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ANALYSIS OF COMMUNITY CAPACITY INDICATORS AND DISASTER PREPAREDNESS USING STRUCTURAL EQUATION MODELING

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ABSTRACT

The geographical condition of Indonesia is an archipelagic country, the meeting of four tectonic plates and many volcanoes has caused a high potential for natural disasters. A regional disaster risk involves three aspects: hazard, vulnerability and capacity. By increasing the capacity of disaster mitigation, the risk of disaster can be reduced. The increase of the capacity is done in order to improve the readiness of the governments/organizations, communities and individuals in facing the disaster. This study examined some aspects relating to the disaster mitigation capacity. The disaster mitigation capacity includes aspects of social, economic and physical environment. While the preparedness aspect discussed was the readiness of the individual and community preparedness. The readiness of individuals was affected by the knowledge and attitude, while the readiness of the communities was affected by their leadership, information and facilities. By using Structural Equation Modeling (SEM) analysis, it has proven that the link between the Community's capacity and preparedness for natural disasters. The community's capacity includes the Social aspects, Physical / Environmental and Economic aspects. Preparedness consists of preparedness of individual and community preparedness. Individual preparedness plan includes aspects, knowledge and attitudes. Community preparedness includes leadership, information, facilities.

Keywords: Capacity; Hazard; Mitigation; Structural Equation Modeling; Vulnerability.

1. INTRODUCTION

Indonesia is a country that has a high potential for natural disasters. Indonesian territory is a confluence of four tectonic plates, namely Australian continent plates, the continent of Asia, the Pacific and the Indian Ocean plate. This condition makes the emergence of fire mountain ranges along the south coast of the island of Sumatra, Java, and the Banda Islands, as well as the emergence of centers of earthquake. With these characteristics, Indonesia has potential and proneness to disasters such as the eruption, earthquakes, tsunamis, volcanoes, floods and landslides. In conducting disaster mitigation, disaster risk assessment of the region is the first step needed. In calculating the risk of a regional disaster three aspects are involved: hazard, vulnerability and capacity of a region that is

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based on the characteristics of the physical condition and territory. Risk is proportional to vulnerabilities and threats, and inversely proportional to the mitigation capacity. Disaster risk can be reduced if mitigation capacity (resilience, preparedness) disaster from the public increased. Therefore, to reduce the risk of disaster, it can be done by raising awareness and building the capacity of disaster mitigation. The increased capacity regarding the mitigation of social, cultural, and technical need to be undertaken simultaneously.

BNPB has set Rule No. 4 of 2008 on guidelines for disaster management plans. BNPB has also devised a scoring guide regional capacity in disaster management in Rule No. 03 of 2012. These laws emphasize the regional capacity of aspects of the policy aspect, preparedness, and the role of institutions. The degree of readiness of a region to anticipate the impact of the disaster will vary from one region to another. The institutional factor is one among many factors that can determine the readiness of a region to anticipate the impact of disasters. Many researchers have conducted research on improving the capacity of a region in the face of disaster. Yulianto et al (2012) proposed the use of data Synthetic Aperture Radar (SAR) for risk reduction and disaster mitigation. Compilation of the adaptive capacity of community's vulnerable areas of drinking water and sanitation-related impacts of climate change has been done by Yuda (2013). Measuring tool to determine the ability of individuals, households and communities in the face of disaster has not been done. This instrument is very important, because it can be used as a basis for evaluation whether the efforts to increase the readiness of the region have been successful.

This paper discusses the factors that affect the capacity and readiness of communities in disaster mitigation. Capacity of mitigation is concerning aspects of socio-cultural, economic, and physical-environmental. While the preparedness aspect discussed was the readiness of the individual and community preparedness. The readiness of individuals is affected by the knowledge and wisdom/attitude, while the readiness of the community is affected by the program, networking, leadership, and facilities. Data analysis was performed using analysis Structural Equation Modeling (SEM).

2. DISASTER PREPAREDNESS

BNPB in Regulation No. 03 of 2012 has defined the following terms:

a. Disaster is an event or series of events that threaten and disrupt the lives and livelihood caused by both natural factors and / or non-natural or human factors that lead to the emergence of human lives, environmental damage, loss of property, and psychological impact.
b. Preparedness is a series of activities as part of efforts to eliminate and / or reduce the threat of disaster.
c. Capacity is the ability of regions and communities to take action to reduce the threat and potential disaster losses in a structured, planned and integrated way.

Yohe and Tol (2002) proposed a method for developing indicators of social and economic capacity in the context of climate change. A simple index for measuring the capacity of adaptation has used by Ionescu et al. (2009) including GDB, the literacy rates, and the rate of female labor force participation. Yohe et al. (2006) used a Vulnerability-Resilience Indicator Prototype (VRIP) which has been developed by Brenkert and Malone (2005) to calculate the index by considering the adaptive capacity of adaptation to the changing environment. Iglesias et al. (2009) has developed

Adaptive Capacity Index (index AC) using three main components; the ability of the economy, civil and human resources, and agricultural innovation. The same approach has also been carried out in the context of drought (Moneo, 2007). In other scheme, Iglesias et al (2011) has developed an index of social vulnerability to drought. Steps measurement vulnerability index are: (i) select the variables that contribute to vulnerability, (ii) normalize variables, (iii) combine the sub-components of the variables within each category of vulnerabilities with a weighted average, and (iv) measure vulnerability as average weighted components.

BNPB Regulation No. 03 of 2012 defines five priority disaster mitigation rules:

a. Ensure that disaster risk reduction is a national and local priority with a strong institutional basis for implementation.
b. Identify, assess and monitor disaster risks and enhance early warning systems to reduce the risk of disaster.
c. The realization of the use of knowledge, innovation and education for capacity building and secure a culture of disaster at all level.
d. Reduce the risk factors .
e. Strengthen disaster preparedness for effective response at all level.

Yuda (2013) has compiled an index of adaptive capacity of regional communities vulnerable to water by using three variables: (1) Individual preparedness described in the aspect of knowledge perception and behavior, (2) community readiness described into aspects of local wisdom, leadership, involvement and presence organization. (3) Institutional readiness described in aspects of the network consists of information and policies. Community preparedness is a process or series of activities as part of efforts to eliminate and/or reduce the threat of disaster with several stages. Community readiness model is made to see the public response policy interventions / programs (Yuda, 2013). The models incorporate five (5) community readiness dimensions, namely: (a) an anticipatory effort through policy; (b) public awareness of the policy; (c) Leadership; (d) understanding of the problem; and (e) funding for anticipatory effort (in the form of money, time, land, etc.). Capacity is a combination of the capabilities and characteristics of the individual, community, or organization, which is used to achieve certain goals. Capacity is the ability to take action to reduce the threat and potential disaster losses in a structured, planned and integrated way.

3. SEM ANALYSIS PROCEDURE

SEM is used instead of designing a theory. It is rather intendedly used to examine and justify a model. Therefore, the main requirement using the SEM is the hypothetical model that consists of the structural model in the form of a diagram of the path that is based on the theory. SEM is a set of statistical techniques that allow the testing of a series of relationships simultaneously. The relationship is built between one or more independent variables. SEM analysis includes three phases, namely the conceptualization of models, preparation of flow diagrams and specification model (Ghozali, 2008). Conceptualization stage of the model is related to the development of hypotheses (based on the theory) as a basis for linking the latent variables to other latent variables and indicator variables. Drafting stage flowcharts (path diagram contruction) will facilitate the visualization of the proposed hypotheses in the conceptualization of the model above. The specification models stage is the step of determining the number and nature of the parameters to be estimated. According to Hair et al (1998), there are 7

(seven) main stages that must be done in using the technique with SEM analysis in a research activity that is:

a. Theoretical Model Development
b. Development Flowchart
c. Conversion flowcharts into equation
d. Selecting input matrix and estimates the corresponding model
e. Identification of possible problems
f. Evaluation Criteria Goodness of fit
g. Interpretation and Modification Model.

4. INDICATORS OF CAPACITY AND COMMUNITY PREPAREDNESS

The capacity is strongly influenced by economic, social, physical and environmental factors. There are two aspects of community preparedness, i.e. readiness of individual and readiness of community. Readiness of individuals is affected by factors of knowledge and attitude, while the community readiness is influenced by factors Program, Network, Leadership, Local Knowledge and Facilities.

a. Knowledge (A). Knowledge factor consists of knowledge of disaster in general (A1), Knowledge of saving themselves from disaster (A2), experience in a training / seminar / simulation disaster preparedness (A3), experience of natural disasters (A4), Knowledge of residence which is the area hazard (A5), and family Knowledge on natural disasters (A6).
b. Plan of Action (C). Plan of action factor consists of a set of decisions about how to protect and rescue people and property from disaster.
c. Local Wisdom / Manners (D). Local wisdom/manner consists of Perception (D1) and Motivation (D2).
d. Leadership and Program (E). Leadership and program factor consists of efforts by the local government in improving disaster preparedness (E1), the Party responsible for disaster preparedness (E2), Efforts by the local government in disaster risk reduction (E3), approach to disaster management (E4), and government efforts in disaster early warning (E5).
e. Information (F). Information factors consist of media's role in disaster preparedness (F1), sources of information and media (F2).
f. Facility (G). Facility factor consist of the evacuation route and early warning equipment/services.

Variable capacity consists of physical / environmental, social and economy.

a. Physical / environmental (H) consists of the physical location house (H1) and type of house (H2).
b. Social (J) consists of the length of stay (J1) and education (J2).
c. Economy (K) consists of the ownership of goods (K1), major Work (K2), assets owned in case of disaster (K3).

The concept of capacity and readiness of the community described in Figure 1 will be tested using SEM analysis.

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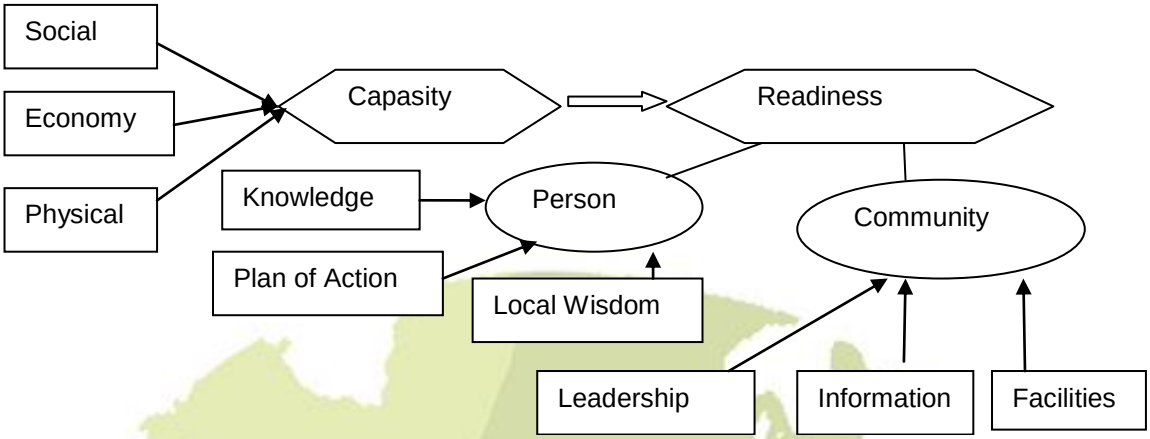

Figure 1 The concept of capacity and society preparedness

The concept of capacity and readiness of the community described in Figure 1 will be tested using SEM analysis. In the pilot phase models, data taken on some areas that represent the type of potential disasters such as floods, earthquakes, landslides, droughts and volcanoes.

5. SURVEY RESULTS AND DISCUSSION

For the purposes of testing the truth of a concept that has been poured in the points questionnaires, the survey was conducted and the data obtained as many as 198 respondents from 114 districts in 28 provinces across Indonesia. Distributions of the number of respondents who have experienced natural disasters are presented in Figure 2. The types of natural disaster in question are (1) Earthquakes, (2) Flood, (3) Extreme Weather, (4) Drought, (5) Tsunami, (6) Landslides, (7) Volcano eruption, (8) Sea waves, (9) Land and Forest fires.

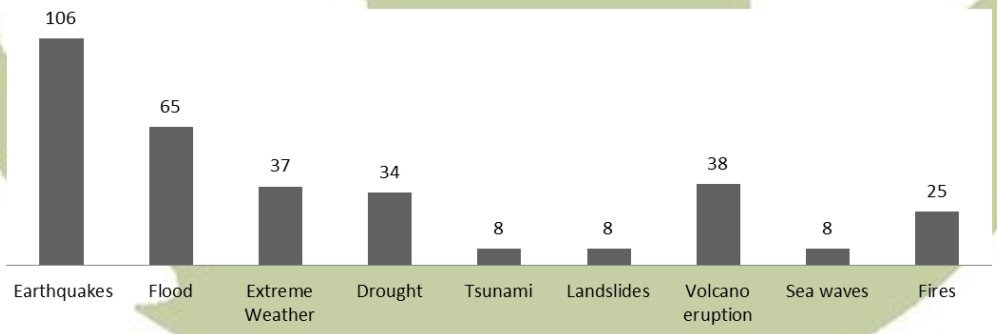

Figure 2 The number of respondents is based on the experience of disaster events.

The questions specifically related to attitudes have been tested for the validity and reliability. From the test results it can be concluded that such questions are valid and reliable. Results of Reliability Test are presented in Table 1.

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Table 1. Results of Test Reliability

Indicators	Number of Items	Cronbach's Alpha
Local Wisdom (Perception and Motivation)	8	0.829
Self-rescue plan	13	0.745
Disaster preparedness	9	0.887
Efforts to reduce disaster risk	4	0.794
Disaster management	3	0.891
Sources of information and media 1	4	0.708
Sources of information and media 2	7	0.849

Observation of each factor is presented in Table 2. Each variable has a value in between 1 to 10. Based on the data in Table 2, it is showed that the average knowledge variable (A1 to A6) is still very low; between 1.224 to 3.249. More than 75% of respondents value the variables A3, A4 and A5 of less than 3,thus, the majority of respondents feel the experience in a training / seminar / simulation disaster preparedness, natural disasters experience, and knowledge of the dwellings are disaster-prone areas (A5) is minimal. The respondents' assessment of the variable C, D1, E4, F2, H1, H2, J showed that over 75% of respondents provide an assessment of more than 7.5. It can be concluded that:

a. the respondents have made well preparations to secure valuables and preparation of rescue plans from disaster,
b. the respondents have the good perception to disasters that they do not complain, do not despair,
c. the respondents argued that the disaster mitigation is important,
d. the respondents are satisfied with the role / involvement of the mass media in providing information to improve the citizen preparedness for natural disasters.

Table 2 Results of observation on each variable

Variable	Mean	Minimum	Q1	Median	Q3	Maximum
A1	3.249	0.000	1.667	2.778	4.722	10.000
A2	3.192	0.000	1.111	2.222	5.000	10.000
A3	1.320	0.000	0.000	0.000	1.667	10.000
A4	1.882	0.000	1.429	1.429	2.500	8.572
A5	1.224	0.000	0.000	1.111	2.222	7.778
A6	2.112	0.000	1.000	2.000	3.000	10.000
C	7.397	4.039	6.654	7.308	8.077	10.000
D1	8.409	2.917	7.500	8.333	9.167	10.000
D2	7.152	1.538	6.154	6.923	8.462	10.000
E1	5.649	1.923	4.704	5.577	6.352	9.039
E2	5.926	0.000	2.500	5.000	10.000	10.000
E3	6.325	2.000	6.000	6.000	7.000	9.500
E4	8.846	3.333	7.500	9.167	10.000	10.000
E5	4.873	0.000	2.500	5.000	7.500	10.000
F1	5.232	0.000	3.929	5.714	6.429	10.000
F2	8.153	3.636	7.500	8.159	8.864	10.000
G	4.315	0.000	0.000	3.333	6.667	10.000
H1	8.159	4.167	7.500	8.333	9.167	9.167
H2	9.305	3.333	8.333	10.000	10.000	10.000
H3	5.766	0.000	5.000	6.000	7.000	10.000
J1	9.109	2.500	8.250	10.000	10.000	10.000
J2	8.051	2.500	7.500	7.500	10.000	10.000
K1	5.766	0.000	5.000	6.000	7.000	10.000

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Variable	Mean	Minimum	Q1	Median	Q3	Maximum
K2	1.782	0.000	1.000	1.000	2.000	10.000
K3	6.168	3.333	4.444	5.556	7.778	10.000

Based on the concept in Figure 1, SEM model was composed as presented in Figure 3 using Amos 20 software:

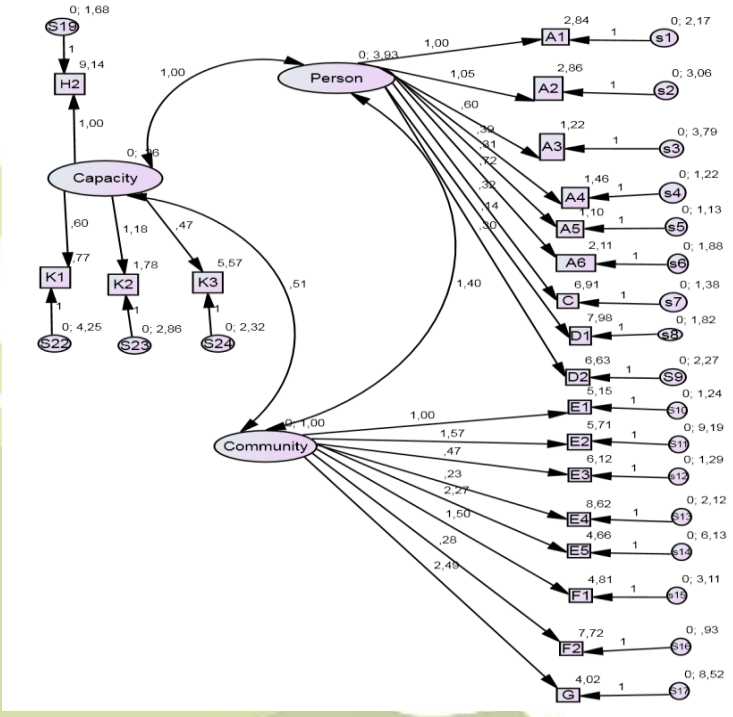

Figure 5 SEM Model

Due to the limited number of sample the preparedness variable could not be included in the model (Figure 5). There are three latent variables; community, capacity, person. The estimated values of the parameter and statistic test on each path are presented in Table 5. As the P-value <0.05, it can be concluded that all parameter is significant at α = 0.05 means that the indicators could explain the latent variables (factors): capacity, individual and society.

Table 5 Parameter Estimation

	Path		Estimate	S.E.	Z.	P-Value
A1	<---	Person	1.000			
A2	<---	Person	1.055	.094	11.258	***
A3	<---	Person	.605	.084	7.241	***
A4	<---	Person	.388	.049	7.975	***
A5	<---	Person	.313	.045	6.931	***
A6	<---	Person	.718	.069	10.447	***
C	<---	Person	.320	.049	6.487	***
D1	<---	Person	.141	.053	2.672	.008
D2	<---	Person	.304	.061	4.978	***
K1	<---	Capacity	.604	.292	2.068	.039
K2	<---	Capacity	1.177	.265	4.443	***
K3	<---	Capacity	.469	.217	2.166	.030
E1	<---	Community	1.000			

Path			Estimate	S.E.	Z.	P-Value
E2	<---	Community	1.570	.282	5.576	***
E3	<---	Community	.469	.100	4.694	***
E4	<---	Community	.233	.117	1.992	.046
E5	<---	Community	2.274	.293	7.759	***
F1	<---	Community	1.502	.200	7.503	***
F2	<---	Community	.278	.080	3.462	***
G	<---	Community	2.493	.332	7.515	***
H2	<---	Capacity	1.000			

Correlation values between the latent variables are as follows:

a. The correlation between the community and person factor of 0.705
b. Correlation between person and capacity of 0.999
c. The correlation between the community and the capacity factor of 0.999 in which correlation of the three variables is quite high. It means that the variable person capacity is affected by capacity and community variable

6. CONCLUSIONS AND RECOMMENDATIONS.

By using SEM analysis, it is proven the link between the Community's capacity and preparedness for natural disasters. Community's capacity included Social aspects, Physical / Environmental and Economic aspects. Preparedness consists of preparedness of individual and community preparedness. Individual preparedness plan includes knowledge and attitude aspects. Community preparedness includes leadership aspects, information aspects, and facilities aspects.

7. ACKNOWLEDGMENT

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