An Analysis of Architectural Approach Towards the Efficiency of RISHA as Post-Disaster Housing Response in Indonesia

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Abstract. Indonesia has been frequently hit by devastating natural disasters that occurred one after another due to its geographical location that falls on the Ring of Fire. The loss of properties and the needs for shelter caused post-disaster housing high on demand. It became a significant sector during the reconstruction period of the post-disastrous event. Indonesian government introduced RISHA – Healthy, Modest, Instantaneous House – as a means to rebuild the houses with earthquake resistant technology. This paper highlights the points associated with the construction of RISHA: the manufacturing process, the complexity of the construction method, and the parties involved. Through analyzing the data obtained, qualitative approach is used to identify the key points in order to determine the efficiency and to suggest the technical solution for improvement of RISHA in architectural and construction perspectives as a response for post-disaster housing in Indonesia.

1. Introduction
The geographical location of Indonesia that falls on the Ring of Fire makes the occurrence of natural disasters inevitable. This circumstance does not only taking tolls on human casualties, but also damaging various infrastructure in which housing often took the biggest hit [1]. Mukherji [2] stated that, with 1,806,648 individuals, Indonesia is placed 8th on the ranks of homelessness due to natural disasters. The following issue further results in the emergence of housing reconstruction urgency, which comprises the needs for suitable methods of construction that can fit the constraints that arise during its implementation to carry out the reconstruction process efficiently. High demand in housing urged the Indonesian government to implement the large scale of the housing recovery program, making conventional construction method is no longer efficient in fulfilling the needs of hundreds and even thousands of post-disaster housing.

In the occurrence of a catastrophic event that leads to homelessness, the immediate demand is for shelter that morphs into housing over several weeks. The recovery program has to be carried out on a short period to settle back to the affected community. Providing housing is a complex action since the many factors affecting the implementation process. Tas et al. [3] carried out participation survey of the parties involved in the reconstruction process regarding the factors that are affecting the construction process, which involves material, construction equipment, workforce, time and economy. It was
determined that among those factors, time makes the most impact, hence, it can be stated that time is a critical factor in post-disaster housing reconstruction process (Figure 1).

![Figure 1. Factors involved on housing reconstruction process according to Tas et al [3].](image)

Since the conventional construction method is considered inefficient to comply with the needs for large scale reconstruction, one of the alternatives to encounter time constraint on the reconstruction process is prefab architecture. The term prefabrication refers to elements intended for building construction that are produced offsite to a greater degree of finish and assembled on site [4]. The schematic construction process is illustrated by Van Gassel and Roders [5] in Figure 2. This technology offers efficiency in various aspect on its construction, method which later results in shorter construction periods and lower cost.

![Figure 2. Modular prefabrication construction process scheme [5].](image)

In regards to that, as part of the rehabilitation process of the earthquake that hit Lombok in 2018, Indonesian government has budgeted IDR 50 million for each head of household whose house have been severely damaged to rebuild their houses with RISHA (Healthy, Modest, Instantaneous House). It is a modular prefabrication with knock-down concept that combines precast concrete panels with bolts. The whole installation process is claimed to be completed within 24 hours, with only three workers [6].

RISHA initially emerged in 2004 as post-disaster housing response of Aceh Tsunami that was considered as the worst disaster of that decade in Indonesia. As of now, the technology of RISHA has met the Indonesian National Standard (SNI), and its patent belongs to the Ministry of Public Works and Housing. RISHA does not only cater as a means to build and rehabilitate damaged houses but also to meet housing needs for low-income community due to its low construction cost. On the implementation of RISHA, Ministry of Public Works and Housing took the initiative to provides training and involves third-party distributor as pre-casters to build these low cost, instant homes. This action is further intended to empower the local workforce and to improve community skills.
Since its first establishment in 2004, RISHA has been going under research and development process and is claimed to provide various advantages in its construction method, including (1) earthquake resistant, (2) environmentally friendly, (3) short construction time, (4) lightweight components that do not require heavy equipment, (5) moveable, and (6) can be installed as office buildings, health centers, hospitals, schools and others [7].

This paper attempts to analyze RISHA from its architectural perspective, which encompasses the construction method and its implication to estimate the potential and efficiency of RISHA as the response for post-disaster housing in Indonesia. The latter result is expected to provide necessary information to develop a more comprehensive approach regarding the housing reconstruction in post-disaster rehabilitation process.

2. Method
A qualitative approach is used as the methodology of this paper to obtain the expected result through a descriptive analysis of literature study regarding modular prefabrication construction method. Comparative study is further done to analyze the literature review to the existing implementation of RISHA with indicators as follows:

- Prefabrication and Architecture. Discussing prefabrication and architecture in the context of its functional design efficiency, both theoretically and the current existing architectural implication of RISHA.
- Time constraints; involves various design strategies which in entirety, encompass the manufacturing process, the complexity of design method, and the parties involved.

3. Results and Discussions

3.1. Post-disaster Reconstruction
Housing reconstruction is a priority in post-disaster recovery program due to its arising immediate demand during the initial period after the occurrence of a catastrophic event. According to Quarantelli [8], there are four phases of post-disaster housing recovery: emergency sheltering, temporary sheltering, temporary housing, and permanent housing (Figure 3). However, as shown in Figure 4, phases of post-disaster housing recovery in Indonesia only went through three phases since it incorporates temporary sheltering and housing. The application of RISHA as post-disaster housing response, inherently, can further simplify those sequence by integrating temporary housing that can also act as permanent housing considering its construction method and building utilization that can fit on its implementation as presented in Figure 5 and described thoroughly on the following discussion. Moreover, explanation by Quarantelli [8] in which temporary housing may become permanent housing for low-income victims is further supporting the simplified sequence that may occur with the application of RISHA.

![Figure 3. Phases of post-disaster housing recovery [8].](image-url)
Figure 4. Phases of post-disaster housing recovery in Indonesia.

Figure 5. The simplified sequence that could be obtained through the application of RISHA.

3.2. Implementation of RISHA

3.2.1. Prefabrication and Architecture
Prefabrication has been associated with endless rows of charmless, cookie-cutter structures built with cheap materials and substandard construction method. It is further supported by Jay Baldwin with his statement that many prefab models are certainly CATNAP (Cheapest Available Technology Narrowly Avoiding Prosecution) and destined for early demise [9]. However, since time is the most critical factor in the context of post-disaster housing that calls for fast response, it encouraged functionality in architectural design. Prefabrication answered to that demand with its technology that fundamentally refers to standardization as a means to improve conventional construction in terms of construction time and to offer better value [4].

The implementation of RISHA is not distinct from its fundamental concept. With modular prefabrication, its design complexity is limited to its module shape, rendering the whole complete form monotonous (Figure 6). As a response for post-disaster housing, RISHA caters the demand for temporary housing as it complies to the needs for functionality to establish household routines. Yet, it is considered inefficient since its bland form does not conform to specific needs required for inhabitation.
Literature study on prefabrication method points out that the technology challenges the prejudices of architecture in which it questions the concept of authorship since it disallows the specific needs and qualities of individual clients. Additionally, the reliance on manufactured production resulted in a bland, monotonous form, eliminating the essence of inhabitation in architecture [4]. In regards to the following pros and cons, it can be concluded that RISHA meets the demand for functionality as the first response for post-disaster housing. However, in the context of design efficiency for current circumstances in which its implementation is also designated for permanent housing, RISHA does not cater its full potential for long term inhabitation.

4. Time
Implication on design to accommodate a building with specific time constraints includes strategies that are similar to prefabrication as follows:

| Design Strategy          | Literature Review                                                                 | RISHA                                                                                       |
|--------------------------|-----------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| Designed for disassembly | User is the core of the design process and construction; hence; it has to be open, adaptable, changeable, and flexible. | The use of modular panels in the implementation of RISHA (Figure 7) is designated for adaptive changes and fast installation that it refers to the simplification of the construction system that is easy for assembly and disassembly. Adequate |
| Designed for reuse       | Facilitating the reuse of building must be accommodated with standard materials and several strategies as follows: | Adequate, yet inefficient                                                                 |
|                          | - Less connection                                                                 | - RISHA used dry jointing with a steel plate and bolts that resulted in fewer and simple connections. The use of steel plate against concrete panels makes it easy to identify the points of disassembly (Figure 8). |
|                          | - Deliberate handling connection                                                  |                                                                                             |

Figure 6. Application of RISHA [7].

Figure 7. Components of RISHA [10]
(lifting points)
- Easily handled components that are lightweight
- Identifying points of disassembly

Figure 8. RISHA jointing [10]

- The crooks on each module make handling and lifting easier, yet in the context of weight, it is still deliberately heavy considering its structural panel P2 and P3 dimension – 20 cm x 120 cm and 30 x 120 cm consecutively – weights on average 40 kg in which it exceeded the maximum weight able to be carried by a person. According to ISO 11228-1, 25 kg is the maximum weight for 95% men and 70% women to lift. Moreover, MMH (Manual Materials Handling) reported that 90% of men can lift 27 kg, and women could lift the weight as heavy as 20 kg [11].

In terms of design, the implementation of RISHA caters to functionality, obtained by the bland shape of each module and construction system that relatively refers to temporal use. The use of OPC as a building material in RISHA resulted in the durability of the house that is claimed to be able to withhold earthquakes on zone 6, of which is the area with the highest risk of earthquake in Indonesia. Additionally, the durability of OPC asserts for long term utilization in terms of building performance, corresponding to its initial aim for both temporary and permanent housing.

Adequate, yet inefficient

Adequate

Discussed for temporality

The key point in disaster relief theory is fundamentally to help the community rebuild themselves. Hence, the architectural solution summed up as “the more temporary, the better,” representing the needs to provide temporary and durable housing.

Designed for change

Design for adaptability, flexibility, changeability can be classified into two primary approaches:  
- **Soft flexibility** (user determines the adaptation, ex: open floor

RISHA is classified into *soft flexibility* approach in regards to its adaptable and changeable floor plans that reckons on the arrangement of its modular panels. It is claimed as a growing house considering its flexibility for expansion; be it an
plan that allows for change and adaptation over time)

- **Hard flexibility**
  (architects making decisions regarding how the adaptation will occur, ex: moveable building elements)

additional upper floor or a larger floor plan [7]. However, this calls for reinforcement or an extension on its structural component – a complex process on its own. Hence, the soft flexibility approach implemented on RISHA is not completely efficient. Moreover, RISHA has its typical floor plan that has been developed before by the Ministry of Public Works and Housing depending on its size (31 m², 36 m², 39 m² and so on), enacting this innovation not as flexible as its intended adaptability and flexibility.

### 5. Conclusions

In general, the implementation of RISHA as post-disaster housing in Indonesia has met several factors required as post-disaster housing response, yet, there are a few aspects that needed to be reconsidered for the later development of this innovation in order to make it as efficient to fulfill its initial objective – both as temporary and permanent housing – which comprises of:

- More convenient installation of RISHA components that did not exceed 30 kg of weight considering the low skilled labor that is commissioned from the local community to build the house.
- Reconsideration on its flexibility aspect that caters the demand for future growth and adaptation over time in terms of its building component element and construction method of this technology.
- Implication on the architectural design that does not only comply for functionality but also incorporating design consideration for long term inhabitation.

Prefabrication shall not put aside the involvement of architects in terms of the loss of originality and authorship yielded from its standardized construction method. It is rather a challenge to highlight the immense importance of creating a well-designed space that is both functional and in correspondence with the demand for inhabitation. Adjustment and improvement that cater to the needs of the user and responding towards its local environment will always have to be considered and developed to provide a better quality of housing for the community.

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