

Developing a Conceptual Model for Resilient Community Against Fire in a Densely Populated Settlement in Surabaya

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Abstract: The purpose of this study was to analyze the factors that affect community resilience and to develop a conceptual model for a resilient community against disaster caused by fire in Surabaya. Fire is one of the main threats in Surabaya, and for the last three years the highest occurrence happened in residential areas. The community resilience factors used in this study was based on the Community Coastal Resilience (CCR) framework of US/IOWTS (2007). This framework has been modified to measure urban community resilience against fire hazards. Smart PLS 2.0 was used to analyze the relationship between the factors and system dynamic modelling was utilized in the development of the conceptual model. The analyses showed that the factors, which include governance, community and economy, land use and structural design, risk knowledge, warning and evacuation, emergency response, and disaster recovery has good predictive influence to the model. The conceptual model itself has three sub models: prevention of fire, action during fire, and support after fire incidence.

1 INTRODUCTION

Surabaya is the second largest city in Indonesia and the capital of East Java Province. Surabaya economic growth is higher than all areas in Java. Development, urbanisation, and population growth makes Surabaya more densely populated and densely built. All these increase the risk of fire in Surabaya.

In the last five years, the fire incident in Surabaya has shown an increasing trend of events. Fire in building category is dominated by fire in residential building. In 2017, the number of fire incidents in building category was 372 incidents or twice as much compared to 2016.

Fire also caused high financial loss as well high losses of life. In 2016, fires caused 5 deaths, 50 injured and an economic loss of almost thirty billion rupiah.

According to Sendai Framework (2015), one of the strategies for disaster risk reduction is to build resilience against disaster in the communities. This strategy also applies for reducing the risk of fire disaster.

Disaster resilience is a combination of three basic characteristics that includes: (1) the level of shock that a community can absorb and withstand; (2) the ability to recover and bounce back from hazard events; (3) the capacity for learning and adaptation (Folke, 2002 in US/IOWTS, 2007). Based on Coastal Community Resilience from US/IOWTS, it should have eight essential elements: governance, social and economy, land use and structural design, risk knowledge, warning and evacuation, emergency response, and disaster recovery.

A community that is resilient and have a risk reduction perspective should have a contingency plan that includes warning and evacuation, emergency response and recovery plan (LIPI-UNESCO/ISDR, 2006; Twigg, 2009; Horney et al, 2017). This plan should be made based on a good risk knowledge (Twigg 2009; DFID, 2012). Successful implementation of the risk reduction plan can be influenced by the community economic capability and the strength of its social ties with each members (Cutter 2008; Paton & Johnston 2001). And Governance is the underlying element that provide

an enabling environment for the other elements of resilient to grow (Twigg, 2009).

Therefore, using a modified CCR framework, this study aimed to analyze the factors that affect community resilience which then will be used to develop a conceptual model for resilient community against fire hazard.

2 METHODS

A hypothetical model was made based on literature reviews. A relationship analysis or correlation between the variables was done to the model using SmartPLS 2.0. Samples for the model were gathered from questionnaire filled out by 103 family representatives in RW 11 Petemon Urban Village, Surabaya.

Petemon was chosen because it is one of the urban villages in Surabaya that has experienced fire incidents. It has a high population and buildings density, and some members of the community had received fire preparedness training in the past. Samples were gathered using simple random sampling method. The number of samples taken from each of neighbourhood group is proportional to the population in each group.

Interview with Dinas Kebakaran (Fire Department) Surabaya was used to further understand the system that was used to build community disaster resilience. A conceptual model of community resilience against fire was then made based on the interview and the analysis result.

3 FINDINGS AND DISCUSSION

Coefficient of determination (R^2) was used to evaluate the model. This coefficient is a measure of a model predictive accuracy (Hair et al., 2014).

Evaluation on the coefficient of determination (R^2) for predictive accuracy criteria showed a result of 0.6535, which means that governance, social and economy, land use and structural design, risk knowledge, warning and evacuation, emergency response, and disaster recovery have moderate influence to community resilience. It can also be interpreted that the variability of resilience constructs that can be explained by the seven exogenous mentioned above were 65.33%, while the remaining 34.67% was explained by other variables that are not examined in this research.

The descriptive statistics of the questionnaire showed that in general Petemon urban village has good community resilience (Table 1). Three resilient elements had moderate scores while the remaining four had good scores. However, further observations found some improper or weak implementation of disaster risk reduction.

Table 1: Descriptive statistics.

Variables	Mean	Standard deviation	Score
Governance (X_1)	2,94	0,63	Moderate
Social and economic (X_2)	0,69	0,33	Good
Land use and structural design (X_3)	3,07	0,59	Good
Risk knowledge (X_4)	0,82	0,15	Good
Warning and evacuation (X_5)	2,91	0,74	Moderate
Emergency response (X_6)	2,71	0,60	Moderate
Disaster recovery (X_7)	3,12	0,60	Good
Community resilience (Y)	0,74	0,27	Good

For example, most of the respondents stated that they have prepared an evacuation route in their house and on their neighbourhood. However, some of the evacuation routes do not have adequate lightings and filled with obstructive items. Furthermore, the existing evacuation signage and warning system are not maintained properly.



Figure 1: Inadequate evacuation route.

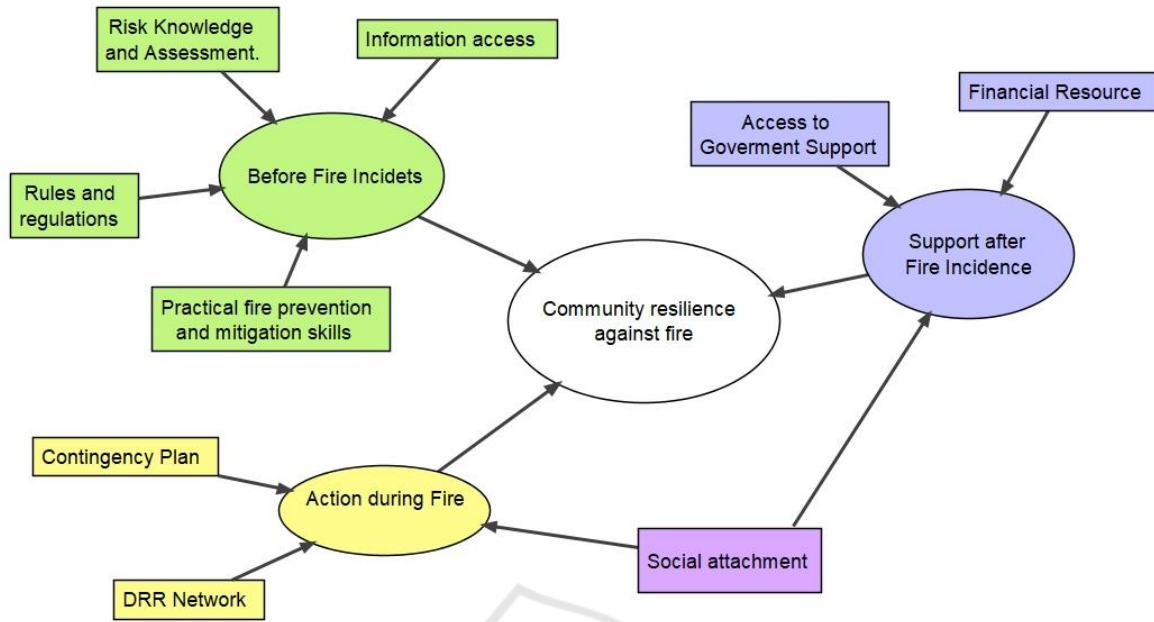


Figure 2: Conceptual model for community resilience against fire.

3.1 Conceptual Model for Community Resilience against Fire

This conceptual model is an iteration of the hypothetical model.

3.1.1 Before Fire Incidents

This segment focuses on factors that could support prevention and mitigation measures:

- a. Risk knowledge and assessment

An individual who is aware of a threat that could happen to him/her will take a preventive measure to avoid or reduce the impact (Lindell and White, 2010 in Sagala, 2014). Furthermore, Pamungkas, *et. al.* (2017) stated that increase in risk knowledge will increase awareness and precautionary measures.

Therefore, risk knowledge is needed to raise awareness about the fire hazards and based on that knowledge the community can do an assessment to identify the gaps between the vulnerability and capacity that they have. Risk knowledge could raise awareness that will encourage people to take actions and the assessment of the gaps could provide necessary information on things to improve.
- b. Practical fire prevention and mitigation skills

Increase awareness of a hazard that is not accompanied by capabilities to avert the threat will not encourage people to take protective actions (Djalante & Thomalla, 2010). However, this preventive and mitigation action should be something that can be implemented by the community; thus, it should be a practical measures and skills that are easy to do.

- c. Information access

Vulnerable people need to know about the hazards and risks that they face. They also need to know about the technology, practices and measures to prevent and mitigate the impact of those risks. Access to this information is needed to enable continuous learning and adaptation on preventing fire incidents and in risk reduction innovations.

Therefore, the communication method for distribution of this information has to be an integral part of the resilient building (Twigg, 2004).
- d. Rules and regulations

Rules and regulations that are made with risk-reduction perspectives would encourage resilience building (Twigg, 2009). It should be adaptive and understand the need and limitation of the community in which it will be implemented.

Surveillance and maintenance procedure should also be considered to ensure proper implementation. The effectiveness, commitment and accountability of community leaders in the implementation of DRR will support the successful implementation of resilient building (Lebel *et.al*, 2006).

3.1.2 Action during Fire

Main focus of this segment is preparedness for effective action plan that can enable the community to absorb the impact of fire incident.

a. Contingency Plan

One of the characteristic of resilient community is the existence of good contingency plan (Arbon et al, 2013). The contingency plan should encourage involvement from the community members in its creation and implementation. Community involvement in problem identification, formulation of the plan, and finding the solution, will foster commitment, a sense of togetherness, and problem-focused coping (Paton & Johnston, 2001).

The contingency plan should include: warning system, evacuation plan and procedures, and emergency response plan.

b. DRR Network

A strong network will support local authorities and community resilience against disaster (Twigg, 2009). The existence of networks between government, local community and third parties, such as NGOs or the private sector, can help cover the shortcomings of local communities in the provision of facilities and infrastructure for disaster risk reduction.

c. Sense of community

According to IFRC (2014) the higher the social cohesion of a society, the higher the ability of that community to overcome stress and shocks from disaster. In the time of disaster, sense of togetherness and attachment could encourage mutual assistance (*gotong royong*).

3.1.3 Support after Fire Incidence

This segment focuses on the community capabilities to bounce back after disaster strikes

a. Financial resource

Recovery requires resources to implement. Sources of this resource are own resources, extended family or institutional and most household usually rely on more than one source (Lindell, 2013).

Financial resource is one of the main factors that can enable fast disaster recovery. The source

for this can be from personal savings, insurance, cooperative savings, or support from government.

b. Sense of community

The impact of lack of financial resource can be minimized when there is a strong sense of community among the member of the community. A feeling of togetherness in facing a disaster and attachment to people and place could encourage people to help each other (Paton and Johnston, 2001).

c. Access to government support

Government support is one of the supporting capabilities for disaster recovery (Lindell, 2013). This support can be in the form of financial help, temporary shelter or housing, or the reparation and rehabilitation of public facilities and infrastructures.

4 CONCLUSIONS

This conceptual model of community resilience against fire disaster is made based on the understanding of the formation of community disaster resilience. The conceptual model consists of three sub-models.

By dividing the conceptual model into three sub-models, the resilience development can concentrate on the sub-models that need attention.

REFERENCES

- Arbon, P.A., et al. 2013. *How Do We Measure and Build Resilience Against Disaster in Communities and Households?* Torrens Resilience Institute. Adelaide.
- Cutter, S.L. et al. 2008. *A place-based model for understanding community resilience to natural disasters*. Global Environmental Change, 18. 598-606.
- Djalante, R., & F.Thomalla. 2010. *Community Resilience to natural hazards and climate change impacts: a review of definitions and operational frameworks*. 5th Annual International Workshop & Expo on Sumatra Tsunami Disaster & Recovery.
- Hair, J.F., Hult, G.T.M., Ringle, C.M., and Sarstedt, M. (2014). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)*. California: SAGE Publications, Inc.
- International Federation of Red Cross and Red Crescent Societies. 2014. *IFRC Framework for Community Resilience*. International Federation of Red Cross and Red Crescent Societies, Geneva.
- Lebel, L., Anderies, J.M., Campbell, B., Folke, C., Hatfield-Dodds, S., Hughes, T.P. and Wilson, J., 2006. *Governance and the capacity to manage resilience in*

- regional social-ecological systems*. Ecology and Society, 11(1).
- Lindell, M.K., 2013. *Recovery and reconstruction after disaster*. In Encyclopedia of natural hazards (pp. 812-824). Springer, Dordrecht.
- LIPI-UNESCO/ISDR. 2006. *Kajian Kesiapsiagaan Masyarakat dalam Mengantisipasi Bencana Gempa Bumi & Tsunami*. Deputi Ilmu Pengetahuan Kebumihan Lembaga Ilmu Pengetahuan Indonesia, Jakarta.
- Pamungkas, A., et al. 2016. *A Conceptual Model for Water Sensitive City in Surabaya*. IOP Conf, Series: Earth and Environmental Science
- Pamungkas, Adjie, et al. *Making a Low Risk Kampong to Urban Fire*. Asian Journal of Applied Sciences, Apr. 2017.
- Paton, D., & Johnston, D. 2001. *Disasters and communities: Vulnerability, resilience and preparedness*. Disaster Prevention and Management, 10(4), 270-227
- Sagala, S., et al. 2014. *Perilaku dan kesiapsiagaan terkait kebakaran pada penghuni permukiman padat kota bandung*. Forum Geografi, 28 (1).
- Twigg, J. 2004. *Disaster risk reduction: mitigation and preparedness in development and emergency programming*. Overseas Development Studies (ODI).
- Twigg, J. 2009. *Characteristic of a Disaster-Resilient Community, A Guidance Note Version 2*. November 2009.
- U.S. Indian Ocean Tsunami Warning System Program. 2007. *How Resilient is Your Coastal Community? A Guide for Evaluating Coastal Community Resilience to Tsunamis and Other Coastal Hazards*. U.S. Indian Ocean Tsunami Warning System Program, Bangkok, Thailand. 144 p.

