Implementation of User Anthropometry Bale “Sakenem” Buildings Based on Height Saka Measurement in Singapadu Tengah Village, Gianyar

I W Parwata1,*, M Umiyati2 and A A G O Wisnumurti3

1Faculty of Engineering, Universitas Warmadewa Denpasar Bali, Indonesia
2Faculty of Letter, Universitas Warmadewa Denpasar Bali, Indonesia
3Faculty of Social and Politics, Universitas Warmadewa Denpasar Bali, Indonesia

*iwayanparwata01@gmail.com

Abstract Traditional Balinese Architecture is an architectural masterpiece Indonesia that should be preserved and developed without eliminating rules prevailing local wisdom in Bali. Bale Sakenem Building is one of the buildings that were in the order of Traditional Bali House. Developments and changes in the form Bale Sakenem building is strongly influenced by the height necessaries, labor shortages both quantity and quality are qualified, time and labor management systems resulting the height intervention builders Bali (Undagi) on the implementation of the construction of the Bale Sakenem. This study identified Bale Sakenem building located in the Singapadu Tengah Village. An identification was based on anthropometry user and measurement of the building dimensions of height saka (column) aspect. This research is observational research by using cross-sectional design. This research was done by means of retrospective observational that is considered the factor that can affect Bale Sakenem Building Anthropometry, with using 20 sample houses based on population research with cluster random sampling. The measurement result was a significant difference between anthropometry users with dimensions of Bale Sakenem calculated based on rai users size and height saka. From the data analyze of research identification, 95% height saka in Bale Sakenem building in the Singapadu Tengah Gianyar have not yet undertaken anthropometry users and more dominant to follow measurements that based on the size of Undagi, as a consequence there was uncomfortableness. Height saka is based on the tolerance of anthropometry using the 95 percentile based on height saka should be.

1. Introduction
Research on the architecture, the people and the environment is an interesting relationship to continue to study. Similarly, Balinese architecture is strongly associated with the user and the surrounding environment. Parwata research results (2011) states that the development of innovation in traditional Balinese residences remain guided by the anthropometry of the Balinese as users of the building, so that the suitability and user convenience can be felt [1].

The baseline survey was developed by considering the change with reference to the ideal traditional house and especially changes to its three main component [2].

Traditional Balinese architecture built following the layout, spatial and building on the concept of Asta Kosala Kosali [3]. This concept is one of the concepts used in the arrangement of the house or
building techniques that are based on the sacred human anatomy (anthropometry) owner. This concept is still used in traditional construction of residential houses in Bali in accordance with the foundation of philosophical, ethical, and ritual with regard conception embodiment, selecting the land, good day (dewasa ayu) to build houses, as well as the ceremony (yadnya) in its development [4].

Size of building land in several hamlets in the Singapadu Tengah village. Ayahan land village is a piece of land given by the village local custom where people live which measure the extent determined by the levels of color (caste), position and dadia (groups / communities of citizens in the number of families) and can be used for generations by the rules villages applicable [5].

Generally building "sakenem" Shudra caste is owned by citizens, in accordance with the size of the land given by the indigenous villages [6]. Each occupant in the land has a responsibility towards their traditional villages such as: participate and build and maintain public buildings owned by the village, set up a ceremony associated with custom activities and some activities that must be obeyed citizens. Residents who owns the building "sakenem" is certainly the size of the land is narrower than the citizens who own the building "sakutus" or "sakaroras". And if forced to construct buildings "sakutus" or "sakaroras" in her yard, and the layout of the building is crowded, uncomfortable and even a shift in values, layout and spatial in Balinese architecture [7].

![Figure 1. Bale "Sakenem" building.](image)

This study focuses on the building of Bali "sakenem" particularly at the height saka (pillar/column). The expected outcome of this research is to create a prototype height saka (pillar/column) on the building "sakenem" in the village of Singapadu Tengah. This research is also expected to generate Intellectual Property Rights (IPR) in the building "sakenem".

The results of this study are also expected to contribute to building measure "sakenem" by using the size of the "meter", in several variables can also be used for building more functionality, both traditional building and modern Balinese in accordance with the development based on the anthropometry of the owner of the building who were in Bali or outside Bali [8].

2. Research method

The strength of this approach lies in its possible parameterization of house according to the traditional Balinese building principles [9]. The study conducted at Singapadu Tengah village, Sukawati, Gianyar. This study was an observational study using cross sectional design. The study conducted by means of an observational retrospective of assessing factors that may affect anthropometry Bale Building "Sakenem". This cross-sectional study can be used to see the distribution of measurement results of the independent variables [10]. The dependent variable in this study is anthropometry of Bale "sakenem" Building, while the independent variables is height saka.

The population in this study is houses that has Bale "Sakenem" buildings in Singapadu Tengah village, Gianyar, with a population of affordable is Bale "Sakenem" building using anthropometry users
and no users. Samples were taken from population studies that met the criteria were randomly using random cluster sampling method.

3. Equations
In this study, the formula used anthropometric tolerance limit (percentile) is as follows:

\[ P = x + \sigma x \ (Z) \]  \hspace{1cm} (1)

Percentile calculation tolerance limit of 95% percentile in height saka can be seen as follows:
95 percentile (maximum percentile)
\[ P_{95} = x + \sigma x \ (Z_1) \]
\[ P_{95} = 194.0375 + 8.87 \times 1.645 \]
\[ P_{95} = 194.0375 + 14.59 \]
\[ P_{95} = 208.6275 \text{ cm} \]
\[ P_{95} = 209 \text{ cm} \]

Nomenclature:
- \( P_{95} \) = 95% percentile
- \( x \) = average height saka
- \( \sigma x \) = standard deviation
- \( Z_1 \) = + 1.645

4. Research results and discussion

4.1. Height Saka

Bale Dangin is building that located on the east side of the traditional houses in Bali. Bale Dangin shape of the building in the form of a rectangular or a rectangle. Bale Dangin building consisting of six pillars (saka) called Bale "Sakenem". The main function of this building is the place of the ceremony. In some houses in Singapadu Tengah Village, bale "sakenem" building functioned as a Manusa Yadnya ceremonial place and also be used as a bed, especially for older family members like grandparents. Bali Dangin (Bale Mundak), this is a pavilion with six pillar. The width of pillar (rai) is 9.5 cm and the height is twenty rai plus anyari kacing [11, 12].

Based on observations in Singapadu Tengah village, often Bale Sakenem building has not noticed the size anthropometry users. The result is the size of the building is too height so that users feel less
safe and comfortable while using. The height of Bale Sakenem buildings can be seen from the size of the saka (pillars), the stairs, bataran, and bale-bale.

Height Saka is the independent variable measured to identify the characteristics of the building typology "sakenem" in Singapadu Tengah village and applied "sakenem" building’s anthropometry aspect of the building owner. Measurement of height saka variable in this study is conducted by comparing the measured height saka in buildings with height saka of bale sakenem should be. The measurement of height saka should be that obtained through the calculation of the rai building that has been measured and then multiplied by 21.5. After comparing the measured of height saka with height saka should be, and known the difference by considering the suitability of tolerances anthropometric measurements. At height saka variable, the value of tolerance that is used the 95% percentile.

4.2. The measurement of height Saka

![Comparison of Height Saka and Tolerance Limit](image)

**Figure 3.** A graphic that shown comparison of height Saka and tolerance limit.

Based on the calculation formula tolerance with tolerance limits can be seen that the value of maximum tolerance which is still acceptable is 209 cm, which means that height saka that still meets the standards of user comfort is height saka with a height of no more than 209 cm. Having regard tolerance measurement results, it can be seen in the figure that as many as 95% of the “sakenem” buildings that do not meet the standards of user comfort. It also indicates that the measuring height saka should be measured based rai building has not been implemented in the community. In addition, the factors of undagi as builders also affects the size of height saka for measuring the concepts and patterns that dominate the time of measurement making "sakenem" buildings.

In the figure can also be known that the height saka that meet the standards of user comfort is in the "sakenem" building from home with R2B2 code. Height saka of the "sakenem" building is 209 cm height saka of the building where the "sakenem" building it still meets the maximum tolerable limits so that they can meet the standards of user comfort. In contrast to the "sakenem" building at home with R4B4 code, where height saka have been measured so far from the tolerance limit is 235 cm. Height saka of building "sakenem" is not yet meet the standards of user comfort its that main effect on user comfort when on the move in the "sakenem" building is.
5. Conclusions
The conclusion of this study is the measurement of height *saka* variable in the study conducted by comparing height *saka* measured in bale *sakenem* buildings with height *saka* should be, after the measurement is known that 95% of the “*sakenem*” buildings that do not meet the standards user comfort. It also indicates that the measuring height *saka* should be that measured based *rai* building has not been implemented in the community. Height *saka* of "*sakenem*" building is not yet meet the standards of user comfort it’s that main effect on user comfort when on the move in the building "*sakenem*" is.

Acknowledgments
We would like to thank to Head of Warmadewa University and all lecturers and students of faculty of Engineering Warmadewa University that support our team to finish this research about Bale “*Sakenem*” Building.

References
[1] Parwata I W 2011 *Jurnal Mudra* 26 1 95-106.
[2] Putra I D G A D, Lozanovska, Mirjana F and Robert J 2017 *Cambridge International Journal of Architectural* 83-100.
[3] Bija I M 2012 *Asta Kosala-Kosali Asta* (Bumi Pustaka Bali Post Denpasar).
[4] Witana I N 1973 *Asta Kosala Kosali Ketentuan Adat Tradisional mengenai Bangunan Bali Building Information Centre Dinas Pekerjaan Umum Prop Bali*.
[5] Parwata I W 2009 *Majalah Ilmu Faal Indonesia* 9 1.
[6] Mulyati M I 2012 Prinsip Ergonomis Dalam Produk dan Sikap Kerja.
[7] Notroatmodjo S 2005 *Pendidikan dan Perilaku Kesehatan* (Jakarta: Rineka Cipta).
[8] Nursalam 2008 *Konsep dan Penerapan Metodologi Penelitian Ilmu Keperawatan* (Editor Tim Editor Salemba Medika Jakarta Salemba Medika).
[9] Peter F, Monika D A and Galina P 2013 “Parametric Balinese Rumah Procedural Modeling of Traditional Balinese Architecture,” *IEEE*.
[10] Widana I B G 2011 *Dharmaning Hasta Kosali Arsitektur Tradisional Bali* (Dharma Pura Denpasar).
[11] Kagami and Haruya 1988 *Balinese Traditional Architecture in Process* (The Little World Museum of Man Japan).
[12] Wignjosoebroto S 2008 *Ergonomi Studi Gerak dan Waktu Teknik Analisis untuk Peningkatan Produktivitas Kerja* Edisi Keempat Cetakan Keempat (Guna Widya Surabaya).