ENHANCING FORECAST COMMUNICATION FOR NATURAL DISASTERS IN THE PACIFIC ISLANDS

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Abstract

This report investigates the imperative need for efficient forecast communication systems in remote, underdeveloped villages, focusing on the Pacific Islands, to provide timely warnings about impending natural disasters. The study encompasses a comprehensive approach involving a literature review, survey, and interviews to gather insights from diverse perspectives.

Remote villages in underdeveloped nations face substantial challenges in receiving timely disaster forecasts due to limited infrastructure and resources. The Pacific Islands serve as a compelling case study, where the vulnerability to various hazards underscores the urgency of effective communication. This report highlights the communication gap and delves into concrete steps taken to address it.

The research methodology involves three crucial phases. Firstly, a thorough literature review evaluates existing literature on forecast communication systems and their efficacy in remote, underdeveloped areas. This establishes a baseline understanding of the issue and identifies gaps in knowledge and implementation.

Subsequently, a survey is conducted to capture the perceptions and experiences of residents from the Pacific Island nations. The survey assesses their access to communication tools, the effectiveness of existing warning systems, and their suggestions for improvements. This quantitative approach provides valuable data to complement the qualitative insights gained through interviews.
Five interviews with key stakeholders, including locals, meteorologists, and community leaders, are conducted to delve deeper into the challenges and potential solutions.

These interviews offer contextualised perspectives on the unique barriers faced in the Pacific Islands and the feasibility of various communication strategies.

The findings highlight the critical role of context-specific communication strategies, considering linguistic diversity, cultural norms, and technological constraints.

Ultimately, the report presents a holistic view of the forecast communication landscape in remote, underdeveloped villages, emphasising the need for a multi-dimensional approach. By integrating insights from the literature, surveys, and interviews, the study provides nuanced recommendations for stakeholders, policymakers, and international organisations to implement effective and rapid forecast communication systems tailored to the needs of these vulnerable communities.
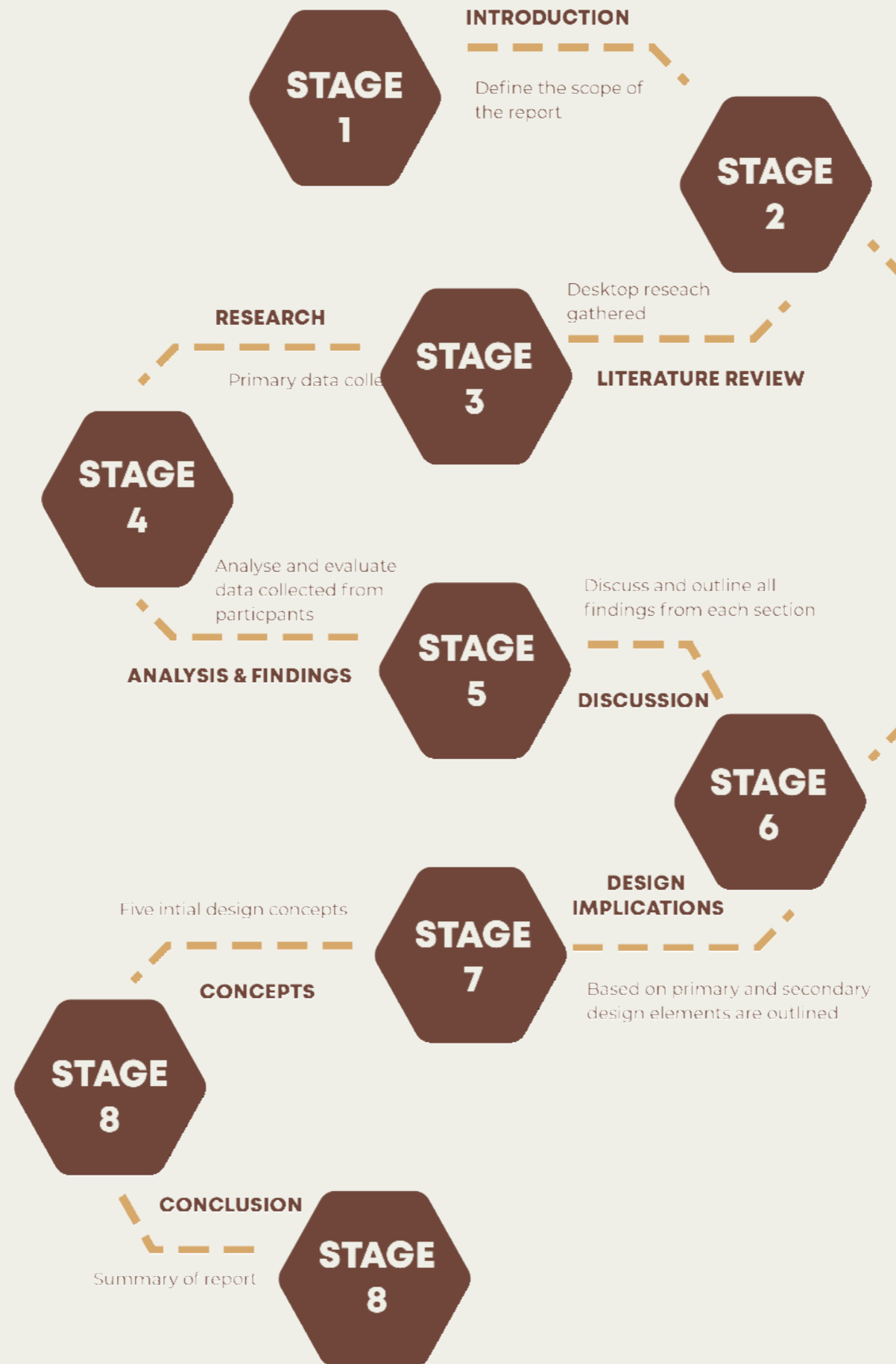
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Introduction

In a world increasingly shaped by rapid technological advancements, the significance of effective communication is undeniable. This holds especially true for small, remote villages and underdeveloped countries that lack access to the advanced technologies and information networks that have become commonplace in more developed regions. These marginalised communities find themselves at a distinct disadvantage, often isolated from the global flow of information and resources, and consequently, more vulnerable to the whims of nature and the uncertainties it brings.

Predicting the weather and understanding impending natural disasters can be an insurmountable challenge for its inhabitants. With limited means to access up-to-date information, these communities need to be equipped to make informed decisions that could safeguard their livelihoods and well-being. A lack of timely information about an approaching natural disaster could lead to devastating consequences, disrupting daily routines, damaging homes and crops, and endangering lives.
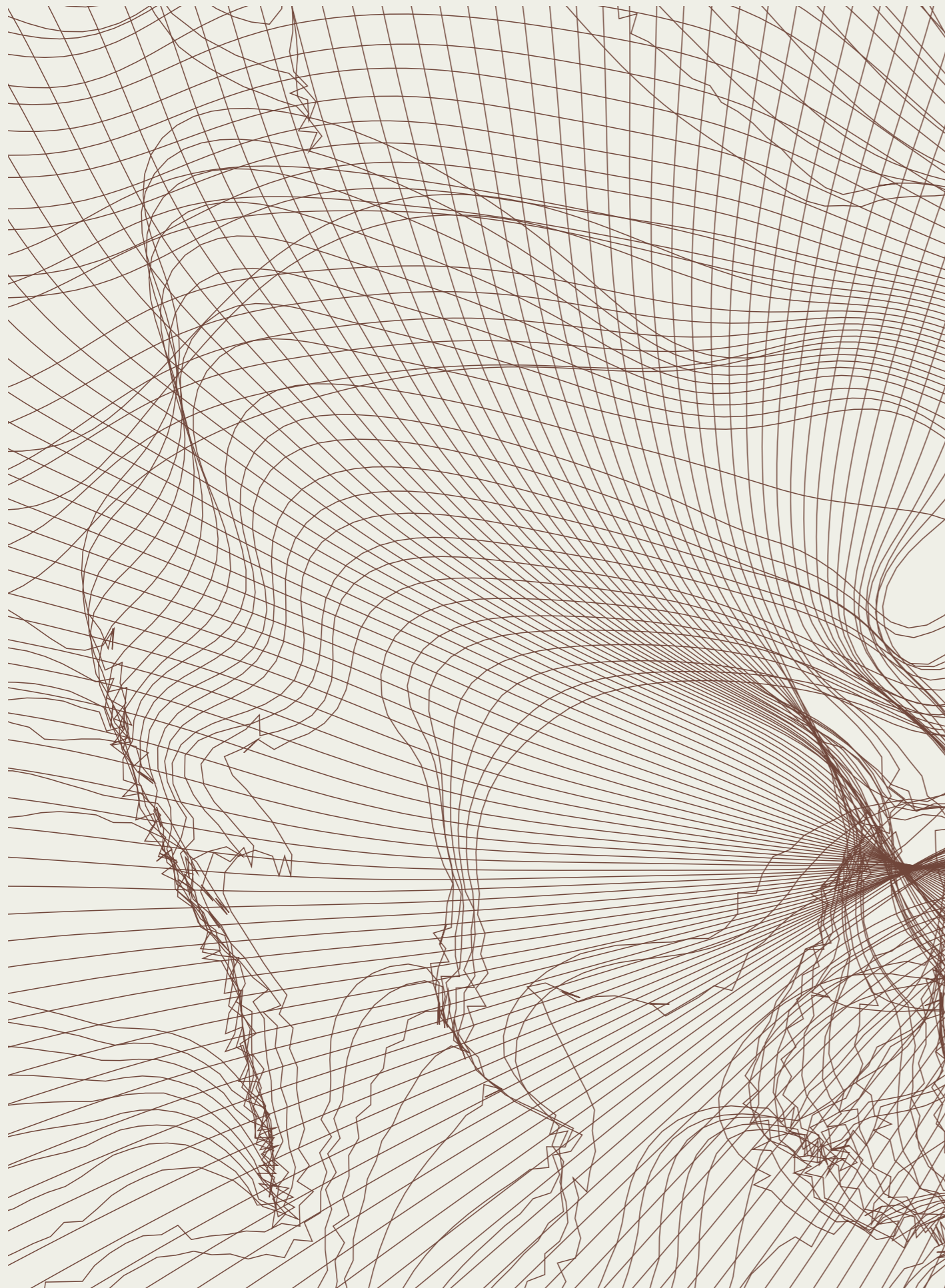
Among the crucial realms of communication, forecast dissemination stands out as a lifeline for these communities. Access to accurate and timely forecasts empowers them to anticipate and mitigate the impact of natural disasters, allowing for better preparedness and response strategies. In unpredictable weather conditions, reliable forecasts aid decision-making, helping these communities allocate scarce

resources more effectively. The aim of this report is to explore the current devices and communication methods in place to inform remote communities in the Pacific Island about the occurrence of natural disasters.

This project seeks to delve into the vital intersection of forecast communication and its profound implications for regions that find themselves on the periphery of progress. By examining how accurate and timely forecast information can uplift these underserved populations, we aim to illuminate the intrinsic value that effective communication holds. In a world increasingly interconnected, understanding the pivotal role of forecast communication in driving resilience, sustainability, and overall well-being becomes paramount.

INTRODUCTION

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Literature Review

An extensive examination of existing literature shaped the foundational elements of this study. This review aimed to uncover the extent of ongoing research and solutions, delineate possibilities and identify areas within the literature that lack coverage.

Early warning systems

Early warning systems for natural disasters have emerged as indispensable tools in minimising the adverse impacts of catastrophic events (1). These systems are pivotal in enhancing disaster preparedness, reducing casualties, and mitigating economic losses. Several papers suggested that by leveraging advanced technologies and efficient communication mechanisms, early warning systems provide timely alerts to individuals, communities, and authorities, enabling them to take proactive measures and informed decisions in the face of impending disasters (1,2,3,4).

Central to the effectiveness of early warning systems is their ability to harness real-time data from various sources, including meteorological sensors, seismic detectors, and satellite imagery (5,6). By integrating geographic information systems (GIS) and sophisticated modelling techniques, these systems can predict the trajectory and intensity of disasters such as hurricanes, tsunamis, and wildfires. These predictions empower authorities to issue accurate and location-specific warnings, facilitating prompt evacuations, resource allocation, and emergency response coordination.

Furthermore, the success of early warning systems hinges on efficient communication networks that swiftly relay alerts to affected populations. Mobile communication technologies have revolutionised this aspect, allowing alerts to be disseminated through SMS, mobile apps, and social media platforms (6). However, challenges still need to be addressed, particularly in regions with limited technological infrastructure and linguistic diversity (7). Bridging these gaps requires the integration of community-based networks, local radio broadcasts, and other innovative strategies that can reach diverse demographics, including those without access to modern devices.

It was agreed through various papers that early warning systems constitute a critical layer of defence against the devastating impacts of natural disasters (1,2,4). By harnessing data-driven insights, predictive modelling, and efficient communication channels, these systems empower societies to respond swiftly and effectively in the face of imminent threats. As technology continues to evolve, further investments in early warning systems, coupled with a comprehensive understanding of cultural and technological contexts, promise to enhance disaster resilience on both local and global scales (7).

Warning Methods

Natural disasters, whether earthquakes, hurricanes, floods, or wildfires, pose significant threats to communities worldwide. Ensuring that communities receive timely and accurate alerts about these impending events is crucial for saving lives, minimising damage, and fostering disaster resilience (12). A range of methods have been established to alert communities, leveraging technological advancements and effective communication strategies.

It was found that one of the primary methods in place for alerting communities about natural disasters is the use of sirens and warning systems (8,9). These systems are often strategically placed in areas prone to specific disasters, such as tsunami-prone coastal regions or tornado-prone areas (9). When triggered by relevant authorities, sirens emit distinct warning sounds that signal the need for immediate action (10). Similarly, loudspeakers and megaphones can be used in densely populated areas to broadcast essential information, reaching a wide audience quickly (11). These audible alerts have been instrumental in alerting communities quickly, especially in remote regions where access to technology is limited.

The advent of digital communication has revolutionised the way communities are alerted about natural disasters. Mobile phones have become ubiquitous, even in remote areas, and text message alerts (SMS) have proven highly effective in rapidly disseminating information (6). Government agencies and emergency services can send geographically targeted alerts, providing real-time updates about disaster risks and recommended actions. Furthermore, mobile apps designed for disaster alerts have gained traction, providing users with a user-friendly interface that delivers alerts, weather updates, and evacuation plans directly to their devices. This method enhances communication efficiency and empowers individuals to stay informed and take appropriate measures independently.

Social media platforms have emerged as influential channels for alerting communities about natural disasters (10,11). Government agencies and emergency services utilise official social media accounts to share real-time updates, emergency contact information, and safety guidelines (13). The interactive nature of social media allows communities to engage with these alerts by sharing, commenting, and tagging friends or family members, thereby extending the reach of the message (7). However, while social media can be highly effective, it also requires careful management to counter misinformation and ensure accurate information reaches the public.

Traditional media, particularly radio and television, remain potent tools for alerting communities about natural disasters (14,15). Radio broadcasts can reach remote areas where internet and mobile coverage might be limited (15). These broadcasts deliver timely information, emergency instructions, and updates on weather conditions, ensuring that even those without internet access are informed. Television broadcasts provide visual cues, maps, and expert analyses that enhance understanding and awareness among viewers (14).

It is discovered through various papers that there is several methods in place to alert communities about natural disasters. From the traditional use of sirens and loudspeakers to the innovative applications of mobile technology and social media, these methods serve as critical bridges between authorities and the public. As technology evolves and communication strategies adapt to changing needs, the effectiveness of alert systems will likely improve, ultimately contributing to safer, more resilient communities in the face of natural disasters.

Trust

Trust plays a pivotal and foundational role in the context of disaster risk communication. It serves as the bedrock upon which effective emergency response and preparedness are built. When trust is robust and unshaken, it fosters a sense of confidence and reliance on the sources and channels through which emergency warnings and information are disseminated. However, the fragility of trust cannot be underestimated. Once eroded, whether due to misinformation, inconsistent messaging, or perceived unreliability, it can have profound consequences. A loss of trust can lead to scepticism and hesitancy among individuals, undermining their willingness to accept the gravity of the situation and take timely and appropriate actions in response to emergency warnings. Therefore, preserving and strengthening trust in disaster risk communication is paramount, as it is not merely a matter of information dissemination but a critical factor in ensuring the safety and resilience of communities in the face of calamities.

West and Orr (24) brought to light a critical aspect of disaster risk communication concerning ethnic minorities. Their findings outlined the potential challenges and misgivings that can arise when disaster-related messages are conveyed through the press in relation to these communities (16,24). Specifically, such messages may be perceived as skewed, erroneous, or lacking fairness by members of ethnic minority groups. This perception can be attributed to a variety of factors, including language barriers, cultural nuances, and historical mistrust of mainstream media outlets (24).

However, what is particularly significant is the heightened vulnerability of minority groups and remote island communities in the context of disaster preparedness and response (16,19,20). These communities often face unique challenges, such as limited access to resources, geographic isolation, and a reliance on close-knit social networks. As a result, they may be more susceptible to the adverse impacts of disasters. This heightened susceptibility necessitates a more substantial requirement for government assistance and support when compared to the broader population. It emphasises the need for tailored and culturally sensitive communication strategies that not only provide accurate information but also address the specific needs and concerns of these marginalised groups. In this context, fostering trust, transparency, and inclusivity in disaster risk communication becomes imperative to ensure that vulnerable communities receive the assistance and support they require during times of crisis.

Extensive research has consistently highlighted a notable trend among individuals residing in remote ethnic communities regarding their preferences for receiving emergency information. These communities tend to place high trust in familiar and reliable sources, most commonly their family members, friends, respected community leaders, and small discussion groups within their social circles (16,25). This inclination toward interpersonal networks and trusted figures reflects the deep-rooted bonds and communal ties that are characteristic of such remote ethnic communities (16,17). However, this preference can also have implications for the timeliness of their response to urgent alerts and evacuation directives during emergencies.

In remote communities, the reaction to urgent alerts often encounters delays due to the time expended in seeking validation and consensus from family, friends, or social connections (16,25). While this approach can provide a sense of security and assurance, it may inadvertently prolong the decision-making process, especially when there is a need for swift action in the face of rapidly evolving disaster situations. These delays can be a source of concern, as they potentially impact the effectiveness of timely responses and evacuations, potentially placing individuals and communities at greater risk (22,23). Therefore, understanding and addressing the dynamics of information flow and decision-making within remote ethnic communities is essential for optimising disaster preparedness and response efforts, ensuring that the trusted sources they rely on are equipped with accurate and timely information to facilitate informed and expedient actions during emergencies.

J-alert system

The J-Alert system serves as a rapid transmission mechanism for disseminating critical emergency information, encompassing data of seismic events, tsunami alerts, and ballistic missile notifications, all of which entail situations requiring immediate response and leaving individuals with insufficient time for deliberation (26). This system facilitates the expeditious relay of information to municipal authorities through satellite communication channels (26,27,28).

Various papers outlined that the J-ALERT represents a satellite-centric infrastructure, enabling the dissemination of alerts to local media outlets and citizens through a network of loudspeaker systems (26,27,28). Japanese authorities have reported that the system achieves near-instantaneous notification of local officials within approximately one second, followed by communication to the broader community within four to twenty seconds (27). Notably, all warnings, except severe weather alerts, are broadcast in a multilingual format encompassing Japanese, English, Mandarin, Korean, and Portuguese (27).

It is stated that the consistent and reliable operation has contributed to increased public awareness and preparedness for disasters. People have come to trust the system and are more likely to take immediate action when they receive an alert, such as seeking shelter during a missile threat or evacuating in response to a tsunami warning (28).

The J-Alert system has become a crucial asset in Japan's disaster management toolkit. Its ability to deliver rapid, multilingual alerts directly to both authorities and citizens has improved emergency response and contributed to a more resilient and prepared society (26,27,28). The system continues evolving and adapting to new challenges, enhancing its effectiveness as an early warning systevm.

Research

A mixed-method primary research approach was carried out to gain a deeper understanding of the subject at hand. It aimed to support and fill the gaps found in the literature review. This research involved the implementation of a distinct survey tailored to the specific user group. Concurrently, five semi-structured qualitative interviews were conducted to gain a more comprehensive perspective on various specialties and their viewpoints regarding their experience with natural disasters. An overview of the primary research participants can be found in Table 1.

Surveys

A total of 15 questions, comprising a mix of qualitative and quantitative inquiries, were posed in the study. Among them, four were designed as short-answer questions, three as nominal questions, and three as a scale question (ordinal in nature).

Notably, the nominal questions were often followed by short-answer questions, enabling respondents to provide more comprehensive insights based on their earlier responses. Additionally, the use of short-answer questions facilitated qualitative analysis based on identified keywords and phrases. The inclusion of the ordinal question aimed to gauge respondents' ratings of various factors. The collected data was subsequently subjected to analysis (Appendix).

Interviews

Interviews were selected as the second research method due to their capacity to generate more profound qualitative data, delving deeply into the subject matter. They provide a platform for detailed discussions, enabling participants to express their thoughts, experiences, and perspectives comprehensively. Each interview was carried out using a semi-structured format, which allowed for the exploration of broader topics while also permitting the discovery of new ideas and subjects that may not have been initially outlined (Appendix).

Following the audio recording of interviews through platforms such as Zoom and Voice Memos, a transcription process was conducted. This transcribed dataset formed the foundation for a rigorous qualitative thematic analysis. Employing thematic analysis allowed for the systematic categorisation of interview content into overarching themes and sub-themes, thereby facilitating the identification of interrelationships and patterns within the collected insights and interview transcripts. These emergent themes assumed a crucial role in shaping the criteria employed for generating design implications. Thematic analysis, noted for its precision and methodological consistency (Nowell et al., 2017), proved instrumental in the comprehensive examination of discussions with industry experts. These discussions encompassed personal and second-hand experiences concerning the experience of natural disasters in Fiji.

P1	●	**Former Head of Meteorology in Fiji**
P2	●	**Pacific Islands Marine Biologist**
P3,4,5	●	**Residents of Fiji**

Analysis & Findings

Under 24

25-34

35-44

45-54
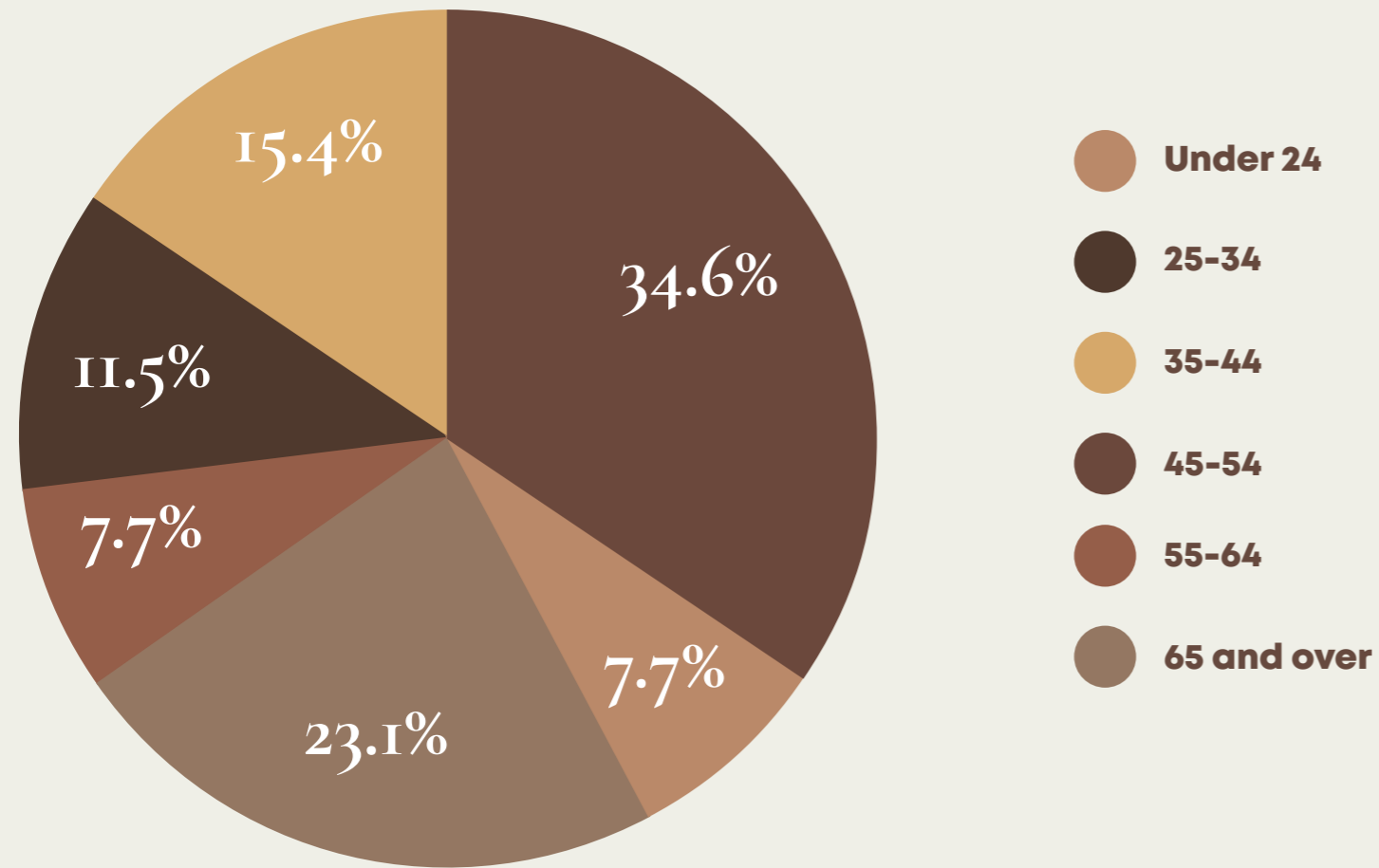
55-64

65 and over
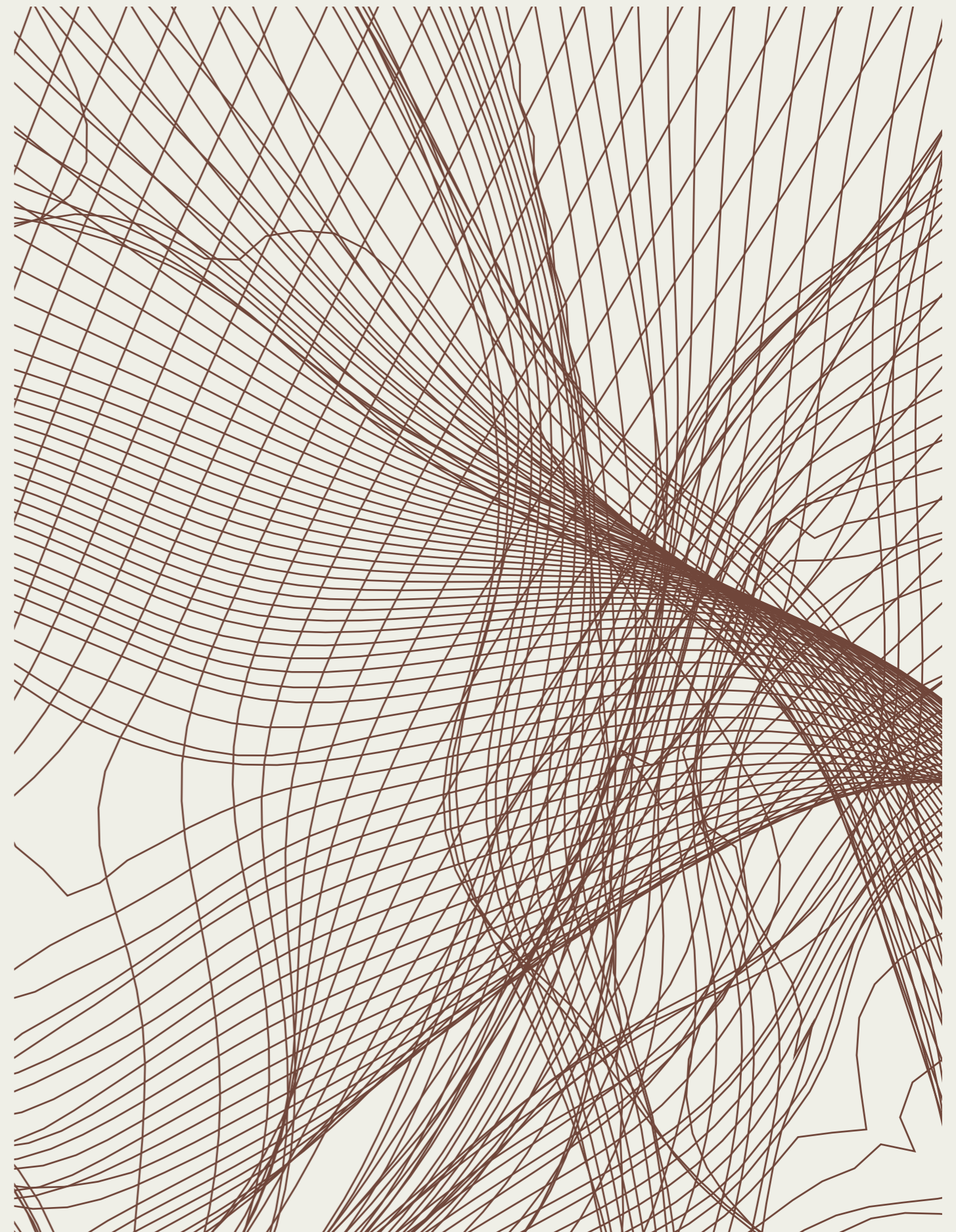
Figure 1 : Frequency of Age Groups

A comprehensive survey was conducted, encompassing a diverse range of participants, including both current and past residents of Fiji. The survey encompassed individuals across a broad spectrum of age groups, categorised as follows: Under 18, 18-24, 25-34, 35-44, 45-54, 55-64, and those aged 65 and over. This inclusive age stratification aimed to capture insights and perspectives from individuals spanning various life stages and experiences, ensuring a holistic understanding of the subject matter under investigation.

Within the surveyed cohort, 96.2% of respondents reported personal experiences with natural disasters within Fiji. These experiences spanned a range of catastrophic events, including cyclones, floods, and earthquakes, which have significantly impacted the lives and livelihoods of the local population. The high prevalence of firsthand encounters with natural disasters underscores the profound vulnerability of Fiji to such climatic and geological events.
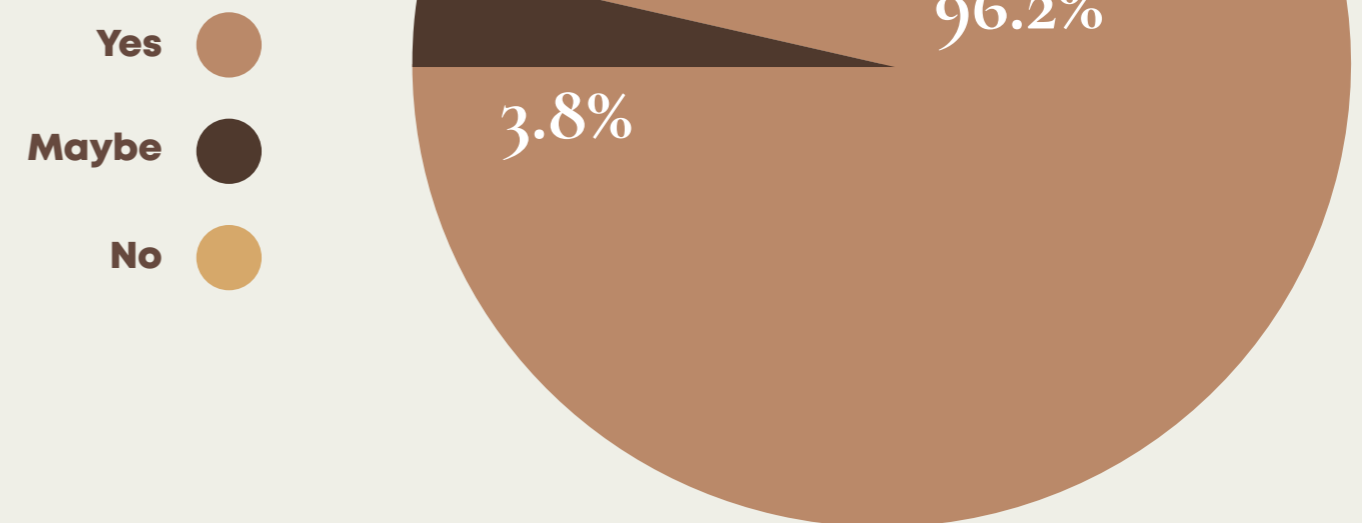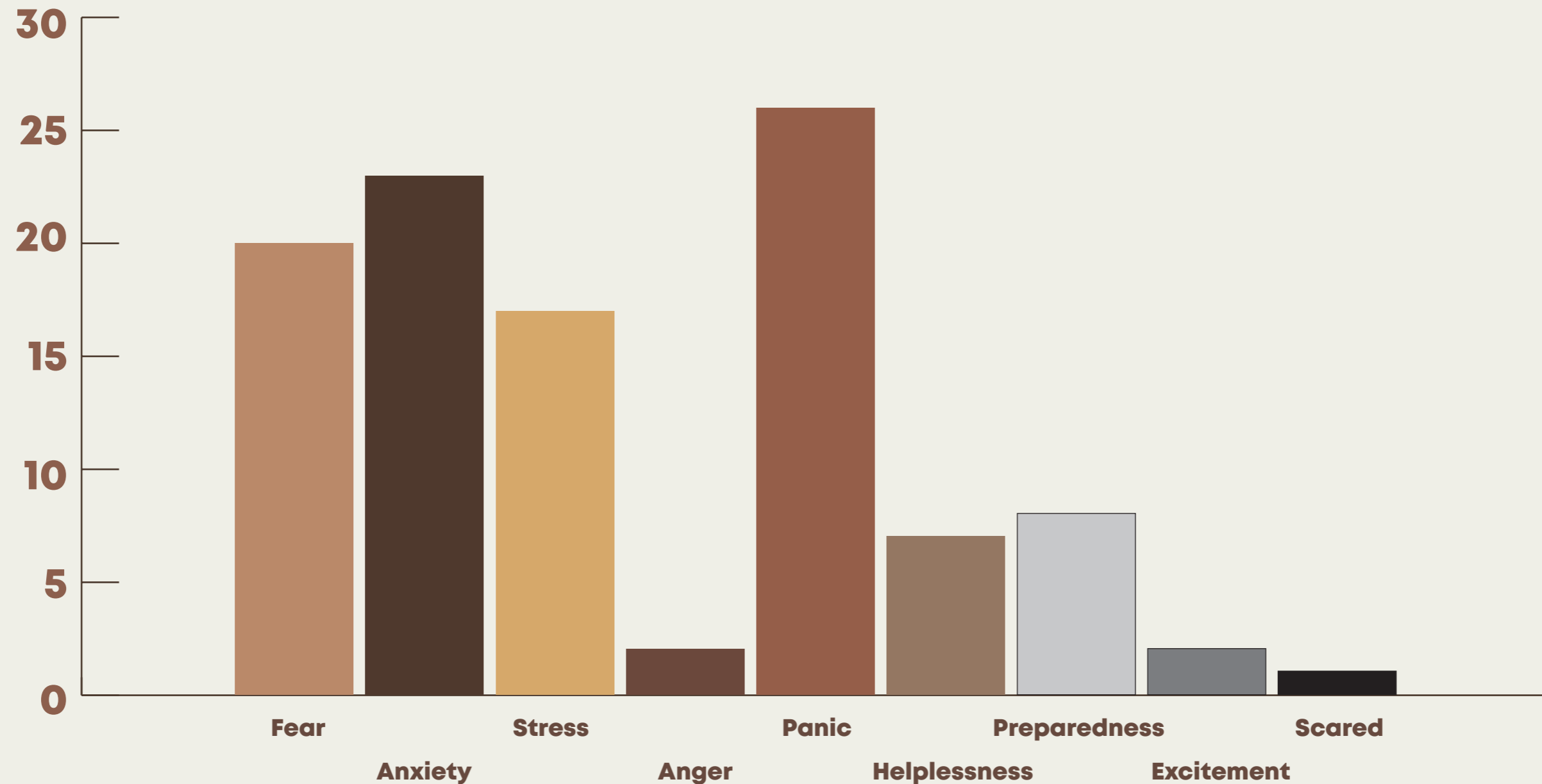
**Yes**

Maybe

No

Figure 2 : Frequency of Residents that Experienced a Natural Disaster

Figure 3 : Primary Emotions Experience when a Natural Disaster is Approaching

Among the respondents surveyed, the primary emotions or feelings reported when a natural disaster approaches is approaching were prominently characterised by a sense of panic, followed closely by fear and anxiety. This emotional profile illuminates imminent hurricanes' intense psychological impact on individuals within the Fijian context. The prevalence of panic as the foremost emotion underscores these natural disasters' immediate and disorienting nature, prompting a visceral response. Fear and anxiety, which closely follow panic, reflect the sustained apprehension and unease associated with the impending calamity. This emotional landscape reveals the significant mental and emotional toll hurricanes impose on those affected, underscoring the importance of comprehensive preparedness strategies and robust communication systems to mitigate the emotional distress experienced during such events.

Figure 4 : Methods of Receiving Natural Disaster Warnings and Updates
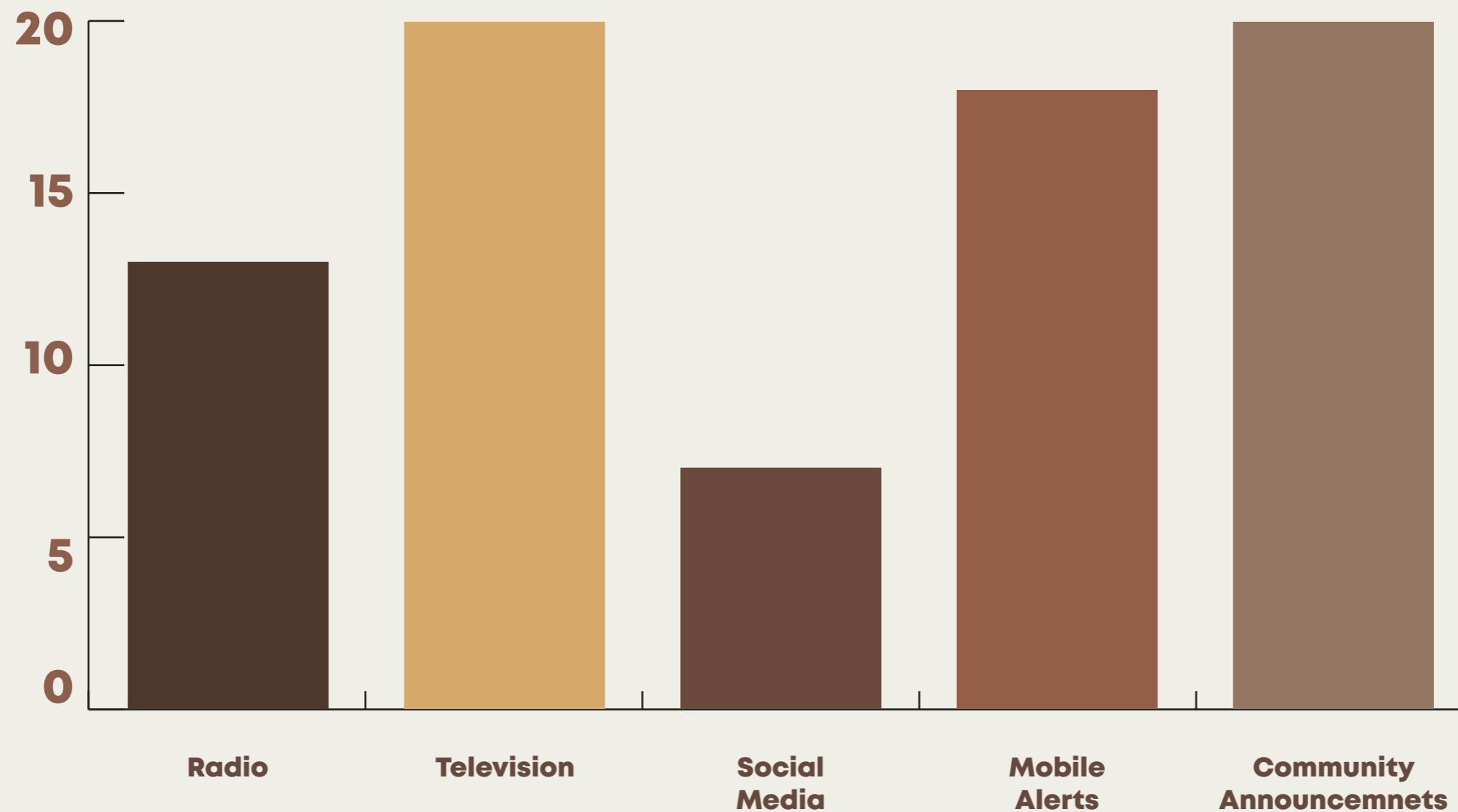
The survey findings shed light on the predominant sources of hurricane warnings and updates among respondents, with Television, Mobile alerts, and Community Announcements emerging as the primary communication channels. Television is a trusted medium for conveying critical weather information to a broad audience, offering real-time visuals and expert analysis. The prevalence of Mobile alerts indicates the growing influence of technology, allowing individuals to receive timely alerts directly on their devices. Additionally, Community Announcements demonstrate the significance of localised communication channels, emphasising the importance of neighbourhood connections and community leaders in disseminating vital hurricane updates. This multifaceted approach to forecast communication highlights the diverse array of resources and platforms that Fijian locals rely on to stay informed and prepared in the face of impending natural disasters.

Figure 5 : Most Trusted Methods of Forecast Communication

National Weather Service or meteorological agency broadcasts

Local community leaders or authorities

Weather apps and websites

Television and radio broadcasts

Social media updates from official sources

Word of mouth from friends and family

Phone alerts

Within the surveyed cohort, 96.2% of respondents reported personal experiences with natural disasters within Fiji. These experiences spanned a range of catastrophic events, including cyclones, floods, and earthquakes, which have significantly impacted the lives and livelihoods of the local population. The high prevalence of firsthand encounters with natural disasters underscores the profound vulnerability of Fiji to such climatic and geological events.
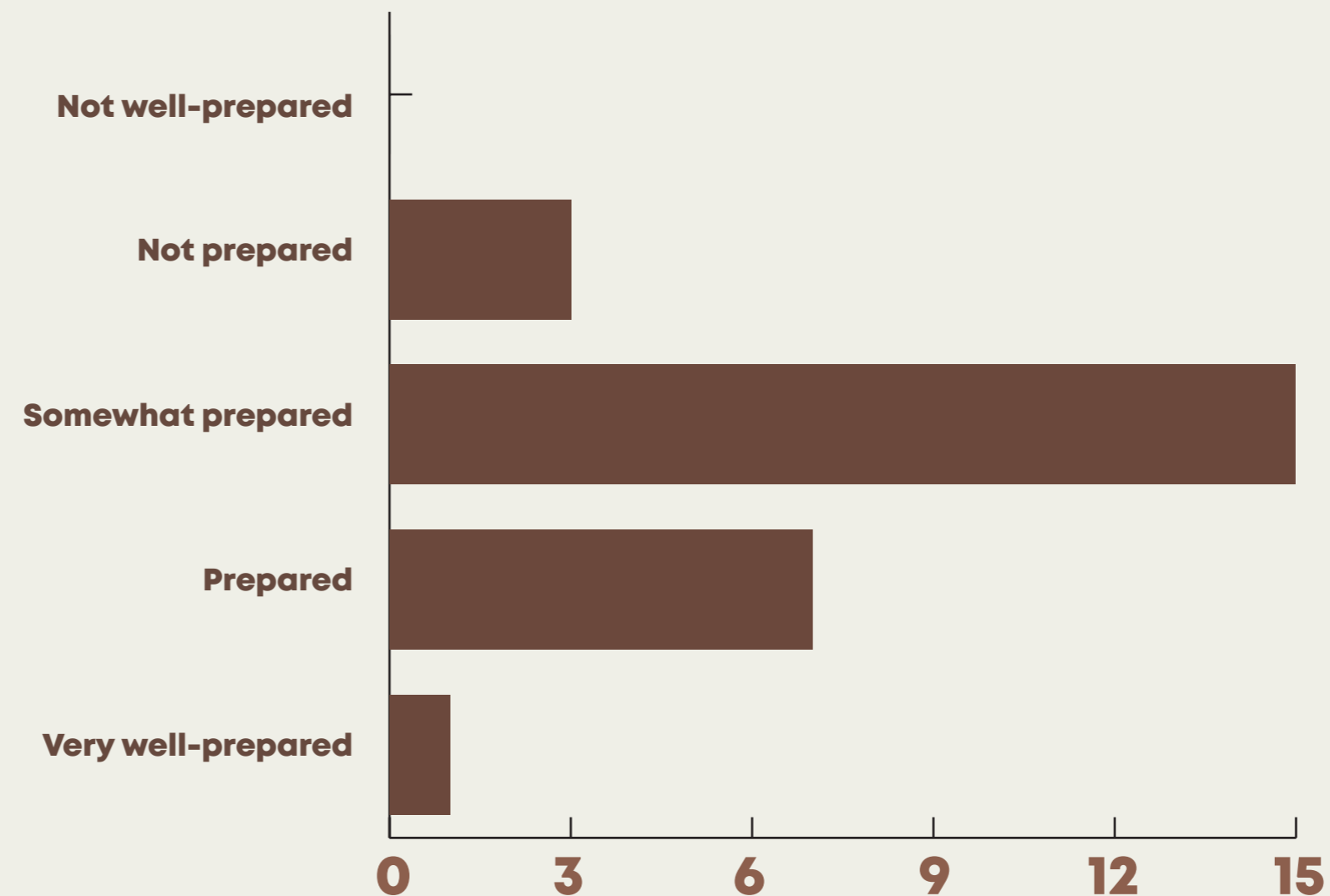
Figure 7 : Community Preparedness for Natural Disasters

The survey results indicate that respondents, on the whole, exhibit a level of preparedness for hurricanes that can be described as "somewhat prepared" when these weather events are on the horizon. While there is a degree of readiness and awareness among the surveyed individuals, it also implies that there is room for improvement in terms of hurricane preparedness. This suggests the importance of enhancing forecast communication to the public, allowing for a sensible amount of time to prepare. The finding emphasises the need for continuous efforts to bolster readiness and resilience within the community, given the recurring threat of hurricanes in the region.

The survey findings reveal a striking consensus among the majority of respondents, who express a profound desire to preserve and protect Fiji's cultural heritage and natural environment for the benefit of future generations. This collective sentiment highlights the deep-rooted commitment to safeguarding the nation's rich cultural identity and the ecological treasures that define Fiji's landscapes. The resounding call for cultural and environmental preservation is a powerful testament to the shared responsibility that Fijian residents feel toward conserving their unique heritage and the natural splendour of the islands. This collective aspiration highlights the imperative for sustainable practices, informed policies, and concerted efforts to nurture cultural traditions and the ecological vitality that sustains Fiji's ecological balance, ensuring its enduring legacy for future generations.

Highly Important
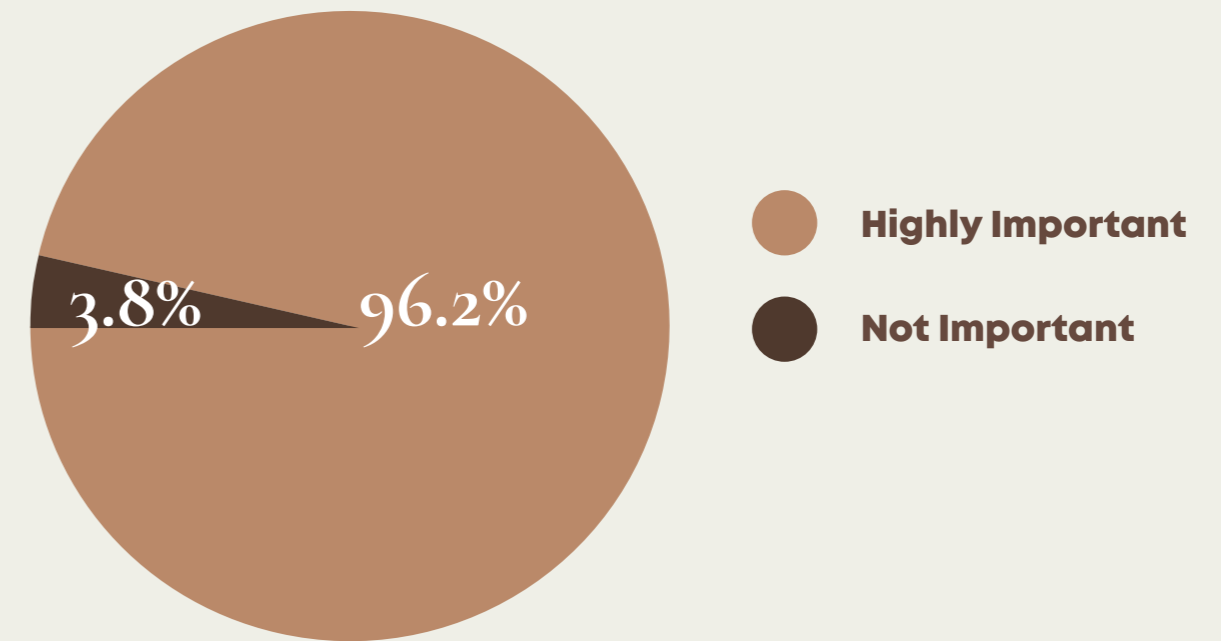
Not Important

3.8%   96.2%

Figure 8 : Importance of Preserving and Protecting the Cultural Heritage and Natural Environment of Fiji for Future Generations

A significant majority of respondents in the survey demonstrated a strong willingness to embrace and utilise new technological tools and innovations aimed at improving hurricane forecast communication and preparedness within Fiji. This prevailing receptiveness outlines a readiness among the surveyed individuals to embrace advancements in the field of forecast communication. The collective openness to incorporating novel technologies into their hurricane preparedness strategies signifies a recognition of the potential benefits that modern technology can offer in enhancing the region's disaster resilience. This substantial willingness to adopt innovative solutions highlights the promising prospect of integrating cutting-edge technology into the existing infrastructure to better inform and prepare Fijian communities in the face of impending natural disasters, ultimately contributing to their safety and well-being.

Figure 9 : Willingness to Adopt or use New Technological Tools or Innovations to Enhance Hurricane Forecast Communication and Preparedness in Fiji

FEAR & PANIC

Primary emotions felt when a hurricane is approahing

Their community is somewhat prepared for hurricanes

57.7%

"My father use to be a community leader and use to use a megaphone and hop on a ute to let all people in the compound a hurricane was coming. So I trust that mode of information plus, its such a nostalgic memory many leaders use a megaphone and I love that"

Willingness to adopt or use new technological tools or innovations to enhance hurricane forecast communication and preparedness

80.8%

The importance of preserving and protecting the cultural heritage and natural environment of Fiji for future generations

96.2%

Survey Insights

The survey findings reveal a predominant reliance on official sources of forecast communication among respondents in Fiji. Notably, 100% of participants trusted the National Weather Service and meteorological agency broadcasts for receiving accurate and timely hurricane information. Concurrently, 61% expressed confidence in local community leaders and authorities for their hurricane forecasts.

In terms of technological awareness, a substantial 74% of respondents exhibited familiarity with recent innovations introduced to enhance hurricane forecast communication and preparedness within Fiji. Suggesting a relatively high level of exposure to new tools and technologies to improve forecast communication in the region.

Perhaps more significant is the notable willingness to embrace these new technologies. Among the survey participants, 58% displayed a strong inclination toward adopting and effectively utilising these innovative tools. This readiness to integrate novel technologies into their hurricane preparedness strategies underscores a receptive attitude toward advancements in forecast communication.

Overall, these survey outcomes shed light on the overarching preference for official channels of forecast communication and a significant openness to incorporating cutting-edge technologies. This confluence of trust in traditional sources and receptiveness to emerging solutions suggests a promising avenue for bolstering hurricane forecast communication within the Fijian context, thereby enhancing community resilience and preparedness.

THEME	CODE	EXAMPLES
Cultural and Environmental Preservation	Cultural Heritage	P3 "It is so important to preserve Fiji. Global warming is killing it and its so devastating" P2 "The rises in sea levels poses as a significant risk for all Pacific Island nations"
	Keeping Traditions	P3 "I don't want the old methods to change. It's so comforting to have the communication method of village leaders so tradition can continue."
Reliability	Trust	P1 "My role involved a lot of trust meaning that everyone in Fiji relied on me" P3 "My father use to be a community leader and use to use a megaphone and hop on a ute to let all people in the compound a hurricane was coming. So I trust that mode of information plus, its such a nostalgic memory many leaders use a megaphone and I love that"
Communication	Mobile Alerts	P3 "When I was living in Fiji we didn't have mobile alerts like nowadays" P4 "My Iphone gives automatic alerts if a storm or hurricane is coming" P5 " I get phone alerts. But I know my family and friends don't because of the phone model they have"
	Community Annoucments	P3 "My father use to be a community leader and use to use a megaphone and hop on a ute to let all people in the compound a hurricane was coming. So I trust that mode of information plus, its such a nostalgic memory many leaders use a megaphone and I love that"
	Accessibility	P1 "We were the National Metoerology agency so everyone was able to access our information. Whether that be on the TV or Radio"
Heightened Emotions	Panic	P4 "I guess panic is a intial emotion I felt" P5 "Everyone starts panicking when they don't know what's going on"
	Fear	P3 "The fear you experience when you see a pitch black sky at 2pm is scary"
Technological advancements	Willingness to adopt technological advancements	P1 "When I was a meterologist in Fiji I thought I was working with such advance technology, but now I laugh cause what we have today is incomparable" P2 "Fiji is in need of innovation that can provide safety"

Figure 10: Interview Example Codes
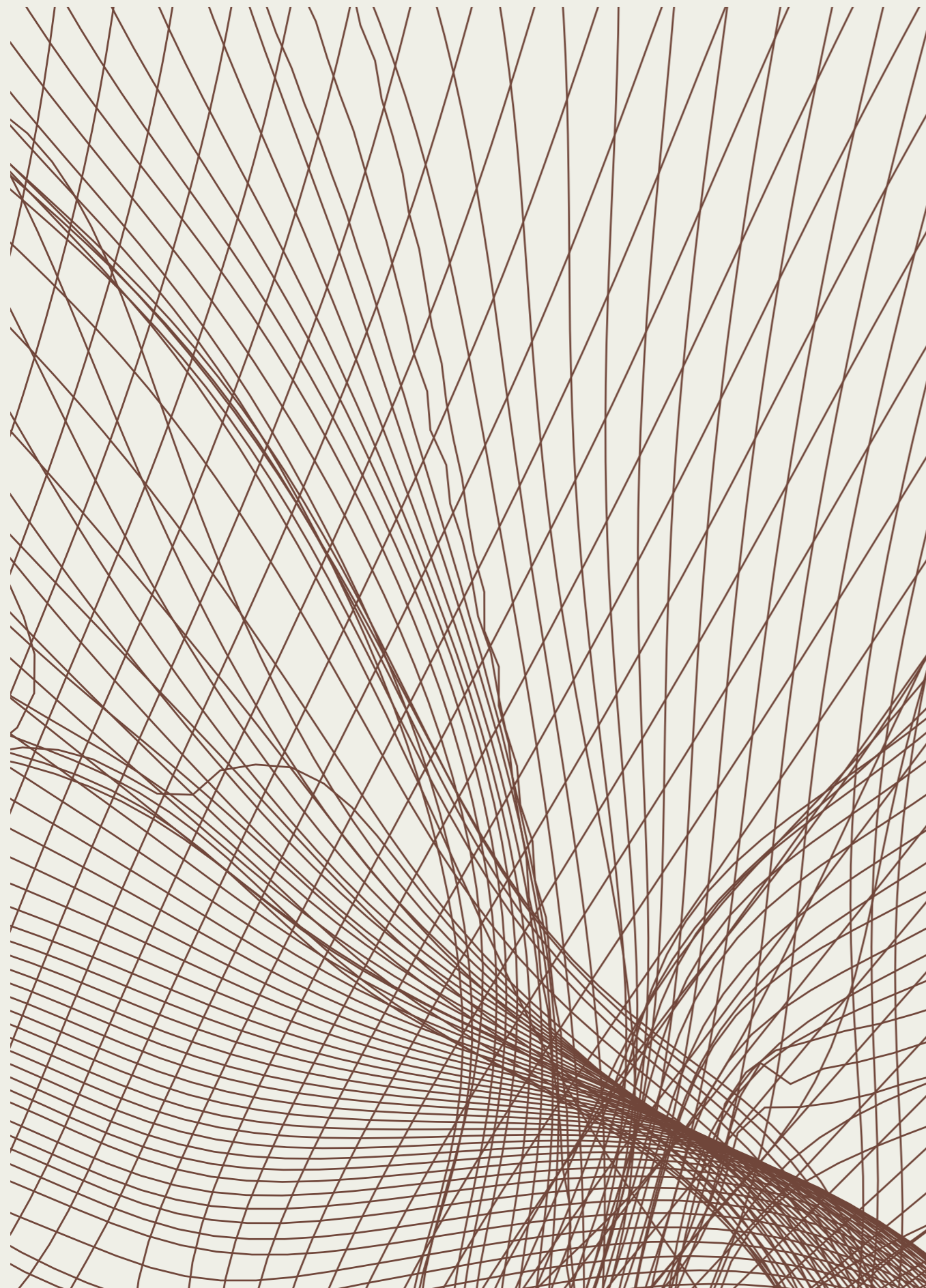
The interview analysis discerned five prominent themes: Cultural and Environmental, Preservation, Reliability, Comunication, Heightened Emotions and Technological Advancements, as outlined in Table 1. Among these, Culture, Preservation, and Accessibility emerged as the most predominant themes throughout the interviews. The respondents exhibited a consistent attachment to Fijian culture, reflecting a shared value system. This coherence in values underlines the enduring significance of cultural preservation and the ongoing challenges posed by accessibility in the context of disaster preparedness and communication within Fiji.

Cultural and Environmental, Preservation emerged as a pivotal factor in respondents' perspectives. Respondent 3, a former Fijian resident, preferred village leaders to retain their traditional role in advising the community about impending natural disasters. In contrast, Respondent 2, a marine biologist, emphasised the potential benefits of integrating emerging technologies into Fiji's forecast communication process.

The theme of accessibility emerged as a significant obstacle in forecast communication. Most respondents highlighted Fiji's status as an underdeveloped nation, resulting in limited access to high-end technology such as televisions and phones. This accessibility challenge highlights the complex landscape that must be navigated to enhance communication and disaster preparedness in Fiji, reflecting the interplay between cultural preservation, technological advancement, and socioeconomic conditions.

The interviews with respondents consistently underscored the paramount importance of cultural preservation. Within the Pacific Islands, notably in Fiji, a community's identity and cohesion are intricately linked with the perpetuation of cultural traditions. When queried about the prospect of introducing innovative technology to enhance weather forecasting communication in remote villages, participants exhibited a favourable disposition toward the current implementation of mobile and television alerts in these contexts. However, it was acknowledged that the prevalence of power outages during hurricanes presents a notable challenge to such technological solutions.

Furthermore, respondents articulated a solid inclination to embrace novel communication systems that align with the overarching objective of safeguarding and fostering Fiji's rich social and cultural fabric. This sentiment highlights the community's resilience and adaptability in the face of environmental and technological changes, all in preserving their cultural heritage.

Respondents highlighted the shared experience of fear and panic during natural disaster preparations. They stressed the essential role of village leaders and government officials, as community trust depends on their reliability. It is also important to note that word of mouth is a vital communication method in remote communities, underscoring the necessity for these trusted figures to convey crucial information effectively. This insight emphasises the significance of interpersonal trust and informal communication networks in disaster-prone areas, illustrating the complex dynamics of disaster preparedness and community resilience.

Discussion

A comprehensive literature review identified several key opportunities and challenges that confront forecast communication on a global scale. Nevertheless, the literature under discussion did not provide the geographical details necessary to address the research question. Primary research successfully collected specific information about the Pacific Island region, thereby addressing gaps in the existing literature. This discussion intends to conduct a comparative analysis between the literature and the research findings.

The scarcity of literature regarding forecast communication in the Pacific Islands represents a significant knowledge gap that has far-reaching implications for disaster preparedness and community resilience in this vulnerable region. Despite being home to diverse cultures and communities, each facing unique challenges in the context of climate change and extreme weather events, the Pacific Islands have yet to receive the attention they deserve in academic research and literature on forecast communication. This notable void can be attributed to several factors.

Firstly, limited research focus has been dedicated to this region, leaving it largely underrepresented in the global discourse on weather communication. Many studies in this field focus on larger, more densely populated areas, which may overshadow the specific needs and challenges faced by the Pacific Island nations.

Secondly, the Pacific Islands present unique challenges when it comes to forecast communication. These challenges, such as geographical isolation, cultural diversity, and limited resources, demand tailored research and strategies (16). The traditional 'one-size-fits-all' approach to forecast communication often overlooks the nuances and complexities of the Pacific Islands, further exacerbating the knowledge gap.

Both research methods, namely literature review and primary research, underlined the crucial role that trust plays in disseminating information about impending natural disasters. The literature review revealed a substantial body of existing knowledge that consistently emphasised trust as a fundamental component of effective disaster communication. Numerous scholarly articles and studies have highlighted that trust acts as the linchpin upon which the success of disaster preparedness and response efforts hinges.

In the literature, it is abundantly clear that trust is pivotal in establishing credibility and fostering cooperation among various stakeholders, including government agencies, meteorological institutions, non-governmental organisations, and communities. For instance, research studies from disaster-prone regions consistently emphasise that trust in authorities and institutions responsible for issuing warnings and providing information can significantly influence people's decision-making and actions in the face of impending disasters.

The primary research conducted further corroborated these findings. Through surveys and interviews with individuals residing in vulnerable areas, it became evident that trust was a recurrent theme in their perspectives on disaster communication. Respondents often articulated that their trust in information sources was central in determining whether they took precautionary measures or evacuated when a disaster was imminent. Government agencies, meteorological services, and local authorities emerged as the most trusted sources of information.

Additionally, the primary research uncovered that trust was not solely a function of the source but was also closely intertwined with the information's clarity, consistency, and transparency. Trust is cultivated when information is conveyed in a straightforward and understandable manner, without ambiguity or contradictory messages.

Design Implications

Four pivotal opportunities for future design improvements were identified by effectively synthesizing data from desktop research, surveys, and interviews. A thorough analysis of this dataset enabled meaningful conclusions regarding the requisite elements and priorities in the design domain. This comprehensive approach ensures that the recommendations are firmly rooted in empirical evidence and aligned with the identified needs and preferences through the research process.

Opportunity 1: New Innovation

The survey results have unveiled a promising opportunity to develop new innovations to enhance forecast communication within Fiji. Notably, the respondents have exhibited a high level of receptiveness and willingness to embrace such advancements in forecast communication. With the majority of survey participants expressing openness to adopting new technological tools to improve hurricane forecast communication, it is evident that there is a fertile ground for innovation in this domain. This receptiveness reflects the potential for an enhanced forecast communication infrastructure to empower Pacific Island residents with more accurate, timely, and accessible information during critical weather events. It is a clear call to action for stakeholders within the Pacific Island and internationally to harness this enthusiasm and collaborate in developing cutting-edge solutions that can significantly benefit the region's disaster preparedness and resilience in the face of natural disasters.

Opportunity 2: Culture and Environmental Preservations

The importance to preserve Fiji's rich cultural heritage and its natural habitat for future generations presents a compelling rationale for enhancing forecast communication. Recognising the profound significance of these cultural and environmental assets, a clear opportunity exists to align efforts in forecast communication with broader objectives of safeguarding Fiji's unique identity and ecological balance. By effectively disseminating accurate and timely weather forecasts, not only is the safety and well-being of current generations ensured, but also the protection of the cultural and natural treasures that define Fiji (16). The synergy between forecast communication improvements and the preservation of culture and nature underscores the importance of investing in resilient communication infrastructure, as it directly contributes to the overarching goal of securing Fiji's cultural heritage and ecological sustainability for future generations. This intersection of priorities highlights the profound interconnection between effective forecast communication and broader cultural and environmental preservation mission in the Pacific Islands.

Opportunity 3: Community leaders

An opportunity emerges to enhance forecast communication by engaging the local community and preserving the cultural hierarchy intrinsic to Fiji's villages. Recognising the pivotal role of village leaders in conveying impending hurricane warnings, there lies a unique avenue for bolstering the dissemination of crucial weather information. By fostering collaboration between official meteorological agencies and these respected community figures, forecast communication can be enriched through culturally sensitive approaches. This harmonious integration of traditional knowledge and modern forecasting techniques not only empowers the community with accurate and timely hurricane alerts but also reinforces the significance of cultural heritage and village leadership in safeguarding the well-being of local residents. In this way, forecast communication is not just about data transmission; it becomes a platform for preserving and honouring the rich cultural hierarchy that shapes Fijian society while enhancing the region's disaster preparedness and resilience. This collaborative approach underscores the profound impact of community involvement in the context of improved forecast communication.

Opportunity 4: Trust

The survey results reveal a significant opportunity to harness the Fijian community's trust in the National Weather Service and leverage it to adopt new innovations in forecast communication. The high level of trust exhibited by survey respondents towards this official meteorological authority underscores its central role as a credible source of weather information within the region. Given this established trust, there is a clear avenue for the integration of cutting-edge technologies and communication methods by the National Weather Service to enhance its forecast dissemination. This heightened receptiveness among the Fijian population to receive updates from this trusted entity presents a favourable environment for the implementation of innovative tools, such as advanced forecasting models and real-time data visualisation aimed at further improving the accuracy, timeliness, and accessibility of natural disaster preparedness.

Concepts

CONCEPT 1

Incorporating cutting-edge features, this speaker device not only boasts an army-grade siren alert system for swift and unmistakable weather warnings but also includes a unique microphone system exclusively accessible by the village leader. To ensure uninterrupted functionality, it harnesses a dual power source, relying on both batteries and solar panels, making it resilient even in prolonged outages. Furthermore, this innovative device demonstrates its commitment to sustainability by tapping into nature itself, connecting to nearby trees to harness energy, ensuring that it can continue to operate efficiently while preserving the fragile ecosystems of these remote Pacific islands.

Key Features

- Army-Grade Siren Alert System
- Village Leader Communication
- Dual Power Sources
- Energy-Efficient
- Meteorological Integration
- Satellite Connectivity
- Remote Location Placement
- Weather-Resistant Construction

Benefits

Reliable Early Warning System
Comprehensive Coverage
Durable Design
Community Safety
Swift Alert Dissemination
Environmentally Sustainable

weather resistant material

army Siren speaker system

Wrapped/attached to trees or poles

green and brown colour to camouflage

CONCEPT 2

A wearable device designed to empower village leaders and authorities in remote Pacific islands with timely natural disaster alerts. This innovative necklace, made from repurposed ocean debris and washed-up ocean life, embodies sustainability while serving a crucial purpose. The device operates seamlessly, using solar power and only uses energy when signifying an alert. When a hurricane approaches, it comes to life with a gentle glow and a subtle vibration, discreetly notifying wearers of impending danger. This discreet and eco-friendly technology ensures that those entrusted with the safety of their communities are always well-informed and ready to take action, safeguarding the lives and well-being of their community while harmonising with the natural environment.

Key Features

- Village leader communication
- Meteorological integration
- Satellite connectivity
- Remote location placement
- Weather-resistant construction
- Light and movement alert system

Benefits

Reliable early warning system
Comprehensive coverage
Durable design
Community safety
Swift alert dissemination
Environmentally sustainable

Leather/beaded strap

Recycled debris

all sizes based on adjustable strap

Shell or coral

Vibration and light when responsive

CONCEPT 3

An advanced at-home alarm system designed to keep residents in remote Pacific islands safe during natural disaster threats. When a hurricane is on the horizon, the alarm system, exclusively activated by the National Weather Service, makes a beeping noise within the house. This alert system provides crucial early warnings to residents, empowering them to take immediate action to safeguard their lives and property. With its widespread accessibility, this device serves as a vital tool in enhancing disaster preparedness for individuals in the remote Pacific islands, ensuring that no one is left unaware of impending danger.
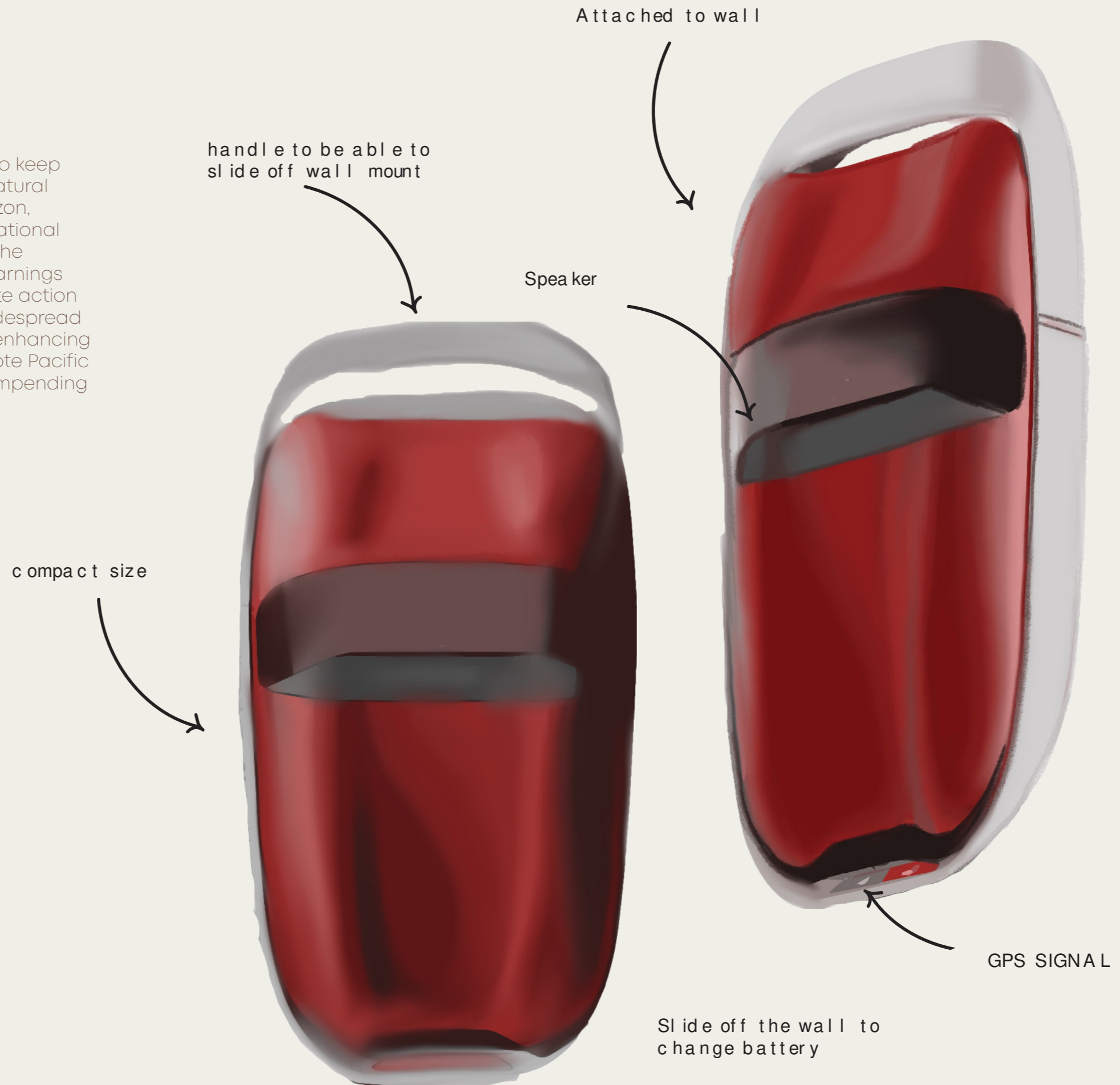
Key Features

- Sound alerting system
- Meteorological integration
- Satellite connectivity
- Portable and tacticle shape
- Weather-resistant construction
- GPS notification system

Benefits

Reliable early warning system
Comprehensive coverage
Durable design
Community safety
Swift alert dissemination

Attached to wall

handle to be able to slide off wall mount

Speaker

compact size

GPS SIGNAL

Slide off the wall to change battery

CONCEPT 4

An essential portable speaker device tailored to the needs of those in remote Pacific islands, whether they are out at sea fishing or exploring secluded mountainous terrains devoid of signals and human presence. Warning alerts reach the portable speaker device, which operates efficiently on batteries, ensuring it functions even in the most remote locations. Moreover, the device is equipped with a GPS location system that users can activate to alert authorities of their precise location and request assistance when needed, adding an extra layer of security for those navigating the challenging landscapes of the Pacific islands.

Key Features

- Sound alerting system
- Meteorological integration
- Satellite connectivity
- Portable and tacticle shape
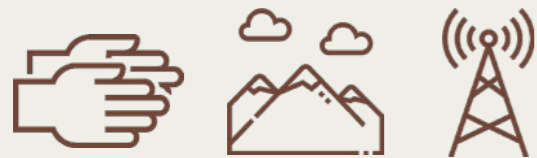- Weather-resistant construction
- GPS notification system

Benefits

Reliable early warning system
Comprehensive coverage
Durable design
Community safety
Swift alert dissemination
GPS tracking

GPS CONTROL BUTTON

Signal antenna

compact/
Easily fit in hand

Front alert Speaker

WEATHER PROOF MATERIAL

Ergonomic ridges

CONCEPT 5

Introducing a revolutionary keychain device designed to provide critical hurricane alerts to locals in remote Pacific islands. This innovative device offers a user-friendly solution available to anyone, as it can be attached to your keys, bag, etc. Crafted from sustainable ocean driftwood, it not only serves its purpose effectively but also contributes to environmental conservation. The operation is simple and intuitive – when a hurricane is approaching, the keychain emits a gentle glow and a subtle vibration, alerting users to impending danger. Its accessibility and eco-friendly design make it an indispensable tool for individuals in these remote regions, ensuring that they can stay informed and take necessary precautions when facing the unpredictable forces of nature.
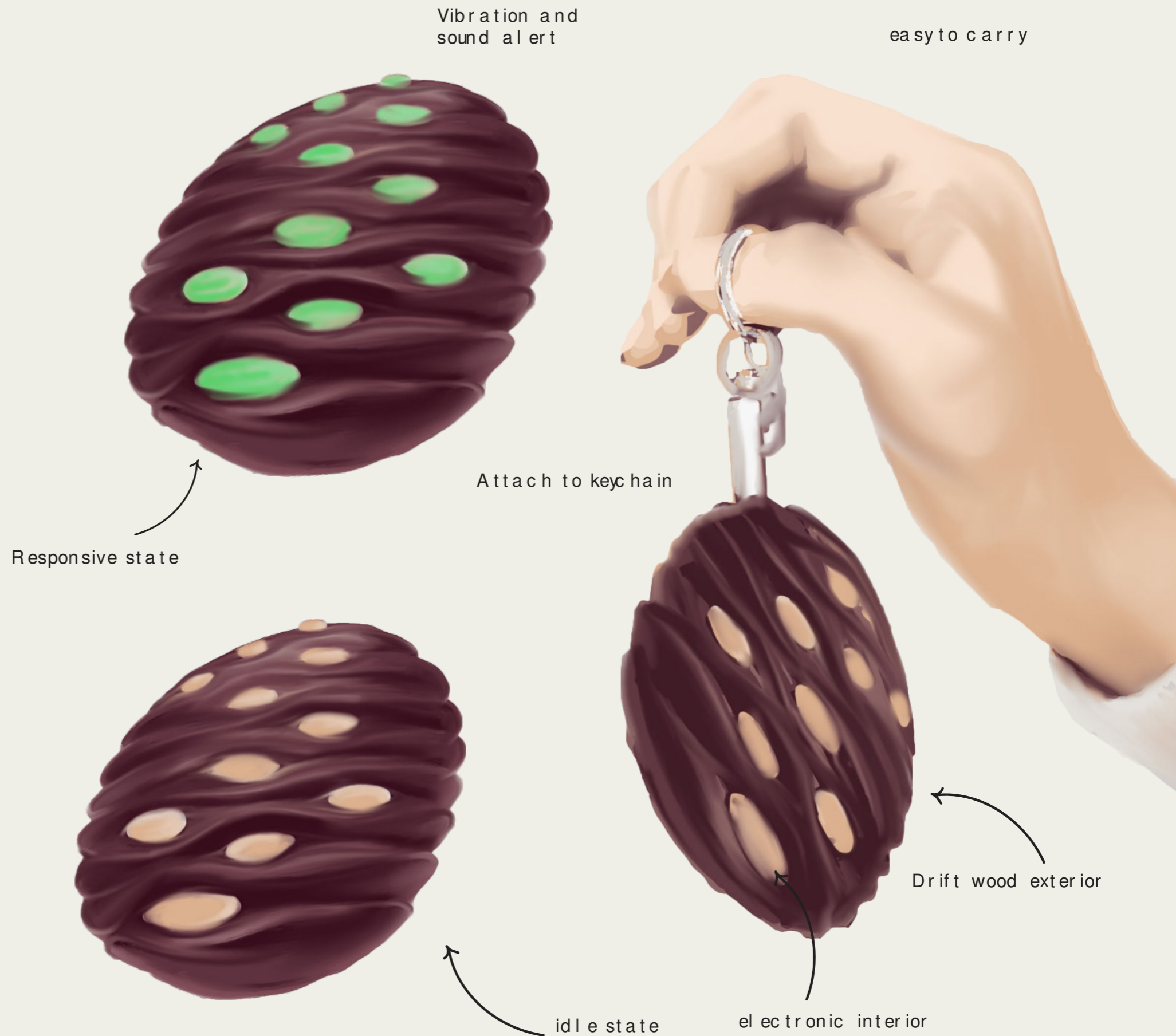
Key Features

- Village leader communication
- Meteorological integration
- Satellite connectivity
- Remote location placement
- Weather-resistant construction
- Light and movement alert system

Benefits

Reliable early warning system
Comprehensive coverage
Community safety
Swift alert dissemination
Environmentally sustainable

Vibration and sound alert

easy to carry

Responsive state

Attach to keychain

idle state

electronic interior

Drift wood exterior

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Conclusion

This report highlighted the pressing need for effective and prompt forecast communication in remote villages of underdeveloped nations, with a particular focus on the challenging circumstances of the Pacific Islands. Exploration began with a thorough review of existing literature, which pinpointed gaps in our understanding, particularly in the specific context of the Pacific Islands. These identified gaps clearly emphasised the urgent requirement for primary research to gain a more nuanced grasp of the intricate issues surrounding forecast communication in these isolated communities.

To address these knowledge gaps, primary research was conducted through a combination of surveys and interviews. This method allowed direct engagement with the residents and experts in the Pacific Islands, providing valuable insights, perspectives, and real-life experiences. Importantly, this approach led to a comprehensive understanding of the multifaceted challenges and opportunities associated with forecast communication in these remote areas.

The findings from our research have underscored the importance of incorporating cultural sensitivity and a community-centric approach into the design of future communication systems. Trust and acceptance of new technologies in these underdeveloped villages are intertwined with the cultural fabric and local dynamics. Therefore, any efforts to innovate or intervene in the realm of forecast communication must begin with a deep appreciation of the community's values, norms, and preferences.

While the need for effective and rapid forecast communication in remote, underdeveloped villages is undeniable, the path forward requires a profound respect for the cultural identity of these communities. Integrating their voices, values, and trust into the development of new technologies is not just a necessity but also a testament to the principles of sustainable, community-centred development. By adhering to these principles, we can ensure that crucial information for safeguarding lives and livelihoods reaches those who need it most in the Pacific Islands and similar remote regions around the world.
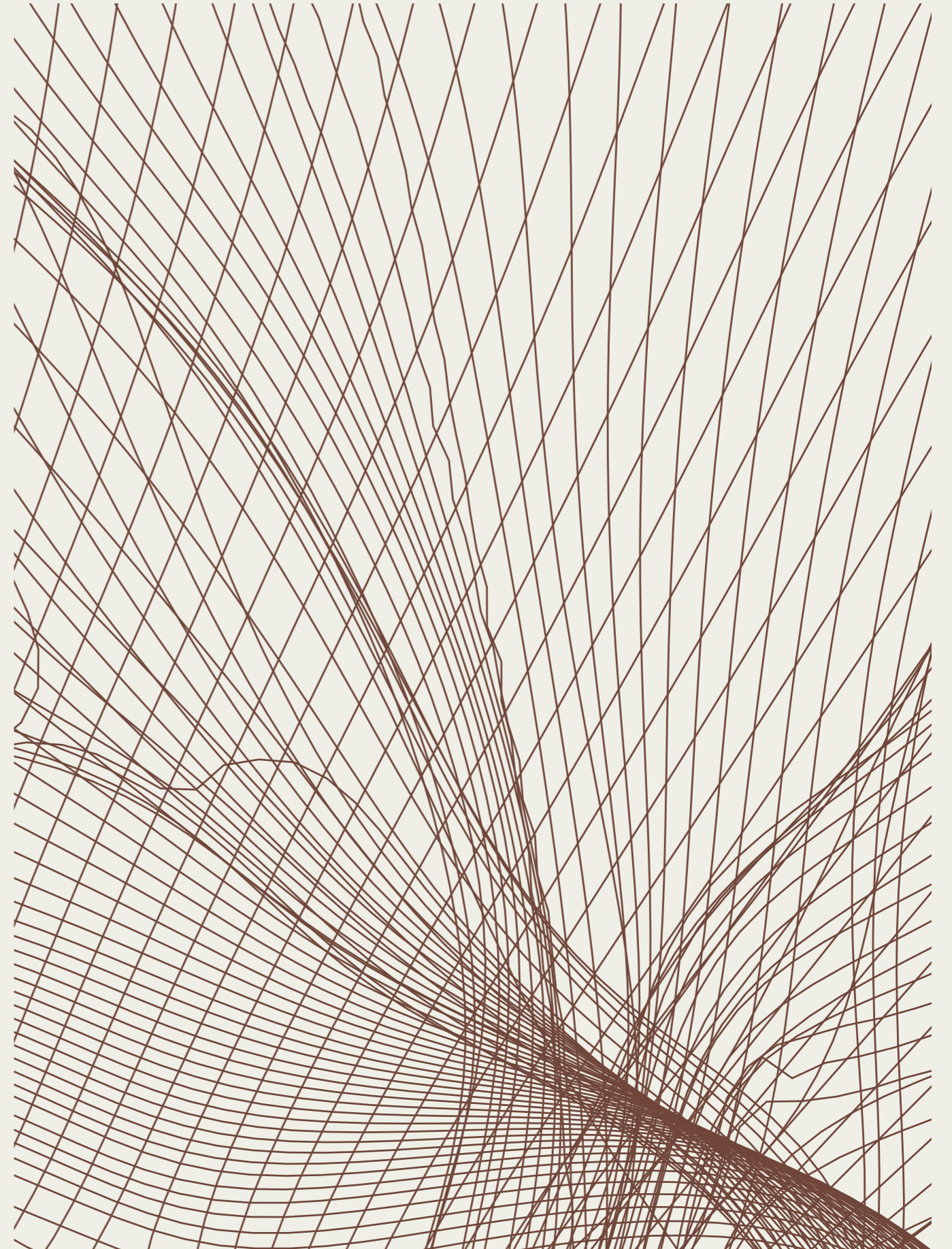
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Appendix

What is your age?
- ○ Under 18
- ○ 18-24
- ○ 25-34
- ○ 35-44
- ○ 45-54
- ○ 55-64
- ○ 65 and over

Where do you currently live?
Short answer text

What is your employment status?
- ○ Employed (Full-time or Part-time)
- ○ Self-employed
- ○ Unemployed
- ○ Student
- ○ Retired
- ○ Other…

Have you personally experienced a natural disaster in Fiji? (e.g., cyclone, flood, earthquake)
- ○ Yes
- ○ No
- ○ Maybe

If yes, please briefly describe your most significant experience with a natural disaster in Fiji.
Long answer text

Have you ever had to evacuate your home or community due to an approaching natural disaster?
- ○ Yes
- ○ No
- ○ Maybe

If you have evacuated, where did you go, and how did you make the decision to evacuate?
Short answer text

When you know that a hurricane is approaching your area, what are the primary emotions or feelings you typically experience? (Select all that apply)
- ☐ Fear
- ☐ Anxiety
- ☐ Stress
- ☐ Anger
- ☐ Panic
- ☐ Helplessness
- ☐ Preparedness
- ☐ Excitement
- ☐ Other…

How do you usually receive hurricane warnings and updates? (Check all that apply)
- ☐ Radio
- ☐ Television
- ☐ Social Media
- ☐ Mobile alerts
- ☐ Community Announcements
- ☐ Other…

Among the various methods of hurricane forecast communication, which one(s) do you trust the most for accurate and timely information? (Select up to three)
- ☐ National Weather Service or meteorological agency broadcasts
- ☐ Local community leaders or authorities
- ☐ Weather apps and websites
- ☐ Television and radio broadcasts
- ☐ Social media updates from official sources
- ☐ Word of mouth from friends and family
- ☐ Phone alerts
- ☐ Other…

What factors influence your level of trust in the chosen method(s) of hurricane forecast communication?
Short answer text

How important do you believe it is to preserve and protect the cultural heritage and natural environment of Fiji for future generations?

	1	2	3	4	5	
Not important	○	○	○	○	○	Very important

What preparations do you typically make when you hear that a hurricane is approaching your area?
Short answer text

How well do you think your community is prepared for hurricanes?

	1	2	3	4	5	
Not well-prepared	○	○	○	○	○	Very well-prepared

How willing are you to adopt or use new technological tools or innovations introduced to enhance hurricane forecast communication and preparedness in Fiji?

	1	2	3	4	5	
Very unwilling	○	○	○	○	○	Very willing

Interviewer: It must have been a fascinating time to work in meteorology. How did you gather information about approaching weather events like hurricanes and cyclones during that era?

METHOD

Former Head of Meteorology: Back in the 1970s, our access to weather information was quite different from today. We relied heavily on international meteorological agencies and their data-sharing initiatives. These agencies provided us with information about weather patterns, including the development and movement of hurricanes and cyclones. It was crucial for us to have access to this global network of meteorologists to stay informed.

Interviewer: It's intriguing to learn about the international collaboration even in that era. How did you go about disseminating this information to the public and city leaders?

Former Head of Meteorology: Communication was a bit more challenging compared to today's instant updates. We worked closely with national news agencies to relay weather forecasts and warnings to the public. The process involved preparing detailed reports and working with news outlets to ensure that the information reached as many people as possible.

In addition to informing the public, we had a direct line of communication with prominent city leaders. It was essential to address them directly, providing them with the latest weather information and forecasts. This ensured that they could make informed decisions to protect their communities.

Interviewer: It's clear that communication played a crucial role in your responsibilities. Can you share a particularly memorable moment or experience from your 20 years in the field during the 1970s?

Former Head of Meteorology: One memorable and challenging moment was during Cyclone Bebe in 1972. It was a powerful storm that caused extensive damage in Fiji. At that time, we had limited technology and resources compared to today, and communicating the impending disaster was a significant struggle.

We did our best to provide warnings and updates through national news outlets and city leaders, but the devastation was still immense. It was a stark reminder of the importance of accurate and timely weather information, as well as the need for continuous improvement in disaster preparedness.

Sample of Participant 1

Interviewer: Thank you for joining us today. Can you tell us about your experiences and why you're so passionate about your work?

Marine Biologist: Certainly, it's a pleasure to be here. My journey as a marine biologist has taken me to some incredible places, including the Marshall Islands and Fiji. What drives my passion is the importance of preserving our natural world for future generations.

Interviewer: That's a noble cause. Can you share a bit about your experiences in the Marshall Islands and Fiji and what you've learned from your time there?

Marine Biologist: Working in the Marshall Islands and Fiji has been both rewarding and eye-opening. These islands are home to some of the most diverse and fragile marine ecosystems on the planet. I've had the privilege of studying and experiencing the vibrant coral reefs, pristine waters, and unique marine life.

But I've also witnessed the challenges these ecosystems face, from overfishing to the impacts of climate change. It's reinforced my belief in the importance of conservation efforts to protect these natural wonders.

Bio

Interviewer: It's clear that your work has given you a deep appreciation for these environments. Why do you feel it's essential to adopt new innovations and technologies in your field?

Marine Biologist: The adoption of new innovations and technologies is crucial for several reasons. First and foremost, it allows us to collect data more efficiently and accurately. Whether it's using underwater drones to study marine life or advanced sensors to monitor water quality, these tools enable us to make informed decisions and track changes in our ecosystems more effectively.

Secondly, innovation helps raise awareness. Through virtual reality experiences, live-streamed underwater expeditions, and interactive educational platforms, we can engage people globally and inspire them to care about these fragile ecosystems.

?

Lastly, new technologies often provide sustainable solutions. From aquaculture techniques that reduce the pressure on wild fish stocks to renewable energy solutions that mitigate the impact of climate change, innovation can lead to more sustainable practices that benefit both the environment and local communities.

Interviewer: Your perspective on the importance of innovation is inspiring. Why do you care so deeply about your work and the preservation of these environments?

Marine Biologist: My passion stems from a profound sense of responsibility. I've been fortunate to witness the beauty and wonder of these ecosystems, and I've seen the impact that human activities can have on them. I believe that we have a moral obligation to protect and preserve these natural treasures for future generations.

Sample of Participant 2

Sample of Participant 3

PARTICIPANT 3

Interviewer: Thank you for joining us today. We understand you've experienced hurricanes in Fiji. Can you share your emotions and experiences during that time?

Interviewee: Of course, it's my pleasure to talk about it. Those were incredibly frightening times, to be honest.

Interviewer: I can imagine. How were you warned about the hurricanes approaching?

Interviewee: Well, my father use to be a community leader and use to use a megaphone and hop on a ute to let all people in the compound a hurricane was coming. So I trust that mode of information plus, it's such a nostalgic memory many leaders use a megaphone and I love that"

Interviewer: That sounds like a big responsibility. What were the emotions you and your family went through during these announcements?

Interviewee: Fear and panic, mainly. When my dad's voice echoed through the village via the megaphone, you could sense the urgency in his tone. It made us all realise that we had to act quickly to prepare for the storm. There was this collective feeling of anxiety, knowing that our homes and lives were at risk.

Interviewer: That must have been incredibly stressful. Did you trust the information coming from your dad, or did you rely on other sources, like the national weather services?

Interviewee: We definitely trusted my dad's announcements, but it wasn't our sole source of information. We also paid close attention to the national weather services. They provided valuable data and forecasts, which helped us understand the severity of the approaching hurricane. However, having our village leader personally address us through the megaphone added a more personal and immediate sense of urgency.

Interviewer: It's interesting to hear about the combination of local leadership and national weather services working together to keep the community informed. Can you describe one specific moment during a hurricane when fear and panic were particularly intense?

Interviewee: One vivid memory I have is during Cyclone Winston in 2016. It was one of the most powerful hurricanes to hit Fiji in recent history. When my dad started his announcement that day, the fear in his voice alarming. The wind was already howling, and the rain was pouring down. It was a moment of sheer panic as we rushed to secure our homes and gather our loved ones to find shelter. The entire village was in a state of chaos and fear as we hunkered down and prayed for safety.

Interviewer: That sounds incredibly harrowing. Thank you for sharing your experiences and emotions during those difficult times. It's clear that the combination of local leadership and trusted information sources played a crucial role in helping your community stay as safe as possible during these hurricanes.

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Interviewer: Thank you for joining us today. We understand you've experienced hurricanes in Fiji. Can you share your emotions and experiences during that time?

Interviewee: Absolutely, I'd be happy to. Those were incredibly anxious times, to be honest.

Interviewer: I can imagine. How were you warned about the hurricanes approaching?

Souce

Interviewee: Well, in today's digital age, mobile alerts and television news played a vital role. When a hurricane was on the horizon, we received timely alerts on our mobile phones. It was a stark contrast to the past. We also relied on television news broadcasts for updates on the storm's progress.

Interviewer: That sounds like a more modern approach to staying informed. Do you prefer having a more modern approach compared to let say community announcements?

Interviewee: yeah for sure but also like power outages are a thing so when we got no power these updates on our phone and TV are kind of useless when we can't charge anything.

Interviewer: That is so true. How long do the outages last for?

TRUST

Interviewee: Depends you know. Could be like a couple of hours or days. But I know for a fact that it is days for more of those remote villages.

Interviewer: What were the emotions you and your family went through during these alerts?

Interviewee: Panic, mainly. When those alerts started coming in, you could feel the tension rising in the household. It was a rush to gather supplies, secure our home, and make sure our loved ones were safe. The fear of the unknown and the potential destruction the hurricane could bring was overwhelming.

EMO

Interviewer: It must have been incredibly stressful. Did you trust the information coming from mobile alerts and television news, or did you seek additional sources?

Interviewee: We did trust the information we received through mobile alerts and television news. It was reassuring to have access to real-time updates and expert advice, which helped us make decisions during those moments. But as I said before the reliability of those digital updates only go so far.

Interviewer: would you be open to a digital information method that doesn't need power to operate it?

NEW

Interviewee: 100% that would be sick! Like although Fiji is behind digitally we are getting there so I reckon it would really help.

Interviewer: I can only imagine. How were you warned about the hurricanes approaching?

Interviewee: Well, back in the day, we relied heavily on community updates. It was a close-knit village, and we had a tradition of spreading news and warnings through word of mouth. When a hurricane was approaching, the village leaders would gather everyone and provide updates and instructions. It was a significant cultural tradition, and there was a strong sense of trust in the information shared within our community.

Interviewer: That's fascinating. So, you used community updates to stay informed. How did that make you feel during those moments?

Interviewee: It felt reassuring, in a way. There was a sense of unity and cultural preservation in receiving updates from our community leaders. It made us feel connected and grounded in our heritage. However, it didn't eliminate the fear and panic, especially when we knew a powerful hurricane was on the way.

Interviewer: I see the importance of cultural preservation in your response. Nowadays, with modern technology, do you still rely on community updates, or has that changed?

Interviewee: While I still have a deep respect for our cultural practices, I must admit that modern technology has made a significant impact. We now receive phone alerts from the national weather services. It's a convenient and reliable way to stay informed.

Interviewer: That's interesting. So, between community updates and phone alerts, which method of communication do you trust more?

Interviewee: It's a bit of a dilemma. I have an appreciation for our cultural traditions and the importance of community updates in preserving our heritage. However, in terms of safety, I lean more towards trusting the phone alerts. So, I value both, but for different reasons.

Interviewer: That makes sense. Moving beyond the immediate impact of hurricanes, how important is it for you and your community to keep Fiji's heritage and environment safe?

Interviewee: It's incredibly important. Fiji's culture and natural beauty are treasures we must protect for future generations. Witnessing the ocean rise and the impact of climate change has made it even more urgent. We need to preserve our heritage, which includes our traditional communication methods, while also embracing modern technology to adapt to the challenges of a changing world. It's a delicate balance we strive to maintain.

Sample of Participant 5