

Risk Communication and Community Cyber Capacity in Mitigating the Merapi Volcano Eruption in Yogyakarta

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Article Info

Article history:

Received Jun 12th, 20xx

Revised Aug 20th, 20xx

Accepted Aug 26th, 20xx

Keyword:

Risk communication; cyber capacity; disaster preparedness; disaster mitigation; Mount Merapi; digital literacy.

ABSTRACT

Earthquakes associated with the activity of Mount Merapi in Yogyakarta pose significant risks to communities living in surrounding areas. Effective risk communication is essential for improving public preparedness and strengthening community capacity to respond to potential disasters. This study aims to examine the influence of risk communication as the independent variable (X) on community cyber capacity as the dependent variable (Y), with a particular focus on disaster preparedness and mitigation knowledge. The study adopts a positivist paradigm and employs a quantitative research approach. Data were collected through a survey involving 258 respondents residing in Kinahrejo Hamlet, Umbulharjo Village, Cangkringan Subdistrict, Sleman Regency, Special Region of Yogyakarta. The collected data were analyzed using simple linear regression to assess the relationship between risk communication and community cyber capacity. The findings indicate that risk communication contributes to enhancing community cyber capacity in accessing, understanding, and utilizing disaster-related information. However, the statistical results reveal that the influence of risk communication on community cyber capacity remains relatively limited, suggesting that additional factors, such as digital literacy, access to technology, and socio-cultural conditions, may also play important roles. Despite these limitations, risk communication remains a crucial component in strengthening disaster preparedness and mitigation efforts. The study highlights the need for more integrated, sustainable, and community-based communication strategies to improve the effectiveness of digital information dissemination and to support disaster resilience in disaster-prone communities around Mount Merapi.



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INTRODUCTION

Risk communication is a method of disseminating information aimed at increasing public knowledge, awareness, and understanding of potential disaster hazards so that communities can anticipate and reduce their impacts. In practice, risk communication not only involves the dissemination of information but also helps build public trust by providing accurate, clear, and timely information. Effective risk communication has become increasingly important with the advancement of information technology, particularly in disaster management, which requires rapid, data-driven responses (Covello & Sandman, 2001; Renn, 2008).

Risk refers to the possibility that an uncertain event may occur in the future and result in losses. This concept encompasses aspects such as uncertainty, change, and the decisions made by individuals or groups when facing potential hazards (Aven, 2015). The Indonesian central government is responsible for establishing disaster-related policies and regulations, including Law Number 24 of 2007 concerning Disaster Management, and for establishing the National Disaster Management Agency (BNPB). Meanwhile, local governments, through Regional Disaster Management Agencies (BPBD), are responsible for implementing these policies at the regional level. The participation of communities, the private sector, and non-governmental organizations is essential for developing an integrated disaster management system (UNDRR, 2015).

The Sleman Regency area, particularly Cangkringan District, is categorized as a disaster-prone region due to its proximity to Mount Merapi, with risk levels ranging from moderate to high. High hazard levels are directly proportional to the potential losses and casualties that may occur if adequate preventive measures are not taken by the community. Therefore, following the 2006 earthquake and

various volcanic activities of Mount Merapi, institutions such as BNPB, BPBD, non-governmental organizations, and universities have undertaken efforts to improve community capacity and preparedness through various disaster mitigation programs. Subsequently, the Special Region of Yogyakarta Government adopted digital-based media (cybermedia) as a means of risk communication. These efforts include the use of social media, official government websites, and disaster early warning applications. The utilization of digital media is expected to help communities access information, understand risks, and make appropriate decisions during emergency situations.

Each regency within the Special Region of Yogyakarta demonstrates different levels of disaster preparedness, influenced by variations in exposure to and impacts from Mount Merapi-related hazards. In this study, the scope of disasters includes volcanic earthquakes, eruptions, and volcanic explosions that may occur at any time due to Mount Merapi's status as an active volcano. Kinahrejo, located in Umbulharjo Village, Cangkringan District, is classified as having a moderate level of disaster risk. Nevertheless, this condition still requires serious attention from the government to enhance community preparedness through effective risk communication, particularly through digital media or cybermedia, in order to strengthen the community's capacity to cope with various levels of disaster risk (BNPB, 2020; UNDRR, 2015).

However, the cyber community capacity in Kinahrejo is still considered relatively low. The utilization of information technology has not yet effectively increased disaster-related knowledge and preparedness. Residents often rely on interpersonal communication or word-of-mouth information when seeking disaster-related information. Accurate and data-driven information regarding disaster risks is crucial to supporting emergency management efforts, both before and after disasters occur (Aven, 2015; Coppola, 2011). Disaster risk studies are essential for identifying the physical, social, economic, and environmental vulnerabilities of communities, particularly in Kinahrejo, which is located within the Mount Merapi disaster-prone area. Therefore, this study aims to analyze the impact of risk communication on the cyber capacity of communities in acquiring disaster-related knowledge, particularly concerning preparedness for earthquakes and Mount Merapi volcanic activities.

Information is one of the fundamental needs of human beings, as it influences individual behavior, attitudes, and decision-making quality. Access to accurate and timely information is particularly important in disaster contexts to improve community preparedness. However, various studies indicate that rural communities still face limitations in utilizing digital technologies, commonly referred to as cyber technologies, to obtain disaster-related information. This situation contributes to lower levels of information literacy and disaster preparedness (van Dijk, 2020; Helsper, 2012). In Indonesia, the disaster management system is regulated by Law Number 24 of 2007 concerning Disaster Management, which was further strengthened through Presidential Regulation Number 8 of 2008. At the regional level, Regional Disaster Management Agencies (BPBD) are established through local regulations and collaborate with BNPB in implementing disaster management programs. Through education, training, and the dissemination of disaster-related information, these institutions play a vital role in enhancing community capacity (BNPB, 2020; UNDRR, 2015).

The success of disaster management is influenced by complex factors, including technical, social, environmental, legal, economic, operational, administrative, and political dimensions. These interconnected factors determine the effectiveness of disaster mitigation and response efforts (Coppola, 2011; Wisner et al., 2012). In this context, disaster knowledge is essential for communities to understand potential threats and take appropriate actions. Effective disaster management depends on the integration of these various dimensions, which collectively shape the capacity of communities and institutions to mitigate risks and respond effectively to disasters.

Disaster preparedness and mitigation are systematic efforts undertaken by governments, academics, organizations, and communities to anticipate and reduce disaster impacts in accordance with regional characteristics and conditions. Mitigation focuses on the continuous reduction of disaster risks, whereas preparedness involves planning and preparatory actions undertaken before disasters occur (UNDRR, 2015; Coppola, 2011).

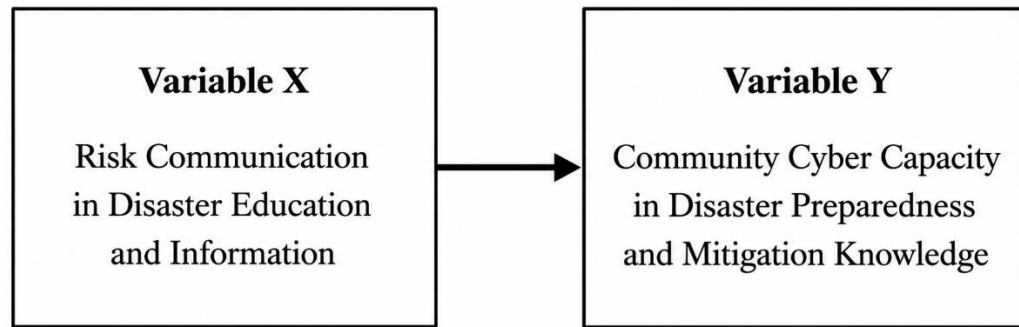


Figure 1. Research Conceptual Framework

Referring to the conceptual framework presented above, this study proposes two hypotheses: H_0 and H_1 . The null hypothesis (H_0) posits that risk communication in disaster education and information does not significantly influence community cyber capacity in acquiring disaster preparedness and mitigation knowledge. In contrast, the alternative hypothesis (H_1) posits that risk communication in disaster education and information significantly influences community cyber capacity in acquiring disaster preparedness and mitigation knowledge.

RESEARCH METHODS

This study adopted a positivist paradigm and employed a quantitative research approach. The positivist paradigm was chosen because it allows researchers to objectively examine causal relationships among variables through empirical observation, measurement, and statistical analysis. The study specifically utilized an explanatory survey design, which is appropriate for investigating the influence of one variable on another and for testing hypotheses derived from existing theories (Creswell, 2014; Neuman, 2014). Through this approach, the study sought to explain the extent to which risk communication contributes to community cyber capacity in the context of disaster preparedness and mitigation.

The research was conducted in Kinahrejo Hamlet, Umbulharjo Village, Cangkringan District, Sleman Regency, Special Region of Yogyakarta, Indonesia. This area was selected because of its proximity to Mount Merapi, one of the most active volcanoes in the world, making the community highly vulnerable to volcanic and earthquake-related hazards. The study focused on examining how disaster-related education and information disseminated through digital platforms influence the community's capacity to access, understand, and utilize disaster information.

The target population consisted of residents living in Kinahrejo Hamlet. A probability sampling technique, specifically simple random sampling, was employed to ensure that each member of the population had an equal opportunity to be selected as a respondent. The sample size was determined using the Slovin formula with a margin of error of 5% ($e = 0.05$), as follows:

$$n = N / (1 + N(e^2))$$

Where:

n = sample size

N = population size

e = margin of error (the tolerated level of error), which in this study was set at 5% or 0.05.

Based on this calculation, a total of 258 respondents were selected to participate in the study. According to Sugiyono (2019), a sample of this size is sufficient to represent the population and generate reliable and statistically valid findings.

Primary data were collected through a structured questionnaire administered directly to respondents. The questionnaire was developed based on relevant theories of risk communication, disaster preparedness, and cyber capacity. Responses were measured using a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to data collection, the instrument underwent validity and reliability testing to ensure that all items accurately measured the intended constructs and produced consistent results.

The independent variable in this study was risk communication (X), operationalized through indicators related to disaster education, disaster information dissemination, warning messages, and the utilization of digital media for communicating disaster risks. The dependent variable was community cyber capacity (Y), which was measured through indicators reflecting respondents' ability to access, evaluate, understand, and utilize digital disaster information, as well as their knowledge of disaster preparedness and mitigation practices.

Data analysis was conducted using IBM SPSS Statistics version 25. Descriptive statistics were first employed to summarize respondents' characteristics and responses to each variable. Subsequently, inferential statistical analysis was performed using simple linear regression to examine the effect of risk communication on community cyber capacity. The regression model was used to assess the strength and direction of the relationship between the independent and dependent variables and to determine the proportion of variance in community cyber capacity explained by risk communication.

Before conducting the regression analysis, several classical assumption tests were performed, including tests of normality, linearity, and homoscedasticity, to ensure that the data met the assumptions required for linear regression analysis (Field, 2018). The significance of the regression model was evaluated using the Analysis of Variance (ANOVA) test, while the coefficient of determination (R^2) was used to measure the explanatory power of the model. Statistical significance was determined at the 5% significance level ($\alpha = 0.05$). A p-value of less than 0.05 indicated a statistically significant relationship between the variables, whereas a p-value greater than 0.05 indicated that the relationship was not statistically significant.

Through this methodological framework, the study provides empirical evidence regarding the influence of risk communication on community cyber capacity for disaster preparedness and mitigation in disaster-prone areas surrounding Mount Merapi.

RESULTS AND DISCUSSION

The results and discussion of this study are analyzed through the distribution of Variable X and Variable Y as follows:

Distribution of Risk Communication Indicators in Providing Information and Knowledge

Three statements were developed as research instruments to measure the risk communication indicator in providing disaster education and information under Variable X. These statements were designed to assess the extent to which the process of disseminating disaster-related information can enhance community understanding, awareness, and preparedness.

Table 1. Risk Communication in Providing Pre-Disaster Education and Information

Statement	Frekuensi	Presentase
Strongly Disagree (SD)	0	0
Disagree (D)	25	8.8
Agree (A)	177	69.9
Strongly Agree (SA)	56	21.3
Total	258	100

Among the 258 respondents surveyed regarding the indicator of *risk communication in providing pre-disaster education and information through cybermedia*, none selected **Strongly Disagree (SD)**, representing 0% of the total respondents. Meanwhile, 25 respondents (8.8%) indicated **Disagree (D)**, 177 respondents (69.9%) selected **Agree (A)**, and 56 respondents (21.3%) selected **Strongly Agree (SA)**. These findings indicate that the majority of respondents agreed with the effectiveness of risk communication in disseminating pre-disaster education and information through digital media.

The results suggest that community members have utilized cybermedia, including official websites, social media platforms such as Facebook and Twitter, and other disaster information platforms, to access information related to disaster preparedness and risk reduction efforts. The information available includes educational materials, disaster-related news, and early warning alerts regarding disaster vulnerability levels provided by relevant institutions, such as the Regional Disaster Management Agency (BPBD) of Sleman Regency. These findings highlight the important role of digital media in enhancing public awareness and preparedness toward disaster threats, particularly earthquakes and volcanic activities associated with Mount Merapi.

Table 2. Risk Communication in Providing Information During Disaster Events

Statement	Frekuensi	Presentase
Strongly Disagree (SD)	0	0
Disagree (D)	25	8.8
Agree (A)	177	69.9
Strongly Agree (SA)	56	21.3
Total	258	100

As shown in Table 2, none of the 258 respondents surveyed selected **Strongly Disagree (SD)** (0%) regarding the indicator of *risk communication in providing education and information during disaster events through cybermedia*. Of the total respondents, 25 individuals (8.8%) selected **Disagree (D)**, 177 respondents (69.9%) selected **Agree (A)**, and 56 respondents (21.3%) selected **Strongly Agree (SA)**. These findings indicate that the majority of respondents held positive perceptions regarding the effectiveness of cyber-based risk communication during disaster situations.

The results suggest that community members rely on cybermedia, including official websites and social media platforms such as Facebook and Twitter, as primary sources of information during disaster events. The information accessed includes updates on disaster developments, such as earthquakes and Mount Merapi eruptions, guidelines for remaining calm, and instructions for protecting oneself, family members, and the wider community. In addition, respondents perceived that they had received adequate information regarding volcanic activity status, alert levels, and potential secondary hazards. Such information has helped communities better understand emergency situations and respond appropriately. Therefore, digital risk communication plays a critical role in enhancing community preparedness and emergency response, particularly in Kinahrejo Hamlet, Umbulharjo Village, Cangkringan District, Sleman Regency, Special Region of Yogyakarta.

A comparative analysis of the risk communication indicators reveals a consistent pattern in respondents' perceptions regarding the effectiveness of disaster information dissemination through internet-based media during the pre-disaster, disaster, and post-disaster phases. During the pre-disaster phase, risk communication contributes significantly to increasing public awareness of potential hazards, mitigation measures, and preparedness actions. Most respondents agreed that internet-based media have become effective channels for disseminating disaster-related information and improving community understanding before disasters occur.

The importance of risk communication becomes even more evident during disaster events, as timely and accurate information is directly related to public safety. The findings indicate that respondents generally agreed with the benefits of digital media in providing real-time information. Access to updated information regarding current conditions, Mount Merapi's volcanic activity, and self-

evacuation guidance helps reduce panic and supports informed decision-making. These findings demonstrate that accessibility, accuracy, and timeliness of information are essential components of effective risk communication during emergency response situations.

In the post-disaster phase, risk communication functions as a mechanism for information recovery, providing updates on post-disaster conditions, available assistance programs, and rehabilitation and reconstruction procedures. Although post-disaster information may not be as intensive as information disseminated during the disaster itself, it remains important in helping communities adapt and minimize subsequent impacts. However, the utilization of cybermedia during the post-disaster phase has not yet reached its full potential compared with the pre-disaster and disaster phases. This situation highlights the need for strengthening continuous and participatory information dissemination efforts.

Overall, these comparative findings indicate that cyber-based risk communication plays a strategic role throughout the entire disaster management cycle. Nevertheless, the effectiveness of communication varies across different phases. Communication during disasters is the most critical due to its direct relevance to public safety, whereas communication before and after disasters requires a more educational, preventive, and sustainable approach. Therefore, enhancing overall community capacity in disaster management requires the implementation of a comprehensive and continuous risk communication strategy.

Table 3. Risk Communication in Providing Information and Education After Disasters

Statement	Frekuensi	Presentase
Strongly Disagree (SD)	0	0
Disagree (D)	22	7.6
Agree (A)	157	61.8
Strongly Agree (SA)	79	30.5
Total	258	100

Of the 258 respondents, none indicated Strongly Disagree (SD) (0%) with the indicator of “risk communication in providing post-disaster education and information through cyber media,” as shown in Table 3. Of the total respondents, 22 (7.6%) stated that they Disagreed (D), 157 (61.8%) Agreed (A), and 79 (30.4%) Strongly Agreed (SA). These findings indicate that the majority of respondents perceive digital-based risk communication as important during the post-disaster phase. The results suggest that communities utilize cyber media, such as official government and Regional Disaster Management Agency (BPBD) websites, as well as social media platforms such as Facebook and Twitter, to obtain information after a disaster. The information accessed includes current post-disaster conditions, the potential for subsequent disasters, and warning messages issued by the government. Such information is essential in helping communities reduce the physical and psychological impacts of ongoing risks.

The availability of post-disaster information is particularly important for the residents of Kinahrejo Hamlet, Umbulharjo Village, Cangkringan District, Sleman Regency, due to its location in an area highly vulnerable to Mount Merapi disasters. Although some incidents may not result in direct casualties, information and educational content delivered through digital media continue to serve as critical resources for enhancing public awareness of potential future hazards. This demonstrates that post-disaster risk communication serves two primary functions: disseminating information and strengthening community resilience to face future disaster threats. On the other hand, post-disaster risk communication still requires optimization, particularly in terms of information continuity, the depth of educational content, and active community engagement. Therefore, a more integrated and sustainable communication strategy is needed to ensure that the use of cyber media is not only informative but also capable of enhancing community capacity and self-reliance in managing disaster risks.

Statistical Analysis of the Influence of Risk Communication in Disaster Education and Information on Community Cyber Capacity for Disaster Preparedness and Mitigation Knowledge

Table 4. Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.052	.002	-.001	1.278

Using simple linear regression analysis, the Model Summary table is employed to demonstrate the strength of the relationship and the influence between the independent variable (X), which represents risk communication in disaster education and information, and the dependent variable (Y), which represents the community's cyber capacity for disaster preparedness and mitigation knowledge. The correlation coefficient (R) indicates the strength of the relationship between the two variables. A higher R value, approaching 1, signifies a stronger relationship. Meanwhile, the coefficient of determination (R Square) is used to determine how well the independent variable explains variations in the dependent variable. A higher R Square value indicates a greater contribution of risk communication in influencing community cyber capacity. Therefore, a higher R Square value reflects the extent to which the regression model explains the relationship between variable X and variable Y. Consequently, this analysis demonstrates the effectiveness of the model in explaining the influence of risk communication on community cyber capacity.

Based on the Model Summary table, the correlation coefficient (R) value is 0.52, indicating that the relationship between variable X (risk communication in disaster education and information) and variable Y (community cyber capacity for disaster preparedness and mitigation knowledge) falls within the moderate or fairly strong category. This finding suggests a moderate relationship in influencing community cyber capacity. Furthermore, the coefficient of determination (R Square), which indicates the extent to which variable X explains variable Y, can also be observed. The R Square value ranges from 0 to 1, with higher values indicating that the independent variable provides a better explanation of the dependent variable.

The analysis results show that the contribution of risk communication to improving community cyber capacity remains limited. Therefore, the influence of risk communication on the community's cyber capacity regarding disaster preparedness and mitigation knowledge is still relatively low. These findings suggest that risk communication through disaster education and information has been implemented; however, improvements are still needed in terms of message quality, frequency of dissemination, and the more effective use of digital media. With these enhancements, it is expected that the residents of Kinahrejo Hamlet, Umbulharjo Village, Cangkringan District, Sleman Regency, Special Region of Yogyakarta, will be better able to access, understand, and utilize disaster-related information.

Table 5. ANOVA

Model		Sum Of Squares	Df	Mean Square	F	Sig.
1	Regression	1.254	1	1.163	.707	.403
	Residual	403.770	253	1.642		
	Total	405.061	257			

The dependent variable (Y) in the regression model used in this study is the community's cyber capacity for understanding disaster preparedness and mitigation, while the independent variable (X) is

risk communication through disaster education and disaster-related information. In this model, the constant serves as the baseline value when the independent variable remains unchanged. The analysis results were obtained by processing the data using SPSS version 25. The selection of these variables aims to examine the extent to which risk communication influences the community's cyber capacity to understand and respond to disaster-related information. Thus, the model is expected to provide an empirical description of the relationship and contribution of risk communication to disaster preparedness and mitigation at the community level.

To determine whether the independent variable has an overall effect on the dependent variable, the ANOVA table is utilized. The significance value (Sig.) is examined and compared with the research significance level ($\alpha = 0.05$). There are two testing criteria: if the Sig. value is less than 0.05, H_0 is rejected and H_a is accepted, indicating that the regression model is significant and that the independent variable affects the dependent variable. Conversely, if the Sig. value is greater than 0.05, H_0 is accepted and H_a is rejected, indicating that the regression model is not significant and that the independent variable does not affect the dependent variable. Therefore, the ANOVA test is employed in this study to ensure that the regression model is appropriate and capable of explaining the relationship between risk communication and the community's cyber capacity to understand disaster preparedness and disaster risk reduction.

According to the ANOVA table, the significance value (Sig.) of 0.403 is greater than the research significance level ($\alpha = 0.05$). This result indicates that H_0 is accepted and H_a is rejected. Therefore, it can be concluded that the independent variable, namely risk communication through disaster education and information, does not have a significant effect on the dependent variable, namely the community's cyber capacity for understanding disaster preparedness and mitigation. Consequently, the linear regression model used in this study cannot explain a significant relationship between the two variables. This finding implies that improvements in community cyber capacity have not been directly influenced by enhanced risk communication through education and information dissemination.

The results suggest that factors other than risk communication may play a more substantial role in influencing community cyber capacity. These factors may include socio-cultural characteristics of the community, levels of digital literacy, access to technology, and the intensity of media usage. Therefore, a more comprehensive strategy is required to strengthen community cyber capacity, not only through information dissemination but also through efforts that address these broader influencing factors.

CONCLUSION

Risk communication delivered through digital education and information influences the community's cyber capacity in dealing with disasters. However, the findings of this study indicate that the residents of Kinahrejo have not yet utilized cyber media optimally as a source of disaster-related information. The influence of risk communication on community cyber capacity remains relatively low, as reflected in the tendency of community members to use digital media more for entertainment purposes than for accessing risk communication content. In addition, limited digital literacy and insufficient dissemination of risk communication by relevant institutions, such as the National Disaster Management Agency (BNPB) and other related organizations, are factors contributing to the low level of cyber capacity. As a result, efforts to enhance disaster preparedness knowledge and promote the use of cyber media for disaster mitigation have not yet achieved optimal outcomes. On the other hand, local culture, beliefs, and indigenous knowledge continue to serve as the primary sources of guidance for communities in responding to disasters. Therefore, more effective and sustainable risk communication strategies are required to increase the utilization of cyber media as a source of disaster-related information and to strengthen community capacity in disaster preparedness and mitigation. Future research is recommended to examine other variables that may influence community cyber capacity, such as digital literacy, the level of trust in information sources, and socio-cultural factors. Furthermore, a mixed-methods approach may be employed to obtain a more comprehensive understanding of the issue. From a practical perspective, there is a need to develop risk communication strategies that are more participatory, adaptive, and responsive to local needs, as well as to continuously strengthen digital literacy programs so that the use of cyber media in disaster mitigation can become more effective and impactful.

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