

ORIGINAL ARTICLE

Technology Potential in Improving Disaster Response Communication: A Qualitative Study in Malaysia

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ABSTRACT

Introduction: Malaysia is a flood-prone region covering around 232,001 km² of the total land area resulting in floods being the most frequent disaster in the country. Major Flood 2021 highlighted persistent challenges in disaster response, particularly in communication and coordination, despite the country's extensive experience with such events. This study aims to explore communication challenges and the potential of technology to enhance disaster response communication among Malaysian disaster responders. **Materials and methods:** A qualitative study (In-Depth Interviews - IDI) was used to examine the perspectives of disaster responders in Malaysia regarding disaster communication. Operational and management teams were selected from relevant agencies, adhering to Malaysia's disaster management policy. Employing snowball sampling, 18 respondents were interviewed, addressing topics of current communication tools, challenges, and suggestions for enhancing inter-agency communication during disaster response. **Results:** Disaster responders in Malaysia utilize various communication tools, including the Government Integrated Radio Network (GIRN), and yet not fully leveraged global technological advancements in disaster response. Consequently, challenges in disaster response communication persist, encompassing both technological and organizational factors. Responders provided valuable recommendations for improvement, emphasizing the need for a unified system, centralization, enhanced GIRN utilization, and continued technology adoption and modernization. **Conclusion:** This study reveals challenges in disaster communication during the response phases and highlights weaknesses in preparedness, noting their interconnection. It emphasizes the critical role of technology in disaster response communication and the necessity of authoritative support to unlock its potential through strategic investment and policy improvements. A standardized communication system is also recommended for future improvement. *Malaysian Journal of Medicine and Health Sciences* (2025) 21(3): 51-62. doi:10.47836/mjmhs.21.3.8

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INTRODUCTION

Flood is defined as an overflow of water on a normally dry land resulting from an increase in water level in an existing waterway (1). Flooding has historically been Malaysia's most frequent and devastating water-related disaster, largely due to the country's extensive flood-prone areas, which cover around 232,001 km² of the total land area, hence, disaster particularly flooding is projected to be happen more often, and the impact for sure will be worsened. (2).

In response to the devastating 2014 floods, Malaysia established the National Disaster Management Agency (NADMA) in 2015 as the focal point agency for Disaster Risk Management (DRM). However, the subsequent floods of December 2021 highlighted ongoing challenges in

disaster management and planning. Ineffective response efforts led to widespread frustration (3, 4). Factors such as unclear organizational roles, inadequate information management, and poor coordination compounded the crisis (5). While global attention has rightly focused on strengthening community preparedness, Malaysia must also prioritize effective disaster response as response time, resource management, and coordination play pivotal roles in minimizing casualties and damages during disasters (6).

The National Security Council (NSC) Directive No. 20 on the National Disaster Management Policies and Mechanisms provides a comprehensive framework for national disaster management and relief. The document outlines the roles and responsibilities of government agencies within an integrated emergency management system and emphasizes the importance of a robust communication infrastructure. The communication infrastructure during the preparedness and response stages of disaster management is multifaceted, involving various agencies and systems to ensure effective

coordination and information dissemination at all levels of incident response. The document emphasizes the importance of establishing a disaster early warning system and utilizing the Government Integrated Radio Network (GIRN). In the preparedness phase, the focus is on creating a robust early warning system tailored to specific jurisdictions. This involves enhancing communication capabilities and technology to ensure that all response efforts are coordinated and efficient. During the response phase, operational control becomes crucial. A Disaster Operation Control Centre (DOCC) is activated to oversee the response, facilitating a reliable communication network with Control Posts on Scene (CPS) to ensure a smooth flow of information. Additionally, effective communication at the incident site is paramount. The document stresses the need for an active communication system among rescue and support agencies, using the GIRN as a vital tool for the Disaster Operation Commander to manage the situation on the ground effectively (7).

Effective disaster response necessitates timely and accurate information transfer from the disaster site to response teams. Robust communication plans and technologies are essential. Malaysia employs a variety of communication tools, each with its strengths and limitations. The universal emergency number (999), government radio network, and internet-based platforms are commonly used (8). The universal emergency number 999 provides public access to emergency services. While user-friendly, it suffers from inter-agency coordination issues and reliance on manual processes. Malaysia has deployed 2 types of radio network with nationwide radio coverage which are GIRN and Royal Malaysian Police network (RMPnet). These networks have supported the government agencies in emergency response activities. GIRN offers a dedicated, resilient communication network for government agencies, enhancing collaboration while preserving operational independence (8, 9).

Rapid technological advancements have encouraged the adoption of internet-based communication platforms for disaster management. Social media and messaging apps such as WhatsApp have become valuable tools for information sharing, offering speed, accessibility, and cost-effectiveness. However, the application of this platforms is tempered by the potential for misinformation dissemination. These platforms often complement traditional systems like GIRN, enhancing overall communication capabilities (8). In context of emergency response during covid, messaging is being used as part of Covid-19 emergency responses in a few country such as Bhutan and India. messaging is likely being used at local level as part of great initiatives (10). While Malaysia has made progress in disaster management, challenges persist as previous literature emphasizes the need for improved coordination, robust data management, and reliable communication technology which are crucial

for effective disaster response (8, 11).

The Sendai Framework for Disaster Risk Reduction (2015-2030) emphasizes the importance of prevention, technology, and resilience (12). It is evident that technology has a significant impact on disaster management. With the continuous advancements in technology, there is an increasing demand for technology to contribute significantly to sustainable disaster management (13). By integrating technology into disaster management strategies, Malaysia can significantly improve its response capabilities and build resilience.

Thus, despite technological advancements and opportunities, challenges persist in effective disaster response communication. This study addresses this gap by examining how technology can enhance communication during disaster response in Malaysia. Through In-Depth Interviews (IDI) with disaster responders, this study aims to understand the current state of disaster communication, identify challenges, and explore technology potential solutions during disaster response between disaster responders. The findings of this research will contribute to the development of more effective disaster management strategies.

MATERIALS AND METHODS

A qualitative study was conducted and employed IDI to explore the current state of disaster communication, identify challenges, and explore technology potential solutions during disaster response between disaster responders. Respondents comprising operational and management teams actively engaged in disaster and emergency response activities, were selected based on criteria outlined in the NSC Directive No. 20 (7). Utilizing the policy's guidelines, connections with directors and senior officers of relevant agencies facilitated respondent selection. Additionally, snowball sampling was utilized to expand the respondent pool. In total, 24 disaster responders were contacted and only 18 of them were interested to participate in this study and successfully interviewed. Information saturation was achieved after the final 2 to 3 interviews, indicating no new themes emerged at that stage and the goals to understand the aim of this study were achieved (14).

Prior to commencing the session, participants were provided with a comprehensive explanation of the study, including their rights as research subjects. To formalize their agreement to participate, participants signed a consent form. Sessions were scheduled flexibly, accommodating responders' availability either in-person or through online sessions via the Zoom application. The interview duration ranged from 30 minutes to 1 hour, conducted between June and October 2023. Interview questions addressed various aspects, including current communication methods and tools used, challenges,

and suggestions for improvement. All interviews were recorded, transcribed, and iteratively analysed for emerging themes using Atlas.Ti software.

Ethical Clearance

The study received ethical approval from the Ethics Committee for research involving humans from the Faculty of Medicine and Health Sciences (Ref. No.: JKEUPM-2023-345).

RESULTS

This study investigates the current state of disaster response communication among responders in Malaysia, focusing on the use of technology including the methods and tools. The research aims to identify gaps in disaster response communication and explore potential technological solutions to enhance disaster response effectiveness. By gathering insights from responders, recommendations were developed for improving communication strategies and technologies.

1. The Current Way Of Communication Used Among Disaster Responders

1.1. Radio Network and Internet-Based Communication Platforms

Disaster responders in Malaysia use various communication technological approach to coordinate and respond during disasters. During interviews, responders were queried about the communication methods and tools utilized for inter-agency coordination and reporting during disaster incidents. As noted earlier, government agencies extensively utilize radio networks, such as GIRN and RMPnet, as critical communication tools during disaster response operations. Many highlighted the use of key tools like the GIRN established by NSC as a dedicated communication network. Additionally, the WhatsApp application is commonly used for quick and direct communication, allowing responders to exchange update instantly. These ways of communication are utilized both internally and externally by agencies.

Some of the respondents stated that:

"Our communication method during disasters involves the use of GIRN. However, with the existence of the WhatsApp application, it has become common to send reports using this platform." - Respondent 4

"In general, we use 2-way radio for communication. Once we have finished our work and regained access to technology, we will utilize the WhatsApp application to create a Situational Report (SitRep)." - Respondent 8

The responders also expanded their use of tools like the Zoom application, suggesting a trend towards virtual collaboration resulting from the string of normalization following the recent pandemic.

One respondent stated:

"First is to use the WhatsApp application, the second

is the Zoom meeting application, and the third is radio communication. These three tools are essential, and not forget the physical meeting." - Respondent 8

Some respondents also have indicated their utilization of walkie-talkies, satellite phones, and amateur radio. Additionally, it was mentioned that the utilization of cutting-edge technology, like drones, can be beneficial. Such technology could capture on-site situation to improve reporting data and improve disaster response communication among inter-agencies.

"These days, responders rely on communication tools provided by their teams to communicate with each other within the agency. The GIRN facilitates communication among various agencies. Furthermore, there are various types of mobile devices such as satellite phones, amateur radios, faxes, and drones." - Respondent 25

2. Current Challenges in Disaster Response Communication

To identify the current communication challenges, the responders were asked about issues with current communication methods. Several key issues emerged, categorized into technological and organizational factors.

2.1. Technological Factors

In the context of technological factors, the main findings highlight various concerns, including network coverage issues, the lack of standardized systems, and doubts about the reliability of disaster communication tools.

2.1.1. Network Coverage Issues

Expanding on the context of network coverage issues, a significant finding has emerged regarding the utilization of the GIRN. The problem with network coverage underscores the urgent need to address connectivity issues to improve the efficiency of disaster communication tools and systems.

Some respondents share their concerns,

"We have GIRN. Unfortunately, it is not feasible for the headquarters to reach out to every district in Malaysia due to the large number of districts, which exceeds 150. When something occurs, certain regions, particularly remote areas, may not have coverage and therefore remain uncovered." - Respondent 7

"Our usage of GIRN reveals certain gaps that need to be addressed. There are specific regions (area) that we are unable to reach." - Respondent 21

2.1.2. Absence of Standardized Systems

There are some difficulties when it comes to standardizing reporting, as different agencies have varying situational reports that lack uniformity. This lack of centralization can result in data inaccuracies. This is a highly debated topic among disaster responders.

The respondents brought attention to:

"in terms of reporting, right now we are still using what I consider to be manual. Although they send it in Excel form and such, there is honestly no system. That is our weakness" – Respondent 21

"Reports are delivered individually, rather than being combined into a single system where you receive a unified report. They need to collect it at that location. So, when it involves a different agency, it automatically becomes a different report." – Respondent 18

2.1.3. Reliability of Disaster Communication Tools

GIRN have faced criticism for their inconsistency in functionality, durability, and capacity, despite being crucial tools used during disasters. GIRN equipment is scarce, which is having an impact on the overall communication capacity. There is a lack of consistency in the performance of GIRNs, resulting in different agencies using the tools in different ways.

"GIRN, some are functional, some are not. There is no perfect system. So, there are agencies that fully use GIRN, some agencies use it occasionally, and sometimes they don't" – Respondent 12

Certain GIRNs may exhibit sensitivity and lack durability, which can impact their reliability in demanding conditions. Based on the feedback from the participants: *"This GIRN is sensitive. Because not all GIRN devices are durable, they are sensitive to water and other factors"* – Respondent 16

2.2. Organizational Factors

When considering organizational factors, the study reveals a range of obstacles including unclear agency roles and responsibilities, insufficient resources and capabilities, and the prevalence of misinformation.

2.2.1. Unclear agency's role and responsibilities

Respondents noted communication gaps in Malaysia's disaster response, including unclear roles and information inconsistencies:

"not necessarily all reports that provided accurately for a particular disaster. For example, it is clear that the data provider such as the number of victims at the evacuation centre comes from the Social Welfare Department (JKM). A slight issue arises regarding the data collected from outside the evacuation centre, where the data are coming from various sources such as the police (PDRM), the fire department (Bomba), and so on. The exact number of rescued victims is uncertain because it involves various parties" – Respondent 12

There seems to be a lack of clarity regarding the roles of the agencies involved, leading to inaccuracies and redundant data due to the information provided by different agencies. In addition, there are concerns regarding command confusion, where conflicting instructions from multiple superiors can disrupt workflow and hinder response efforts.

Respondents stated:

"...because those who carry out the work are the ones responsible for its execution, we receive reports or instructions from officers. We carefully adhere to and complete the instructions. When the instructions from one officer differ from those of another officer, that is the actual problem" – Respondent 15

The interviews uncovered intriguing insights into the attitudes of the agencies regarding their roles and responsibilities. It was noted that certain agencies tend to strive for greater visibility, likely influenced by the unique nature of their work in this specific field.

Some responses from the respondents:

"so, even though sometimes we say that understanding for each agency is important, we must not forget that each agency has its ego. Each wants to stand out. It is not that they actually want to, maybe it is because the Malaysian administrative management system itself has caused if the agency stands out, it signifies they are doing work, and they will receive additional funding" – Respondent 7

2.2.2. Inadequate human resources and capabilities

This study has discovered there are insufficient human resources. One major issue that arises on-site is the insufficient availability of personnel to efficiently provide situational reports. As a result, the delivery of situational reports becomes inefficient because there are no dedicated personnel responsible for sending the reports.

Respondents stated:

"data gain and human resources. Related to individuals managing and monitoring the situation at the State or District level. These are factors that may cause delays in delivering reports" – Respondent 12

"I waited in the operations room, but there were no reports. So, I had to chase after the officer, but the officer was busy in the field" – Respondent 9

Furthermore, there are certain challenges related to individual competencies that arise, where some individuals face difficulties in effectively utilizing technology, which in turn affects their overall capabilities.

Respondents mentioned:

"Sometimes the problem arises when using GIRN, where someone changed the channel (channels get mixed up). When calling (using GIRN), there is no response. When trying to communicate with people at the scene, they might not be using the correct channel designated for operation" – Respondent 6

The change of personnel within an agency introduces challenges, as individuals who have not previously utilized or lack competence in communication tools

may encounter difficulties. Furthermore, the new personnel may face obstacles in adapting to the use of these tools, contributing to a potential disruption in effective communication within the agency. There is great potential in utilizing new emerging technologies in disaster management, but unfortunately, these opportunities are overshadowed by several challenges.

Some of the remarks highlighted by respondents:

“when there is no telecommunication service, and we introduce to them how to use the 2-way radio, they may struggle to adapt to new things and cannot use it efficiently. So, it will lead to communication errors” – Respondent 8

“and also, when there is a change in members, the existing members may not be skilled in using that communication tool” – Respondent 6

2.2.3. Misinformation and Data Integrity

The respondents expressed concerns regarding the data that was provided. There seems to be an issue with either incorrect data or insufficient data provided. Ensuring data accuracy in disaster response poses challenges due to the various reporting stages involved. As a consequence, the data that is reported can quickly become outdated due to the time it takes to report.

Respondent stated:

“it will become a problem if, for example, in each region like the East Coast Pahang, Terengganu, Kelantan, there might be one centre in Terengganu, but if the disaster happens and the PKTK is in Kelantan. In that situation, it could become an issue because there will be multiple layers (for reporting)” – Respondent 18

Furthermore, the lack of timestamps for organizing reported data may result in duplicated or overlooked information. Responders may choose to include or exclude certain data when reporting their findings.

Respondents indicated that:

“timestamps are not present. The numbers sometimes go amiss because of the absence of timestamps, and most worrisome is the creation of non-existent (numbers). The figures are faked” – Respondent 18

“the crucial aspect is when we report data, among the steps we take is to ensure that when we report the data, it must come with a ‘time’. There needs to be a data cut-off time. This data cut-off time is crucial for coordination. It prevents data mismatches” – Respondent 7

During the interviews, it became apparent that there had been deliberate manipulation of data. There are valid concerns that arise, especially when the data that has been manipulated is used for aid purposes. Using fabricated numbers undermines the accuracy and integrity of the data. Errors in data input and statistical misinformation can greatly complicate communication

in disaster response.

As highlighted by the respondents:

“Another thing is that data integrity is also crucial. There is an intention to take advantage, especially when that data is used for aid distribution” – Respondent 21

“for example, like when an agency reports that in a certain area, they say there is no food. But the thing is there. Sometimes, it is reported as not being there. So, these are the issues, issues that involve miscommunication between agencies” – Respondent 23

In addition, the lack of data sharing, as evidenced by challenges in sharing data between agencies, can result in inadequate and disjointed information, which in turn hinders effective disaster response.

Respondents mentioned that:

“in terms of data sharing that is most crucial. Usually, when any disaster occurs, any decisions we make are based on data. So, if we don’t share that data, it is actually quite difficult for the Disaster Chairman to make a decision” – Respondent 21

3. Disaster Responder Recommendation For Future Improvements

Based on the insights from the IDI, disaster responders offer valuable recommendations drawn from their extensive experience in disaster response. Specifically, they were requested to provide recommendations for enhancing interagency communication in times of emergencies.

3.1. Unified system and centralization

To improve disaster response capabilities, it is crucial to establish a unified system and centralize operations. It is crucial to create a cohesive system or central hub that facilitates smooth coordination among different agencies involved in disaster management. This approach promotes effective communication and optimizes efforts during important situations.

A few respondents suggested:

“next, perhaps another application. Nowadays, various software can be developed. Maybe we can create an application system, possibly from the earlier-mentioned drone. Information can be transferred and sent. So, we disseminate it through an application that will be used by responders” – Respondent 14

“the use of a Command Centre. A Command Centre with multiple video panels or TV panels that need to have weather forecasts.... Weather forecasts and other aspects inform the strength of each agency. Such information must be available, followed by geography and topography of the area in terms of population information, water areas flood hotspots, landslide hotspots, and others” – Respondent 7

In addition, it is essential to focus on creating new applications or systems to establish a strong communication platform for efficient reporting. Adopting cutting-edge technologies allows agencies to improve data collection, analysis, and dissemination, facilitating faster and more informed decision-making in emergencies.

This was supported by the respondents:

"in Malaysia, it needs to be centralized because different agencies will provide different figures, and we don't know when their last update was" – Respondent 18

"The delivery of reports can be synchronized. Is there a method for us to channel information directly from the field, and everyone can monitor it" – Respondent 21

There is a proposal to implement a new system with push notifications that highlights the importance of leveraging modern communication methods for early warnings. This system would greatly enhance response times and increase community readiness.

Respondents suggested:

"so, if we want to establish another warning system on every phone for all agencies, officers, and also victims, surely, we need additional investment. This warning system, like push notifications, will automatically receive notifications for designated danger zones" – Respondent 7

Another important aspect that was discussed is the improvement of data security through the use of more advanced encryption methods. This is particularly relevant considering the widespread use of platforms such as WhatsApp applications. Enhancing data protection measures is essential to maintain the integrity and confidentiality of sensitive information, which is vital for an efficient disaster response.

One of the responders suggested that:

"in terms of communication, I think for now, of course, we will use WhatsApp application. WhatsApp is the largest and easiest communication field. We can send pictures, videos, and so on. The only disadvantage of this application is the issue of data encryption, where everyone can access that information, and there is also an issue of information leakage. So, in the future, we hope to have encrypted communications" – Respondent 7

In addition, the inclusion of image sharing alongside traditional voice communication can greatly improve the clarity and depth of information exchange. This approach recognizes the significance of visual data in fully comprehending and addressing disaster scenarios. According to one of the respondents:

"so, when talking about communication, it doesn't necessarily have to be through voice conversations."

Communication can also be conveyed through the distribution of images. In fact, various countries worldwide have moved towards a more advanced, modern era. Therefore, the platform for information delivery should adapt according to technology" – Respondent 19

Hence, establishing a centralized system, developing advanced communication platforms, ensuring data security, and embracing multichannel communication are seen as vital steps in encouraging the effectiveness of disaster response efforts among the responders.

3.2. Improve GIRN utilization

The disaster responder recommendations emphasize the significance of enhancing the utilization of the GIRN for improved disaster response capabilities. The key areas identified including to enhance GIRN network coverage and ensuring its reliability in various situations.

The respondents suggested:

"If there is a suggestion regarding the use of GIRN, I think the coverage needs to be expended. Because sometimes the coverage is not available" – Respondent 6

"I mean, we need to broaden the signal, like how to expand the signal in the forest, if possible, to communicate casually. In terms of the signal, the signal needs to be studied, because in the sea there is no coverage yet, in thick forests, there is also no coverage" – Respondent 16

To improve GIRN utilization, comprehensive training session are proposed. These sessions aim to empower responders with the knowledge and skills needed for effective GIRN utilization.

Some suggestions that supported the point:

"training is also one of the improvement methods. Next, the improvement of existing assets. But for me, it is more about training. When we regularly conduct exercises like simulations, everyone is already aware when a disaster emergency occurs" – Respondent 12

"experience and training are essential.....we need to always be prepared and think about the worst-case scenario. So, if experience is not gained through actual incidents, at least we have knowledge of what we need to do when it happens, which is the most important thing" – Respondent 4

Through the training, the responder will be able to use terminology to give instructions and enhance the ability to give clear and precise instructions for effective communication. Clear and precise instructions are highlighted as essential, emphasizing the importance of sharpening communication skills to enhance operational efficiency.

Respondents stated that:

"First, we need specific training regarding communication with all involved agencies. Second, we need to expose all agencies to amateur radio or 2-way radio. Where everyone will know how to use it, need to teach everyone so it will be easy in the future" – Respondent 8

"I am more prefer towards tabletop exercise..... regarding the procedures for using the equipment and the terminology used. This is because using GIRN cannot be like talking on the phone. Members need to provide information shortly and concisely" – Respondent 6

These recommendations in terms of improving the GIRN utilizations aim to strengthen the GIRN infrastructure and the competence of disaster responders, with the overarching goal of ensuring a more effective and coordinated response to emergencies.

3.3. Technology adoption and continuous modernization

Respondents highlighted the importance of improving the integration and utilization of cutting-edge technologies, such as drones and satellite phones, to enhance communication effectiveness.

Respondents shared:

"I just feel that alternative might be satellite phones. I think our government does not yet have the satellite phones that we should have" – Respondent 13

"Perhaps one of the things we can use is drones. Drones are something crucial. Maybe for the future, we include this in the study" – Respondent 14

It is crucial to keep up with the latest technological advancements on a global scale, as the push for continuous modernization becomes increasingly important. Staying current with the latest technologies is crucial to ensure that the country's disaster response capabilities stay relevant and effective.

Respondents view:

"in the future, in line with the country and global modernization trends, we will follow technology and changes. In reality, various countries worldwide have taken steps into a more advanced, modern era. Therefore, the platform for information delivery should evolve according to technology" – Respondent 19

Moreover, embracing foreign technology and integrating it into our country poses no harm. It offers valuable opportunities for our nation to enhance its disaster response capabilities.

Respondents shared:

"I see this thing (INSARAG Coordination Management System-ICMS) can really go far. The implementation of

INSARAG at the national level, I don't know how serious it is. If the higher authorities initiate it, it will become a commitment for Malaysia" – Respondent 18

DISCUSSION

Communication Methods

Disaster responders in Malaysia use various communication technologies to coordinate and respond during disasters, with GIRN as the main communication method. It is worth noting that the communication approaches used within responder agencies in Malaysia may vary depending on the agency. Although the preference for platforms like WhatsApp and Zoom among disaster responders indicates a move toward integrating everyday communication technologies with traditional methods, most disaster responder agencies in Malaysia have yet to take full advantage of the latest technological advancements, as seen in other countries, to facilitate disaster response communication.

For instance, Japan is known for its technological ability and leading disaster management practices, has developed a diverse range of tools, including robots, drones, and intelligent sensors (15, 16). Japan has leveraged drones for various applications in disaster management, including facilitating communication and information sharing among emergency responders including transport of emergency supplies, and inspect on damaged facilities (17). Additionally, the country has deployed robots to enhance disaster response capabilities by providing reliable communication and navigation through mapping systems (18).

Communication Challenges

Previous research believed effective communication during disaster response is hindered by a complex interplay of technological and human factors (19, 20). While some studies categorize these challenges into technological, sociological, and organizational dimensions (21), the latter two often converge on human-related factors. These challenges manifest in communication breakdowns both within and between agencies involved in disaster response, and some includes community. While the specific categorization of human and sociological factors may vary across studies, their fundamental impact on communication remains consistent. Thus, in this study is focusing on both technological and organizational factors that may affect the effectiveness of disaster response activities, particularly in communication aspects.

Technological Challenges

Network coverage issues with GIRN and the lack of a standardized reporting system indicate significant gaps in Malaysia's disaster response infrastructure. The unreliability of GIRN raises concerns about whether Malaysia is sufficiently equipped for large-scale disasters, where communication breakdowns could cost

lives. Issues with network coverage frequently disrupt effective communication, a critical component of disaster response operations. Reliable network coverage is essential for maintaining dependable communication and ensuring the success of search and rescue efforts. In emergencies, the ability to rapidly deploy networks is key to facilitating these operations efficiently (22). Additionally, research underscores the importance of robust network infrastructure, which enables seamless communication and data exchange among emergency responders (23).

Moreover, the absence of a standardized reporting system compounds the challenges faced during disaster management. Currently, the situational reports some are manually generated, leading to inefficiencies and difficulties in coordination. Standardized reporting during disasters is vital for ensuring transparency, accountability, and informed decision-making. Such consistency not only enables easy comparison and quality improvement but also enhances communication between agencies. For instance, a study focused on improving disaster coordination developed a standardized template for reporting emergency surgery data, highlighting the benefits of uniformity (24). Similarly, research on Australian disaster data systems emphasized the importance of consistent reporting methods that align with international standards to increase the validity and applicability of disaster response policies (25).

Organizational Challenges

Confusion regarding roles and responsibilities is a common issue in disaster response systems globally, where multi-agency operations often face conflicting instructions. Establishing clear protocols and well-defined roles is crucial for improving inter-agency coordination and minimizing operational inefficiencies. A comprehensive understanding of the roles of various responder agencies, such as first responders and medical professionals, is essential for ensuring efficient disaster response and strengthening community resilience. Expanding the understanding of the roles of first responders, including medical personnel, is critical to enhancing disaster resilience (26, 27).

In some cases, the drive for visibility within certain agency cultures can lead to dissatisfaction and disputes, ultimately straining relationships between agencies. Maintaining positive rapport and a clear understanding of each other's responsibilities is key to fostering smooth coordination during disaster response. Effective collaboration and communication among agencies are vital for a successful response, as efficient emergency management heavily depends on cohesive teamwork (28).

The shortage of human resources highlights broader organizational challenges that can significantly weaken

disaster management efforts. Addressing these gaps requires more effective resource planning and targeted training programs. Adequate manpower and capabilities are essential for a successful disaster response. A key issue is the shortage of personnel and material resources, often caused by differing interpretations of the disaster among response teams. Ensuring sufficient resources is critical to maintaining organizational effectiveness during emergencies. Research on the impact of human resource capacity and policy in disaster preparedness underscores the vital role that well-trained and adequately staffed teams play in improving disaster response outcomes (29).

Data Management and Integrity

The challenges of misinformation and outdated data are critical in disaster management. Inaccurate information can result in the misallocation of resources and, in severe cases, loss of life. To overcome these issues, it is essential to implement real-time data management systems and ensure transparency across all involved agencies. Obtaining reliable, up-to-date, and accurate data is vital for effective disaster response. Timely and precise spatial data is particularly crucial in managing emergencies, as it enables quicker and more effective responses, ultimately reducing risks (30). High-quality data is important, as poor data can hinder decision-making and negatively impact disaster response efforts (31, 32).

Future Directions

Based on insights gathered from disaster responders through IDI, several valuable recommendations have been proposed for improving interagency communication during emergencies. Drawing on their extensive field experience, responders emphasized the importance of implementing a unified communication system and centralized operations, enhancing the utilization of GERN, and advancing technology adoption and continuous modernization. These suggestions align with global best practices in disaster management and reflect a forward-thinking approach to addressing communication challenges.

Past studies support these recommendations, highlighting the development of real-time collaboration systems to streamline disaster response (33). Effective coordination between different organizations remains a significant challenge, as responders and decision-makers require instant access to accurate, up-to-date information. Systems like ASSIST have been proposed to improve information access and interoperability among agencies (34), while UICDS demonstrates how incident management systems can enhance collaboration by enabling seamless information sharing (35). The need to implement such systems aligns with the global trend of utilizing advanced technologies to disseminate timely information efficiently (36, 37). These technological advancements are critical for ensuring more effective

disaster communication through improved information access and system integration.

Additionally, studies have emphasized the importance of strengthening telecom networks during disasters, underscoring the importance of preventing cascading failures in networks, which can disrupt connections and cause instability (38). Ensuring the resilience of communication networks through protective measures and recovery techniques is essential for maintaining stable connections during emergencies (39).

Another key aspect for future improvement is training. Enhancing communication practices through consistent and specialized training is crucial for fostering collaboration and coordination among agencies. Research supports the idea that well-designed training programs can bridge gaps in communication, ultimately leading to more effective disaster response (40). Such training benefits responders at all levels by equipping them with the skills needed and promotes effective emergency management (41).

The future of disaster response communication also depends on the integration of cutting-edge technologies. Drones, AI, and other advanced tools have the potential to significantly improve situational awareness and response capabilities (42). For instance, the ICMS system, designed for Urban Search and Rescue (USAR), offers a standardized and systematic approach to collecting and reporting information, supporting better coordination among multiple agencies involved in disaster response (43). These recommendations reflect a forward-looking approach, keeping pace with global technological advancements and recognizing the need for continuous innovation in disaster management.

Potential Biases and Limitations

The majority of respondents working at the headquarters may introduce a slight bias in the data, as their insights are primarily influenced by a broader perspective. While their responses provide valuable information about overarching strategies and frameworks, the perspectives of district branch employees, though fewer in number, offer essential context about local implementation and challenges. This distribution suggests that the findings may reflect a more centralized view of disaster management, which could overlook specific regional issues. However, the data still offers valuable insights and a solid foundation for understanding the overarching communication approach.

Another limitation is that some participants may not have provided complete information during the interviews. Different agencies showed varying levels of transparency, and some respondents might have adjusted their answers due to concerns about inter-agency relationships, even though confidentiality was assured. A few participants requested off-the-record discussions

for certain responses, suggesting potential response bias. However, it is noteworthy that some respondents, aside from those seeking off-the-record conversations, offered similar insights openly. This indicates that while some may have felt inclined to modify their responses, the overall data still holds significance for analysis.

CONCLUSION

Existing prior research consistently highlights the challenges associated with emergency communication, emphasizing the interplay of technological and organizational factors. (44-46). To address these challenges effectively, a comprehensive understanding of technological and organizational issues is crucial for unlocking the full potential of technology in enhancing disaster response communication. By identifying the current approaches and the key barriers, this study provides a foundation for developing effective strategies to improve disaster communication among responder agencies.

This study has identified Malaysia's current disaster communication primarily relies on traditional radio networks, often using handheld devices for inter-agency communication. While supplementary methods like WhatsApp have been adopted for rapid communication, Malaysia has yet to fully capitalize on global technological advancements in disaster response. However, a gradual shift is evident, with some agencies beginning to explore cutting-edge technologies such as drones. Moreover, there is no doubt that numerous studies have also explored the application of technology in disaster response communication that seeks to contribute to this body of knowledge (47). These emerging technologies offer the potential to significantly enhance overall communication effectiveness during disaster response efforts.

Consequently, stakeholders and authorities are seen to be having a critical role in enabling the implementation of technologies that improve disaster response communication. By addressing communication challenges, they can significantly enhance the efficiency and effectiveness of disaster management efforts (48, 49). Given the extensive research on this topic, it is imperative that stakeholders and authorities in Malaysia should recognize the value of these potential and take proactive steps to support their implementation, whether through financial investment or policy initiatives, as the integration of technology and strategic financial investment is crucial for enhancing disaster response management (50).

Moreover, preparedness and response stages are inherently interconnected and mutually dependent, playing a crucial role in effective disaster management. Preparedness lays the groundwork for a successful response, while the response phase can reveal gaps

in preparedness, prompting improvements for future events. Thus, future research should take the responders' perspective considering their extensive experience in disaster response for more comprehensive approaches. As per the findings, it is suggested that a focused study on standardizing systems could address disaster communication challenges. Establishing a unified and centralized system would contribute to mitigating technological and organizational challenges by optimizing the potential of using technology, information, and communication. Additionally, integrating available systems across the pre-disaster, during-disaster, and post-disaster phases could help address existing challenges and ensure seamless communication (8). This approach would not only enhance communication but also streamline coordination and resource allocation among responder agencies. Piloting such a system would provide valuable insights into its effectiveness in enhancing disaster response communication during emergencies.

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REFERENCES

- World Health Organization (WHO). Floods: Health Topics [Internet]. [cited 2024 Aug 22]. Available from: https://www.who.int/health-topics/floods#tab=tab_1
- Ministry of Natural Resources and Environmental Sustainability (NRES). Malaysia's Fourth National Communication Report (NC4). UNFCCC [Internet]. 2024 [cited 2024 Aug 22]. Available from: <https://unfccc.int/documents/638313>
- Zainuddin A. Frustration grows in Malaysia over government's slow flood response. The Diplomat [Internet]. 2021 [cited 2024 Aug 19]. Available from: <https://thediplomat.com/2021/12/frustration-grows-in-malaysia-over-governments-slow-flood-response/>
- Al Jazeera. 'Where's the help?': Malaysia PM under fire after deadly floods. Al Jazeera and news agencies [Internet]. 2021 [cited 2024 Aug 19]. Available from: <https://www.aljazeera.com/news/2021/12/28/malaysia-govt-under-fire-over-slow-clean-up-after-deadly-floods>
- Hadi. Ensuring Malaysia's disaster preparedness. NADMA [Internet]. 2022 Feb 27 [cited 2024 Aug 19]. Available from: <https://www.nadma.gov.my/bm/media-2/berita/302-ensuring-malaysia-s-disaster-preparedness>
- Brown DB, Smith MJ, Chibi MT, Hassani N, Lotfi B. Minimizing post-disaster fatalities. Fed Pract [Internet]. 2017; 34(2):10-3. Available from: <https://pubmed.ncbi.nlm.nih.gov/30766251/>
- National Security Council (NSC). NSC Directive No. 20 on the National Disaster Management Policies and Mechanisms. Prime Minister Department. 2016 [cited 2024 Aug 22]; 1-44. Available from: https://www.umpsa.edu.my/doc/arahan-mkn-no.20-semakan-semula-09_02_2013.pdf
- Sahar MA, Juliana N, Idrose A, Amin N, Saudi A. Challenges of communication system during emergency disaster response in Malaysia: A review. J Neuroimmunol. 2017; 9(4S):890-904. doi:10.4314/jfas.v9i4s.51.
- Kementerian Kesihatan Malaysia (KKM). Garis Panduan Prosedur Operasi Radio Komunikasi. Bahagian Perkembangan Perubatan KKM [Internet]. 2019 [cited 2024 Aug 22]. Available from: https://moh.gov.my/moh/resources/Arkib/Garis_Panduan_ProRK_KKM.pdf
- Jordan K, Mitchell J. Messaging apps, SMS, and social media: A rapid evidence review (1.0). Zenodo. 2020. doi: 10.5281/zenodo.4058180.
- Yusoff S, Yusoff NH. Disaster risks management through adaptive actions from human-based perspective: case study of 2014 flood disaster. Sustainability. 2022;14(12):7405. doi: 10.3390/su14127405.
- United Nations Office for Disaster Risk Reduction (UNDRR). Sendai Framework for Disaster Risk Reduction 2015-2030. Geneva: United Nations. 2015 [cited 2024 Aug 19]. Available from: <https://www.undrr.org/publication/sendai-framework-disaster-risk-reduction-2015-2030>
- Underwood S. Improving disaster management. Commun ACM. 2010;53(2):18. doi:10.1145/1646353.1646362.
- Weller SC, Vickers B, Bernard HR, Blackburn AM, Borgatti S, Gravlee CC, Johnson JC. Open-ended interview questions and saturation. PLoS ONE. 2018;13(6):e0198606. doi: 10.1371/journal.pone.0198606.
- Doi T, Kinugasa T, Okugawa M, Yamauchi H, Takamori T, Ohtsubo Y. Development of rescue vest using ICT. In: 2013 IEEE International Symposium on Safety, Security, and Rescue Robotics (SSRR). 2013; p. 1-5. doi: 10.1109/SSRR.2013.6719317.
- Zhang H. A real-time optimization for disaster-relief distribution in heterogeneous crowdsourcing. Impact. 2022;2022(1):23-5. doi: 10.21820/23987073.2022.1.23.
- Ishiwatari M. Leveraging Drones for Effective Disaster Management: A Comprehensive Analysis of the 2024 Noto Peninsula Earthquake Case in Japan. Prog Disast Sci. 2024;100348. doi: 10.1016/j.pdisas.2024.100348.
- Bhandari V. Use of Technology in Disaster Management. Unity J. 2022; 3:292-304. doi:10.3126/unityj.v3i01.43333.
- Chuang S, Cheng C-H, Chen H-C, Lee C-A, Woods

- DD. Coping with communication challenges after the Formosa Fun Coast Dust Explosion. 2018 Resilience Week (RWS). 2018; p. 5-10. doi:10.1109/rweek.2018.8473499.
20. Terry FR. Role of technology and human factors in emergency management. In: Crisis and emergency management. 2nd ed. Routledge. 2014; p. 12. eBook ISBN: 9781315095264.
21. Abukhalaf AH, von Meding J. Psycholinguistics and emergency communication: A qualitative descriptive study. *Int J Disaster Risk Reduct.* 2021;55:102061. doi: 10.1016/j.ijdr.2021.102061.
22. Jahir Y, Atiquzzaman M, Refai H, Paranjothi A, Lopresti P. Routing protocols and architecture for disaster area network: A survey. *Ad Hoc Netw.* 2019;82:1-14. doi: 10.1016/j.adhoc.2018.08.005.
23. Premkumar R. Wireless networks for disaster relief. *Dep Comput Sci Eng, Wash Univ St Louis [Internet].* 2014;3. Available from: <https://www.cse.wustl.edu/~jain/cse574-14/ftp/disaster/index.html>
24. Burkle F, Nickerson J, Schreeb J, Redmond A, McQueen K, Norton I, et al. Emergency surgery data and documentation reporting forms for sudden-onset humanitarian crises, natural disasters, and the existing burden of surgical disease. *Prehosp Disaster Med.* 2012; 27:577-82. doi: 10.1017/s1049023x12001306.
25. Cuthbertson J, Archer F, Robertson A, Rodriguez-Llanes JM. Improving disaster data systems to inform disaster risk reduction and resilience building in Australia: a comparison of databases. *Prehosp Disaster Med.* 2021;36(5):511-8. doi: 10.1017/s1049023x2100073x.
26. Harris C, McCarthy K, Liu E, Klein K, Swienton R, Prins P, et al. Expanding understanding of response roles: an examination of immediate and first responders in the United States. *Int J Environ Res Public Health.* 2018; 15:534. doi: 10.3390/ijerph15030534.
27. Chacko S, Randolph R, Morsch G. Disaster medicine: public health preparedness for natural disasters. *FP Essent [Internet].* 2019; 487:17-22. Available from: <https://pubmed.ncbi.nlm.nih.gov/31799816/>
28. Paturas JL, Smith S, Albanese JE, Waite GE. Inter-organisational response to disasters. *J Bus Continu Emerg Plan.* 2016;9(4):346-58. doi: 10.69554/CUWU6504.
29. Efendy Z, Salju S, Surullah M, Sapar S. The impact of human resources capacity and policy on disaster preparedness. *Quant Econ Manag Stud.* 2022;3(1). doi: 10.35877/454RI.qems909.
30. Alamouri A, Hassan M, Gerke M. Development of a methodology for real-time retrieving and viewing of spatial data in emergency scenarios. *Appl Geomat.* 2021; 13:747-761. doi: 10.1007/s12518-021-00389-w.
31. Oddo PC, Bolten JD. The value of near real-time earth observations for improved flood disaster response. *Front. Environ. Sci.* 2019;7:127. doi: 10.3389/fenvs.2019.00127.
32. Jayawardene V, Huggins TJ, Prasanna R, Fakhruddin B. The role of data and information quality during disaster response decision-making. *Prog Disaster Sci.* 2021;12:100202. doi: 10.1016/j.pdisas.2021.100202.
33. Saeed MR. A system for disaster response process management. *KTH R Inst Technol. [Internet].* 2012. Available from: <https://www.diva-portal.org/smash/get/diva2:504617/fulltext01.pdf>
34. Mobasheri A, Bakillah M. Towards a unified infrastructure for automated management and integration of heterogeneous geo-datasets in disaster response. 2015 IEEE Int Geosci Remote Sens Symp. 2015: 4570-3. doi: 10.1109/IGARSS.2015.7326845
35. Atluri V, Shafiq B, Chun SA, Nabi G, Vaidya J. UICDS-based information sharing among emergency response application systems. In: *Proc 12th Annu Int Digit Gov Res Conf: Digit Gov Innov Challeng Times.* 2011: 331-2. doi: 10.1145/2037556.2037611.
36. Shonhe L. A literature review of information dissemination techniques in the 21st century era. *Libr Philos Pract. (e-journal).* 2017;1731. Available from: <https://digitalcommons.unl.edu/libphilprac/1731/>
37. Lin L, Li Y. An efficient approach to identify social disseminators for timely information diffusion. *Inf Sci.* 2021; 544:78-96. doi: 10.1016/j.ins.2020.07.040.
38. Bao N, Su G, Wu Y, Kuang M, Luo D. Reliability-sustainable network survivability scheme against disaster failures. In: *Int Conf: Comp, Inform & Telecom Syst.* 2017: 334-7. doi: 10.1109/CITS.2017.8035299.
39. Ashraf M, Idrus S, Iqbal F, Butt R, Faheem M. Disaster-resilient optical network survivability: a comprehensive survey. *Photonics.* 2018;5(4):35. doi: 10.3390/photonics5040035.
40. Rosen M, Weinstock DL, Rockafellow-Baldoni M, Freeman K, Remington J. Responding to disasters: training can overcome issues in disaster response. *New Solut J Environ Occup Health Policy.* 2023;33:104-12. doi: 10.1177/10482911231179916.
41. Nazli N, Sipon S, Radzi H. Analysis of training needs in disaster preparedness. *Procedia - Social and Behavioral Sciences.* 2014;140:576-80. doi: 10.1016/J.SBSPRO.2014.04.473.
42. Kedia T, Ratcliff JD, O'Connor M, Oluic S, Rose M, Freeman JD, Rainwater-Lovett K. Technologies enabling situational awareness during disaster response: a systematic review. *Disaster Med Public Health Prep.* 2020; 16:341-59. doi: 10.1017/dmp.2020.196

43. International Search and Rescue Advisory Group (INSARAG). INSARAG Coordination and Management System (ICMS) UCC Based Field Operations Guide [Internet]. 2021 [cited 2024 Aug 22]. Available from: <https://www.insarag.org/wp-content/uploads/2021/06/ICMS20-20UCC20Guide.pdf>
44. Carreras-Coch A, Navarro J, Sans C, Zaballos A. Communication Technologies in Emergency Situations. *Electron*. 2022. doi: 10.3390/electronics11071155.
45. Zhang Z, Brazil J, Ozkaynak M, Desanto K. Evaluative Research of Technologies for Prehospital Communication and Coordination: a Systematic Review. *J Med Syst*. 2020;44(1):1-14. doi: 10.1007/s10916-020-01556-z.
46. Wang Q, Li W, Yu Z, Abbasi Q, Imran M, Ansari S, Sambo Y, Wu L, Li Q, Zhu T. An Overview of Emergency Communication Networks. *Remote Sens*. 2023;15(6):1595. doi: 10.3390/rs15061595.
47. Nazli N, Sipon S, Norwawi N. One Stop Center For Disaster Training Information In Smartphone Platform: A Mobile Prototype. *Int J Interact Mob Technol*. 2015; 9:12-16. doi: 10.3991/ijim.v9i4.4418.
48. Fajardo C. Emergency Communications Network for Disaster Management. *Nat Hazards - Risk, Expo, Resp, Resil*. 2019. doi: 10.5772/intechopen.85872.
49. Madhavaram S, Matos V, Blake B, Appan R. ICTs in the context of disaster management, stakeholders, and implications. *J Inf Commun Ethics Soc*. 2017; 15:32-doi: 10.1108/JICES-11-2015-0038.
50. Taylor O. The policy landscape and challenges of Disaster Risk Financing: navigating risk and uncertainty Disasters. 2022. doi: 10.1111/disa.12560.