International Journal of Multicultural and Multireligious Understanding

http://ijmmu.com
editor@ijmmu.com
ISSN 2364-5369
Volume 12, Issue 1
January, 2025
Pages: 239-255

Impact of Fatalistic Seismic Belief and Risk Communication towards Earthquake Risk Perception in Indonesia

Resti Kinanthi[1,4]; Subejo[2]; Muhamad Sulhan[3]

[1] Doctoral Study Program of Extension and Communication Development, Graduate School, Universitas Gadjah Mada, Indonesia

[2] Department of Agricultural Socio-Economics, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, Indonesia

[3] Department of Communication, Faculty of Social and Political Sciences, Universitas Gadjah Mada, Yogyakarta, Indonesia

[4] Politeknik Akbara, Surakarta, Indonesia

http://dx.doi.org/10.18415/ijmmu.v12i1.6427

Abstract

Socio-cultural factors are responsible in shaping earthquake risk perception asides psychological factors. According to preliminary research, the interaction of social and cultural factors associated with earthquake risk in Indonesia need to be examined due to the high occurrence. The impact of risk with diverse socio-cultural conditions will give rise to different complexities for disaster management. Therefore, this research aims to examine the interaction of fatalistic seismic belief and risk communication associated with earthquake perception in Indonesia. Data were collected from 400 respondents to obtain fatalistic seismic belief, risk communicate $on, and perception using a questionnaire with a multistage random sampling method. The data collected were analyzed using the PLS-SEM model in SmartPLS 4. The results showed that fatalistic seismic belief had a negative and significant influence of 0.310, while risk communication had a positive and significant influence on risk perception by 0.223. Risk communication also influences fatalistic seismic belief negatively and significantly by 0.285. In conclusion, research regarding individual risk perception in facing earthquake is important to reduce losses caused by this natural disaster in Indonesia.

Keywords: *Risk Communication; Fatalistic Seismic Belief; Earthquake Risk Perception*

Introduction

Earthquake is a prevalent occurrence in Indonesia, which has approximately 148 million people or 62.4% with an area of 92.2 million hectares (48.5%) exposed to high and medium threat levels (BNPB et al., 2015). According to the National Disaster Management Agency, the Disaster Risk Index showed that 59.14% of cities or regencies were exposed to high risk earthquake (BNPB, 2023). This is also in line with the report published by the Meteorology, Climatology and Geophysics Agency (BMKG). In addition, the losses incurred during seven major earthquake events experienced between 2004 and 2023, reached 128 T.

The global agenda for disaster risk reduction in 2015-2030 led to the formulation of the Sendai Framework, which aimed to reduce impact of the natural occurrence of earthquake on several aspects, including livelihood, health, economy, and the society. The Sendai Framework also contributes to achieving the SDGs, namely social protection to end poverty (SDG1), making cities resilient, inclusive, safe and sustainable (SDG11) and reducing the impact of climate change (SDG13). However, a significant priority of the Sendai Framework is understanding disaster risk (Nations Office for Disaster Risk Reduction, 2015). A comprehensive understanding prompts a community to engage in risk reduction activities, specifically for earthquake. This also incites the willingness and ability to adopt preventive actions to reduce risk of disasters. Furthermore, to analyze risk management plans from a community resilience perspective, integration of physical, social, financial, technological and human capital is required in all components of risk management cycle, comprising recovery, assessment, prevention, mitigation, and preparedness. A critical challenge is the difference in community perception of earthquake disaster risk management (Mañez et al., 2016).

Risk perception refers to individual subjectivity in terms of how the characteristics of a phenomenon are viewed or assessed (Agrawal, 2018a). It also plays an important role in earthquake disaster risk management. Poor perception of a particular risk, leads to inappropriate reactions, or even more dangerous situations (Mañez et al., 2016). Additionally, risk perception is a major predictor of disaster preparedness. This factor also plays a significant role in motivating individuals to avoid, reduce, adapt, or even ignore risks (Wachinger et al., 2013). Asides from shaping behavior, risk perception is a basic element for increasing awareness and preparedness in respect to disaster risk management (Landeros-Mugica et al., 2016). Further exploration offers valuable information for behavioral interventions in adopting preparedness measures, as well as understanding why communities usually fail to prepare for disasters (Chesterman et al., 2019). Individual perception of risk disaster are as a result of distinct factors, and social interactions (Xue et al., 2021). Knowledge and understanding of diverse perception are essential in determining the successful implementation of risk communication plan, as part of the reduction strategy and adaptation measures (Agrawal, 2018a; Alcántara-Ayala & Moreno, 2016). However, several factors influence risk perception, namely 1) the type of information available and how it is processed, 2) characteristics and emotional states of the recipients, 3) personal experiences and prejudices, and 4) socio-economic factors (Agrawal, 2018b). Risk perception is associated with the information available and the interpretation process (Kammerbauer & Minnery, 2019). Meanwhile, risk communication is defined as the process of exchanging information among stakeholders about the nature, magnitude, significance, and controllability of risk (Covello, 1992). The way risks and crises are communicated to the public, would influence perception of future events (Dressel, 2015). A better understanding of the reciprocal relationship between risk perception and communication is essential in terms of identifying constraints associated with decisions to adopt mitigation actions, including the formulation of strategies for risk reduction (Egbelakin et al., 2011). Effective risk communication increases knowledge about hazards, raises awareness of safety, as well as aids in the development of rational risk-perceived behavioral patterns (Rahman, 2019). The way and manner risks and crises are communicated to the public generally influences perception of future events (Dressel, 2015). Risk communication reportedly has a positive and significant influence on perception of Covid-19 disaster in Iran (Heydari et al., 2021).

Based on this perspective, fatalistic seismic belief led to the conviction that earthquake is caused by uncontrollable factors, such as divine intent, luck, and fate, resulting in the passive acceptance of the consequences (Liu & Sun, 2022; Sun et al., 2022). Several research had reported that fatalistic seismic belief influence perception of earthquake risk. High belief in fatalism has a negative relationship with perception of earthquake risk. Therefore, the higher belief in fatalism, the lower perception of earthquake risk (Aksa et al., 2020). Fatalistic belief spread across generations results in lack of adequate rational thinking skills to analyze, criticize and assess information. It also causes society to be passive in disaster risk reduction activities (Baytiyeh & Naja, 2016). Meanwhile, the importance of reducing fatalistic belief about earthquake risk was reported by (Sun et al., 2018) because it causes lack of public confidence in reduction activities. The results of the research conducted by (Massimo et al., n.d.) showed that 80% of Italians residing in earthquake-prone zones had inappropriate perception of earthquake risk. Additionally, lack of knowledge causes people to ignore the existing risk. Inappropriate perception held by the community hindered management activities, causing people to ignore risk encountered. Lack of risk perception and proper interpretation led to increased risk potential in the community, despite carrying out a comprehensive assessment (Fakhruddin et al., 2020). However, this research aimed to examine how fatalistic seismic belief and risk communication influenced perception of earthquake risk in Indonesia. The purpose was to ascertain how the community perceived risk faced, as well as the implications.

Research Method

Research Location

This research was conducted in four provinces with the largest earthquake risk exposure, namely West, East, and Central Java, including North Sumatra.

Data Collection

Data collection was carried out using the survey method, which entailed the distribution of questionnaires to 400 respondents selected proportionally from the four provinces. Determination of the sample size using the Cochran formula (Sugiyono, 2018). In addition, the sampling process was carried out using a multistage random sampling method. From the four selected provinces, two regencies/cities were randomly selected. Each selected city/regency was randomly selected by 2 sub-districts, and each selected sub-district was randomly selected by 1 village. From the 16 selected villages, random samples were then taken using simple random sampling. The following shows the sample size from each province.

Table 1. Sample Distribution

Province	Number of Population	Sample
North Sumatra	15.115.206	42
East Java	41.416.407	115
Central Java	37.032.410	104
West Java	50.025.605	139
Total	143.589.628	400

The research location map is shown in Figure 1

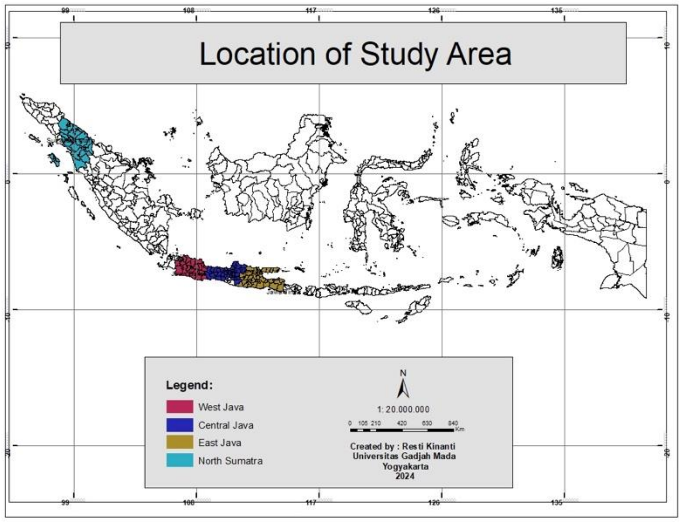

Figure 2. Location of Research Area

The questionnaire used for data collection included variables of earthquake risk perception, communication, and fatalistic seismic belief. In addition, it was divided into two parts. The first part mainly contained basic information, such as gender, age, and education level. While, the second part focused on, risk perception, and communication, as well as fatalistic seismic belief. Question items were designed using a 5-point Likert scale, namely, strongly agree, agree, uncertain, disagree, and strongly disagree. The respondents made judgments based on the level of consistency between the questions and respective perception.

Data Analysis

This descriptive research adopted a quantitative method, with the scoring of each variable calculated using a Likert scale. Meanwhile, data analysis was carried out using the PLS-SEM model in SmartPLS 4. The following hypotheses were tested

H1 risk communication has a significant and positive effect on earthquake risk perception

H2 fatalistic seismic belief variable has a significant and negative effect on earthquake risk perception

H3 risk communication has a significant and negative effect on fatalistic seismic belief

Partial least squares-path modeling (PLS-PM) is a multivariate statistical technique first introduced by Herman Wold in the late 1960s and has developed rapidly over the past decade (Latan & Noonan, 2017). Its ability to model factors and combinations makes PLS path analysis used by researchers from across disciplines (Hoök & Lowgren, 2012). This study used Smart Partial Least Square (Smart PLS) software. The advantages of SmartPLS include: 1) it has a function to test the relationship between variables; 2) it is not based on various assumptions so it is considered more powerful. 3) it is able to analyze a smaller number of samples than other software; 4) the data does not have to be normally distributed because SmartPLS uses the bootstrapping/random duplication method; 5) it is able to test models with different indicator measurement scales in one model. The stages of interpreting the results of the SmartPLS analysis according to (Hair Jr et al., 2022) include:

Outer Model Analysis

1. Convergent Validity and Discriminant Validity

The convergent validity test aims to determine the validity of each relationship between indicators and their constructs or latent variables. In PLS-SEM Analysis, there are two types of validity, namely convergent validity and discriminant validity. Convergent validity is used to determine how a set of indicators represents one latent variable and what underlies the latent variable. Convergent validity can be seen from the average value of the extracted variance (Average Variance Extracted / AVE) and the outer loading value. An AVE value> 0.5 means that the convergent validity is adequate, one latent variable is able to explain more than half of the variance of its indicators on average. The loading factor limit is 0.70 but the outer loading value between 0.5 - 0.6 is still acceptable (Chin, 1988).

Discriminant validity testing is carried out to ensure that each concept of each latent model is different from other variables. Validity testing is carried out to determine how precisely a measuring instrument performs its measurement function (Ghozali, 2016). Discriminant validity testing in SEM-PLS can be done by looking at the fornell-larcker criterion and HTMT values. In the fornell-larcker criterion test, discriminant validity can be said to be good if the root of the AVE in the construct is higher than the correlation of the construct with other latent variables. While the heterotrait-monotrait ratio (HTMT) value with an acceptable limit value is <0.9 (Hair Jr et al., 2022).

2. Reliability Test

Reliability testing in SEM-PLS can be done using two methods, namely Cronbach's alpha and composite reliability. Cronbach's alpha measures the lower limit of the reliability value of a construct while composite reliability measures the actual value of the reliability of a construct. To be able to meet good reliability, the composite reliability value and Cronbach's alpha value must be greater than 0.70 (Chin, 1988).

Inner Model Analysis

The structural model (also called the inner model in PLS-SEM) is a model that describes the relationship between latent variables.

1. Multicollinearity Test

The multicollinearity test is the first test performed on the structural model. The multicollinearity test is carried out because the path coefficient estimate in the structural model is based on the ordinary least squares regression of each endogenous latent variable on its corresponding predecessor construct. The expected VIF value is <5.

2. Hypothesis Test

Hypothesis testing is carried out to determine the direct and indirect influence of the construct.

3. R2

The coefficient of determination (R^2) is calculated as the squared correlation between the actual and predicted values of a particular endogenous construct.

Results and Discussion

The characteristics of respondents based on education level, age and gender, are shown in Table 2. In addition, the present research collected data from 400 respondents.

Table 2. Socio-demographic characteristics of the respondents (number = 400) in this research

Characteristics	Category	Number	Percentage (%)
Education Level	not willing to say	42	10,50
	Primary or below	70	17,50
	Secondary	259	64,75
	Tertiary or above	29	7,25
Sex	Male	225	56,25
	Female	175	43,75
Age	15-24	71	17,75
	25-34	88	22
	35-44	80	20
	45-54	73	18,25
	>65	88	22

The results of the survey showed that majority of the respondents, approximately 64.75% had secondary education, while 17.5% and 7.25% had completed primary, and tertiary education. However, 10.5% were unwilling to mention respective educational background. The respondents comprised 56.25% and 46.75% of males, and females, respectively with majority relatively 22% within the age group of 25 to 34 years, and over 65 years, while 17.75% were between 15 to 24 years.

Validity and Reliability Test

Convergent Validity

Convergent validity is used to determine how a set of indicators represents one latent variable and the underlying latent variable. Convergent validity can be seen from the average value of the extracted variance (Average Variance Extracted / AVE) and the outer loading value. An AVE value> 0.5 means that convergent validity is adequate, one latent variable is able to explain more than half of the variance of its indicators on average (Hair Jr et al., 2022). The loading factor limit is 0.70 (Hair Jr et al., 2022) but the outer loading value between 0.5 - 0.6 is still acceptable (Chin, 1988). The loading factor value can be seen in Table 3.

Table 3. Convergent Validity

Latent Variable	Indicator	Outer Loading	AVE
Risk Communication	KR1	0,747	0,581
	KR2	0,691	
	KR3	0,772	
	KR4	0,659	
	KR5	0,824	
	KR6	0,872	
	KR7	0,812	
	KR8	0,695	
Fatalistic Seismic Belief	KF12	0,935	0,834
	KF13	0,894	
	KF14	0,910	
Earthquake Risk Perception	PR5	0,747	0,538
	PR8	0,815	
	PR9	0,722	
	PR10	0,615	
	PR11	0,802	
	PR12	0,682	

From table 3 it can be seen that the AVE value> 0.5, and the loading factor on all indicators> 0.6. So, we can conclude that the model has good convergent validity.

Discriminant validity test was conducted to prove that each latent model concept differed from the other variables. This also included determining the precision function of a measuring instrument (Hair Jr et al., 2022). Discriminant validity test was conducted by analyzing the fornell-larcker criterion and cross loading values. Additionally, the results of the discriminant validity test are shown in Table 4 and Table 5.

Table 4. Fornell-larcker criterion

	Earthquake Risk Perception	Fatalistic Seismic Belief	Risk Communication
Earthquake Risk Perception	0.734		
Fatalistic Seismic Belief	-0.374	0.913	
Risk Communication	0.312	-0.285	0.762

Table 5. Cross Loading Test

	Earthquake Risk Perception	Fatalistic Seismic Beliefs	Risk Communication
KF12	-0.366	**0.935**	-0.288
KF13	-0.284	**0.894**	-0.230
KF14	-0.365	**0.910**	-0.259
KR1	0.226	-0.295	**0.747**
KR2	0.167	-0.114	**0.691**
KR3	0.230	-0.117	**0.772**
KR4	0.147	-0.120	**0.659**
KR5	0.285	-0.248	**0.824**
KR6	0.310	-0.291	**0.872**
KR7	0.251	-0.276	**0.812**
KR8	0.217	-0.144	**0.695**
PR10	**0.747**	-0.230	0.185
PR11	**0.815**	-0.291	0.252
PR12	**0.722**	-0.256	0.169
PR5	**0.615**	-0.191	0.304
PR8	**0.802**	-0.394	0.202
PR9	**0.682**	-0.245	0.258

Based on the fornell-larcker criterion test, the discriminant validity of the instrument can be categorized as good, assuming the root of the AVE is greater than the correlation of the construct with other latent variables. In the cross-loading test, the indicator value of each construct must be greater than the others (Hair Jr et al., 2022).

Reflective Measurement and Structural Model

Reliability testing in SEM-PLS can be done using two methods, namely Cronbach's alpha and composite reliability. Cronbach's alpha measures the lower limit of the reliability value of a construct while composite reliability measures the actual value of the reliability of a construct. To achieve good reliability, the composite reliability value and Cronbach's alpha value must be greater than 0.70 (Chin, 1988).

Table 6. Reliability Test

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Earthquake Risk Perception	0.826	0.837	0.874	0.538
Fatalistic Seismic Beliefs	0.901	0.913	0.938	0.834
Risk Communication	0.897	0.922	0.917	0.581

However, from Table 6 it can be seen that the composite reliability value and Cronbach's alpha value are greater than 0.7, so the reliability requirements have been fulfilled.

Earthquake Risk Perception

Earthquake risk perception refers to individual assessment of the threat, impact, and ability to control the consequences faced. This research adopted 12 risk perception indicators, but after being subjected to validity and reliability tests using SEM-PLS, six were proven valid and reliable. The achievements of earthquake risk perception indicators are shown in Table 7.

Table 7. Earthquake Risk Perception Indicators

No	Code	Indicator	Score		achievement level	Category
			Interval	Mean		
1	PR5	Feeling that earthquake could damage respective residences.	0-4	2,59	64,63	Agree
2	PR8	It is felt that the incidence of fatalities/injuries due to earthquake can be reduced by increasing preparedness measures.	0-4	2,23	55,63	Uncertain
3	PR9	Feel the need to prepare oneself to face the threat of earthquake (such as evacuation drills, strengthening building structures, preparing emergency bags).	0-4	3,05	76,31	Agree
4	PR10	Feeling that a possible earthquake could have a serious impact on the safety of the respondents.	0-5	2,9	58,00	Uncertain
5	PR11	Feeling that an impending earthquake could have a serious impact or damage the residence of the respondent.	0-4	0,53	13,38	Strongly disagree
6	PR12	Feeling that a possible earthquake could have a severe impact on the health condition of the respondent.	0-5	0,53	10,50	Strongly disagree
		Total score	**26**	**11,83**		
		score achievement			**45,49**	Uncertain

The score achievement on earthquake risk perception variable is 45.49%, included in the uncertain category. The indicator with the highest score achievement of 76.31% is that the community feels the need to for preparedness in facing the threat of earthquake. It also agrees that a possible earthquake can cause damage to diverse buildings. However, the community strongly disagrees that a possible earthquake can have a serious impact on diverse houses (score achievement 13.38%), and health (score achievement 10.50%). It was also doubtful (score achievement 58%) that earthquake can have a serious impact (injury/death) on the people. Considering earthquake risk reduction indicator, the community was doubtful (score achievement 55.63%) that preparedness measures reduces risk of injury and loss of life.

Risk Communication

Risk communication is defined as the process of exchanging information among stakeholders about the nature, magnitude, significance, and control of risk (Covello, 1992). This research focused on the eight risk communication indicators in Table 8.

Table 8. Earthquake Risk Communication Indicators

No	Code	Indicator	Score		achievement level	ategory
			Interval	Mean		
1	KR1	Get information about the possibility of earthquake occurring around the location.	0-4	1,01	25,13	isagree
2	KR2	Obtain information about potential losses incurred if earthquake occurs.	0-4	0,83	20,63	isagree
3	KR3	Get information about how to prepare for earthquake.	0-4	1,42	35,50	isagree
4	KR4	Get information about buildings that are resistant to earthquake.	0-4	0,86	21,50	isagree
5	KR5	Get information about personal protective measures during earthquake.	0-4	1,61	40,13	ncertain
6	KR6	Get information about how to evacuate during earthquake.	0-4	1,41	35,19	isagree
7	KR7	Obtain information regarding the need for an emergency plan to deal with risk of earthquake.	0-4	0,99	24,81	isagree
8	KR8	Get information about the need to prepare a disaster preparedness bag.	0-4	0,64	15,88	trongly Disagree
		Total score	**32**	**8,75**		
		score achievement			**27,34**	**isagree**

The score achieved on risk communication variable was 27.34, included in the disagree category. The community agreed that it did not get information about the possibility of earthquake in respective residential location (score achievement 25.13%), potential losses (achievement 20.63%), how to prepare for the disaster (achievement 35.50%), earthquake-resistant buildings (achievement 21.50%), were hesitant regarding self-protection measures (achievement 40.13%), evacuation process (achievement 35.19%), the need for an emergency (achievement 24.81%), as well as the need for a disaster preparedness bag (achievement 15.99%). In general, 57.5%, 40.75% and 1.75% of respondents had low (<33%), medium (33 to 66%) and high (>66%) scores.

Fatalistic Seismic Belief

Fatalistic seismic belief offer the conviction that earthquake are caused by uncontrollable factors, such as divine intent, luck, and fate. In addition, one can passively accept the consequences (Liu & Sun, 2022; Sun et al., 2022), based on the indicators of fatalistic seismic belief in Table 9.

Table 9. Fatalistic Seismic Belief Indicators

No	Code	Indicator	Score		achievement level	Category
			Interval	Mean		
1	KF12	Losses due to earthquake cannot be reduced by evacuation drills.	0-4	0,84	21,06	Disagree
2	KF13	Earthquake-resistant buildings cannot reduce risk of injury.	0-4	0,85	21,19	Disagree
3	KF14	Risk of injury caused by earthquakes cannot be reduced by increasing knowledge about preparedness measures.	0-4	0,83	20,81	Disagree
		Total score	**12**	**2,52**		
		score achievement			**21**	Disagree

The score obtained from fatalistic seismic belief variable is 21%, included in the disagree category. In accordance with the three indicators of seismic fatalistic seismic belief, the community disagrees that losses caused by earthquake cannot be reduced by evacuation training with an achievement score of 21.06%. Furthermore, earthquake-resistant buildings do not lessen risk of injury while risk of injury cannot be moderated by increasing knowledge about preparedness with achievement scores of 21.19% and 20.81%. Therefore, 98.5% of Indonesians have low fatalistic seismic belief (score achievement <33%).

Structural Model/Inner Model

Multicollinearity Test

The multicollinearity test is the first test performed on the structural model. The multicollinearity test is performed because the path coefficient estimation in the structural model is based on the ordinary least squares regression of each endogenous latent variable on its corresponding antecedent construct. The expected VIF value is <5. The results of the multicollinearity test are presented in Table 10.

Table 10. Multicolinearity test

Path	**VIF**
Fatalistic Seismic Beliefs -> Earthquake Risk Perception	1.089
Risk Communication -> Earthquake Risk Perception	1.089
Risk Communication -> Fatalistic Seismic Beliefs	1.000

From Table 10, it can be seen that the VIF values on all paths are <5, so it can be concluded that the model is free from collinearity problems.

R^2

The coefficient of determination (R^2) is calculated as the squared correlation between the actual value and the predicted value of a particular endogenous construct. The coefficient of determination represents the combined effect of exogenous latent variables on endogenous latent variables. The R^2 value ranges from 0 to 1, with higher levels indicating higher levels of explanatory power. Acceptable R^2 values are based on the context (Hair Jr et al., 2022). The R2 values of model 1 are presented in Table 11.

Table 11. R-square

	R-square	R-square adjusted
Earthquake Risk Perception	0.186	0.182
Fatalistic Seismic Beliefs	0.081	0.079

From Table 11, it can be seen that the R^2 value of earthquake risk perception is 0.186. This means that the risk perception variable can be explained by the variables in the model by 18,6% while 81,4% is explained by other variables outside the model.

Hypothesis Test Results of Factors Affecting Earthquake Risk Perception in Indonesia

The present research tested three hypotheses, with the results shown in Table 12 and Figure 1.

Table 12. Hypothesis Test Results of Factors Affecting Earthquake Risk Perception in Indonesia

Path		Coefficient	St.Dev	T.Stat	P.Value
From	To				
Fatalistic Seismic Belief	Earthquake Risk Perception	-0.310	0.053	5.897	0.000
Risk Communication	Earthquake Risk Perception	0,223	0.053	4.227	0.000
Risk Communication	Fatalistic Seismic Belief	-0.285	0.057	4.986	0.000

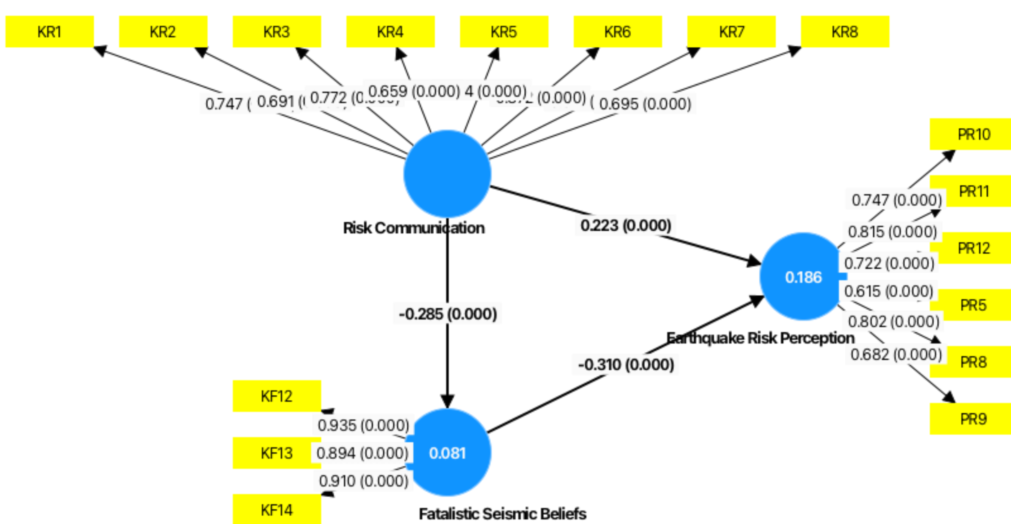

Figure 1. Model of the Influence of Risk Communication and Fatalistic seismic belief on Earthquake Risk Perception

Based on the results of the hypothesis test in Table 6, risk communication has a significant influence on perception of earthquake risk in the country (P value 0.000), with a path coefficient is 0.223.

Furthermore, eight indicators reflected risk communication variable. The three indicators with the highest loading factors were KR5 get information about personal protective measures during earthquake (0.824), KR6 get information about how to evacuate during earthquake (0.872) and KR7 Obtain information regarding the need for an emergency plan to deal with risk of earthquake (0.812). H1 was accepted, hence risk communication variable had a significant and positive effect on perception of earthquake risk. This was related to the information available to the people who assessed, and interpreted risk (Kammerbauer & Minnery, 2019). The major source of information for the community is through risk communication. It has a significant and positive effect on perception of earthquake risk. This tend to occur because effective risk communication increased knowledge about hazards, awareness of safety as well as helped people build rational risk perception behavior patterns (Rahman, 2019). The manner risk and crises were communicated to the public affected perception of future events (Dressel, 2015). The results of this research showed that as many as 57.5% of respondents had low risk communication scores. Therefore, effective risk communication was needed to improve public risk perception of earthquake. Various authorities such as the government, academics, business world, media, and even communities are exposed to opportunities to communicate risk. Research on the most effective media and communication methods were needed to optimize risk communication, enabling it to be right on target. The effect of fatalistic seismic belief variable on earthquake risk perception was shown in Table 6. This variable had a significant effect on earthquake risk perception in Indonesia (P value 0.000), with a path coefficient value of -0.310. Figure 1 shows that three indicators reflected fatalistic seismic belief variable. The indicator with the highest loading factor is risk of injury caused by earthquake cannot be reduced by increasing knowledge about preparedness by 0.935. H2 was accepted, because fatalistic seismic belief variable had a significant negative effect on earthquake risk perception. The results of this investigation are in line with the research conducted by (McIlroy et al., 2022). Meanwhile, the influence of fatalistic seismic belief on risk perception was also reported by (McIlroy et al., 2022), an investigation which focused on traffic safety in Brazil and Ecuador. The research showed that fatalistic seismic belief were found to significantly influence general traffic risk perception. Previous research that reported high fatalistic seismic belief also stated lower road risk perception. In this context, high belief in fatalism were also negatively associated with earthquake risk perception. The higher belief in fatalism, the lower perception of earthquake risk (Aksa et al., 2020). Fatalistic belief spread across generations also resulted in lack of adequate rational thinking skills to analyze, criticize and assess information. Additionally, fatalistic belief caused people to become passive in disaster risk reduction activities (Baytiyeh & Naja, 2016). The importance of reducing fatalistic belief was also reported by (Sun et al., 2022) because it leads to lack of confidence in disaster risk reduction activities. Previous investigations had shown that this variable adopted different forms, depending on the cultural background. Generally, there were various kinds of fatalistic seismic belief which were divided into three groups in this research. This included fatalistic belief about the causes, impact and reduction of earthquake risk. However, after being subjected to validity and reliability tests, only two indicators focused on fatalistic belief about impact and one on reducing earthquake risks. Therefore, the score achievement on fatalistic seismic belief variable was included in the low category, but the results obtained showed that reducing fatalistic seismic belief held by individuals can significantly increase risk perception.

The effect of risk communication variables on fatalistic seismic belief was tested in hypothesis 3. The results showed that risk communication has a significant effect on fatalistic seismic belief (p value 0.000) with a path coefficient value of -0.285. Hypothesis 3 was accepted, because risk communication has a significant negative effect on fatalistic seismic belief. Meanwhile, risk communication is the process of exchanging information between interested parties about the nature, magnitude, significance, and control of risk (Covello, 1992). Majority of the respondents approximately 57.5% have risk communication score achievement, included in the low category. This was caused by several factors including lack of risk communication intensity by the authorities, use of less targeted communication media, or people who tend to underestimate risk of earthquake. Risk communication reduces fatalistic seismic belief by straightening knowledge about the causes, impact and reduction of earthquake risk. Fatalistic seismic belief was often observed in those who resided in disaster-prone areas, because the individuals tend to experience helplessness in terms of controlling the negative impact of disasters. These individuals often hold fatalistic seismic belief that nothing can be done to prevent the damage caused by earthquake (Lindell & Perry, 1992). If earthquake damage was attributed entirely to uncontrollable causes, these individuals tend not to prepare for disaster. However, when the damage was attributed to controllable causes, such as building design that does not meet earthquake-resistant requirements, it implied actions such as strengthening buildings could have prevented the damage (McClure et al., 2001). Fatalistic seismic belief held by the public can be significantly reduced through appropriate risk communication.

Conclusion

Research focusing on the influence of risk communication on earthquake risk perception has been widely conducted in various countries. This study provides novelty by adding a fatalistic belief factor that has not been widely studied by experts. The results of this study indicate that risk communication has a positive and significant influence on earthquake risk perception. Effective and targeted risk communication has been shown to increase public risk perception of earthquakes. While fatalistic seismic beliefs have a negative and significant influence on risk perception, various fatalistic beliefs held by the public related to earthquakes can reduce public risk perception so that people tend to ignore the existing earthquake risk. Risk communication has been shown to significantly reduce fatalistic seismic beliefs held by the Indonesian people. In addition to having a direct influence on increasing earthquake risk perception, risk communication also has an indirect influence by reducing fatalistic beliefs held by the public. This study provides recommendations to the authorities (government, media, academics, private sector) in communicating earthquake risks to the public to continue to improve earthquake risk communication both in terms of information quality, quantity, and media selection that is appropriate for the target community. Risk communication provided to the community must be able to translate scientific information from experts so that it is easily understood by the community to reduce fatalistic beliefs, considering the high diversity of socio-cultural conditions in Indonesia that have contributed to forming fatalistic beliefs in the community related to earthquakes. The limitation of this study is the limited indicators of fatalistic beliefs used in all research areas, research on fatalistic beliefs in earthquakes needs to be conducted locally to provide recommendations on the types of fatalistic beliefs that exist in each region so that the risk communication carried out can specifically reduce fatalistic beliefs in the community.

Acknowledgements

The authors are grateful to the Indonesia Endowment Funds for Education (LPDP) and Center for Higher Education Funding (BPPT) for funding this research.

References

Agrawal, N. (2018a). Disaster perceptions. In *Advances in Natural and Technological Hazards Research* (Vol. 49, pp. 193–217). Springer Netherlands. https://doi.org/10.1007/978-94-024-1283-3_5.

Agrawal, N. (2018b). Disaster perceptions. In *Advances in Natural and Technological Hazards Research* (Vol. 49, pp. 193–217). Springer Netherlands. https://doi.org/10.1007/978-94-024-1283-3_5.

Aksa, F. I. ;, Utaya, S., Bachri, S., & Handoyo, B. (2020). The role of knowledge and fatalism in college students related to the earthquake-risk perception. *Jàmbá - Journal of Disaster Risk Studies*, *12*(1), 1–6.

Alcántara-Ayala, I., & Moreno, A. R. (2016). Landslide risk perception and communication for disaster risk management in mountain areas of developing countries: a Mexican foretaste. *Journal of Mountain Science*, *13*(12), 2079–2093. https://doi.org/10.1007/s11629-015-3823-0.

Baytiyeh, H., & Naja, M. (2016). The effects of fatalism and denial on earthquake preparedness levels. *Disaster Prevention and Management*, *25*(2), 154–167. https://doi.org/10.1108/DPM-07-2015-0168.

BNPB. (2023). *RBI RISIKO BENCANA INDONESIA BNPB "Memahami Risiko Sistemik di Indonesia" Diterbitkan oleh*.

BNPB, UNFPA, & BPS. (2015). *POPULATION EXPOSED TO NATURAL HAZARDS*.

Chesterman, A., Lopez, A., Rateau, P., & Weiss, K. (2019). When factors of risk perception are an obstacle to risk representation: Earthquakes in Southern France. *Revue Europeenne de Psychologie Appliquee*, *69*(1), 31–39. https://doi.org/10.1016/j.erap.2018.12.001.

Chin, W. W. (1988). *The Partial Least Squares Approach to Structural Equation Modeling*. https://www.researchgate.net/publication/311766005.

Covello, V. T. (1992). Risk Communication: An Emerging Area of Health Communication Research. *Annals of the International Communication Association*, *15*(1), 359–373. https://doi.org/10.1080/23808985.1992.11678816.

Dressel, K. (2015). Risk culture and crisis communication. *International Journal of Risk Assessment and Management*, *18*(2), 115–124. https://doi.org/10.1504/IJRAM.2015.069020.

Egbelakin, T. K., Wilkinson, S., Potangaroa, R., & Ingham, J. (2011). Challenges to successful seismic retrofit implementation: A socio-behavioural perspective. In *Building Research and Information* (Vol. 39, Issue 3, pp. 286–300). https://doi.org/10.1080/09613218.2011.552264.

Fakhruddin, B., Clark, H., Robinson, L., & Hieber-Girardet, L. (2020). Should I stay or should I go now? Why risk communication is the critical component in disaster risk reduction. *Progress in Disaster Science*, *8*. https://doi.org/10.1016/j.pdisas.2020.100139.

Hair Jr, J. F., Hult, G. T., Ringle, C. M., & Sarstedt, M. (2022). *A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM) Third Edition*.

Heydari, S. T., Zarei, L., Sadati, A. K., Moradi, N., Akbari, M., Mehralian, G., & Lankarani, K. B. (2021). The effect of risk communication on preventive and protective Behaviours during the COVID-19 outbreak: mediating role of risk perception. *BMC Public Health*, *21*(1). https://doi.org/10.1186/s12889-020-10125-5.

Hoök, K., & Lowgren, J. (2012). Strong concepts: Intermediate-level knowledge in interaction Design research. *ACM Transactions on Computer-Human Interaction*, *19*(3). https://doi.org/10.1145/2362364.2362371.

Kammerbauer, M., & Minnery, J. (2019). Risk communication and risk perception: lessons from the 2011 floods in Brisbane, Australia. *Disasters*, *43*(1), 110–134. https://doi.org/10.1111/disa.12311.

Landeros-Mugica, K., Urbina-Soria, J., & Alcántara-Ayala, I. (2016). The good, the bad and the ugly: on the interactions among experience, exposure and commitment with reference to landslide risk perception in México. *Natural Hazards*, *80*(3), 1515–1537. https://doi.org/10.1007/s11069-015-2037-7.

Latan, H., & Noonan, R. (2017). Partial least squares path modeling: Basic concepts, methodological issues and applications. In *Partial Least Squares Path Modeling: Basic Concepts, Methodological Issues and Applications*. Springer International Publishing. https://doi.org/10.1007/978-3-319-64069-3.

Lindell, M. K., & Perry, R. W. (1992). *Behavioral Foundations of Community Emergency Planning*. https://www.researchgate.net/publication/232442117.

Liu, X., & Sun, L. (2022). Examining the impact of fatalism belief and optimism orientation on seismic preparedness: Considering their roles in the nexus between risk perception and preparedness. *Journal of Contingencies and Crisis Management*, *30*(4), 412–426. https://doi.org/10.1111/1468-5973.12383.

Mañez, M., Carmona, M., Haro, D., & Hanger, S. (2016). Risk Perception. In *In: Novel Multi-Sector Partnerships in Disaster Risk Management*.

Massimo, C., Federica, L. L., Romano, C., Alessandro, P. N., & Laura, P. (n.d.). *What's the seismic risk perception in Italy?* http://www.terremototest.it.

McClure, J., Allen, M. W., & Walkey, F. (2001). Countering fatalism: Causal information in news reports affects judgments about earthquake damage. *Basic and Applied Social Psychology*, *23*(2), 109–121. https://doi.org/10.1207/S15324834BASP2302_3.

McIlroy, R. C., Mont'Alvão, C., Cordovez, S. P., Vásconez-González, J., & Ortiz Prado, E. (2022). The influence of fatalistic beliefs and risk perceptions on road safety attitudes in Latin America; A two-country study. *Transportation Research Part F: Traffic Psychology and Behaviour*, *90*, 84–99. https://doi.org/10.1016/j.trf.2022.08.003.

Nations Office for Disaster Risk Reduction, U. (2015). *Sendai Framework for Disaster Risk Reduction 2015 - 2030*.

Rahman, M. L. (2019). Risk perception and awareness of earthquake: the case of Dhaka. *International Journal of Disaster Resilience in the Built Environment*, *10*(1), 65–82. https://doi.org/10.1108/IJDRBE-04-2018-0020.

Sun, L., Deng, Y., & Qi, W. (2018). Two impact pathways from religious belief to public disaster response: Findings from a literature review. In *International Journal of Disaster Risk Reduction* (Vol. 27, pp. 588–595). Elsevier Ltd. https://doi.org/10.1016/j.ijdrr.2017.10.004.

Sun, L., Liu, X., & Yang, Y. (2022). Source of fatalistic seismic belief: The role of previous earthquake experience and general fatalism. *International Journal of Disaster Risk Reduction*, *83*. https://doi.org/10.1016/j.ijdrr.2022.103377.

Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The risk perception paradox-implications for governance and communication of natural hazards. *Risk Analysis*, *33*(6), 1049–1065. https://doi.org/10.1111/j.1539-6924.2012.01942.x.

Xue, K., Guo, S., Liu, Y., Liu, S., & Xu, D. (2021). Social networks, trust, and disaster-risk perceptions of rural residents in a multi-disaster environment: Evidence from Sichuan, China. *International Journal of Environmental Research and Public Health*, *18*(4), 1–25. https://doi.org/10.3390/ijerph18042106.