Smart response criteria for fire emergency in Surabaya City

M Yusuf¹, A M Navastara¹, S H Kusuma¹, F Firmansyah¹ and F A B Sari²

¹ Lecturer in Department of Urban and Regional Planning, Faculty of Architecture, Design and Planning, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia
² Magister Student in Department of Architecture, Faculty of Architecture, Design and Planning, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia

Abstract. Surabaya City is one of the second major cities in Indonesia. The development of Surabaya City is very rapid in various fields. Population density increase is supported by the increasing trend of settlement housing development and industry. It can triggers the danger of fire. In 2017, there were 321 fire incidents in Surabaya City and caused huge losses not only materially but also fatalities. So there needs to be an innovative effort to reduce losses due to fires in Surabaya City. However, there are no clear criteria related to smart response for fire emergency response. This study uses descriptive qualitative research (triangulation analysis) strategy to formulate the criteria for smart response to fire disasters Surabaya City. The research will focus on the formulation of smart response criteria based on the existing literature review. From the results of this study, several criteria will be obtained in the implementation of the smart response to the fire disaster in Surabaya City. In this case the smart response prioritizes the use of the Internet of Things in the process. These smart response criteria set limits on the application of the internet of things which is the core of this smart response concept.

1. Introduction

Surabaya has the title of the second Big City in Indonesia. The area of Surabaya City is 326.81 km² with a population of 2.7 million (2019 Population Census). Population growth in the city of Surabaya has increased. This increase in population triggered an increase in the need for shelter. This condition resulted in many residential buildings appearing that filled urban areas. Urban settlement buildings tend to be in densely populated areas where the buildings coincide with one another and many narrow and difficult aisles are accessed by large vehicles. The existence of housing and settlement areas increases the potential threat of a fire disaster because of the building which coincide with one another and are densely populated [1]

The incidence of fires in Indonesia is quite high especially in densely populated community settlements due to its high density. Fire disasters are unpredictable disasters that often occur in large cities. This fire disaster is a danger that can threaten the safety of human life and property if the flame cannot be controlled. The fires that have occurred in addition to being dangerous and threatening the safety of the soul also result in the loss of property and can even eliminate human lives. Correspondingly, the high death toll from fires in urban areas is generally from buildings during fires due to physical limitations [2]

In the city of Surabaya the occurrence of fires recurs every year. Since 2012 until 2017, there have been ups and downs. In 2012 there were 539 fires, but in 2013 there were only 397 fires. Then the growth trend of fires increased, in 2014 596 fires occurred, in 2015 600 fires occurred. However, the incidence
of fire has decreased again in 2016, where only 300 fire incidents occurred in the city of Surabaya. But the incidence of fires has increased again throughout 2017, there were 321 fire incidents in the city of Surabaya. Based on the number of fire incidents that occurred throughout 2017, the losses were quite large [3]

The Surabaya City Fire Department, said several locations in the city of Surabaya had a response time of more than 15 minutes where this condition had the potential to experience a fire due to officers who were late coming to the scene. It can also increase material losses and fatalities due to fires. In addition to the above problems, there are several problems related to PMK (Fire Extinguisher) infrastructure and facilities such as the absence of special infrastructure for fire engines and ambulance vehicles that can access directly to the location of water sources, road widths in several locations that are considered to be inadequate are inadequate to guarantee smooth flow fire trucks to the scene of the fire [1].

Surabaya City is a pilot city for smart city. One of the applications of smart city in the city of Surabaya is a public reporting service known as the Command Center that can be accessed by the public through the toll-free telephone service 112. This command center service 112 is one of the government's innovations in overcoming disasters in the city of Surabaya one of which is a fire. Through the Surabaya City 112 Command Center, the Government brings together various OPDs related to disaster management. So that with this integration disaster management becomes faster and more effective because of the integration between OPDs. To maximize the efforts to deal with fire disasters, there needs to be research related to the smart response based fire emergency response in the city of Surabaya

2. Methods

2.1 Research Theory

2.1.1 Response Time

This response time greatly influences the success of the fire disaster response. According to Burklin (1980), response time is the time needed by firefighters to get to the fire location and start a fire fighting operation. Included in the response time are dispatching time, travel time, turnout time, and set up time.

In Indonesia, the government regulates the response time based on the Decree of the Minister of Public Works No. 11 / KTSP / 2000 Regarding Technical Provisions on Fire Management in Cities stated that the response time should not be more than 15 minutes consisting of: (1) time from the date of receipt of notification of fire in the location of the place, interpretation of the determination of the location of the fire and the preparation of troops and fire fighting facilities; (2) travel time from the fire station to the location of the incident; (3) the time to hold the equipment on site until the ready for the spraying operation.

In addition, the government also issued regulations through the Minister of Public Works as stipulated in Minister of Public Works Regulation No. 20 of 2009 concerning Technical Guidelines for Fire Protection Management in Cities where: (a) the time of receiving notification of a fire in a place, interpretation of the determination of the location of fire, and preparation of fire stations and fire fighting facilities; (b) travel time from the fire station to the location of the incident; (c) the time of title of equipment on site until the ready for the spraying operation.

2.1.2 Smart Response

According to (Boukerche and Coutinho, 2018), smart response is an Internet-of-Things (IoT) based disaster detection and response. This system has been proposed to overcome disasters and emergencies by increasing disaster detection and search and rescue missions during disaster response. As such, IoT devices are used to collect data and help identify hazards after a disaster and localize injured people.

Smart responses according to (Boukerche and Coutinho, 2018), focus on the search and rescue of victims by utilizing technology components. In particular there are teams that carry out special rescue tasks in this case are firefighters. Officers use the VHF / UHF radio system to coordinate and exchange information. But according to (Boukerche and Coutinho, 2018) this approach is less profitable. Then
they in their research related to the "Smart Disaster Detection and Response System for Smart Cities" proposed the concept of smart responses by utilizing a sensor system that can be used and autonomous devices to improve the process of monitoring, communication, and actuation of victims.

Based on the Smart Emergency Response System (SERS), 2013 the need to create a culture of readiness that can improve the ability to deal with any new disasters that arise. Disaster emergency response needs to be done through various disaster training, improving the quality and effectiveness of emergency response by utilizing cyber systems technology and tools that are currently widely available. The Smart Emergency Response System (SERS) enhances shared responsibility among all stakeholders including individuals, first responders, the community and government. The Smart Emergency Response System (SERS) focuses on providing information for survivors of disasters, rescue missions, adaptive electronic communication, and optimal allocation of resources. The Smart Emergency Response System (SERS) connects physical physical technology with humans in a circle to save lives, save people, and meet their critical needs when disasters strike.

2.2 Methods
This research is a qualitative descriptive study. Descriptive research tries to find the right description of all activities, objects, processes and people. Descriptive research is concerned with collecting facts and data validly to provide an overview of the object under study. Descriptive research is a process of gaining a better understanding of the complexity of human activities. Descriptive research produces and processes data that is qualitative in nature such as interview transcripts, field notes, pictures, photos, video recordings and so on. While qualitative research is research that relates to ideas, perceptions, opinions or beliefs of the person being studied and all of them cannot be measured by numbers.

Qualitative descriptive research in this study is to obtain a complete picture of the smart response criteria. Smart response criteria obtained from the theories based on existing literature. This study aims to obtain conclusions in general where the results of the study are based on testing. In achieving that goal, this study used the theory of triangulation analysis method. Triangulation analysis facilitates validation of data through cross verification from more than two sources. It test the consistency of findings obtained through different instruments and increase the chance to control, or at least assess, some of the threats or multiple causes influencing a results. Triangulation analysis is not just about validation but about deepening and widening one’s understanding. It can be used to produce innovation in conceptual framing. Triangulation is an attempt to map out, or explain more fully the richness and complexity of human behaviour by studying it from more than one standpoint.

From this study triangulation analysis uses to formulate the criteria of smart fire response for Surabaya City. Triangulation analysis using a tools for processing the analysis, the tools consist of: 1) Quisioner; 2) Oral Interview (semi structured); 3) Observations (on this study using the Literature Review).

![Figure 1. Tools for Triangulation Analysis](image)

There are several stages of triangulation analysis in this study including: 1) Review the criteria from two or three different literature; 2) Make a conclusion for the same criteria from a literature; 3) Make an Oral Interview for the interviewees about the criteria; 4) Crosscheck the interview result from every
interviewees; 5) Compare the interview result from every interviewees and make a conclusion and using that to formulate the criteria for fire smart response.

![Diagram of the interview process]

**Figure 2. Stage of Triangulation Analysis**

### 3. Results and Discussion

In urban developments and technological advances there are many new ideas related to fire management systems. Primarily the response of firefighters in the event of danger is done quickly, precisely and intelligently so that losses from fires can be minimized. In Indonesia, the government regulates response time based on the Decree of the Minister of Public Works No. 11 / KTSP / 2000 Regarding Technical Provisions on Fire Management in Cities. in the location of the place, interpretation of the determination of the location of the fire and the preparation of troops and fire fighting facilities; (2) travel time from the fire station to the scene; (3) when the equipment is on site until the spraying operation is ready.[4]

According to (Boukerche and Coutinho, 2018) this approach is less profitable. Then they in their research related to the “Smart Disaster Detection and Response System for Smart Cities” proposed the concept of smart responses by utilizing a sensor system that can be used and autonomous devices to improve the process of monitoring, communication, and actuation of victims[5]

In its development many studies have begun to develop the concept of smart response / smart fire fighting in an effort to reduce fire losses including the following:

| No | Variabel | Literature Review | NFPA | Conclusion |
|----|----------|-------------------|------|------------|
| 1  | Time to Recieve News | Application of technology as an approved communication device (smartphone) as a reporting system | - | Application of communication technology such as social media, website, and application (on smartphone) for reporting media and giving an information in real time. |
| No | Variable | Smart Firefighting Hertfordshire Fire and Rescue Service | Research Roadmap for Smart Firefighting the Fire Protection Research Foundation | National Institute Standards and Technology U.S. Department of Commerce | NFPA | Conclusion |
|----|----------|--------------------------------------------------------|---------------------------------------------------------------------------------|--------------------------------------------------------------------------------|------|------------|
| 2  | Travel Time | Extinguishing vehicles are equipped with equipment that is adapted to fire events (small, medium, large). | Application integrated adaptive sensor systems through route sensors and tagging | Utilization of GPS technology and sensors that can provide direction and location of the route to the scene | - | Use of robot technology assistance as search, rescue and evacuation personnel |
|    |          | | | | | Development of simulation technology for training and education of personnel |
|    |          | | | | | Utilization of thermal / heat sensor technology connected to smartphones |
| 3  | Tools Preparation Time On Site | - | - | - | Application of sensors in every extinguish equipment | Application of sensors in every extinguish equipment |
| 4  | Search | The use of simulation technology in an effort to reduce losses with personnel skills training | - | Utilization of smart equipment connected blackout personnel to reduce physical contact, save victims' efficiency and reduce injuries | - | Utilization of simulation technology for training and educate personnel |
|    |          | Utilization of thermal / heat sensor technology connected to smartphones. | Use of robot technology assistance as search, rescue and evacuation personnel | Development of simulation technology for training and education of personnel | | Utilization of smart technology for training and educate personnel |
| 5  | Rescue | The use of simulation technology in an effort to reduce losses with personnel skills training | - | Utilization of smart equipment connected blackout personnel to reduce physical contact, save victims' efficiency and reduce injuries | - | Utilization of simulation technology for training and educate personnel |
|    |          | Utilization of thermal / heat sensor technology connected to smartphones. | Use of robot technology assistance as search, rescue and evacuation personnel | Development of simulation technology for training and education of personnel | | Utilization of smart technology for training and educate personnel |
| 6  | Evacuation | The use of simulation technology in an effort to reduce losses | - | Utilization of smart equipment connected blackout | - | Utilization of simulation technology for training and educate personnel |
| No | Variable | Smart Firefighting Hertfordshire Fire and Rescue Service | Research Roadmap for Smart Firefighting the Fire Protection Research Foundation | National Institute Standards and Technology U.S. Department of Commerce | NFPA | Conclusion |
|----|----------|---------------------------------------------------------|-------------------------------------------------|-------------------------------------------------|------|------------|
| 6  |          | with personnel skills training Utilization of thermal / heat sensor technology connected to smartphones. | evacuation personnel Development of simulation technology for training and education of personnel | personnel to reduce physical contact, save victims' efficiency and reduce injuries. |      | personnel, utilization of smart technology and utilization of thermal sensor are connected with smartphone. |
| 7  | Vehicle Routes | - Application integrated adaptive sensor systems through route sensors and tagging | Utilization of GPS technology and sensors that can provide direction and location of the route to the scene | - | - Utilization of transportation sensor with GPS technology to inform the way and the route to location of fire accident. |
| 8  | Vehicle Access | Match the vehicle class based on the fire event (small, medium and large vehicle) | - Application of smart robots that can detect victims, measure temperature, heat flow, gas and as a rescue team. | - | - Adjustment of the vehicle that was launched to the scene was based on the class of fire and the use of sensors connected with smartphones that can detect victims, measure temperature, heat flow, gas and as a rescue team. |
| 9  | Personnel Access | The use of simulation technology in an effort to reduce losses with skills training | - Application of smart robots that can detect victims, measure temperature, heat flow, gas and as a rescue team. | - | - Utilization of simulation technology for training and educate personnel, utilization of smart technology and utilization of thermal sensor are connected with smartphone. |
| 10 | Mobility of Evacuation Vehicle | - Implementation of rapid response Application of integrated adaptive sensor | Utilization of GPS technology | - | Utilization of transportation sensor |
| No | Variabel                        | Literature Review                                                                 | NFPA                                                                 | Conclusion                                                                 |
|----|---------------------------------|-----------------------------------------------------------------------------------|----------------------------------------------------------------------|---------------------------------------------------------------------------|
| 11 | Mobility of Evacuation Victims  | system response, medium response, and full response) tailored to the type and size of the vehicle | systems through route sensors and tagging                           | technology and GPS technology which can giving direction dan route to the location of fire accident and adjustable vehicle with response system fast, intermediate, and full. | Utilization of technology in optimizing evacuation routes                  |
| 12 | Smoke Sensor                    | Application of sensor technology to enhance vigilance and assist in planning outages | Application of technology sensor such as: Fire / heat and gas detectors, The use of remote sensing, Unmanned vehicles, Sensing integration, Long distance communication, Sensors increase platform reliability, Use of robot technology as search and rescue personnel, Development of stationary sensors that provide | Application of smart building technology is equipped with sensors that can send information control | Application of smart building and various sensor like: Therma l sensor and Gas Sensor, Application of Remote Sensing, Unmanned Vehicle, Integration of Remote Sensing, Application of robot technology as search and rescue personnel, Development of stationer sensor to inform the situation in real time. To increase awareness and assist in |
| No | Variable | Literature Review | NFPA | Conclusion |
|----|----------|-------------------|------|------------|
|    | Smart Firefighting Hertfordshire Fire and Rescue Service | | |  |
|    | Research Roadmap for Smart Firefighting the Fire Protection Research Foundation | | |  |
|    | National Institute Standards and Technology U.S. Department of Commerce | | |  |
| 13 | Fire Sensor | Application of sensor technology to enhance vigilance and assist in planning outages | Application of technology sensor such as: - Fire / heat and gas detectors - The use of remote sensing - Unmanned vehicles - Sensing integration - Long distance communication - Sensors increase platform reliability - Use of robot technology as search and rescue personnel - Development of stationary sensors that provide information throughout the incident - Utilization of social media as a source of data. | Application of smart building technology is equipped with sensors that can send information control | - Application of smart building and various sensor like: - Thermal sensor and Gas Sensor - Application of Remote Sensing - Unmanned Vehicle - Integration of Remote Sensing - Application of robot technology as search and rescue personnel - Development of stationer sensor to inform the situation in real time. |
| 14 | Gas Sensor | Application of sensor technology to enhance vigilance and | Application of technology sensor such as: - Fire / heat and gas detectors | Application of smart building technology is equipped with sensors that | - Application of smart building and various sensor like: |
| No | Variable | Literature Review | National Institute Standards and Technology U.S. Department of Commerce | NFPA | Conclusion |
|----|----------|------------------|-------------------------------------------------|-------|-------------|
| 15 | Utilization Application as a Reporting Systems | The use of an interface systems based on application or websites for civilians | - | - | The use of an interface systems based on application or websites for civilians |
| 16 | Navigation based on Application | Utilization of GPS technology and sensor technology that can provide direction of location and route to location of fire accident. | - | - | Utilization of navigation technology (GPS) integrated with sensor that can give direction of location and route to location of fire accident. |
### Literature Review

| No | Variable | Smart Firefighting Hertfordshire Fire and Rescue Service | Research Roadmap for Smart Firefighting the Fire Protection Research Foundation | National Institute Standards and Technology U.S. Department of Commerce | NFPA | Conclusion |
|----|----------|--------------------------------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------|------|------------|
| 17 | Traffic Light Sensor | Application of sensor technology to enhance vigilance and assist in planning outages | Application of technology sensor such as: - Fire / heat and gas detectors - The use of remote sensing - Unmanned vehicles - Sensing integration - Long distance communication - Sensors increase platform reliability - Use of robot technology as search and rescue personnel - Development of stationary sensors that provide information throughout the incident - Utilization of social media as a source of data. | Application of smart building technology is equipped with sensors that can send information control | - Application of smart building and various sensor like: - Thermal sensor and Gas Sensor - Application of Remote Sensing - Unmanned Vehicle - Integration of Remote Sensing - Application of robot technology as search and rescue personnel - Development of stationer sensor to inform the situation in real time. | To increase awareness and assist in formulating outage plans |

**Source:** analysis results, 2019

From the tables of triangulation theory of smart response was based on every variable of smart response. There are several criteria according to smart response from this study. The results of this research should be owned by the government and of fire fighting department to adapt on their emergency fire response in Surabaya City.

### 4. Conclusions

In this study produced 17 points of smart fire response criteria. Where these criteria mostly utilize the use of Internet of Things (IoT) to maximize response to fire hazards. Hope that the results of this study can be useful for the Surabaya government and other academics.
5. References

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