.

The form and façade of a vernacular house solves the physical problems faced at its location. Especially in Southeast Asia, the roof is one of the dominant components on the façades of these houses. The roof is even mentioned as the most important element in Indonesian vernacular building for its role of providing shade (Prijotomo, 2017). The shape of this roof is also intended for an interior air-cooling system (Oliver, 2006). Among the major characteristics of the South East Asian vernacular house architecture, most of them—e.g. the elevation of the structure upon stilts or piles (Waterson, 1990), the elongated roof peak or the outward slanting gable (Waterson, 2002; Scheifold, Nas, & Domenig, 2004).

The visual appearance of a house is also often related to the owner's position in the social order, to the point of symbolizing their beliefs. It is not surprising that the façade of the house was then designed very seriously. Although this study will not highlight the relationship specifically, it is quite certain that the visual complexity of façades is a substantial design phenomenon to be appreciated and studied, especially when compared with different loci and backgrounds.

2. Rumah Gadang

The Minangkabau ethnic mainly lives in West Sumatra Province, Indonesia. They are also scattered all over Sumatra island. The vernacular house of the Minangkabau ethnic is called the *Rumah Gadang* (Figure 1), which means big house in their language.

Figure 1. Rumah Gadang
Source: Author

According to the categorization of structure types by Lehner (2016), *Rumah Gadang* is a post and beam type of house. The floor of the house is raised from the ground with wooden stilts or posts. The formal characteristics of the *Rumah Gadang* including the regular and symmetrical shape of the mass, the use of posts with stone base support, and the striking and curvy configuration of roof. To balance the weight, especially at the top, lightweight materials such as wood, bamboo, palm fiber or other organic fibers are used (Rini, Numan, & Idham, 2021).

The form of the *Rumah Gadang* symbolizes the position of the owner in the Minangkabau social system, as well as the traditional system they adhere to. One aspect of this is the location of the house in the regional unit or *luhak* (Wongso, 2014). The number of pointed roofs (*gonjong*) indicates the number of family ancestors. The size and complexity of the house shows the social position of the family. The leveling style of the floors and the positioning of the stairs show the various school of thought in viewing life (*lareh*) adopted by the family historically (Agus, 2006; Hasan, 2007).

The *Rumah Gadang* modeled in this study is based on direct observations carried out in 2020 in Nagari Koto Baru, Solok Selatan district of West Sumatra. The typology is a highland house called '*Sitinjau Lawik'* which is usually owned by *'penghulu*' or traditional leaders. This house type is not only found in the observed region but is spread throughout various clans of Minangkabau (Hasan, 2007).

Based on its formal visual components, the parts of *Rumah Gadang* can be summarized in Table 1.

Table 1. Formal Visual Components of *Rumah Gadang's* Façade

Silhouette	Boxy base, striking - curvy - pointy roof (*gonjong*)
Main tripartite	Stilt – rectangular façade – sloping roof
Structure	Frame structure
Façade components	Doors, windows, stairs, ornamented stilt cover
Material texture	Wooden panel, wooden stilt cover, palm fiber roof

Source: Author

3. Uma

Sumbanese live on the island of Sumba, central Indonesia. Sumba is a sub-ethnicity of *Sumba-Sawu-Roti* main ethnicity. According to the categorization of structural type by Lehner (2016), *Uma* (Figure 2) is a pile house type. The floor of the house is raised from the ground with wooden piles, and the main piles are inserted deep into the ground.

Uma is built based on an ancient belief in an ancestor named *Marapu* (Reny, Subroto, & Saifullah, 2018). The belief system affects the layout and shape of the house (Irwanuddin, 2018) and the layout of the village (Solikhah, 2020; Adon & Renda, 2022). The house plan is designed to accommodate ceremonies with parts of the building and rooms designated for *Marapu*. Sumbanese still practices the megalithic tradition such as using sarcophagi (*reti*) and menhirs (*penji*) (Handini, 2019). The placement of the megalithic artifacts also shapes the whole village layout, since the artifacts must be placed in the the shared sacred central courtyard which technically is in front of the house to ensure the connection between the deceased and family members.

The vernacular house modeled in this study is based on direct observations carried out in 2019 in Kampung Tarung, a traditional village in West Sumba District, complimented with observations of similar vernacular houses in *Praigoli* village.

Referring to the categorization of structural forms by Schodek (1991), the main structure of Sumba vernacular house is rigid frame, composed of all linear structural elements. The four most important piles in the substructure continue to be posts in the middle structure. The linear elements mostly consist of piles, posts, beams, and diagonal bracing. There is no curved shape in this house. *Mayela* and *nangka* wood are mainly used in original house conditions, while the wall and floor covering are from bamboo. In the same fashion as *Rumah Gadang*, a lightweight bamboo frame and sago palm roof are used for roof structure and cover, compensating for the large area and height of the roof.

Figure 2. Uma
Source: Author

Based on its formal visual components, *Uma's* parts can be summarized in Table 2.

Table 2. Formal Visual Components of Uma's Façade

Silhouette	Boxy base, wide sloping roof base, towering roof center
Main tripartite	Posts – rectangular façade – sloping and towering roof
Structure	Frame structure
Façade components	Doors, windows, climbing ladder
Material texture	Bamboo wall panel, wooden log, sago-palm roof

Source: Author

With different historical, cultural, and geographical backgrounds that form different formal characteristics, it can be hypothesized that *Rumah Gadang* and *Uma* have different visual complexities on their façades.

4. Fractal Dimension Analysis in Formal Studies of Vernacular Architecture

Fractal dimensional analysis is a quantitative method that is commonly used in studies related to image and aesthetics in vernacular, historical buildings, or urban. Burkle-Elizondo, Sala, and Valdez-Cepeda (2014) used fractal analysis to study geometric and complex analyses of Maya architecture. Sardar and Kulkarni (2015) studied the role of fractal geometry in Indian Hindu temple architecture. İlhan and Ediz (2019) use fractal geometry to calculate the urban morphological change of the historical city Bursa. Lionar and Ediz use fractal dimension calculation to measure the visual complexity of Sedad Eldem's SSK complex and its historical context in Istanbul (2020), to measure the architecture of the İMÇ and the SSK complexes and its historical urban fabric (2021a), and to analyze the influence of traditional Indian architecture in Balkrishna Doshi's IIM complex at Bangalore (2021b). Ostwald and Ediz (2015) use fractal dimension analysis to measure form, ornament, and materiality in Sinan's Kılıç Ali Paşa Mosque. The fractal dimension was also used to measure complexity in the artistic representation of the architecture of Balkrishna Doshi by Lionar (2022). The methods in the last two papers mentioned are probably the closest to what was done in this study.

Fractal dimension is a number commonly used to describe the visual complexity of a 2-dimensional image or 3-dimensional object, including building façades. According to Lionar (2022), the fractal dimension number before the decimal point indicates dimension, and the number after the decimal point indicates visual complexity. The number 1 before the decimal point indicates the object has a shape between a line and a plane, the number 2 indicates the object has a shape between a plane and mass. The larger the number after the decimal point, the more visually complex the object is, and vice versa.

Visual complexity is the density of visual information per certain unit of space (Lionar & Ediz, 2021a). The higher the visual complexity - which is indicated by the number after the decimal point - the more information can be obtained from an object.

Methodology

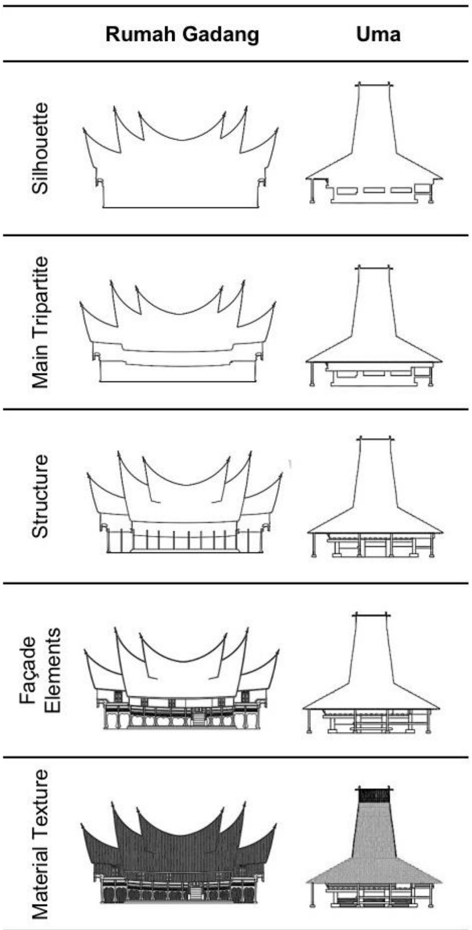
1. Architectural Attributes as Layers in Fractal Dimensional Analysis

In the case of building façades, visual complexity can explain the amount of visual information from architectural attributes attached to the façade, for example, silhouette, material, texture, structure, massing line, opening, ornament, and other attributes that are considered important in forming the character of the façade.

These architectural attributes are then included in the calculation method as layers. In researching the artistic representation of Balkrishna Doshi's architecture, Lionar (2022) slices the image into two layers namely architectural components and entourage, to find that the architectural components alone contribute a larger part to the total visual complexity of the Sangath painting. Ostwald and Ediz include 3 layers of form, ornament, and materiality to analyze the visual complexity of historical Ottoman monuments Süleymaniye Mosque (2012) and Kılıç Ali Paşa Mosque (2015), to find that the form dominates the visual complexity.

In this research, layers are divided into silhouette, main tripartite, structure, façade component, and material texture (Table 3). This division refers to the importance of these attributes according to experts in Indonesian and Southeast Asian vernacular architecture.

Table 3. Layers Based on Architectural Attribute



Source: Author

Prijotomo (2017) and Waterson (2002) emphasize the distinct roof shape which has implications for the emergence of silhouettes as a layer.

The importance of structure upon stilts or piles, outward-sloping exterior walls (Waterson, 1990), and various ways of assembling stilts structures as the base of the house (Lehner, 2016) had implications for the emergence of main tripartite layer, which consists of the base, middle, and the upper part of the house. This is also supported by many literatures that state the importance of tripartite division in the study of Indonesian vernacular houses, to either identify their structural divisions (Novrial & Siregar, 2021) or their spiritual meanings (Mohd Nawawi, Abdul Majid, & Mohd Ariffin, 2010; Irwanuddin, 2018; Reny, Subroto, & Saifullah, 2018).

Lehner (2016), Domineg (2002), and Prijotomo (2010) emphasized the uniqueness of the wooden frame structure, the knock-down system, and the use of organic materials in Indonesian vernacular houses. These ideas have implications for the emergence of the structure and material texture as a separate layer. All of these layers are seen on one main façade of the house. The type of house used as a specimen is a general commoner's house, not a very complex noble house or non-permanent house.

2. Box-Counting Method

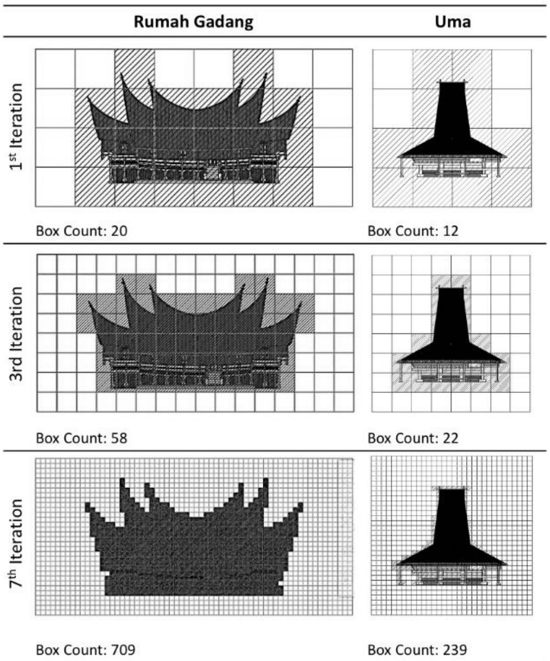
The box-counting method is used to calculate the fractal dimension in this research. A set of grids containing boxes of varying numbers and sizes are superimposed on the façade image which represents the specified layers. Following the method used by Lionar (2022), the box size is reduced according to a certain scaling coefficient (SC), namely ~√2, so that we get a different number of boxes containing image parts (N#, where # = #iteration) for each grid. The estimated fractal dimension (D#) is calculated using the equation:

$$D\# = \frac{[(\log(N\# + 1) - \log(N\#)]}{\log(SC)}$$

$D\#$ = approximate fractal dimension
$N\#$ = numbers of boxes containing parts of the images
SC = Scaling Coefficient

In this research, 10 iterations were carried out to reach the minimum and ideal number to obtain accurate results (Ostwald & Vaughan, 2016). Table 4 shows some results of box-counting for both houses in the 1st, 3rd, and 7th iterations for the material texture layer.

Table 4. Sample of Box Counting Process Depicting the Material Texture Layer for 1st, 3rd, and 7th iteration



Source: Author

The fractal dimension results between *Rumah Gadang* and *Uma* will be compared as a whole to see which one has higher visual complexity. Furthermore, we will see a comparison of the proportion of visual complexity for each layer, to find out which architectural attributes most dominate the overall visual complexity, and which attributes do not dominate. These results were then linked to the qualitative reading of the façades of the two houses which has been done.

Result and Discussion

1. Fractal Dimensions of *Rumah Gadang* and *Uma*'s Façade

The calculation results (Figure 3) show that in general, the fractal dimensions of *Rumah Gadang* façade are higher than those of *Uma*. This means that the façade of *Rumah Gadang* quantitatively has a higher visual complexity than *Uma*. These basic results are then used to calculate the proportion of visual complexity for each architectural attribute using summation as shown in Table 5.

Figure 3. Fractal Dimension of the Façades
Source: Author

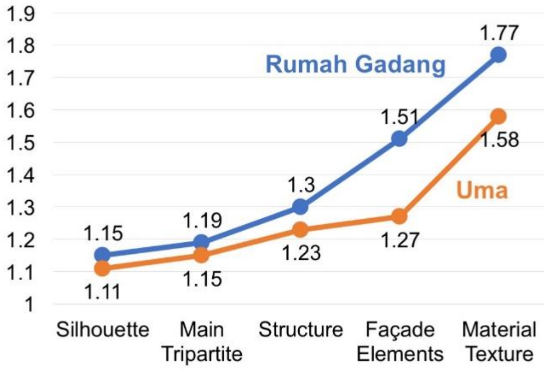


Table 5. Calculation of Visual Complexity Proportion

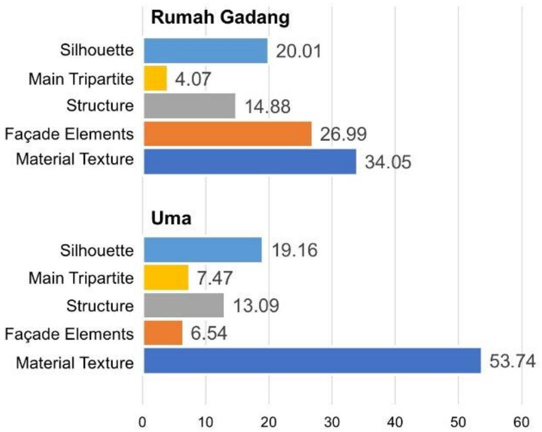
		Fractal Dimension	Decimal		Silhouette		Main Tripartite		Structure		Façade Elements		Material Texture
Rumah Gadang	Layer 1	1.15	0.15	=	0.15								
	Layer 2	1.19	0.19	=	0.15	+	0.03						
	Layer 3	1.30	0.30	=	0.15	+	0.03	+	0.11				
	Layer 4	1.51	0.51	=	0.15	+	0.03	+	0.11	+	0.21		
	Layer 5	1.77	0.77	=	0.15	+	0.03	+	0.11	+	0.21	+	0.26
		%	**100**	**=**	**20.01**	**+**	**4.07**	**+**	**14.88**	**+**	**26.99**	**+**	**34.05**
Uma	Layer 1	1.11	0.11	=	0.11								
	Layer 2	1.15	0.15	=	0.11	+	0.04						
	Layer 3	1.23	0.23	=	0.11	+	0.04	+	0.08				
	Layer 4	1.27	0.27	=	0.11	+	0.04	+	0.08	+	0.04		
	Layer 5	1.58	0.58	=	0.11	+	0.04	+	0.08	+	0.04	+	0.31
		%	**100**	**=**	**19.16**	**+**	**7.47**	**+**	**13.09**	**+**	**6.54**	**+**	**53.74**

Source: Author

In *Rumah Gadang's* façade, the fractal dimension (D) of the material texture is 1.77 (high), D of the façade elements is 1.51 (medium), D of the structure is 1.3 (low), D of the main tripartite is 1.19 (low), and D of the silhouette is 1.15 (low). In *Uma's* façade, the fractal dimension (D) of the material texture is 1.58 (medium), D of the façade elements is 1.27 (low), D of the structure is 1.23 (low), D of the main tripartite is 1.15 (low), and D of the silhouette is 1.11 (low).

The more detailed calculation results for each layer show that in *Rumah Gadang,* material texture dominates visual complexity (34.05%), followed by façade elements (26.99%), silhouette (20.01%), structure (14.88%), and finally the main tripartite (4.07%). Material texture also dominates the visual complexity of *Uma* (53.74%), followed by silhouette (19.16%), structure (13.09%), the main tripartite (7.47%), and finally façade elements (6.54%). These results can be seen in the following Figure 4.

Figure 4. Proportion of Visual Complexity for Each Architectural Attribute
Source: Author



2. Proportion of Visual Complexity of Material Texture

The finding that material texture dominates visual complexity goes back to the fact that the most dominant texture is found in the organic material covering the roof. In proportion, the roof area takes up most of the façade area, as stated by Prijotomo (2010) that the roof is the most important element in a building for it is the roof that plays the role of providing shade, and Waterson (2002) that the roof ridge is deliberately extended or made to an impressive height. This also reaffirms the primacy of organic materials in Indonesian and Southeast Asian buildings according to Domineg (2002). When large areas of the roof are covered with organic materials that have the texture of voluminous strands such as sago palm leaves on *Uma* and palm fiber on *Rumah Gadang*, the texture quantitatively makes the greatest contribution to the visual complexity of the façade. When compared with other architectural attributes in *Rumah Gadang,* the dominance of material texture is not too contrasting even though it is still the highest. This is because the roof area of *Rumah Gadang* is not very large, and the parts other than the roof are quite complex with doors, windows, wooden panels, and adorned stilt cover. This is different from the *Uma* case where the roof area is so dominant compared to other parts, so the visual complexity of the material texture is also very contrasting. The body and base of *Uma* tend to be very simple with minimal decoration and openings.

3. Proportion of Visual Complexity of Façade Elements and Structure

When examining the comparison between the visual complexity of the façade elements and the main structure in the two vernacular houses, significantly different results were found. In *Rumah Gadang,* the visual complexity of the façade elements is higher than the main structure. This is logical because there are many doors, windows, wooden panels, and adorned stilt covers which visually cover the main structure of the house. In contrast at *Uma*, the visual complexity of the main structure is higher than the façade elements. The main structures in *Uma* such as wooden piles, wooden body frames, and some of the roof frames are still clearly visible without any covering or decoration. The number and size of window doors are also relatively small.

This finding can be related to the function and position of the house in its respective social system. The façade of *Rumah Gadang* reflects the social position, the number of ancestors, and the family of the owner (Hasan, 2007; Wongso, 2014) so it is natural that the façade is decorated seriously.

Meanwhile, based on direct observation, the appearance of *Uma's* façades tends to be the same as each other, because it does not function as self-actualization or a reflection of its owner as an individual. *Uma* is seen more as part of the overall village structure. *Uma's* level of importance is demonstrated by the sacred heirlooms it possesses and the specific function it fulfills during rituals held throughout the village (Reny, Subroto, & Saifullah, 2018; Adon & Renda, 2022). Each *Uma* has its specific function and position (Solikhah, 2020), and the level of *Uma's* importance is not always shown by the appearance of the façade.

If we look further back, this tendency can be linked to the development of civilization behind the two houses. The Sumbanese are known for their megalithic civilization which is still practiced today (Handini, 2019). Residential construction and woodworking are not their only focus. Most of this stonework is located outdoors in sacred communal yards (*natar*). One of the characteristics of megaliths is attention to the giant overall shape (Sukendar, 1997) which may be reflected in the silhouette of the building.

On the other hand, although there are traces of megalithic artifacts (Suardi, 2015), the Minangkabau people are already far from practicing it. Remains of large stonework are no longer found around the residence. Folk records mostly tell of their focus on building *Rumah Gadang* with all attention to woodwork (Hasan, 2007; Syafwan, 2016; Wongso, 2020). It is not surprising that their attention to detail in how to arrange wood and organic materials on the façade is high.

4. Proportion of Visual Complexity of Silhouette

The difference between the subjective capture of the human eye and quantitative calculations is clearly visible in the findings regarding the silhouette of the *Rumah Gadang*. The pointy roof silhouette, which is often identified as the strongest character of *Rumah Gadang's* architecture, surprisingly only ranks third in terms of contribution to visual complexity. Meanwhile, in *Uma*, the silhouette which also stands out with its towering roof has a high contribution to its visual complexity and is ranked second.

5. The Proportion of Visual Complexity of the Main Tripartite

In both houses, the main tripartite has a low contribution to the visual complexity of the façade. The concept of dividing a house into 3 parts consisting of a base, middle, and upper part is a popular approach in explaining the vernacular architecture, which is one of the authors' considerations in making it one of the layers in the calculations. It turns out that this tripartite concept does not make a high visual contribution to the two façades of the house. Thus, philosophical approaches and mathematical quantification do not always show consistent results.

Breaking down the layers of architectural attributes in the analysis in this study also has the potential to draw greater conclusions in the future. For example, the dominance of material texture in the visual complexity of these two cases of Indonesian vernacular houses can be compared with similar cases in Turkiye and India. Two cases in Turkiye show the dominance of visual complexity by form (Ediz & Ostwald, 2012; Ostwald & Ediz, 2015). Analysis of other cases in India shows dominance by structure (Lionar, 2021). By noting that the comparative buildings partly come from the grand tradition, we can still see the tendency for the proportion of visual complexity in each locus.

Fractal dimension analysis is an eminent method; therefore, it has often been used in analyzing the visual complexity of vernacular buildings. Another method that is often used to analyze visual complexity is lacunarity analysis, especially if the visual information in the object is heterogeneous or organic. Lacunarity quantifies how visual information are spatially organized (Mandelbrot, 1983). In this research, the visual information in vernacular house facades tends to be orderly, repetitive and homogeneous. Thus, fractal dimension analysis is more appropriate to use and lacunarity analysis is not deemed necessary.

However, fractal dimension analysis has several limitations. It requires accurate depiction to obtain valid results, so it is sometimes difficult to do with objects without organized documentation such as vernacular houses. The calculations are very specific to the object under study and cannot be generalized to assess vernacular house types of very different complexity. To achieve higher accuracy, hundreds of iterations and three-dimensional box counting calculations can be required, so very large computing power is a must. This calculation can only identify visual density, but cannot identify the distribution (homogeneous / heterogeneous) of that density.

With a high effort for documentation and depiction, fractal dimension analysis can be applied to all vernacular houses in Indonesia because it focuses on visual complexity, and the decorative-ornamented nature of Indonesian vernacular houses makes it potential as an object for fractal analysis. This approach can also expand studies on the aesthetics and forms of vernacular buildings in a quantitative and measurable way, complementing research on meaning and culture which is already widespread.

Conclusion

This study compares the visual complexity of the *Rumah Gadang* and *Uma* façades using the fractal dimension calculation method. The calculation results show that the *Rumah Gadang* façade has higher visual complexity than the *Uma* façade. Observed from the architectural attribute layer, material texture is the attribute that dominates the visual complexity of the two houses façades. This means that the most information that will be obtained visually when looking at the two vernacular house façades is the texture of the material. This is in line with the claim that organic material is one important feature of Indonesian and Southeast Asian vernacular architecture.

However, there are differences between the two when observed using other architectural attributes. In *Rumah Gadang*, façade elements such as doors, windows, and adorned stilts-cover provide a high contribution to visual complexity. Meanwhile, in *Uma*, the silhouette of the house with a wide roof and soaring tower makes a big contribution.

Based on the fractal dimension calculations, it is concluded that there are differences in the degree and proportion of visual complexity in the cases of the two vernacular houses. This finding can be attributed to the way the homeowners place importance on the façade and the house in its respective social system, or even the development of civilization behind the two houses. This result is an output of a mathematical calculation and does not always correspond to subjective qualitative visual perception. Research can be further developed by increasing the number of building specimens from different loci, developing studies for certain types of buildings with more variables, or assessing more layers of architectural attributes.

This research is limited to looking at façades as two-dimensional or planar graphic objects. Considering that Indonesian vernacular house facades have a strong three-dimensional aspect, further research using three-dimensional fractal dimension calculation methods is also potential for future work.

References

Adon, M., & Renda, M. (2022). Umma Kalada Sebagai Ruang Sakral dan Media Pendidikan Moral Suku Kalindakana Weelewo Katodalobo Sumba Barat Daya Menurut Pemikiran Mircea Eliade. *Harmoni, 21* (2), 278-299. DOI:https://doi.org/10.32488/harmoni.v21i2.590

Agus, E. (2006). Kajian topologi, morfologi, dan tipologi pada rumah gadang Minangkabau. *Proceedings of International Conference on*

Construction Industry (ICCI). Padang: Universitas Bung Hatta.

Burkle-Elizondo, G., Sala, N., & Valdez-Cepeda, R. (2014). Geometric and complex analyses of Maya architecture: Some examples. In K. Williams, & M. Ostwald (Eds.), *Architecture and Mathematics from Antiquity to the Future* (Vol. 1, pp. 113-126). Basil: Birkhäuser, Cham.

BPS Kabupaten Sumba Barat. (2020). *Sumba Barat Dalam Angka.* Sumba Barat: Badan Pusat Statistik Kabupaten Sumba Barat.

Dinas Komunikasi dan Informatika, Persandian dan Statistik Kabupaten Sumba Barat. (2018). *Kondisi Geografis Kabupaten Sumba Barat*. Retrieved April 16, 2021, from Kabupaten Sumba Barat: https://sumbabaratkab.go.id/kondisi-geografis/

Domineg, G. (2002). Teknik konstruksi. In G. Tjahyono (Ed.), *Indonesian heritage: arsitektur* (6 ed., pp. 16-17). Jakarta: Grolier International.

Ediz, Ö., & Ostwald , M. (2012). The Süleymaniye Mosque: A computational fractal analysis of visual complexity and layering in Sinan's masterwork. *ARQ Architectural Research Quarterly , 16* (2), 171-182. doi:10.1017/S1359135512000474

Hasan, H. (2007). *Rumah Adat Minangkabau - Falsafah, Pembangunan, dan Kegunaan.* (G. T. Fasli, Ed.) Jakarta: Yayasan Citra Pendidikan Indonesia.

Handini, R. (2019). Kubur Batu Sebagai Identitas Diri Masyarakat Sumba: Bukti Keberlanjutan Budaya Megalitik di Anakalang, Sumba Tengah. *AMERTA Jurnal Penelitian dan Pengembangan Arkeologi , 37* (1), 39-54. DOI 10.24832/amt.v37i1.18-26

İlhan, C., & Ediz, O. (2019). Fractal Geometry Analysis of Urban Tissue Morphological Change: The Case Study of Bursa. *Journal of Architecture and Life , 4* (1), 117-140. doi:10.26835/my.546927

Irwanuddin, I. (2018). Identifikasi Genotype Rumah Adat Sumba Barat dengan Metode Space Syntax . *Review of Urbanism and Architectural Studies (RUAS) , 16* (1), 58-70. https://doi.org/10.21776/ub.ruas.2018.016.01.5

Lehner, E. (2016). *Roots of Architecture - Building Traditions in Non-European Cultures.* Vienna: IVA - ICRA Publishing.

Lionar, M., & Ediz, O. (2020). Measuring visual complexity of Sedad Eldem's SSK Complex and its historical context: A comparative analysis using fractal dimensions. *Nexus Network Journal: Architecture and Mathematics , 22* (3), 701-715. https://doi.org/10.1007/s00004-020-00482-4

Lionar, M., & Ediz, O. (2021a). Measuring architecture and urban fabric: The case of the İMÇ and the SSK Complexes. *JCoDe Journal of Computational Design , 2* (1), 335-354. https://dergipark.org.tr/en/pub/jcode/issue/60846/852307#article_cite

Lionar, M., & Ediz, O. (2021b). The influence of traditional Indian architecture in Balkrishna Doshi's IIM Complex at Bangalore: A comparative analysis using fractal dimensions and lacunarity. *A|Z ITU Journal of the Faculty of Architecture , 18* (1), 235-252. doi:10.5505/itujfa.2021,80388

Lionar, M. (2022). Measuring Complexity in the Artistic Representation of the Architecture of Balkrishna Doshi. *Journal of Architectural Research and Design Studies , 6* (1), 1-10. DOI: 10.20885/jars.vol6.iss1.art1

Lionar, M. (2021). *Fraktal Boyuta Dayalı Çok Katmanlı Bir Analiz: Eldem ve Doshi Mimarlığı.* Ph.D Thesis, Bursa Uludağ University, Architecture, Bursa.

Mandelbrot, B. B. (1983). *The Fractal Geometry of Nature*. New York: W.H. Freeman and Company.

Mohd Nawawi, N., Abdul Majid, N. H., & Mohd Ariffin, N. (2010). In Search of the Origins of the Malay Architectural Heritage. *International Conference on Malay Heritage*, (pp. 1-24). Phnom Penh.

Novrial, & Siregar, N. (2021). Characteristics of Vernacular Architecture Malay Deli Traditional House Based on Technical Aspects of Building Structure. *International Journal of Architecture and Urbanism , 5* (2), 148-160. DOI: 10.32734/ijau.v5i2.6834

Nurdiah, E. A., & Hariyanto, A. D. (2013). Struktur Rangka Atap Rumah Tradisional Sumba. *Semnas Reinterpretasi Identitas Arsitektur*

Nusantara (pp. 117-124). Bali: Universitas Udayana Press.

Oliver, P. (2006). *Built to Meet Needs.* Oxford: Architectural Press.

Ostwald, M., & Ediz, O. (2015). Measuring form, ornament and materiality in Sinan's Kılıç Ali Paşa Mosque: An analysis using fractal dimensions. *Nexus Network Journal: Architecture and Mathematics , 17* (1), 5-22. doi:10.1007/s00004-014-0219-3

Ostwald, M., & Vaughan, J. (2016). *The Fractal Dimension of Architecture.* Basel, Switzerland: Birkhäuser.

Prijotomo, J. (2010). Arsitektur Nusantara Arsitektur Naungan Bukan Lindungan - Sebuah Reorientasi Pengetahuan Arsitektur Tradisional. *Seminar Nasional Arsitektur Nusantara.* Ternate: Universitas Khairun.

Prijotomo, J. (2017). Nusantara Architecture: The Architecture of Shade and 'Liyan' Architecture. An Architectural Reading of the Architecture of the 'Society Without-writing'. In A. Kusno, *Gunawan Tjahjono & Josef Prijotomo: Postcolonial Traditionality* (Vol. 2, p. 69). Delft: TU Delft Open.

Reny, E., Subroto, T., & Saifullah, A. (2018). Konsep Ka'bani – Mawinne dalam Arsitektur Rumah Tradisional Sumba di Kampung Tarung Sumba Barat. *Tesa Arsitektur , 16* (2), 94-105. https://doi.org/10.24167/tesa.v16i2.1143

Rini, J., Numan, I., & Idham, N. (2021). Structural Performance and Constructional Phases of Rumah Gadang of West Sumatra, Indonesia. *bāb Journal of Architecture and Design , 2* (1), 22-42. https://dergipark.org.tr/tr/pub/babdergisi/issue/59868/797490

Sardar, D., & Kulkarni, S. (2015). Role of fractal geometry in Indian Hindu temple architecture. *International Journal of Engineering Research & Technology , 4* (5), 532-537. http://dx.doi.org/10.17577/IJERTV4IS050709

Scheifold, R., Nas, P. J., & Domenig, G. (2004). *Indonesian Houses : Tradition and Transformation on Vernacular Architecture.* Singapore: Singapore University Press.

Schodek, D. L. (1991). *Structure.* Bandung: PT Eresco.

Solikhah, N. (2020, August 5). *Penelitian.* Retrieved February 13, 2024, from Repositori Untar: https://lintar.untar.ac.id/repository/penelitian/buktipenelitian_10311017_15E040321223108.pdf

Suardi, A. (2015, April 9). *Jejak Purba Minangkabau. Harta Karun Nusantara*. Retrieved Fabruary 13, 2024, from Good news from Indonesia: https://www.goodnewsfromindonesia.id/2015/04/09/mengenal-minangkabau-dan-sumatera-barat-pesona-jejak-purba-megalithikum-minangkabau-di-luhak-limo-puluah-koto

Sukendar, H. (1997). *Masyarakat Sumba Dengan Budaya Megalitiknya.* Jakarta: Departemen Pendidikan dan Kebudayaan.

Syafwan. (2016). The Viability of Minangkabau Traditional House and Social Change in The Cultural Nature Surambi Sungai Pagu, South Solok Regency. *Humanus , VX* (1), 105-119. https://doi.org/10.24036/jh.v15i1.6417

Waterson, R. (1990). *The Living House: An Anthropology of Architecture in South-East Asia.* Great Britain: Oxford University Press.

Waterson, R. (2002). Ciri umum: pemanjangan bubungan atap. In G. Tjahjono, & J. Miksie, *Indonesian Heritage : Arsitektur* (Vol. 6, pp. 14-15). Jakarta: Grolier International.

Wongso, J. (2014). Understanding the Elements of Nagari As an Approach for Urban Heritage Conservation in the Historic Cities of Minangkabau. *Proceedings of International Conference on Urban and Regional Planning.* Johor: Universiti Teknologi Malaysia.

Wongso, J. (2020, September 10). Arsitektur Minangkabau. *Kebinekaan Arsitektur Nusantara* , 4-66. Kendari, Sulawesi Tenggara, Indonesia: BARATA Universitas Haluoleo.