A Preliminary-study of environment evaluation (Case study: Houses in Aceh Province, Indonesia)

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Abstract. A healthy house is a building used to protect humans from climate disturbances, bacteria, and other hazards for human health. A healthy and safe home is necessary to meet human needs both physically, mentally, and socially. A healthy home is also a way to protect ourselves from the current pandemic of Covid-19. Aceh is one of the provinces in Indonesia which has a rising number of infections. This research is a preliminary study to evaluate the home performance, including its environment in Aceh, which utilizes the quantitative method of collecting data through a survey. The evaluation parameters are referred to the healthy house standards from the Indonesian Ministry of Health. The data collection was done conveniently to 14 houses located across Aceh. The study shows that among the surveyed house, one house (7.1%) is good, six houses (42.8%) are moderate, seven houses (50%) are bad. The number of the survey is small; however, it can be a start to figure out the quality of houses in Aceh based on the healthy home standard. This study also indicates that the ventilation for providing air circulation and daylight is the poorest. While, actually an excellent ventilation will outlast the pandemic due to the increase of the infiltration rate that will reduce the trapped virus, odors, and other contaminants.

1. Introduction
A healthy house is a building used to protect humans from climate disturbances, bacteria, and other hazards for human health. A healthy, safe, and orderly home is necessary to meet human needs physically, mentally, and socially. A healthy house is also a place to grow a sound body and mind. The percentage of healthy houses in Indonesia in the good category reached 35.3%, the moderate category was 39.8%, and the bad category was 24.9%. The target of healthy homes in Indonesia is 80% of the categories of healthy homes above; none meet the target, so healthy homes in Indonesia have not been achieved [1].

Currently, we know that Covid-19 is still a dilemma for Indonesia and other countries. The increase of the positive number of Covid-19 is felt in Jakarta's capital city and several provinces in Indonesia. One of them is Aceh, which is currently still marked with a red zone. The number of Covid patients is continuously rising. From 2019 to July 7, 2021, Covid-19 has infected up to 19,893 people in Aceh, which comprise 3,717 people being treated either in hospitals or self-isolation at homes, 15,335 people being recovered, and 842 people had been dead. Banda Aceh, as the capital city, suffers the highest rate of infection [2]. This number shows the urgency of preparing a good house complying with the healthy standard. Self-isolation at home needs the house to meet the healthy standard to boost the immune of
the patients to be recovered soon. In addition, work from home (WFH) as the effect of the pandemic also requires a good house. An excellent house should function as a working space and a studying place for the school people. The need for an ideal house should be accommodated with the knowledge of building healthy homes.

Based on this description, it is necessary to evaluate the houses in Aceh, whether the house meets the requirements for a healthy house to self-isolate and a place to work and study. This study evaluates the houses across Aceh provinces following the regulations of the Indonesian Ministry of health.

1.1 Healthy homes
A healthy house is a home that allows its residents to develop and foster physical and mental, and family social. Therefore, the existence of a healthy, safe, and orderly home is very much needed to meet human needs both physically, mentally, and socially. The standard for a healthy home is that the house has good air ventilation, good spatial planning in terms of lighting and circulation, uses environmentally friendly furniture, is away from pests, and has minimal chemicals. Under the requirements of the Indonesia Ministry of Health No. 829 of 1999 [3], the healthy home standard should consider several aspects. Those are the building materials, home components and layout; lighting; air quality; ventilation; disease contagious animals; water; safe food storage facilities are available; waste; and density of sleeping house occupancy. The standard predominantly concerns the environment. The Indonesian ministry Of Public Works and Human Settlements (PUPR) [4] also indicates similar factors as the requirement of being a healthy house.

A healthy home considers the facade design by paying attention to the sun's orientation. Lack in designing the façade will result in indoor thermal discomfort [5]-[6]. Openings such as windows must be carefully considered both the model/type and the material of the window. Ventilation standards should be capable of providing minimum ventilation of an average of 8 l/s per person to extract odors, dust, virus through airborne and other contaminants [7]. Windows also play a significant role in bringing natural light to the room. Inadequate lighting levels in buildings will cause danger, decrease visual health abilities and affect psychological and work productivity levels [8]. Inadequate ventilation can also cause respiratory diseases such as asthma [9]. Space pattern planning, furniture, and circulation are closely related to ergonomics and anthropometry, which are parameters of the comfort level of the space [10]. Building materials have a significant role in providing thermal comfort, which indirectly affects health [11]. Sanitation, namely the availability of clean water and dirty water/dirt disposal, is essential in presenting a healthy home [10].

2. Materials and methods
This study uses quantitative methods to collect data, which is evaluated based on the standards of a healthy home from the Ministry of Health of the Republic of Indonesia. The houses that will be investigated are 14 houses located in several cities in Aceh, namely Banda Aceh, Aceh Besar, Bireuen, Central Aceh, and South Aceh (Figure 1). The houses were selected conveniently based on the occupant's availability to be involved in the survey (Table 2). The parameters assessed were 22 parameters based on the healthy home standard of the Indonesian Ministry of health. The parameters include building materials, home components, and layout; lighting; air quality; ventilation; disease contagious animals; water; safe food storage facilities are available; waste; and density of sleeping house occupancy. The parameters are quantified from a 1 to 5 rating scale, which means Very Poor, Poor, Average, Good, and Excellent. Then each house is evaluated by looking at the percentage of the score value: very good (100%), good (>83%), moderate (69-83%), bad (<69%). The percentage range complies the requirements of healthy home standard by the Indonesian Ministry of Health [3] and the related journal [1].

The percentage of the score is calculated by utilizing the following equation:
\[
\text{Percentage of score} = \left( \frac{\text{Total calculated score}}{\text{number of parameters} \times 5} \right) \times 100\%
\]

Total calculated score: the total of each parameter multiplied by the 1-5 rating scale
Number of parameters: 22 parameters (Table 1)

**Table 1.** The parameters evaluated in this study.

| No | Code | Healthy home categories                                                                 |
|----|------|----------------------------------------------------------------------------------------|
| 1  | A.1  | Not made of materials that can release substances that can be harmful to health.         |
| 2  | A.2  | Not made of materials that can lead to the growth and development of pathogenic micro-organisms. |
| 3  | B.1  | The floor is waterproof and easily cleaned.                                             |
| 4  | B.2  | The ceiling should be easily clean and not prone to accidents.                          |
| 5  | B.3  | The space in the house functions properly                                               |
| 6  | B.4  | The kitchen space must be equipped with smoke exhaust.                                  |
| 7  | C.1  | The room is bright enough with natural lighting.                                        |
| 8  | D.1  | Comfortable air temperature ranges from 18°C - 30°C                                     |
| 9  | D.2  | Air humidity ranges from 40%-70%                                                       |
| 10 | E.1  | Good ventilation throughout the house                                                   |
| 11 | F.1  | No disease-transmitting animals                                                        |
| 12 | G.1  | Clean water facilities are available.                                                   |
| 13 | H.1  | Safe food storage facilities are available.                                            |
| 14 | I.1  | Liquid waste that comes from the house does not pollute water sources.                 |
| 15 | I.2  | Solid waste must be managed so that it does not cause odors.                            |
| 16 | J.1  | The minimum bedroom area is 8 sqm. However, it is not recommended, except for children under 5 years old. |
17  K.1  The couple's room is 9.6 sqm.
18  K.2  The bedroom for two teenagers is 9.6 sqm.
19  K.3  The bedroom for 1 teenager is 9 sqm.
20  L.1  Using waterproof material on all four sides of the wall
21  L.2  Using a waterproof material for door and easy to clean
22  M.1  Setting the flow of hot air from the kitchen out of the building.

Source: Summarized from KEPMENKES 829 TAHUN 1999 [3]

3. Results and discussion
The houses surveyed in this study are located scattered in Aceh province. The house façade is shown in Table 2. The fourteen houses are:
- 5 houses located in Banda Aceh (H5, H6, H7, H8, H9).
- 3 houses located in Aceh Besar (H10, H11, H12).
- 4 houses located in Aceh Tengah (H1, H2, H3, H4).
- 1 house located in Bireuen (H13).
- 1 house located in Aceh Selatan (H14).

The parameters evaluated in the fourteen surveyed houses are shown in Table 1. The parameters that are resumed from the healthy home standard recommended by the Indonesian Ministry of health are close to the environmental factors in buildings to provide comfort.

Table 2. The houses surveyed in the study.
Figure 2 shows that A2, B1, and B2 are mainly about the quality and the cleanliness of the building materials, scored at 3.9; 3.9; 3.7, and 3.6, respectively. A1 is ‘not made of materials that can release substances that can be harmful to health.’ The majority of the house is made from moderate concrete work that would not harm the occupants. L1, therefore, also averagely scored at 4, which performs that all four sides of the wall are built from waterproof material. Almost half of the total surveyed houses work nearly well on being easily cleaned and made from healthy materials. However, some materials like ceilings and doors are frequently humid so that the fungus quickly grows, which is also shown by L2 averagely scored at 3.3. B3, which is about the space in the house that must function properly, shows the score at 3.8. B3 has almost similar values to H1, which is about the availability of safe food storage facilities. The houses are variously designed. We indicate that the larger the floor plan, the more spaces for storing furniture and facilitating many home activities.

The poor ones are B4, C1, E1, and M1 which are scored at 2.4; 2.1; 2.4, and 2.4, respectively. All of these parameters are about the provision of air circulation and daylight. Many cases show that the windows installed at the house are fixed windows and casement top-hung. Fix window does not work to flow the air due to the closed surface area. In theory, casement side-hung is the best window type to get the air circulated throughout the rooms. Cross ventilation is essential to obtain good air circulation. In this study, those approaches are not well applied. The causes include the limited size of the house, or the lack of a relevant window, or even the occupants frequently closed the window.

The daylight is significantly accessed by the fixed-large glass window, such as shown in house H5 (Figure 3). Yet, the sunlight does not illuminate the room sufficiently due to the limited number of windows. There are also obstructions against the window, either from outside or inside. At last, there is a lack of maintenance which reduces the amount of light emitted into the room.
Many cases in this study show that many kitchens or rear parts of the house do not get sufficient daylight, therefore need additional artificial lighting during the day. The cause is the lack of windows at the back of the house, such as H10, H2, H12, and H14 (Figure 4). The rear part of the houses is closed mainly by the concrete wall which also functions as a barrier to the neighbor's house. In addition, the dark area at the rear part is also caused by the frequently closed ventilations which also creates poor air circulation.

The air conditioner (AC) installations mainly cause the minimum aperture in the houses. AC requires the compacted room to get the room maximally cooled. The occupants installed AC primarily in the bedrooms, which are conditioned to be cool. It is no wonder that some occupants regard themselves to be fine with indoor air temperature and relative humidity obtained by the mechanical air conditioner. In Aceh Tengah, where the local climate is relatively cooler than the other districts, most of the respondents living in Aceh Tengah also feel fine with the indoor thermal environment obtained naturally from the local climate. However, people frequently address this natural cooling condition by closing the window due to the cold thermal sensation. It consequently rejects the air circulation throughout the house.

F1, G1, I1, and I2 are about the utility and surrounding environment graded at 3.1; 3.7; 3.4; and 3.4, respectively. The house occupants graded the provision of clean water and grey and black water treatment as average. Some of the respondents specify that the treatment of black and grey water is by letting the water flow in the open small shallow drainage, which during the heavy rain, the water
frequently overflows (Figure 5). The small drainage is located surrounding the house. Yet, it does not affect the clean water quality due to the space surrounding the house to absorb the dirty water into the ground. Therefore most of the respondents gave average the grade. Clean water is mostly centrally distributed by the local government (PDAM). However, in several houses, the water is not frequently running. Only several hours during the day that the water supply works. Therefore, most houses are also equipped with shallow wells to back up the water provision (Figure 5).

Figure 6 shows the overall result of this study shows that there are seven houses in the bad category, six houses in the moderate category, and one house in the good category. The bad category includes H1, H2, H3, H4, H9, H10, H11. The worst one is H10 which is a two-story house designed like a shophouse. The limitation of space creates the small size of bedrooms. It gives neither sufficient openings for circulating air nor daylight provision. The moderate category covers 6 houses i.e. H5, H7, H8, H12, H13 and H14 graded in 78.2%; 72.7%; 73.6%; 79.1%; 72.7%; and 71.8% respectively. The good category one is H6 which is graded at 83.6%. H6 has a good performance for overall healthy home categories. It has a very spacious floor plan with sufficient openings. The spacious floor plan also accommodates many activities which are functioned properly.

4. Conclusions
We figure out that 50% of the houses are classified in the bad category, 42.8% in the moderate, and 7.1% in the good category. There are no houses graded at 100%. Related to the number of healthy houses in Indonesia [1], the quality of the surveyed houses in this study is lower. We agree that it is not a proper justification to indicate the score representing the whole houses in Aceh since the number of surveys is minimal compared with the number of houses in Aceh. However, this study is helpful to indicate what aspects we have to concern to improve the house quality. This study indicates that the lowest value is dominantly on daylight provision and the thorough air circulation across the rooms in the house. These aspects are significant to be rectified to outlast the Pandemic. The houses that are located far from the polluted area are urged to be naturally ventilated. The presence of windows that meet the standard is a way to provide good natural ventilation, allowing air circulation in and out and presenting good daylight inside the house. The surrounding environment also should be accounted for, such as the treatment of black and grey water and the availability of clean water that will support healthy homes and healthy occupants.
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References
[1] Lubis A, Warou S P 2003 *Uraian Perumahan Sehat Di Indonesia, Susenas 2001*, Bul Penelitian Vol 31, No 4. 2003. 223-231
[2] covid19.acehprov.go.id
[3] Kepmenkes 829 Tahun 1999 *Persyaratan Kesehatan Perumahan*
[4] Kementrian Pekerjaan Umum dan Perumahan rakyat (PUPR) 2016 *Dasar-dasar Rumah Sehat,*
[5] Khadraoui S 2015 A nonparametric approach to design robust controllers for uncertain systems: application to an air flow heating system. J. Process Control 36, 1–10
[6] Sari L H, E N Rauzi, M Mahmud, Muslimsyah 2021 *Sun-path model as a simple helping tool for architecture students in understanding saving energy building design*, IOP Conf. Ser.: Mater. Sci. Eng. 1087 012017
[7] Bakó-Biró Z, D J Clements-Croome, N Kochhar, H B. Awbi, and M J Williams 2012 *Ventilation Rates in Schools and Pupils’ Performance*. Building and Environment 48: 215–223.
[8] Glen F C, N D Smith, L Jones, and D P Crabb 2016. ‘I Didn’t See That Coming’: Simulated Visual Fields and Driving Hazard Perception Test Performance. Clinical and Experimental Optometry 99 (5): 469–475
[9] Bonetta S, S Bonetta, S Mosso, S Sampò, and E Carraro 2010. *Assessment of Microbiological Indoor air Quality in an Italian Office Building Equipped with an HVAC System*. Environmental Monitoring and Assessment 161 (1- 4): 473–483
[10] Puslitbang Perkim, 2011 *Modul Rumah Sehat*, Pusat Penelitian dan Pengembangan Permukiman – Balitbang Kementerian Pekerjaan Umum
[11] Mirrahimi, S, M F Mohamed, L C Haw, N L N Ibrahim, W F M Yusoff, and A Aflaki 2016 *The Effect of Building Envelope on the Thermal Comfort and Energy Saving for High-Rise Buildings in hot–Humid Climate*. Renewable and Sustainable Energy Reviews 53: 1508–1519.