https://doi.org/10.69598/najuahata.22.2.281810

Anthropometric Dimensions in the Architectural Design of Guol Community Houses of the Katu People in Vietnam

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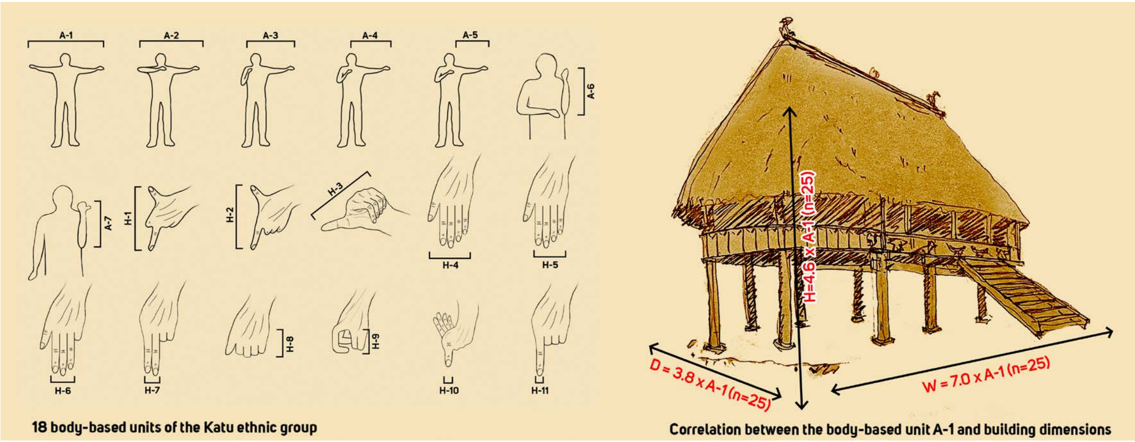
Received 02-08-2025
Revised 11-11-2025
Accepted 05-12-2025



Eighteen Katu anthropometric units and the dimensional correlation of unit A-1 in Guol construction

Abstract

Local knowledge concerning human body-based units of measurement exists across all societies and has been recognized as a key part of traditional architecture. Among the Katu ethnic group in Central Vietnam, this knowledge was historically applied in constructing the Guol, a traditional communal house. The Guol was dimensioned using 18 distinct body-based units, including arm spans (A-1), hand spans, and body heights passed down orally through generations. However, with the onset of modernization, traditional building techniques have gradually faded, and Guol structures have almost entirely disappeared from areas such as Nam Dong District in Thua Thien Hue Province.

Fieldwork involved interviews with 25 elder Katu informants across 25 hamlets, each recalling a Guol they had participated in building. Through comparative analysis of verbal accounts, it was found that key structural dimensions, height (H ≈ 7.26m), depth (D ≈ 6.01m), and width (W ≈ 11.06m) were determined predominantly by the A-1 unit (≈ 1.59m). The resulting average ratios, H/A-1 ≈ 4.6, D/A-1 ≈ 3.8, and W/A-1 ≈ 7.0, reveal a consistent anthropometric logic underpinning the spatial form, even with physical variation among individuals. The findings show that body-based units were used to determine structural components rather than to define abstract spatial concepts. The findings provide not only a record of intangible heritage but also a human-centered design framework relevant to contemporary architecture. This study contributes to rethinking measurement systems by drawing attention to embodied spatial cognition and the cultural foundations of proportionality.

Keywords: Katu ethnic group, Guol traditional community house, body-based units of measurement, indigenous building methods, vernacular architecture

Introduction

The measurement system has long been a driving force in both cultural and technical evolution. Among these systems, body-based units of measurement were widely standardized in ancient civilizations such as Mesopotamia, China, Rome, Greece, and the Maya.[1] When determining a quantity, people commonly compare it with the size of a specific body part, for example, the foot.[2] Other terms include the fathom, ell, cubit, hand, palm, finger length, and finger breadth.[3] In construction, as houses are designed for human use, spatial dimensions often correlate with bodily proportions. This practice exists across societies and is widely recognized as a form of local knowledge.[4]

In Vietnam, several ethnic groups still exhibit knowledge of body-based units in housing and daily life. The Katu—one of the 54 recognized ethnic groups—retain such knowledge, which serves as an intellectual resource for architectural design and construction passed down through generations.[5] However, this heritage has gradually eroded with post-1975 modernization. As a result, efforts are needed to conserve and sustain this form of intangible knowledge.

This study focuses on the Katu, who belong to the Katuic subgroup of the Mon-Khmer language family in Mainland Southeast Asia. They primarily inhabit mountainous regions in Thua Thien Hue and Quang Nam provinces, as well as parts of Da Nang City. While their origins remain unclear, various hypotheses suggest a long-standing presence in Vietnam.[6] Luu Hung hypothesizes that the Katu appeared in Vietnam 300-400 years ago and were one of the first owners of the famous stone pillars and stone jars in the Plain of Jars in Laos.[7] Some other research works hypothesized that this ethnic group may have originated in the upper area of the Mekong River[8] and later immigrated from Laos.[9] Traditionally, each Katu village contained a Guol, the traditional community house located at its center, typically with a circular, horseshoe, earring, or polygonal layout.[10]

Guols were originally built using indigenous knowledge and techniques, including dimensioning based on the human body.[11] However, in the present context, Guol construction has undergone significant changes, and most villagers now follow external building forms without engaging in the full construction process. As a result, the Katu have lost much of their intangible heritage related to architecture, which is only preserved through hands-on practice, often without any written or drawn records. This study seeks to examine that knowledge by interviewing elderly villagers in Nam Dong district, with a particular focus on dimensional planning based on body-based units of measurement.

Previous research on the Katu has primarily addressed cultural traditions, social organization, and settlement patterns.[12] While these studies offer valuable insights into Katu heritage, few have systematically examined their construction methods, particularly the use of anthropometric measurement in architectural design. In Nam Dong district, some research has addressed the changing characteristics of Guols due to modern influences,[13] but without a focused investigation of measurement techniques. Notably, Hirohide Kobayashi's earlier work documented the application of body-based units in a reconstruction project of a Guol in Hong Ha commune, A Luoi district, in 2007.[14] This line of inquiry was later expanded to three additional communes,[15] whereas the present study covers all 25 Katu hamlets in Nam Dong and standardizes the system at 18 units. Another reconstruction, conducted in A Ka hamlet (Thuong Quang commune, Nam Dong district), was completed in August 2018,[16] during which the authors visited most hamlets in the region to obtain a comprehensive understanding of Katu construction practices. Nam Dong was selected as the focal case because it allowed continuous surveys from 2018 to 2021 and still has a relatively large number of elders who retain body-based construction knowledge. This district provides a representative case for future expanded studies among Katu and other highland communities.

Beyond the Vietnamese context, comparative research has shown that the use of body-based units is common in vernacular traditions worldwide. These units—paces, cubits, feet, spans, fingers, and thumbs—are visible in both the components and overall design of vernacular architecture.[17] The Moklen people of Tubpla village in Thailand employed ten such units in house construction,[18] while Fijian villagers used seven in constructing traditional wooden dwellings.[19] While these cases illustrate the persistence of embodied techniques, few studies have mapped these units in relation to spatial planning or analyzed their internal proportional logic.

In Vietnam, recent studies have verified the use of body-based units in designing the Katu traditional community house.[20] These findings illuminate a vital aspect of indigenous building knowledge and help clarify the cultural identity embedded in spatial practices. However, existing research often provides only descriptive accounts or case-specific observations without systematically analyzing the proportional relationships between body-based units and architectural dimensions.

This study addresses that gap by identifying and comparing 18 distinct body-based units used by the Katu people, and statistically examining how these units inform building layout, form, and spatial organization. By focusing on the internal proportional logic of 18 body-based units and their application to Guol structural components, this paper clarifies a quantitative aspect that previous descriptive studies did not address. The case study in Nam Dong district may also provide a reference point for future research in related contexts. The goal is to document and analyze body-based architectural knowledge embedded in Guols architecture as a form of intangible cultural heritage.

Research Framework

This study employed a qualitative research design integrating ethnographic fieldwork, semi-structured interviews, and comparative analysis of anthropometric measurement systems in vernacular architecture. The overarching aim was to investigate how body-based units informed the determination of key architectural dimensions (height, depth, width, roof beams, pillar span) in Guol construction. While the spatial configuration of Katu villages has been addressed in earlier studies, this research does not investigate settlement layouts, but rather focuses on the measurement knowledge embedded in Guol construction.

The research was conducted in Nam Dong, a mountainous district in Thua Thien Hue Province,[21] which covers an area of 64,782.1 square kilometers.[22] In this district, the Katu ethnic group comprises the majority, with a population of 12,301.[23] The Katu account for approximately 70% of the total Katu population in Thua Thien Hue Province.[24]

The Katu in Nam Dong district are believed to have migrated primarily from northwest Quang Nam province, having resided in the area for an estimated 200–300 years.[25] However, most present-day villages and hamlets of the Katu in Nam Dong were established after 1973, influenced by emigration movements related to the Vietnam War.[26] As of the time of research, Guols had disappeared from nearly all settlements, with the exception of three hamlets: A Ka (Thuong Quang commune), Doi (Thuong Lo commune), and A Xang (Thuong Long commune) (Fig. 1). Although most villagers today lack hands-on experience in traditional construction, elderly residents continue to preserve oral knowledge and embodied memories of building practices from before 1975.

Fig 1

Three Guols

in Nam Dong district

A Ka hamlet, Thuong Quang commune (in 2021)

Doi hamlet, Thuong Lo commune (in 2018)

A Xang hamlet, Thuong Long commune (in 2021)

Fig 1

1) Data Collection Methods

The research combined secondary data synthesis with primary field investigations. Relevant articles, papers, books, and documents pertaining to body-based units of measurement, the Katu ethnic group, and the Guols were collected. These materials were synthesized to provide an overview of the Katu people, their traditional communal house, and the application of body-based units of measurement in design and construction.

Field surveys were conducted in January 2018, February 2018, August 2018, September 2019, and June 2021 across 25 hamlets in Nam Dong District (Fig. 2).[27] During fieldwork, semi-structured interviews were purposively conducted with 25 Katu villagers, aged between 50 and 97 years (average age: 73.9), who were identified through village elders and other influential persons (such as member of Association of the Elderly or hamlet heads) as those possessing practical experience or professional memory of Guol construction—i.e. knowledge rather than age, was the primary criterion. Most had directly participated in the construction of Guols prior to 1975 and some had joined later constructions after the Katu resettled in Nam Dong in 1973. All interviewees were still mentally alert and able to demonstrate the body-based units, which helped reduce memory-related bias. These individuals were respected elders within their respective hamlets, including former builders, ritual specialists, and village leaders. The measurement units they described and demonstrated reflected embodied professional knowledge transmitted orally within the community, rather than any standardized or communal model.

The interviews focused on two main aspects: (1) the participants' recollections of traditional village spatial organization, architectural features of the Guol, and their hands-on construction experiences; and (2) their detailed descriptions and practical demonstrations of body-based units of measurement, including instances where village elders were invited to physically perform the measuring gestures to illustrate how these body-based units were applied in architectural planning and construction.

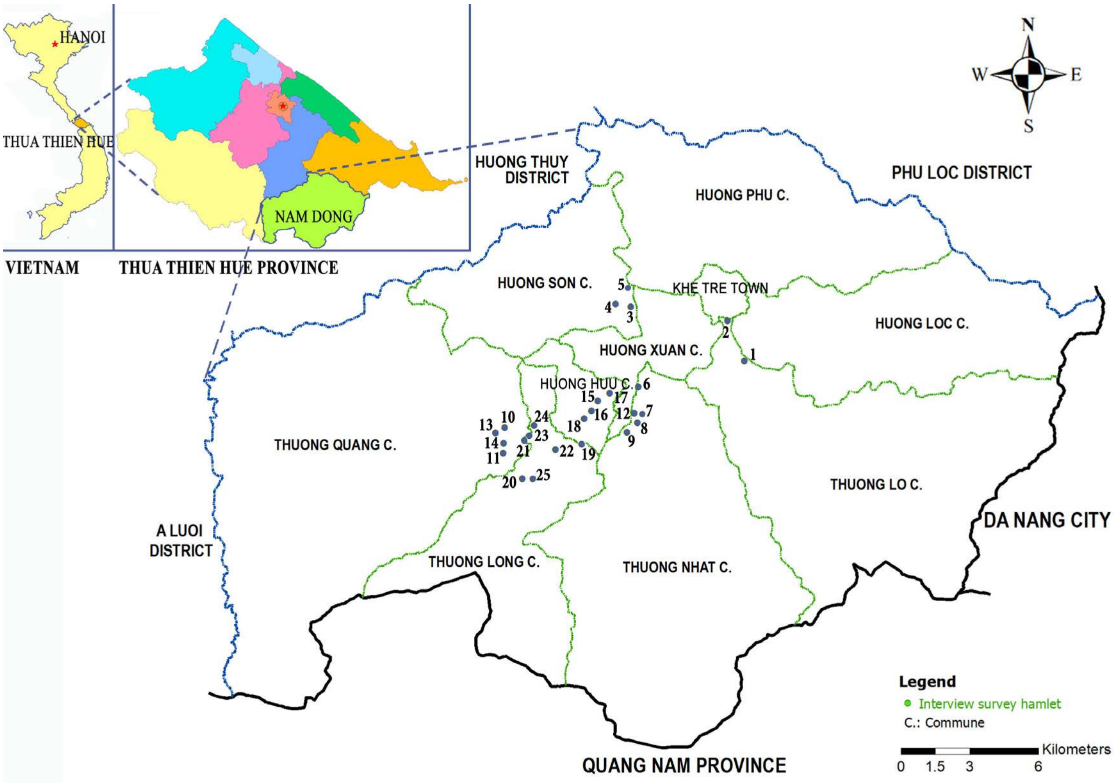


Fig 2

Fig 2

Interview sites across 25 hamlets in Nam Dong

Interview transcripts were thematically coded to identify references to body-based units of measurement practices. Descriptions of spatial dimensions and construction components were cross-verified through participants' demonstrations and field notes. Reported measurements were converted into metric equivalents based on each participant's physical proportions, enabling standardization across cases. When informants gave slightly different values for the same structural member, the mean value (± standard deviation) was used as the representative measure, while rarely mentioned values were recorded qualitatively. This process standardized memory-based data for comparative analysis. All interviews were conducted on a voluntary basis, with participants informed of their right to withdraw at any time. Personal information was anonymized and used solely for academic purposes.

2) Analysis Methods

The data collected from interviews were compiled and processed using Microsoft Excel to extract dimensional information related to the Guol, focusing on both its spatial configuration in plan and vertical profile. Key architectural dimensions, such as height, width, and depth were recorded and standardized. These values were then statistically analyzed using mean and standard deviation to explore potential relationships between architectural proportions and body-based units. The analytical workflow, including data collection, measurement categorization, and comparative analysis of anthropometric ratios, is summarized in Figure 3.

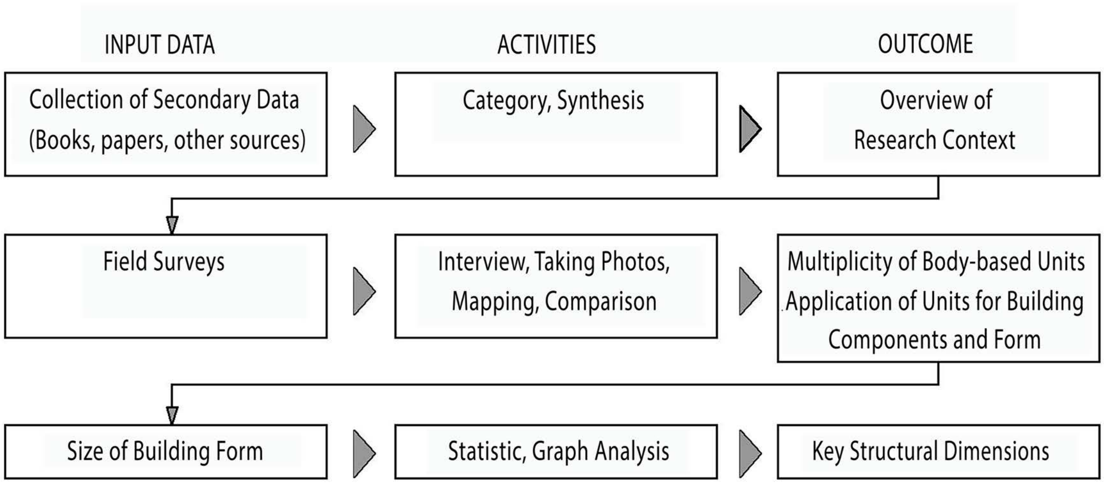


Fig 3

Discussion and Results

Fig 3

Process diagram of the study

1) A description of the Katu traditional community house

Guol, a traditional community house of the Katu people (Fig. 4), is located in the center of the village. It plays an essential role as a sanctuary and a social gathering space exclusively for males.[28] As the largest and most symbolically significant structure, it is referred to as the "face," "head," "soul," or "pride" of the village.[29]

Architecturally, the Guol is a stilt house characterized by a central pillar known locally as the "father pillar." (Fig. 4 and 5) This element embodies patriarchal authority and leadership, supporting the ridge beam and transmitting roof loads to the underlying crossbeams and additional posts. Traditionally, the Guol was constructed through collective effort, involving the entire village. Its multifunctional roles included conflict resolution, ritual ceremonies, information dissemination, storage, and hosting communal gatherings.[30] This socio-ritual setting shows that Guol construction was a collective, male-led practice in which architectural making and ceremonial functions were integrated, making it comparable to other Central Vietnamese highland traditions that also employ embodied measuring techniques.

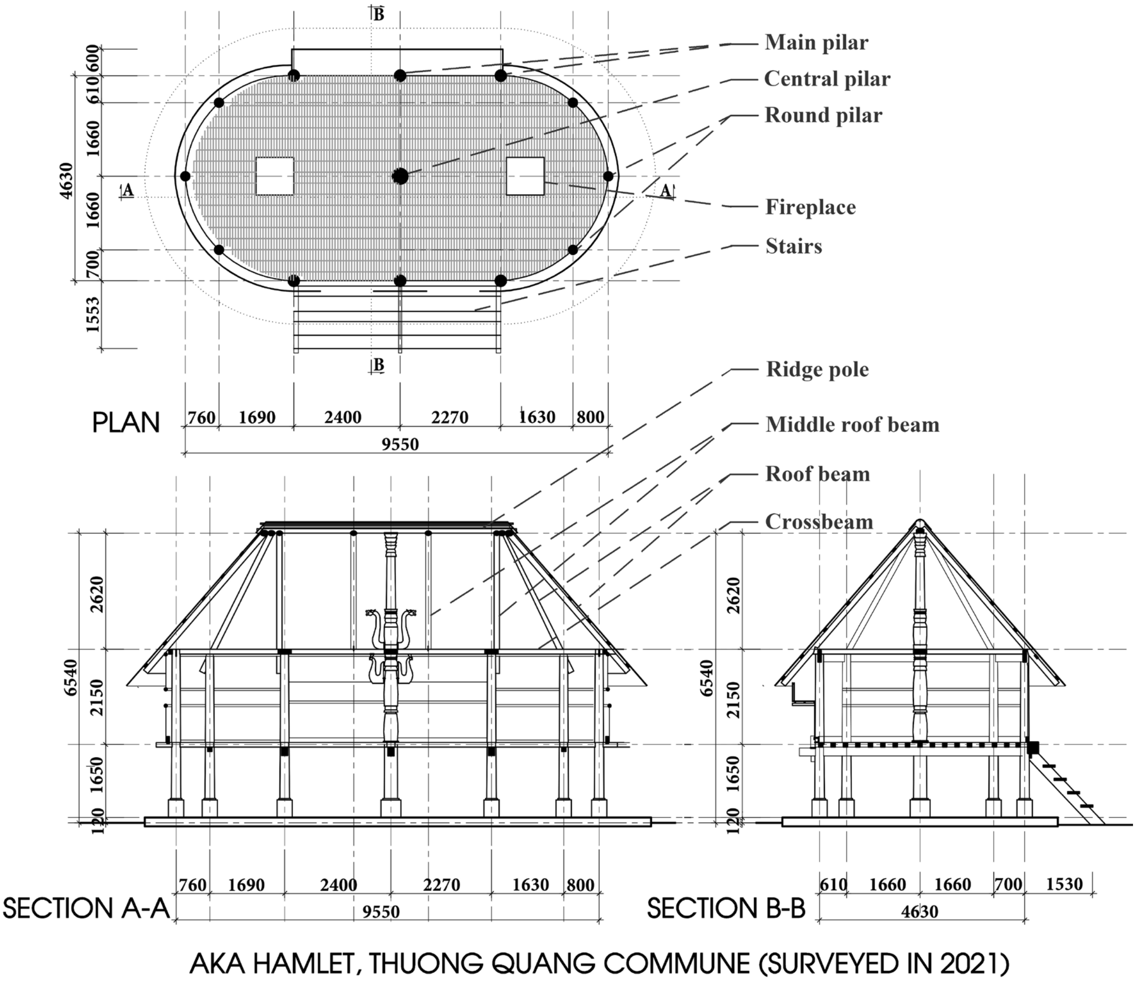


Fig 4

A key feature in its design was the use of body-based units of measurement. The Katu relied on arms, hands, and other body parts to define component sizes and building proportions. Field surveys in Nam Dong district confirm that body-based units were widely applied, especially those derived from the patriarch or construction leader, who served as the reference model. In the case from Hong Ha commune (A Luoi district), a healthy villager of average height was selected, as his proportions were believed to bring good fortune to the building process.[31]

Fig 4

Guol in A Ka hamlet, Thuong Quang commune in Nam Dong district

Fig 5

Fig 5
Guol in A Ka hamlet, Thuong Quang commune in Nam Dong district

2) Application of multiplicity of body-based units in traditional construction

Previous research, conducted through interviews, clarified 17 kinds of units used for construction in three communes of the Katu ethnic minority.[32] They had seven arm-based units and 10 hand-based ones, which were applied to determine the size of components and the building form using some of these units.

The preliminary report continuously exploited human body-based units of 24 hamlets in Nam Dong district and the application of these units for dimension planning and building form.[33] This research developed and completed the above report, showing a comprehensive understanding of the wholly human body-based units of the Katu and their application for component measurement and building form.

According to the surveys of 25 hamlets in Nam Dong district, an elderly Katu villager of Doi hamlet in Nam Dong district, Mr. Tran Van Dinh, demonstrated these body-based units as illustrated drawing in Appendix A. It was found that the Katu of 24 hamlets had one more hand-based unit, shown as H-11 in Appendix A (i.e., the Katu has 18 body-based units). This is the width of the forefinger, and it is rarely used for construction. Based on fieldwork conducted between 2019 and 2021, this study therefore standardizes the Katu body-based measuring system at 18 distinct units.

Appendix A indicated that the arm-based units are usually used for measuring and designing large distances and sizes, such as pillar spans, pillar heights, and beam heights. In contrast, the hand-based units are mainly used for component sizes, such as pillars, beams, rafters, purlins, and so on. Among the interviewees, six individuals showed the same unit types of seven arm-based and eleven hand-based units, while the others did not use one to four unit types for construction.

3) Body-based units for building components

Body-based units of measurement, as shown in Appendix A, were commonly used to determine the sizes of the main building components such as the central pillar, main pillars, round pillars, and roof beams. These units were primarily based on H-1 or A-1 of the selected reference person. Appendix B presents detailed data collected from 25 interviewees, whose body heights mostly ranged from 150 to 170 cm, except for one case (No. 8) at 144 cm. Measurements were expressed in terms of perimeter (round length), and in fewer cases, diameter.

Central pillar: 21 interviewees indicated that the size of a central pillar was decided by the perimeter. Among them, 19 cases were expressed as 4 to 7 times of H-1 (22.9–42.3 cm in diameter), while the other two cases were measured as A-1 to [(A-1) + (H-1)] (51.6–55.1 cm in diameter). Four interviewees used the diameter, which was 2 to 3 times of H-1 (40.4–55.4 cm in diameter).

Main pillar: All interviewees affirmed that the size of the main pillars was smaller than that of the central pillar. 22 interviewees indicated that the size of the main pillar was decided by the perimeter, which was expressed as 2.5 to 5 times of H-1 (15.1–31.8 cm in diameter). Two interviewees indicated that the diameter of the main pillars was 2.5(H-1), while another case claimed that the perimeter of the main pillars was 2/3(A-1).

Round pillar: 18 interviewees indicated that the size of a round pillar is decided by the perimeter, which is expressed by 2(H-1) to [4(H-1) + (H-3)] (12.1–25.5 cm in diameter). Among them, six cases mentioned that the sizes of the round pillar and the main pillar were the same. Two interviewees decided the size of the round pillar by diameter, which was expressed by H-1 (18.0–18.5 cm in diameter).

Roof beam: 14 interviewees claimed that the size at the top of the roof beam was smaller than that of the one at the bottom of the beam. 17 interviewees indicated that the size at the top of a roof beam was decided by the perimeter that was expressed as 1.5(H-1) to 0.5(A-1) (8.4–25.8 cm in diameter). For the bottom of a roof beam, it was decided by the perimeter that was expressed as 2(H-2) to 0.5(A-1) (9.6–25.8 cm in diameter).

Overall, H-1 was the most commonly used body-based unit for estimating component sizes, though A-1 and hand-based units were also occasionally applied. Generally, the central pillar is the largest, followed by the main pillar, round pillar, and roof beam. This hierarchy of sizes confirms that Katu builders first fixed the principal load-bearing members with H-1, and only then adjusted secondary members with shorter arm or hand units. According to Table 1, their average perimeters are 112.7 cm, 78.2 cm, 57.8 cm, and 45.2 cm respectively, with standard deviations of 33.1, 24.2, 15.3, and 11.1 cm.

Table 1

	Central pillar (cm)	Main pillar (cm)	Round pillar (cm)	Roof beam (cm)
Average	112.7	78.2	57.8	45.2
Average ± SD	112.7 ± 33.1	78.2 ± 24.2	57.8 ± 15.3	45.2 ± 11.1

Note: SD = Standard deviation.

Table 1
Average sizes of the main building components

4) Body-based units for building form

Body-based units were applied in order to determine the building form, including the floor plan and height plan by defining the dimensions of certain building parts, as shown in Figure 6 and Appendix C. As shown in Appendix C, A-1 is the main unit applied, while units from A-2 to A-6 serve as complementary units in the application. The dimensional combinations used to determine a building form reveal consistent patterns.

Floor plan: The floor plan of the Guol is symmetrical and determined by the combination of G1, G2, G3, B1, and B2 (Fig. 6). Normally, G3 is smaller than G2 (12 interviewees), except for one case where G3 is larger than G2 (interview No. 12). Seven interviewees indicated that G3 and G2 were equal, resulting in the round shape of the Guol being semicircular. Five interviewees (Nos. 2, 3, 9, 10, and 14) used only G1 or G2, although this was insufficient to complete the total length of the front side (G1). The floor plan of the lateral side (beam direction, B1 and B2 in Fig. 6) was determined using 2(A-1) to 5(A-1).

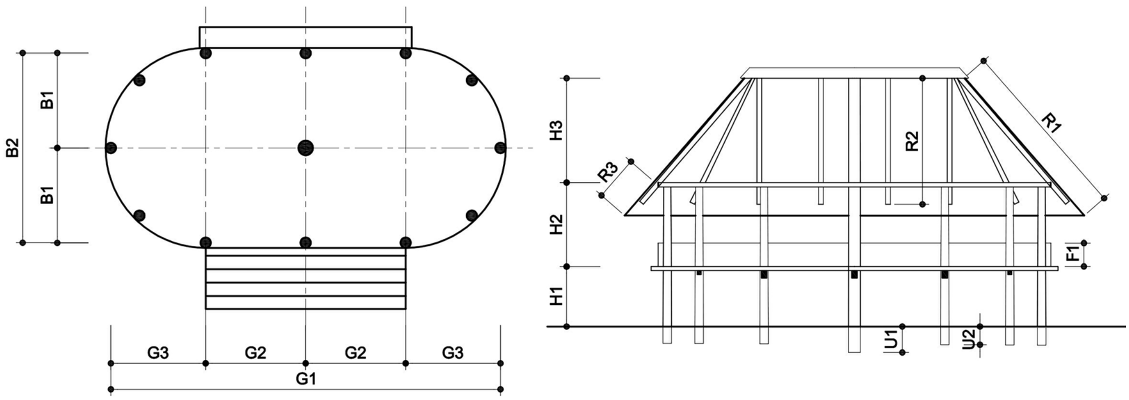


Fig 6

Fig 6
Unit application
for building parts

Height plan: All interviewees determined the height of the Guol by using H1, H2, H3, or a combination of them (H1+H2, H2+H3, or H1+H2+H3) as shown in Appendix C. Four interviewees (Nos. 8, 10, 15, and 16) used no units for the height of the top roof and may have determined the roofing form by the application of a roof beam (R1).

The length of the round roof beam was expressed as 2.5(A-1) to 5(A-1), while the length of the middle roof beam was normally shorter. Most interviewees used arm-based units to express R3, ranging from A-6 to A-2, except for two interviewees (Nos. 11 and 21), who used hand-based units for R3. Regarding the additional parts (F1), 12 interviewees expressed the height of the floor fence using body-based units, metric units, and neck or eye height of a sitting person.

The depths of the underground central pillar and other pillars were represented as U1 and U2 in Figure 6. U1 was decided from A-6 to (A-1) + (A-6). U2 was decided from A-6 to A-2. Normally, the central pillar was buried deeper than the other pillars, but 18 interviewees stated that U1 and U2 were equal. Most interviewees used A-1 as the main body-based unit to determine pillar spans, floor and beam heights, roof height, and roof-beam length. Other arm-based units were used either in addition to A-1 or to estimate short distances.

5) Characteristics of building form

Figure 7 presents the floor and section plans reconstructed from interview data, based on body-based units of measurement provided by 25 elderly villagers. These drawings reflect each informant's personal interpretation of a Guol they had previously experienced participating in construction. Variations in form and dimension illustrate differences in individual body proportions and memory-based knowledge. Each dimension reflects direct

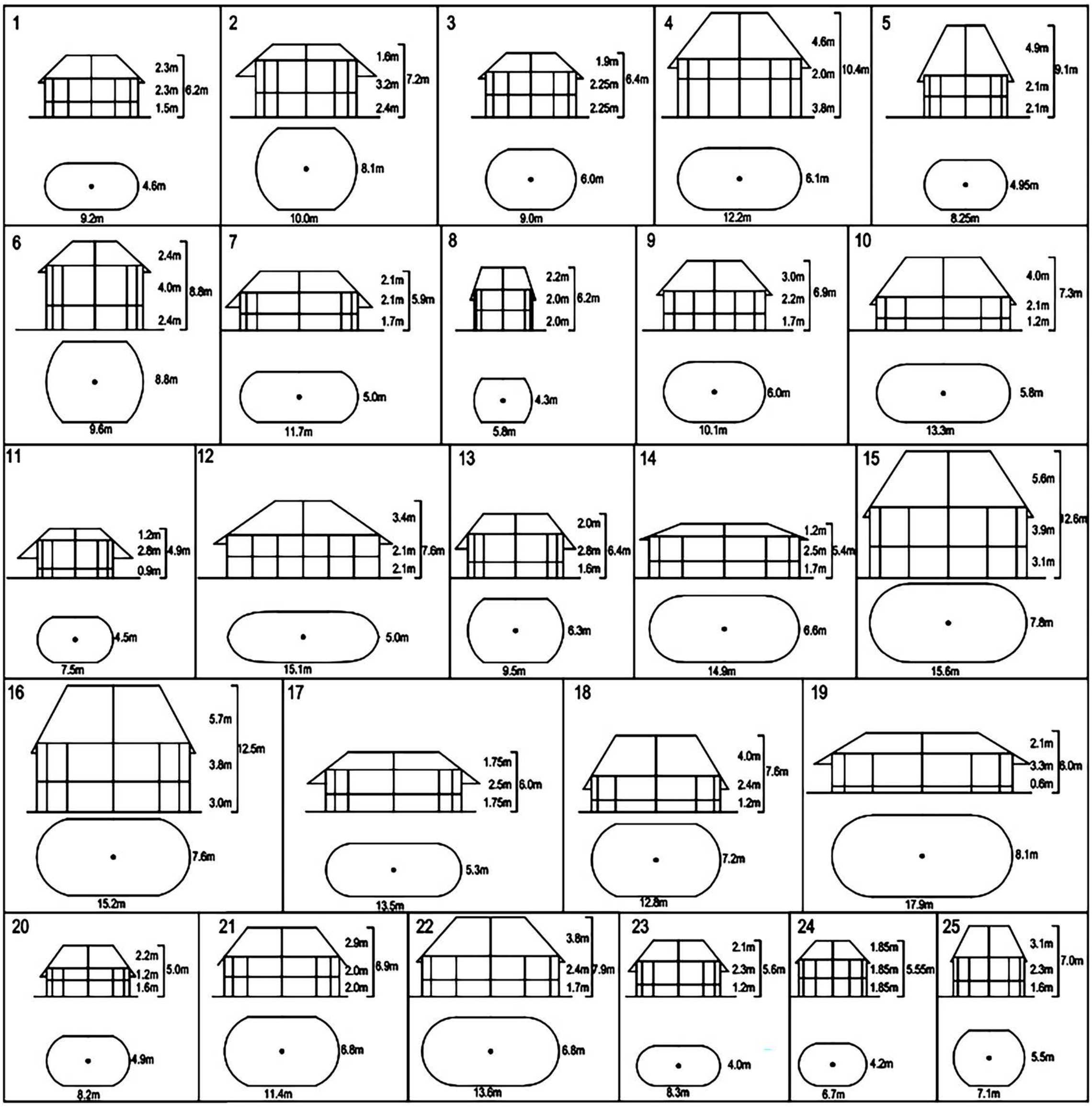


Fig 7

anthropometric ratios recorded during fieldwork. The overall scale of Guols varied depending on the individual or hamlet. The smallest recorded plan was 5.8 m × 4.3 m (Interviewee No. 8), while the largest reached 17.9 m × 8.0 m (No. 19). Building height ranged from 4.9 m (No. 11) to 12.6 m (No. 15).

Fig 7
Reconstructed Guol forms from body-based interviews

Two plans (cases Nos. 2 and 6) featured nearly equal width and length, suggesting a circular or oval layout typical of the Guol Duon type.[34] The remaining cases reflect the Guol Cho Ri Moc style, characterized by trapezoidal forms common in the central region.

Among 25 cases, 20 structures had heights ranging from 5 to 8 meters, within the normal range suggested by Akiko Iizuka and Luu Hung, who recorded typical Guol heights of 6–7 meters during the 2007–2012 period.[35] This range corresponds with a time when large timber was increasingly scarce, making lower structures more feasible. In contrast, an earlier 1965 source noted a traditional Guol height of 35 feet (10.67 m).[36] These reductions in height are thus attributable to changing material availability and village resettlement after 1973, rather than to a breakdown of the body-based units of measuring system itself. In all periods, A-1 remained the anchor unit from which height, depth, and width were multiplied. Recent measurements of three existing Guols in Doi, A Xang, and A Ka hamlets (Nam Dong district) confirmed heights of approximately 6.985 m, 6.780 m, and 5.830 m, respectively.[37]

According to Le Pichon, the height of a Guol could reach up to 12 meters, though such cases were rare. This observation aligns with the current dataset, where only three interviewees (Nos. 4, 15, and 16) reported Guol heights exceeding 12 m.[38] Floor height relative to body height also varied. Six interviewees placed the floor below their body height, while others matched or raised it higher. Those who elevated the floor cited practical purposes, such as using the subfloor space for storage. All interviewees agreed that the internal clearance from floor to beam should exceed a person's height to ensure comfortable movement within the space.

Regarding the distance from the beam to the roof, it was interpreted as roof slope. All calculated sloping angles were above 30 degrees, ranging from 31° to 72°, except in one case (No. 14) where the slope was 22°. Among them, 17 interviewees confirmed that the roof slope exceeded 45°, which supports the idea that a steep roof is essential to adapt to the rainy climate in Central Vietnam.

Table 2 presents a comparative analysis of anthropometric ratios based on responses from 25 interviewees, divided into two groups by body height: Group A (≤160 cm) and Group B (>160 cm). The analysis focuses on the relationship between the arm-span-based unit A-1, equivalent to the reference person's body height, and three principal architectural dimensions: height (H), depth (D), and width (W).

Table 2

No. of People	Average A-1 (m) ± SD	Average Height (H, m) ± SD	Ratio H/ A-1	Average Depth (D, m) ± SD	Ratio D/ A-1	Average Width (W, m) ± SD	Ratio W/ A-1
Group A – Smaller n = 13	1.53 ± 0.05	7.89 ± 2.47	**5.15**	6.32 ± 1.30	**4.13**	10.72 ± 3.06	**6.99**
Group B – Taller n = 12	1.66 ± 0.03	6.57 ± 1.24	**3.97**	5.68 ± 1.41	**3.43**	11.43 ± 3.50	**6.91**
Group (A + B) n = 25 interviewers	1.59 ± 0.07	7.26 ± 2.05	**4.56**	6.01 ± 1.37	**3.78**	11.06 ± 3.23	**6.95**

Table 2
Anthropometric ratios in vernacular architecture: correlation between the body-based unit A-1 and building dimensions

The results indicate a strong anthropometric logic underlying the traditional dimension planning of Guols. In Group A, characterized by interviewees with smaller body frames, the average A-1 was 1.53 ± 0.05 meters, while Group B, with larger body frames, had a slightly longer average A-1 of 1.66 ± 0.03 meters. Despite this physiological variation, the corresponding ratios between building dimensions and A-1 revealed a coherent design logic, emphasizing proportionality rather than absolute scale.

Specifically, the H/A-1 ratio in Group A reached 5.15, higher than the 3.97 in Group B. This suggests that individuals with smaller A-1 units constructed taller buildings in proportion to their body reference, possibly reflecting symbolic or spatial functions requiring greater interior volume. The combined average ratio across all participants was 4.56. For building depth (D), the D/A-1 ratio in Group A (4.13) also exceeded that of Group B (3.43), while the combined group yielded 3.78. This suggests a consistent tendency across groups to extend the depth dimension by approximately 3.5 to 4.0 times A-1, ensuring functional spatial balance along the longitudinal axis of the structure. Interestingly, width (W) displayed the highest proportional consistency, with W/A-1 ratios of 6.99 (Group A), 6.91 (Group B), and 6.95 overall. This finding implies that the lateral span of the Guol may have been anchored to a more fixed proportion across groups, potentially due to constraints of roofing systems, communal seating arrangements, or symbolic symmetry in the village layout. To further visualize these proportional patterns and the relationships among anthropometric units and spatial dimensions, an infographic summary of the findings is presented in Figure 8.

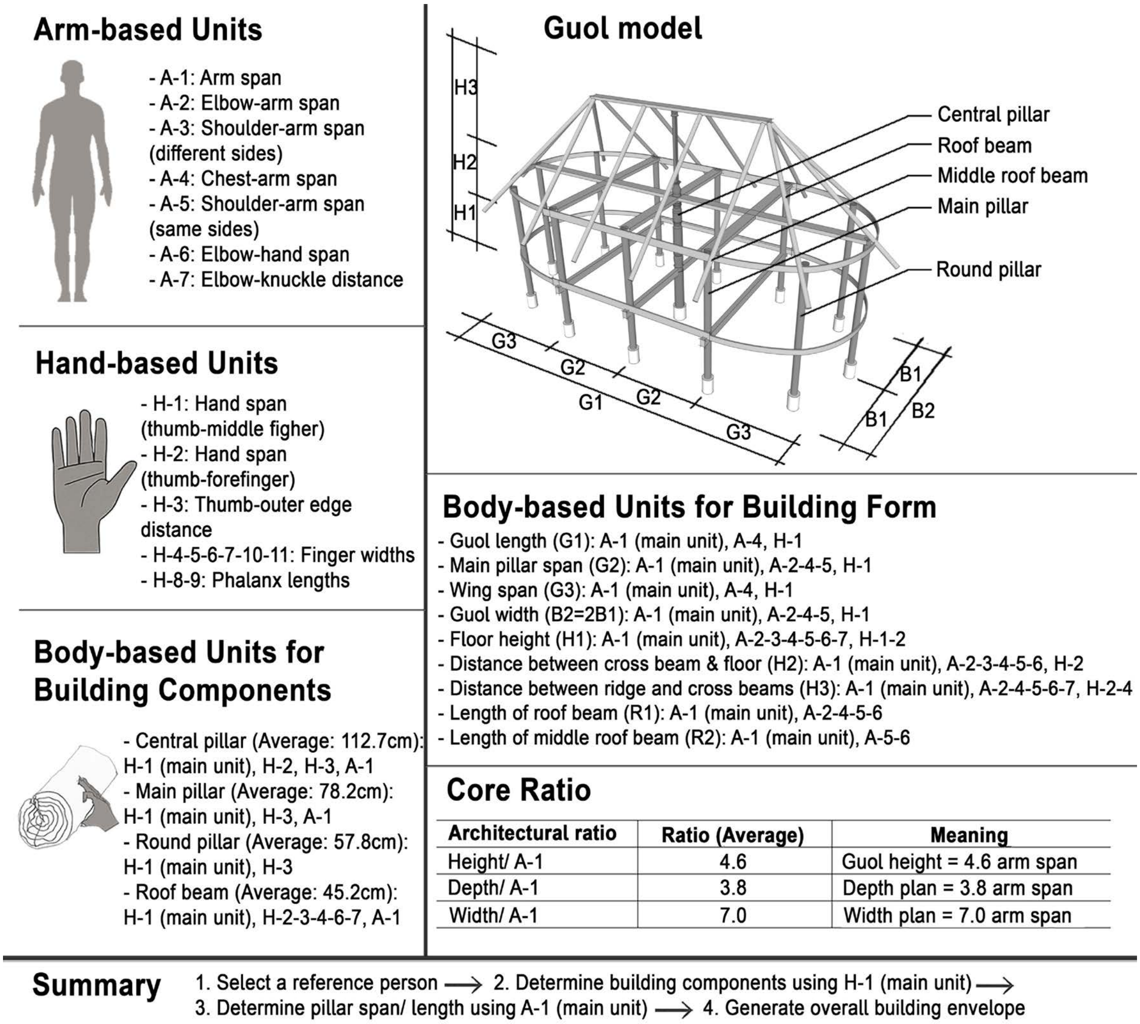


Fig 8

These patterns affirm that Katu architectural design is grounded in embodied knowledge, rather than abstract geometry. As Merleau-Ponty emphasized, the body is not merely situated in space but actively constitutes spatial perception and orientation.[39] From this perspective, the consistent use of body-based units, especially A-1 (body height) as a referential unit, illustrates how

Fig 8

Anthropometric logic in the spatial design of the Guol the builders' own bodies become the active instruments of spatial cognition and decision-making. This aligns with Ingold's anthropological view that vernacular construction is a performative process of engagement, where form emerges through material interaction and bodily memory, not predetermined plans.[40] In the case of the Katu, the observed proportional consistency, especially in the W/A-1 ratio reflects what Ingold calls "making through inhabiting", a practice in which spatial dimensions are enacted through embodied repetition and socialized craft.

This resonates with broader cultural evolution theories suggesting that body-based systems endure due to their cognitive economy and adaptive value.[41] The dimensional coherence of the Guol, as shown in Table 2, exemplifies how built form can be structured by bodily logic, bridging measurement, memory, and meaning.

In sum, the Guol exemplifies a design system that integrates bodily scale, cultural function, and construction logic in a unified whole. A-1 operates not only as a physical metric but as a conceptual anchor, embodying the convergence of measurement, experience, and identity within Katu architectural practice.

Conclusions

This study has systematically examined the body-based knowledge embedded in the indigenous construction practices of the Katu people, with a particular focus on the use of body-based units of measurement in the design and construction of Guols. By documenting 18 distinct body-based units and their applications across multiple structural elements and overall building dimensions, the research reveals a coherent and culturally embedded system of proportioning, grounded in the lived bodily experience of community members.

Findings demonstrate that unit A-1 (the span of both arms fully extended) served as the foundational metric for defining key architectural dimensions: height, depth, and width of the Guol. Across two body-type groups (n = 13 and n = 12), despite variations in physical stature, the H: A-1, D: A-1, and W: A-1 ratios maintained remarkable internal consistency (approx. 4.56, 3.78, and 6.95, respectively). This indicates that Katu builders prioritized proportional balance over absolute scale, reflecting a deeply internalized spatial logic. Importantly, the Guol's lateral width (W) exhibited the greatest proportional stability across groups, implying architectural consensus tied to communal social functions or symbolic symmetry. Conversely, greater variability in vertical (H) and longitudinal (D) dimensions suggests functional or symbolic adaptability based on builder stature or village traditions.

However, the reliance on oral recollections from elderly villagers, in the absence of surviving original structures or drawings, presents an inherent limitation. The interpretations may reflect memory-based approximations, filtered through time and cultural transition. Despite this, the convergence of multiple testimonies across 25 hamlets strengthens the study's reliability. This district-wide mapping of 18 body-based units goes beyond earlier, case-specific reconstructions and provides a reproducible proportional basis for Guol conservation. Future research should pursue comparative ethnographic studies across other indigenous groups in Southeast Asia and beyond to test the generalizability of anthropometric logic in vernacular architecture. Furthermore, digital reconstructions of Guols using body-based ratios may serve both academic and heritage preservation purposes, ensuring that this intangible knowledge is not only archived but also reactivated in architectural discourse.

Acknowledgment

The authors would like to thank 25 elder villagers, who agreed to be interviewed and provided useful information for this study. We also thank to anonymous reviewers for providing valuable comments and suggestions.

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Illustration Sources

All illustrations by the authors.

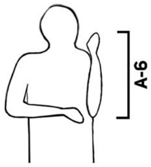
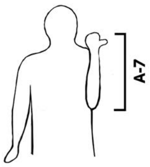
Appendix A

Description and function of the body-based units

	Unit	Description	Function
Arm based units	A-1	 Fathom of the human	This is the main unit, which is usually used to measure pillar perimeter, length of pillars, beams and other components of the house. It is also used to calculate the distance of pillar span, the height of floor and roof.
	A-2	 The distance between the tip of one bent arm and the tip of the other extended arm	This is an additional unit when unit A-1 is too long. It is often used to calculate the length of pillar, beam, and distance of pillar span.
	A-3	 The distance between the shoulder at one side and the tip of the extended arm at the other side	This is an additional unit when unit A-1 is too long. It is often used to calculate the length of pillar, beam, and distance of pillar span.
	A-4	 The distance between the chest and the tip of the extended arm	This is an additional unit when unit A-1 is too long. It is often used to calculate the length of pillar, beam, and distance of pillar span.

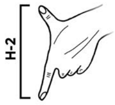
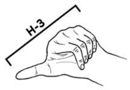
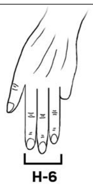
Appendix A (Continued)

Description and function of the body-based units

	Unit	Description	Function
Arm based units	A-5	 The distance between the shoulder at one side and the tip of the extended arm at the same side	This is an additional unit when unit A-1 is too long. It is often used to calculate the length of pillar, beam, and distance of pillar span.
	A-6	 The distance between the elbow and the tip of the extended hand on the same arm	This is an additional unit when unit A-1 is too short. It is often used to calculate the length of pillar, beam, and distance of pillar span.
	A-7	 The distance between the elbow and the tip of the grasped hand on the same arm	This is an additional unit when unit A-1 is too short. It is often used to calculate the length of pillar, beam, and distance of pillar span.

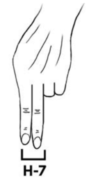
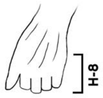
Appendix A (Continued)

Description and function of the body-based units

	Unit	Description	Function
	H-1	 Distance between the tip of the extended thumb to the tip of the middle finger on an outstretched hand	This is the main unit, which is usually used to measure pillar perimeter. It is sometimes a complementary unit to measure the length of pillars and other components of the house.
Hand based units	H-2	 Distance between the tip of the extended thumb to the tip of the forefinger on an outstretched hand	This is the main unit, which is usually used to measure pillar perimeter. It is sometimes a complementary unit to measure the length of pillars and other components of the house.
	H-3	 Distance between the tip of the extended thumb to the outer edge of the little finger on the clenched hand	This is an additional unit to measure short distance such as the distance between floor beams, woven panels, and so on.
	H-4	 Width of five fingers of the hand	This is an additional unit to measure short distance such as the distance between floor beams, woven panels, and so on.
	H-5	 Width of four fingers of the hand except for the width of the thumb	This is an additional unit to measure short distance such as the distance between floor beams, woven panels, and so on.
	H-6	 Width of three fingers, which are the forefinger, the middle finger, and the ring-finger	This is an additional unit to measure short distance such as the distance between floor beams, woven panels, and so on.

Appendix A (Continued)

Description and function of the body-based units

	Unit	Description	Function
Hand based units	H-7	 Width of the forefinger and the middle finger	This is an additional unit to measure short distance such as the distance between floor beams, woven panels, and so on.
	H-8	 Length of the upper phalanx of the middle finger	This is an additional unit to measure short distance such as the distance between floor beams, pillar span, and so on.
	H-9	 Length of the middle phalanx of the middle finger	This is an additional unit to measure short distance such as the distance between floor beams, pillar span, and so on.
	H-10	 Width of the thumb	This is an additional unit to measure short distance such as the distance between floor beams, woven panels, and so on.
	H-11	 Width of the forefinger	This is an additional unit to measure short distance such as the distance between floor beams, woven panels, and so on.

Appendix B

Units for main building components

Interview No.	Body height (cm)	Components' size							
		Round length of central pillar		Round length of main pillar		Round length of round pillar		Round length of roof beam	
		Body-based unit	Size (cm)	Body-based unit	Size (cm)	Body-based unit	Size (cm)	Body-based unit	Size (cm)
1	154	4(H-1)	80	3(H-1)	60	2.5(H-1)	50		
2	162	(A-1)	162	2/3(A-1)	108			1/2(A-1)	81
3	150	5(H-1)	92.5	4(H-1)	74			1.5÷2.5(H-1)	27.8÷46.3
4	153	6(H-1)	120	4÷5(H-1)	80÷100			2.5(H-1)	50
5	165	5(H-1)	100	4(H-1)	80	3(H-1)	60	3(H-1)	60
6	160	5(H-1)+(H-2)	121.5	4(H-1)	82.8	2(H-1)	41.4		
7	167	7(H-1)	133	4(H-1)	76	4(H-1)	76	1.5÷2(H-1)	28.5÷36
8	144	5(H-1)	85	3.5(H-1)	59.5	3.5(H-1)	59.5	1.5÷2.5(H-1)	26.3÷43.8
9	150	5(H-1)+(H-3)	105.5	4(H-1)+(H-3)	87	4(H-1)+(H-3)	87	2(H-1)	37
10	166	4(H-1)	86	3.5(H-1)	75.3			2.5(H-1)	53.8
11	150	5(H-1)	96	4(H-1)	64.8			2÷2.5(H-1)	38.4÷48
12	168	6(H-1)	120	5(H-1)	100	4(H-1)	80	D=(H-2)	53.4
13	158	D=2(H-1)	128.7	3(H-1)	61.5	2.5(H-1)	51.3	D=(H-2)÷(H-3)	53.4÷42.4

Appendix B (Continued)

Units for main building components

		Body height (cm)	Components' size							
			Round length of central pillar		Round length of main pillar		Round length of round pillar		Round length of roof beam	
			Body-based unit	Size (cm)	Body-based unit	Size (cm)	Body-based unit	Size (cm)	Body-based unit	Size (cm)
Interview No.	14	166	4(H-1)	80	3÷3.5(H-1)	60-70	2÷2.5(H-1)	40÷50	2÷2.5(H-1)	40÷50
	15	156	D=3(H-1)	174.3	D=2.5(H-1)	145.2	D=(H-1)	58.1	D=(H-1)	58.1
	16	152	D=3(H-1)	169.6	D=2.5(H-1)	141.3	D=(H-1)	56.5	D=(H-1)÷(H-2)	56.5÷50.2
	17	150	4÷5(H-1)	76÷95	2.5(H-1)	47.5	2(H-1)	38	2(H-2)÷2(H-1)	33÷38
	18	160	6(H-1)	102	4(H-1)	68	4(H-1)	68	2.5(H-1)÷2(H-1) +(H-6)	
	19	163	D=2(H-1)+(H-2)	163.3	4(H-1)	72	2.5(H-1)	45	D=(H-4)÷(H-2)	29.8÷50.2
	20	164	5(H-1)	87.5	4.5(H-1)	78.8	4(H-1)	70	2(H-1)÷2(H-1) +(H-7)	35÷39
	21	158	(A-1)+(H-2)	173	3.5(H-1)	66.5	3(H-1)	57	2÷2.5(H-1)	36÷47.5
	22	170	6(H-1)	120	4(H-1)	80	4(H-1)	80	2(H-1)÷2(H-1)+(H-7)	40÷43.8
	23	166	4(H-1)	72	3.5(H-1)	63	3(H-1)	54	2(H-1)÷2(H-2)	36÷30
	24	168	4(H-1)	76	3(H-1)	57	2.5(H-1)	47.5	2(H-2)	38
	25	157	5(H-1)	85	3(H-1)	51	3(H-1)	51	2.5(H-1)	42.5

Appendix C

Units' application for building form

No.		Floor plan				Height plan								
		B2=2B1	G1	G2	G3	H1	H2	H3	R1	R2	R3	U1	U2	F1
Interview No.	1	3(A-1)	6(A-1)	1.5(A-1)	1.5(A-1)	(A-1)	1.5(A-1)	1.5(A-1)	2.5(A-1)			(A-4)	(A-4)	0.65m
	2	5(A-1)	10m	(A-1) +(A-2)		1.5(A-1)	2(A-1)	4(A-2) -2(A-1)	4(A-1)		(A-5)	(A-5)	(A-5)	(A-5)
	3	4(A-1)		1.5(A-1)		(A-1) +(A-4)	(A-1) +(A-4)	(A-1) +(A-6)	2.5(A-1)	2(A-1)		(A-4)	(A-5)	
	4	4(A-1)	8(A-1)	2(A-1)	2(A-1)	2.5(A-1)	(A-1) +(A-6)	3(A-1)	3(A-1)		(A-6)	(A-5)	(A-5)	
	5	3(A-1)	5(A-1)	1.5(A-1)	(A-1)	(A-1) +(A-6)	(A-1) +(A-6)	3(A-1)	3(A-1)	2.5(A-1)	(A-5)	(A-4)	(A-5)	
	6	5(A-1)	6(A-1)	2(A-1)	(A-1)	1.5(A-1)	2.5(A-1)	1.5(A-1)	3(A-1)		(A-4)	(A-4)	(A-5)	
	7	3(A-1)	7(A-1)	2.5(A-1)	(A-1)	(A-1)	(A-1) +(A-6)	(A-1) +(A-6)	2(A-1) +(A-2)	2(A-1) +(A-6)	(A-5) or (A-6)	(A-4)	(A-4)	(A-1)
	8	3(A-1)	4(A-1)	(A-1) +(A-4)	(A-1) +(A-4)	(A-1) +(A-5)	(A-1) +(A-5)		3(A-1)	3(A-1)	(A-2)	(A-5)	(A-5)	0.53m
	9	2(A-1) or 2(A-1) +(A-4)		(A-1) +(A-5)		(A-1) +(H-1)	(A-1) +(A-4)	2(A-1) -(A-4)	3(A-1)	3(A-1)	(A-4)	(A-4)	(A-4)	
	10	2(A-1) +2(A-2)	8(A-1)			4(A-7)	(A-1) +(A-6)		3.5(A-1)			(A-6)	(A-6)	
	11	3(A-1)	5(A-1)	1.5(A-1)	(A-1)	(A-3)	2.5(A-1) -(A-3)	1.5(A-1) -(A-2)	3(A-1)		5(H-5)	(A-5)	(A-6)	
	12	3(A-1)	9(A-1)	1.5(A-1)	3(A-1)	(A-1) +(A-6)	(A-1) +(A-6)	2(A-1)			(A-5)	(A-1)- (A-6)	(A-4)	4(H-1) +(H-5)
	13	4(A-1)	6(A-1)	2(A-1)	(A-1)	(A-1)	(A-1) +(A-2)	(A-1) +(A-6)	3.5(A-1)		(A-5)	(A-4)	(A-2)	(A-1) +(A-2)

Appendix C (Continued)

Units' application for building form

No.		Floor plan				Height plan								
		B2=2B1	G1	G2	G3	H1	H2	H3	R1	R2	R3	U1	U2	F1
Interview No.	14	4(A-1)	9(A-1)			(A-1)	(A-1) +(A-4)	2(A-1)	2.5(A-1)	2.5(A-1)	(A-6)	(A-5)	(A-6)	
	15	5(A-1)	10(A-1)	2.5(A-1)	2.5(A-1)	2(A-1)	2.5(A-1)		5(A-1)		(A-2)	(A-5)	(A-5)	2.5(A-1)
	16	5(A-1)	10(A-1)	3(A-1)	2(A-1)	2(A-1)	2.5(A-1)		5(A-1)		(A-2)	(A-5)	(A-5)	
	17	3(A-1) +(A-4)	9(A-1)	3(A-1)	1.5(A-1)	(A-1) +(A-7)	(A-1) +(A-3)	(A-1)+(A-6) or (A-1)+(A-7)	3(A-1) +(A-5)		(A-3)	(A-5)	(A-5)	
	18	4.5(A-1)	7(A-1) +2(A-4)	2.5(A-1)	(A-1) +(A-4)	(A-2)	1.5(A-1)	2.5(A-1)	2(A-1) +(A-6)		(A-2)	(A-4)	(A-4)	1m
	19	5(A-1)	11(A-1)	3(A-1)	2.5(A-1)	(A-5)	2(A-1)	(A-1) +(A-6)			(A-2)	(A-4)	(A-4)	(A-1)+(A-6)
	20	3(A-1)	5(A-1)	1.5(A-1)	(A-1)	(A-2)	(A-1) +(A-2)	(A-1)+(A-5)	3(A-1)		(A-3)	(A-4)	(A-4)	Equal nest
	21	30(H-1)	60(H-1)	15(H-1)	15(H-1)	6(H-1) → 10(H-1)	(A-1) +(A-6)	(A-1) +(A-2)	3(A-1)		3(H-1)	(A-2)	(A-2)	
	22	4(A-1)	8(A-1)	2(A-1)	2(A-1)	(A-1)	(A-1) +(A-5)	2(A-1) +(A-6)	3(A-1) +(A-4)		(A-5)	(A-5)	(A-5)	
	23	2(A-1) +(A-5)	5(A-1)	1.5(A-1)	(A-1)	(A-2)	(A-1) +(A-5)	(A-1) +(A-6)	2(A-1) +(A-5)	2(A-1) +(A-5)	(A-5)	(A-4)	(A-4)	Equal nest
	24	2(A-1) +(A-4)	4(A-1)	(A-1)	(A-1)	(A-1) +(H-2)	(A-1) +(H-2)	(A-1) +(H-2)	3(A-1)	3(A-1)	(A-6)	(A-5)	(A-5)	
	25	2(A-1) +2(A-2)	4.5(A-1)	1.25(A-1)	(A-1)	(A-1)	(A-1)+(A-4)	2(A-1)	3(A-1)			0.5m	0.5m	(A-2)