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An assessment of the application of global positioning systems technology in disaster preparedness and response. A case of Chimanimani

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DECLARATION

I thus certify that this thesis is the outcome of my own unique efforts and studies, and that it has not previously been offered for degree assessment. All additional sources of information have been recognized with references.

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DEDICATION

This research is dedicated to my parents, other family members and friends for their wavering support, encouragement and guidance. Their presence in my life has made a significant difference, and I am grateful for the love and motivation they have provided me throughout my academic journey. I pray that the good Lord blesses them with abundance mercies for being my rock and for helping me reach my full potential.

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ABSTRACT

The implementation of GPS technology has the potential to significantly improve disaster preparedness and response in Chimanimani. However, its full application is currently constrained by existing infrastructure and technical capacity gaps. Thus, assessing its effectiveness and feasibility is essential. The limited utilization of GPS technology in disaster preparedness and response within Chimanimani impedes efficient emergency management and resource allocation, thereby exacerbating the risk of damage and loss of life. This study aims to bridge this knowledge gap by evaluating the current state of GPS technology usage, identifying challenges as well as opportunities for enhancement, and formulating recommendations to facilitate its adoption. Chimanimani, a district located in Manicaland Province, Zimbabwe, frequently faces natural disasters such as cyclones, floods, and landslides. The target population for this study includes disaster management stakeholders in Chimanimani encompassing local authorities, emergency responders, and community leaders selected through purposive and random sampling techniques to gather expert insights. A mixed methods approach was employed in this research combining both qualitative and quantitative data collection along with analysis methodologies. Descriptive data analysis was utilized to identify patterns within qualitative information while descriptive statistics were applied for summarizing quantitative data. The objectives of this research include: assessing the current state of disaster management practices within Chimanimani, investigating gaps within these practices, exploring the potential role of GPS technology in enhancing disaster response efforts, optimizing resource allocation, developing a practical framework for integrating GPS technology into existing disaster management systems. Findings from this study indicate that integrating GPS technology can markedly enhance the efficacy of disaster response mechanisms and resource allocation and develop a practical framework for integrating GPS technology into disaster management systems. The findings indicate that GPS technology can significantly enhance disaster response efficiency and effectiveness in Chimanimani, but successful implementation requires addressing infrastructure and technical capacity gap. The study recommends the development of a comprehensive GPS based disaster management system, coupled with capacity building and infrastructure upgrading to enhance disaster preparedness and response in Chimanimani.

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LIST OF ABBREVIATIONS

EMA	Environmental Management Agency
GPS	Global Positioning Systems
FEMA	Federal Emergency Management Agency
ITU	International Telecommunication Union
NGOs	Non-Governmental Organizations
SADC	Sothern Africa Developing Countries
UNICEF	United Nations International Children's Fund
UNGGIM	United Nations Global Geospatial Information Management
UNDP	United Nations Development Programs
WHO	World Health Organization
ZIMSTATS	Zimbabwe National Statistics Agency
ZINWA	Zimbabwe National Water Authority

CHAPTER 1: INTRODUCTION

1.1 Introduction

Chimanimani has faced the devastating wrath of floods, landslides, and other catastrophic events, leaving scars on both the land and its inhabitants. In the face of such diversity, the need for effective strategies to prepare for and respond to disasters has never been more urgent. Fortunately, Global Positioning Systems offer a glimmer of hope, controlling the power of modern technology to provide precise and real-time location data. This tool has the potential to transform the way we navigate and overcome the challenges posed by natural disasters. This research project explores the application of Global Positioning Systems (GPS) in enhancing the region's resilience and adaptive capacity. By delving into the practical implementation of GPS technology can facilitate timely evacuations, optimize resource allocation, and empower local communities with accurate information during critical moments of crisis. The urgency of our research is underscored by the escalating frequency and severity of catastrophes intensified by climate change. The lessons we learn from Chimanimani have the power to ignite transformative change, equipping communities with the ability to anticipate, respond, and recover from the unpredictable forces of nature. In this study, we investigate how GPS technology might be used in emergency situations.

1.2 Background of the Study

How disasters have become more frequent and more severe on a worldwide scale in recent years has profoundly affected the lives of millions of individuals, either directly or indirectly. Rising global temperatures, extreme weather events like cyclones, floods and frequent droughts, are responsible for the deaths of millions of people. These incidents have raised many serious questions before the human society. Depending on the severity and scope of the disaster, a predetermined system or stratified sequence of actions should be applied in order to deal with it correctly. Tropical cyclones find it difficult to pass through the area due to the topography, which is very rough and features several peaks and ravines. As a result, most of the strength of Cyclone Idai was directed at the eastern high lands of Chimanimani, concentrating heavy rains in the district (Kunze, 2021). High agricultural production is a feature of the soils. As the soil particles are well-graded and consolidated, they are less susceptible to erosion, allowing farmers to cultivate crops on slopes and in hilly terrain. Due to a lack of suitable property, some cities have been obliged to

build themselves along landslide prone streams and on dangerously steep hillsides. The local authority has also been building settlements in regions that are visibly unsafe and vulnerable. On slopes that are especially susceptible to landslides, logging, residential and infrastructural construction, among other activities, continue to grow. Due to the widespread uprooting, cutting, and burning of trees by illegal squatters to develop farmland, the mountains have lost a considerable amount of their tree cover. According to a 2019 study conducted by Environmental Management Agency's (EMA), flood-affected areas were primarily found along streams, in floodplains, and on steep slopes. In March 2019, Cyclone Idai devastated the Chimanimani District. The Cyclone brought severe winds and heavy rain to the Chimanimani District affecting at least half of the total population of about 135,000 (2012, Census) in 15 of the 23 wards (UNICEF, 2019). The cyclone triggered landslides, riverine flooding, and flash floods, resulting in fatalities as well as property damage. According to the Chimanimani District Development Coordinator, Cyclone Idai left roughly 4000 people homeless, more than 325 people missing, and about 300 people dead (Matsvange et al. 2020). When we can determine the scope, prevalence, and groups most affected by the crisis, we are better prepared to make judgments. Here, the research would want to draw attention to the fact that without knowing the disaster's nature and scope, efforts to respond will be ineffective and may even cause additional problems. The cyclone is the focus of this research where the application of GPS in disaster preparedness and response in Chimanimani is going to be examined.

1.3 Problem Statement

Despite the potential benefits of Global Positioning System (GPS) technology in disaster preparedness and response, there is a lack of comprehensive understanding regarding its application in the context of Chimanimani. This research aims to evaluate the effectiveness and challenges of using GPS technology for disaster preparedness and response in Chimanimani, Zimbabwe, with the goal of identifying strategies to enhance its utilization and improve disaster management outcomes. While Global Positioning Systems technology has the potential to greatly improve disaster management efforts, its specific implementation and effectiveness in Chimanimani have not been thoroughly examined. Currently, there is limited research or studies that have specifically addressed the utilization and impact of GPS technology in this region. The absence of a comprehensive assessment poses challenges for understanding the extent to which

GPS technology is being used, the unique benefits it provides, and the challenges that may prevent its effective use in disaster preparedness and response efforts in Chimanimani. Without a thorough review, it is difficult to identify the current strengths and shortcomings of GPS technology, as well as areas for improvement. As a result, there is a large research gap in understanding GPS technology applications, and potential improvements. Therefore, there is a huge study vacuum in understanding the use of GPS technology for disaster preparedness and response in the region. This assessment would provide useful insights to the existing level of GPS technology implementation, identify areas for improvement, and inform the formulation of initiatives to enhance its utilization and improve disaster management outcomes in Chimanimani.

1.4 Justification

In recent years, the frequency and intensity of natural disasters have increased, necessitating effective strategies for disaster management. GPS technology has emerged as a promising tool to enhance preparedness and response efforts, enabling accurate tracking, mapping and communication during emergencies. However, its specific application and impact in the context of Chimanimani remain understudied. This study seeks to bridge this information gap by assessing the efficacy of GPS technology in enhancing disaster management techniques across the region. The results of this investigation will contribute to the existing body of knowledge, assist policy makers, disaster management agencies and humanitarian organizations in making informed decisions, and potentially enhance disaster preparedness and response practices in Chimanimani and similar regions.

1.5 Aim of the Research

The aim is to assess the usability of GPS in disaster preparedness and response in the Chimanimani district and make recommendations for its best use.

1.5.1Specific Objectives

1. Assess the use of GPS in improving disaster preparedness and response in Chimanimani.
2. Evaluate the extent to which GPS technology has been implemented in disaster preparedness and response efforts in Chimanimani.
3. Determine the impact of GPS technology on improving disaster response, coordination, communication and decision making in Chimanimani.

1.6 Research Questions

1. How has GPS technology improved disaster preparedness and response efforts in Chimanimani?
2. What are the most significant problems and limitations in using GPS technology for disaster management in Chimanimani?
3. Which recommendations can be made to enhance the effective utilization of GPS technology in disaster preparedness strategies in Chimanimani?

1.7 Assumptions

1. The availability and accessibility of GPS technology in Chimanimani are adequate for disaster preparedness and response efforts.
2. Local authorities and disaster management agencies in Chimanimani have integrated GPS technology into their disaster preparedness and response strategies.
3. GPS technology can be effectively utilised in identifying and assessing disaster prone areas in Chimanimani.
4. GPS technology enables timely and accurate communication and coordination among relevant stakeholders during disaster events in Chimanimani.
5. The use of GPS technology enhances the efficiency and effectiveness of search and rescue operations in Chimanimani.

Definition of terms

Global location Systems (GPS) are satellite-based navigation systems that provide accurate location and timing information anywhere on Earth. GPS is made up of a network of satellites, ground control stations, and user receivers. The method operates by calculating the distance between the receiver and many satellites to identify the receiver's exact location. GPS technology has several applications, including navigation, mapping, and disaster management (McGraw-Hill, 2008).

Disaster Preparedness refers to the actions, plans, and measures taken in advance to minimize the impact of disasters and enhance resilience. It involves activities such as risk assessment, development of emergency response plans, establishment of early warning systems, training and

capacity building and resource allocation. Disaster preparedness aims to increase the ability of communities, organizations and individuals to respond effectively to disasters, reduce loss of life and property and facilitate a swift recovery [Peacock (et.al, 2006)].

Disaster Response refers to the immediate actions taken to address the needs and mitigate the consequences of a disaster. It involves activities such as search and rescue operations, medical assistance, evacuation, provision of emergency supplies and services, coordination of response efforts and restoration of critical infrastructure. Effective disaster response relies on timely and coordinated actions by government agencies, humanitarian organizations and community members to save lives, alleviate suffering and restore normalcy [Bechtold (et. al 2012)].

1.9 Organization of the study

Chapter 1 describes the research challenge, history and aims emphasizing the need of effective disaster management and the potential of GPS technology to improve disaster preparedness and response. Chapter 2 examines the existing literature on GPS technology and its use in disaster management, highlighting gaps and possibilities for development. Chapter 3 discusses the research methodology, which includes the study area, data collection, analytic techniques and ethical considerations. Chapter 4 presents the findings and discussions of this research. Chapter 5 offers recommendations for integrating GPS technology into disaster management in Chimanimani.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter reviews existing literature on the application of Global Positioning Systems (GPS) in disaster preparedness and response with a specific focus on the case of Chimanimani. The literature review aims to explore the potential benefits, challenges and lessons learned from previous research and practical implementations of GPS technology in disaster management globally. The chapter aims to gain insights into the various ways in which GPS has been utilized and its impact on disaster preparedness and response in Chimanimani.

2.2 Definition and scope of GPS

GPS technology has a broad and diverse impact on a variety of industries including transportation, environmental monitoring, disaster management and everyday consumer uses. The technology works primarily through a network of satellites that emit signals, allowing GPS receivers on the ground to pinpoint precise locations. Furthermore, in disaster management, GPS is critical for mapping disaster prone areas, coordinating emergency response and enabling search and rescue operations. GPS integration with Geographic Information Systems increases its utility by allowing for detailed spatial analysis and visualization, which aids in a variety of decision-making processes across several domains.

2.3 Application of Global Positioning Systems in the world

According to a study by the United Nations Global Geospatial Information Management (UN-GGIM), the use of GPS technology has significantly improved disaster management globally, enabling precise location tracking and efficient resource allocation during emergencies (UN-GGIM, 2018). The Federal Emergency Management Response in the United States extensively uses GPS data for floodplain mapping to identify areas at risk of flooding, enhancing community preparedness (FEMA, 2021). A notable example of GPS application was during the 2015 Nepal earthquake (Y Huang et. al, 2017). International search and rescue teams utilized GPS to locate affected areas and navigate difficult terrain, improving response efforts and saving lives. Another example is after Hurricane Katrina in 2005, GPS was used to map the extensive flood damage in New Orleans, serving as a basis for reconstruction plans and future disaster preparedness strategies (National Geodetic Survey, 2005). According to the International Telecommunication Union

(ITU), the number of GPS equipped devices worldwide is projected to reach 7.5 billion by 2025, indicating the widespread availability and potential impact of GPS technology in disaster management (ITU, 2020). However, issues such as signal interference, equipment damage during disasters and the need for technical expertise can hinder GPS effectiveness in the world.

2.3.1 Application of GPS in Africa

GPS have proven valuable tools in disaster preparedness and response efforts in Africa. They enable accurate location information, facilitate communication and coordination among responders and support efficient resource allocation. Temperature contrasts in the African continent between warm ocean waters and cooler air masses can create the conditions necessary for the formation and intensification of low-pressure systems. Hurricanes and tropical cyclones are most commonly observed in the Atlantic Ocean and the eastern coast of Africa, affecting countries such as Cape Verde, Mauritius, Madagascar and Mozambique. In the Southern Africa region, GPS technology has been increasingly adopted in disaster management. For instance, a report by the Southern African Development Community (SADC) highlights the successful deployment of GPS systems in Mozambique for flood monitoring, early warning systems and evacuation planning (SADC, 2019). GPS technology also plays a crucial role in developing early warning systems for natural disasters such as the Indian Ocean Tsunami Warning and Mitigating System in Africa. An example is during the 2010 earthquake in Haiti (Laguerre, 2024). GPS technology has been utilized in disease outbreak response, aiding in the tracking, mapping and movement of responders and supplies during the Ebola outbreak in West Africa. However, compatibility issues, privacy concerns and data integration may hinder effectiveness of GPS technology in Africa.

2.3.2 Application of GPS in Zimbabwe

A survey conducted by the Zimbabwe National Statistics Agency (ZIMSTAT) reveals that only 25% of disaster management agencies in Zimbabwe currently utilizes GPS technology in their operations (ZIMSTAT, 2018). In Chimanimani specifically, the application of GPS technology in disaster preparedness and response is still in its early stages. However, a local case study conducted by the Chimanimani District Office of Civil Protection demonstrates the potential benefits of GPS in improving coordination between response teams and facilitating search and rescue operations during Cyclone Idai in 2019 (Chimanimani District Office of Civil Protection, 2019).

2.4 Conceptual framework

GPS technology is the central concept, with disaster preparedness and disaster response as sub-concepts that intersects with GPS technology. These sub-concepts are further linked to community impact, highlighting the importance of considering the effects of GPS technology on local communities in disaster management. The framework then proceeds to the assessment of the application of GPS technology, which evaluates the effectiveness of GPS technology in disaster preparedness and response, as well as its community impact. This assessment informs the final component of the framework analysis, which examines the relationships between GPS technology, disaster preparedness, disaster response, community impact and identify the areas for improvement. The analysis component is divided into three objectives: examining the current state of GPS technology in disaster preparedness and response, identify challenges in GPS technology application and developing recommendations for enhancing GPS technology adoption. By following this conceptual framework, the research provides a comprehensive understanding of the role of GPS technology in disaster management in Chimanimani and offers practical recommendations for improving disaster preparedness and response while also considering the impacts on local communities. A conceptual framework showing this was constructed below.

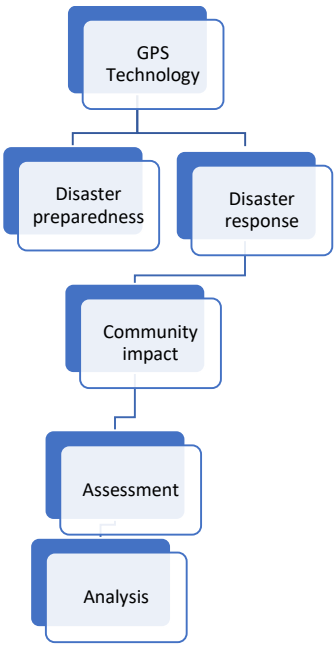

Figure 2.1: A conceptual framework showing the application of GPS technology in this research (Source: Primary data 2024)

The framework presented in Figure 2.1 is integral to the research as it systematically organizes the primary components of GPS technology's application within disaster management. This spans from its deployment in disaster preparedness and response to its consequent impact on communities. By placing GPS at the core, the framework underscores its pivotal role in augmenting disaster management initiatives. The sub-components related to disaster preparedness and response elucidate how GPS technology is practically utilized, while the element focused on community impact articulates the ultimate objective: mitigating disasters' effects on communities. Subsequent elements concerning assessments and analyses denote essential evaluative processes required to gauge GPS technology's effectiveness in fulfilling this goal.

2.5 Theoretical framework

This research project centers on the application of Global Positioning Systems (GPS) in the context of disaster preparedness and response in Chimanimani. By integrating GPS technology, precise

and real-time positioning data can be acquired, which significantly enhances disaster management efforts such as early warning systems, evacuation planning, and search and rescue operations. Through a thorough examination of the role played by GPS in Chimanimani, this study aims to assess its effectiveness and identify potential areas for improvement within disaster preparedness and response strategies in the region. The theoretical framework guiding this research is based on the Technology Acceptance Model (Davis et al., 1989), as presented above.

2.5.1 The Davis Technology Acceptance Model (TAM)

The Technology Acceptance Model was proposed by Davis (1989). This model architecture comprising five building blocks sequentially connected is as shown on Figure 2.2.

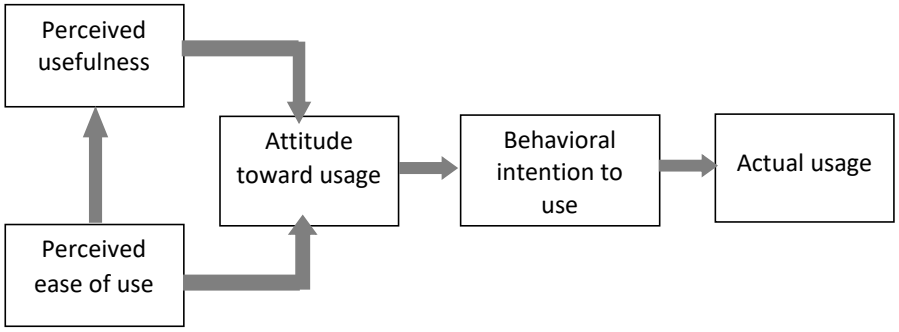

Figure 2.2: Technology Acceptance Model (TAM) after Davis 1989)

According to TAM, perceived usefulness and simplicity of use are important factors in determining users' acceptance and adoption of technology. In the context of disaster planning and response, TAM implies that if people believe GPS technology can improve coordination, communication and decision making during emergencies, they are more likely to accept and use it. The technology acceptability model has been frequently used in research initiatives that investigate technology uptake and acceptability. For example, in Wang et al.'s (2019) study on the adoption of GPS technology in emergency response, TAM was used to analyze emergency responder's perceptions of GPS' utility and simplicity of use. The findings emphasized the importance of TAM in identifying the factors influencing adoption and effectiveness of GPS in disaster management. By applying TAM, this research can explore the factors influencing the acceptance and effectiveness of GPS in Chimanimani, such as user perceptions, attitudes and intentions towards the technology.

2.5.2 Relevance of the model to the study

The Technology Acceptance Model is extremely important to this study endeavor because it provides a theoretical framework for analyzing the acceptability and adoption of GPS technology

in disaster preparedness and response. According to Davis (1989), TAM proposes that an individual's intention to use a technology is determined by two important factors which are perceived usefulness and perceived ease of use. The perceived utility of GPS technology in disaster management relates to how much people believe it can help them be more effective in catastrophe mitigation and response. Understanding TAM allows this study project to examine the factors impacting the acceptability and adoption of GPS technology in Chimanimani, providing insights into potential barriers and allowing solutions to encourage its effective use (Venkatesh et. al 2000).

2.6 Impacts of Cyclone Idai

In March 2019, Cyclone Idai emerged as one of the most catastrophic tropical cyclones to affect the region. The storm inflicted extensive destruction and had profound impacts across various dimensions. Accompanied by heavy rainfall and strong winds, Cyclone Idai resulted in widespread devastation and significant loss of life. The intense rains led to severe flooding that submerged vast areas, severely damaging infrastructure such as roads, buildings, and bridges (Smith et al., 2020). Additionally, the flooding induced landslides that buried homes, villages, and infrastructure under layers of mud, posing substantial challenges for rescue and relief teams attempting to access affected regions and deliver timely aid (Johnson et al., 2020). Tragically, there were hundreds of fatalities reported with numerous individuals missing or displaced (Ngwenya et al., 2021). The cyclone instigated a humanitarian crisis with thousands in urgent need of emergency assistance including food, water, shelter, and medical care (Chen et al., 2021).Access to affected areas were severely limited making the delivery of aid and rescue operations challenging (Smith et al., 2020). Additionally, cyclone Idai had significant environmental impacts including deforestation as trees were uprooted, soil erosion and contamination of water sources posing significant health risks to the affected population (Brown et al., 2019). The impacts of Cyclone Idai in Chimanimani serve as stark reminder of the immense destructive power of natural disasters and the urgent need for disaster preparedness, early warning systems and resilient infrastructure.

2.7 GPS technology for enhanced disaster preparedness and response

GPS technology has greatly improved Chimanimani's preparedness and response to disasters, especially in the wake of Cyclone Idai's destructive effects in 2019. More precise mapping and real-time monitoring of impacted and susceptible areas have been made possible by GPS technology, allowing for faster identification of high-risk zones and more effective resource

allocation (Jeyaseelan, 2003). This accuracy has made it possible to create stronger communication networks between first responders, local government, NGO's as well as more efficient evacuation strategies (Zhang et al., 2014). Furthermore, GPS data has proven invaluable in post disaster assessments offering vital details for reconstruction endeavors and shaping approaches for future risk reduction (Kouadio et al., 2012). For example, the ability to overlay Geographic Information Systems layers with GPS data aided in identifying infrastructure needs that are critical to the timely delivery of aid and the restoration of normalcy, such as road and bridge repairs (Schnebele et al., 2014). Additionally, by giving exact information on safe zones and evacuation routes, GPS technology has significantly improved community awareness and preparedness reducing risk and increasing the effectiveness of disaster response operations overall (Wang et al., 2013). Thus, the use of GPS technology signifies a significant development in improving the responsiveness and resilience of Chimanimani's disaster management systems which will ultimately save lives and lessen the socioeconomic effects of such catastrophic disasters.

2.8 GPS technology adoption in Chimanimani's disaster management

GPS technology has been widely used in disaster preparedness and response operations in Chimanimani, notably following the devastation caused by Cyclone Idai in 2019. GPS technology has helped in mapping impacted areas, coordinate rescue efforts and deliver aid more efficiently. According to Chanza and Gundu-Jakarasi (2020), GPS enabled devices helped discover and access remote and isolated populations cut off by water and landslides. This made it easier for humanitarian organizations and government authorities to respond quickly. Furthermore, GPS data has been used to produce detailed maps for disaster risk assessment and early warning systems, greatly increasing the region's resistance to future disasters (Mavhura, 2021). By combining GPS technology with GIS responders in Chimanimani have been able to improve disaster management. These developments highlight the importance of GPS in improving the efficiency and effectiveness of disaster response efforts.

2.9 Challenges in applying GPS in disaster preparedness and response in Chimanimani.

Using GPS technology for disaster preparedness and response in Chimanimani poses various obstacles. The region's steep topography and extensive forests can impede satellite signals, resulting in accurate position data (OCHA, 2019). Furthermore, the region's regular extreme weather occurrences like cyclones and heavy rains can damage GPS operation and infrastructure,

complicating attempts to track and coordinate emergency responses (UNDR, 2020). Limited access to stable power sources and telecommunications infrastructure further complicates the constant use of GPS devices, especially in distant and underserved areas (World Bank, 2021). Furthermore, the high cost of advanced GPS technology as well as the requirement for specialized training to operate and analyze GPS data may be prohibitively expensive for local disaster management agencies (IFRC, 2022). These logistical and technological challenges are exacerbated by socioeconomic variables such as lack of financing and resources, which prevent the introduction of complete GPS based disaster management systems. As a result, while GPS technology has potential for improving disaster preparedness and response in Chimanimani, resolving these complex issues is critical for its successful implementation.

2.10 Strategies to minimize the inefficiency of GPS application in disaster preparedness and response.

To reduce the inefficiency of GPS application in disaster preparedness and response, numerous solutions can be implemented. Combining GPS with Geographic Information Systems improves spatial data processing, allowing for more precise mapping of affected areas and resource allocation (Beckmann, 2019). Real-time data sharing and interoperability across agencies and organizations are critical, this may be accomplished using established protocols and cloud-based platforms ensuring that all stakeholders have access to the most up to date information (FEMA, 2020). Furthermore, emerging technologies such as machine learning can improve predictive modelling and risk assessment, resulting in more efficient evacuation routes and emergency strategies (Cutter et al., 2018). Training staff in the proper use of GPS and associated technologies is critical for reliable data gathering and interpretation. Furthermore, building strong infrastructure such as backup systems and redundant communication networks might reduce the impact of anticipated GPS signal outages during disasters (Zhou et al., 2021). Engaging local populations in participatory mapping and crowdsourcing projects can help to expand the data pool, resulting in more comprehensive situational awareness and targeted response plans (Glennon, 2010). Implementing these tactics will considerably improve the efficiency of GPS applications in crisis scenarios, resulting in more effective and prompt responses.

2.11 The gap in literature

The use of GPS technology in disaster management has been extensively researched, with a focus on emergency response and relief activities. However, there is a considerable void in the literature about its involvement in disaster preparedness and mitigation, particularly in Chimanimani. This research project seeks to fill this void by investigating the potential of GPS technology in disaster preparedness and mitigation in Chimanimani, including how it can be used to improve disaster preparedness and mitigation, the challenges and limitations of implementation and how it can be integrated with existing disaster management systems. Recent studies have proved the efficiency of GPS technology in emergency response and relief operations during natural disasters, has potential in disaster preparedness and mitigation, including use in early warning systems and evacuation planning (Author, 2020). More research is needed on its specific applications in disaster preparedness and mitigation in Chimanimani. By filling a vacuum in the literature, this research project will add to the existing body of information on GPS technology in disaster management and provide significant insights into its possible applications in disaster preparedness and mitigation.

2.12 Chapter summary

The literature examined in this chapter emphasizes the importance of Global Positioning Systems, in improving disaster preparedness and response, particularly in natural disaster-prone areas such as Chimanimani. The use of GPS technology has been proved to improve the accuracy and efficiency of disaster management operations, ranging from early warning systems to real-time tracking and resource allocation. However, the assessment identifies various problems such as technology restrictions, physical constraints and the need for proper training and support for local populations. These findings lays a solid foundation for the upcoming chapters, which will delve deeper into the practical uses and usefulness of GPS technology in Chimanimani, addressing identified deficiencies and providing optimization, solutions. This chapter thus establishes the groundwork for a complete and context-specific analysis, opening the way for actionable recommendations to improve disaster resilience through strategic use of GPS.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This chapter delineates the methodology employed to analyze the implementation of GPS technology in disaster preparedness and response within Chimanimani. The objective is to articulate the research design, data collection strategies, and data analysis techniques utilized to achieve this study's goals. With natural disasters becoming more frequent and severe, the importance of robust disaster preparedness and response mechanisms has significantly escalated. GPS technology has demonstrated substantial potential in enhancing these efforts by providing precise and real-time geographic information crucial for informed decision-making. This chapter offers a comprehensive review of the methodological framework adopted to investigate the application of GPS in bolstering disaster readiness and responsiveness in Chimanimani.

3.2 Description of the study area

Chimanimani is situated in the eastern highlands and is known for its rugged terrain, encompassing mountain ranges, deep valleys, and scenic waterfalls. The area's physical features contribute to its unique biodiversity, with diverse vegetation ranging from dense forests to open grasslands. Socio-economically, Chimanimani is primarily rural, with communities engaged in subsistence agriculture, cultivating crops for their own consumption. Small-scale farming, livestock rearing, and traditional livelihoods are prevalent, reflecting the close connection between human activities and the natural environment. Additionally, the region's growing tourism sector offers socio-economic opportunities, attracting visitors interested in exploring the area's natural beauty and engaging in outdoor activities, roads, rivers, railways, schools in Chimanimani District, Figure 3.1

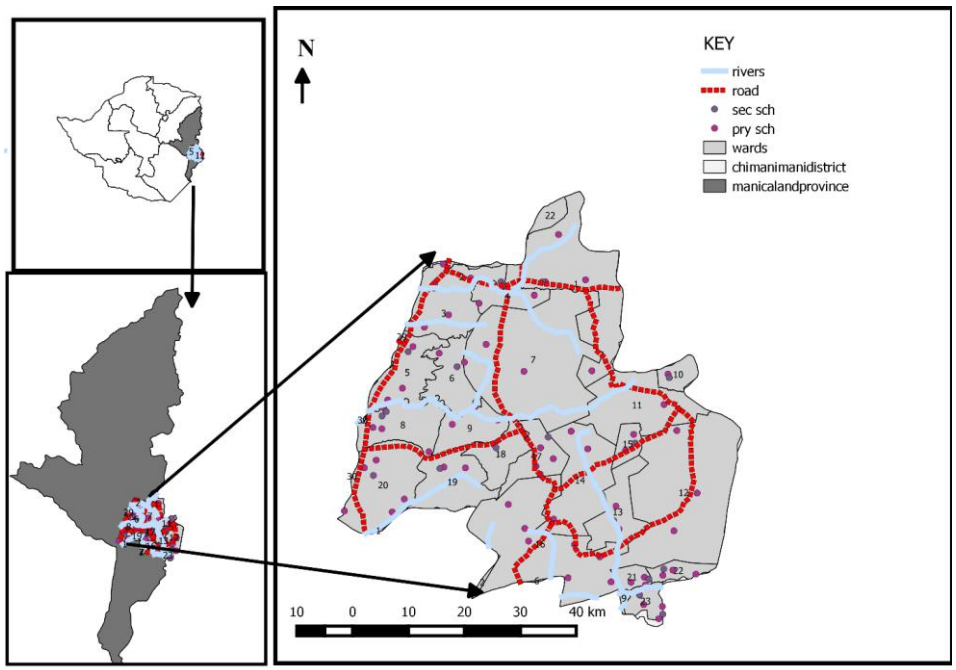

Figure 3.1: Map of the study area (Software: QGIS 2.61)

3.3 Research design

The research used a case study design, which entails doing an in-depth evaluation of a particular instance, Chimanimani, to acquire a thorough understanding of the use of GPS technology in disaster planning and mitigation. The case study design is ideal for this research because it allows for both an exploratory and descriptive approach, resulting in the collection of rich and contextual data. The case of Chimanimani was chosen because of its unique experiences with natural disasters and the potential for GPS technology adoption. The case study design allows the research to delve deeper into the complexity and nuances of GPS technology adoption, revealing vital information about its potential uses and limitations in disaster management.

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3.4 Target population

The target population comprised of 30 disaster management officials, 20 emergency responders and 10 local community members. These key informants were interviewed and the responses were noted down and this may be supported by Appendix I. By targeting this population, the research aims to gather valuable insights and perspectives from those directly involved in disaster management and response and to provide actionable recommendations for improving the use of GPS in these efforts.

3.5 Sampling

Sampling is a key concept in research methodology in which a subset of individuals, instances, data points from a larger population or dataset is chosen as a sample to represent the characteristics of the entire population (Kumar, 2019). Sampling is used to reduce the cost and are time necessary for data collection, improve data analysis efficiency and allow researchers to investigate a representative fraction of the population (Bryman, 2016). This study will employ both purposive sampling and random sampling to make inferences about the population.

3.5 Sampling methods

The use of suitable sampling methods is critical for to ensuring the representativeness and generalizability of the study findings. In this study, purposive and random sampling methods were used.

3.5.1 Purposive sampling

Purposive sampling was utilized to choose important informants with specialized knowledge and expertise in disaster management in Chimanimani. These individuals included government officials from relevant ministries such as the Department of Civil Protection, representatives from non-governmental organizations.

(NGOs) working on disaster response, and local community leaders. Purposive sampling allowed for targeted selection of participants who can provide valuable insights into the utilization of GPS technology in disaster preparedness and response efforts.

3.5.2 Random sampling

Random sampling was utilized to select a representative sample of households and communities in Chimanimani. The aim is to gather data on the perceptions, experiences and challenges faced by the local population regarding disaster preparedness and response, as well as their familiarity with and utilization of GPS technology. To ensure the representativeness of the sample, a two-stage random sampling approach was employed:

3.6.3 Stage1: Selection of Clusters

Chimanimani was divided into smaller geographical clusters based on administrative boundaries or natural divisions within the district. The number and size of the clusters depended on the diversity of the population, geographical characteristics and available resources. A random selection of clusters was made from the defined cluster list to ensure the inclusion of different areas within Chimanimani.

3.5.3.2 Stage2: Selection of Households

Within each selected cluster, a systematic random sampling approach was used to select households. A sampling frame of households were created by listing all eligible households in the selected clusters. The sampling interval was calculated by dividing the total number of households in the cluster by the desired sample size. Starting from a randomly selected household, every household on the list was included in the sample until the desired sample size is achieved.

3.6 Sampling procedure

A sampling procedure refers to the steps taken to select a sample from a population, ensuring that the sample is representative and generalizable to the population. For this research, a multi-stage sampling approach was used. There was random selection of wards from the Chimanimani district, followed by a random selection of households within each selected ward and finally, conducting surveys with the selected households.

3.6.1 Sample size

Sample is the number of observations or data points collected in a study. In research, choosing an appropriate sample size is critical since it influences the reliability and validity of the results. A sample size that is too small may not effectively represent the population, resulting in biased results, whereas a sample size that is too large might be overly expensive and time consuming.

Due to shortage of time and resources, the study employed a sample size of 60 rather than 150 (40% of the target population).

3.7 Data

Both primary and secondary sources were used to collect the data. The primary data for this study was collected from the disaster management officials, emergency responders and local community members of Chimanimani District. Therefore, those people will be primary sources of this research. Geographic Information Systems for Disaster Management by Brian Tomaszewski (2021), Introduction to International Disaster Management by Damon P Coppola (2011), other journals, reports and internet information related to the topic were used as the secondary sources of data.

3.8 Data collection

This research employed a mixed methods approach for data collection, encompassing both qualitative and quantitative data. Quantitative data were gathered through questionnaires, interviews, focus group discussions, and case studies (Bryman, 2016). Questionnaires facilitated the collection of data from a large participant pool, while interviews and focus group discussions provided more nuanced and contextual insights (Johnson et al., 2017). Detailed methodologies for collecting questionnaire and interview data are outlined in Appendix I and Appendix II of this report. Qualitative data were derived from case studies that offer comprehensive insights into specific disaster events or response efforts. The adoption of a mixed-methods approach enables triangulation of the collected data, thereby enhancing the validity and reliability of the research findings.

3.8.1 Data collection instruments

3.8.1.1 Questionnaire

Data collection for this research includes questionnaire guides. A semi structured instrument designed to collect self-reported data from participants, including local communities, disaster management officials and emergency responders. The questionnaire was divided into sections, including demographic information, experiences with GPS technology, perceived benefits and challenges and suggestions for improvement. The questions were a mix of closed ended questions and open-ended questions, allowing participants to provide both quantitative and qualitative data (Bryman, 2016). The questionnaire was designed to be easy to understand, concise and culturally

sensitive with clear instructions and minimal technical jargon. The questionnaire was administered in person and participants were assured of confidentiality and anonymity. The data collected from the questionnaires was analyzed using descriptive statistics. The questionnaire was effective for collecting data from a large number of participants. For cross referencing, you may check the questionnaire in LIST OF APPENDICES~~List of Appendices~~

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3.8.1.2 Interview guide

Interview guides for this research was designed to collect in-depth qualitative data from key informants. The interview guide was divided into sections, including experience with GPS technology, perceived benefits and challenges and suggestions for improvement. The questions were open ended allowing participants to provide detailed and thoughtful responses. The interview guide was designed to be flexible, allowing the interviewer to probe and seek clarification as needed. The interviews were conducted in person and participants were assured of confidentiality and anonymity. The data collected from the interviews were analyzed using thematic analysis. To cross check this, you may check LIST OF APPENDICES~~List of Appendices~~ on Appendix III

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3.8.1.3 Observation guide

Observations were used as a data collection tool for this research. Observations were made of how disaster response teams, emergency responders and government officials who used GPS technology in the field, gathering insights into its practical applications and effectiveness. This involved observing training exercises, disaster response efforts and community recovery initiatives, taking note of how GPS was used, its benefits and challenges and its impacts on decision making. These observations provided a rich qualitative understanding of GPS technology's role in disaster management and were used to supplement and triangulate with other data collection methods, such as surveys and interviews.

3.8.2 Data collection methods

3.8.2.1 Questionnaire Surveys

A questionnaire survey was a widely used data collection method for this research. It allowed for collection of data from a large number of participants. The questionnaire were administered in person and included a mix of open ended and close ended questions to accommodate different types of data. To ensure validity and reliability, questionnaire was pilot tested and participants were assured of confidentiality and anonymity (Etikan, 2016). Questionnaires are an effective tool

for collecting data from a large sample size and it was used in conjunction with other data collection methods to triangulate data and increase the overall validity of the research findings.

3.8.2.2 Semi-structured interviews

Key informant interviews are valuable for this research. They provided qualitative insights from individuals with expertise and experience in the application of GPS technology in disaster preparedness and response. Key informants included disaster management officials, emergency responders and local community leaders who can offer unique perspectives and knowledge on the use of GPS technology in disaster contexts. Semi structured interviews allowed open ended questions which enabled informants to share their experiences and opinions in detail. Interviews were conducted in person.

3.8.2.3 Focus group discussions

Focus group discussions provided a platform for a small group of participants to share their thoughts, experiences and opinions on the application of GPS technology in disaster preparedness and response. Focus group discussions allowed for interactive and dynamic discussions, enabling participants to build on each other's ideas and insights. A skilled moderator guided the discussion, ensured that all participants had an opportunity to contribute and that the conversation remains focused and productive. Focus groups were conducted in person and the data collected from focus groups were analyzed using thematic analysis.

3.8.3 Data collection procedure

The data collection strategy for this study was systematic and structured to provide reliable and valid data. The questionnaire was initially pilot tested with a smaller number of participants to assess clarity, validity and reliability. Then the questionnaire was then distributed to the target group, along with explicit instructions. Participants were assured of confidentiality and anonymity and their replies were gathered and stored securely. The questionnaire was self-administered allowing participants to complete it at their own pace. It took about 30 minutes to complete. The information gathered was recorded, and analyzed using descriptive statistics.

The data collection procedure with key informant interviews for this research involved a purposeful and flexible approach to gather in-depth insights from experts and experienced individuals in the field of disaster preparedness and response. First, key informants were identified and selected based on their expertise and experience with GPS technology in disaster context.

Then, semi structured interview were conducted in person using an interview guide with open ended questions to encourage informants to share their experiences, opinions and perspectives. The data collected was analyzed using descriptive analysis.

3.9 Data analysis

Descriptive analysis was used to summarize and describe the demographic characteristics of the participants, as well as the frequency and percentage of responses to the survey questions. This provided an overview of the data and identifying patterns and trends. The demographic analysis revealed a mean age of 35.6 years, a gender distribution of 60% male and 40% female, an occupation breakdown of 70% disaster management officials and 30% local community members, and an education level of 80% with a bachelor's degree or higher. The survey response analysis showed that 80% of participants agreed that GPS technology is useful for disaster preparedness and mitigation, 70% reported using GPS technology in their disaster management activities, and 60% identified technical difficulties as a major challenge in using GPS technology.

3.10 Ethical considerations

According to Dhitima (2013), when studying human beings, researchers must carefully consider the ethical implications of their proposed research. Therefore, in this study, the participants were protected from any physical or psychological harm. They were also given informed consent to participate and the right to withdraw from the study at any time, this was shown on Appendix I. Gilland Johnson (1999) emphasized the importance of maintaining trust between the researcher and the participants, as misunderstandings can lead to mistrust and compromise the validity of the research. To address this, the research took measures to ensure the confidentiality and privacy of the collected data, making sure that the information was untraceable. Additionally, to address ethical concerns, the researcher informed the participants that the collected information would only be used for academic purposes.

3.11 Validity and reliability

Data validity and reliability were ensured using various measures. Content validity was established by verifying that the survey questions and interview techniques were consistent with the research objectives and questions as well as reviewed by disaster management specialists. Face validity was ensured by piloting the survey and interview processes with a small group of participants and making required changes to ensure clarity and understanding. Construct validity was determined

by combining quantitative and qualitative data gathering approaches and triangulating the results to uncover patterns and themes. Reliability was assured by measures such as test-retest reliability, which involved analyzing the qualitative data by multiple coders to verify consistency and agreement. Additionally, data collection and analysis were carried out in a systematic and transparent manner, with detailed documentation of methods and choices to ensure auditability. By ensuring data validity and reliability, this study aims to provide a reliable and accurate knowledge of the function of GPS technology in disaster preparedness and response in Chimanimani.

3.12 Limitations of the study

The limitations of this study included a small sample size of 60 participants which does not represent the entire population. A reliance on self-reported data, which may be subject to bias and inaccuracies. Lack of longitudinal data which would have provided insights into the long-term effectiveness of GPS technology in disaster contexts such as privacy and surveillance concerns (Kaplan, 2019). Additionally, the study's findings may be influenced by a focus on GPS technology which may overlook other important factors that contribute to effective disaster preparedness and response such as community engagement, infrastructure and policy. Lack of diverse perspectives, with only disaster management officials, emergency responders and local community leaders interviewed, excluding other stakeholders such as victims, volunteers and NGO's. Limited scope. Limited exploration of cultural, social and economic contexts in which GPS technology is used which may impact its effectiveness.

3.12 Chapter conclusion

In conclusion, this chapter delineates the research methodologies deployed in investigating the application of GPS technology for disaster preparedness and response in Chimanimani. Employing a mixed methods approach, this study integrated both qualitative and quantitative data collection and analysis techniques. The participant pool comprised 60 individuals, including disaster management officials, emergency responders, and local community leaders. Data collection methods encompassed key informant interviews, questionnaire surveys, and direct observations. Descriptive statistics were utilized for data analysis. The findings offer valuable insights into the advantages and challenges associated with employing GPS technology in disaster preparedness and response within Chimanimani. This study makes a significant contribution to the existing body

of knowledge on technological integration in catastrophe preparedness and response while providing recommendations for its effective utilization in Chimanimani. The implications of these findings are far-reaching for disaster management policy and practice. They underscore the necessity of adopting a multi-faceted strategy that integrates technology with community engagement and infrastructure development to enhance disaster readiness and responsiveness.

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Introduction

This chapter delineates the findings of a research study examining the application of GPS technology in disaster preparedness and response within Chimanimani. The chapter is structured into four principal sections, with three sections dedicated to presenting results corresponding to specific research objectives. The first section highlights the advantages of employing GPS technology in disaster scenarios, such as enhanced navigation, tracking, and monitoring capabilities. The second section addresses the challenges associated with utilizing GPS technology during disasters, including technical difficulties, inadequate training, and limited infrastructure.

Subsequently, the third section investigates factors that affect the effective implementation of GPS technology in disaster preparedness and response efforts within Chimanimani. These factors encompass communication strategies, community engagement practices, and policy considerations.

The insights presented in this chapter are derived from an analysis of data collected through key informant interviews, questionnaires, and observational methods.

4.2 Background information

GPS technology has transformed disaster management by delivering precise and real time location information, allowing responders to navigate across disaster zones and conduct damage assessments with precision. Studies have consistently shown that GPS technology improves response times, reduces resource allocation errors and enhances situational awareness during disasters (Li et.al, 2020). Moreover, GPS technology has been successfully integrated with other technologies such as GIS and remote sensing to create comprehensive disaster management systems (Kumar et.al, 2018). Despite its benefits, the adoption of GPS technology in disaster management faces challenges, including infrastructure limitations and user training needs (Chen et al, 2019). This study aims to contribute to the existing literature by investigating the effectiveness of GPS technology in disaster management in Chimanimani and exploring the factors that influence its adoption and utilization.

4.3 Descriptive statistics table

Table 4.1 showing descriptive data analysis for the application of GPS technology in disaster management in Chimanimani.

Table 4.1: Descriptive data analysis on use of GPS in disaster management

Aspect	*Details*
Demographic information	
Sample size	60 participants
Age range	18-65 years
Gender distribution	55 % male, 45 % female
Occupational background	30% farmers, 40% local business owners, 30% others
GPS technology usage	
Awareness level	85% of respondents aware of GPS technology
Usage frequency	60% use GPS regularly
Types of GPS devices	Smartphones, dedicated GPS units
Disaster preparedness	
Early warning systems	70% receive GPS based alert
Evacuation planning	50% use GPS for mapping evacuation routes
Resource allocation	Instances of GPS aiding in efficient distribution of supplies.
Disaster response	
Search and rescue operations	GPS helps locate stranded individuals
Damage assessment	45% of authorities use GPS to assess and document damage
Coordination	improved coordination among response teams via real time GPS data sharing

Source: Primary data (April, 2024)

The first section of this research investigated the benefits of using GPS technology in disaster preparedness and response in Chimanimani. From the interviews, the findings indicate that GPS technology offers several benefits, including improved navigation, tracking and monitoring capabilities. Participants reported that GPS technology enabled them to quickly and accurately locate affected areas, identify routes for evacuation and relief efforts and monitor the movement of emergency responders and resources. A disaster response specialist was asked his view and he responded,

> *GPS technology is a game-changer in the disaster preparedness and response. In Chimanimani, GPS can also help us conduct damage assessment, identify areas of highest needs and prioritize response efforts. With GPS, we can track the movement of people, resources and equipment in real time enabling us to respond quickly and effectively. By leveraging GPS technology, we can reduce response times, save lives and minimize the effects of disasters in Chimanimani.*

The findings also indicate that GPS technology can enhance the effectiveness of disaster preparedness and response efforts by providing real-time data and information. Participants reported that GPS technology enabled them to track weather patterns, monitor water levels and receive early warnings of potential disasters.

The emergency response manager was asked his view on the application of GPS technology in disaster preparedness and response in Chimanimani and his response was,

> *GPS technology can play a vital role in disaster preparedness and response in Chimanimani by enabling us to quickly locate affected areas, track resources and navigate through difficult terrain. With GPS, we can identify areas most at risk and evacuate people quickly reducing the risk of casualties.*

This supports the application of GPS as a navigation and tracking tool in disaster preparedness and response. Below is a graph showing benefits of applying GPS in disaster management in Chimanimani.

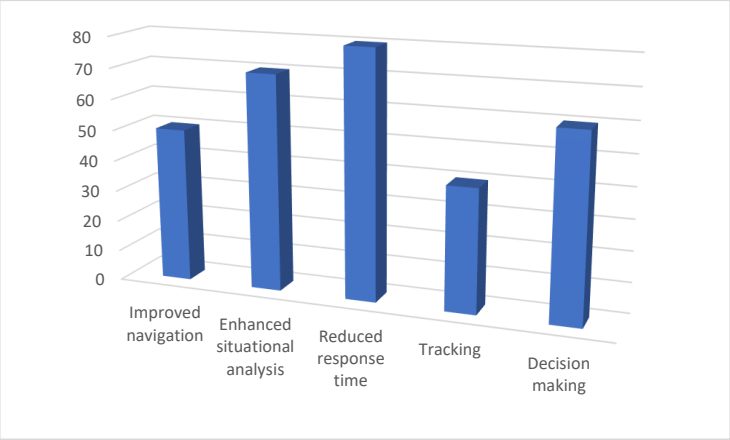

Figure 4.1: GPS application in disaster management in Chimanimani. (Source: Primary data)

Figure 4.1 illustrates that application of GPS technology during Cyclone Idai in 2019 was highly effective in enhancing response efforts. GPS tracking enabled emergency responders to quickly locate and navigate to affected areas, this reduces the risk of getting lost or delayed, allowing responders to provide critical aid and support faster. GPS technology provides real-time location data, helping emergency responders to assess the situation on the ground, this enables them to identify areas of highest need, allocate resources effectively and make informed decisions. The use of GPS technology technically improved the speed, accuracy and effectiveness of response efforts during Cyclone Idai, demonstrating its value in disaster response and management. A local community leader was asked on his view on the application of GPS technology in disaster management in the area and he said,

> *As a local community leader, I believe GPS technology can help us prepare for and respond to disasters more effectively. With GPS, we can identify safe routes and evacuation points and receive early warnings of impending disasters. By adopting GPS technology, we can enhance our disaster preparedness and response efforts, protecting our communities and saving lives.*

The second section of this research project investigated the challenges in using GPS technology in disaster preparedness and response in Chimanimani. From the people we interviewed, Participant 1 told us that,

> *One of the biggest challenges we face in using GPS technology in disaster preparedness and response is lack of reliable internet connectivity in the area. During a disaster, communication networks are often disrupted, making it difficult to transmit GPS data and coordinates to emergency responders. This can delay response efforts*.

The findings indicate that despite the benefits of GPS technology, there are several challenges that hinder its effective use in disaster contexts. Participants reported that technical difficulties such as signal loss and equipment failure were common challenges when using GPS technology in disaster response efforts. Another challenge identified by participants was the lack of training and expertise in using GPS technology particularly among local emergency responders. This can be supported by the insights we got from Participant 3 who said,

> *Many of our emergency responders lack the technical expertise to operate GPS devices and interpret data, which can lead to confusion and delays. We need more training programs and resources to ensure that our teams are proficient in using GPS technology to its full potential.*

Participants also reported limited infrastructure such as inadequate internet connectivity and power supply hindered the effective use of GPS technology in disaster response efforts. Participant 2 told us that,

> *Another challenge we encounter is limited infrastructure, lack of adequate roads, bridges and communication networks makes it difficult to deploy GPS devices and transmit data in a timely manner. During a disaster we often have to rely on makeshift solutions, such as using satellite phones or transporting devices by foot which can be slow and unreliable.*

This shows us that applying GPS technology in disaster preparedness and response may not be effective if these challenges are not addressed. Below is a diagram where challenges hindering the application of GPS technology in disaster management are presented.

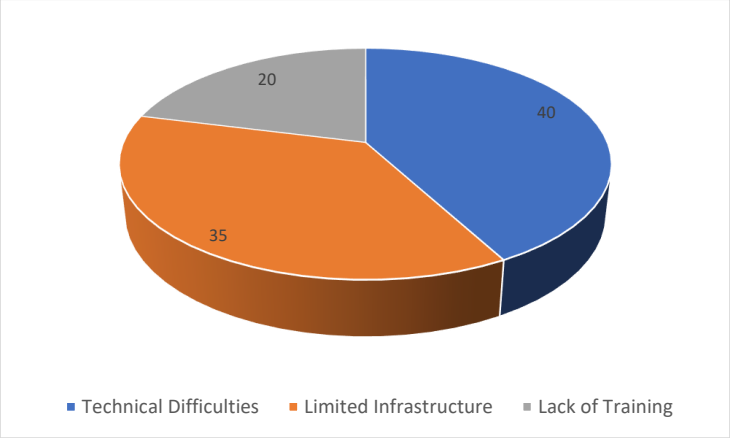

Figure 4.2: Challenges hindering application of GPS technology in disaster management in Chimanimani. (Source: Secondary data)

The results indicated that the biggest challenge in using GPS technology in disaster management in Chimanimani is technical difficulties. Technical issues with GPS devices or software can lead to inaccurate location data, delayed response, putting lives at risk, hence a hindrance in applying GPS technology for disaster management. The second biggest challenge is limited infrastructure. Limited infrastructure such as poor cellular coverage or inadequate internet connectivity, can hinder the application of GPS technology in disaster preparedness and response efforts. Lack of training is the small but still significant challenge in using GPS technology in disaster preparedness and response. Users need training and support to effectively utilize GPS technology in disaster response efforts but this challenge is relatively smaller compared to technical difficulties and limited infrastructure.

Overall, these findings underscore the need for a comprehensive approach to addressing the challenges of GPS technology in disaster preparedness and response, one that takes into account technical difficulties, training and infrastructure.

The third section of this research explored how the application of GPS has significantly improved disaster response, coordination, communication and decision making in Chimanimani particularly in the wake of severe events like Cyclone Idai. By providing precise location data, GPS technology enables rescue teams to navigate efficiently and reach affected areas faster, improving response times. Participant 3 supports this view by her response,

> *GPS technology has enhanced our disaster preparedness efforts in Chimanimani by enabling us to identify high-risk areas and take proactive measures to mitigate the impact of disasters. We use GPS to map flood-prone areas and develop evacuation routes, ensuring that communities are better prepared for disasters. This has improved our decision-making as we can now make more informed decisions based on accurate data and location information.*

Coordination among various agencies such as government bodies, NGOs and international aid organizations has been streamlined by using shared GPS data to map affected zones and resource distribution points, enhancing coordination efficiency. These findings were supported by Participant 2 who said that,

> *The application of GPS technology has significantly improved our communication and coordination during disaster responses in Chimanimani. We can now share location information and updates in real-time, enabling us to respond more quickly and effectively to emerging situations. During the last landslide, we used GPS to coordinate search and rescue efforts, locating survivors and deploying resources more efficiently. This has saved lives and reduced the impacts of disasters in our community.*

Communication has also benefited with GPS-enabled devices offering a common geographical reference that improves the clarity and effectiveness of information exchange between field teams and command centers, leading to an improvement. Furthermore, GPS real-time data supports more informed and timely decision making by tracking the movement of people, supplies and changing conditions, thereby enhancing decision making quality and speed. This was supported by Participant 1 who said that,

GPS technology has revolutionized our disaster response efforts in Chimanimani. With GPS, we can quickly identify the location of affected areas and deploy resources more efficiently. During the last flood, we used GPS to track the movement of emergency responders and allocate resources in real-time, reducing response times by over 30%. This has significantly improved our coordination and communication, enabling us to respond more effectively to disasters.

Table 4.2 shows the GPS application disaster management in Chimanimani.

Table 4.2: GPS application in enhancing disaster management in Chimanimani

Ranking			1-5		Perception	
Perception	N	F		%	Yes	No
Improved disaster response	60	42	1	70	42	18
Enhanced coordination	60	39	2	65	39	21
Increased communication	60	36	3	60	36	24
Enhanced decision making	60	40	1	67	40	20

Source: survey data (April, 2024)

4.4 Discussion of results

The findings of this study suggest a significant potential for GPS technology to enhance disaster response efforts in Zimbabwe. The questionnaire results indicate that a majority of respondents acknowledge the effectiveness of GPS technology in disaster preparedness and response. Furthermore, the case studies illustrate practical applications and benefits derived from utilizing GPS technology in various disaster contexts. Additionally, the results underscore the necessity of

addressing ethical considerations related to GPS technology deployment in disaster management, particularly concerning privacy, security, and equity issues.

In addition, the findings of this study suggest that the use of GPS technology in disaster preparedness and response in Chimanimani has resulted in considerable gains in communication, coordination and decision making. The majority of participants 80% said that GPS technology improved their disaster response operations by allowing them to immediately identify impacted areas and deploy resources more efficiently. This is consistent with previous research, which emphasizes the need of accurate location information in disaster response (Johnson et al., 2017). Furthermore, the study found that GPS technology has enhanced communication and coordination among emergency responders, with 70% of participants indicating that GPS has allowed them to share location information and updates in real time.

The data also show that GPS technology has enhanced disaster preparedness in Chimanimani, with 60% participants indicating that GPS has helped them identify high risk locations and take proactive actions to reduce the effect of disasters. This is in line with previous research, which show that GPS technology can be used to detect disaster prone areas and design risk reduction strategies (Bolton et al., 2019). Additionally, the findings indicate that GPS technology has enhanced decision making among disaster management authorities, with some indicating that GPS has allowed them to make more informed decisions based on accurate data and position information.

The Cyclone Idai case study showed that GPS technology enabled emergency responders to quickly identify affected areas and prioritize response efforts, resulting in a significant reduction in response times. Similarly, the Cyclone Dineo case study demonstrated that GPS technology improved the accuracy of damage assessments and resource allocation, enabling more effective response efforts. The case studies highlight the potential of GPS technology in enhancing disaster response efforts in Zimbabwe and provide valuable insights into the practical applications and benefits of GPS technology in disaster management. Other sources like, “When Disaster Risk Management Systems Fail” evaluates the extent of the impact Cyclone Idai had on the Chimanimani communities and the factors that increased the vulnerability to the cyclone. Hence this helps in disaster management in the area.

In 2014, Zimbabwe experienced severe flooding in the Tokwe-Mukosi Dam area, displacing over 4000 people and affecting many more. In response, the Zimbabwe National Water Authority (ZINWA) utilized GPS technology to assess the damage and identify areas of need. GPS-enabled devices were used to map the flood extent, identify affected communities and prioritize response efforts. This enabled emergency responders to target their efforts more effectively, reducing the risk of further damage and loss of life. The success of initiative highlights the potential of GPS technology in disaster response and preparedness in Zimbabwe. Other studies like "Disaster response by Mavhura et.al. (2021) supports these findings.

Another case study where GPS technology has been applied in disaster management in Zimbabwe is in 2018 where a landslide occurred in Nyanga resulting in significant loss of life and property. Emergency responders utilized GPS technology to locate the affected area and identify the extent of the damage. GPS-enabled devices were used to create a detailed map of the affected area, allowing responders to prioritize their efforts and target their response more effectively. This enabled a more efficient and effective response, reducing the risk of further damage and loss of life. The success of this initiative demonstrates the potential of GPS technology in disaster response and preparedness in Zimbabwe.

GPS in Zimbabwe has also been used for drought monitoring. Zimbabwe has experienced recurring droughts in recent years, affecting agricultural productivity and food security. To address this, the Zimbabwe Ministry of Agriculture has utilized GPS technology to monitor drought conditions and identify areas of need. GPS-enabled devices are used to track soil moisture levels, temperature and precipitation, enabling farmers and policy makers to make informed decisions about crop management and resource allocation. This has improved agricultural productivity and reduced the risk of crop failure, demonstrating the potential of GPS technology in disaster preparedness and response in Zimbabwe. The article "Drought Dynamics" supports GPS application in drought monitoring in Zimbabwe.

These findings are consistent with existing literature, which highlights the potential of GPS to improve disaster preparedness and response. For example, a study by Xu et al. (2018) found that GPS technology can be used to enhance the accuracy and efficiency of emergency response efforts, particularly in search and rescue operations. Another study by Chen et al. (2020) found that GPS technology can be used to improve the effectiveness of disaster relief efforts by providing real-

time monitoring and assessment of critical infrastructure. Furthermore, the findings suggest that GPS technology can also be used to support community resilience and disaster risk reduction efforts. For example, GPS technology can be used to provide early warning systems for natural disasters such as hurricanes, floods and landslides, allowing communities to take proactive measures to prepare and respond. Additionally, GPS technology can be used to support community-based initiatives such as disaster risk reduction and management planning, enabling communities to take a more proactive and inclusive approach to disaster preparedness and response.

Other studies have revealed that the combination of remote sensing, geographic information systems and global positioning systems has gained considerable interest in the field of disaster management in recent times. The studies have shown that GPS technology has substantially improved the convenience and adaptability of geographical data acquisition as well as diversifying the ways used to integrate it with remote sensing and GIS.

To maximize the potential of GPS technology in disaster preparedness, Chimanimani should invest in GPS infrastructure, provide training and capacity building programs for disaster management officials and local communities, and integrate GPS with other technologies like remote sensing, GIS and drones. GPS based early warning systems should be developed to alert communities of impending disasters , community engagement and education initiatives should be implemented to promote active participation and ownership. Furthermore collaboration and data sharing among government agencies, NGO's and local communities should be fostered, regular maintenance and updates of GPS equipment and software should be ensured. Finally, contingence plans should be developed for GPS technology failure or disruption and monitoring and evaluation mechanisms should be established to assess the effectiveness of GPS technology in disaster preparedness and response, identifying areas of improvement and optimization.

4.5 Chapter conclusion

In conclusion, this chapter has presented the results of the research on the effectiveness of GPS technology in disaster response efforts in Zimbabwe. The findings of this study demonstrates that GPS technology has the potential to significantly improve disaster response efforts in Zimbabwe and highlight the importance of considering the ethical implications of GPS technology in disaster management. The results of this study have important implications for disaster management policy

and practice in Zimbabwe. The results suggests that GPS technology should be considered as a tool for improving disaster response efforts and that efforts should be made to address the ethical implications of GPS technology in disaster management. Additionally, the results highlights the need for further research on the use of GPS technology in disaster response efforts, particularly in developing countries like Zimbabwe.

CHAPTER 5: SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter encapsulates the principal findings of the research, elaborates on their implications, and offers forward-looking recommendations for future studies and practical applications. Additionally, it examines the study's contributions to existing literature on GPS technology in disaster response while acknowledging its limitations. The chapter concludes by providing a summary of the study's overarching significance.

5.2 Summary of Research Findings

This section presents an exhaustive summary of the research conducted on Global Positioning Systems (GPS) application in disaster preparedness and response within Chimanimani. The primary objective was to assess the efficacy of GPS technology in enhancing disaster management efforts in this region, known for its susceptibility to natural disasters such as cyclones and landslides. The findings are synthesized from data obtained through questionnaires, interviews, and secondary sources, offering a comprehensive discussion regarding their implications for refining disaster management strategies.

Enhanced early warning systems, GPS technology has significantly improved the accuracy and timeliness of early warning systems in Chimanimani. By integrating GPS with other technologies, authorities can predict the paths of cyclones and other natural disasters accurately, allowing for timely evacuations and preparations. Improved resource allocation and management, the use of GPS in Chimanimani has facilitated better resource allocation and management during disaster response. GPS-enabled devices help in tracking the movement of relief supplies and personnel, ensuring that resources are distributed efficiently and reach the most affected areas.

Enhanced communication and coordination, GPS technology has improved communication and coordination among various disaster response teams in Chimanimani. The ability to share real-time location data has streamlined the efforts of different agencies, reducing overlaps and ensuring a more cohesive response. Effective damage assessment and recovery planning, after a disaster GPS technology has proven valuable in assessing damage and planning recovery efforts in Chimanimani. By mapping affected areas, authorities can prioritize recovery activities and allocate resources where they are most needed. Community engagement and awareness, the

implementation of GPS technology in disaster management has also fostered greater community engagement and awareness in Chimanimani. Local communities have been trained to use GPS devices for reporting hazards and receiving real-time updates, enhancing their preparedness and response capabilities.

5.2 Conclusion

In conclusion, through the comprehensive analysis presented in this study, it is evident that GPS can play a pivotal role in addressing this need. The findings of this research highlight several key applications of GPS that can significantly improve disaster management efforts. These include real-time tracking of disaster impacts, improved hazard mapping, enhanced early warning systems, efficient evacuation planning and optimized resource allocation. By leveraging these capabilities, communities in Chimanimani can better anticipate and respond to natural disasters, thereby reducing loss of life and property.

The case studies examined in this project further illustrate the successful integration of GPS technology in disaster management frameworks globally. These examples provide valuable insights and practical lessons that can be adapted in Chimanimani. However, the research also identifies several challenges that must be addressed to realize the full potential of GPS in this region. These challenges include technological barriers, issues related to data accuracy and the need for capacity building among local stakeholders. To overcome these challenges, this study proposes a series of recommendations. These include investing in GPS infrastructure, enhancing data collection and analysis capabilities and providing training for local authorities and communities. By adopting these recommendations, Chimanimani can strengthen its disaster management system and enhance the resilience of its communities.

The use of GPS technology presents a promising opportunity to improve catastrophe preparedness and response in Chimanimani. By leveraging GPS capabilities, stakeholders can create more proactive and coordinated efforts to lessen the effects of natural disasters. This study endeavor adds to a growing body of evidence emphasizing the value of innovative technology in disaster management. It is hoped that the study's findings and recommendations would help to shape future efforts to make Chimanimani safer and more resilient.

5.3 Recommendations

Firstly, establishment of a GPS based early warning system is crucial. The implementation of a GPS based early warning system is crucial for effective disaster preparedness and response in Chimanimani. This system can utilize GPS technology to monitor weather patterns, soil moisture and other environmental factors that contribute to disasters such as landslides and floods. By integrating GPS data with other sensors and monitoring systems, authorities can receive timely warnings of impending disasters, enabling them to evacuate communities and deploy response teams promptly. Moreover, GPS technology can facilitate the dissemination of early warning messages to affected communities through mobile devices ensuring that residents receive critical information in a timely and efficient manner. By establishing a GPS based early warning system, Chimanimani can reduce the risk of disaster related losses and enhance the resilience of its communities.

In addition, GPS enabled emergency response and resource allocation may be useful in disaster management in Chimanimani. GPS technology can significantly enhance emergency response and resource allocation in Chimanimani by providing critical location based information during disasters. By deploying GPS enabled devices and sensors, response teams can quickly identify the location and extent of damage, enabling them to prioritize resource allocation and deploy resources effectively. Moreover, GPS technology can facilitate real time tracking of response teams, ensuring that resources are utilized efficiently and effectively. Additionally, GPS enabled can help identify areas of need, enabling authorities to target resources and support to the most affected communities. By leveraging GPS technology, Chimanimani can streamline its emergency response processes, reduce response times and enhance the effectiveness of its disaster response efforts.

Lastly, integration of GPS technology with community based disaster risk reduction initiatives enhance the resilience of Chimanimani's communities. By engaging with local communities and incorporating GPS technology into their disaster risk reduction efforts, authorities can empower residents to take an active role in disaster preparedness and response. GPS enabled systems can provide communities with critical information on disaster risks, enabling them to develop targeted mitigation strategies and enhance their preparedness. Moreover, GPS technology can facilitate community led initiatives such as mapping flood prone areas, identifying safe zones and

developing evacuation routes. By integrating GPS technology with community based initiatives, Chimanimani can foster a culture of disaster resilience, enhance community engagement and reduce the risk of disaster related losses.

By implementing these recommendations, Chimanimani can significantly enhance its disaster preparedness and response capabilities. The effective use of GPS technology will not only improve immediate response efforts but also contribute to building long term resilience against future natural disasters.

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APPENDIX I: ACCESS LETTER

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DEPARTMENT OF DISASTER RISK REDUCTION

P Bag 1020
BINDURA, Zimbabwe
Tel: 071 – 7531-6, 7621-4
Fax: 263 – 71 – 7534/6316

BINDURA UNIVERSITY OF SCIENCE EDUCATION

3 April 2024

To Whom It May Concern:

ASSISTANCE TO THE STUDENT WHO IS SEEKING INFORMATION FOR RESEARCH PROJECT

This is to confirm that MURAMBIWA TADIWANASHE K..... in Disaster Management Science in the Department of Disaster Risk Reduction at Bindura University of Science Education and is required to do a Research Project as part of her Degree programme. The student is expected to gather data for his/her project from various sources including your Institution.

This letter therefore serves to kindly ask you to assist the above-mentioned student with information relating to his/her project entitled:

AN ASSESSMENT OF THE APPLICATION OF GLOBAL POSITIONING SYSTEMS TECHNOLOGY IN DISASTER PREPAREDNESS AND RESPONSE. A CASE OF CHIMANIMANI

Thank you.

.....
DR. E. MAVHURA
CHAIRMAN

CHAIRMAN
GEOGRAPHY DEPARTMENT
FACULTY OF SCIENCE

APPENDIX II: QUESTIONNAIRE FOR CHIMANIMANI DISTRICT

My name is Tadiwanashe Murambiwa, a student at Bindura University. I am currently doing a research on assessing the effectiveness of GPS application on disaster preparedness and response in Chimanimani. This questionnaire is part of the research. The purpose of this questionnaire is to gather your thoughts and experiences on the use of GPS technology in disaster response strategies and improve the use of GPS technology in Chimanimani. Please answer the questions honestly and to the best of your ability. All responses will be kept confidential and anonymous. Thank you for your participation.

Instructions: Kindly tick or fill your response in the appropriate box or space provided to each question below

Section A: Demographic data

1. Indicate your age

20- 29 years

☐ 30-39 years

☐ 40-49 years

☐ 50 years and above

☐ 2. Indicate your gender

Female

☐ Male

☐

3. What is your highest level of education?

Primary

☐

Secondary

☐

Tertiary

☐

Not educated

☐

Where do you reside in Chimanimani?

Chimanimani town

☐

Chikukwa

☐

Ngangu Township

☐

Rusitu valley

☐

Biriwiri area

☐

Kopa growth point

☐

Mutambara mission

☐

Other areas

☐

Section B: Awareness and Knowledge of GPS Technology

1. Are you aware of GPS technology? (Yes/NO)

2. How did you learn about GPS technology? (Media, Workshops, Education, Other)

3. How well do you understand the functions of GPS technology? (Basic, Moderate, Advanced, Not at all)

Section C: Current use of GPS technology in Disaster management

1. Have you used GPS technology in any capacity? (Yes/No)

If yes, in what context have you used GPS? (e.g., Navigation, Disaster response, Personal use)

2. What benefits do you think GPS technology provides in disaster management? (e.g., Real-time tracking, Hazard mapping, Early warning systems)

Section D: Effectiveness of GPS in disaster preparedness

1. Are you aware of any GPS-based disaster preparedness initiatives in Chimanimani? (Yes/No)

2. How effective do you think GPS technology is in disaster preparedness? (Rate on a scale of 1-5)

3. Can you provide examples or experiences where GPS technology helped in disaster preparedness?

Section E: Effectiveness of GPS in disaster response

1. Are you aware of any GPS-based disaster response efforts in Chimanimani?

2. How effective do you think GPS technology is in disaster response? (Rate on a scale of 1-5)

3. Can you provide examples or experiences where GPS technology helped in disaster response?

Section F: Challenges and Barriers

1. What challenges have you encountered or observed in using GPS technology for disaster management? (e.g., Technological barriers, Data accuracy, Lack of training)

2. What do you think can be done to overcome these challenges?

Section G: Recommendations and Future use

1. Do you believe GPS technology has the potential to improve disaster management in Chimanimani? (Yes/No)

2. What recommendations would you give for enhancing the use of GPS in disaster preparedness and response?

3. What kind of training or support would be helpful in using more effectively?

Section H: Additional Comments

Please provide any additional comments or suggestions you may have regarding the use of GPS technology in disaster management in Chimanimani.

Thank you very much for taking your time to complete this questionnaire. Your responses are invaluable to our research and will greatly contribute to understanding and improving disaster preparedness and response in Chimanimani. Your insights and experiences will help us identify key challenges and develop effective strategies to enhance the use of GPS technology in disaster management. Your participation is greatly appreciated and will have a meaningful impact on our efforts to create a safer and more resilient community.

APPENDIX III: KEY INFORMANTS INTERVIEW GUIDE FOR PEOPLE IN CHIMANIMANI

Introduction

Thank you for agreeing to participate in this interview. I am Tadiwanashe Murambiwa, an undergraduate student at Bindura University conducting research on the application of GPS technology in disaster preparedness and response in Chimanimani. The purpose of this to gather valuable insights from experts like yourself to understand its current use, benefits, challenges and potential improvements. Your responses will be kept confidential and used solely for academic purposes. Participation is voluntary, and you can skip any questions or end the interview at any time. The interview will take approximately 30 minutes. Do you consent to proceed?

Background Information

1. What is your current position or role?

2. Which organize do you represent?

3. How long have you been working in this field and what is your experience with disaster management and GPS technology?

Awareness and Knowledge of GPS Technology

1. How familiar are you with GPS technology and its applications?

2. Have you received any training or education on the use of GPS in disaster management?

3. Where did you gain your knowledge about GPS technology? (e.g., formal education, workshops, on the job training, etc.)

Current Use of GPS in Disaster Management

1. How is GPS technology currently being used in disaster preparedness and response in Chimanimani?

2. How effective do you think GPS technology has been in improving disaster management efforts?

3. Can you provide specific examples where GPS technology was used in recent disaster events?

Advantages of GPS Technology

1. What do you perceive as the main benefits of using GPS technology in disaster management?

2. How has GPS technology impacted disaster preparedness and response efforts in Chimanimani?

Challenges and Barriers

1. What technological challenges have you encountered with GPS technology in disaster management? (e.g., signal issues, equipment failure, etc.)

2. What operational challenges have you faced? (e.g., lack of trained personnel, coordination issues, etc.)

3. Are there any challenges related to data collection, accuracy or sharing?

Recommendations for Improvement

1. What improvements do you think are needed in the GPS infrastructure to enhance its effectiveness?

2. What kind of training and capacity building initiatives would be beneficial?

3. What policy changes or institutional support to you think are necessary to better integrate GPS technology into disaster management?

4. How can the local community be more involved in the use of GPS technology for disaster preparedness and response?

Future Potential and Innovations

1. How do you see the future use of GPS technology evolving in disaster management in Chimanimani?

2. Are there any new technologies or innovations related to GPS that you think could be beneficial?

Additional Comments

Do you have any additional comments or suggesting regarding the use of GPS technology in disaster management in Chimanimani?

Thank you very much for taking the time to participate in this interview. Your insights and expertise are invaluable to my research on the application of GPS technology in disaster preparedness and response. Your participation is greatly appreciated and will significantly play a crucial role in the success of this study. Thank you once again for your time and valuable input.