The identification of parameter arrangement for hypothetical model of campus with earthquake disaster mitigation insight

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Abstract. Universitas Pendidikan Indonesia is one of the leading university that should be responsive to environmental phenomena, especially about the earthquake disaster. Thus, developing disaster mitigation model is a very important thing to do. The purpose of this research is (1) identification of disaster risk factors, (2) classifying parameters and disaster risk indicator based on the availability of data, difficulty in obtaining data, and the accuracy of data, (3) develop alternative parameters to be used as a campus disaster mitigation model-based classification of disaster risk indicator. The method used in this research is literature study, analysis, and synthesis of theory and approach based on consideration of the expertise of the several specialist's mitigations. The result of this study is an arrangement of the parameter for a campus with disaster mitigation hypothetical model insight which is divided into 3 parts, namely: ideal parameter consisting of 30 parameter indicators, medium parameter consisting of 27 parameter indicators, and simple parameter consisting of 22 parameter indicators.

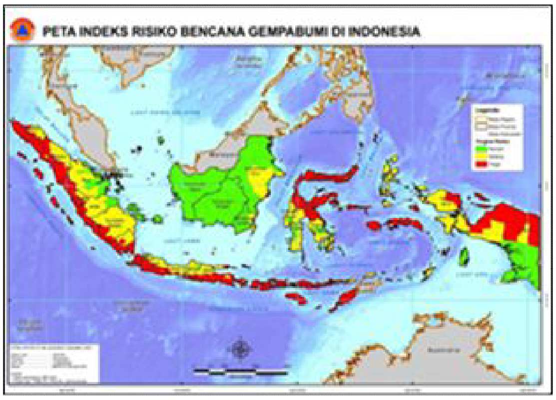
1 Introduction

In Indonesia, there are 28 provinces stated as prone-areas of tectonic earthquake, volcano earthquake, and tsunami earthquake disaster. Those areas are Aceh, North Sumatera, West Sumatera, Bengkulu, Lampung, Banten, Central Java, southern Daerah Istimewa Yogyakarta (DIY), southern East Java, Bali, Nusa Tenggara Barat (NTB), and Nusa Tenggara Timur (NTT) [1,2] One area which is vulnerable to earthquake disaster risk is Bandung City in West Java Province (See Figure 1). In Figure 1, it is known that Bandung City has the index of earthquake disaster risk with high-level classification.

The earthquake has unique characteristics because it cannot be prevented, occur suddenly and shocking, the central location and its magnitude are unpredictable precisely or accurately by anyone, including the earthquake experts [3]. These characteristics make earthquake become one of the disasters which could cause many casualties.

Realizing the effect of the earthquake, it is important to grow awareness and to reduce disaster risk. The campus community should become a model to give a positive response to earthquake disaster. Indonesia University of Education campus as educator higher education with pioneer and excellent motto, located in Bandung City, try to arrange the campus with earthquake disaster mitigation insight.

As the initial step toward the model of campus with disaster mitigation insight, it needs a parameter and indicator relate to a model of campus with disaster mitigation insight.



Source: BNPB

Fig. 1. Map of earthquake index disaster risk

However, the guidance developed so far in Indonesia is focused on the guidance of disaster mitigation assessment in school/madrasa level, whereas guidance of assessment for university level have not been developed yet. So the objective of the study is as follow:

- Identify the indicators of disaster risk
- Clarify parameter and indicator of disaster risk based on data availability, difficulty in obtaining data, and level of data accuracy
- Arrange alternative parameter to be used as a model of campus with disaster mitigation insight which is ready to be trialed and consist of the ideal model parameter, medium model parameter, and simple model parameter.

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2 The material and method

2.1 Location

The case study of identification and arrangement of the parameter for a model of campus with disaster mitigation insight was conducted in the Indonesia University of Education or UPI Bumi Siliwangi campus which is located in Bandung City, West Java Province. UPI is one of the campuses with a high risk of the earthquake disaster, in which there is Lembang fault spanned as far as 29 KM from zero points of Padalarang to the east so it is between Bukit Batu Lonceng and Manglayang Mountain. As for earthquake disaster risk in Bandung City according to study result of LIPI [4], it is mentioned that "with Cesar length achieving 29 km, the team calculates that potency of earthquake derived from the land is quite big. With the worst scenario, it can cause the earthquake with magnitude scale of 6.5 until 7 if all segments are moved." Other than the potency of the tectonic earthquake from Lembang fault, another potency of the earthquake in Bandung City is volcanic earthquake from Tangkuban Parahu Mountain which is still active.

2.2 Study method

The method used in this research is the literature study, analysis, and synthesis of theory and approach based on consideration of the expertise of the expertise of several specialists mitigation. Reviewing the literature pertaining to disaster risk both from research, government regulations, and standards that have been recognized.

2.3 Hierarchy of data

The hierarchy of the data in this study consisted of factors, parameters, indicators, and sub-indicators as follows:

- Factors: Factors are components that affect the level of disaster risk. The factor components are selected based on Badan Nasional Penanggulangan Bencana [5] about The Head Regulation of BNPB No. 4/2008 about The Guidance of Arrangement of Disaster Mitigation Plan and Toyfur [6], namely hazard, vulnerability, and capacity
- Parameter: Parameters are part of disaster risk factors. Parameter selection is based on the study of literature.
- Indicator dan sub-indicator: Indicators and sub-indicators are part of a more detailed parameter describes the level of the earthquake risk.

The following is a hierarchical data began explaining in this research (See Figure 2).

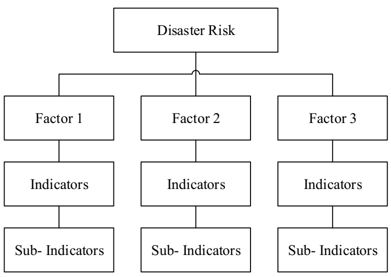


Fig. 2. The hierarchy of data research

2.4 Data analysis technique

The technique of data analysis with qualitative classification method based on weighting and scoring adoption and modification from Toyfur [6] as follows:

- Weighting

Weighting is given to the sub-indicators. Parameters are arranged into 3 parts based on data availability, difficulty in obtaining data, data accuracy level. The indicator of those parameters are given weight (3, 2, 1) in each part of data availability, data difficulty, and data accuracy level, as in the table follow.

Table 1. The weighting of data availability

Indicator	Data Availability		
	Available	Simple Analysis	Complicated Analysis
……	3	2	1

Table 2. The weighting of difficulty in obtaining data

Indicator	The Weighting Of Difficulty In Obtaining Data		
	Easy	Medium	Difficult
……	3	2	1

Table 3. Data accuracy level

Indicator	Data Accuracy Level		
	Accurate	Medium	Less
……	3	2	1

- Scoring

Scoring is determining the value of the score on the sub-indicators that have been assigned weights (3,2,1). Determining the value of a score by adding up all the weights in each sub-indicator.

2.5 Preparation of model hypothetic

Preparation of model hypothetic by weighting the results of classification data sub-indicators based on data availability, the difficulty obtaining the data, and the level of accuracy of the data.

3 Result and discussion

3.1 The basis for determining the parameters and indicators

The determination of parameter used to arrange hypothetical model of campus with earthquake disaster mitigation insight is adopted from various sources related to mitigation in school/campus environment. The following is the source of the parameter adopted.

- The Head of BNBP Regulation No.4/2008 about The Guidance for Arrangement of Disaster Mitigation Plan [5]
- The Head Regulation of BNBP 2012 about The Guidance for Application of School/Madrasah Safe from Disaster [9]
- SNI 03-1726-2003 about Procedure of Earthquake Resistance for High Building [10]

- Minister Regulation PU No. 29/2006 about The Guidance for Technical Requisite of High Building [11]
- Federal Emergency Management Agency (FEMA) 2003. Building A Disaster-Resistant University. Federal Emergency Management Agency. Jessup. USA [12]

The parameter indicator of earthquake disaster has been developed by many experts, such as Urban Local Earthquake Disaster Risk Index [7], Seismic Risk Index of Urban Fabrics [8], Earthquake Disaster Risk Index Model developed [6]. Those studies become a reference in arranging parameter indicator for the hypothetical model of campus with disaster mitigation insight.

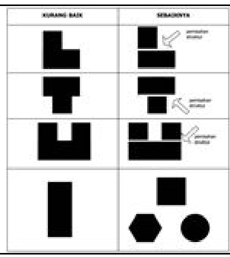
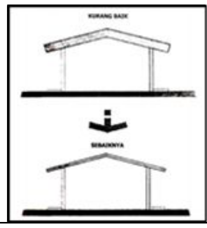
3.2 Identification of parameter, indicator, and sub indicator

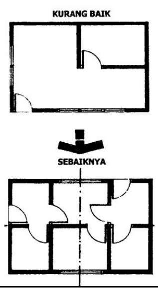
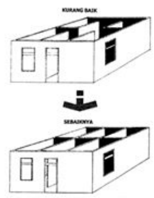
Identification of parameters is done because not all parameters of the earthquakes risk generally suited to be used as an indicator of the scale of the campus. The main indicator of earthquake risk of campus adopted from BNPB's National Disaster Management Guidelines on School Safety Policy [9], is as follow:

- Hazard: Location Risk
- Vulnerability: Building Structure Risk
- Capacity: Disaster Knowledge Capacity, Campus Policy, Preparedness Planning, resources mobilization

As for the results of the identification parameters, indicators, to sub-indicators was presented in Table 4.

Table 4. Parameter, indicator, and sub-indicator

The Result Of Weighting		
Parameter	**Indicator**	**Sub-Indicator**
Hazard Component		
(A) Location	(a) Location with earthquake zoning	(1) Location in earthquake zoning map from the government.
	(b) The potency of frequency and magnitude of the earthquake	(1) Potency
		(2) Frequency
		(3) Earthquake Magnitude
	(c) Distance with earthquake potency source	(1) Distance to earthquake potency source
	(d) Meet minimum ratio of land width and campus members.	(1) The minimum land width of University is 10.000 m^2
		(2) The ratio of lecturing room width at least 1.5 m^2/student
		(3) The width of the lecturing room not less than 20m^2
Vulnerability Component		
(A) Structure of Building	(a) The sketch form of building as symmetrical and simple as possible to anticipate destruction caused by the earthquake.	
	(b) The roof of a building should be made from light construction and material to reduce the intensity of destruction caused by the earthquake.	
	(c) A building should be designed based on technical standard and quality applied for building design, the building material used, and procedure of construction implementation, by referring to SNI and law regulation applied.	(1) The height of the building structure is measured from a lateral degree, not more than 10 floors or 40m.
		(2) The sketch of the building structure is rectangle without bulge and if it has bulge then the length of bulge not more than 25% of the biggest size of building structure sketch.
		(3) The sketch of building structure does not show angle shred and if it has it, then the length of shred side not more than 15% of the biggest size of building structure sketch.
		(4) The structure system of building formed by subsystems of lateral load buffer which is perpendicular and parallel with orthogonal main axes of building structure sketch in a whole.
		(5) The system structure of the building showed no springboard field advance and if have a springboard field advance, measure from the floor plan of the structure of the building is looming in each direction, not less than 75% of the size of the largest floor plan structure parts of the building next door
		(6) The system of building structures have a lateral stiffness of irregular, without any level of software. Software level is a level, where the stiffness of laterally is less than 70% lateral stiffness levels above it or less than 80% of the lateral stiffness of the average three levels above it
		(7) The system structure of the building has a floor rate of regular weight, meaning each floor level having a weight that is not more

The Result Of Weighting		
Parameter	**Indicator**	**Sub-Indicator**
		than 150% of the weight of the floor level above it or below it.
		(8) The system structure of the building has the vertical elements of the system bearers lateral loads, without displacement of the point of severity, except when the transfer is no more than half the size of the element in the direction of the displacement.
		(9) The system structure of the building has a floor level, without holes or openings that the extent of more than 50% wide the entire floor level. If there is a floor level with holes or openings that way, the amount may not exceed 20% of the number of floor level entirely.
	(d) The building design should count earthquake analysis in accord with SNI which regulate Earthquake Resistance Planning for Building Structure and refer to the newest earthquake zoning map.	(1) Table 2 Factor of maximum earthquake reduction and resistance.
	(e) The building should be designed by providing evacuation path which is enough and not blocked as anticipation of the earthquake disaster emergency condition.	(1) The building should be designed by providing evacuation path which is enough and not blocked as anticipation of the earthquake disaster emergency condition.
	(f) The building should be designed by providing the infrastructure of accessibility for people with special needs and the elderly.	(1) There are tiles for disabled
		(2) There are lift description for disabled
		(3) There are alternative ways for disable
(B) Design and Planning Classroom	(a) Has evacuation path and safe access which can be achieved easily and completed by direction sign which is clear and known well by children, including children with special needs particularly if a disaster occurs.	(1) Emergency lighting follows SNI 03-6573-2001 emergency lighting design Ordinance, a sign of the direction and danger warning system in the building.
		(2) Exit directional signs should follow SNI 03-6574-2001 Procedures for designing emergency lighting, directional signs and hazard warning systems in buildings.
		(3) Hazard warning system in the building should follow SNI SNI 03-6574-2001 Procedures for designing emergency lighting, directional signs and hazard warning systems in buildings.
	(b) Class design and arrangement refer to PerMenPU No.29/2006.	 (1) Placement of insulating walls and holes of the door/window and tried wherever possible axis-symmetrical with respect to the axis of the floor plan of the building in anticipation of the occurrence of the damage from the earthquake.
	(c) It better than the planes of wall form closed boxes to anticipate destruction as a result of an earthquake.	 (1) Wall areas should form a checkered closed to anticipate the damage caused by the earthquake.
Capacity Component		
(A) Knowledge, Attitude, and Action	(a) The availability of knowledge about the hazard, vulnerability, capacity, risk, and history of earthquake disaster occur in the campus environment.	(1) The availability of knowledge about the hazard, vulnerability, capacity, risk, and history of earthquake disaster occur in the campus environment.
	(b) The availability of knowledge about the effort which can be done to reduce the risk of the earthquake disaster in the campus.	(1) The availability of knowledge about the effort which can be done to reduce the risk of the earthquake disaster in the campus.
	(c) The implementation of socialization about knowledge on earthquake disaster mitigation	(1) The implementation of socialization about knowledge on earthquake disaster mitigation
	(d) Implementation of a simulated earthquake drill regularly on campus	(1) Implementation of a simulated earthquake drill regularly on campus
(B) Campus Policy	(a) There are policy, agreement and campus regulation which support the effort to apply the campus safe from the earthquake disaster.	(1) There are policy, agreement and campus regulation which support the effort to apply the campus safe from the earthquake disaster.
	(b) The availability of access for all components of campus toward information on knowledge and training to increase capacity in PRB (reference material, participate in training, etc).	(1) The availability of access for all components of campus toward information on knowledge and training to increase capacity in PRB (reference material, participate in training, etc).
(C) Alertness	(a) The availability of document on assessment of	(1) The availability of document on assessment of earthquake disaster

The Result Of Weighting		
Parameter	**Indicator**	**Sub-Indicator**
Planning	earthquake disaster risk	risk
	(b) The availability of action plan in the campus in earthquake disaster mitigation (before, during and after the disaster)	(1) The availability of action plan in the campus in earthquake disaster mitigation (before, during and after the disaster)
	(c) The availability of early warning system understood by all campus members	(1) The availability of early warning system understood by all campus members
	(d) The availability of Alertness Permanent Procedure on the campus which is agreed and implemented by all campus members.	(1) The availability of Alertness Permanent Procedure in the campus which is agreed and implemented by all campus members.
	(e) Their evacuation maps campus with signs and signs attached, which is easily understood by all campus residents, including children with special needs	(1) Their evacuation maps campus with signs and signs attached, which is easily understood by all campus residents, including children with special needs
	(f) The agreement and the availability of the location of evacuation/shelter nearby	(1) The agreement and the availability of the location of evacuation/shelter nearby
	(g) The existence of a permanent campus preparedness procedure agreed and implemented by all the citizens of the campus	(1) The existence of a permanent campus preparedness procedure agreed and implemented by all the citizens of the campus
(D) Resource Mobilization	(a) The number and type of equipment, supply, and basic needs post-disaster owned by campus.	(1) The number and type of equipment, supply, and basic needs post-disaster owned by campus.
	(b) There is safe campus officer unit who involve students representatives individually or in a group in the campus organization.	(1) There is safe campus officer unit who involve students representatives individually or in a group in the campus organization.
	(c) There is safe campus officer unit who involve students representatives individually or in a group in the campus organization.	(1) There is safe campus officer unit who involve students representatives individually or in a group in the campus organization.
	(d) Participative monitoring and evaluation of campus alertness and safety routinely (test and train alertness in campus regularly).	(1) Participative monitoring and evaluation of campus alertness and safety routinely (test and train alertness in campus regularly).

Source: Analysis Result, 2018

Table 5. Result of weighting

Weighting			Data Availability			Difficulty In Obtaining Data			Data Accuracy Level			Weight Score
Parameter	**Indicator**	**Sub-Indicator**	Available	Simple Analysis	Complicated Analysis	Easy	Medium	Difficult	Accurate	Medium	Less	
Hazard Component												
(A) Location	(a)	(1)	3			3			3			9
	(b)	(1)	3			3			3			9
		(2)	3			3			3			9
		(3)	3			3			3			9
	(c)	(1)		2		3			3			8
	(d)	(1)	3			3			3			9
		(2)	3			3			3			9
		(3)	3			3			3			9
Vulnerability Component												
(A) Structure of Building	(a)	(1)	3			3				2		8
	(b)	(2)		2			2			2		6
	(c)	(1)			1			1		2		4
		(2)			1			1		2		4
		(3)			1			1		2		4
		(4)			1			1		2		4
		(5)			1			1		2		4
		(6)			1			1		2		4
		(7)			1			1		2		4
		(8)			1			1		2		4
		(9)			1			1		2		4
	(d)	(1)			1			1		2		4
	(e)	(1)		2			2			2		6
	(f)	(1)		2		3				2		7
		(2)		2		3				2		7
		(3)		2		3				2		7
(B) Design and Planning Classroom	(a)	(1)			1		2			2		5
		(2)			1		2			2		5
		(3)			1		2			2		5
	(b)	(1)		2			2			2		6
	(c)			2			2			2		6
Capacity Component												
(A) Knowledge,	(a)	(1)		2		3				2		7

Weighting			Data Availability			Difficulty In Obtaining Data			Data Accuracy Level			Weight Score
Parameter	**Indicator**	**Sub-Indicator**	Available	Simple Analysis	Complicated Analysis	Easy	Medium	Difficult	Accurate	Medium	Less	
Attitude, and Action	(b)	(1)		2		3				2		7
	(c)	(1)		2		3				2		7
	(d)	(1)		2		3				2		7
(B) Campus Policy	(a)	(1)		2			2				1	5
	(b)	(1)		2			2				1	5
(C) Alertness Planning	(a)	(1)		2			2		3			7
	(b)	(1)		2		3				2		7
	(c)	(1)		2		3				2		7
	(d)	(1)		2			2			2		6
	(e)	(1)		2		3			3			8
	(f)	(1)		2			2			2		6
	(g)	(1)		2		3				2		7
(D) Resource Mobilization	(a)	(1)		2				1			1	4
	(b)	(1)		2		3				2		7
	(c)	(1)		2				1		2		5
	(d)	(1)		2				1		2		5

Source: Analysis result, 2018

3.3 The parameter, Indicator, and sub-indicator coding

Parameter and indicator coding is done to make easier readability and efficiency of the paper. The following is annotation from parameter and indicator coding to arrange hypothetical model of campus with disaster mitigation insight which had been presented in Table 6. The application of parameter coding can be seen in Table 4.

Table 6. Parameter coding

Description	Code
Parameter	A, B, C, D
Indicator	a, b, c, d
Sub-Indicator	1,2,3,4

3.4 Weighting result and classification of parameter

Weights are classified based on 3 levels (3, 2.1) adoption and modification from Toyfur [6]. The weighting value is the summation of the total weighting of results on each parameter. Based on the results of known value weighting the weighting parameters of 3 up to 9. The next election is conducted based on the parameters in the following Table 7. As for the results of the weighting of each indicator, parameters have been presented in Table 5.

Table 7. Classification of parameter

Classification of Parameter	Weight Score
Ideal Parameter	3 until 9
Medium Parameter	5 until 9
Simple Parameter	6 until 9

Description:

- Ideal parameter: parameter with weight score of parameter indicator 3 until 9 or all parameter indicators including in it.
- Medium parameter: parameter with the weight score of parameter indicator 5 until 9.
- Simple parameter: parameter with the weight score of parameter indicator 6 until 9.

3.5 Classification of model

Classification of a model is done to adjust the existing condition of campus. The selection of model classification is divided into 3 parts namely, ideal model parameter, the medium model parameter, and a simple model parameter which is classified based on the result of weighting on Table 5.

3.5.1. Ideal model parameter

The parameter for an ideal model is the one with the indicator parameter score is <4 until 9 in Appendix 1. The following is an ideal model parameter which had been presented in Table 8.

Tabel 8. Ideal model parameter

Component	Parameter	Indicator
Hazard	Location	a (1), b (1,2,3), c (1), d (1,2,3)
Vulnerability	Structure of Building	a (1), b (1), c (1,2,3,4,5,6,7,8,9), d (1), e (1), f (1,2,3)
	Class Design and Arrangement	a (1,2,3), b (1), c (1)
Capacity	Knowledge, Attitude, and Action	a (1), b (1), c (1), d(1)
	Campus Policy	a (1), b (1)
	Alertness Planning	a (1), b (1), c (1), d(1), e (1), f (1), g (1)
	Resources Mobilization	a (1), b (1), c (1), d(1)

Source: Analysis result, 2018

3.5.2. Medium Model Parameter

The parameter to medium model is a parameter with parameter indicator score is 5 until 9. There are some parameters omitted from ideal parameter namely structure of the building. The following is a medium model parameter which had been presented in Table 9.

Table 9. Medium model parameter

Component	Parameter	Indicator
Hazard	Location	a (1), b (1,2,3), c (1), d (1,2,3)
Vulnerability	Structure of Building	a (1), b (1), e (1), f (1,2,3)
	Class Design and Arrangement	a (1,2,3), b (1), c (1)
Capacity	Knowledge, Attitude, and Action	a (1), b (1), c (1), d(1)
	Campus Policy	a (1), b (1)
	Alertness Planning	a (1), b (1), c (1), d(1), e (1), f (1), g (1)
	Resources Mobilization	b (1), c (1), d(1)

Source: Analysis result, 2018

3.5.3. Simple model parameter

The parameter for a simple model is the one with an indicator score is 6 until 9 in Appendix 1. A simple model parameter is arranged for a campus with a simple physical condition and the small size of campus members. Usually, it is used for regional campuses with the low level of vulnerability. The following is a simple model parameter which had been presented in Table 8 as follow.

Table 10. Simple model parameter

Component	Parameter	Indicator
Hazard	Location	a (1), b (1,2,3), c (1), d (1,2,3)
Vulnerability	Structure of Building	a (1), b (1), e (1), f (1,2,3)
	Class Design and Arrangement	b (1), c (1)
Capacity	Knowledge, Attitude, and Action	a (1), b (1), c (1), d(1)
	Alertness Planning	a (1), b (1), c (1), d(1), e (1), f (1), g (1)
	Resources Mobilization	b (1)

Source: Analysis result, 2018

3 Conclusions

Campus model of mitigation insight is very important to be developed especially for the campus in the earthquake-prone area. The campus model is based on 7 parameters that each parameter was orderly based on data availability criteria, data difficulty, and data accuracy. The simulation result will get 3 level of the model that is an ideal model, medium and simple. This model will be implemented in UPI Campus as a case study.

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