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## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

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**ABSTRACT:** In several traditional villages, there are still traditional houses that are used by the community as residences. In the past, there were no room dividers in traditional houses; now, residents apply the privacy of each room so that room dividers are added to traditional houses, and there are additional rooms as the need for activities also increases. These changes in activities and use of space have also caused changes in the anthropometry of traditional houses, which are being reused as residences today. So, this research aims to determine whether the spatial pattern transformation in the Sitolumbea Traditional House meets the space standards for simple residences in Indonesia. This research was carried out by directly observing 1 Original Traditional House and 2 Sitolumbea Traditional Houses, which have been transformed to determine changes in anthropometry and the size of the space used. Then, it is compared with the standard size of residential space in Indonesia. Based on the results of the research conducted, the dimensions of the bedroom, bathroom, and laundry room do not meet the standard size of residential houses in Indonesia. Meanwhile, the living room and kitchen require wider dimensions.

**KEYWORDS-** Batak Traditional house, Sitolumbea, Anthropometry, Transformation, Simple residences

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### I. INTRODUCTION

Traditional houses have specific anthropometric applications by original customs. Data collection on anthropometric measurements in original traditional houses is needed to determine how humans adapt each activity in traditional houses and how to adapt them in the present. Initially, Batak traditional houses were mostly used at night to rest after being active throughout the day. However, in its current use, there is more activity in the house due to the increased duration of use during the day and at night. Apart from that, there are changes in increasingly modern lifestyles that change the traditional pattern of communal living to become more private (only inhabited by one family) (Prasetyo, 2014), so there is a need for more private spaces. The modernization of urban living standards also influences the transformation of traditional houses, the addition of household furniture, and new spaces (Hanan, 2012), so some traditional houses are undergoing expansion. The expansion can be placed behind and on the side. In the original building, there were changes in the division of spaces with partitions.

In connection with the above, the researcher aims to discover the anthropometry of traditional Batak houses and how their transformation corresponds to lifestyle and living patterns changes. This research also aims to assess whether the changed/increased spaces in traditional houses used as residences currently meet anthropometric standards for simple residential buildings. The results of this research can be a reference for the amount of comfortable space for the Sitolumbea Traditional House, which is still used as a residence today based on anthropometric considerations.

### II. LITERATURE REVIEW

Anthropometry is a science that studies measurements based on the human body's size to formulate length differences for each individual or group. Anthropometry is divided into 2 (Littlefield, 2008): the space needed when humans move (dynamic anthropometry) and when they don't move (static anthropometry). There are two classes of dynamic measurements: a) Measuring skill level as an approach to understanding the mechanical conditions of activity, and b) Measuring the range of space needed when working. The space size and the range needed for each group are different.

#### A. Anthropometry in Standard-Type Houses

Anthropometric standards for standard-type houses refer to literature sources written by Prasetyo and Enggar Sari and published by the Ministry of Public Works and Housing (PUPR) Research and Development Center. The anthropometric standards in the book are based on Research on simple dwellings (standard-type houses) in Indonesia. This Research collects anthropometric data by measuring the body dimensions of occupants in buildings—measurement of body dimensions in static anthropometry, namely sitting and standing positions. Anthropometry at home includes sitting/gathering activities, eating, sleeping, cooking, bathing and

## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

defecating, washing clothes, climbing stairs, and entering the house. These are standard room dimensions for simple dwellings according to the PUPR Research and Development Center, as seen in Table 1:

**Table 1. Minimum Space Area in Standard Type Houses**

<i>No.</i>	<i>Room</i>	<i>Length (m)</i>	<i>Width (m)</i>	<i>Area</i>
1	Guest room	3.84	3.73	14.32
2	Living room	4.11	3.42	14.06
3	Dining room (on the floor)	3.58	3.27	11.71
4	Dining room (with table)	3.39	3.27	11.09
5	Master Bedroom	3.72	3.43	12.76
6	Bedroom	2.9	2.41	6.99
7	Kitchen	3.42	1.97	6.74
8	Bathroom	1.5	1.37	2.06
9	Laundry room	1.89	1.49	2.82

### B. The Sitolumbea Batak House

Sitolumbea Traditional House was a permanent residence. This type of Batak Toba house was previously owned by a king and was inhabited by 4-6 families. The Sitolumbea Batak house has these characteristics: the stairs are under the house, a loft and a balcony under the roof, and the entrance is from under the house. It is the most complete traditional house (Domenig, 2003).

The Sitolumbea Traditional House's stairs are installed in the front part of the house (as the entrance to the house) and back part. The stairs are located between the front and back pillars supporting the house. Batak household stairs consist of an odd number of steps (Napitupulu, 1997). According to Batak's belief, there are two types of numbers: even and odd. Even numbers are numbers humans cannot see, while odd numbers are human numbers. The number of steps has social meaning. In the Toba Batak community, the house with the odd number of steps is the house of a free person, such as a raja Huta or a clan that opens a village. Meanwhile, a house with an even number of steps indicates that the people who live in the house are enslaved people or descendants of enslaved people.

The floor is laid on round wooden beams at close spacing, at a height of approximately 1.7 meters from the ground (Sargeant and Saleh, 1973). Batak house floor consists of three layers. After the tustus, which is the particular stake at the very top, there is the gulagulang. Gulagulang is logs arranged across the floor. A plank barrier overlays the gulagulang. After the board hitch, there are sheets of floorboards. The first-floor section is where most family activities are in the house. Daily gathering activities are carried out at home by sitting and sleeping on the floor and cooking activities. The original traditional Batak house had no furniture for sitting and sleeping; it was only for cooking. Bathing activities are carried out in the river because the original Batak traditional house did not have a bathroom.

The lofts are located above the floor. Its function is as a place to store goods and a place to put 'offerings' to the ancestors. At certain times when traditional ceremonies are held, which are celebrated by the villagers, this loft is a place for musicians to play their musical instruments. In the Sitolumbea Batak traditional house, there are two lofts at the front and the back. This front loft is used for offerings to the ancestors and a place for musicians during a customary event. The front loft has a wider dimension than the back loft. It has a width of approximately 2.3 meters, with a length the size of the Sitolumbea Batak traditional house, which is 6.5 meters. This front loft is accessed via the ground floor by climbing a ladder installed perpendicularly (without a tilt angle) at a height 2.2 meters from the ground floor, enough for one adult to stand under it. The staircase leading to the front loft is 0.86 m wide, enough for one adult to climb it. The distance between the loft and the roof is enough for adults to stand on it almost without bending their heads, which is 1.8 meters to 2.89 meters. Unlike the front loft, the back loft is used only for storing things, not for climbing or doing activities. So that the width is narrower than the front loft, the width of the back loft is 1.45 meters. Items stored are crops, food supplies, and cooking utensils. The height of the back loft is the same as the back loft, which is about 2.2 meters, so adults can still pass under it if they want to leave through the back door.

## III. RESULT AND DISCUSSION

This research took four objects of the Sitolumbea Traditional House. The first study object maintains its original spatial structure, while the other two objects are Traditional Houses that have been transformed. The location of the study object was North Tapanuli Regency, North Sumatra Province, Indonesia.

### A. Original Traditional House (House 1)

This House has not undergone any changes either in its exterior or interior. In this traditional Batak house, there is still no partition for a room divider. However, because it has not been used for a long time, the conditions in this House are not maintained. The original furniture contained in this House has also been damaged. It is shown in Fig. 1 shows that there is no room partition.

## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

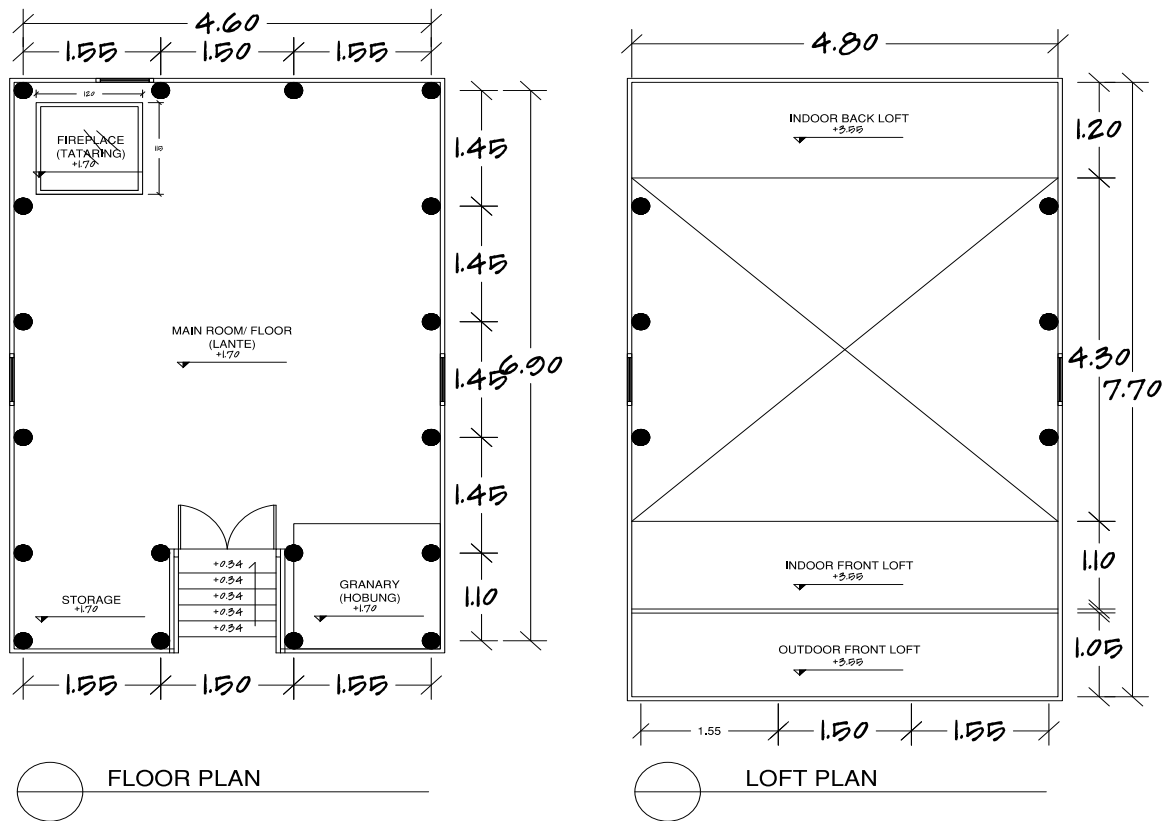


Figure 1. House 1's Floor Plan

The following are anthropometric considerations regarding room size in traditional House 1 (Table 2,3,4). This table has a column for design considerations based on the position of the human body. Column 4 (Dimensions) is a consideration based on anthropometry, while column 5 (Existing Dimensions) is the condition of the study object. Table 2 and 3 shows the dimensions for in-home gathering, eating, and sleeping activities. Gathering, eating, and sleeping activities occur in the same room at different times.

Table 2. Anthropometry of Entertaining Guests, Gathering, and Eating in House 1

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Overall Serving Width	Arm Reach	148	148
2	Individual Serving Width	Shoulder	48	48
3	Space between Serving and Person	Body depth	27.5	30
4	Sitting Width	Buttock popliteal length	49	49
5	Person Reaches to Serving	Thumb tip reach	68	80
6	Backrest Height	Sitting Height	86	86
7	Backrest to Serving	Buttock leg length	105	105
8	Circulation	Elbow range	76	106

Table 3. Anthropometry of Sleeping Activity in House 1

No.	Design Considerations	Positions	Dimensions (m)	Existing Dimensions (cm)
1	Bed Height	Popliteal height	38	0
2	Circulation	Shoulder	48	60
3	Mats Width	Buttock popliteal length	49	76
4	Mats Length	Stature	168	180

## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

**Table 4. Anthropometry of House 1 Cooking Activity in Fireplace**

No.	Design Considerations	Positions	Dimensions (m)	Existing Dimensions (cm)
1	Fireplace Length	Shoulder	40	120
2	Space to Fireplace	Body depth	25	30
3	Fireplace Width	Thumb tip reach	62	115
	Firewood Height	Elbow rest height	24	30
4	Squatting Work Area	Buttock knee length	56	55

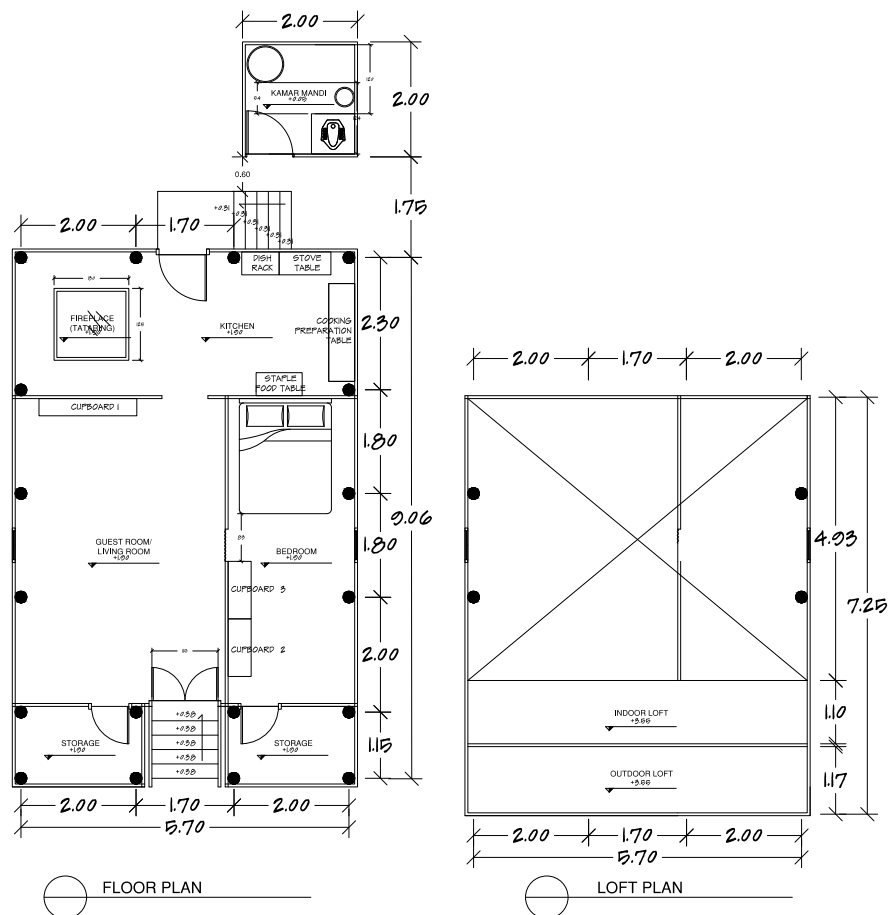
From anthropometric considerations in House 1, Table 5 compares the required space, available space, and minimum standards from Table 1. Based on Table 5, the available space in House 1 is still sufficient. Only gathering, eating, and sleeping activities cannot be done simultaneously because they use the same room.

**Table 5. Needs, Existing Room Area, and Minimal Standard in House 1**

No.	Rooms	Needs (m <sup>2</sup> )	Existing Room Area (m <sup>2</sup> )	Minimal Standard (m <sup>2</sup> )
1	Guest room/ Living room/ Dining Room/ Bedroom	17.22	20.01	14.32
2	Kitchen	2.82	6.67	6.74

### B. Transformed Traditional House 2 (House 2)

This traditional house has been transformed into changing activities. However, there are changes. The change is in adding a partition in the living room, which is used as a bedroom. And there is also a partition to separate the living room from the kitchen room. There is an additional bathroom behind the main building for bathing and washing clothes. As seen in Figure 2, there is a transformation in the space layout from the original traditional house.



**Figure 2. House 2's Floor Plan**

House 2 has been transformed by adding rooms from its original condition. Sleeping activities are no longer in the same room as eating and gathering activities. There is already a separate room, which is the result of dividing the shared space into its original

## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

condition. Anthropometric considerations for sleeping activities are shown in Table 7. Then, there is also the addition of a separate bathroom from the main building, which is located at the back of the house. Washing dishes and clothes is done in the bathroom. Bathing and washing activities are shown in Tables 10 and 11. Table 6-11 shows the anthropometric considerations for each room in house 2.

**Table 6. Anthropometry of Entertaining Guests, Gathering, and Eating in House 2**

<i>No.</i>	<i>Design Considerations</i>	<i>Positions</i>	<i>Dimensions (cm)</i>	<i>Existing Dimensions (cm)</i>
1	Overall Serving Width	Arm Reach	146	146
2	Individual Serving Width	Shoulder	39	39
3	Space between Serving and Person	Body depth	29	30
4	Sitting Width	Buttock popliteal length	48.5	48.5
5	Person reach to Serving	Thumb tip reach	65	73
6	Backrest Height	Sitting Height	80	80
7	Backrest to Serving	Buttock leg length	102	102
8	Circulation	Elbow range	73	103

**Table 7. Anthropometry of Sleeping Activity in House 2**

<i>No.</i>	<i>Design Considerations</i>	<i>Positions</i>	<i>Dimensions (cm)</i>	<i>Existing Dimensions (cm)</i>
1	Bed Height	Popliteal height	38	45
2	Circulation	Shoulder	39	83
3	Bed Width	Buttock popliteal length	48.5	160
4	Cupboard Width	Thumb tip reach	65	40
5	Cupboard Height	Vertical Grip Reach	181	160
6	Squatting Work Area	Buttock knee length	54	100
7	Bed Length	Stature	158	200

**Table 8. Anthropometry of House 2 Cooking Activity in Fireplace**

<i>No.</i>	<i>Design Considerations</i>	<i>Positions</i>	<i>Dimensions (cm)</i>	<i>Existing Dimensions (cm)</i>
1	Fireplace Length	Shoulder	39	130
2	Space to Fireplace	Body depth	29	31
3	Fireplace Width	Thumb tip reach	65	125
4	Firewood Height	Elbow rest height	23	29
5	Squatting Work Area	Buttock knee length	54	55

**Table 9. Anthropometry of House 2 Cooking Activity in The Kitchen**

<i>No.</i>	<i>Design Considerations</i>	<i>Positions</i>	<i>Dimensions (cm)</i>	<i>Existing Dimensions (cm)</i>
1	Kitchen Table Height	Elbow Height	90	55
2	Standing Work Area	Body depth	29	85
3	Circulation	Shoulder	39	85
4	Squatting Work Area	Buttock knee length	54	85
5	Cooking, Washing, Mixing work areas	Arm Reach	146	170
6	Top Cabinet Height	Eye height standing	152.0	130
7	Table Width	Thumb tip reach	65	45
8	Stove Top Height	Elbow Height-Stove Height	78	60

## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

**Table 10. Anthropometry of Bathing and Toilet Activities in House 2**

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Faucet Height	Hand height	70	76
2	Bucket Width	Thumb tip reach	65	65
3	Bucket Height	Hand height	70	30
4	Closet Width	Shoulder	39	70
5	Maintenance Work area	Buttock knee length	54	140
6	Dress up Work area	Arm reach	146	200
7	Mirror Height	Eye height standing	152.0	-
8	Closet Work area	Elbow range	73	70
9	Closet Height	Lifted leg	20	15
10	Closet Length	Buttock popliteal length	38.9	70

**Table 11. Anthropometry of Laundry and Washing The Dishes in House 2**

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Space between Bucket and Circulation	Body depth	29	54
2	Circulation	Shoulder	39	54
3	Squatting Work Area	Buttock knee length	54	54
4	Furniture Space	Arm reach	146	135
5	Reach to the Bucket	Thumb tip reach	65	65
6	Walk in carrying Bucket of Clothes	Elbow range	73	125
7	Bucket Height	Elbow rest height + small bench height	43	30

From anthropometric considerations in House 2, Table 12 compares space required, available space, and minimum standards from Table 1. As seen on Table 12, the available space in House 2 is still sufficient. Only gathering and eating activities can be done at different times because they use the same room. Washing dishes and clothes should be done separately from the bathroom for hygiene purposes.

**Table 12. Needs, Existing Room Area, and Minimal Standard in House 2**

No.	Rooms	Needs (m <sup>2</sup> )	Existing Room Area (m <sup>2</sup> )	Minimal Standard (m <sup>2</sup> )
1	Guest room/ Living Room/ Dining Room	19.38	20.72	14.32
2	Bedroom	9.50	11.2	6.99
3	Fireplace for Cooking	3.38	4.60	-
4	Kitchen	8.51	8.51	6.74
5	Bathroom	2.81	4	2.06
6	Laundry & Washing the Dishes Area	2.31	2.4	2.61

### C. Transformed Traditional House 3 (House 3)

This house has also been transformed. Changes occurred in partitioning the main room, which is used as the bedroom. House 3 only has one bedroom with dimensions of 1.9 x 1.9 m; in this bedroom, there is only one mattress/mattress without a bed, and there is no other furniture. The bedroom is used by the husband and wife who own the house. The mattress in this bedroom measures 140 x 200 cm and leaves a side passage to leave the room. This room also does not have a door because the room is narrow, so there is only a curtain to cover the room's opening. The bedroom layout can be seen in Figure 3. In addition, there is rice storage, which is used as a table for placing some household items. Receiving guests, gathering, and eating activities are carried out in the Living Room/Family Room, which was previously the main room. The attic is no longer used because of the age of the old building, so the wood in that area has started to rot. Inside the house, there is also an additional kitchen space. In the kitchen room of House 3, there is a lot of furniture, namely: kitchen table, side dish cupboard, stove table, grocery cupboard, plate rack, water bucket table, and shoe rack are also placed in the kitchen room.

## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

The kitchen table is used to prepare food concoctions before cooking and as a place for kitchen furniture such as rice cookers and freshly cooked side dishes. It is sufficient based on the size, height, and width of the kitchen table. The stove table also has an appropriate height, namely 80 cm. Apart from the kitchen table and stove table, there is a water bucket table. Because the bathroom is outside and downstairs, the water used for cooking is stored in a container/bucket. Even though they both carry out their activities standing, the height of this table is much lower than other tables in the kitchen. Still, because the bucket where the water is stored is relatively high, the size of this table is appropriate to the size of the user. The position of the stairs and the door at the back were moved to the side. This house is only inhabited daily by a husband and wife. Here is a picture of the floor plan of House 3 (Figure 3):

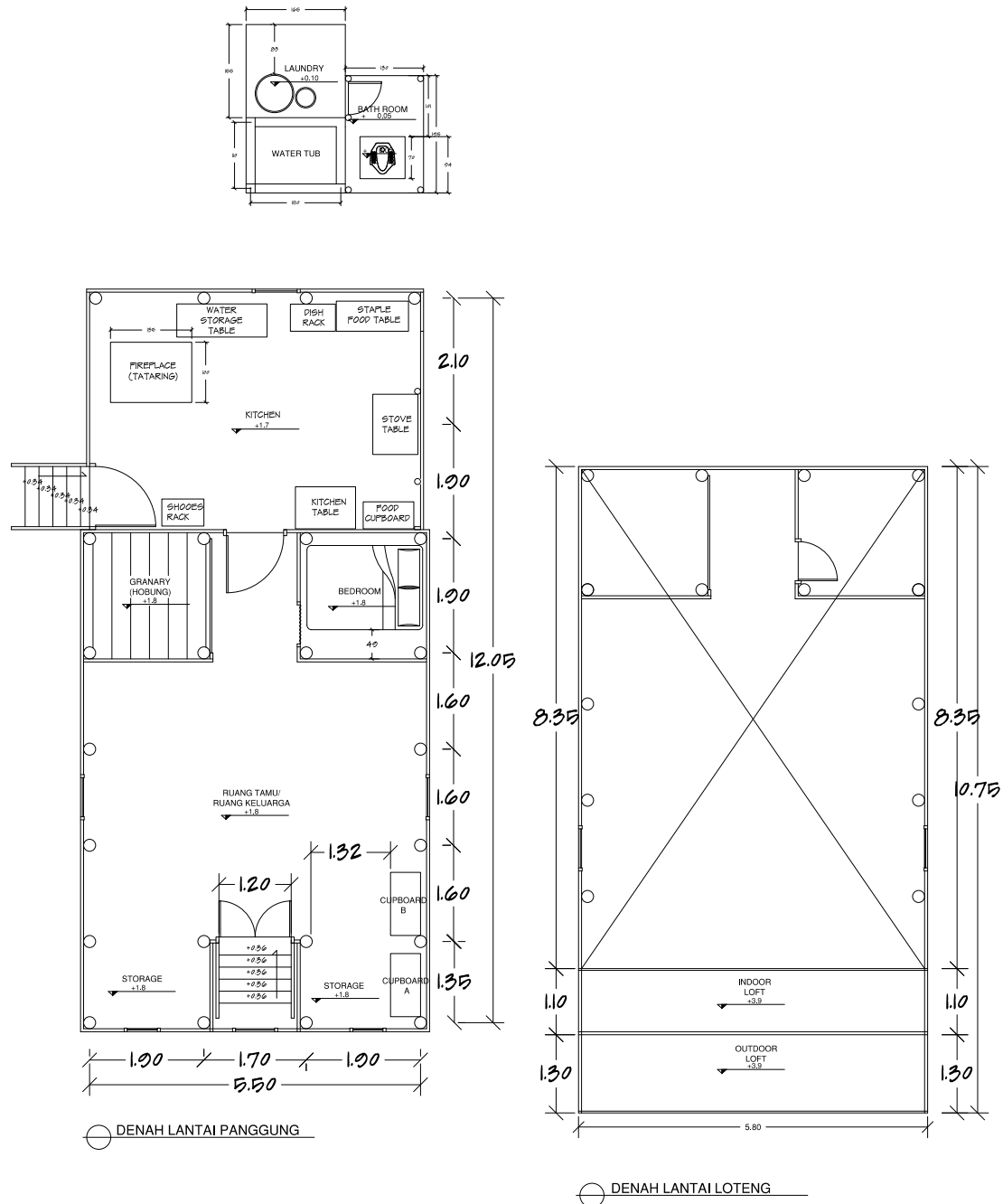


Figure 3. House 3's Floor Plan

Washing dishes and laundry activities are separate from the bathroom but are still done outside the house. Behind the main building, a bathroom is added, directly adjacent to the clothes and dishwashing room. Apart from that, there is a tank that is quite large as a water reservoir with dimensions of 1.1 m x 1.5 m x 1.4 m. The bathroom in House 3 is behind the main building, and there is only a side staircase to access the bathroom. So, the circulation is quite circular because the stairs that used to be at the back have been moved to the side. The bathroom in House 3 was built very simply using wooden poles cut directly from trees; the walls still use garments, and the roof is covered with zinc material. The bathroom has only a closet, a bucket for showering, and a

## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

toilet. The bathroom layout can be seen in Figure 3. Anthropometric considerations for each activity in house three can be seen in tables 13-18.

**Table 13. Anthropometry of Entertaining Guest, Gathering, and Eating in House 3**

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Overall Serving Width	Arm Reach	152	152
2	Individual Serving Width	Shoulder	45	45
3	Space between Serving and Person	Body depth	28	30
4	Sitting Width	Buttock popliteal length	49	49
5	Person reach to Serving	Thumb tip reach	67	76
6	Backrest Height	Sitting Height	84	84
7	Backrest to Serving	Buttock leg length	102	102
8	Circulation	Elbow range	82	112

**Table 14. Anthropometry of Sleeping Activity in House 3**

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Mattress Height	Popliteal height	39	10
2	Circulation	Shoulder	45	49
3	Mattress Width	Buttock popliteal length	49	140
4	Mattress Length	Stature	165	200

**Table 15. Anthropometry Of House 3 Cooking Activity in Fireplace**

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Fireplace Length	Shoulder	45	135
2	Space to Fireplace	Body depth	28	34
3	Fireplace Width	Thumb tip reach	67	100
4	Firewood Height	Elbow rest height	24	29
5	Squatting Work Area	Buttock knee length	56	57

**Table 16. Anthropometry of House 3 Cooking Activity in The Kitchen**

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Kitchen Table Height	Elbow Height	92	80
2	Standing Work Area	Body depth	28	100
3	Circulation	Shoulder	45	100
4	Squatting Work Area	Buttock knee length	56	100
5	Cooking, Washing, Mixing work areas	Arm Reach	147.5	100
6	Table Width	Thumb tip reach	67	75
7	Stove Top Height	Elbow Height-Stove Height	80	80
8	Stove Table Width	Thumb tip reach	67	75
9	Top Cabinet Height	Eye height standing	155.0	195
10	Water Storage Table Height	Elbow Height	92	60
11	Water Storage Table Width	Thumb tip reach	67	55

**Table 17. Anthropometry of Bathing and Toilet Activities in House 3**

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Faucet Height	Hand height	73	90
2	Bucket Width	Thumb tip reach	67	65
3	Bucket Height	Hand height	73	30
4	Closet Width	Shoulder	39	70
5	Maintenance Work area	Buttock knee length	56	94
6	Dress up Work area	Arm reach	147.5	130
7	Mirror Height	Eye height standing	152.0	-



## Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation

8	Closet Work area	Elbow range	82	130
9	Closet Height	Lifted leg	20	10
10	Closet Length	Buttock popliteal length	49	70

**Table 18. Anthropometry of Laundry And Washing The Dishes in House 3**

No.	Design Considerations	Positions	Dimensions (cm)	Existing Dimensions (cm)
1	Space between Bucket and Circulation	Body depth	28	56
2	Circulation	Shoulder	45	83
3	Squatting Work Area	Buttock knee length	56	83
4	Furniture Space	Arm reach	147.5	110
5	Reach to the Bucket	Thumb tip reach	67	67
6	Walk in carrying Bucket of Clothes	Elbow range	82	165
7	Bucket Height	Elbow rest height + small bench height	41	30

From anthropometric considerations in House 3, Table 19 compares space needed, available space, and minimum standards from Table 1. Table 19 shows the available space in House 3 is still sufficient except for the bedroom. The bedroom only has one bed and no other furniture, such as a wardrobe, so the wardrobe is placed in the Living Room. In House 3, the need to receive guests, family gatherings, and eat is still separate in one room. The laundry room's size is slightly below standard but still by the user's anthropometric size.

**Table 19. Needs, Existing Room Area, and Minimal Standard in House 3**

No.	Rooms	Needs (m <sup>2</sup> )	Existing Room Area (m <sup>2</sup> )	Minimal Standard (m <sup>2</sup> )
1	Guest room/ Living Room/ Dining Room	19.86	26.40	14.32
2	Bedroom	7.55	3.61	12.76
3	Fireplace for Cooking	3.15	3.42	-
4	Kitchen	14.4	14.4	6.74
5	Bathroom	2.07	2.54	2.06
6	Laundry & Washing the Dishes Area	2.48	2.56	2.61

## CONCLUSIONS

In the original Sitolumbea Batak House, there were no activities for bathing, washing clothes or washing cooking utensils. For storage of household goods, the space in the attic is used, because there is no furniture in the *lante* area. The activities of receiving guests, gathering, eating and sleeping are carried out in the main room alternately, because there is no room divider to divide the space. Activities of gathering and receiving guests are also still carried out on the floor, sitting cross-legged or stretching your legs forward, because there are no chairs or tables. Sleep activities are carried out directly on the floor with mats, without any bed furniture. The cooking activity uses a fireplace/arrangement with many squatting body positions in preparing food mixes, as well as in the cooking process. Meanwhile, the transformed house has started to make partitions to divide rooms, so there are sleeping activities in a separate rooms. However, of the two houses, only 1 house has a standard bedroom size. In the house that has been transformed, a bathroom and laundry room have also been made so that bathing and washing activities are accommodated at home. The following is a recommendation for the minimum room size for the Sitolumbea Traditional House used as a residence:

**Table 20. Needs, Existing Room Area, and Minimal Standard in House 3**

No.	Rooms	Length (m)	Width (m)	Area (m <sup>2</sup> )
1	Guest room/ Living Room/ Dining Room	5.60	3.61	20.22
2	Master Bedroom	3.72	3.43	12.76
3	Bedroom	2.90	2.41	6.99
4	Fireplace for Cooking	2.30	2.00	4.60
5	Kitchen	4.00	3.60	14.40
6	Bathroom	1.50	1.37	2.06
7	Laundry & Washing the Dishes Area	1.75	1.49	2.61

## **Anthropometry in the Sitolumbea Toba Batak Traditional House and its Transformation**

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