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Worst Case Scenario: Analyzing Big Data in Disaster Crisis

Pipit Fitriyah[1], Ismi Dwi Astuti Nurhaeni[2], Andre N Rahmanto[3], Drajat Tri Kantono[4]

[1,2,3,4] Faculty of Political and Social Science, Universitas Sebelas Maret, Surakarta, Indonesia

Correspondence: Ismi Dwi Astuti Nurhaeni, Public Administration Department, Faculty of Political and Social Science, Universitas Sebelas Maret, Surakarta, Indonesia.

Abstract

The industrial and information age has brought significant changes in the way we manage risk and response to disasters. In this context, Big Data analysis is becoming an important tool in improving the effectiveness of crisis communication. This approach enables faster and more informed decision-making in worst-case scenarios, which can ultimately minimize damage and loss of life. However, challenges such as data overload, misinterpretation, and the spread of disinformation remain obstacles that need to be overcome. By analyzing 14,083 tweets using Natural Language Processing (NLP), this study found that negative sentiment dominated public responses to the crisis (12,947 tweets), while positive sentiment was relatively small (1,136 tweets). Frequently occurring words, such as "gempa," "korban," "bencana," indicate that the public's attention is mostly focused on the consequences of the disaster, while the words "kecepatan," "informasi," and "pengolahan data" reflect high expectations of a fast and accurate response. The results of this study confirm that effective crisis communication should be data-driven and integrate big data analysis to understand communication trends during a crisis. The use of NLP enables real-time sentiment monitoring, misinformation detection, and the development of more adaptive communication strategies. From a crisis management perspective, this approach can help government agencies to reduce public uncertainty, quell panic, and rebuild public trust. The study also recommends the need for stricter regulations related to disaster communication to address disinformation that has the potential to worsen the situation. With technology-based approaches and data analysis, crisis communication strategies can be more effective in dealing with the dynamics of public opinion during emergency situations.

Keywords: Big Data, Crisis Communication, Natural Language Processing (NLP), Sentiment Analysis, Social Media

1. Introduction

In the last two decades, the frequency of disasters in Indonesia, from the tsunami cases of Aceh (2004), Palu-Lombok (2018), Cianjur (2022), initiated a variety of crisis communication studies that developed in a relatively short time, social media has forced academics and practitioners to reconsider their assumptions about how to best reach the public in times of crisis and emergency. The information and industrial age has spawned new risks, a more informed public, new technologies, and new strategies for dialog, decision-making, and risk assessment (Palenchar, 2009). This has forced crisis communication theory and practice to evolve rapidly since the turn of the century (Coombs & Holladay, 2010).

Electronic resources such as Twitter allow users to create and disseminate content, and facilitate shared understanding of content and topics among users and communities (O'Reilly & Battelle, 2009; Westerman, Spence, & Van Der Heide, 2014). The popularity, efficiency and ease of use of social media have led to its widespread use in disaster management (Denis et al., 2014; Hiltz et al., 2014; Hughes, 2014; Ngamassi et al., 2016; Yates & Paquette, 2011). Social media helps and enables the public and government to collaborate in a mutually beneficial way at the crisis response stage (Velve and Zlateva, 2012).

Social media is used as a major source of news during natural disasters and emergency situations. It provides information on pre- and post-disaster scenarios through the internet or messaging. It also raises awareness among affected communities, and helps in mobilizing volunteers and donors for emergency services. In addition, social media provided information on assistance and resource centers available to the affected areas. According to the research review, there are four main ways the public uses social media technologies: communication with family and friends; situation updates; situational awareness/enhancement; and service access assistance. Before a disaster, social media helps communities to prepare, during a disaster social media aids communication, and after a disaster, social media helps communities to reunite and improve capabilities in recovery efforts and aid distribution.

Social media becomes the link between the affected public, family and friends. This, in turn, has expanded the predictive capabilities of crisis communication theory. Research has revealed the causal impact of various aspects of crisis communication, such as message content, communication channels, tone, as well as nonverbal behavior, on post-crisis reputation (Claeys et al., 2010; Coombs and Holladay, 2009; De Waele et al., 2018; van der Meer and Verhoeven, 2014). In virtual public spaces, these aspects do not stand alone, but rather are integrated into the actual crisis response.

Crisis communication is a field of study that focuses on how organizations, governments, or other entities manage, respond to, and mitigate the impact of crises through effective communication strategies. When a crisis occurs, organizations must take immediate and appropriate action to control the situation and ensure that the correct information is conveyed to the public. At this stage, the speed and accuracy of communication become a key factor in preventing confusion and panic in the public. By utilizing big data, organizations can access real-time information about the development of the crisis, including information dissemination patterns, public reactions on social media, and public perceptions of the ongoing situation.

This data analysis allows organizations to determine the most effective communication strategy, whether through social media, press conferences, or other official communication channels. In addition to the technical aspects, the success of a crisis response also depends on how the organization demonstrates empathy, transparency, and credibility in every statement delivered. Using clear language, providing accurate information, and acknowledging problems can help maintain public trust and ensure that the public remains well-informed in emergency situations. Effective communication must follow several key principles to ensure that information is well received by the public and avoid panic. Openness and transparency are important aspects, where any information provided must be clear, accurate and timely to prevent the spread of misinformation that can worsen the situation. In addition, speed of response is also crucial, especially by utilizing real-time data from social media that allows organizations to respond more quickly to public perception and address the various narratives that develop. In every crisis communication, organizations must show empathy and care, use humane language and pay attention to the conditions of the victims and the affected public so that the message is better received.

Consistency of information must also be maintained, avoiding contradictions in message delivery so as not to cause confusion or distrust from the public. for example, in the event of an emergency, the government must consider the words "siaga," "awas" and "waspada". In addition, effective crisis communication must be supported by big data analysis, which helps in understanding communication trends and adjusting communication strategies to evolving conditions. In addition, effective crisis communication should be supported by big data analysis, which helps in understanding communication trends and adapting communication strategies to evolving conditions. By following these principles, organizations can better manage crises, maintain public trust, and minimize the negative impact of the situation.

By adopting big data in crisis communication, this research seeks to improve the effectiveness of information management in disaster situations. The integration of big data analytics and social media-based communication can accelerate crisis response, increase public engagement, and reduce information uncertainty. Thus, a data-driven crisis communication approach can be a solution to overcome communication challenges in modern disaster response.

These findings will add a more qualitative and in-depth understanding of the existing body of knowledge on crisis communication. When all the elements that have previously received significant research attention are combined in a real crisis response, which elements do the public pay the most attention to and why?
Many studies, after years of focusing on the impact of discrete strategies, are now taking a broader view of how the public actually understands and assesses the crisis response as a whole?

2. Literature Review

2.1. Big Data of Social Media for Disaster Management

Utilizing big data from social media can be used to improve communication before, during, and after a disaster (Houston et al., 2014). The development of Big Data systems to assist disaster management efforts began to grow significantly. The United States and Japan started joint research in this area, especially focusing on earthquake and tsunami mitigation. Social media also acts as a peer-to-peer or backchannel communication tool, where users not only receive but can also share information, thus increasing the social capacity to generate and disseminate information (Xiao et al., 2015).

Studies on the utilization of data from social media in disaster management have only begun to be reported in recent years, especially after the emergence of real-time information services such as Twitter (Vieweg et al., 2010). According to Lindsay (2010), social media ranks as the fourth most popular source of emergency information. Efficient integration, aggregation and visualization of big data, especially from social media, are important elements in accelerating responses to disaster situations.

One of the main benefits of Big Data in crisis communication is its ability to monitor public sentiment and public perception of a crisis. Through Natural Language Processing (NLP) and sentiment analysis, organizations can identify the level of public anxiety, distrust or satisfaction with the actions taken (Xiao et al., 2015). In addition, Big Data enables more accurate and rapid information dissemination, thereby reducing the impact of hoaxes or disinformation that often appear during a crisis.

Data processing algorithms can be used to detect fake news circulating on social media and prevent its further spread (van Atteveldt & Peng, 2018). By analyzing public communication patterns, organizations can also identify key actors influential in information dissemination and ensure that valid information reaches the wider public more effectively (Coombs & Tachkova, 2019).

Furthermore, the use of Big Data in crisis communication enables the optimization of crisis response strategies. By collecting and analyzing real-time data, organizations can evaluate the effectiveness of their communications and adjust their strategies to deal with evolving crisis dynamics (Grimmer & Stewart, 2013). The use of predictive analytics also helps in estimating the potential escalation of a crisis based on historical patterns, so that mitigation steps can be taken earlier to reduce the wider negative impact (van der Meer, 2016).

Once the crisis has subsided, the data that has been collected during the response phase can be used to evaluate the effectiveness of the communication that has been carried out. Through retrospective analysis, organizations can learn about public interaction patterns, the impact of the communication strategies implemented, and identify areas for improvement in future crisis responses (Wallach, 2016). Thus, the use of Big Data in crisis communication not only helps in responding to emergency situations, but also contributes to organizational learning in improving preparedness for future crises.

2.2. Response Phase

In the disaster response phase, quick and appropriate action is crucial to the success of rescue and mitigation of disaster impacts. In recent years, social media (SM) has become an important source of communication in disseminating information related to disaster management. One example of the successful utilization of social media in emergency communication is the Code Maroon system developed by Texas A&M University through Twitter. This system allows the dissemination of alerts to thousands of people in a short time after an emergency occurs (Villarreal & Sigman, 2010).

Humanitarian organizations and authorities are increasingly encouraged to use social media to disseminate information about needs and developments in disaster situations. In addition, Big Data analysis of social media plays an important role in building passive and active situational awareness, which is a major factor in the effectiveness of crisis response.

Real-time data analysis from various social media platforms can improve various aspects of disaster management, such as helping emergency responders identify the areas most in need of assistance, determine the most crucial resources, and choose the most effective treatment methods. Thus, the integration of Big Data in the disaster response phase not only improves communication efficiency, but also supports more informed decision-making in dealing with emergency situations.

In crisis management, the response phase is a critical phase where organizations or governments must act immediately to control the situation and deliver accurate information to the public. The utilization of Big Data in crisis communication is growing, enabling real-time analysis of communication and assisting in the formulation of more effective communication strategies (Houston et al., 2014). With the amount of data generated from various digital platforms, such as social media, online news, and public reports, Big Data can be used to monitor public sentiment, detect the spread of misinformation, and adjust communication strategies based on the dynamics of the crisis (Vieweg et al., 2010).

2.3. Crisis Situation Assessment

A conceptual approach in crisis management studies that focuses on how a crisis is assessed based on the level of responsibility assigned to the affected organization. This concept has been widely developed in crisis communication research, especially within the framework of Situational Crisis Communication Theory (SCCT) proposed by W. Timothy Coombs (2004, 2007). In his theory, Coombs explains that crisis assessment depends on the extent to which the public attributes responsibility to the organization experiencing the crisis.

This evaluation is based on three main factors, namely locus of control, which determines whether the cause of the crisis comes from inside or outside the organization, stability, which measures whether the crisis is incidental or recurring, and controllability, which assesses the extent to which the organization can overcome and prevent further crisis impacts. By understanding these factors, organizations can design appropriate crisis communication strategies to mitigate negative impacts and maintain public trust.

Crises often have broad and significant social impacts, making them events of great interest to the media and the public. Therefore, various actors intensively communicate about the ongoing crisis situation (Thelwall & Stuart, 2007). As most people do not directly experience the event, they tend to rely on social media and online news to understand the situation, find out the causes of the crisis, and explore its impact and possible solutions (van der Meer, 2018).

Due to their complex nature, crises are often difficult to understand immediately, so the need for accurate and credible information remains high over a longer period of time. As a result, large amounts of both text-based and visual communications become widely available, especially through social media platforms (van der Meer & Verhoeven, 2013; Ott & Theunissen, 2015; Madden et al., 2016). With the availability of large amounts of digital data, computational approaches have become a highly effective method of analysis for understanding

communication dynamics during crises. These analyses enable large-scale studies of actual social behavior in emergency situations (van der Meer, 2016; van Atteveldt & Peng, 2018).

3. Method

In the context of digital communication, the infinite flow of information creates great opportunities for researchers to analyze big data using computational methods. Especially in natural disaster situations, communication patterns become very complex, where information spreads rapidly through various networks. Previous studies (Dong et al., 2018; Pourebrahim et al., 2019; Liu et al., 2020) show that in emergency conditions, information can spread through social media, news platforms, and other communication channels with dynamics that are difficult to predict. This shows that it is important to understand how official and unofficial information is spread, how social media algorithms affect its spread, and how public sentiment develops towards policies implemented by authorities.

This research utilizes big data from the distribution of information that occurs on Twitter social media to analyze communication patterns in crisis situations. The data collection process was carried out during the period June 2022 - June 2023, with the results showing that there were 14,083 tweets related to the topic under study. This data reflects the intensity of public conversations, the dynamics of information dissemination, as well as the potential for the spread of misinformation and disinformation in certain contexts.

Through big data analysis, researchers identified patterns of information dissemination, how public sentiment evolves over time. The use of computational methods, such as automated text analysis, natural language processing (NLP) enabled this research to uncover key trends and relationships between various entities in discussions on social media. The results of this research are expected to provide valuable insights for policymakers, humanitarian organizations, as well as related parties in designing more effective communication strategies in handling crisis situations.

Through computational methods such as sentiment analysis, predictive modeling, and machine learning, researchers are gaining deeper insights into how the public responds to crises, as well as the effectiveness of communication strategies used by governments and related organizations. Thus, the application of big data and computational methods is a very important tool in understanding the dynamics of communication in various types of crises, including natural disasters, in order to improve the effectiveness of response and mitigation in the future.

4. Results

4.1. Worst-Case Scenario in Crisis Communication

In a worst-case scenario, failure to utilize big data and social media in crisis communication can worsen the social impact of a disaster. One of the main threats is the uncontrolled spread of misinformation and disinformation, especially in situations where official information is unavailable or delivered late. When the public is deprived of accurate and timely information, they tend to seek alternative sources on social media, which are often filled with speculation, hoaxes and narratives that can exacerbate panic (Lazer et al., 2018).

In natural disaster situations such as earthquakes or tsunamis, delays in data processing and analysis can cause government agencies and humanitarian organizations to fail to identify the most affected areas. This can result in delays in aid delivery, increase the number of casualties, and fuel public distrust of responsible authorities (Vieweg et al., 2010). Without a big data-based detection system capable of analyzing communication patterns on social media in real-time, governments and relevant organizations may lose control of the crisis narrative, allowing rumors to spread faster than official information (Cinelli et al., 2020).

Communicators in these crisis situations often have a tendency to exaggerate danger scenarios in order to scare the public into action. While this approach can sometimes work, there is a risk that the public will overreact. When they eventually find out that things are not as bad as they were portrayed, this can lead to distrust of the information

provided. A more appropriate approach to dealing with emergency situations, especially in worst-case scenarios (Sandman, 2004).

Ineffective responses in an earthquake disaster crisis can worsen the impact of the disaster, especially if there are delays in information dissemination, lack of coordination between actors, and failure in timely mitigation and evacuation. Disinformation and the spread of fake news through social media in earthquake situations can exacerbate public panic, trigger impulsive actions, and increase the risk of casualties due to chaos and errors in decision-making.

Failure to coordinate between government agencies, humanitarian organizations and volunteers in the distribution of aid and evacuation of victims, exacerbated by communication and logistics disruptions due to infrastructure damage, can hamper effective disaster response and increase the risk of a humanitarian crisis. Preparedness, accurate information dissemination and effective coordination between actors are crucial factors in the response to an earthquake disaster crisis to prevent public distrust, minimize casualties and avoid a widespread humanitarian crisis.

Therefore, in a worst-case scenario, failures in the integration of big data and crisis communications not only risk exacerbating the impact of a disaster, but can also lead to social instability, decrease the effectiveness of emergency response, and prolong the recovery period. To prevent this, more responsive, data-driven communication strategies and effective real-time monitoring systems are needed to ensure that information circulating in the community actually supports crisis mitigation and recovery efforts (van der Meer, 2018).

4.2. Disaster Crisis Response Sentiment

Twitter in particular becomes an extremely useful resource during crises and disasters, given its ability to provide real-time updates to a wide public. This research also explores the possibility that the Twitter medium has not been optimally utilized by first responders, i.e. disaster stakeholders and provides recommendations for using the medium to mitigate the impact of crises and disasters.

The results of the response content data analysis during the period June 2022 - June 2023 show that there were 14,083 tweets discussing the crisis that occurred. This data reflects the high intensity of public discussion on social media related to issues that developed during the crisis. Through big data analysis, it is possible to identify communication patterns, public sentiment, and the main topics of public concern. In addition, this data also helps in understanding how public perception evolves over time and how crisis communication strategies that have been implemented by various parties impact public opinion.

The following word cloud visualization was generated from a Natural Language Processing (NLP) analysis of 14,083 tweets collected during the period June 2022 - June 2023. The results of this analysis illustrate the pattern of public communication on social media related to crises, especially earthquake disasters can be seen in Figure 1, as follows:
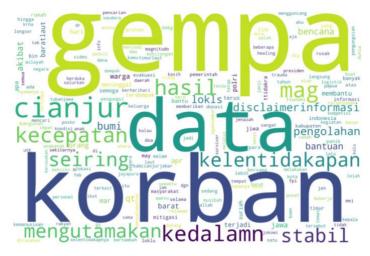
Figure 1: Visualization of Public Response Wordcloud
Source: Researcher processing, using Natural Learning Processing

The analysis of 14,083 tweets collected during the period June 2022 - June 2023 shows that crisis-related conversations, especially natural disasters, have complex communication patterns. Based on the word cloud generated, dominant words such as "gempa," "korban," "data," "Cianjur," and "bencana" confirm that the main focus of discussion on social media revolves around the earthquake event and its impact on the public.

The words "korban" and "bencana" indicate that the public is very concerned about the number of victims and their condition after the incident. Meanwhile, the words "data," "pengolahan," and "disclaimer informasi"highlight the importance of transparency and data accuracy in crisis reporting. This is in line with the emergence of the terms "kecepatan" dan "stabil" which indicate that the public is concerned with the speed of information dissemination as well as the unpredictability in the development of reports.

In addition, the words "mengutamakan" and "kedalaman" indicate an expectation of prioritization of disaster management and attention to technical factors such as the depth of the earthquake. Locations such as "Cianjur" were mentioned a lot, indicating that disasters in the area were one of the dominant topics of conversation.

The Cianjur 2022 earthquake disaster highlights the urgency of improving big data-based crisis management and digital communication in disaster mitigation and response in Indonesia. By leveraging real-time data analysis from social media and disaster monitoring systems, the government and relevant agencies can optimize faster, more transparent and effective crisis communication strategies to reduce social impact and build public trust in disaster management efforts.

Analysis showed that the majority of responses had negative sentiment (12,947 tweets) compared to positive sentiment (1,136 tweets). This predominance of negative sentiment is most likely triggered by factors such as information uncertainty, the magnitude of the impact felt by the public, and expectations of the government and related institutions in responding to the crisis quickly and accurately.

The results of the analysis, which showed 1,136 positive tweets and 12,947 negative tweets, indicate that public sentiment towards the crisis was dominated by negative reactions. This predominance of negative responses could indicate several things:

1. Public Dissatisfaction - The majority of the public is dissatisfied with the way the crisis was handled, both in terms of the government's response, the organization, and the communication delivered.
2. Lack of Trust - A high level of negative sentiment can be an indication that the public is experiencing a crisis of trust in those responsible for handling the situation. This can be caused by a lack of transparency, delays in information, or inconsistencies in statements.
3. Spread of Misinformation - It could be that much of the information circulating on social media is inaccurate or has been twisted, worsening public perception of the crisis.

4. High Emotional Impact - Crises often trigger strong emotional reactions, especially if they directly affect the public. High negative reactions can indicate that the public feels threatened, disappointed, or angry about the situation.

With this dominance of negative sentiment, it is imperative for relevant parties to immediately implement more effective communication strategies, such as increasing information disclosure, responding more quickly to public criticism, and educating the public to counteract misinformation. If not addressed immediately, protracted negative sentiment could exacerbate the crisis and prolong the social impact.

5. Discussion

An approach in crisis communication research that looks at crisis response strategies as a whole allows for a more comprehensive understanding of the impact of each strategy than a unidimensional approach. By examining each strategy separately, researchers can analyze how they affect public perceptions of organizational responsibility, crisis severity, and the reduction of negative emotions such as anger (Fediuk et al., 2010). The results of this study emphasize that each crisis communication strategy has a specific function and can be applied according to the needs of the situation at hand.

Based on the various theoretical concepts that have been reviewed, it can be concluded that communication responses in crisis situations must be strategically designed by considering various factors, including transparency, speed, and effectiveness in managing public perception. Disaster crisis management emphasizes the importance of preparedness and rapid response in dealing with crises, while the Crisis Situation Assessment approach shows that each communication strategy has a different impact on public reception and reaction.

A big data and natural language processing (NLP) analysis of 14,083 tweets over the period June 2022 - June 2023 revealed that most public responses to the crisis were negative (12,947 tweets), with only a small proportion showing positive sentiment (1,136 tweets). This suggests that public perceptions of crisis management are still dominated by dissatisfaction, distrust or concern about the steps taken by relevant parties.

From the results of the word cloud analysis, it was found that the words that appeared most frequently in crisis discussions were "gempa," "korban," "bencana," and "dampak," indicating that public attention was mostly focused on the consequences of the disaster and the condition of the victims. In addition, words such as "kecepatan," "informasi," and "pengolahan data" indicate a high expectation from the public for a quick and accurate response from the responsible parties.

In an academic context, this research reinforces the argument that effective crisis communication should be data-driven and consider the psychological and emotional factors of the public. By applying big data and NLP-based approaches, organizations can better understand communication trends during a crisis, identify public sentiment, and adjust communication strategies to mitigate negative impacts and rebuild public trust.

Further research is needed to understand how these various strategies contribute to dealing effectively with crises, with all the more complex aspects of disaster crisis communication, including: Mitigation, Planning, or Recovery or maximizing the application of crisis management.

6. Conclusion

Big data and social media have become key elements in crisis communications, enabling faster, more transparent and data-driven responses in emergency situations. Big data analytics, especially through social media, plays an important role in real-time monitoring, misinformation detection and the formulation of adaptive communication strategies, supporting more accurate decision-making during the crisis response phase. The research findings show that negative sentiment dominates public communication during crises, often fueled by dissatisfaction with disaster management and a lack of trust in authorities.

Data-driven, responsive communication strategies that take into account the psychological and emotional factors of the public are crucial in managing public opinion, easing panic, and rebuilding trust. With a more strategic and technology-based approach, the effectiveness of crisis management can be improved, ensuring accurate and timely information is delivered to the public.

These worst-case scenarios emphasize the importance of a balanced approach to utilizing big data for crisis response. While technology offers useful tools in disaster management, over-reliance without backup plans for system failure, control of misinformation, ethical considerations, and fairness in algorithms can lead to serious consequences.

Therefore, integrating conventional crisis management practices, improving people's digital literacy, and ensuring robust validation mechanisms in big data analysis are crucial steps in mitigating risks and increasing resilience in the face of disasters.

7. Implication

The results of this study have far-reaching implications for crisis communication management, especially in the face of the dominance of negative sentiment in public responses. From a crisis management perspective, the findings confirm the importance of responsive, transparent and empathy-based communication strategies to reduce public uncertainty. Organizations and governments must be more proactive in delivering accurate and fast information to reduce panic and build public trust. In terms of public policy, this research shows that social media plays a major role in shaping public opinion during a crisis. Therefore, regulations related to disaster communication need to be strengthened, including monitoring hoaxes and disinformation that can worsen the situation.

In the context of digital communication strategies, the utilization of NLP (Natural Language Processing) analysis becomes highly relevant to understand public sentiment in real-time. With this data, organizations can tailor communication messages to be more effective and in line with public needs. The dominant words in online discussions can be a guide in designing more relevant messages, so that the information conveyed is more easily received. In addition, from an academic perspective, this research contributes to the development of big data-based crisis communication studies, opening up opportunities for further research into the factors that influence public perception of crises as well as the effectiveness of various communication strategies in handling them.

Overall, this research confirms that in the face of a crisis, organizations and governments must not only act quickly but also ensure that the communication strategies implemented are able to build trust and ease public anxiety. With a data-driven approach and in-depth analysis of public sentiment, crisis response can be more targeted and effective in dealing with the dynamics of growing opinions, so as not to experience the worst scenario of a disaster crisis situation.

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