Threshold space for prevention and control of COVID-19 exposed environment

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Abstract. Dwelling as an alternative to cure and isolate confirmed positive or asymptomatic people of COVID-19 becomes an essential place. However, it is necessary to ensure no physical contact between dwelling users since COVID-19 can be transmitted through droplets. Preventing and controlling the transmission is achieved by inserting transitional space between users, activities, or programs. The idea of transitional space is determined from Ramoh Aceh, an adaptive vernacular design that provides a boundary between public and private zones to limit access to strangers. This paper aims to translate space configurations of Ramoh Aceh as local wisdom to break the chain of COVID-19 transmission by making transitional space, a separation between confirmed positive or asymptomatic and healthy people. The data is obtained from the observation of three Ramoh Aceh in Banda Aceh and Aceh Besar. The space configurations are translated into five types of threshold space, promoting social distancing between users, providing cleaning space for personal hygiene, giving atmosphere for self-isolation, having natural ventilation features, and daylight exposure. Then, these types are explored and adapted in a contemporary dwelling design. As a final translation and exploration, this paper provides strategies and design recommendations for a threshold space in a contemporary dwelling design. The strategies and recommendations are explored and adapted in a 60 square meter house plan.

1. Introduction
COVID-19 outbreak has spread and become local transmission in the family cluster. The number of confirmed positive cases is increasing but at the same time, the healthcare facilities do not provide adequate service. Therefore, a house as an alternative place for self-isolation becomes essential, especially for asymptomatic patients. Since COVID-19 can be transmitted through droplets, it is necessary to ensure no physical contact between dwelling users. Personal hygiene and self-isolation are the important keys to prevent transmission and separate positive or asymptomatic people from healthy people during incubation. Then, activities and other layers occurring in the domestic environment should be adapted and transformed to protect inhabitants from threats [1].

On the other hand, local wisdom from vernacular architecture in Indonesia provides design solutions for prevention and control from pandemics in traditional houses for years. One of the local
wisdoms is the transition that occurs because of zoning in traditional houses. In this study, *Rumoh Aceh*, the Acehnese traditional house, is observed and translated because the architectural and structural model of *Rumoh Aceh* is an adaptive design [2]. At first, transitional activity and space in *Rumoh Aceh* existed to give a boundary between public and private zones, to limit access for strangers. The adaptive design of *Rumoh Aceh* for social distancing, personal hygiene, daylight, and airflow, etc is adapted and transformed to respond to the resilient interior of modern dwellings recently.

This paper aims to translate the local wisdom of *Rumoh Aceh* in the context of breaking the disease transmission of COVID-19 by making the transition, a separation between affected and healthy people. Finally, the translation results are proposed to a healthy and resilient contemporary dwelling design.

This paper also challenges the study of Suryandari [3] that analyzes spatial relation layout learned from the outdoor layout of Chinese and Javanese yards. Suryandari proposed that for prevention of disease transmission, there are three layout typologies of program combination (indoor, transition, outdoor) applied into modern dwelling according to five variables such as disinfectant, cleaning, natural lighting, isolation, health worker circulation, and social distancing [3]. Instead, this paper proposed a new way to translate and implement the local wisdom to contemporary dwelling design.

2. Threshold as material and experience for healthy space

Thresholds are transitional situations and experienced spaces that state different conditions [4]. In the context of materiality, thresholds exist as physical architectural elements such as doors, gates, portals, doors, bridges, porches, etc [4]. Subjectively, a threshold is an experienced space as moving in between medium qualities [4]. As a material, the threshold is a function to block, limit, to ensure the boundary in-between space. Instead, the threshold as space elicited transitional activities to minimize disease transmission through physical contact. These activities can include cleaning, changing, and interaction.

A study by Emmanuel [5] reveals that there are four strategies for infection prevention and control in healthcare facilities, such as social distancing, natural ventilation, daylight, and materials. These strategies can be applied to threshold space design and configuration. Since the COVID-19 virus is transmitted through droplet transmission and physical contact, providing enough space at least 100 cm apart supports social distancing including circulation and waiting [5]. Space that is exposed to daylight and natural airflow restricts threat transmission [5]. Threshold space design should consider the material used, specification, and treatment of the surfaces since the COVID-19 reacts and occupies differently depending on the material [5]. COVID-19 virus occurs on plastic and stainless-steel surfaces up to 3 days more than on aerosol, copper, and cardboard (less than 24 hours) [6].

To briefly summarize, threshold space for infection prevention and control of COVID-19 is an experience and material space in between which has four qualities and configurations to users. Supporting social distancing, providing natural ventilation, exposing daylight, and using materials with COVID-19 treatment surfaces are the four qualities and configurations.

3. Methods

The study used a qualitative method that relied on primary and secondary data. The primary data was obtained from observation, which observed the space configuration and material of *Rumoh Aceh*. The secondary data was obtained from a literature study to get information about strategies for healthy and safe space, as well as information about other local wisdom in *Rumoh Aceh*. Field observations are conducted in three *Rumoh Aceh* located in Aceh Besar and Banda Aceh owned by Mrs. Mahyuni in Lambunot Village, Aceh Besar, Mrs. Hindun binti Abdul Qodir in Purauda Village, Banda Aceh and Mr. Sulaiman Abda in Tibang Village, Banda Aceh.

Data from observation are displayed in images, diagrams, and descriptive texts. The data from the literature study is coded based on the adequate information demanded. The data obtained was
displayed in descriptive texts along with appropriate figures. Analysis of the data using an interpretive technique to translate the idea of the application in *Rumoh Aceh* to a contemporary design.

The configurations of space and adaptive use of these *Rumoh Aceh* are translated into ideas to form threshold design exploration. The translation was displayed in the table to simplify the keywords. The exploration design is based on the definition by Atmodiwirjo [4] and the strategies of Emmanuel’s study [5] applied in contemporary dwelling design. This study applied the translation into a dwelling model of a healthy and safe interior.

4. Result and discussion

4.1. Translation of threshold space in *Rumoh Aceh*

*Rumoh Aceh* is a stilted house that has ground level or underneath space and upper level (rumoh). In the interior zoning of the upper level, *Rumoh Aceh* is divided into three areas, seuramoe agam/seuramoe keu, seuramoe teungoh/dalam and seuramoe inong/seuramoe likot [2]-[7]-[8]. This section explores the area of *Rumoh Aceh* that provides transitional space according to the definition explained in the previous section.

The *Rumoh Aceh* observed are owned by Mrs. Hindun binti Abdul Qodir, Mr. Sulaiman Abda and Mrs. Mahyuni. As seen in the figures below (figure 2a-f), even though these *Rumoh Aceh* have been adapted according to its users’ life cycle, it still preserved the original type of main configurations. Since the upper level of *Rumoh Aceh* owned by Mrs. Hindun binti Abdul Qodir and Mr. Sulaiman Abda still has a different elevation (figure 3a-b), it can be a boundary of threshold space as experienced space.

There are eight zoning areas in *Rumoh Aceh* that have transitional activities and spaces (figure 4-11). The transitional activities and spaces occur in the underneath level (*rumoh yub*), cleaning space, stair, hallway (seulasa), seuramoe keu, seuramoe teungoh or kama, rambat and seuramoe likot.

![Figure 1. Rumoh Aceh owned by Mrs. Hindun binti Abdul Qodir (left), Mr. Sulaiman Abda (middle) and Mrs. Mahyuni (right)](image-url)
Figure 2. Space configuration on the underneath level (a) and upper level (b) of Rumoh Aceh owned by Mrs. Hindun binti Abdul Qodir; on the underneath level (c) and upper level (d) of Rumoh Aceh owned by Mr. Sulaiman Abda; on the underneath level (e) and upper level (f) of Rumoh Aceh owned by Mrs. Mahyuni.

Figure 3. Space configuration on cross section (a-left) and longitudinal section (a-right) of Rumoh Aceh owned by Mrs. Hindun binti Abdul Qodir; on cross section (b-left) and longitudinal section (b-right) of Rumoh Aceh owned by Mr. Sulaiman Abda; on cross section (c-left) and longitudinal section (c-right) of Rumoh Aceh owned by Mrs. Mahyuni.

The underneath or rumoh yub area is an open space which is the most desirable space [2], flexible and multifunctional public space [8]. Even though the majority of people assemble in this area, the minimum 600-900 centimeters wide and long and 250-300 centimeters high provides adequate social distancing and natural ventilation. Hence, rumoh yub is the type of transitional space that supports social distancing and ensures airflow. The space which is occupied mainly during the day [2] is a transitional experience to strangers before entering Rumoh Aceh (upper level).
Figure 4. The mechanism of social distancing (magenta areas) and airflow (blue arrows) in plan (a) and section (b) of Rumoh Aceh owned by Mrs. Hindun binti Abdul Qodir; in plan (c) and section (d) of Rumoh Aceh owned by Mr. Sulaiman Abda; in plan (e) and section (f) of Rumoh Aceh owned by Mrs. Mahyuni.

Rumoh Aceh owner provides a cleaning space next to the stairs [8]. In this area, there is a clay jar as a water reservoir, a wood stick to hook a dipper, and composed stone as floor. Thus, everyone has cleaned his or her hands and feet before entering the house. This space includes transitional activities such as cleaning personal stuff and body, and mechanism from contaminated conditions from outside into hygienic conditions. Only Rumoh Aceh owned by Mr. Sulaiman Abda still has a cleaning space put next to one of the entrance stairs. This space also provides experience transition with gravel in the bottom layer.

Figure 5. The mechanism of cleaning space in Rumoh Aceh owned by Mr. Sulaiman Abda.

Stairs in Rumoh Aceh function as social control and a threshold to strangers [9]. Then, some types of Rumoh Aceh provide 100 centimeters wide hallways [8] that connect stairs to the seuramoe keu entrance as the foyer. Hallway as foyer can be a waiting space and separate activities between man, guest, and woman. In Rumoh Aceh owned by Mrs. Hindun binti Abdul Qodir, there is a door as a physical architecture element that separates the stair area and hallway. All the hallways in observed Rumoh Aceh are open spaces that get natural air circulation and daylight exposure. Both stair and hallway give material transition to users.

Figure 6. The stair as threshold space in Rumoh Aceh owned by Mrs. Hindun binti Abdul Qodir (a); owned by Mr. Sulaiman Abda (b); owned by Mrs. Mahyuni (c)
Figure 7. The mechanism of *seulasa* (hallway) as threshold space in *Rumoh Aceh* owned by Mrs. Hindun binti Abdul Qodir (left), Mr. Sulaiman Abda (middle), and Mrs. Mahyuni (right).

*Seuramoe agam* or *seuramoe keu* area functions as public space [2]-[7]-[9] and semipublic [8] for man’s (*agam*) and private guest activities. *Seuramoe agam* area separates activities between man–woman and owner–private guests in *Rumoh Aceh* [7]. *Seuramoe agam* also becomes the last zoning that allows non-owner to stay. So, it indirectly inhibits private guests from entering private areas such as *seuramoe teungoh* and *seuramoe likot* [7]. These characteristics minimize transmission by physical contact. This area is experience and material transition.

![Diagram of Seuramoe Agam and Seuramoe Keu](image1)

**Figure 8.** The mechanism of threshold in *seuramoe keu* of *Rumoh Aceh* owned by Mrs. Hindun binti Abdul Qodir (a); owned by Mr. Sulaiman Abda (b); owned by Mrs. Mahyuni (c)

*Seuramoe teungoh* [8] or *dalam* [2] or *tungai/kama* [9] or *seuramoe inong* [8]-[9] area is a bedroom for parents and/or daughter/girl [7]. The bedroom is located in West-East orientation so it gets natural ventilation and exposure to daylight. This private zone has the highest hierarchy in *Rumoh Aceh* and allows the owner to do self-isolation. In this area, *rambat* become a space for circulation and separation. *Rambat* not only connects *seuramoe keu* and *seuramoe likot* but separates between two bedrooms. Mrs. Mahyuni combined *seuramoe keu* with one of *dalam* (bedroom) to become a wider space for *seuramoe*. Both *seuramoe teungoh* and *rambat* provide experience and material transition. Mr. Sulaiman Abda does not connect *seuramoe keu* and *seuramoe likot* with *rambat* but with *seulasa* or hallway.

![Diagram of Rambat](image2)

**Figure 9.** The mechanism of threshold in *rambat* of *Rumoh Aceh* owned by Mrs. Hindun binti Abdul Qodir (left) and Mrs. Mahyuni (right)
As rumoh yub or underneath of Rumoh Aceh function as a communal kitchen [2], Acehnese people use Seuramoe likot as a private kitchen and only women's area [7]. Rumoh Aceh owned by Mrs. Hindun binti Abdul Qodir has private access from the hallway to seuramoe likot. This characteristic of threshold space separates two circulations, hallway-seuramoe keu and hallway-seuramoe likot. It can be the threshold between a suspect and a healthy person. All of these observed Rumoh Aceh have other access to seuramoe likot through back stairs. This condition can allow seuramoe likot as a self-isolation zone if it is separated from the kitchen.

Zoning in Rumoh Aceh reveals the distinct transitional activities that can be translated and adapted into spatial configurations or programming of contemporary dwellings. In addition, Rumoh Aceh has moving structural systems allowing it to be moved from one place to another [10] and combining spaces [2]. Thus, movable elements of the structure of Rumoh Aceh can be explored to either form new configurations or merge spaces into new threshold space. Table 1 below concludes the translation of the transitional characteristics of threshold space in Rumoh Aceh.

| Type    | Program          | Transition   | Translation          |
|---------|------------------|--------------|----------------------|
| A, D    | underneath/rumoh yub | experience transition | social distancing natural ventilation |
| B       | cleaning space   | experience transition | personal hygiene |
| A       | stair            | material transition | social distancing |
| A, D, E | hallway/seulasa  | material transition | social distancing |
4.2. Exploration threshold on contemporary dwelling

The COVID-19 pandemic provides lessons learned on how spatial configurations can alter to respond for protection [11]. Architects should rethink the dwelling configurations to allow users to do daily life activities at the same time to do self-isolation securely. For instance, inserting cleaning space between the garage and living room or living room and bedroom. Domestic activities are forced to adapt as COVID-19 outbreak that prohibits contact with the threatening world [1].

|   | Experience transition | Material transition | Natural ventilation | Daylight exposure | Social distancing |
|---|------------------------|---------------------|---------------------|-------------------|------------------|
| A | seuramoe keu           |                     |                     |                   |                  |
| A, C, D, E | bedroom/dalam         |                     |                     |                   |                  |
| A | rambat                 |                     |                     |                   |                  |
| A | seuramoe likot         |                     |                     |                   |                  |

As figure 12 illustrates, the occurrence of threshold becomes essential as transitional between dangerous zone and healthy zone. In an ideal context, the outdoor is threatening and the indoor should be a safe zone. Instead, threshold space is a buffer in between this zone, especially during pandemics. This section aims to explore the translation of the existing threshold of Rumoh Aceh into contemporary dwelling design.

Figure 12. Threshold is transitional state between threatening outdoor and safe indoor

Figure 13. Translation of threshold types in Rumoh Aceh
Based on the translation of transitional space in *Rumoh Aceh*, there are five types of threshold space that can be adapted into contemporary dwellings. Type A is a threshold space that promotes social distancing between users. Type B is a threshold space that provides cleaning space for personal hygiene and changing. Type C is a threshold space that gives an atmosphere for self-isolation. Natural ventilation is a feature of threshold space of type D. Exposing daylight in space is a threshold space of type E. These types and their relation to other spaces are illustrated in the diagrams below.

4.3. Model

In this section, this paper attempts to ‘insert’ the explored threshold space into contemporary dwelling design. The type of designed dwelling is a 60 square meter house plan, the domestic design which has enough space for 4-6 users. The explored dwelling design has a large courtyard, a cleaning space, a kitchen, a dining/living room, three bedrooms, and two bathrooms. Figure 14 shows the configuration of these programs.

![Figure 14. The explored model of a 60 square meter house plan](image)

As figure 15-left illustrates, a large courtyard permits interactions with strangers, providing natural ventilation and exposing daylight. This experience transition of type A, D, and E mechanisms are translated from the underneath level of *Rumoh Aceh*.

![Figure 15. The mechanism of type A, D, and E (left) and type A (right) in dwelling design](image)

Stair, *seulasa*, and *rambat* as experience and material transition are adapted into a hallway and a dining/living room (figure 15-right). A hallway separates outdoor (courtyard) with indoor (cleaning space and kitchen) for strangers. In addition, a dining/living room gives an experience and material boundaries to users before entering the bedroom (private area).
Type B is inserted in dwelling design as a cleaning space. Cleaning space put in between outdoor and kitchen (indoors). It has spaces for personal hygiene (washing hands and showering) and changing clothes. This programming promotes users to change contaminated conditions from outside into hygienic conditions.

There are three scenarios that occur when exploring type C, D, and E as threshold space for self-isolation. The designed bedrooms support self-isolation by giving access to the confirmed positive or asymptomatic people to the toilet, providing natural ventilation, and exposing users to daylight. Green zones are the material transition that separate incubation space from the safe zone or healthy people.

5. Conclusions
Threshold space is one of the local wisdoms of Rumoh Aceh, an adaptive house model design that provides design mechanisms. Its mechanism can prevent and control dwelling users from pandemics by five types such as separating threatening activities and safe zones, allowing natural ventilation and daylight, promoting social distancing and personal hygiene, and self-isolation.

This paper showed that the vernacular house in Aceh had its own genius loci which sustained for years that can be adapted to contemporary design. It proves that local wisdom translated from vernacular houses can not be ignored.

This study contributed to finding a shifting of space strategies from the local wisdom of vernacular houses which is not yet a concern in solving virus spread in the pandemic era. Further research should be undertaken to measure the natural lighting and ventilation demanded in a quantitative method as well as the anthropometric space required. In addition, other typologies of dwelling should be explored to ‘insert’ threshold space in order to prevent and control the transmission of COVID-19.
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