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Resilience Residental Planning on Safety-based Urban Housing

Case study on urban housing in Malang City, Indonesia

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Abstract: The design of an environment can affect the quality of any habitable space that humans can live in with a sense of security and comfort. Malang is one of the most developed cities in Indonesia faced with high population and building density problems, where floods and fires are a major threat. This requires a solution that involves planning and physical structuring studies in order to produce a concept of safe urban settlements to improve the safety of city environment toward fire-related disasters. This will also includes planning for evacuation routes, safety facilities and emergency measures within building requirements. It is expected that the concept of fire-responsive settlements will be obtained by using safety-based urban design elements. The method was carried out by conducting an analysis of observing the existing physical conditions by considering socio-cultural, psychological, behavior, and safety aspects. The result of this study will be in the form of design criterias and concepts for residential areas. Furthermore, the concept can be used to support disaster mitigation efforts, reduce fire vulnerability, and increase preparedness to disasters.

1. INTRODUCTION

The development of Malang city is an opportunity for the surrounding area to urbanize. Every human being who resettles is trying to fulfill one of their main needs: residence. Unfortunately, limitations have often made this effort goes unfulfilled. The lack of land availability for the provision of settlements has a direct impact on the growth of inadequate settlements. It is considered as inadequate or improper because these settlements were erected in places that should not be turned into residential land; for example, settlements in watersheds, on the outskirts of the railroad tracks, or along the green lines. Even worse, the quality of buildings were also far below the standard. Furthermore, Malang City is not vulnerable to natural disasters like earthquakes and landslides, and now floods and fires have occurred more frequently following the rapid developments in the city. Most fires in Malang were caused by electric shortings and negligence of the residents themselves. The densed and crowded buildings within an environment have also contribute in the spreading of fire. Narrow residential roads hampered the evacuation process, and the temperatures during the dry season have raised

the risk of fire even greater, since traditional houses still cannot be separated from the use of woods in their design. To reduce potential damage and losses due to fires, preventive measures are needed and they are viable by structuring settlements and designing fire responsive environments. This is to support disaster mitigation efforts, also to improve preparedness in the face of disasters. Several factors that were taken into consideration in this study were population density, buildings, data of fire incidents, building conditions, and water availability.

1.1 Disaster Management and Environmental Design

With disaster management, we can reduce the impact of disasters and be able to make recovery strategies after a disaster (Ali and Novogradec, 2008, Dahl, 2011, Khan et al., 2008, Navitas, 2013). The strategies and activities carried out are:

- **Pre-disaster (disaster mitigation and preparedness):**
  Mitigation related to activities or actions in avoiding disasters, or minimizing impacts. Preparedness include all activities and actions in the event of a disaster.
- **In the event of a disaster (response):**
  Activities carried out when a disaster take place. These steps designed to reduce the casualties and prevent greater damage.
- **Post-disaster (Recovery):**
  After the disaster, the efforts made to repair the damages and restore the environment like its original state. This stage is also known as the 'bounce back' stage.

The activities in each of the stages above are interrelated and formed a cycle of an experience that later will become an input for preparation in the event of a disaster in the future. This experience will provide important input for better mitigation and preparedness which will result in a better response as well.

Figure 1. Disaster Management Cycle

The basic objectives of urban design are to create a place with many contributing factors and to create an environment of good quality. These goals are also a major determinant of the success of urban design (Cai and Wang, 2009). Public safety is one of the key factors to determine the quality of a good environment. An environment may not be considered as a successfully designed space if it cannot guarantee the safety of its users, even though if it is aesthetically beautiful. There are three opportunities in which

environmental design can be normatively and creatively included within the disaster management cycle:

- **Mitigation:** In the event of a fire, fire spreads through convection, conduction, and thermal radiation (Himoto and Tanaka, 2008, Ramli, 2010, Schrol, 2006), therefore an environmental design must measure a minimum distance between buildings or include a fire-resistant structure installed between them as requirements.
- **Preparedness:** Has a clear escape route and informative signs that will be very helpful for the residents in case of fire. Fire hydrant posts must also be available in all regions to store water supplies and be within reach of the firefighters.
- **Response:** Improve pedestrian paths and vehicle circulation. The road lane must physically be able to accommodate the width, length, and maneuverability of a fire truck.

2. METHODOLOGY

The research is a case study to the existing conditions of settlements in Kidul Dalem Village, Malang City and its relationship with fire hazards. The study will focus on 3 aspects: building density, road conditions, and environmental facilities & infrastructure. The data collection process will be started by collecting initial data, namely secondary data such as maps and other documents. Then a non-participant observation was carried out to collect primary data regarding the actual condition of the object the study. After data collection, the analysis process will be carried out by using mixed analysis method; both qualitative and quantitative analysis, to produce problem solving conclusion.

3. PROPOSED DESIGN APPROACH

3.1 Overview of the Location of Kidul Dalem Village

The focus of the study are the settlements located in the Kidul Dalem Village, Malang. Also known as Embong Brantas, this area consisted of 7 RT (neighbourhood association) with ±1000 residents with an area of +2,4ha.

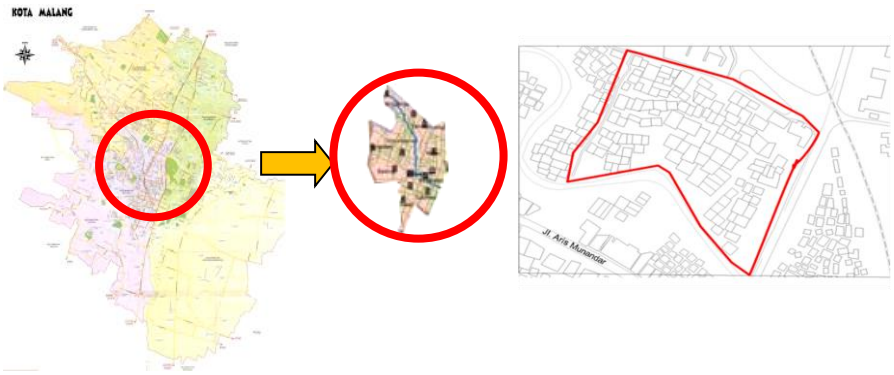

Figure 2. Reasearch Area

3.2 Site Analysis

Environmental problem solving is divided into two alternative concepts, namely **a)** improvement concept (existing) and **b)** development concept (ideal).

3.2.1 Improvement Concept

This concept considers aspects of local conditions, which are land availability and conditions in the community. This concept can be realized in a shorter time, because it does not change the existing conditions. Some of the steps need to be taken in conducting settlement arrangements will also include:

a. Determine the hose radius and the bursts rate of water from the river.
b. Determine the location of additional water sources (i.e. ponds) at locations that may not be able to be reached by hydrants and river post radius, by adjusting the available vacant land.
c. Adding access to dead-end roads by connecting them to the nearest road; both to facilitate evacuations and to put out fire.
d. A mapping of fire truck paths to plan hose range from the lane.

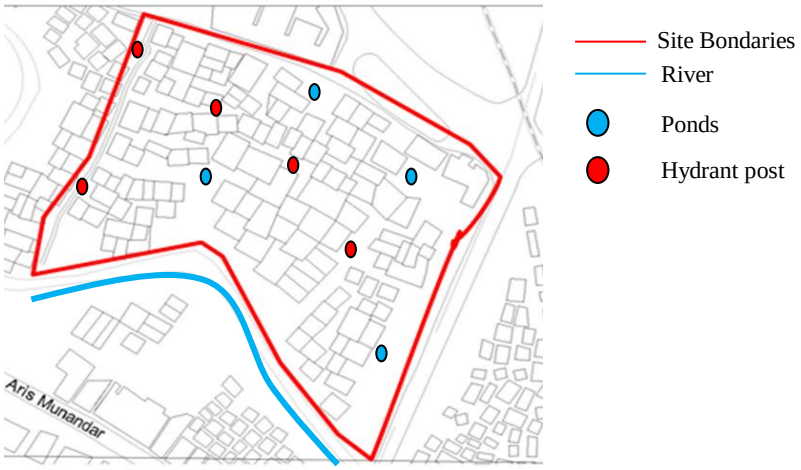

Figure 3. Improvement Concept

3.2.2 Development Concept

The ideal concept is an alternative concept that is expected to be applied in the future or long-term manifestations. This ideal concept can be a proposed criteria for future residential fire response.

A. Analysis of the size and number of residents

In SNI 03-1733-2004, the requirements stipulated that a settlement consisted three types of standard houses: small, medium, big. The settlement must use a ratio of 6 small houses : 3 medium houses : 1 big house within one residential block. The three types of building are divided into occupancy magnitude and number of occupants.

Table 1. Analysis of Occupancy Magnitude and Number of Occupants

Building Type Standart	Building Type Exsistimg	Minimum Floor Area Per Person	Total Occupants in the Building
Small House (36 Type)	36 Type	9 m^2	4 Person
Medium House (45-54 Type)	45 Type	9 m^2	5 Person
Big House (70-120 Type)	72 Type	9 m^2	8 Person

B. Analysis of the lot size

Residence that are too close to each other can accelerate the spread of fire during a fire. To determine the dimensions of the lot, we must refer to several regulations regarding the provisions of the housing development plan. Based on the regulations from the government of Malang city, a building boundary line is determined on the environmental road; the alley is at least 1 meter away from each other, the minimum distance between the walls of each houses should be 4 meters each, while the roof distance between buildings is at least 2 meters away. With this measurement, the possibility of fire propagation can be reduced.

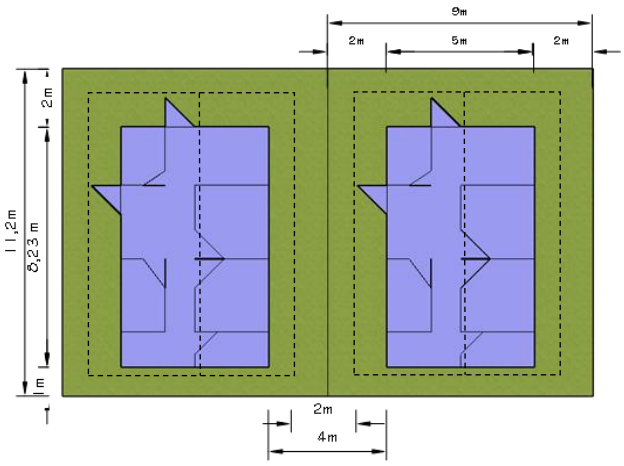

Figure 3. Distance between buildings according to The Government of Malang City

With these calculations, the resulting lot area is generated for each building type as follows:

1) Type 36, plot area = 100.8 m
2) Type 45, plot area = 117 m
3) Type 72, plot area = 160 m

Based on the ideal ratio for settlements in SNI 03-1733-2004, if one residential block consists of 6 small houses, 3 medium houses, and 1 large house, then one block area should be an area at least 1115.8 square meters wide.

4. CRITERIA AND CONCEPTS

4.1 Building Density

Based on the findings, the criterias to build a fire-responsive residence are as follows:

a. The ideal ratio of a residential block is 1 large house : 3 medium houses : 6 small houses.
b. The distance between the walls each buildings is at least 4 meters.
c. The distance between roof of each building is at least 2 meters.

4.2 Road Condition

Based on the regulations, the criteria for the road access in a fire-responsive settlements are as follows:

a. The width of the alley road is at least 1.2 meters wide.
b. The width of the main road is at least 3 meters wide for each lane.
c. The road access in a settlement should be built from asphalt material for the convenience of vehicle access.

4.3 Environmental Facilities and Infrastructure

Based on the analysis and the design criteria, facilities and infrastructure in a fire-responsive settlements should consider:

a. Availability of assembly points and signage.
b. Availability of water sources (ponds) on several assembly points.

5. CONCLUSION

Based on the initial analysis and the design criteria, settlements in Embong Brantas; or even in Malang City should consider:

a. Road conditions (including road cover materials) must be safe for vehicle access in general, and the width of the road must meet the dimensions of a fire truck in order to facilitate the access to the source of fire.
b. Environmental facilities and infrastructure must be available in any settlements, including the availability of clean water for suppression of fire, and an easy access to assembly points for evacuation along with signage / directions.

The criterias and the proposed design concept serve as an input for settlements in case fire incidents, so that it can reduce the impact of damage, and help the residents to prepare and be rescued at locations that have been determined as gathering points.

Because it is still in the initial development stage, this concept will need to be developed further. A safe environment design can compliment the suggested design criteria. Good environmental design can be improved by residents' cooperation in dealing with emergency situations. In turn, this will support mitigation efforts and indirectly can improve disaster preparedness, also resilience of settlements to fire disasters.

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