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The obstacles hierarchy of school disaster preparedness implementation in Mount Sinabung area, Indonesia

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The incidence of natural disasters has an impact on various sectors of life, including the education sector. Schools as educational facilities are considered vulnerable areas that need handling steps to reduce disaster risk. As one of the most vulnerable countries to natural disasters, Indonesia already has several policies and programs from the government to address these problems. However, several studies have shown that the implementation did not go according to plan. These studies also reveal that this implementation lies in the local context in which the program or policy is implemented. That is why the study aims to examine the school disaster preparedness implementation in the Mount Sinabung area as one of the disaster-prone areas in Indonesia. This research utilizes the Interpretative Structural Modeling approach to build a hierarchy and classification of obstacles in implementing school disaster preparedness around that area. Data are collected through a combination of observation, interview, and survey techniques in 2017 and 2018 that involved a total of 35 participants. The result showed 14 sub-elements identified as limiting factors of school preparedness implementation in the Mount Sinabung area. Three elements serve as the first level (or the basis/key element) of the obstacles hierarchy: Integration of subject, school policy, and school curriculum. Intervention at the base level will trigger changes and give impact the other upper-four levels of elements. This hierarchy and classification are relevant to the context of the Mount Sinabung eruption and cannot be applied in other areas. This research did not measure the numeric data per sub-element in disaster preparedness. Therefore, the limitations of this study can be directions for future research

to examine the implementation in another area by using numeric data. The results of this study also provide major recommendations to several stakeholders. The existing policies regarding school disaster preparedness and their implementation need to be reviewed to improve the result.

KEYWORDS

disaster risk reduction, disaster education, preparedness education, school preparedness model, disaster management, disaster communication, Mount Sinabung eruption

Introduction

Recently, the number of natural disasters and casualties due to disaster events has increased around the world (Midtbust et al., 2006; Codreanu et al., 2014). Earthquakes, floods, hurricanes, and other types of disasters occurred across the world (Fahad and Jing, 2018; Fahad and Wang, 2018; Monteiro, 2020; Woodall, 2022). This results in the loss of various material and non-material resources, especially suffered by those living around the epicenter (Kitagawa, 2016; Sajow et al., 2020; Pranata et al., 2021). Related to health matters, disaster impact can take the form of the spread of various diseases, injuries, malnutrition, post-traumatic physical and psychological complications, even causing death (Midtbust et al., 2006; Sajow et al., 2020; Ali, 2021). It can also change the demographical structure, culture, rising levels of violence, loss of livelihoods, poverty, instability of the political situation (Boetto et al., 2021), and severe damage in agricultural sector impacting the food security, crop failure, food production and distribution (Fahad and Jing, 2018; Fahad and Wang, 2018) linked to the overall vulnerable condition of the population (Fahad et al., 2022b).

Along with the health and sociopolitical sector, the educational sector also faces the impact of natural disasters. About 175 million children are victims of natural disasters caused by climate change (Codreanu et al., 2014; Fahad and Wang, 2020). This could be more severe if the disaster occurred during school time. Ruins of buildings and objects can fall or bury students and other school elements in the location. In the longer run, the damaged school building and inaccessibility of school equipment disturb the whole process of learning not only in the physical sense but also affecting the psychosocial aspects of learning (Ministry of Education and Culture, 2015a). Furthermore, the raise of dropout cases, trauma and mental health issues, loss of property and family, can significantly affect the children's future (Rode and Michelsen, 2008; Pereznieto and Harding, 2013; Kitagawa, 2015; Peek et al., 2018; Ali, 2021; Kusumastuti et al., 2021; Pranata et al., 2021).

Education has always been one of the top priorities in global Disaster Risk Reduction (DRR) initiatives (Amri et al., 2016), mentioned in Hyogo Framework for Action (HFA) 2005–2015 and Sendai Framework for Disaster Risk Reduction 2015–2030 (UNISDR, 2005, 2015). These global commitments were signed to ensure widespread awareness and multilevel collaboration for the DRR agenda and become the basis of policymaking at national levels. The DRR agenda itself generally aims to minimize the damage caused by natural hazards (Hicks et al., 2019). It is achieved through a series of Disaster Risk Management (DRM) efforts, which emphasizes the systematic efforts in preventing, analyzing, and reducing the causal factors of disaster risk that can be structured into three different phases, namely action before the disaster, during the disaster, and after the disaster (Hicks et al., 2019; Oktari et al., 2020).

In the educational sector, integration of the DRR agenda in school life involves joint efforts among national, regional, and local stakeholders, as well as the contribution of the central government, local governments, civil society organizations, and/or industrial sectors to make it possible and sustainable. School is a central point in the community that can be optimized as both the source of disaster-related information and the participatory education hub for surrounding communities (Takahashi et al., 2015). It is also can be used as a landmark evacuation in times of need. In DRM phases, school activation falls into the action before the disaster phase, with preparedness strategy as the highlighted agenda. Through appropriate and effective arrangements and measures, a well-designed preparedness strategy can save many lives, and minimize disaster impacts by increasing the overall community resilience (Paton, 2003; Oktari et al., 2020; Kusumastuti et al., 2021). This is how disaster preparedness becomes a determining factor of disaster risk management success (Paton, 2003; Salmerón and Apte, 2010; Kusumastuti et al., 2021). Conceptually, disaster preparedness is defined as an intervention developed to effectively equip individuals and communities with the knowledge and skills needed when disaster strikes (Bay, 2020). A disaster preparedness intervention can include efforts to increase the knowledge and capacity of individuals, communities, governments, and non-governmental organizations (Bay, 2020; Kusumastuti et al., 2021).

In the school community, the integration of a disaster preparedness program is known as a school preparedness program. This program is urgently needed especially for those schools located in disaster-prone areas (Sajow et al., 2020). School disaster preparedness refers to the ability of the community or elements in the school is facing and manage disasters (Sujarwo et al., 2018). It reflects the application of responsive mechanisms to overcome and minimize hazardous impacts (Kusumastuti et al., 2021). These capabilities are fulfilled when the school has a disaster management plan (before, during, and after a disaster); logistic availability; safety and comfort in education; infrastructure and emergency systems, supported by knowledge and preparedness; standard operating procedures and early warning systems (Sujarwo et al., 2018).

As one of the most vulnerable countries to natural disaster, in Indonesia, DRR mainstreaming has been started long before global agreement like HFA and Sendai framework was signed. It was accommodated through the Law Number 24 of 2007 concerning Disaster Management, Government Regulation Number 21 of 2008 concerning the Implementation of Disaster Management, and widely announced to regional heads for mainstreaming disaster risk reduction in schools through the Circular Letter of the Minister of National Education Number 70a/MPN/SE/2010. All children under 18 years old are entitled to disaster preparedness education through an official social institution called the school. National Disaster Management Agency (BNPB) supports this initiative by issuing the implementation Guidance for Disaster Safe School/Madrasa (SMAB). Related ministries and organizations also contributed to the development of Sekolah Siaga Bencana (SSB), or Disaster Preparedness School (Ministry of Education and Culture, 2015a). On the practical level, the SSB program was not solely done by the government. Other institutions operated under international or national grant programs also brought forth the SSB initiatives (Sakurai et al., 2017).

However, the execution of the mentioned policies seemed to be different from expected. Public schools in Indonesia have not implemented disaster preparedness education even years after terrible disasters (Syamsidik et al., 2021). This results in the low quality of disaster management that potentially affects the high number of victims, both in the form of fatalities, moral, or material. Another study found that although the SSB program has been implemented, not all the schools in Indonesia have received the proper training, materials, and facilities like an SSB (Sakurai et al., 2017). Due to the limited resources, the Indonesian government and other grant organizations prioritize the most vulnerable schools like the ones affected by previous disaster events. Most public schools do not have the privilege to be SSB beneficiaries. Even in some of the SSB, school preparedness programs only last once or twice. After the program ended, evacuation training was no longer performed, not all teachers engaged in the program, and physical facilities like the danger alarm and signages were no longer well functioned. It is hard to maintain sustainability and ensure effectiveness.

The roots of the insignificant impact of the program lie in the incompatibility of the materials provided with the needs of the local context (Sakurai et al., 2017; Maryani, 2021). Kurniadi and Bahar (2020) examined the obstacles of the SSB program and found that unclear target and purpose, lack of socialization, and inadequate training for teachers and other school elements were the main obstacles. In the same year, Afisa and Sakir (2020) conducted a case study on two SSB beneficiaries in Yogyakarta. She found that both schools implemented SSB differently and each of them faced different obstacles. The inequality of SSB implementation was also addressed in the national evaluation report of the SSB program. The report mentioned that the quality of SSB implementation depends on the teachers' capacity. Central government still becomes the dominant actor, instead of teachers and local governments (Resilience Development Initiative, 2020; Suharto et al., 2020). Another study was conducted to reveal different perspectives from teachers, civil society organizations, and students (Amri et al., 2016). This study showed that even though most of the respondents tend to feel confident enough to behave accordingly if a hazardous event, the knowledge, and skill test did not confirm it. Students' knowledge and teachers' skills in delivering the materials tend to score middle to low. It revealed that school disaster preparedness ability was still lacking even though the schools have implemented the disaster preparedness curricula.

Different context raises different obstacles, needs, expectations, and resources, as well as different starting points. Previous studies have been conducted to examine or assess the localized risks, vulnerability, livelihoods potential, people's perceptions and adaptation to deal with natural disaster (Fahad and Jing, 2018; Fahad and Wang, 2018; Su et al., 2021; Fahad et al., 2022b) to ensure better understanding of the localized context and recommend a more relevant approach to increase the resiliency of the community. That is why, this study aims to examine the school disaster preparedness implementation in Mount Sinabung area, one of disaster-prone area in Indonesia.

Mount Sinabung is located in Karo, a regency in North Sumatra. It was chosen in consideration of the mountain's activity history. Mount Sinabung is one of the volcanoes in Indonesia that has been inactive for centuries, but suddenly reactivated and released volcanic ashes in 2010 (BBC News, 2010). Most of the victims of this eruption were the residents, and not the visitors or foreigners like the one in Aceh's 2004 tsunami disaster. It is not a residential area that has long been safe for living. People did not prepare for the worst-case scenario. Therefore, this sudden eruption caused many losses for the residents of the area, both in the matter of lives, material things, and/or public facilities. In the context of Mount Sinabung eruption, education became the highest

impacted sector. Several schools are located on the foothill, near the disaster epicentrum. The field observation of this study conducted before data collection showed at least 91 of the 425 schools in the region are located on the Mount Sinabung foothill and most of them were damaged during the eruption of Mount Sinabung in 2010. One of the schools destroyed could be seen in **Figure 1**. The close location between the school and the disaster area caused the school building to damage, ranging from roofs, walls, and doors to windows. the spaces that originally functioned as classrooms, teacher's rooms, or storage rooms for educational devices were damaged by volcanic ash. The roof of the room was completely damaged, leaving just part of the wall.

According to the local government, the major losses cannot be separated from the lack of disaster preparedness capacity of the school elements, especially related to the evacuation process. This phenomenon seems different with the notion of school disaster preparedness program as initiated by the government as well as by civil society organizations. Therefore, it becomes important to see the obstacles faced by the school community in implementing the SSB program in this area. These obstacles then, will be analyzed further to find the hierarchy model of the identified problems to determine which problem should be addressed first in building a school disaster preparedness program in the Mount Sinabung area. The methodological part of this research is designed with interpretive structural modeling (ISM) approach, which is well established and relevant to identify relationships between the variables underlying a problem (Attri et al., 2013).

Several previous studies have also shown interest in the DRR implementation in the Karo Regency. Research from Situmorang (2018) and Sihombing et al. (2022) focused on disaster mitigation as an action set after the disaster at the local government level. Moreover, Erianjoni et al. (2020) measured the adaptation and survival process of the community after the eruption. Another research from Kristian and Hutapea (2021) examined the overview of available resources in implementing disaster mitigation at the community level. However, those studies have not focused on disaster preparedness at the school community level. This study aimed to fill this gap by answering the following research questions:

Research Question 1: What are the obstacles that was faced by school community in dealing with the eruption of Mount Sinabung?

Research Question 2: What is the hierarchy and classification of obstacles in implementing school disaster preparedness in the Mount Sinabung area in Indonesia?

Academically, this study contributes to enhance the literature about obstacles of SSB implementation in Indonesia. While practically, result and recommendations of this study can be treated as the foundation for solving the local obstacles faced by the schools around Mount Sinabung to develop a better and more relevant disaster preparedness program for schools in the area.

Literature review

Disaster Risk Reduction (DRR) initiatives (Amri et al., 2016) was mentioned in Hyogo Framework for Action (HFA) 2005–2015 and Sendai Framework for Disaster Risk Reduction 2015–2030 (UNISDR, 2015, 2005). These global commitments were signed to ensure widespread awareness and multilevel collaboration for the DRR agenda and become the basis of policymaking at national levels. The DRR agenda itself generally aims to minimize the damage caused by natural hazards (Hicks et al., 2019). It is achieved through a series of Disaster Risk Management (DRM) efforts, which emphasizes the systematic efforts in preventing, analyzing, and reducing the causal factors

FIGURE 1
School buildings destroyed by volcanic dust.

of disaster risk that can be structured into three different phases, namely action before the disaster, during the disaster, and after the disaster (Hicks et al., 2019; Oktari et al., 2020).

In the educational sector, integration of the DRR agenda in school life involves joint efforts among national, regional, and local stakeholders, as well as the contribution of the central government, local governments, civil society organizations, and/or industrial sectors to make it possible and sustainable. School is a central point in the community that can be optimized as both the source of disaster-related information and the participatory education hub for surrounding communities (Takahashi et al., 2015). It is also can be used as a landmark evacuation in times of need. In DRM phases, school activation falls into the action before the disaster phase, with preparedness strategy as the highlighted agenda. Through appropriate and effective arrangements and measures, a well-designed preparedness strategy can save many lives, and minimize disaster impacts by increasing the overall community resilience (Paton, 2003; Oktari et al., 2020; Kusumastuti et al., 2021). This is how disaster preparedness becomes a determining factor of disaster risk management success (Paton, 2003; Salmerón and Apte, 2010; Kusumastuti et al., 2021). In the school community, the integration of a disaster preparedness program is known as a school preparedness program. This program is urgently needed especially for those schools located in disaster-prone areas (Sajow et al., 2020). School disaster preparedness refers to the ability of the community or elements in the school is facing and manage disasters (Sujarwo et al., 2018). The comprehensive understanding for each concept of this research could be seen in **Table 1**.

Materials and methods

Research design

In this study, ISM was used to find hierarchical models that contained clear relationship structures among previously identified constraint variables. ISM has a slightly similar function with Sustainable Livelihood Approach (SLA) that has been widely used in the context of poverty reduction to find the cause of the problems and provide multiple solutions (Su et al., 2021). However, while the SLA emphasizes the relationship between five capital assets (human, natural, physical, social, and financial capital) to assess the livelihood capacity (Serrat, 2017), ISM further emphasizes the need to observe the relationships between sub-elements as the identified variables and summarized them into the hierarchy of the problems by classifying them into levels of urgency. This step enables the researchers and users to present relevant tools or solutions that can be applied to solve the complexity of problems faced by individuals or groups of people. This approach is often used to strengthen a basic understanding of complex situations and devise appropriate problem-solving actions (Saxena et al., 1992; Attri et al., 2013).

As mentioned in the introduction, Mount Sinabung suddenly reactivated and released volcanic ashes in 2010 (BBC News, 2010). But several studies conducted 7–11 years after the eruption showed that the existing efforts and programs to reduce disaster risk is still needed to be fixed or improved (Situmorang, 2018; Wulandari et al., 2018; Sihombing et al., 2022). The existing studies on Mount Sinabung were conducted at the community and local government levels (Situmorang, 2018; Wulandari et al., 2018; Erianjoni et al., 2020; Sihombing et al., 2022). There is no research that could explain the situation in the school community that is considered the vulnerable part and the central point in the community (Takahashi et al., 2015; Amri et al., 2016). This shows the need for research that provides concrete steps to accelerate the process of handling disasters on Mount Sinabung, especially at the school community level. ISM is considered could answer and provide gradually steps to fix or improve the disaster preparedness implementation.

The existing studies also used various methods to answer their research questions. Suharto et al. (2020) evaluated the effectiveness of implementing a school-based disaster reduction program using the Kirkpatrick evaluation model. This model is for training evaluation and does not give an idea of what needs to be improved first in order to the overall activity or program (Situmorang, 2018) measures post-eruption mitigation and uses literature review as a method. The resulting results only describe the conditions, not a concrete step. Moreover, Wulandari et al. (2018) measures the involvement of community-based organizations at Mount Sinabung using thematic analysis. However, the method only describes the state and the constraints. Therefore, ISM is also considered better than other methods in describing or narrowing down problem-solving actions in the implementation of disaster preparedness at Mount Sinabung.

ISM consists of two main parts, namely variable identification, and hierarchical preparation (Attri et al., 2013). In this study, the variables identified were the obstacles faced in organizing and developing disaster preparedness in schools located nearest to Mount Sinabung. Literature studies are used to identify sub-elements that can lead to the success of disaster preparedness programs. There were 48 sub-elements of disaster preparedness constraints derived from the literature review, yet 14 sub-elements were determined as variables after consulting with expert participants through the interview process and brainstorming. Field observations were also applied to obtain a more complete picture of the actual situation at the disaster site. The hierarchy model of relationships between these 14 variables is then traced through the Structural Self Interaction Matrix (SSIM). The data on the SSIM table is then converted into the Reachability Matrix (RM) until a matrix model is formed and a structural model extraction is obtained.

TABLE 1 Explanation for each concept from several research.

Author	Description
1. Disaster preparedness	
Sutton and Tierney (2006)	**Disaster preparedness** is consisting of actions set that enable different units (individuals, households, organizations, communities, and societies) to respond effectively and recover more quickly when disasters strike. Disaster preparedness aims to ensure that the resources necessary for responding effectively in the event of a disaster are in place, and that those faced with having to respond know how to use those resources. There are eight dimensions to measure preparedness activities: (a) Hazard knowledge; (b) Management, direction, and co-ordination of emergency operations; (c) Formal and informal response agreements; (d) Resource acquisition aimed at ensuring that emergency functions can be carried out smoothly; (d) Life safety protection; (e) Property protection; (f) Emergency coping and restoration of key functions; (g) Initiation of recovery activities.
Verheul and Dückers (2020)	**Preparedness** is described as an action (managing, planning, or maintaining) aimed at minimizing or reducing certain consequences that needed to be carried out adhering to particular quality criteria. **Disaster preparedness** is an action (managing, planning, maintaining) aimed at minimizing or reducing disaster consequences that needed to be carried out adhering to particular criteria. There are 9 components in disaster preparedness that consist of (1) disaster plans or protocols; (2) available equipment; (3) education, training, and exercises; (4) command, control, and coordination; (5) crisis communication strategies: (6) Available staff; (7) public engagement models; (8) safety and security; (9) continuity strategies.
Bay (2020)	**Disaster preparedness** is defined as an intervention developed to effectively equip individuals and communities with knowledge and skills needed when disaster strikes.
Kusumastuti et al. (2021)	**Disaster preparedness** is a stage in the disaster management cycle in which the response mechanisms are implemented to overcome factors that cannot be mitigated by society. Activities in disaster preparedness consist of educating residents regarding disaster risks in the area; educating residents about safety procedures in the event of a disaster; developing, testing, and exercising emergency plans; and installing early warning systems.
2. School preparedness	
Ozmen (2006)	**School disaster preparedness** is activities in the school systems to plan for disaster, to mitigate risk, to protect the safety of students and educators and to ensure that schools recover quickly. The following actions for school: a. Identify hazards likely happen to your schools b. Mitigate against the hazards c. Develop a response plan, including evacuation route d. Plan for coping after a disaster e. Implement drills and family education
Sujarwo et al. (2018)	**School disaster preparedness** is the school's capabilities of managing disaster risks by having disaster management planning (before, during, and after a disaster), availability of logistics, security and comfort in education, infrastructure and emergency systems supported by knowledge and skills of preparedness, standard operational procedures, and early warning systems.
Seddighi et al. (2021)	**School disaster preparedness** has an important factor to be done, disaster education. Disaster education enhances the awareness of students about disaster and their risk perception. The School have a critical role in disaster risk reduction by providing policy frameworks, skilled teachers, textbooks and curriculum for learning, and peer education.
3. Disaster risk reduction	
UNISDR (2004)	**Disaster risk reduction** is defined as the systematic development and application of policies, strategies, and practices to minimize vulnerabilities, hazard, and the unfolding of disaster impacts throughout a society, in the broad context of sustainable development.
Hicks et al. (2019)	**Disaster risk reduction** is an agenda in the Sendai Framework that generally aims to minimize the damage caused by natural hazards. It is achieved through a series of Disaster Risk Management (DRM) efforts, which emphasizes the systematic efforts in preventing, analyzing, and reducing the causal factors of disaster risk that can be structured into three different phases, namely action before the disaster, during the disaster, and after the disaster.
Russell et al. (2021)	**Disaster risk reduction** aims to implement certain strategic initiatives such as policies, strategies and practices that will ultimately reduce or eliminate conditions of hazard and vulnerability at the local level.
Toyado (2022)	**Disaster risk reduction** assessment includes the following indicators: (a) disaster-related knowledge; (b) disaster prevention and mitigation; (c) disaster capacity building; (d) disaster preparedness; (e) disaster response; (f) disaster rehabilitation and reconstruction; (g) disaster risk perception.

Participant

The population of this study is all schools ranging from elementary, junior high, to senior high school in Karo Regency that impacted the eruption of Mount Sinabung in 2010, 2013, 2014, and 2015. Samples of schools were chosen purposively under two criteria: the proximity to the foothill and experienced severe impacts due to the eruption of Mount Sinabung. Proximity refers to schools located at a maximum of 5 km from the foothill. While the severeness of the impacts was determined based on the people's testimonials on the presence of thick volcanic dust that damaged the school's buildings and stopped the teaching-learning activities. These criteria obtained 7 schools for samples consisting of 3 elementary schools, 3

junior high schools, and 1 senior high school. From each sample school, the data was obtained through a combination of observations of school conditions, interviews, and the dissemination of questionnaires to purposively selected school elements. The selected school elements consist of the principal and deputy principal as experts who understand school policies, teachers in schools who experienced the eruption of Mount Sinabung directly during teaching and learning activities, as well as school guards who felt the eruption of Mount Sinabung in the school and understood the state of the school building.

Research procedure and data collection

The research collected primary data related to respondent profile data, and disaster preparedness in schools consisting of 14 measurement sub-elements. Primary data collection took place in 2017 and 2018. The primary data taken in this study consists of 2 types: numerical data and non-numerical data. Non-numerical data was taken first through observation by researchers and continued by brainstorming with school elements using pre-compiled guidelines related to 5 elements of school community preparedness. Based on the results of observation and brainstorming then the sub-elements in the previous guide were condensed into 14 sub-elements for guidance in retrieving numerical data. Numerical data collection was done by interviewing the principal, deputy principal, 2 teacher representatives, and 1 school guard representative in each school. The interview was conducted by researchers with questionnaires as guidance.

Instrument development

In this study, primary data are collected using discussion guidelines and questionnaires. The discussion guideline was developed based on several references, with school disaster preparedness assessment tools 2010 provided by The Indonesian Institute of Sciences (LIPI) and UNESCO/International Strategy for Disaster Reduction (ISDR) as the main reference. Another reference that is used is Safe School/Madrasah Modules by Berau Secretariat- General of the Ministry of Education and Culture (2015) cooperated with UNICEF. These modules are the guidelines for the implementation of safe school/madrasah based on the comprehensive school safety framework and divided into 3 modules with three different focuses: The Safe Learning Facilities, the School Disaster Management, and the Risk Reduction and Resilience Education.

Several international modules are also used to build a broader understanding of the elements and sub-elements. Inter-agency Network for Educaion in Emergencies (2020) published Education in Emergencies Competency Framework to address a set of required, valued, and recognized competencies for the humanitarian and education in emergencies sectors. This framework is relevant at the global level to support planning and emergency preparedness. The Education in Emergencies Competency Framework consists of 6 parts: Humanitarian guiding principles; foundational standards; access and learning environment; teaching and learning; teachers and other education personnel; education policy. Another reference comes from UNISDR (2017), Comprehensive School Safety. This framework aligns with Sustainable Development Goals 2015–2030 and Sendai Framework for Disaster Risk Reduction. The overview of the 5 elements and 55 sub-elements drawn from the literature review is presented in **Supplementary Appendix 1**. After brainstorming with the school community in the Mount Sinabung area, the previously mentioned elements and sub-elements were condensed into 14 sub-elements. The school community identified the lack of those 14 sub-elements as the major causes of the low level of school disaster preparedness capacity around the Mount Sinabung foothill. The explanation of these sub-elements is re-adjusted based on brainstorming results and school needs in the Mount Sinabung area. Further explanations can be seen in **Supplementary Appendix 2**.

Data analysis

The data analysis procedure in this study was designed following the ISM flowchart from Attri et al. (2013). Based on the literature review conducted, a list of elements related to the obstacles that the school community faces in building disaster preparedness. From the 55 elements found before, the 14 elements were defined as variables or sub-elements identified after being validated in consultation with the principal as expert participants. These fourteen sub-elements were organized in the Structural Self Interaction Matrix (SSIM) created in the form of *a* Reachability Matrix (RM) table by replacing V, A, X, O into numbers 1 and 0. The classification of elements is based on the Structural Self Matrix (SSM) created based on the VAXO system, namely:

$$\text{V if eij} = 1 \text{ and eji} = 0;$$

$$\text{A if eij} = 0 \text{ and eji} = 1;$$

$$\text{X if eij} = 1 \text{ and eji} = 1;$$

$$\text{O if eij} = 0 \text{ and eji} = 0$$

The matrix is then transformed into a closed matrix. This aims to correct the matrix to meet the transitivity rule i.e., if A affects B and B affects C, then A must affect C. Value 1

means there is a contextual relationship between the i-element and the j-element, while eij = 0 means there is no contextual relationship between the i-element and the j-element. Then SSM is converted into a reachability matrix by changing VAXO to 1 and 0, then testing the rules of transitivity, until there is a closed matrix. The matrix that has fulfilled transitivity will be continued its processing to get matrix reachability, to generate the Driver Power (DP) and the Dependence (D). The last stage is to categorize sub-elements into four sectors (Saxena et al., 1992), which consists of:

(a) *Weak drivers—weak dependent variables* (*AUTONOMOUS*), variables in this sector are generally not related to the system, the relationship is slight.
(b) *Weak driver—strongly dependent variables (DEPENDENT)*, variables that fall into this group are dependent variables.
(c) *Strong drivers—strongly dependent variables (LINKAGE)*, variables in this sector should be carefully reviewed because the interaction can have an impact and feedback on the system.
(d) *Strong drivers—weak Dependent variables (INDEPENDENT)* variables in this sector have a strong influence on the system and greatly determine the success of the program.

Result and discussion

Result

The obstacles of school community preparedness

RQ 1: What are the obstacles that was faced by school community in dealing with the eruption of Mount Sinabung?

As the important point of disaster management success, the development and implementation of disaster preparedness often find obstacles. It could be different from each location. In the context of the Mount Sinabung eruption, data obtained from interviews and field observations showed the largest losses suffered by the school community. And these losses are caused by several major obstacles faced by the school community explained in the following paragraphs.

The close location between the school and the disaster area caused the school building to damage, ranging from roofs, walls, and doors to windows. These damages relate to the availability of disaster preparedness construction in the school buildings. Participant 1 said there are no adequate school buildings according to safety standards. As was said by Participant 3, the school community does not have enough knowledge about disaster risks such as what hazards can occur due to eruptions and the level of danger when the building does not comply with determined disaster safety standards.

> "Our school did not have proper construction according to disaster safety building standard. Because this school was built before the eruption and the process of school establishment did not consider disaster risk." (Participant 1)

> "The school elements such as teachers, students and their parents, and also other school members have not enough understood about disaster risks such as what is the potential impacts of the eruptions, what are the school assets that could be broken, how vulnerable is the school construction and environment." (Participant 3)

In addition to material losses, non-material losses post-disaster are experienced by the school community consisting of students, teachers, school leaders, education staff, and school guards, especially those who were on site when the disaster occurred. Data from interviews showed the low knowledge and skills of teachers in dealing with disaster situations. Some participants attributed the low knowledge and skill to the dormant status of Mount Sinabung for more than a century as Participant 14 said. In line with Participant 14, Participant 9 who has settled in this region since 1997 stated that when he had decided to move to this village, he and his family did not consider the possibility of an eruption disaster. This area is known as a safe area, there is no potential for disaster that needs to be anticipated.

> "Since I was born, this mountain has never erupted. That's why we didn't expect the disaster to happen. We never learned how to handle disaster situations. It took us a quite long time to evacuate students." (Participant 14)

Brainstorming results showed most of the school samples also noted that some participants mentioned the sudden eruption made them panic instantly. No self-rescue procedures were implemented at the school. The school community, such as teachers do not have adequate capacity to mentally calm down the student's panic and fear. The teachers and other school community such as the school's staff do not have adequate skills to evacuate, provide first aid, and other skills related to disaster preparedness as Participant 11 said. The schools also have inadequate facilities in early warning systems and mobility source capacity as Participant 3 said to support the evacuation. Furthermore, explanations from Participant 11 also indicated that teachers have not been receiving enough training and simulation.

> "We don't know exactly how to evacuate the students. We received materials training a couple of times, but we did not do the simulations. And there were no continuity acts of those training, and we gradually forgot its materials." (Participant 11)

> "Besides the school construction, the facilities about disaster warning system and others system related to evacuation does not match the requirement." (Participant 3)

Moreover, the interview revealed the fact that the school does not have a special subject, or integration disaster material in the related subject as Participants 8 and 11 said. Schools also do not have enough printed learning resources that are particularly associated with volcanic eruptions to support disaster preparedness education implementation such as books or integrated modules. As Participant 11 said, disaster material is barely taught in school because the teachers have no guidance and confidence to teach disaster materials. Participant 11 also mentioned that the whole core for the availability of printed materials is the availability school curriculum.

> "In this X school, there is no special subject that teaches about the eruption and how to deal with it. Even school does not put little disaster materials in related subjects like geography or social science. I think it is because our school does not have the policy to cover these implementations." (Participant 8)

> "I feel that I am not an expert in disasters, so I feel hesitant to give disaster-related materials to students. In addition, there are no facilities from the school in the form of study books or the like to be used in teaching and learning activities or guidance module for teachers." (Participant 11)

> "Printed materials regarding eruptions materials could not been provided if there is no curriculum as a basic foundation in implementing disaster preparedness education." (Participant 11)

As mentioned before from Participant 8, it could be showed that there is no comprehensive policy from schools to support the implementation of disaster preparedness in school. The disaster education could not be implemented properly. Because the implementation is also not carried out, the evaluation of disaster education will not work either.

> "How could we implement the evaluation of disaster education if we have not been implemented the disaster education." (Participant 8)

Disaster knowledge has only been mentioned as part of general material in certain subjects such as geography at the high school level, as well as social-related courses at elementary and junior high levels. There has never been an effort to raise awareness of the school community regarding the potential eruption of Mount Sinabung, both in the form of subject matter, disaster response socialization, provision of equipment, education and training, or school policies that support the implementation of school preparedness education.

Not only that, the results of discussions and interviews also revealed that the school lacked communication and coordination with stakeholders outside the school, such as local governments or related organizations in the school area. The school feels less involved in efforts to improve community preparedness for disasters, as revealed by one of the principals interviewed. Evaluation reflected in the brainstorming process and interviews with various elements clearly explain the huge need for disaster preparedness education for schools located at the Mount Sinabung foothill.

> "I see two main issues that we need to evaluate together. First, the internal school itself needs to build awareness of the potential for disasters followed up with disaster preparedness education policies and programs both for educators and for students. Second, what is also important to note is that schools in potential disaster areas such as us urgently need external support in improving disaster preparedness, for example in the form of policies related to curriculum integration, providing helping tools and training guidelines, as well as in the form of cooperation to increase disaster preparedness capacity." (Participant 1)

Hierarchy and classification of school preparedness obstacles

RQ 2: What is the hierarchy and classification of obstacles in implementing school disaster preparedness in the Mount Sinabung area in Indonesia?

After finding the obstacles of school disaster preparedness implementation in Mount Sinabung area, the existing sub elements based on the observation, brainstorming, and interview results with the school community are placed in the contextual relationship, as listed in **Table 2**.

The contextual relationship in **Table 2** shows that each sub-elements is related or affecting the other sub-elements. However, this table cannot predict the strength of the relationship among those variables. That is why, the next data analysis step in ISM is

to develop the hierarchy and the classification of sub elements (Saxena et al., 1992), in order to unveil the most important variable(s) among the 14 obstacles faced by the school around Sinabung Area in implementing disaster preparedness program.

Hierarchy development of the 14 sub-elements

The contextual relationship in Table 2 shows that every sub-element is assumed to affect the other sub-elements. However, it cannot explain which one of the sub-element has the major impact on the other ones. To determine the major sub-element(s) affecting the others, contextual relationship is further injected into the Structural Self Interaction Matrix (SSIM) with the V, A, X, O systems that can be seen in Table 3.

The SSIM represents the relationship between each sub-elements. X indicates that two sub-elements are affecting each other directly. V and A indicate a one way relationship in which a sub-element affect another sub-element, but not vice versa. While O indicates that no direct relationship established between the two sub-elements. From Table 3 can be deducted that for most sub-elements, the established relationship is one way as indicated with V and A indicators, with a total seven mutual relationships are established as in between sub-element 2 (disaster risk) and 9 (disaster education materials), where the presence of disaster risk results in the need of disaster education materials and vice versa. To measure the total strength of the relationship and determine the most prominent variable(s)/sub-element(s) in this context, SSIM indicators are then transformed into the table of *Reachability Matrix* (RM) by replacing V, A, X, O with the numbers 1 and 0. The results are obtained in Table 4.

TABLE 2 Contextual relationship between 14 sub-elements.

No	Sub-elements	Contextual relationships
1	Disaster preparedness	Disaster preparedness affects other sub-elements.
2	Disaster risk	Disaster risk affects other sub-elements.
3	Awareness	Awareness of disasters affects other sub-elements.
4	Knowledge	Disaster knowledge affects other sub-elements.
5	Skills/attitudes	Skills/attitudes affect other sub-elements.
6	Disaster education	Disaster education affects other sub-elements.
7	Evaluation of disaster education programs	Evaluation of disaster education programs affects other sub-elements.
8	Teacher training	Teacher training affects other sub-elements.
9	Disaster education materials	Disaster education material affects other sub-elements.
10	Integration of subjects	Integration of subjects affects other sub-elements.
11	School policy	School policy affects other sub-elements.
12	School curriculum	School curriculum affects other sub-elements.
13	Book	Disaster book affects other sub-elements.
14	Integrated modules	Integrated modules affect other sub-elements.

Table 4 shows that there are three sub-elements achieve the highest score/driven power of 11. Those sub-elements are sub-elements 10 (integration of subjects), 11 (school policy), and 12 (school curriculum). Based on RM analysis results, all 14 sub-elements are classified into five levels or rankings. The smaller number in the ranks represents the more major the problem to handle. To simplify the interpretation process, the hierarchy of 14 elements and ranks are described in this Interpretive Structural Model (ISM) figure.

The hierarchy structure development as shown in the ISM figure informs that the sub-elements 10 (integration of subjects), 11 (school policy), and 12 (school curriculum) become the key elements (level 1) that should be addressed first in handling the obstacles of school disaster preparedness program around Mount Sinabung area. These three sub-elements have the strongest and most fundamental influence on the other sub-elements. It means a suitable intervention in these sub-elements can be a driver factor that influences the success of intervention on the sub-elements listed on the next levels. By establishing school policy, designing relevant school curriculum, and integrating the disaster preparedness materials into school subjects (Level 1), further intervention in developing teacher training, designing disaster education materials, providing books, and creating integrated module (4 sub-elements listed in Level 2) becomes more achievable. Any improvement at Level 1 and Level 2 will contribute positively to the change in disaster education and program evaluation (2 sub-elements of Level 3), help increase the knowledge, awareness, and skill/attitudes (3 sub-elements of Level 4), and support the final goal of enhancing disaster preparedness capacity as well as minimize the disaster risks potential (2 sub-elements of Level 5) of the Mount Sinabung disaster.

Classification of sub-elements

The five levels hierarchy of the 14 sub-elements as mentioned in ISM figure then classified into the four sectors Driver Power Dependence (DPD) matrix. Result analysis described in Figure 2 shows that integration of subjects (10), school policy (11), and school curriculum (12) are sub-elements with the strongest impact influencing the success of the program, which labeled as Independent Variables. Any intervention to improve these three sub-elements will simultaneously influence the whole system hierarchy. Independent variables thus, should be addressed first in optimizing the effort to implement school disaster preparedness

program in Mount Sinabung area. Teacher training (8), disaster education materials (9), disaster related books (13), and integrated modules (14) fall into Linkage Variables with strong driver and strongly dependent variables. Intervention to establish these variables will result in the improvement of the system hierarchy. To maximize the benefit of the program, Linkage Variables should be addressed right after the intervention strategy for the Independent Variables has been started. The rest of the sub-elements are classified as Dependent Variables. Although most of the sub-elements turn to be Dependent Variables, as long as the problem in Independent and Linkage Variables has been gradually addressed, the problems in Dependent Variables can simultaneously be addressed. The relation between elements and sub-elements and the degree of power is described in Table 5.

Discussion

The basic idea of implementing ISM for analyzing the obstacles that schools face in the development of disaster preparedness is motivated by the need for schools in mapping relationships between obstacles to create effective and relevant programs (Attri et al., 2013). The resulted model in the analysis describes the intervariable relationship or sub-elements. Interpretation of this hierarchy model then becomes the basis of

TABLE 3 Matrix structural self-interaction matrix (SSIM).

Sub-element	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1		O	A	O	A	A	A	A	A	A	A	A	A	X
2			A	O	A	A	A	A	X	A	A	A	A	A
3				V	A	A	A	A	A	A	A	A	A	A
4					V	A	A	A	A	A	A	A	X	X
5						A	A	A	A	A	A	A	A	A
6							O	O	O	O	A	O	A	O
7								O	O	O	A	O	A	O
8									X	A	A	A	A	V
9										A	A	A	V	O
10											X	A	V	V
11												O	V	O
12													V	X
13														A
14														

TABLE 4 Reachability matrix for the 14 sub-elements.

Sub element	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Driven power	Ranking
1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	5
2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	5
3	1	1	0	1	0	0	0	0	0	0	0	0	0	0	3	4
4	0	0	0	0	1	0	0	0	0	0	0	0	1	1	3	4
5	1	1	1	0	0	0	0	0	0	0	0	0	0	0	3	4
6	1	1	1	1	1	0	0	0	0	0	0	0	0	0	5	3
7	1	1	1	1	1	0	0	0	0	0	0	0	0	0	5	3
8	1	1	1	1	1	0	0	1	1	0	0	0	0	1	8	2
9	1	1	1	1	1	0	0	1	1	0	0	0	1	0	8	2
10	1	1	1	1	1	0	0	1	1	1	1	0	1	1	11	1
11	1	1	1	1	1	1	1	1	1	1	1	0	1	0	11	1
12	1	1	1	1	1	0	0	1	1	1	0	1	1	1	11	1
13	1	1	1	1	1	1	1	1	0	0	0	0	0	0	8	2
14	1	1	1	1	1	0	0	0	0	0	0	1	1	1	8	2
Dependence	11	11	10	10	10	2	2	6	6	2	2	2	6	6		
Hierarchy	2	3	5	4	4	3	4	2	2	2	1	1	2	2		

Analysis result.

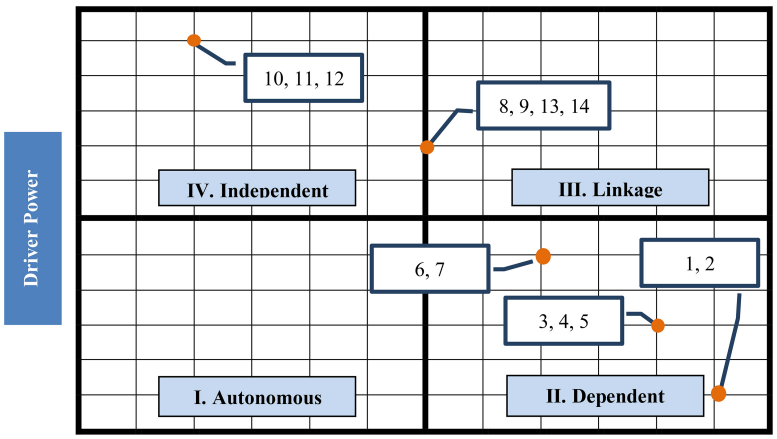

FIGURE 2
Matrix *driver power dependence (dpd) on the elements* of school preparedness constraints facing the Mount Sinabung disaster.

TABLE 5 Classification of sub-elements.

Element	Autonomous	Dependent	Linkage	Independent
Disaster knowledge	–	*(1) Disaster preparedness* *(2) Disaster risk* *(3) Awareness* *(4) Knowledge* *(5) Skills/attitudes*	*(13) Book* *(14) Integrated module*	–
Policy	–	*(6) Disaster education*	–	*(10) Integration of subjects* *(11) School policy* *(12) School curriculum*
Emergency planning	–	–	*(8) Teacher training*	
Warning system	–	–	–	
Mobility source capacity	–	*(7) Evaluation of disaster education programs*	*(9) Disaster education materials*	–

decision making, which is among the 14 identified obstacles that need to be resolved first.

From the 14 obstacle sub-elements that need to be evaluated in developing disaster preparedness in seven schools at the Mount Sinabung foothill, three variables are identified to be the key roles. The three key sub-elements are the integration of subjects, school policy, and curriculum. School preparedness efforts to deal with the Mount Sinabung disaster will fail or will not be effective if the three key sub-elements have not been done.

The school policy as key sub-elements underlines the importance of formal decision-making by relevant stakeholders to launch bureaucratic processes that have the potential to hinder the activation of disaster preparedness programs (Hidayati et al., 2006). The school preparedness program will be strengthened and supported by the school policy that will be used as a basis and legal reference for implementing various disaster preparedness activities in schools (Ministry of Education and Culture, 2015a). In the implementation of school disaster preparedness, there should be educational policies and guidance about disaster preparedness and supported by the availability of facts and data about the implementation of disaster preparedness policies at the school level (Ministry of Education and Culture, 2015a). Previous research shows that policies served as the foundation for the adaptation and implementation of the regulation to support the disaster risk management (Fahad and Wang, 2018). The indicators that are stand-in school policies and regulations are the inclusion of disaster preparedness materials in teaching and learning in school, the existence of disaster evacuation simulation, a disaster preparedness committee, the fund allocations for disaster preparedness activities, the partnership mechanisms with external organizations, and the program monitoring and evaluation (Kamil et al., 2019). This result is in line with the study from Fahad et al. (2022a) that showed regulations will increase the innovation and continuity of the program.

Another key sub-factors to be fixed is the school curriculum. It is important to integrate disaster preparedness education into the formal curriculum to develop student's

abilities in facing disasters. The development of the school curriculum should consider some attributes related to the design process, implementation process, and evaluation process of the curriculum. The major attributes are: (1) Curriculum responds to the needs of students, parents, and society; (2) curriculum is intellectually and emotionally stimulating, (3) curriculum optimizes students' learning potential; and (4) curriculum support e-learning/distance learning (Gul and Khilji, 2021). The indicators of a formal curriculum consist of teaching materials, laboratory guidelines or modules, learning instructions, evaluation tools, and extracurricular (Widowati et al., 2021).

The integration of subjects demonstrates the importance of integrating disaster preparedness materials in the structure of subjects in schools (Stanley and Wolanski, 2015). It is not limited to the subjects in intracurricular activities only, but also can be integrated into the subjects in extracurricular activities (Ministry of Education and Culture, 2015b). Intracurricular activities encompass the formal teaching and learning situation. In this context, disaster preparedness material can be blended with the syllabus of various subjects, like geography, sports, natural science, and so on. It would be better if this initiative is supported by a structured curriculum (White, 2004), so that the pattern of mixing disaster materials in the teaching-learning process is more targeted, accountable, and can be duplicated. In extracurricular activities, disaster preparedness material can also be inserted in Student Scouts and Red Cross Youth (Ministry of Education and Culture, 2015a). The importance of integration of preparedness education in teaching and learning activities is also in line with the findings of two other studies. Research from Kamil et al. (2019) shows that integrating disaster material in one subject provides increased knowledge and understanding of disasters in high school students. Meanwhile, Sari et al. (2014) mentioned that disaster preparedness education presented to students in school affects the level of readiness in facing disasters.

The combination of the three sub-elements at Level 1 (see **Figure 3**), becomes the basis for the development of the program at Level 2, where teacher training, preparation of disaster education materials, books, and integrated modules become the priority of intervention after intervention at the first level begins. These four sub-elements at level 2 could be categorized as the implementation stage. The teacher training includes some indicators to be done. The first indicator is the amount of training and simulation conducted by school-related disaster. Moreover, the school teachers have collaboration activities between boards, teachers, and teacher associations related to DRR efforts at school (Ministry of Education and Culture, 2015a). Education and training programs aimed at teachers are considered able to strengthen the preparedness capacity of the educational community (Yoseph-Paulus and Hindmarsh, 2018).

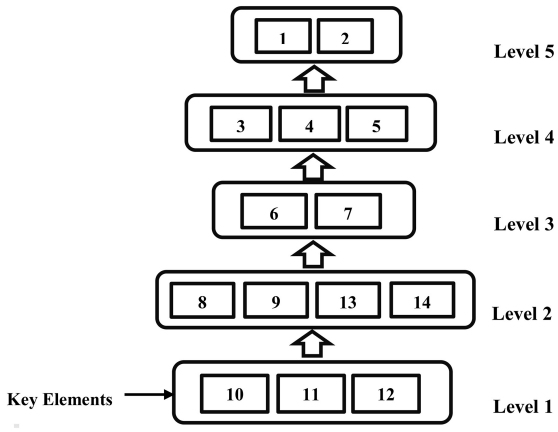

FIGURE 3
Interpretive structural model (ISM) for obstacles in implementing school disaster preparedness program in Mount Sinabung area.

Other sub-elements at Level 2 that needed to be fixed are disaster education materials, books, and integrated modules that could be categorized as a set of educational sources. Education materials are teaching material that is systematically arranged based on the developed syllabus and lesson plan. The educational materials can be developed into various types such as printed materials (books, modules, worksheets, brochures, leaflets, etc.), audiovisual (video/film), audio (radio, cassette, audio CD), visual (pictures, models/mock-ups), and multi-media (interactive CD, computer-based, internet). Books and integrated modules as sub-elements at Level 2 are educational materials in the form of printed materials.

Once the teachers obtain the training, book and integrated modules have been prepared, the program intervention continues to sub-elements at Level 3. At this level, disaster education programs can begin to be implemented. The production and transfer of disaster-related knowledge become vital at this stage so that school sub-elements are no longer vulnerable in dealing with potential disasters (Weichselgartner and Pigeon, 2015). The scope of disaster education is broader than that of formal education in school (Ministry of Education and Culture, 2015a). This includes the recognition and use of traditional wisdom and local knowledge for protection against natural disasters. Disaster education implementation is marked by the availability of dissemination activities at school conducted regularly and continuously, the access for all school community to information system (e.g., bulletin boards, libraries, books, modules) that contains the disaster risk reduction information. In order to realize a sustainable program, program evaluation becomes mandatory. That's why program implementation and evaluation need to go simultaneously. Program evaluation requires a systematic measurement and emphasizes on both programs and outcomes (Guyadeen and Seasons, 2018).

Intervention at Levels 1–3 is the foundation to generate awareness, knowledge, and skills as a set of output which is the focus of intervention at Level 4. Awareness, knowledge, and skills of school sub-elements will become higher when preparedness education programs are not only in the form of providing cognitive materials, but also involve simulation or practice of disaster preparedness (Kitagawa, 2015). The school community's knowledge and skills are considered an indicator to measure the level of disaster preparedness in school (Sujarwo et al., 2018). As mentioned in the result before, the school community around Mount Sinabung have low awareness of the potential and risk of disasters they may face when an eruption occurs. This condition is exacerbated by the lack of adequate learning resources around potential disasters, particularly those associated with volcanic eruptions. With the achievement of intervention priorities from Level 1 to Level 4, it is expected that disaster risk can be minimized and disaster preparedness in intervention schools can be improved. Problem-solving at Level 5, thus, is the result of a long process of intervention at the previous 4 levels.

The findings of this study are in-line with the findings of previous studies that emphasize the importance of local capacity building in facing natural disaster risk as a form of adaptation to climate change (Yoseph-Paulus and Hindmarsh, 2018). Intervention at the community level strengthens cross-sector solutions that have been built but still tend to be *ad hoc* and not yet systemic because it relies on incidental agendas such as seminars, workshops, and dialogue.

Previous research shows that in several parts of the world, disaster preparedness implementation began to become mainstream (Kitagawa, 2016). As a potentially catastrophic country, Japan, for example, makes disaster preparedness one of the priorities on the national agenda (Kitagawa, 2015). In Japan, disaster preparedness education is integrated with the formal school curriculum as well as with the lifelong learning flow applied at the community level (Kitagawa, 2016). Awareness of the importance of integrating disaster preparedness education into the formal and community education curriculum in Japan is a form of reflective thinking that arises due to traumatic experiences throughout the history of disasters that occurred in Japan (Preston et al., 2015; Dahl and Millora, 2016). The reflection is then implied into the four main pillars of disaster preparedness education, consisting of public aid, self-help, mutual aid in the neighborhood, and mutual aid between strangers (Kitagawa, 2015).

Therefore, based on this research, it can be suggested that some recommendations to the relevant parties, such as stakeholders at the local government level, schools, community, and organizations. For stakeholders at the central government must be more active to coordinate with disaster-prone school parties and actively provide socialization and simulation for school. Schools need to actively coordinate with external parties as well. Moreover, the school stakeholders must begin actively developing school policies as a basic guideline for further disaster preparedness activities. Schools could work with community organizations to conduct disaster preparedness education such as conducting training or simulations.

The result of this research contributes academically to the field of disaster education and geography. Interestingly, several respondents showed that they lacked confidence in their knowledge and skills in disaster education. They also said there are not enough teaching materials to support disaster courses. This research provides broader insight into the availability of disaster teaching materials in specific areas in Indonesia that need to be improved or added to support the educational process. Moreover, this study showed that the history of Mount Sinabung, organization relationships, and policy impacted the disaster preparedness of the school community. Therefore, this study also contributes to enhancing the literature about SBB implementation obstacles in Indonesia that could be variant based on their area. Furthermore, this research practically contributes to decision-makers at the government level. This result gives information on the obstacles to policy implementation in a specific area, Mount Sinabung Area, that could be considered while formulating the future policy. For the school community, this overall result could be guidance in fixing the school system in disaster preparedness comprehensively.

As mentioned before, there are several kinds of research about disaster preparedness that was conducted in the area of Mount Sinabung (Situmorang, 2018; Erianjoni et al., 2020; Kristian and Hutapea, 2021; Sihombing et al., 2022). But there was no research that focused on the implementation at the school community level. Thus, this research fills that gap as the novelty of research by conducting research at the school community level to measure disaster preparedness. Moreover, this research used ISM as the research design. Most of the previous research used ISM for the production process categorized as an engineering field (Adabavazaeh and Nikbakht, 2019; Euchi et al., 2019; Kaswan and Rathi, 2019; Huang et al., 2020; Yang and Lin, 2020). And on the disaster field, there are several researches using ISM but could not address Indonesia's need as a disaster-prone area (Jahantigh and Jannat, 2019; Mercado et al., 2019). Those researches showed it is still rare for ISM to be used in social science and in the Indonesian context. Therefore, this research could be considered as the early research that uses ISM in social science and in the context of Indonesia.

Conclusion and policy implication

Results of the study shows there are five levels of obstacles with total 14 sub-elements to be improved to establish the school disaster preparedness program at schools in Mount Sinabung area. From those 14 sub-elements, three sub-elements

are identified as the key elements with the strongest driver power making them as the most fundamental obstacle to be solved. The three sub-elements are integration of subjects (10), school policy (11), and school curriculum (12). By integrating disaster preparedness materials into school subjects, establishing relevant school policies, and designing proper curriculum, the capacity of the schools in facing disasters can be gradually improved. These key elements are the basics requirements to promote teacher training program (8), develop disaster education materials (9), books (13), and integrated modules (14). Thus, disaster education program (6) can be implemented, and evaluation of disaster education program (7) will be followed. The implementation of this disaster education will increase school community's awareness (3), knowledge (4), and at the same time improve their skills/attitudes (5), so that disaster preparedness (1) will be formed and will reduce the disaster risks (2) that potentially occur.

The result of this research contributes academically to the field of disaster education and geography. This study also contributes to enhancing the literature about SBB implementation obstacles in Indonesia. Furthermore, this research practically contributes to decision-makers at the government level and the school community. This result could be guidance in fixing the policy-making process and the school system in disaster preparedness comprehensively. Moreover, this research measure of disaster preparedness at the school community level which could be considered as this research novelty. This research also could be considered as the early research that uses ISM in social science and in the context of Indonesia.

Limitations and future directions

This study had several limitations to be considered. First, the sample is drawn by the purposive sampling technique. It indicates that the result only fits for school disaster preparedness programs in the Mount Sinabung area and cannot be generalized to other areas. Second, the research did not measure the level of the sub-elements by numeric data. The results could not explain precisely what the category of each sub-element is, whether it is considered at a low, moderate, or high level. Furthermore, this study did not measure further the relationship between the different levels of school disaster preparedness toward concrete response in facing disasters. Based on mentioned limitations, future research could measure the implementation in different disaster prone-area so that it could provide a broader explanation related to school disaster preparedness implementation in Indonesia. Future research could measure the numeric data per sub-element in disaster preparedness and the relationship between school disaster preparedness level and the disaster response.

Data availability statement

The original contributions presented in the study are included in the article/**Supplementary material**, further inquiries can be directed to the corresponding author/s.

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee Faculty of Social Science, Universitas Negeri Jakarta. The patients/participants provided their written informed consent to participate in this study.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.842990/full#supplementary-material

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