Sustainable housing as an approach to adaptive built environment to COVID-19 (case study: Keudah walk-up flat in Banda Aceh)

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Abstract. A home is one of the basic humans needs. In Covid 19 era, the conventional concept of a home has been challenged by the new face of requirement for covid 19 protocol. A home is not only functioned as a private individual domestic activity but it has also been used as a response of its new tasks as an office (WFH concept) or as a healing facility (self quarantine system). Another challenge for development nowadays is the limitation of natural resources. Thus, it is essensial that every development need to considered sustainable approach. This paper will explore on how sustainable approach implemented in walk-up flats and how the design adapts to global pandemic. Qualitative methods will be used with observation and interview as the main data collection. The finding of this study reveals that most of sustainable criteria has not yet implemented in Keudah walk-up flat. Accordingly, sets of design concepts for walk-up flats in Banda Aceh are proposed. Finally, the proposed concept can be used in the future, in order to adjust the need to prevent covid 19 as well as other pandemic in the future.

1. Introduction
Covid 19 has been around for more than a year from when was declared by World Health Organization (WHO) as a global pandemic on March 12th 2020. This pandemic is hazardous for its infectiousness. Indonesian Health Ministry stated that people infected by covid 19 has been significantly increase from 1.636.792 to 1.641.194 [1]. In order to minimize exposure and reduce the transmission of infection of Covid 19, many strategies were employed such as Work From Home (WFH) due to lockdown measure and hygiene measurement as well some protocol were temperature check on the entrance and maintain distance[2]. Thus, people were required to spend most of time at home. As a consequence, the way buildings as well as houses transform in order to adjust the needs for covid 19 requirements. Architects and designers need to response the challenge not only in response to covid 19 pandemic but another pandemic that might occur in the future. Thus, there is a need to establish a design that is not only fit human need but is based on its adaptation to the global pandemic.

In 2009, Banda Aceh Municipality has developed a Walk-up Flats in Gampong Keudah in order to overcome population growth in Banda Aceh that cause by urbanization. According to Badan Pusat Statistik in 2017, population in Banda Aceh increase by 2-5% yearly [3]. The development of walk-up Flat is seen as a solution for providing affordable housing for low-income community (Law Number
16 Year 1985 concerning Walk-up Flat) [4]. The Development of Walk-up Flats needs to highlight comfort and health for its residences especially under the current situation of covid 19. As stated recently by The Health Foundation, that housing can contribute positively to people’s mental and physical health and there is a need link between housing and health [5]. Similarly, housing expert from Diponegoro University, Dr.-Ing, Asnawi Manaf, S.T., explains that affordable housing can be measured based on three criteria: safety, spaciousness and health [6]. Whilst Ariffin and Raji cited in Murni and Samodra, suggest that one of criteria of decent and quality housing is that guarantee security, deliver easy access and other service facilities and low-cost environment [7].

The sustainability approach in housing is significantly becoming a key option for the recent housing development in Indonesia since it would help solve problems: preserving natural resources and creating a healthier, more humane domestic environment [8]. In Aceh case, which one of the government priority programs is known as Aceh Green that is highlighted in RPJM Aceh, the sustainable approach needs to be implemented in housing as well [9]. Thus, the development will guarantee the minimum environmental degradation as well as global warming or future global pandemic. Law Number 1 Year 2011 concerning Housing and Settlement, the government is obligated to provide access to low-income residences to affordable and liveable housing in an environment that guarantee safety, health, legal aspect as well as sustainability [10].

Keudah walk-up flat was commenced in 2010 and it consists of 4 blocks, 393 units [11]. The typical unit layout available comprised of 24 m² consist of a bedroom, a living room, pantry and a bathroom. According to the Housing Ministry of Indonesia, Peraturan Menteri Perumahan Rakyat No.22/PERMEN/M/2008, the minimum standard of living is 7.2 m² per person, whilst most of residence who live in walk-up flats are family of three [12]. Thus, most of residence will live in less than the required standard of living space (4.8 to 8 m² per person). The requirement for tenants who can live in keudah walk-up flat are having low income and are married.

This paper would like to investigate on how sustainable approach implemented in walk-up flats and how the design adapts to global pandemic. The case study is Keudah walk-up flat in Banda Aceh. The framework of this study guided by sustainable Architecture. However, this study will only explore three out of six above components of sustainable architecture because of limitation in time and resource of the study. Qualitative methods will be used with observation and interview as the main data collection.

2. Theoretical framework

2.1. Pandemics have re-shaped the built environment

WHO has labelled covid 19 as a global pandemic since it has infected more than 200 countries. It has significantly changed the way people behave toward the built environment. In order to reduce the risk of infection and prevent coronavirus such precaution as reduce mobility, physical distancing, work from home (WFH) and using online activity[13]. Another precaution is by increasing the level of basic of good hygiene such as promote regular hand washing. WHO also suggests that corona virus 19 stay alive in air conditioned room [14].

Thus, covid 19 has altered the behaviour pattern and health measurement needs to be considered such as checking temperature, hygiene precaution (hand washing, using hand sanitizer, etc) and providing enough space. According to Sonnenfeld, the way people adapt to built environments are divided into two ways [15]:

a. Adaptation, that is altering people behaviour and physical responses that fit in the build environment.

b. Adjustment, that is to change the built environment in order the fit the new required behaviour pattern.

A more appropriate approach will be selected depend on the existing physical setting of built environment and the need of user of the built environment[13]. This theoretical framework will be explored on Keudah walk-up flat and which adaptation is being used in order to adapt with the new
regulation. It seems that the fastest way to response to the need to covid protocol is “adaptation”, to altering people behaviour and physical responses that fit in the build environment[13]. Whilst the second approach of “adjustment” of the architecture design will require time as well financial capacity to renovate the built environment.

2.2. Sustainable development approach
Sustainable development concept is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs [16]. Pitts suggests that Sustainable Architecture have a goal to environment have limitation and cannot be hugely exploited [17]. Natural resources can be used as long as there is a sustainable principle and the implementation is based on to minimize the degradation of environment and promotes the harmonisation between architecture and environment as well as the use of natural resources.

Paola Sassi explains that there are some components to be considered in order to achieve sustainable design, those are[18]:

![Figure 1. Consideration for sustainable architecture](source: Strategies for Sustainable Architecture, 2006)

This study will only explore three out of six above components, because of limitation in time and resource of the study. Those three components used are also those closely links to the adaptation of built environment to covid 19 protocols.

2.2.1. Water
Water is a significant component of earth and 97,25% of water is the sea, whilst small other is in icecaps glacial and aquifer [18]. According Alley et al, ground water is one of the Nation's most important natural resources. It provides about 40 percent of the Nation's public water supply. Many people in the world including most of the rural population, supply their own drinking water from domestic wells[19].

Despite the fact that the SDGs has been largely acknowledged, the current development lack of consideration sustainability. As a result, rain water will directly flow to the ocean. A strategy such as minimising water need and maximising efficiency by reducing the amount of water used, which will subsequently reduce the amount of wastewater produced. Another strategy to conserve water is finding an alternative water source. Greywater and rainwater are alternative water sources that can be used for non-potable uses and, if treated appropriately, rainwater can also be used for drinking. Using alternative sources of water collected on the site reduces the need for the extraction, treatment, and distribution of fresh mains water, reducing pressure on freshwater sources and energy use.

2.2.2. Energy
The use of energy wisely is the most appropriate approach in implementing sustainable concept. The ideal way in implementing sustainable concept when energy is efficiently utilized. In addition, it is important to produce minimum waste. Using alternative energy from renewable resource is promoted. Some approaches can be used to minimize negative effect on environment. Firstly, by analysing the
amount of energy needed and altering with friendly energy resource without reducing the capacity of energy needed. Secondly, by initiating zero energy building or low energy building [18].

2.2.3. Health & well-being
Heath aspects that need to be considered including physical, psychological and social. In addition to the health aspect of the user of built environment, it is also important to considered environmental health. Built environment has optimal role involving safety, comfort and healthiness. The sustainable building gives positive impact to their surrounding environment. In the current pandemic context, the sustainable buildings can become a solution to health solution in response to covid 19.

3. Research methodology
This study utilizes qualitative methods, comprising in-depth interviews, direct observations and the use of archival material or documents as data resources. This multiple-method approach offers an understanding into how the data collection process builds up an enriched picture of the phenomenon under investigation, as well as providing a ‘triangulation’ process for data verification [20].

A case study approach has been chosen to address the research question as only this can explore the real-life context of the riverbank kampung residents. According to Yin, a case study approach provides a specific and in-depth analysis of phenomena in the inhabitants’ daily context in a particular place for a sustained period. This approach focuses on attempts to gain rich and deep information concerning the complexity of the study’s context [21]. In a similar way, Gilham argues that the meticulous description of a case study can have an impact much greater than almost any other form of study [22].

Qualitative interviewing is usually intended to refer an in-depth, semi-structured or loosely structured form of interviewing. Three residences were interviewed and were all conducted face-to-face lasted around sixty minutes. Observation is to capture a particular condition from real-life [23]. Data collected during observation were in the form of pictures and sketches. Secondary data were collected from online resources and some were obtained from relevant institutional agencies such as the office of Public Works and the office of Housing and Settlement and the Management Unit of Rusunawa.

4. Results and Discussion

4.1. The adaptation of Covid-19 in Keudah walk-up flat
Keudah walk-up flat is located at TWK Raja Keumala street in Gampong Keudah, Kutaraja district, Banda Aceh. The location is very strategic, it is placed in the heart of Banda Aceh. The walk-up flat comprises 384 residential units that is clustered into four blocks. In addition, there are also eight residential units for diffable that is located on the first floor. Moreover, there are a praying room, an aula, commercial area, parking area for motorcycle, garbage dump, facility for government as well public service. A typical residential unit consists of a bedroom, a living room, pantry and a bathroom. The size of residential unit is 4,5 m x 5,4 m= 24m2.
According researcher’s observation, the number of people live in residential unit is three to five people. Thus, from the perspective of minimum standard Jumlah for residential (7.2 m² per person) the current density of people live in the unit is between (4.8 to 8 m² per person). The existing typical residential unit is 24 m², does not fit with the number of people that is normally live in the unit which is four (interview. 4th April 2021).

The need for larger residential unit can be seen in the way they manage their balcony. From three units studied, two utilized balcony to keep their belongings such as clothes, shoes, cleaning tools and so on. Another existing function of a balcony in Keudah walk-up flat beside as a warehouse, a balcony also utilize as a clothesline area. The effect of high density of residential unit and a balcony that are not well functioned, the existing residential unit present as dense, lack of fresh air, dump, humid, hot temperature and rather dark.

From a sustainable approach, a balcony is an important element as it is often perceived as a "green" provision in modern residential buildings [24]. According to Chau et al, balcony boosts energy efficiency such as providing natural lighting and ventilation. Some other function of balcony is it mitigates traffic noise, advances the circulation of fresh air, and offers planting space.

Moreover, in current situation where covid 19 protocol suggests people to spend their time more at home (WFH), a balcony need to functioned as they are designed. It gives circulation of fresh air, which useful in keeping the air in the room flow. A balcony can be used as a place of covid patient get direct sun shine, do their hobby for instance planting decorative plants which is quite preferable nowadays.

Three residents interviewed hope that they have larger unit since the current unit cannot provide enough space for them to be able to ensure their daily activity done comfortably. The residents also hope to have two bedrooms in each residential unit, since they have two children which need their own
private space (second bedroom). Therefore, this study proposes to enlarge the unit to two-bedroom unit of 33m² as detailed in the below figure.

Another element in dwelling unit explored in the study is openings. Openings are voids in a wall such as windows, doors, vent, or niches. The design of Keudah walk-up flat have a quite good utilization of wind and sunlight orientation. The size of windows, doors and vents are considered appropriate to allow good circulation (Figure 4). However, there is a lack consideration in the selection of material for windows, which is from glass; it can give enough natural lighting and sunshine but it cannot provide cross ventilation. Thus, the quality of the dwelling unit is less comfortable as stated by some residents as follow: “....in the afternoon, our dwelling unit are quite comfortable in terms of wind can flow inside the room and we usually open all our doors and window during the day. However, we feel rather hot at night and it is uncomfortable since all the window are closed. We don’t open windows and doors because of mosquitos and the need to do private activity...” (Interview 1, 2021).

The proposed design to overcome the problem is by replacing glass window as well as glass ventilation with material that is still allowing wind to go through window, such as strip wooden window. In terms natural lighting in the dwelling unit is quite good, since all window has direct
connection with outside building. However, in some cases, the room quite dark and lack of natural lighting as well as natural ventilation in the case that opening are used to keep their belonging as describe in Figure 6.

![Figure 6. Kitchen](image)
(Source: field observation, 2021)

In figure 7. can be seen that the design with void in the middle allow to have enough windows and balcony allow them to have natural light for air circulation as well as drying the clothes. The building orientation is east-west thus natural wind can flow for the benefit of natural comfort in dwelling unit. The design of form of building layout as well as dwelling unit are incorporated in terms of allowing cross-ventilation happen in the dwelling unit.

![Figure 7. 3th - 5th floor plan – the use of void in the design](image)
(Source: Analysis)

Another problem occur in the Keudah walk-up flat is that the appearance as slum, unorganized and dirty. The corridor which shapes as a shape corridor use as clothes-lines, as a mean as a place to put resident’s belonging. The impact to the building is seen as slum and reduce the effectiveness of a corridor as a mean of common access to link between dwelling units (Figure 8).
One of covid Protocols ensuring a certain level of hygiene, such as promoting a regular use of hand washing with soap to prevent the germs attached on our hand. To ensure the protocol operates, there is a need of washing facility such as wastafel as well as a need of “water” itself. The clean water is supplied by PDAM (a public water company), which often well-supplied. The water supply by PDAM is not enough to be used by the residences. Thus, a drilled well is also used as a secondary mean of water supply. (Interview 2, 2021).

As previously mentioned, covid 19 promotes WFH. In Banda Aceh situation, when the city status is stated as “redzone”, WFH system are largely encourages. Thus, it is recommended that a dwelling can provide relaxation, increasing the mood in order to create self-healing process. The use of material mimic to nature are encouraged. Material relates to wood combined with the use of planting will give the intended effect (Figure 10).

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**Figure 8.** The existing situation of the corridor  
(Source: Field observation, 2021)

**Figure 9.** Keudah walk-up flat from the front  
(Source: Field observation, 2021)
In addition to building material that mimics nature as well as the use of plantation to create self-healing facility, an open space is also needed. Open space is available in Keudah walk-up flat and is located on each cluster on the ground floor. The activity on the open space during the covid 19 is used for sports dan obtaining sun-shine. However, the quality of existing open space needs to be increased. The existing condition of the flooring, that is from paving block which is likely to decrease the catchment area as well as lacking of “green” element needed for relaxation (Figure 11).

4.2. The adaptation of Keudah walk-up flat to sustainable approach: the proposed concepts
Sustainability is usually recognized as the procedures and actions through which civilization avoids the exhaustion of natural resources. It is also an action that in focused on keeping an ecological balance which the quality of life of modern cultures are not allow to decreased natural resources [25].
As earlier mentioned in previous part, the sustainable approach by Paola Sassi will be used to evaluate whether sustainable approach has been employed in the case study. Three from six criteria were explored. The first is how the water is provided, the second is how energy used, and the third is the health and wellbeing.

The water management considered an important criterion of sustainability, it is link to the situation in Banda Aceh where clean water is not perfectly supplied by PDAM, a public company. In Keudah walk-up flat, the supply for clean water is also provided by using drilled well. However, there is not gave alternative sources as to re-use gray water. The gray water that is processed can be used as a means of watering plants, cleaning motor cycle and cars and many other uses. The following approach is proposed: processing rain water to be used as some purposes.

![Figure 12. Collecting rain water to be uses as wateringthe plants and cleaning vehicles](source: analysis)

The second criteria need to be considered is the use of energy. The use of energy in Keudah walk-up flat is a conservative means which is using electricity supplied by PLN, a public owned company. The systems use by the residence is quite comfortable by using individual meter with prepaid electricity system. The maximum limits of electricity supplied is six amperes. However, the residents are likely to protest of the high electricity bill. This is written on Interview 3: “..... the prepaid system for electricity payment is quite expensive compare to conventional system. I wish there is system that allows us to pay less than our regular electricity bill. It will help us to minimize our daily expenses” (Interview 3, 2021)

Thus, this study proposes the use of solar panels at least for public facility so that it will decrease the burden of the management as describe in the following figure 13.

![Figure 13. The use of solar panel for public electricity](source: analysis)
The third criteria of sustainable approach by Paola Sassi is health and wellbeing. In terms of healthy measurement, an important measurement is to allow circulation and sunshine enter the dwelling unit. Most residents explained that there is enough natural lighting as well as ventilation in the room, however, in reality most window and balcony were block by residents’ belongings. Thus, the unit lack of natural lighting as well as natural ventilation and therefore, the dwelling unit seems to be uncomfortable. The proposed layout for two-bedroom unit also guarantees the natural lighting as well as wind can penetrate the dwelling unit to create comfortable thermal.

Figure 14. The proposed 2-bedroom unit and the opening system that allow natural lighting and natural thermal comfort.

Another criteria of the health and wellbeing for inhabitants is related to flood. One of the obvious positive impacts living in Keudah walk-up flat is that the residents do not experience regular flood anymore, which avoid them to be prone to water-based disease during the flood event. Each dwelling unit is furnished with a proper bathroom and toilet which oblige the resident to live healthier in term of sanitary aspect. In term of waste management, the previous system of vertical garbage system allowing minimum of effort to dump their rubbish, thus most residents are likely use the garbage facility properly.

Most important link to the health of residence is the density which less than required by health standard (7,2m2), thus to ensure that the dwelling room is healthy it needs to be enlarged from 24 m2 to 36 m2. The existing plan for dwelling unit has not provided enough space to put residents’ belonging, thus below design proposes the storage at the plafond balcony area (Figure 15).

Figure 15. The proposed 2 bedroom plan and the proposed storage in the balcony (Source: analysis)
5. Conclusions
As earlier mentioned, this study is to explore on how sustainable approach implemented in Keudah walk-up flats and how the design adapts to covid 19. The three components examined are water, energy, and health and wellbeing. Most of the sustainable criteria has not yet been employed in Keudah walk-up flat. Thus, sets of design are proposed such as using photovoltaic as an alternative energy source, using environmentally friendly building material, proposing larger dwelling unit, and so on. Some proposed changes are quite easy to be implemented and some are difficult. The most difficult to be exercised is the need for wider layout comprises 36 m2. Thus, sets of approach is also proposed in order to adjust to the need to prevent covid 19 as well as other pandemic in the future. Moreover, this study has limitation in investigating the full components of sustainability, another three of components has not investigated yet, thus it is recommended for future study.

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