Civil Engineering and Architecture 10(3): 800-815, 2022 http://www.hrpub.org
DOI: 10.13189/cea.2022.100305

Community Response to Thermal and Its Influence to Outdoor Use

Idawarni Asmal[1,*], Baharuddin Hamzah[1], Happy Ratna[2]

[1]Department of Architecture, Faculty of Engineering, Hasanuddin University, Makassar 92173, South Sulawesi, Indonesia
[2]Department of Architecture, Institute Technology Sepuluh Nopember Surabaya, Surabaya 60117, West Java, Indonesia

Received November 29, 2021; Revised February 25, 2022; Accepted March 15, 2022

Cite This Paper in the following Citation Styles

(a): *[1] Idawarni Asmal, Baharuddin Hamzah, Happy Ratna , "Community Response to Thermal and Its Influence to Outdoor Use," Civil Engineering and Architecture, Vol. 10, No. 3, pp. 800-815, 2022. DOI: 10.13189/cea.2022.100305.*

(b): *Idawarni Asmal, Baharuddin Hamzah, Happy Ratna (2022). Community Response to Thermal and Its Influence to Outdoor Use. Civil Engineering and Architecture, 10(3), 800-815. DOI: 10.13189/cea.2022.100305.*

Abstract Karamak in North Galesong is a fishing village located adjacent to Makassar Strait. Temperatures can reach more than 40°C; as well as in the house units, temperatures can reach up to 37°C during the day in the dry season. From the thermal comfort aspect, it is then far from comfort to do activities. It has an impact on changes in the occupant's attitude in choosing the activity space. The research objectives are to find the differences between indoor and outdoor temperatures that affect community response to the transfer of their activities from indoor to outdoor during the daytime with the aim of finding a comfortable activity atmosphere so that activities can be more optimal. The method used was to conduct thermal measurements on the macro and micro scale, including temperature, humidity by the HTC-2 to measure temperature and humidity, while for wind speed using an anemometer. Macro scale climate measurements were carried out in outdoor and micro-scales in indoor of the stage house units. Data collection was carried out simultaneously in the rooms in the sample house. The measurement results were presented in the table. The analysis was used in a comparison between outdoor and indoor climates. Measurements also take off people's perceptions of indoor-outdoor thermal as supporting data measured by the tool. The study has given information about the coastal climate effects on microclimate conditions (residential units) so that it became hot during the day. This study also provided insights for planners and policymakers going forward in response to heated conditions. The microclimate made the residents move the activity space to outdoor that was more comfortable and able to support their activities.

Keywords Climate Impact, Community Responds to Climate, Livelihood, Adaptation, Local Climate Scenarios

1. Introduction

Thermal comfort is an assessment of one's satisfaction with the environmental surroundings, in which an individual depends on factors such as indoor temperature, activity level, clothing, and relative humidity [1].

This situation can increase the resident's activity and creativity in space, and affect the decision of someone or group to use space. The lack of human comfort has a direct effect on workers' productivity and an indirect impact on production, economy, and environment [2-3]. In a warm climate, heat waves increase human heat stress and morbidity and decrease productivity [4-8], their study results showed that people's behavior was highly dependent on the outdoor thermal conditions, concerning the expectation of the weather and its activity.

Climate factors that influence human thermal comfort according to Auliciems and Szokolay [9], Stathopoulosa [10] depend on climate variables (radiation, air temperature, humidity, and wind speed) and subjective variables in some individuals, such as clothing, acclimatization, age, sex, obesity and health, food and drink type consumed, and color skin. Putra [11] defined thermal comfort as a sense of satisfaction from someone to deal with the thermal environment. Climate plays a significant role in influencing the community's response to the use of coastal settlements during the day, which has an impact on the emergence of new habits of residents to move all their activities from the body of the house (indoor) to the more comfortable outdoor, especially from 11.00 a.m. to 3.00 p.m. In general, people gather in a limited number of 3-6 people spending time in open spaces, even if the shaded r exceeds that amount. Many activities were carried out, such as socializing, napping, parenting, playing, eating, and working. At present, the occupants' activity room has moved from indoor to outdoor during the day. The house was originally a center for daily activities, social and cultural, gradually changing, a shady outdoor area and sheltered to be the people's choice for daytime activities.

There have been a small number of studies on thermal comfort for the external environment [12-16], however, they have not specifically discussed its relation to the community response why choosing outdoor for activities. Based on this statement, research is arranged to determine the occupant's response to changes in user space activity from indoor to outdoor.

The research objectives

The climatic conditions are extreme and discomfort in coastal areas. Especially in the dry season, temperatures can reach more than 40^{o}C, which has an impact on the settlement environment temperature. One of the parameters that affect human performance is temperature comfort. People have daily routines related to economic and social activities, and comfort in activities would be able to increase the quantity and quality of these activities. It may be one of the reasons for moving these activities from indoor to outdoor. Therefore, the research objective is to find the difference between indoor and outdoor temperatures that affect community response to the transfer of their activities from indoor to outdoor during the daytime. A similar study conducted by Chen and Edward [17], who adjusted outdoor comfort with occupant [activity also, that the microclimate also influences] the decision whether to use the room. The difference between this research from others is this study researcher not only see outdoor conditions that affect the occupant's activity in it but also find out things that affect indoor conditions to be uncomfortable to move inside during the day, such as house materials, openings, and densities as well housing configuration.

2. Materials and Methods

The study uses macro and micro-scale thermal measurement methods. Thermal measurements include temperature, humidity, wind speed, and occupant perception. The equipment used is the HTC-2 hygrometer to measure temperature and humidity, while for wind speed using the Anemometer. Macro-scale measurements are implemented in residential environments, such as beaches, green open spaces, and guard posts. Micro-scale measurements are done on the units of the house on stilts involving the living room, service room, and terrace. The room selection is because it is a place that is widely used for joint activities and interactions. Sampling is done randomly indoors and outdoors. To obtain data accuracy, the researchers placed the measuring instrument for 10-15 minutes simultaneously inside and outside the room to make the device in a stable condition in retrieving data.

The data collection was carried out by several people from 11.30am to 2.30pm for a week. Taking these hours is based on a pan of residents' information that temperatures start to heat from 11.00 am to 3.00 pm. Data is taken on a sunny day in October when the beach temperature reaches more than 40°C.

The number of samples was represented by 31 houses or around 15% because there were around 200 houses on stilts. Next, make measurements in the form of graphs and tables to determine the average temperature, humidity, and wind speed conditions of each housing unit. To further enhance the data validity, the researchers also used community response data on the comfort level of the room using a closed questionnaire. The assessment of public responses to the principle of thermal sensation using the ANSI/ASHRAE standard [18], which has been developed for use in heat-sensitive people is +3 (heat), +2 (warm), +1 (slightly warm), 0 (neutral), -1 (slightly cold), -2 (cold), -3 (cold). However, its implementation in this study was only divided into five flavors to make it simpler and younger understood by respondents who are a fishing community group in rural areas that have a different climate (humid tropics).

Measurement of respondents' perception used a Likert scale with a sample of 40 people and the sample is the population at the time of data collection that is active and uses public and semi-public spaces. On the scale, measurements use positive questions for outdoor, whereas indoor use negative questions because less space is used during the day. The resulting data is used for cross-checking with data taken from measurements using tools. The measuring of the optimal temperature data uses the formula [19-20].

$$Top = \frac{\text{Tmrt} + (\text{Ta}\sqrt{10\ \text{Va}})}{1 + \sqrt{10\ \text{Va}}} \quad (1)$$

Operative temperature (Top) is a metric that combines the effects of air and the average temperature of radiation and is estimated to assess the effects of microclimatic conditions only. Average radiation temperature (Tmrt) (°C); Air temperature (Ta) (°C); Air Speed (Va) (ms^{-1}). The analysis uses a comparison between outdoor and indoor climate conditions and public perception. Simple statistical data is performed, and a statistical analysis scheme is developed to handle most data and ensure the validity of the results.

Research Location**.** The research location was in Karama Hamlet, Aeng Batu Village, North Golesong District, Takalar Regency, South Sulawesi Province, Indonesia. The location is directly adjacent to the Makassar Strait and is a fishing settlement; it can be seen in Figure 1.

The settlement is located in a coastal area and directly borders the Makassar Strait. Its form is irregular, congested, and unplanned, with the form of buildings on stilts and landed houses. The settlement is directly adjacent to the Makassar Strait and faces westward. The settlement is inhabited by fishermen.

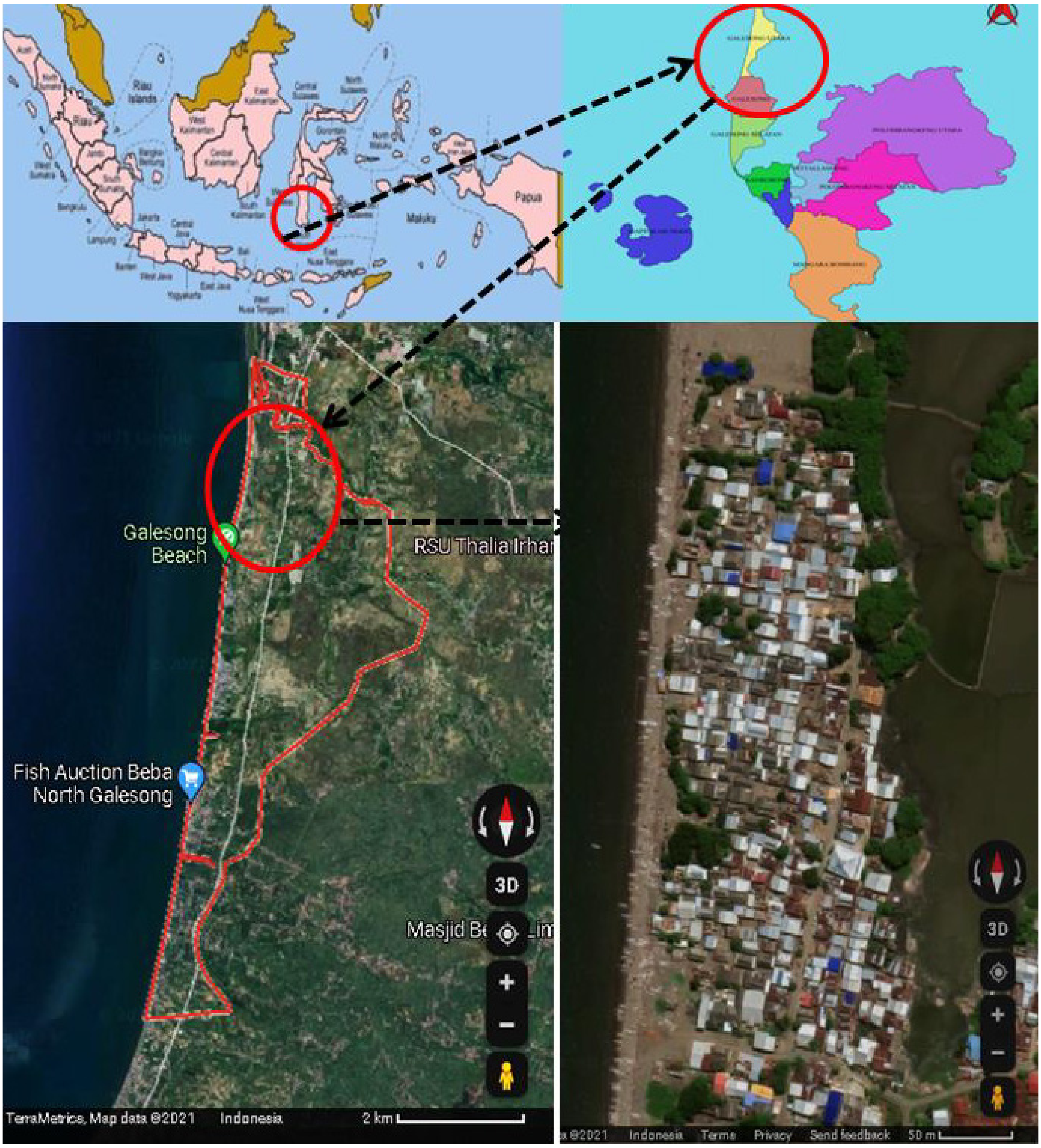


Figure 1. Research Location, map of Indonesia - South Sulawesi Province - North Galesong District-Aeng Batu Village-Karamak Hamlet (source: Google)

3. Result

Based on field data, climate data obtained include temperature, humidity, and wind speed in outdoor and indoor rooms. The house sample position and form in Figures 2 and 3 show the Green Open Space (GOS) location and condition in Karama village. In the GOS, people use bamboo/wood benches (bale-bale) for activities, the Guard Post GP) is a place to interact, play, and rest. The presentation of images needs to be an initial description of the thermal conditions of the sample, with the images then research hopes the reader can predict the thermal conditions of the place which can then be proven by measurements.

The location of the house in the settlement (yellow color) which is the sample temperature measurement

The house form that is the sample for temperature measurement

Figure 2. Position and house sample

Location of GOS and GP in settlements that are samples of temperature measurement

Aeng Batu beach.

GOS (Green Open Space) location directly on the beach is a place that is widely used by the community to carry out various activities such as work, interaction, play, relax/rest. GOS conditions are shady, windy, airy, close to boat parking and fishing equipment. People generally work under trees, and sometimes they are in groups, but some are on themselves.

GOS spaces bordering the beach are also visited by visitors from outside the village for recreational purposes and hold fish-eating parties with family and friends

Green Open Space which is between people's houses and bordering ponds and settlement roads. Users of space are local people

GP (Guard Post) bordering the village road is a place protected by a roof, becomes a night watch station when controlling the village. In the daytime, people use it as a social interaction space, play, and rest

Figure 3. Position and condition of GOS and post guard station

Table 1. Climate Temperature indoor

No	Guest and living room			Room under the house (*kolong*)			Service room on house			Terrace		
	Real air tempt.	Wind Speed	TOP	Real air tempt.	Wind Speed	TOP	Real air tempt.	Wind Speed	TOP	Real air tempt.	Wind Speed	TOP
H. 1	40.2	0.1	36.10	30.5	0.2	31.12	37	0.1	34.5	39	0.1	35.50
H. 2	38	0.1	35.00	31.4	0.1	32.00	38	0.1	35.0	37	0.1	34.50
H. 3	37.5	0.1	34.75	30.5	0.2	31.12	37	0.1	34.5	36	0.2	34.34
H. 4	38	0.1	35.00	32.3	0.1	32.15	35.6	0.05	33.5	34	0.3	33.27
H. 5	34	0.1	33.50	31	0.2	31.41	34	0.2	33.2	33	0.2	32.59
H. 6	34.4	0.2	37.91	32.5	0.2	32.00	34.3	0.3	33.5	35	0.1	34.00
H. 7	37.3	0.05	33.03	30	3.6	30.29	38	0.05	35.0	36	0.1	35.50
H. 8	36.8	0.1	34.81	30.5	0.2	31.12	37	0.1	40.4	35	0.1	33.50
H. 9	36	0.05	33.66	31	0.2	31.41	36	0,0	34.0	36	0.1	34.00
H. 10	32	0.05	32.41	30.5	0.3	31.05	33	0.1	32.5	31	0.2	31.41
H. 11	33	0	32.00	31.5	0.1	31.75	33	0.1	32.5	34.5	0	32.00
H. 12	37	0.05	32.83	30.8	0.3	31.24	33.5	0.1	32.8	34	0.5	33.38
H. 13	38	0	32.00	30	0.4	30.67	36	0.1	34.0	34.6	0.3	33.59
H. 14	37.8	0.1	34.90	31	0.2	31.50	37.8	0.1	34.9	39	0.1	35.50
H. 15	37	0.05	34.07	31.5	0.05	32.00	37	0.1	34.5	34	0.1	33.00
H. 16	37	0.05	34.07	31	0.1	31.00	33.5	0.2	32.8	36	0.1	33.00
H. 17	36.5	0.05	33.86	31	0.05	31.50	37	0.2	34.9	36.1	0.1	34.05
H. 18	38	0.05	34.49	30.5	0.3	31.25	34	0.2	33.2	34.5	0.1	33.25
H. 19	37.03	0.15	32.00	30	0.3	30.83	37	0.05	34.1	34	0.1	33.00
Ave.	36.61	0.087	34.02	30.92	0.39	31.34	35.72	0.19	34.2	35.19	0.153	33.65

H = House unit, Temp. = Temperature, Ave = average, TOP = Operative Temperature Table informs that, the highest temperature is in the living room, the average is 35.60°C at 11.30 p.m. - 2.30 p.m. with an average wind speed of 0.11 ms^{-1}, and a TOP of 35.53°C. While the lowest temperature is *kolong* with an average real temperature of 31.32°C, and TOP of 31.33°C, and an average wind speed of 0.64 ms^{-1}

Table 2. Climate Temperature Outdoor

Location	Green open space (GOS) and Guard Post (GP)					Beach					
	Real temp. ℃	**TOP ℃**	**Humidity %**	**Wind speed (ave) ms^{-1}**	**Wind speed (max) ms^{-1}**	**Location**	**Real temp. ℃**	**TOP ℃**	**Humidity %**	**Wind speed (max) ms^{-1}**	**Wind Speed (ave) ms^{-1}**
GOS.1	33	32.8	70	8	13.3	1	40	40	50	13.1	8.65
GOS.2	29	25.6	71	5.85	9.4	2	39	39.1	53	13.4	7.3
GOS.3	34	29.4	65	4.13	8.1	3	40	40	45	14.4	9.45
GOS.4	33	26.0	70	1.4	2.6	4	40.4	39.97	39	14.9	8.45
GOS.5	31.8	24.8	71	1.25	2.3	5	40.8	41.12	38	15.4	8.7
GOS.6	29.7	26.4	71	6.4	12	6	38.4	38.54	42	15.8	10.4
GOS.7	33.3	27.9	67	2.7	4.6	7	39.4	39.46	41	12.2	7.85
GOS.8	31	27.9	63	8.05	15	8	39.2	39.28	41	11.7	7.4
GOS.9	29.6	21.9	77	9.15	13.6	9	39	35.38	53	13.3	7.3
GOS.10	32.12	28.6	65	6.6	11.7	10	42.2	41.97	64	15.1	8.6
GOS.11	31.51	27.9	67	6.13	15.3	11	40	40	59	14.7	9.4
GOS.12	30	27.2	71	9.8	14.8	12	40.8	40.7	58	15.6	10.1
GP-1	30.3	27.4	70	8.8	14.3						
GP-2	29.5	25.8	81	4.8	7.6						
GP-3	32	25.5	68	1.5	2.7						
Average	**31.49**	**27.48**	**69.56**	**5.89**	**10.03**		**39.93**	**39.63**	**49**	**13.04**	**7.9**

Note: Temp. = Temperature., Ave = average, TOP = Operative Temperature

Table 1 shows the microclimate (1) and macroclimate value (2) based on field data and optimal calculations according to ANSI/ASHRAE 55 (2013). Table 1 shows the data taken in the micro (indoor) rooms which include the living room, family room, terrace, service room, and pit. Table 2 contains macro (outdoor) data that includes GOS and beaches.

Table 2 shows the real value of the temperature, operative temperature, humidity, and wind speed in outdoor fishing settlements. Low temperature correlates with high humidity and high wind speed.

Table 3. Climate Temperature out door

Terrace				
Real temp.	Top	Humidity %	Wind speed (ave) m/s	Wind speed (max) m/s
35.9	33.65	60.82	0.15	0.73
GOS and GP				
Real temp.	Top	Humidity %	Wind speed (ave) m/s	Max. Wind speed, m/s
31.5	31.06	70%	5.89	10.03
Beach				
Real temp.	Top	Humidity %	Wind speed (ave) m/s	Wind speed (max) m/s
40	39.63	49	7.9	13.04

Tables 1, 2 and 3 show quantitative values of climatic conditions regarding temperature (field temperature and optimal temperature, humidity, and wind speed (average and maximum) in outdoor and indoor fishing settlements. Low temperature has a correlation with high humidity and high wind speed. Tables 4a, 4b, 4c, 4d below, show the percentage of people's responses and interpretations of comfort in *kolong*, green open spaces, and inside the house. The use of these three spaces for analysis of public perception because these three spaces are the most widely used activities throughout the day.

Table 4a. Perception of respondents to the space comfort in *kolong* (room under the stage house)

Respondent feeling	Number of respondents	Score	Total
Cool		5	0
Slightly cool	13	4	52
Comfortable	25	3	75
Slightly hot	2	2	4
Hot		1	0
Total	40		131

Y= highest score Likert x respondent numbers =13 x 40 = 520

X= lowest score Likert x respondent numbers = 2 x 40 = 80

Index of percentage =131/520*100 = 25.19 %

Figure 4. Various activities undertaken by the residents

Kolong is a space that is shaded by the body of the house and is open so that air is free to flow in it, and almost all the activities of the occupants of the house during the day take place in that room.

Table 4b. Perception of respondents to the comfort of GOS

Respondent feeling	Number of respondents	Score	Total
Cool		5	0
Slightly cool	15	4	60
Comfortable	23	3	69
Slightly hot	2	2	4
Hot		1	0
Total	40		133

Y= highest score Likert x respondent numbers =15 x 40= 600

X= lowest score Likert x respondent numbers =2 x 40=80

Index of percentage = (133/600) *100 = 22.16667 %

Table 4c. Respondents to the comfort in a house (indoor)

Respondent feeling	Number of respondents	Score	Total
Cool		5	0
Slightly cool		4	0
Comfortable		3	0
Slightly hot	15	2	30
Hot	25	1	25
Total	40		55

Y=highest score Likert x respondent numbers =15 x 40 = 600
X=lowest score Likert x respondent numbers =25 x 40 =1000

Index of percentage = (55/600) * 100 = 9.17 %

Table 4d. Interpretation of the score based on the interval:

Interpretation of respondents	Presentation
Cool	0%-19.99%
Slightly cool	20%-39.99%
Comfortable	40%-59.99%
Slightly hot	60%-79.99%
Hot	80%-100%

Perception of respondents to the space comfort (*kolong*) =25.19 %, cool

Perception of respondents to the comfort of green open space= 22.17 %, slightly hot

Perception of respondents to the comfort in a house (indoor) = 9.17, hot

Comfort can be seen from the number of residents who do the activity of rest (sleeping) in a shady open space and are protected both by home and trees.

4. Discussion

4.1. Green Open Space (GOS)

GOS in Karama settlement (Table 2,3 and Figure 3) has TOP (Operative temperature) of 27.48 ^{O}C, an average temperature of 31.49 ^{O}C, a humidity of 69.56 %, an average wind speed of 5.89 ms^{-1}, and a maximum wind speed of 10.03 ms^{-1}. In calculating the Likert scale, the public response statement to green open space was very comfortable at 22.17%. Likewise, with temperature, humidity, average wind speed, and the resident's perception, the green open space can be categorized as a comfortable space for activities.

GOS has many benefits for its inhabitants, as a place for socialization, rest, and a place that supports a healthy lifestyle. GOS conditions in the Karama Hamlet are shaded by trees, and everyone places a bamboo bench (*bale-bale*) under a tree as a place to do some activities. This condition has been stated by Chen and Edward [17] that the microclimate influences outdoor activities with counters of people sitting on benches on sunny and shady days. Several studies [13,21-24] suggested that there was a strong relation between microclimatic conditions and the patterns of use of open spaces. Survey studies also show that most users tend to perceive the importance of green spaces in improving the thermal environment [25-27], especially by providing shade during the warmer periods. He points out that sunny or shady conditions significantly affect people's desire to stay or leave. Likewise, Lestan [28] said that spending time outside the home (outdoor) has a positive value because it will reduce the body's exposure to air outside the home which may have been contaminated by artificial materials. According to him, there was also a definite relationship between spending time outdoors and various chronic diseases including, obesity, type II diabetes, high blood pressure, heart disease, asthma, back pain, and joints. It reminds us of the GOS's existence importance which has many benefits for the health and the population's well-being. A study revealed that open space provides opportunities for people of all ages, especially children and the elderly, to interact with others and spend their free time in the area [29]. The presence of GOS to encourage physical activity is also able to create social contact and health [30-31].

In addition to thermal comfort, social contact is the most important thing for people to use GOS. Another reason is the attractive view to the sea and the desire to observe the arrival and departure of fisher family members from and to the sea. During the day, residents spend time outside the house, especially in the GOS in small and large groups, generally using the place for interaction and rest starting from 9.00 am (after the housework is finished for the mothers) to Asr prayer (4.00 p.m.).

4.2. Open Space under the House (*kolong*)

Kolong is an open space located under the house on stilts that use for members of family and neighbors to interact, receive non-formal guests, play, and work. This room is protected by the housing body from heat and rain, has an average temperature lower than the indoor of the house temperature that Top is 31.33°C and an average is 31.32°C, humidity level of 65.9 %, and wind speeds 0.36 - 3 m/s during the day (Table 1 and Figure 2 and 4). Related to the population's perception of the space issue calculated on a Likert scale, then 25.19% has a very comfortable (cold) answer. When it comes to conditions that are considered cold, some experts think of it as Telarosa [32] states that the warm comfortable threshold condition is 31°C and 60% humidity. Nico [33] said that the temperature of 30°C was considered normal for this climate (humid tropics), and air movements of more than 1 ms^{-1} were expected to reduce heat. But if we read several theories such as Lippsmeier [34] states that the best temperature in tropical buildings is 24°C -28°C, humidity between 60 - 70%, and wind speeds of 0.2 ms^{-1} 1.5 ms^{-1}. According to ASHRAE [35] (Guide to building a hot & humid climate), a comfortable feeling for humid tropical is between 23.30°C - 26.10°C with a humidity of 50% - 60%. SNI (Indonesian National Standard, 2001) [36] writes that comfortable feeling is obtained at a temperature of 20.50°C - 27.10°C with an active relative humidity of 40% - 60%.

Kolong temperature is considered by the local people to be in cold conditions, but based on the expert's opinion; the air condition is still high because it is still around 4°C between home body and service, and 3°C between terraces. This is due to the level of community adaptation to environmental conditions; coastal people are accustomed to being under the scorching sun at about 40°C. When discussing comfort from the aspect of wind speed, according to the American Society of Civil Engineers [37], [38] that the comfortable range (ms^{-1}) for sitting activities is 0-2.6 ms^{-1}. Dowall [39] said that the higher the air velocity above the body, the greater the cooling effect and the minimum speed needed around 0.2 ms^{-1}. Wind speed of 0.25 ms^{-1} is a comfortable condition without feeling, the airflow 0.25 - 0.5 ms^{-1} is still in pleasure and it is still felt. The airflow of 1.0 ms^{-1} - 1.5 ms^{-1} feels mild to uncomfortable, and the wind above 1.5 m/s feels uncomfortable. Based on expert views, wind speed and temperature local are still in a comfortable range for local community activities, this can be seen by the variety of activities that take place in *kolong* (Figure 4).

GOS and *kolong* are two spaces that are used the most during the day by residents for activities, the selection of the two spaces is closely related to Tables 1, 2, and 3. Table 1 shows the real temperature value indoor average was 36.61°C, and *kolong* average was 30.92^{o}C, while the average temperature for the actual temperature of GOS in Table 3 was 31.5°C. This temperature condition is then associated with Table 4 regarding public perception, so that they feel the *kolong* and GOS temperature was more comfortable than other rooms. The two spaces (*kolong* and GOS) are shaded and protected. Regarding work or activities, this is in line with several expert opinions, namely thermal discomfort in the workplace that can cause work to be disrupted, as stated by Idealistina [40]. Elnabawi, and Hamza [7] said that the significant influence of the microclimate in shaping people's behavior and the use of outdoor space, and Zacharias et al. [41], at higher temperatures (> 20°C), there is a tendency for people to move into the shade or, however, out of direct sunlight. The significant reduction in overall presence at higher temperatures reflects the compensatory behavior of users who move into shady conditions or do not use public places. Kuo-Tsang Huang [42], people tend to use shady and engage in static activities in hot temperatures. Elnabawi and Hamza [7], in hot temperatures then heat waves can increase human heat stress and morbidity, lessen productivity, and increase heat stress, contributing to diminishing productivity.

4.3. House Body (Living and Service Room)

Based on indoor measurements, the living room and family room of the fishing house unit have an average temperature of 35.60°C (real condition) and a Top of 35.53°C, a humidity of 59.56%, and a wind speed average of 0.11 m/s. The service room has an average temperature of 35.40°C (real conditions) and a Top of 35.42°C, a humidity of 64.78%, and a wind speed average of 0.10 ms^{-1}. This condition is not comfortable to do activities in the room, and just a few minutes in the room, then someone will feel hot and sweaty. Likewise, the results of the calculation using a Likert scale indicate that respondents' perceptions of indoor comfort of 9.17% are very uncomfortable. Several factors contribute to the indoor heat conditions in the fishing house unit, namely: (1) housing orientation; 2) housing density and configuration; 3) the height of the house from the ground; 4) house material; 5) closed window models.

Housing orientation

Generally, the houses face to the east and the rest to the west (residential road) in the fishing settlements. This is contradicting with Toding [43] that houses oriented to the South and North are very useful because the sun is only exposed to the short side of the building. Likewise, Toding [43] said that the orientation of the sun also determines the intensity of heat entering a room in buildings in the tropics, so when building a house it is advisable to minimize the facade to the west and east.

Density and Housing configuration

Settlement's form is irregular, congested, and unplanned (Figure 1), a pattern will block the path of the wind causing parts deeper difficult to release hot air. Consequently, the inner settlement becomes hotter. The building masses placement with a chessboard pattern will create a more evenly distributed airflow, and the building is not in the shadow of the wind. A large number of buildings with lined positions can create turbulence pockets that contain small air movement and create unusual jump patterns in airflow [34]. The outdoor thermal comfort arises from the effect of building mass configuration on the temperature in an area, finally obtaining a thermal comfort environment [44,45].

The housing height

The high average of houses was 2 meters from the ground and has low humidity compared to the ground floor. This condition was in agreement with the report of Riyanto [46] who stated that the higher the floor building surface from the land, the lower the average humidity, and the closer the house location from the water/river than the moisture increases.

Material aspects

Zinc and asbestos are a type of material that is widely used for roofs and walls, both of which are artificial materials. Figure 5 shows the percentage of the materials use on roofs and walls of fishermen's houses. The figure informs the use of 12% zinc and 6% asbestos as a roofing material, and similarly to walls, almost all homes use zinc.

The front wall only uses wood, about Prasetyoadi [47], a building was said to be a friendly environment when using building materials with a minimum prefabricated offsite system 30% of the total material used, meaning use natural building materials. Natural materials such as wood and thatched roofs require high maintenance, making it unsuitable for the needs of today's society, although climatically performing well [48,49]. Conversely, materials that require less intensive maintenance such as concrete, plaster bricks, concrete blocks, metal/zinc roofing are preferred. However, these materials are not recommended to affect the built environment characteristics or respond to tropical climate [49].

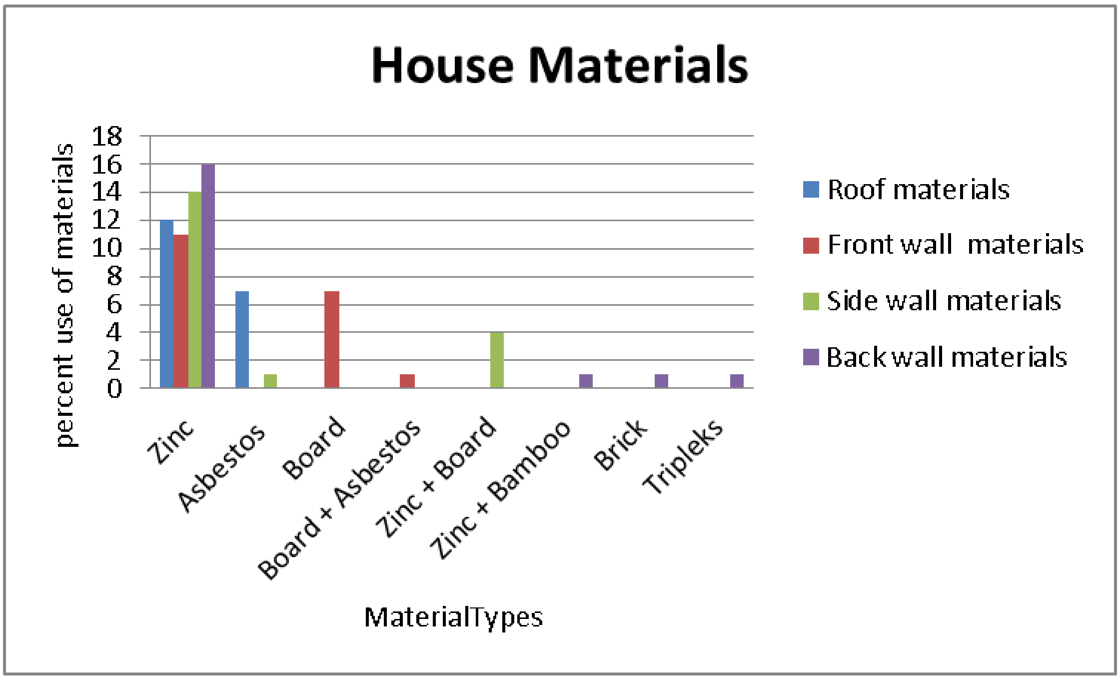


Figure 5. The type of material used of the houses

The roof is an element that was not protected from heat and directly related to the sun. The excessive heat from the roof surface will affect the thermal conditions of the space inside which will surely increase the energy consumption for cooling [50]. The average thermal profile of roof space and roof surface temperature due to the influence of solar radiation can be seen in Table 5.

Table 5. Thermal roof space and roof surface temperature

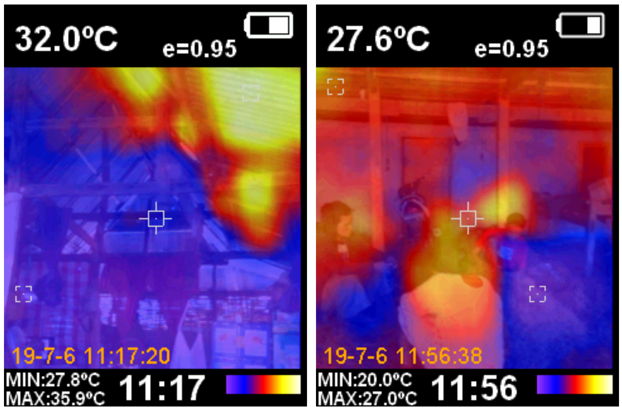
Roof materials	Thermal roof space	Roof surface temperature
Tile roof	27.32	32.99
Zink	29.23	33.28
Asbestos	29.63	34.55

Generally, zinc is used for roofs and walls, wood is only used on the front wall, and a small part on the side walls for aesthetic purposes.

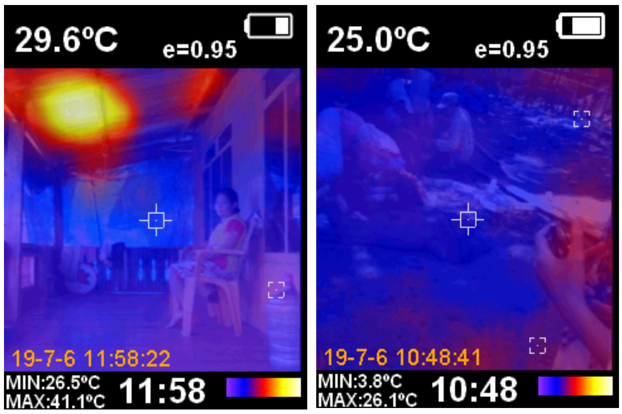
Oliveira [3] states that the roof is responsible for about 70% of the total heat gain in a building and there are significant differences in its performance as to color use and properties of the material in use. Zinc roofing material tends to increase the thermal of roof space. According to Selparia [51], this was because the thickness of the zinc was thinner and has the highest thermal conductivity value of 0.482 wm^{-1}, When correlating to Figure 5 and Table 5, it is clear that the use of zinc and asbestos as roof and wall materials greatly affect the high temperatures in the room because asbestos has a very low-performance reduction.

Window opening. Table 1 shows the wind speed to the house is in the range of 0.05 (minimum) - 0.2 (maximum) ms^{-1}, average 0.087 ms^{-1} which means it has a slight effect on the human body, because of the ratio between the floor area and openings is not balanced. The floor area of the building is around 42 m^2 (living room and family), openings on the left and right sides of the wall with 1 or 2 windows with an area of 0.5 m^2 / window and an average facade of 1.5 m^2, so the total opening is only about 2 m^2 or 0.82%. Besides, windows generally have a closed type that only functions for lighting not for air flowing, the airflow into the house is only through a gap between the floor and the roof that is deformed, also with the window openings percentage is less than recommended by Tantasavasdi [52].

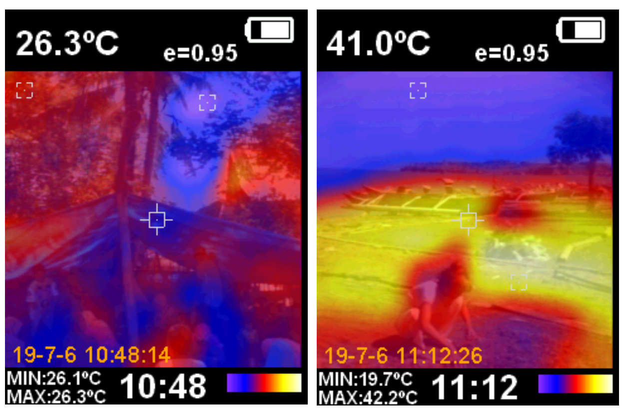
Susanta and Aditama [50] Quoted from the Indonesian National Standard (SNI) [36] that the minimum requirement for a living room must be ventilated not less than 5% of floor space, and window 20% of floor space. The natural ventilation must provide permanent openings like windows, doors, and other openable. The ratio dimensional between the inlet and outlet will be highly influential in the ventilation process, good open inlet space which about 20% of floor area building. Tantasavasdi [49] said to achieve both the inlet and outlet dimensions have the same area so that the total exposure area was 40% of the floor area. Natural ventilation can provide comfort in the building through openings/holes to enter the wind flow into the building as a cooling room that causes residents to feel comfortable [54-56]. Other studies have also found it difficult to achieve the right thermal comfort zone in certain spaces due to several factors, Nugroho [57], Santoso [58] state that this design is capable of causing high solar radiation into space. Roonak [59] and Santoso [58] mention that air circulation was less than optimal due to the relatively small air velocity into the room.



Indoor (living room) and *kolong* Temperature



Terrace and GOS Temperature



GOS and Beach Temperature

Figure 6. The comparison of indoor, *kolong*, terrace, beach and GOSTemperature

The terrace is a transitional space from the bottom into the house (stilts house), is semi-open, the roof is lower than the body of the house, and the semi-open walls cause free air to flow in it. The real temperature is an average of 34.34°C, a TOP of 34.20^{o}C, average humidity of 60.65%, and an average wind speed of 0.5 - 4 ms^{-1}. The terrace temperature is lower than the body of the house temperature because the air flows more in the terrace than in the house, but it is hotter than under the roof because it has a zinc material roof, the slope of the angle is small so that it is almost flat, then the heat from the roof feels directly on the room. The following is the comparison of the temperature in the room in the house, underneath, and the house terrace has taken using HT02 Handheld Infrared Thermal Thermograph Camera, which can be seen in Figure 6.

The figures above show color gradations that indicate the level of temperature in these spaces, bright yellow has a high heat value, then red, blue and brown have the lowest temperature values. Temperature is taken between 11.00 a.m. and 12.00 a.m. The highest temperature in the house is 32°C; the lowest temperature is 27°C in *kolong*, and the terrace temperature is 29°C. The distance between the floor and the roof is 1.8 m to 2 m. The house site is bordered by the highest tide. While the temperature at the beach reaches 41°C and GOS 25°C. Figure 6 is closely related to Table 4, which discusses people's perceptions associated with the space comfort that is often used. Table 4 shows the public's perception that under and GOS are comfortable places to do activities, and it is evident from Figure 6 that the room temperature is lower than indoor. Likewise, in Table 3, the real temperature column in GOS` and GP is lower than in other rooms, while the terrace temperature is slightly lower than indoor and coastal, which is a difference of 3.5°C under than the beach and 4.4°C higher than GOS and GP. At high temperatures, there is a sense of discomfort and decreased productivity.

Beach

The TOP of the beach reaches 38.93°C, the real temperature is 40°C, and the airspeed ranges from 4.2 to 13.1 ms^{-1}. When viewed from the aspect of velocity, according to ASCE [37], wind speed > 5.4 ms^{-1} is uncomfortable for any activities, and > 2 ms^{-1} is classified as disturbing blows. This causes the community less activity on the beach, especially during the day. If there is, then they put a plastic tent to shelter from the blazing sun. I addition, if his body is exposed directly by the sun on the beach then people wear thick clothing with long sleeves cotton material and wear a hat.

5. Conclusions

Thermal conditions affect the use of outdoor and indoor space in fisherman's settlements. Based on the study results, those outdoor thermal conditions are more comfortable than indoor. The thermal comfort outdoor is strongly influenced by the presence of trees as air fresheners and as a protector/shade for the environment. Similarly, the *kolong* position is shielded and shaded by the house and open. It can cause free airflow to enter and left the room. As a result of these conditions, people put *bale-bale* and guard post in that room for doing many activities. In contrast to the hot and uncomfortable indoor conditions, it is influenced by factors such as the use of zinc and asbestos materials for roofs and walls that are good heat conductors, window conditions and door openings that have less percentage than they should, solid and irregular housing formation that blocks the free airflow from the sea/beach to the housing. These cause residents to move all activities to spaces that are protected and comfortable in the daytime.

Compared to previous study, the quality and location are affected by the main climate factors of temperature and sunlight. It is proved to have a dominant effect in determining whether seating is used. Similar to the results of the test that use tools that can provide a quantitative and qualitative understanding of the relationship between the microenvironment, subjective thermal assessment, and social behavior. This shows a similarity finding on the seating placement aspect or benches in the outdoor as a widely used place due to the quality of the climate in the venue. Similarly, the measurements made on microclimatic conditions (indoor) with subjective assessments (space users) are measured by the Likert scale and changes in occupant activity from indoor to outdoor

The research advantages for researchers also highlight the cause of the inconvenience of indoor conditions that affect the subjective perception of society that impacts on changes in social behavior during the day.

Acknowledgments

Thank you also to the Hasanuddin University Research Center for facilitating the implementation of research, to the Directorate General of Higher Education-Indonesia who has provided superior research grants for research implementation, and to the fishing communities of Pantai Bahari, for their cooperation in field research. This research is supported by its national character with funding from the Applied Research Grant, DIKTI (Directorate of Higher Education) of the Republic of Indonesia. No. Contract: 1516/UN4.22/PT.01.03/2020

Authors' Contributions

This article is one of the results of the research entitled "Revitalizing the Slums of Seaweed and Fishing". Thanks to Prof. Baharuddin Hamzah and Prof. Happy Ratna for his guidance in completing this article research.

REFERENCES

[1] Yuan Fang,Yuto Lim, Sian En Ooi, Chenmian Zhou, and Yasuo Tan, "Study of Human Thermal Comfort for Cyber–Physical Human Centric System in Smart Homes", Sensors (Basel). Jan, vol. 20, no. 2, pp. 372, 2020. Doi: 10.3390/s20020372

[2] M.Castilla, J.D.Álvarez, M.Berenguel, F.Rodríguez, J.L.Guzmán, M.Pérez, "A comparison of thermal comfort predictive control strategies", Energy and Buildings, vol. 43, no. 1, pp. 2737-2746, 2011. https://doi.org/10.1016/j.enbuild.2011.06.030

[3] Etianne Alves Souza de Oliveira, Antonio Augusto Paula Xavier, Ariel Orlei Michaloski, Elisandra Montes Pizybski, "Human thermal comfort and architectural", Acta Scientiarum Technology, vol. 38, no. 2, pp. 129-135, 2016. DOI: 10.4025/actascitechnol.v38i2.28308

[4] Sharon L.Harlan, Anthony J.Brazel, LelaPrashad, William L.Stefanov, LarissaLarsen, "Neighborhood microclimates and vulnerability to heat stress", Social Science & Medicine, vol. 63, issue 11, pp. 2847–2863, 2006. https://doi.org/10.1016/j.socscimed.2006.07.030

[5] Christer Hogstedt and Tord Kjellström, Book Chapter, "Global situation concerning work-related injuries and diseases. In OSH for Development", Elgstrand, K., Pettersson, I., Eds.; Royal Institute of Technology: Stockholm, Sweden. pp. 741–761, 2009. http://www.diva-portal.org/smash/get/diva2:465599/FULLTEXT01.Arch. (Accessed August, 12. 2021).

[6] Ariane Adam Poupart, France Labrèche, Audrey Smargiassi, Patrice Duguay, Marc-Antoine Busque, Charles Gagné, Hannu Rintamäki, Tord Kjellstrom, Joseph Zayed, "Climate change and Occupational Health and Safety in a Temperate Climate: Potential Impacts and Research Priorities in Quebec, Canada.", Industrial Health, vol. 51, pp. 68–78, 2013. DOI:10.2486/INDHEALTH.2012-0100

[7] Mohamed H. Elnabawi and Neveen Hamza, "Behavioural Perspectives of Outdoor Thermal Comfort in Urban Areas: A Critical Review", Atmosphere, vol.11, no. 1, pp. 51, 2020. DOI: 10.3390/atmos11010051.

[8] Lutz Katzschner, "Behaviour of People in Open Spaces in Dependence of Thermal Comfort Conditions", PLEA 2006 - The 23rd Conference on Passive and Low Energy Architecture. Geneva, Switzerland, September 2006, pp. 6-8. DOI:10.1.1.492.383&rep=rep1&type=pdf

[9] Andris Auliciems and Steven V Szokolay, "Thermal Comfort", Edition: 2nd Publisher: PLEA Note 3 Passive and Low Energy Architecture International. Editor: Steven V. Szokolay, 50 Halimah St-Chapel Hill, 4069, Australia, 200, pp.1-66.

[10] Theodore Stathopoulosa, Hanqing Wub, John Zacharias, "Outdoor human comfort in an urban climate", Building and Environment, vol. 39, no. 3, pp. 297-305, March 2004. DOI: 10.1016/j.buildenv.2003.09.001

[11] Jouvan Chandra Pratama Putra, "A study of thermal comfort and occupant satisfaction in office room", Engineering Physics International Conference, EPIC 2016, Procedia Engineering, 170 (2017), pp. 240 – 247. DOI: 10.1016/j.proeng.2017.03.057

[12] Swaid, H., M. Bar-El and M. E. Hoffman, "A bioclimatic design methodology for urban outdoor spaces", Theoretical and Applied Climatology, vol. 48, pp. 49-61, March 1993. https://link.springer.com/article/10.1007/BF008649103. (Accessed August, 12. 2021).

[13] Marialena Nikolopoulou, Spyros Lykoudis, "Thermal comfort in outdoor urban spaces: Analysis across different European countries", Building and Environment, vol. 41, issue 11, pp. 1455–1470, 2006. https://doi.org/10.1016/j.buildenv.2005.05.031

[14] Baruch Givoni, Mikiko Noguchi, Hadas Saaroni, Oded Pochter, Yaron Yaacov, Noa Feller and Stefan Becker,

"Outdoor comfort research issues", Energy and Buildings, vol. 35, pp. 77-86, 2003. DOI:10.1016/S0378-7788(02)00082-8

[15] Craig Morgan & Richard de Dear, "Weather, clothing and thermal adaptation to indoor climate", Climate Research, vol. 24, pp. 267–284, 2003. DOI: 10.3354/cr024267

[16] Tsuyoshi Honjo, 'Thermal Comfort in Outdoor Environment', Global Environmental Research, vol. 3, pp. 43-47, 2009. https://www.researchgate.net/publication/228521038 (Accessed August, 12. 2021).

[17] Liang Chen and Edward Ng., "Outdoor thermal comfort and outdoor activities: A review of research in the past decade", Cities, vol. 29, issue 2, pp. 118–125, April 2012. https://doi.org/10.1016/j.cities.2011.08.006

[18] ANSI /ASHRAE, Standard 55-2010 Thermal Environmental Conditions for Human Occupancy. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. 2013 ASHRAE, 1791 Tullie Circle NE, Atlanta, GA 30329. pp. 1-37.

[19] ANSI/ASHRAE Standard 55 (2013). Thermal environmental conditions for human occupancy. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Editorial responsibility: Robert Davis (Editor), 2013 ASHRAE, 1791 Tullie Circle NE Atlanta, GA 30329. pp. 1-49.

[20] Yafei Wang, Rudolf de Groot, Frank Bakker, Heinrich Wörtche, Rik Leemans, "Thermal comfort in urban green spaces: a survey on a Dutch university campus", International Journal of Biometeorology, vol. 61, no. 1, pp. 1-15, 2016. DOI: 10.1007/s00484-016-1193-0.

[21] Tzu Ping Lin, Andreas Matzarakis, Ruey Lung Hwang, "Shading effect on long-term outdoor thermal comfort", Building Environment, vol. 45, issue 1, pp. 213–221, 2010. https://doi.org/10.1016/j.buildenv.2009.06.002

[22] Liang Chen, Yongyi Wen, Lang Zhang, Wei-NingXiang, "Studies of thermal comfort and space use in an urban park square in cool and cold seasons in Shanghai", Building and Environment vol. 94, part 2, pp. 644–653, 2015. https://doi.org/10.1016/j.buildenv.2015.10.020

[23] Salman Shooshtarian, Priyadarsini Rajagopalan, Ron Wakefield, "Effect of seasonal changes on usage patterns and behaviors in educational precinct in Melbourne", Urban Climate, vol. 26, pp. 133–148, 2018. https://doi.org/10.1016/j.uclim.2018.08.013

[24] Artur Gonçalves, António Castro Ribeiro, Filipe Maia, Luís Nunes and Manuel Feliciano (2019), "Influence of Green Spaces on Outdoors Thermal Comfort Structured Experiment in a Mediterranean Climate", Climate, vol. 7: 20, 2019. Doi: 10.3390/cli7020020

[25] C. Y. Jim, Wendy Chen, "Perception and attitude of residents toward urban green spaces in Guangzhou (China)", Environmental Management, vol. 38, no. 3, pp. 338–349, 2006. DOI: 10.1007/s00267-005-0166-6

[26] Giovanni Sanesia, Francesco Chiarello, "Residents and urban green spaces: The case of Bari", Urban For Urban Green, vol. 4, issue 3-4, pp. 125–134, April 2006. https://doi.org/10.1016/j.ufug.2005.12.001

[27] Raffaele Lafortezza, Giuseppe Carrus, Giovanni Sanesi, Clive Davies, "Benefits and well-being perceived by people visiting green spaces in periods of heat stress", Urban Forestry and Urban Greening, vol. 8, issue 2, pp. 97–108, 2009. https://doi.org/10.1016/j.ufug.2009.02.003

[28] Katarina Ana Lestan, Ivan Eržen, and Mojca Golobič, "The Role of Open Space in Urban Neighbourhoods for Health-Related Lifestyle", Environmental Research and. Public Health, vol. 11, no. 6, pp. 6547-6570, 2014. DOI: 10.3390/ijerph110606547.

[29] F. Gómez, Alejandro Pérez Cueva, Manuel Valcuende, Andreas Matzarakis. "Research on ecological design to enhance comfort in open spaces of a city (Valencia, Spain). Utility of the physiological equivalent temperature (PET)", Ecological Engineering, vol 57, August, pp. 27-39, 2013. https://doi.org/10.1016/j.ecoleng.2013.04.034

[30] Richard Mitchell, "Is physical activity in natural environments better for mental health than physical activity in other environments?", Social Science & Medicine, May 8, vol. 91, pp. 130-134. 2012. DOI: 10.1016/j.socscimed.2012.04.012

[31] Catharine Ward Thompson, Peter Aspinall, Jenny Roe, Lynette Robertson, and David Miller, "Mitigating Stress and Supporting Health in Deprived Urban Communities: The Importance of Green Space and the Social Environment". Environmental Research and. Public Health, vol. 13, no. 4, pp. 440. April 2016. DOI: 10.3390/ijerph13040440

[32] Basaria Talarosha, "Creating Thermal Comforts in Building", Jurnal Sistem Teknik Industri, July vol. 6, no. 3, pp. 148-158, 2005. https://www.academia.edu/10852013/Menciptakan_Kenyamanan_Thermal_dalam_Bangunan. (Accessed August, 12. 2021).

[33] Fergus Nicol, "Adaptive thermal comfort standards in the hot–humid tropics", Energy and Buildings, vol. 36, issue 7, pp. 628–637, July 2004. https://doi.org/10.1016/j.enbuild.2004.01.016

[34] George Lippsmeier, Kiran Mukerji, Syahmir Nasution, "Tropis Building" (in Indonesian: Bangunan tropis), *Jakarta*: *Erlangga*, 1997, pp.1-201.

[35] ASHRAE STANDART, "Thermal Environment Condition for Human Occupancy@2010 American society of heating, refrigerating, and air conditioning engineers, incorporate. 2010. ISSN 1041-2336.

[36] SNI (Indonesia National Standard) 03-6572-2001. Procedures for Design of Ventilation and Air Conditioning Systems. http://staffnew.uny.ac.id/upload/132100514/pendidikan/perencanaan-pendingin.pdf. (Accessed August, 12. 2021).

[37] ASCE, "Outdoor Human Comfort and its Assessment: State of the Art, Task Committee on Outdoor Human Comfort", American Society of Civil Engineers. May 5, 2004, pp. 1-68.

[38] Agota Szucs, "Wind comfort in a public urban space—Case study within Dublin Docklands", Frontiers of Architectural Research, vol. 2, issue 1, pp. 50–66, March 2013. https://doi.org/10.1016/j.foar.2012.12.002

[39] Ross Montgomery and Robert McDowall, "Fundamental of HVAC System", American Society of Heating,

Refrigerating and Air-Conditioning Engineers, 2011,. 2009. pp. 1-359.

[40] Farida Idealistina, “Body Thermoregulation Model for Determining the Best Thermal Impression Magnitude in relation to Human Performance”. Dissertation, Institut Teknologi Bandung, Bandung, 1991.

[41] John Zacharias, Ted Stathopoulos, Hanqing Wu, “Microclimate and Downtown Open Space Activity”, Environment and Behavior 33 (2): 296-315. DOI: 10.1177/0013916501332008.

[42] Kuo-Tsang Huang, Tzu-Ping Lin, and Hsiao-Chi Lien, “Investigating Thermal Comfort and User Behaviors in Outdoor Spaces: A Seasonal and Spatial Perspective”, Advances in Meteorology, Volume 2015, Article ID 423508, 11 pages. http://dx.doi.org/10.1155/2015/423508

[43] Juprianto Bua Toding, Jefrey I. Kindangen, Sangkertadi, “Thermal Comforts at River House Case Study Kahayan River House in Palangka Raya City”, Radial, Vol. 3, no. 2, pp. 103-111, 2015. DOI: https://doi.org/10.37971/radial.v3i2.72

[44] Wonorahadjo Surjamanto, Koerniawan Donny, “The Influence of Shape Building on Bandung Thermal Environment, Proceeding National Seminar the Role of Tropical Architecture in Realizing Tropical City”, 2008. https://adoc.pub/pengaruh-bentuk-bangunan-pada-lingkungan-thermal-kota-studi-.html. (Accessed August, 12. 2021).

[45] Dwi Maidinita, Gagoek Hardiman, Eddy Prianto, “Spatial Pattern of Housing and Thermal Comfort Area in Semarang”, Riptek, vol. 3, no. 20, 2009, pp. 21 – 26. https://bappeda.semarangkota.go.id/uploaded/publikasi/Pola_Ruang_Luar_Kawasan_Perumahan_Dan_Kenyamanan_Thermal_Di_Semarang_-_MAIDINITA._D_dkk.pdf. (Accessed August, 12. 2021).

[46] Bambang Riyanto, “The Influence of Building Components on Thermal Conditioning in Traditional Fishermen's House in Demak, Case Study Housing Fishers Morodemak Floor”. 2000. [Tesis]. http://eprints.undip.ac.id/11783/1/2000MTA665.pdf. (Accessed August, 12. 2021).

[47] Tiyok Prasetyoadi, “Green Building Council Indonesia World GBC –International Relations”, IAI, PIA; Indonesia. September, 20. 2011. https://docplayer.info/46223933-Green-building-council-indonesia-world-gbc-international-relations.html. (Accessed August, 12. 2021).

[48] O.H. Koenigsberger, T.G. Ingersoll, Alan Mayhew, S.V. Szokolay, “Manual of Tropical Housing and Building”, Part One Climate Design, Longman, London. 1973. https://www.slideshare.net/yashu2211/manual-of-tropical-housingkoenigsberger-52000850. (Accessed August, 12. 2021).

[49] Elizabeth Karol and Vincent Voon Chin Lai, “Climatic Design and Changing Social Needs in the Tropics: A Case Study in Kuching, Sarawak”, Sustainability, vol. 6, no. 9, pp. 6278-6292, 2014. https://doi.org/10.3390/su6096278

[50] Amat Rahmat, Eddy Prianto, Setiabudi Sasongko, “Study of the Effect of Roofing Materials on Thermal Conditions in Roof Space”, Arcade, vol. I, no. 1, pp.: 35-40, July 2017. DOI: https://doi.org/10.31848/arcade.v1i1.12

[51] Ersi Selparia, Maksi Ginting, Riad Syech, “Preparation and testing of tools to determine the conductivity of zinc, multiroof and asbestos plates”, JOM FMIPA, vol. 2, no. 1, pp. 191-197, 2015. https://jom.unri.ac.id/index.php/JOMFMIPA/article/view/4639/4521. (Accessed August, 12. 2021).

[52] Chalermwat Tantasavasdi, Daranee Jareemit, Anake Suwanchaiskul, Thitiporn Naklada “Evaluation and design of natural ventilation for houses in Thailand”, Architectural/ Planning Research and Stud., vol. 5, no. 1, pp. 85–98, 2007. https://so02.tci-thaijo.org/index.php/jars/article/view/169223/121745. (Accessed August, 12. 2021).

[53] Gatut Susanta dan Hafidh Aditama, “In order House is not Dark and no Dish” (in Indonesian: agar rumah tidak gelap dan tidak pengap). Jakarta: Raja Grafindo Persada, 2007, Pp. 1-79

[54] Tong Yang, Derek John Clements-Croome, “Natural Ventilation in Built Environment”, In book: Encyclopedia of Sustainability Science and Technology, Publisher: Springer, January 2012, pp. 6865- 6896.

[55] D. Prakash, P. Ravikumar. “Analysis of thermal comfort and indoor air flow characteristics for a residential building room under generalized window opening position at the adjacent walls”, International Journal of Sustainable Built Environment, Volume 4, Issue 1, June 2015, Pages 42-57. https://doi.org/10.1016/j.ijsbe.2015.02.003

[56] Kussoy Wailan John, “Wind Flow Calculations on Building Vents Using Numerical Simulation” Ilmiah Sains, April, vol. 11, no. 1, pp. 69-72, 2011. DOI: 10.35799/jis.11.1.2011.45

[57] Agung Murti Nugroho, “A Preliminary Study of Thermal Environment in Malaysia’s Single Storey Terraced Houses”, Economic Engineering, vol. 2, no.1, pp. 25-28, 2011. https://doi.org/10.3130/jaabe.6.175

[58] Eddy Imam Santoso, “Indoor Thermal Comforts on Buildings in Tropical Climate Humid Areas”, Indonesian Green Technology Journal, vol.1, no.1, pp. 13-19, 2012. https://www.academia.edu/6904042/Indonesian_Green_Technology_Journal_KENYAMANAN_TERMAL_INDOOR_PADA_BANGUNAN_DI_DAERAH_BERIKLIM_TROPIS_LEMBAB. (Accessed August, 12. 2021).

[59] Roonak Daghigh, Kamaruzzaman Bin Sopian, “Thermal Comfort in Naturally Ventilated Office Under Varied Opening Arrangements: Objective and Subjective Approach, European Journal of Scientific Research, Euro Journals Publishing, Inc., vol. 26, no.2, pp. 260-276, 2009. https://www.researchgate.net/publication/237456161_Thermal_Comfort_in_Naturally_Ventilated_Office_Under_Varied_Opening_Arrangements_Objective_and_Subjective_Approach. (Accessed August, 12. 2021).