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Environmental communication and disaster mitigation by mobile application and website

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ABSTRACT

Background: Indonesia is a disaster-prone area, situated in the equatorial zone where several tectonic plates converge, and the Ring of Fire runs through. Indonesia requires an effective disaster mitigation system to minimize risks and losses during disasters. Meteorological, Climatological, and Geophysical Agency (BMKG) is a non-departmental government institution. Through its mobile application and official website, BMKG actively provides various information accessible to all Indonesians. **Purpose:** The research aimed to understand how BMKG conducts environmental communication and disaster mitigation through a mobile application and website. **Methods:** This research is descriptive qualitative using a constructive paradigm. The data was collected using documentation and observation studies. The authors carried out content analysis using Philipp Mayring's methods on the "Info BMKG" application and the website http://www.bmkg.go.id/. **Results:** The BMKG application and website cover some aspects of environmental communication, including rhetoric, media, public participation, and education campaigns, delivering a range of environmental messages. They facilitate disaster mitigation by providing information and vulnerability maps for different types of disasters but lack details on regulatory measures and planning for disaster-prone areas. **Conclusion:** The BMKG application and website effectively communicate environmental and disaster-related information but need to improve coverage, speed of notifications, and include more details on regulation and planning for disaster-prone areas. **Implications:** This study suggests the need to enhance the platforms' content and user education. Besides, it emphasizes theoretical implications for communication, public participation, and media theories in the context of disaster risk reduction.

Keywords: Environmental communication; disaster mitigation; mobile application; website; BMKG

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INTRODUCTION

Indonesia is surrounded by four main tectonic plates: the Eurasian Plate, the Indo-Australian Plate, the Philippine Sea Plate, and the Pacific Plate. More specifically, Indonesia is situated atop multiple smaller plates, which include the Woodlark Plate, the Timor Plate, the Bird's Head Plate, the Sunda Plate, the Banda Sea Plate, the Maluku Sea Plate, and the Burma Plate (Tim Pusat Studi Gempa Nasional, 2017). The Indo-Australian Plate is compressing against the Eurasian Plate in western Indonesia. Natural catastrophes brought on by this trend include the 2010 Mentawai earthquake and the 2004 Aceh tsunami in Indonesia.

Indonesia is situated inside the Pacific Ring of Fire due to the ongoing movement of tectonic plates. The destruction caused by the movement of these plates is exemplified by earthquakes and tsunamis (Tim Pusat Studi Gempa Nasional, 2017). The propensity for natural disasters is a result of tectonic activity and meteorological factors. Due to its equator-facing location, Indonesia lies in the tropical monsoon climate zone, characterized by high temperatures, humidity, and rainfall (Slamet & Suwarno, 2022). Based on its tectonic and climatic conditions, Indonesia frequently experiences natural disasters such as earthquakes, volcanic eruptions, floods, and tsunamis.

According to the Emergency Events Database (EM-DAT), Indonesia, a densely populated nation with more than 17,000 islands, faces significant vulnerability to disasters triggered by natural hazards (Gan et al., 2021). Based on data from the National Agency for Disaster Management/Badan Nasional Penanggulangan Bencana (2024), at least throughout the early year, there have been 403 natural disasters consisting of 125 floods, 151 landslides, 10 floods and landslides, 11 abrasions, 90 tornadoes, 10 forest and land fires, as well as 6 earthquakes. If reviewed every month, at least 100 or more natural disasters occur.

Apart from the geographical situation, global climate change also increases the risk of disasters. Globally, land and marine temperatures are rising. Climate change is the term used to describe alterations in regional or global climate patterns, particularly those that became evident in the middle to late 20th century and were linked to rising atmospheric carbon dioxide levels brought on by the burning of fossil fuels. Changes alter not only patterns but also the intensity. The occurrence of changes in patterns can cause extreme climates in one season (Lineman et al., 2015; Suhadi et al., 2023; Urry, 2015).

Indonesia is particularly vulnerable to disasters due to some variables, including geographic location and climate change. It is necessary to take steps to ensure that the community is prepared for any calamity, which could strike at any time. People must be conscious of the circumstances facing those who are most likely to suffer from natural disasters.

Educating and raising public awareness through media is crucial to making people more concerned about climate change (Appelgren & Jönsson, 2021). Indonesian cyber media has not fulfilled such a role in climate change prevention due to limited coverage of environmental issues (Muslikhin & Prawira, 2023). One reason for this is the lack of economic incentives as climate topics are not profitable for cyber media outlets (Strauss et al., 2022).

Rescue efforts and disaster response alone cannot resolve environmental issues in Indonesia (Wahyudin, 2017). Environmental communication can enhance community's capacity to respond to any environmental cues (Lestari et al., 2016). Environmental communication can also provide knowledge and understanding to the public about good environmental planning. Ultimately, it fosters a community behavior conducive to environmental preservation (Lestari et al., 2016).

Communication plays a crucial role in our understanding of the environment and environmental issues, and communication media serve as a major public forum for raising awareness of these issues and the ways in which they are discussed, debated, and, potentially resolved (Hansen, 2018). There are numerous media sources providing information about the environment. Environmental information is accessible through mainstream media, such as TV, radio, newspapers, and magazines. The advancement of information and communication technology also influences how people access information. Environmental messages can also be communicated through online media, such as blogs, websites, and other sources (Cox, 2013).

Mass media and the internet have become important information channels in environmental communication. Information and communication technology development has caused environmental issues to spread through new media. In terms of spreading awareness of environmental issues and implementing catastrophe mitigation strategies, the government is a crucial role model. The Indonesian government is highly aware of the vulnerability our land to natural disasters. The government's commitment to disaster management is demonstrated by Law No. 24 of 2007 concerning disaster management.

BMKG is a part of the Indonesian government responsible for meteorological, geophysical, and climatological observations. In disseminating information, BMKG also involves printed, electronic, and online media. "Info BMKG" is the name of the BMKG application, and http://www.bmkg.go.id/ is the address of the official BMKG website. A variety of information is available in the application, including satellite photos, seismic reports, meteorological updates, and climatic data. More comprehensive information is available on the BMKG website, which also offers weather predictions, climate data, air quality, earthquake and tsunami alerts, potential geophysical information and indications, early

catastrophe warnings, and more.

BMKG is one of the authorized bodies by law responsible for managing data and information about weather, climate, and disasters in Indonesia. Apart from that, BMKG is one of the sources of information commonly referred to when disasters occur in Indonesia and is the fastest source of information.

This research investigates how environmental issues is communicated by BMKG through the Info BMKG mobile application and website. Additionally, the research explores the efforts in disaster mitigation through the Info BMKG mobile application and website.

Research on media, communication, and the environment was initially conducted in the 1970's. An influential early pioneering study was "Up and Down With Ecology: The "Issue-Attention Cycle" by Anthony Downs. The authors conducted a literature review to identify research gaps. Several studies related to environmental communication and disaster mitigation were found, such as environmental communication concerning eruption disaster mitigation efforts (Lestari et al., 2016), the use of radio as a medium for environmental communication and disaster mitigation (Dwivayani & Karim, 2020), environmental communication for disaster prevention within organizations (Yasir et al., 2023), and the empowerment of social institutions through environmental communication in disaster mitigation (Bakti et al., 2017).

On a more global scale, research has been carried out regarding environmental communication and disaster mitigation in its relevance to the media, among others social media for crisis management and disaster risk reduction (Alexander, 2014), functional framework for social media use in disaster planning and response (Houston et al., 2015) official, and scientific literature was carried out in 2012–13 to develop a framework of disaster social media. This framework can be used to facilitate the creation of disaster social media tools, the formulation of disaster social media implementation processes, and the scientific study of disaster social media effects. Disaster social media users in the framework include communities, government, individuals, organisations, and media outlets. Fifteen distinct disaster social media uses were identified, ranging from preparing and receiving disaster preparedness information and warnings and signalling and detecting disasters prior to an event to (re, role of social media in effective crisis management (Jin et al., 2014)consequently, crisis communication professionals need to understand how to strategically optimize these tools. Despite this need, there is scarce theory-grounded research to understand key factors that affect how publics consume crisis information via social media compared to other sources. To fill this gap, an emerging model helps crisis managers understand how publics produce, consume, and/or share crisis information via social media

and other sources: the social-mediated crisis communication model (SMCC, and social media in disaster communication (Lovari & Bowen, 2020). Other research looks at environmental communication and disaster mitigation efforts with relevance to social media. In this research, the author focuses on applications and websites as one of the novelties. The authors found no studies that specifically explored environmental communication and disaster mitigation efforts through the application and website of BMKG.

According to Oepen & Hamacher, (1999), environmental communication involves plans and strategies used in the communication process and media products to support policy-making, public participation, and the implementation of projects related to environmental sustainability. In Oepen's view, environmental communication defines the implementation process of two-way social interaction that fosters public concern for environmental preservation and responds to issues in a competent manner.

Environmental communication is the process of interpreting and conveying messages about nature, disasters, and their impacts, which are then passed on from generation to generation. The process of interpreting nature and its messages can be conveyed through mass media by and for the government and the people (Dwivayani & Karim, 2020). Environmental communication can refer to the communication process and media products to support environmental sustainability.

The goal of environmental communication is not primarily focused on the dissemination of information. Rather, it aims to create a shared vision of sustainable lifestyles, enhancing the capacity of social groups to address and prevent environmental issues (Oepen & Hamacher, 1999). Environmental communication is greatly influenced by worldviews or cultural frameworks regarding God, existence, the afterlife, the universe, reality, material wealth, and other philosophical questions relevant to life (Lestari et al., 2016). How environmental issues and topics are communicated depends significantly on the ideologies inherent in the sources where the information is disseminated.

According to Cox (2013), the field of environmental communication encompasses several areas of study. First, environmental rhetoric and discourse; this area is the broadest in environmental communication studies, which cover rhetoric from environmental activists, writings about the environment, corporate public relations campaigns, including media and websites. Second, environmental media and journalism; this area focuses on reporting, advertising, commercial programs, and websites. It depicts environmental and natural issues, the impact of media on societal behavior, and media agenda-setting and framing. Third, public participation in decision-making related to environmental issues. Fourth, public education and advocacy campaigns, are also known as social marketing. This area of study includes campaigns aimed at changing societal behavior to achieve social and environmental

goals.

The fifth area of study is environmental collaboration and conflict resolution, which examines alternative models for addressing dissatisfaction with public participation and conflict resolution methods. The key aspect of this area of study is collaboration by inviting stakeholders to engage in problem-solving discussions. The sixth area is risk communication, which traditionally evaluates the effectiveness of communication strategies in conveying technical health information, and with a more modern approach, assesses the impact of public understanding of risk and public acceptance of risk. The seventh area is the representation of environmental issues in popular culture and green marketing; this area of study examines the use of images, music, television programs, photography, and commercial advertising to influence societal behavior toward the environment.

Disaster mitigation fundamentally aims to develop a community conscious of and responsive to disasters by providing Disaster Risk Reduction (PRB) education. The PRB solution framework is tailored to align with the disaster cycle, which encompasses the pre-disaster, during-disaster, and post-disaster phases, as illustrated in the diagram (Suhardjo, 2015). The concept of disaster management has been shifting from conventional paradigms towards holistic approaches. The conventional paradigm views disasters as inevitable events where victims require assistance. The objective of disaster management within this paradigm is to minimize losses and facilitate recovery.

The paradigm has evolved into a mitigation paradigm, which focuses more on identifying disaster-prone areas, recognizing vulnerability patterns, and implementing structural (construction engineering) and non-structural (disaster understanding, information dissemination, and spatial planning) mitigation measures. In-depth environmental communication can be utilized for disaster mitigation activities. According to Flor & Canggara (2018), there are several objectives of mitigation. First, to reduce the risk/impact of disasters on the population, economic losses, and damage to natural resources. Second, it functions as a guideline for development planning. Third, to enhance public awareness and reduce impacts/risks.

Flor & Canggara (2018) assert that disaster mitigation should encompass the importance of having information and disaster vulnerability maps covering types of disasters in every region, the need for socialization among communities residing in disaster-prone areas, the necessity for broad knowledge about self-rescue techniques, actions to take, and behaviors to avoid during disasters, and, lastly, the requirement for regulation and spatial planning in disaster-prone areas to reduce the risks and threats they pose. Considering these four elements, disaster can be more effectively and sustainably mitigated.

RESEARCH METHOD

This study adopts a qualitative descriptive research design within a constructive paradigm. The qualitative technique in this study does not seek to verify preexisting hypotheses. A qualitative method, on the other hand, seeks to identify novel concepts associated with a phenomenon (Sarmanu, 2017). The research explores the environmental communication strategies employed by BMKG through a mobile application and website. Additionally, the study seeks to understand the disaster mitigation efforts facilitated by the mobile application and website.

Data collection was conducted through documentary study and observation on the mobile application and website. In general, data can be categorized into two types: primary data and secondary data. In this study, primary data comprise documentation results from the Info BMKG application and the website http://www.bmkg.go.id/. The secondary data was obtained from environmental communication theory and disaster mitigation concepts from books, journals, electronic media, and other verified information sources.

The data analysis technique is the qualitative content analysis model. There is no doubt that the proponents of both approaches sample text, in the sense of choosing what is relevant; unitize text, in the sense of distinguishing words or propositions and using quotes or examples; contextualize what they are reading considering what they know about the circumstances surrounding the texts; and have specific research questions in mind. Qualitative researchers persuasively argue that each body of text is unique, affords multiple interpretations, and needs to be treated accordingly (Krippendor, 2004).

To bolster their interpretations, qualitative researchers create parallelisms, triangulate, elaborate on any analogies they spot, and incorporate excerpts from the texts they have researched, and literature about the contexts in which these writings are found. Readers who are curious about the settings of the examined works typically find these research findings compelling. Content analysts also argue (or assume that readers understand) that their designs are sensitive to context, but they also persuade readers to accept their results by emphasizing the thorough application of their design (Krippendor, 2004).

Through Mayring's analysis, criteria are formulated from definitions derived from theoretical backgrounds and research questions to determine the aspects of textual material that have been classified. The analysis process involves research question formulation, data collection through documentation, content classification related to environmental communication and disaster mitigation, re-examination, and finally analysis of the results of categories.

Mayring outlines the inductive analysis process which involves establishing research questions, defining categories, and determining

the level of abstraction for inductive categories. Subsequently, data formulation occurs by considering the definitions of categories, arranging categories or formulating new categories, revising categories as a form of formative reliability check while considering the research questions, and finally, completing the final categorization process as a summative reliability check and final interpretation (Mayring, 2000).

Research limitations lie in the subject. The author only focused on the BMKG application and website. BMKG's other media channels were not the focus of the research. Other matters unrelated to environmental communication and disaster mitigation by BMKG are not part of the research.

RESULTS AND DISCUSSION

The BMKG application and website are freely accessible platforms. The Info BMKG app is available for free download from the Play Store and App Store for users of Android and iOS devices. This application was initially released on May 6, 2012. The BMKG motto featured in this application is: *"Informasi Cuaca, Iklim, Kualitas Udara, dan Gempa Bumi di Indonesia dalam Satu Genggaman Aplikasi"*/"Tackling Weather, Climate, Air Quality, and Earthquakes in Indonesia All in One App".

The first field of environmental communication is rhetoric and discourse. Rhetoric is the science that presents the ways (Faizah, 2014) in which humans interact with others through communication. Rhetorical structure theory is a detailed framework for understanding textual organization. As interest in this theory has grown, rhetorical structure theory has been utilized in various advanced applications (Hou et al., 2020).

In this context, BMKG serves as the communicator, while users of the BMKG application and website are the audience or communicants. BMKG's rhetorical style can be observed through the way it delivers messages via application and website. Through its official application and website, BMKG presents a clear, firm, and unique governmental image as a government entity. The website and application display messages in text, audio, and video. Rich data and information are available from BMKG, provided in many ways like maps and graphs.

The application and the website are communication tools that enable direct user interaction. Furthermore, people can get in touch with BMKG directly by using several tools on the BMKG website, like public complaints and social media data from Instagram, Twitter, YouTube, and Facebook, which can be accessed by clicking links on the website.

The user of the application can give direct feedback to BMKG through, one of which, the crowdsourcing features. Crowdsourcing is a form of coordinated activity, involving an unlimited amount of civil participation, there is a semi-autonomous function in information

Source: Research Results, 2024
Figure 1 Crowdsourcing Feature

management issues (Liu, 2014). Crowdsourcing has become a widely used method for involving a broad range of stakeholders, not only in developing new products and services for companies but also in finding innovative solutions to complex societal issues (Mahotra & Majchrzak, 2024). The crowdsourcing model emphasizes collecting information directly from the public, the media commonly used is social media. The collected data is then analyzed according to needs and situations (Center for Digital Society, 2021)

Figure 1 depicts the crowdsourcing feature available in the application. This feature is only applicable to earthquake and weather information. Figure 1 illustrates the feature that users can utilize when experiencing an earthquake according to the information provided in the application. The crowdsourcing feature is also provided for weather information. Users can provide information regarding the weather and the impact experienced by the current weather conditions.

The application serves as a comprehensive platform for environmental discourse with a plethora of information curated by BMKG. This includes detailed weather forecasts spanning all districts in Indonesia for the upcoming week, ensuring users are well-prepared for weather fluctuations. Moreover, the application delivers real-time earthquake updates, accompanied by the distance between the event's epicenter and the user's location, enhancing situational awareness. Climate data for Indonesia is also readily available to help users understand long-term environmental trends. Additionally, the application offers insights into air quality across various cities, maritime weather conditions such as sea wave heights, and precise weather forecasts tailored to airports throughout Indonesia. Notably, users can access impact-based weather information and UV index data crucial for understanding health risks associated with sun exposure.

Furthermore, the application provides vital information on potential forest fires, land fires, and hotspots. It contributes to environmental awareness and prevention efforts. With features like event-specific weather forecasts and early weather warnings for all Indonesian provinces,

Info BMKG ensures users stay informed and safe. Moreover, access to radar and satellite images allows users to visualize weather patterns effectively. Lastly, official press releases by BMKG are accessible to enhance transparency and credibility in environmental communication.

The third aspect of environmental communication is environmental media and journalism. In the era of information proliferation, the media functions as a vital channel for disseminating information, which brings about significant influence and communicative power (Zhang et al., 2024). The BMKG application and website also function as media that carry out environmental journalistic activities. BMKG produces various publications across different media, including press releases, articles, magazines, visual exhibitions, journals, brochures, leaflets, and booklets. Generally, the content or information presented by BMKG through media publications can be categorized into three main areas: information related to environmental issues. BMKG produces articles containing environmental data and information, often compiled thematically in magazines. Environmental studies are published in the form of journal articles and proceedings. Contributors to these journals and articles come from different backgrounds, including practitioners and academics.

Secondly, there are press releases about BMKG's activities. Through its website, BMKG actively publishes press releases. Thirdly, there is information about activities organized by BMKG, including workshops, training sessions, and more. BMKG conducts comprehensive publication activities through the official website, whereas the Info BMKG application only provides limited access to press releases.

Another aspect of environmental communication is community participation in decision making regarding environmental issues. Public participation is an embodiment of the democratic process (Grote, 2024). Public participation affects the performance of public service organizations (Putra, 2014). As a governmental institution, BMKG is responsible for facilitating public participation. Public participation in environmental issues can be observed through various ideas, opinions, and perspectives expressed by different groups. These ideas are documented in writings published through proceedings articles and nationally indexed journals.

Another form of public participation is an effort through the crowdsourcing feature available in the application. Users of the application provide direct feedback to BMKG, through the crowdsourcing feature, per se. Crowdsourcing is a coordinated activity involving unlimited civilian participation, with semi-autonomous functions in information management issues. The crowdsourcing model emphasizes the direct collection of information from the public, commonly utilizing social media as a medium. The collected data are

then analyzed according to needs and situations (Center for Digital Society, 2021).

Public Education and Advocacy Campaigns are the fourth aspect of environmental communication. Restoring human connection with the environment and biodiversity is a key approach to addressing various environmental issues. However, this effort necessitates enhancing the teaching-learning process in pro-environmental education for children, youth, and adults. It involves promoting environmental awareness and creating opportunities to expand environmental and biological knowledge, which serves as a foundation for developing critical and transformative citizens (Campos et al., 2021).

The fact that disaster knowledge is still not covered in Indonesian school curricula is one of the causes of the lack of public awareness of disaster mitigation (Fakhrurrozi, 2021). It is essential to release education disasters for the learners at school in light of these concerns. A catastrophe in education can be characterized as an effort to lower the risk of disaster for the student (Logayah et al., 2023).

Through a website, BMKG provides education to students on earthquake and tsunami preparedness. BMKG provides education in videos, handbooks, and leaflets with animated images and bright colors. All videos, handbooks, and leaflets are accessible on the website. The goal of this education campaign is to help individuals prepare for earthquakes and tsunamis as early as possible, ideally starting from the school education level.

One form of disaster mitigation is providing information and maps of disaster vulnerability in each region. The map is a product of the Geographic Information System (GIS). There are several applications for GIS, one of which is disaster relief. Geographic information systems for disaster mitigation help raise awareness and give essential information when disasters strike (Dzulkarnain et al., 2016). It is a collection of initiatives to lower the likelihood of disasters, by increasing knowledge and development of physical hazards and strengthening response capabilities to such threats (Bhatt et al., 2014).

The "Info BMKG" application provides information on meteorological, climatological, and geophysical disasters. Based on the information provided, the information is broadly divided into three categories: earthquakes, weather, and climate. The notifications frequently displayed by the application primarily concern real-time earthquake events. The information displayed includes not only major earthquakes but also earthquakes with a magnitude as low as 2.3 Richter scale. This illustrates that the Info BMKG application informs users about all earthquake events. The latest earthquake information provided includes the magnitude of the earthquake, the time of occurrence, the epicenter location, the affected areas, and the distance from the user's location, as depicted in Figure 2.

The strength of earthquakes displayed in the application is measured using the magnitude

Source: Research Results, 2024

Figure 2 Earthquake information display

scale. Technically, the higher the magnitude value, the greater the strength produced at the earthquake's epicenter.

Furthermore, the application provides information about the earthquake's epicenter, including data on depth, coordinates, and distance from the nearest city center. The application also displays the earthquake's epicenter point data on a base map. Visualizations like this can be highly effective as they allow users to visually assess the distance between the earthquake epicenter and populated areas or activity centers. The displayed time information includes the exact hour when the earthquake occurred.

The BMKG application also provides information about areas affected by earthquakes. This information is crucial for users who intend to visit the affected areas, such as travel plans or visiting intentions. The most important information for users is the distance between the earthquake's epicenter and the user's location. Users can set their location manually or automatically using their GPS devices. The accuracy provided by GPS generally represents the user's latest location.

Another interesting feature is the survey function, which can be filled out by the public. The crowdsourced data is presented "as it is" and the program lacks a vetting procedure. For this reason, the agency uses it to develop situational awareness rather than to address specific reports (Harrison & Johnson, 2016). The survey can be easily completed by selecting the intensity scale perceived by the public. There are five scales with explanations for each, as shown in Figure 4. This feature can also serve as a correction or validation of the data displayed based on the actual conditions in the field. The scale used to fill out the survey is the Modified Mercalli Intensity (MMI). The MMI scale is a unit for measuring the strength of earthquakes. Initially, the Mercalli scale had 12 levels of earthquake strength. The weakness of this scale is that subjective assessment can lead to different ratings from different people. Research by Irawan et al., (2020) provides a comparison between the Richter scale and the MMI scale as follows Table 1.

In the Info BMKG application, the MII scale has undergone adjustments. There are 5 scales used: I-II MMI, III-V MMI, VI MMI, VII-VIII

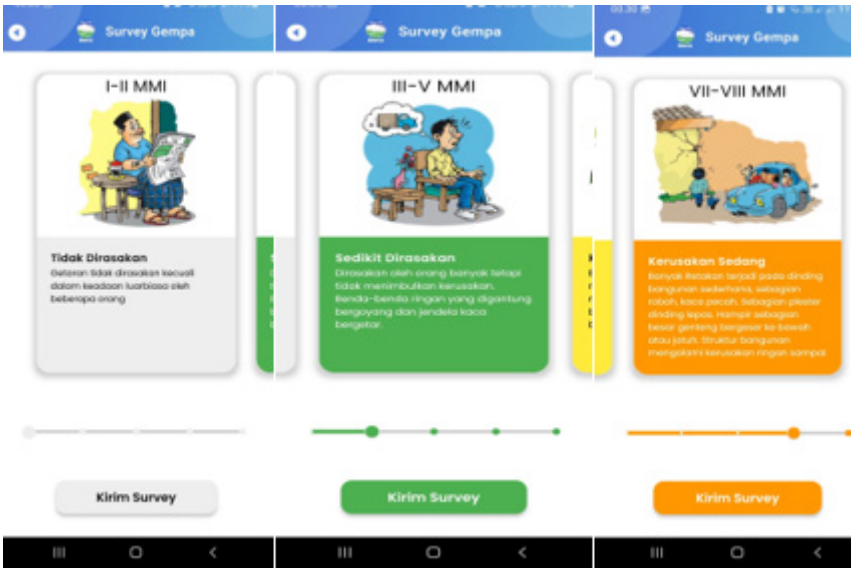
Table 1 Relationship between the Richter Scale and MMI Scale

Magnitude (Richter)	Intensity (MMI)	Description
≤ 2	I - II	Not felt except by a very few under favorable conditions.
3	III	Felt quite noticeable by a person indoors, vibrations similar to the passing of a truck.
4	IV - V	Felt by nearly everyone, many are awakened.
5	VI - VII	Felt by all, many are frightened. The walls make a cracking sound.
6	VII - VIII	Vibration can break the walls.
7	IX - X	Most masonry and frame structures are destroyed with foundation.
≥ 8	XI - XII	Can destroy all buildings in an area.

Source: Irawan et all, 2020

MMI, IX-XII MMI as shown in Figure 3. These five scales are accompanied by explanations for each scale as presented in Figure 3. This feature can also serve as a correction or validation of the data displayed based on field conditions.

The "Info BMKG" application provides various weather information such as current weather conditions, weather warnings, impact-based weather, forest fire weather, maritime weather, flight weather, and Cumulonimbus cloud potential. Based on Figure 4, the display for current weather conditions provides data on humidity, wind speed, wind conditions, and weather forecasts every 3 hours throughout the day. Additionally, there is a graph that visualizes temperature data to make it easier for



Source: Research Results, 2024

Figure 3 Earthquake Survey

Source: Research Results, 2024
Figure 4 Weather Condition Information

users to understand the forecast for the entire day. The information presented is user-friendly using symbols and simple numbers. Even wind conditions are classified so that users can easily understand them

The early warning feature provided offers notifications predominantly in the form of narrations about areas to be affected by extreme weather conditions, as in Figure 5. It not only consists of narratives but also includes infographics accompanied by maps. The areas are divided into three categories: early warning areas, which are vulnerable regions; potential expanding areas, which will be affected if the weather becomes more extreme; and unaffected areas, which are not affected by extreme weather. The classification of areas is based on the administrative boundaries of districts and sub-districts. BMKG also adds information

Source: Research Results, 2024
Figure 5 Early Warning

about the possible duration of extreme weather conditions.

Based on the type of map used, it is a thematic map. Thematic maps convey specific information (Saily et al., 2021), in this case, conveying the level of vulnerability of an area to extreme weather. Symbolization used in the map employs color differences or color gradients according to the level of vulnerability. The use of color gradients will greatly assist users in quickly providing vulnerability information.

Green is used for unaffected areas, yellow for areas with potential expansion, and orange for areas experiencing extreme weather.

The weather information is provided using a three-tier impact approach. This information is deemed valid until 7:00 a.m. tomorrow. There are provinces interested in knowing their weather forecast conditions. This feature also includes the impacts on the community in their daily activities. There are also directives for actions to take. Forest and land fire disasters, known as karhutla, are also available on the application. Information on hotspots, smoke distribution imagery, daily potential for karhutla, and monthly potential for karhutla are provided. The information is presented in a map. Smoke distribution information (Figure 5) is one of the pieces of information that directly impacts the community because it allows them to know which areas are affected by smoke so that they can avoid them.

Information about maritime areas is also available in the application. The display includes a map with information on the classes of maritime weather conditions. The maritime areas are categorized into 7 classes: calm, low, moderate, high, very high, extreme, and very extreme. The map covers all Indonesian waters, allowing users to navigate as desired. One application of this feature for the community is as a reference for sea travel, aiding in making informed decisions for ship journeys.

Info BMKG also provides flight weather information to support travel information. The flight weather provided by BMKG is based on weather information from airports across Indonesia. Users can select the airport they want to know about. The information displayed includes temperature, air pressure, visibility, wind speed, and wind direction (Figure 8). There is also an estimate of flight weather conditions for the next four hours. Another warning related to aviation is the Cumulonimbus cloud warning, which is also available in the application. This information is crucial for aviation as it can pose hazards.

Knowing weather information can serve as a reference to anticipate secondary disasters such as floods, landslides, droughts, and forest fires. However, Info BMKG does not provide maps of flood-prone and landslide-prone areas. According to BNPB data, floods and landslides ranked second and third in 2023. Flood disasters occurred in 299 incidents across Indonesia. Floods are the most frequent disasters in settlements and have a significant impact on communities.

The climate information provided by the application includes monthly rainfall forecasts, analyses of rainfall from the previous month, and days without rain and rainy days. All information is presented in the maps showing the entire territory of Indonesia. Rainfall information is presented in the form of areas with nine classes of rainfall. Visualization helps identify affected areas. For information on days without rain, point visualization is chosen. The drawback of this data visualization is the

inability to determine which areas are affected; only the values from the sampling locations are known. Other climate information presented in the application includes radar imagery, providing information on rainfall intensity. The unit used in radar imagery is decibels (dBZ). According to the BMKG, dBZ is a unit of energy reflection emitted back by water particles in clouds. The higher the dBZ value, the bigger the likelihood of heavy rainfall. The provided information is in real time. Additionally, there is also Himawari satellite imagery with the latest time available in the Info BMKG application. Secondary disasters that can result from extreme climate conditions include tornadoes. However, a map for tornado vulnerability is not yet available.

Weather-related information is also available on the website provided by BMKG at http://www.bmkg.go.id/. This website offers more comprehensive information compared to the application. For example, in maritime weather information, it provides warnings of high waves and port weather forecasts. The high wave warning provides information on wave height and the extent of these conditions expected to persist in the upcoming days. In the port weather feature, visitors to the website can select maritime regions, port locations, marine tourism spots, and ferry routes to obtain more detailed information on the map. The information is crucial for the public as considerations for beachside activities and maritime transportation.

Additionally, there is also information on tropical cyclones, which is crucial for understanding the potential for strong winds and even storms. There is also a map of the potential flood disasters throughout Indonesia every month. The regions are divided into five classes: high potential, moderate potential, low potential, safe areas, and non-flood areas. Information has also been provided based on all provinces in Indonesia, indicating the districts to be affected by floods.

Another interesting piece of information is the availability of water, visualized on a map with three classes: water scarcity (<40% water availability), moderate (40%-60% water availability), and sufficient water (>60% water availability). The map displays all provinces with data updates every month. Another available map is the lightning strike map that occurred during the last month. The earthquake map information on the website is almost identical to what is available on the application, and there is even a link on the application that connects to the website. An additional map provided is the isoseismal map, which depicts areas with the same shaking impact.

Another form of disaster mitigation is outreach to communities living in vulnerable areas. The method of socialization employed by the "Info BMKG" application is through notifications that appear when an earthquake occurs. The earthquake scale conveyed is not limited to large-scale earthquakes. During my usage of the application, earthquakes as small as 2.3 Magnitude were notified. These notifications

can be utilized for disaster mitigation activities as preparation before facing larger earthquakes.

One weakness of the application is that it only provides notifications for earthquake disasters, not for other natural disasters such as weather and climate-related events. Socialization is also given through notifications of impacts and what actions to take. This information can be found in the impact-based weather menu. Impact information will be tailored to the weather category present in a specific area. Users are also provided with information on what actions to take during such weather conditions.

The website http://www.bmkg.go.id/ provides a menu connected to YouTube for earthquake and tsunami education. There are numerous video themes such as earthquake awareness, earthquake mitigation (Before, During, and After an earthquake), tsunami awareness, tsunami disaster mitigation, and the disaster preparedness bag awareness campaign. Not only videos, BMKG also provides pocketbooks for earthquake and tsunami awareness. There are also documents on earthquake and tsunami preparedness. Socialization is also conveyed through printable infographics.

Lastly, a form of disaster mitigation is the arrangement of disaster-prone areas to reduce the threat of disasters, but the application and website do not provide spatial maps or regulations governing disaster-prone areas. BMKG does not directly regulate spatial planning. Based on the BMKG website, its function is primarily to coordinate policies, planning, and programs in the fields of meteorology, climatology, and geophysics.

CONCLUSION

The environmental communication aspects in the BMKG application and website encompass rhetoric and environmental discourse, environmental media and journalism, public participation in decision-making related to environmental issues, and public education and advocacy campaigns. Various environmental messages are communicated by BMKG via an application and website. The findings suggested that the application can assist in disaster mitigation efforts with the provided information. However, not all disasters receive notifications, so mitigation for disasters such as extreme rain and storms are not quickly communicated. The website serves as a supporting platform that provides more comprehensive information.

Based on the research findings, the authors suggest collaboration among various stakeholders to make the communication and dissemination of information more effective. Furthermore, future research could develop quantitative models to examine content analysis from different perspectives. Additionally, considering that this application and website are continuously evolving, further research is required to update and monitor changes occurring over time.

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