INFORMATION AND COMMUNICATION TECHNOLOGY IN DISASTER PREPAREDNESS BY eTHEKWINI MUNICIPALITY.

By

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ABSTRACT

Natural disasters devastate societies, resulting in the loss of lives and infrastructure. The eThekwini Municipality has experienced a recurrence of flooding due to severe rains brought on by the bad weather leaving vulnerable people in distress. In order to mitigate or minimise the impact of flood disasters, the Municipality must ensure that these communities must be flood prepared. When natural disasters strike, efficient disaster communication, which includes the use of information and communication technologies, particularly from the government to the impacted communities is critical. When a disaster occurs, good communication between many parties is critical for disaster management to prepare for such events and information and communication technology tools can be valuable in communicating impending life-threatening natural hazards. Information and communication technologies play an important role in disaster prevention, mitigation, and management, and they can be used as instruments to distribute early warning information, as well as track and communicate during emergency circumstances and post-disaster periods.

The purpose of this study was to examine the role of information and communication technology in disaster preparedness by eThekwini Municipality. The study was conducted within the eThekwini Municipality Disaster Management Department, KwaMashu and Amaoti areas, which assisted the researcher to gather the information on a role of ICT in disaster preparedness. The researcher used a qualitative approach in the form of face-to-face interviews as the primary data collection, a non-probability sampling was done by means of expert and purposive sampling. This method helped the researcher in selecting disaster management practitioners and municipal ward councillors and ward committee members who could provide sufficient data for the purposes of completing the study. These instruments gave the researcher an understanding of the study and the outcomes addressed the key questions and objectives of the study.

The findings revealed that that the Disaster Operation Centre has a network infrastructure which facilitates the linkage and integration of CCTV, communications, incident log, and other systems displayed onto a video wall. The study also revealed that the city has established a flood early warning system (FEWS), a new technological strategy used to detect flood hazards prior to their occurrence to prevent destruction and save people's lives. The study noted that there are challenges from these communities in terms of receiving early warnings which leads to the lack of disaster preparedness. It emerged from the study that effective communication channels such as those that cater for vulnerable people should be established and early warnings should be communicated and understood by vulnerable people in affected communities in order for them to respond to the emergency of flood hazards.

Relevant and ongoing information communication and public awareness programmes must be undertaken to develop the capacity of the local community in order for communities within the eThekwini Municipality to be able to mitigate and prepare for natural hazards and react appropriately when early warnings are issued to avoid loose of lives and injuries.

DECLARATION OF ORIGINALITY

(i) I, **Goodness Ntokozo Sibiya**, hereby present for consideration by the Durban University of Technology within the Faculty of Management Sciences my dissertation titled “Information and Communication Technology in disaster preparedness by eThekwini Municipality” in fulfilment of the requirements for the Masters Degree in Management Science: Public Administration.

(ii) I undersigned declare that this dissertation is the product of my own original work and that no other person has published a similar study from which I might have copied.

(iii) All sources used or quoted in the study have been acknowledged by means of complete references in accordance with University’s requirements.

(iv) This work will not be published without my consent and that of the Durban University of Technology.

Name: Ms Goodness Ntokozo Sibiya

Signature:

Date: 13 May 2022

DEDICATION

I dedicate my study to my late mother Babhekile Sibiya, my guardian angel. I know you are happy with me since I have accomplished what was vital to you, may your soul rest in eternal peace, my love. You were always talking about the importance of education and how it was everything to you; you had always wanted me to be an educated woman and a better person; I believe you are proud of me. To my daughter Ayanda, I hope that one day this work will motivate you to work hard and achieve your goals and that you will always see education as the key to unlocking doors.

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TABLE OF CONTENT

Contents

LIST OF FIGURES.

LIST OF TABLES

LISTS OF ACRONYMS

AGRC	Aon Global Risk Consulting
CBDRM	Community-based Disaster Risk Management
DMA	Disaster Management Act 57 of 2002
DMO	Disaster Management Official
DOC	Disaster Operation Centre
DOI	Diffusion of Information Theory
DRR	Disaster Risk Reduction
EWS	Early Warning System
HFA	Hyogo Framework for Action 2005-2015
ICT	Information and Communication Technology
IDP	Integrated Development Plan
IFRC	International Federation of Red Cross and Red Crescent Societies
ISDR	International Strategy for Disaster Reduction
IT	Information Technology
MDMC	Municipal Disaster Management Centre
MWC	Municipal Ward Councillor
NDMF	National Disaster Management Framework
SAWS	South African Weather Services

TAM	Technology Acceptance Model
TRA	Theory of Reasoned Actions
UNDP	United Nations Development Program
UNISDR	United Nations Strategy for Disaster Risk Reduction
UNDRR	United Nations Strategy for Office on Disaster Risk Reduction
WCM	Ward Committee Member
WMO	World Meteorological Organization

CHAPTER ONE

Introduction and background to the study

1.1 Introduction

Extreme climate and weather-related events, such as floods are becoming more common and intense in many parts of the world. Flood disasters are a serious threat locally and internationally, they expose populations to risks, and their effects are varied, including injuries, infrastructure damage and loss of lives. The eThekwini Municipality has been faced with recurring floods which have caused disruption in communities within the city. The role of information and communication technology (ICT) in disaster preparedness was examined by the eThekwini Municipality to prevent and prepare for flood disasters to minimise their impact.

This chapter explains the background of the study, as well as the research problem that guided the investigation. It presents the study's aim, objectives and research questions. It provides the significance of the study and the justification and lastly it highlights the structure of the dissertation and provides the conclusion. The following section provides a clear background of the study.

1.2 Background

The problem of disasters is one of the environmental difficulties and problems that the world's largest human settlements are experiencing (Nojavan, Salehi, & Omidvar, 2018). Flood disasters are becoming more frequent and growing in intensity, and more people are affected by natural catastrophes than by any other sort of catastrophe on a global scale. They are disruptive to the lives of the people and the community. Natural catastrophes have had a significant impact on humanity in a variety of ways, one of the reasons is the growing urbanisation trend. This is changing the use of the land and increasing the number of people living in locations that are especially vulnerable to natural disasters, such as flood-prone areas.

According to the United Nations International Strategy for Disaster Reduction report (UNISDR, 2018), Individuals in low- and middle-income countries are seven times more likely to die in natural disasters than people in rich countries. The 1987 flood in

Bihar, India culminated in what is today recognised as the worse flood disaster incident in the memory of Bihar, affecting more than 10 million people. Japan is another country that is usually plagued by flood disasters, in 2011 heavy floods resulted in the death of over 800 people.

Cyclone, Idai in 2019 caused widespread destruction across Southern Africa, in Mozambique, Zimbabwe and Malawi which caused the deaths of many people. Some were missing and more than 1.5 million were affected across these three Southern African countries (Rafi, Aziz & Lodi, 2018). Flooding in May 2020 occurred in East African countries including amongst others, Kenya, Uganda, Libya and Ghana. Communities were left homeless due to floods that had washed away their homes, and the losses of hundreds of lives were reported (Rafi *et al*., 2018).

The year 2019 flood crisis in Southern Africa has drawn widespread attention to the life-saving function of contemporary technology in reducing the impact of disasters on people's lives. According to International Federation of Red Cross and Red Crescent Societies (IFRC) Annual Report on disasters (2018) information and communication technology allows for proactive risk reduction. It aims to deal with the fundamental issues of vulnerability, promote resilience and strengthen anticipation and preparedness.

South Africa faces an annual flood risk of 83.3% and the population is vulnerable due to economic conditions and geographic position (Zuma *et al.*, 2012). According to Aon Global Risk Consulting (AGRC) (2018), reports on local statistics reveal that South Africa is no longer considered a low-catastrophe-risk region, as the country has seen a high frequency of large-scale losses in the recent five years. There have been more than 80 flood disaster events in South Africa between 1980 and 2018 (Membele, Naidu & Mutanga, 2021). In March 2019, cyclonic flooding caused widespread damage across Southern Africa. According to the ratios, the provinces of the Eastern Cape, KwaZulu-Natal, the North-West, and Limpopo are the most vulnerable. Floods have been recurring in surrounding areas of KZN Province, especially in the eThekwini Municipality which has raised questions about the city’s preparedness plans for natural disasters.

ICT performs a significant role in disaster prevention, mitigation, and preparedness. For example, numerous technologies, such as telecommunication satellites, radar, telemetry, and meteorology make remote sensing for early warning systems possible (Islam, 2010). An enhanced early warning system has the potential to save lives and decrease losses, it is a critical resilience component. Budhimir *et al*. (2019) stress that more complex early warning systems supported by forecasts can provide an additional lead time for preparation. Information and communication technology plays an important role in disaster preparedness by communicating with individuals in hazardous sites to reduce damage to properties and minimise human suffering (Mukhopadhyay and Bhattacherjee, 2015). There must be clear communication on disasters such as floods and enhanced preparedness to minimise loss of lives and properties. The goal of this research is to look at the role of ICT in disaster preparedness within the eThekwini Municipality.

1.3 Research Problem

In South Africa, current legislation places accountability on the three spheres of government (national, provincial and local) to manage disasters. For example, the Disaster Management Act, No. 57 of 2002, establishes an integrated and coordinated disaster management strategy that focuses on disaster prevention and mitigation, disaster severity mitigation, emergency preparedness, disaster response, and post-disaster recovery and rehabilitation across spheres of government. Natural or man-made disasters cause a serious disruption in the functioning of communities around the world. The world has experienced rapid climate change, leaving society vulnerable due to various catastrophes that resulted in the loss of lives and building structures and environmental destruction; this necessitates timely and efficient management of information and communication.

The current problem in this study centres on the recurring flood disasters affecting the communities of KwaMashu and Amaoti within the eThekwini Municipality. Disaster preparedness has remained a priority in the disaster management cycle in raising awareness on how to prepare for and respond to catastrophes. This includes activities and procedures that are prepared ahead of time to decrease the loss of

lives and property, offer adequate reaction to risks, such as early warnings that are prompt and effective, as well as the temporary removal of persons and property from susceptible areas. Previous studies on ICT in disaster management by Mohan & Mittal, (2020) have shown that information and communication technology is important in disseminating flood information in areas where people are affected by disasters. It also provides a platform for disaster risk reduction, mitigation, and preparedness to reduce disaster effects and minimise human suffering (Mukhopadhyay & Bhattacherjee, 2015). The Constitution of the Republic of South Africa, 1996 (Act of 1996) establishes a framework for communication in the South African context and considers freedom of expression and the fundamental right of the public to knowledge. The Disaster Management Act, No. 57 of 2002, in South Africa establishes an integrated and coordinated disaster management strategy that focuses on preventing or lowering catastrophe risk, moderating disaster severity, emergency preparedness, speedy and effective disaster response, and disaster recovery and rehabilitation across the spheres of government. The Act also makes provisions for the establishment of a disaster management information system that collects, processes and analyses such information. It is also accountable for the prevention and mitigation of disasters, as well as an early warning system. An early warning system makes it possible for the detection and forecasting of imminent extreme events, as well as the formulation of warnings based on scientific understanding, monitoring, and analysis of the elements that influence the severity and frequency of disasters (National Disaster Framework, 2005).

Hmoudi and Aziz (2015) stress that natural disaster management is not only about shelter and distribution of blankets and food, but it is also about education, awareness generation, mitigation strategies, and community participation. The purpose of this study is to investigate how ICT is used and its importance in disaster preparedness by the eThekwini Municipality to minimise the loss of people’s lives. The recurring and growing number of disaster situations in South Africa and other developing countries has motivated this research.

1.4 Aim of the Study

The aim of the study was to examine the importance and the use of ICT and its impact on disaster preparedness.

1.5 Study Objectives

The study objectives were:

- To review the status of ICT tools used by the Disaster Management Centre of eThekwini Municipality and their effectiveness.
- To determine the challenges eThekwini Municipality experienced in the implementation of ICT tools in disaster risk reduction.
- To make suitable recommendations on the ICT that will be effective and enhance disaster preparedness of the eThekwini Municipality.

1.6 Research Questions

The research intended to find answers to the following questions:

- What is the status of ICT tools that the Disaster Management Centre of eThekwini Municipality use in disaster preparedness and how effective are they?
- What challenges does the eThekwini Municipality's Disaster Management Centre face in the implementation of ICT tools in disaster preparedness?
- How can the existing ICT tools of the eThekwini Municipality be improved in disaster preparedness?

1.7 Significance of the Study

The intention of this study was to examine the role of ICT in disaster preparedness by the eThekwini Municipality and intended to make recommendations to improve disaster preparedness to avoid and minimise the flood impact. Disaster preparedness seeks to attain a suitable degree of preparedness in answer to any disaster situation by enhancing the technical and management capabilities of governments, organisations, and communities (Ofrin & Salunke, 2006 cited in Burke & Kent, 2014). The researcher hopes that the research will be useful to the field of Public Management regarding disaster management and promote a culture of

preparedness within the eThekwini Municipality and other municipalities in South Africa.

1.8 The justification for the Study

Techniques for disaster management are born or motivated by a single tragedy, but they grow through time both as a response to prior incidents and in a preparatory way for future emergencies (Marie, 2017). The research has been influenced by the number of flood calamities in South Africa as well as other emerging countries such as Indonesia, India, and Malaysia. The study has been encouraged by the recurring flood disasters that have resulted in the loss of many lives in the eThekwini Municipality of KwaZulu Natal Province. In disaster prevention, mitigation, and management of information and communications technology (ICT) is critical. Communication technologies such as communication radios, television and radios are important in disseminating information. The outcomes of this research study are expected to be used locally to assist the community to gain knowledge on the importance of ICT in disaster management.

1.9 The Structure of the Dissertation

The dissertation is organised as follows:

1.9.1 Chapter 1: Introduction

The first chapter comprises the introduction of the study. It provides background information on disaster management and outlines the research problem. It provides the research aim, objectives, and key questions to the study. The chapter also highlights the significance of the study as well as the study's justification.

1.9.2 Chapter 2: Literature review

This chapter explores the existing literature on disaster management and ICT in disaster management. The chapter further discusses the diffusion of innovations as the theoretical framework on which the study is centred. The use of information and communication technology in disaster preparedness is explored in detail.

1.9.3 Chapter 3: Research methodology

This chapter describes the study approach used to collect data from participants. It further discusses the research design, data collection techniques, target population and sampling technique. The chapter provides insight into how the data was collected, processed, and analysed and it also explains how ethical considerations were followed.

1.9.4 Chapter 4: Data presentation and analysis

This chapter discusses and analyses the role of ICT in disaster preparedness by the eThekwini municipality. The findings of the research are presented, and data is analysed to fulfil the study objectives.

1.9.5 Chapter 5: Recommendations and conclusion

The research summary, results, and recommendations are found in this chapter. The main objectives of the study are reconsidered in light of the fieldwork data in the conclusion, and pertinent recommendations are provided in light of the fieldwork findings.

1.10 Conclusion

This chapter introduced the study. It gave the context of the research, research problem, objectives of the study and research questions. It further discusses the significance of the study as well as the justification of the study and summarises the structure of the dissertation. The next chapter presents the literature reviewed on disaster management and information and communication technology.

CHAPTER TWO

Literature review

2.1 Introduction

The research studies show how ICT plays a role in preparing communities for natural hazards and highlights how ICT theories are incorporated into disaster preparedness. This chapter seeks to discuss the importance of ICT with reference to disaster preparedness. The researcher has done that by reviewing relevant literature on ICT in disaster preparedness in terms of the community's readiness prior to disaster occurrences. ICT can help people to be more resilient by allowing a wide range of people to have a relevant, consistent, and coherent understanding of a crisis scenario and perhaps empower them to make better decisions.

A literature review is a comprehensive overview of previous research on a certain subject (De Vos *et al.*, 2005). This chapter reflects on the literature reviewed on ICT in disaster preparedness and disaster management. The purpose of this study is to examine the importance of ICT and its importance in disaster preparedness by the eThekwini Municipality. The researcher used a literature review to position her own research in the context of current literature, demonstrating why more research is required.

ICTs prepare people living in disaster-stricken areas by providing them with real-time natural hazard information. Primarily, ICTs are important tools that have been widely used previously by professional humanitarian responders to facilitate decision making on disaster preparedness by disseminating flood risk information timeously to lower the level of risk and uncertainty. The researcher’s arguments are developed by first conducting a study of the literature and a conceptual discussion of the relationship between disaster mitigation, preparedness, risk reduction, and ICT. Thereafter, the elements to show how ICTs help during the pre-disaster stages are explored.

This paragraph is a summary of this chapter and serves as a link to the sections that follow. The next paragraph commences with the use of ICT in disaster preparedness

as the enabler of individuals to receive their fair share of information to best contribute to and be aided by crisis response activities, including an overview of pre-disaster management. The chapter then looks at important literature in disaster management, with a focus on research that looks at the role of information and communication technology (ICT) in the pre-disaster phases which are: disaster preparedness, mitigation and risk reduction. The theoretical framework for this study is discussed in this chapter to show the relevance of the ICT in disaster preparedness, and the chapter wraps up with a summary of the study's justification.

2.2 Natural Hazard

Natural disasters may strike anywhere, regardless of whether a country is developed, developing, or least developed. Natural hazards are one of the most serious difficulties facing our societies today, posing one of the most serious threats to our society's well-being. Severe natural disasters such as earthquakes, floods, tsunamis, and storms have shaken the planet in recent decades. Natural disasters are unavoidable phenomena that cause serious physical harm and societal disturbance (Fritz, 1961; Sagintaye & Collins, 2016; Goddard *et al.*, 2018).

Disasters have a significant impact on human lives, with hundreds of thousands of people losing their lives and property as a result of them. Disaster preparedness refers to the steps done ahead of time to anticipate and mitigate the effects of calamities; it aims at lessening the impact of disasters on vulnerable communities. Floods and other climate and weather-related severe events are becoming more common and intense in many parts of the world, putting people in greater danger and that leads to the loss of lives and infrastructure. Glaser *et al.* (2018) are of the view that the ability to adapt and mitigate climate change is not uniform across locations. Climate change can come in a variety of forms and the results cannot be generalised; in such circumstances, the impact of climate change can be disproportional and will not necessarily follow the global trend. The consequences of climate events are not borne equally because communities do not experience the same disaster event in the same way. Communities coping with flood disaster north of KwaZulu Natal are different than those adapting to the same event south of

KwaZulu Natal. In essence, the nature and level of risk vary from community to community, from place to place and country to country.

Disaster risk communication is widely recognised as a critical tool for reducing the most devastating effects (Rahman *et al.*, 2019). The eThekwini Municipality Communication Policy (2009) provides clear principles and guidelines for communication to make sure that communications are well-coordinated, well-managed, and responsive to different types of information demands of the municipality's residents. The policy seeks to ensure that communication is conducted in a consistent and coordinated manner. According to Sakurai and Murayama (2019), information has been identified as a critical component of disaster relief operations while information record and exchange are initial functions of an information system prior to a disaster. Information about disaster is necessary both before and after a disaster occurrence and with information communication technologies, social media could be used as a new information source for disaster management phases. In the 21st century ICTs have been described as having the potential to improve the resilience of disaster-stricken societies. Communities may now collect and exchange information and connect with a network of peers in new ways thanks to information and communication technology. Studies on ICTs such as Disaster Management and Information and Communication Technology (Ngang, 2010) believe that both information and communication technologies have the ability to enable actors to be more effective and efficiently prepared before a disaster occurs.

The next section will describe what information and communication technologies are, and their importance in disaster preparedness.

2.3 Use of Information and Communication Technology in Disaster Management

Providing the relevant information to the individuals who need it in a timely manner is key to saving lives and property. Disaster management stakeholders prepare in advance to rescue the affected people dwelling in disaster-prone areas, as well as to lessen the effects of disasters. Information that is distributed in time about the nature

of the disaster and its impact is essential. If the information is provided in time, in an effective manner and is specific, it helps to reduce the disaster impacts. Information and communication technology (ICT) has become a catchword with different interpretations and views. ICT is sometimes synonymous with information technology (Pratt, 2019). ICT refers to the technologies that enable telecommunication-based access to information. It is similar to IT, but it is more concerned with communication technologies. Osterwalder (2004) states that ICT refers to every technology that helps with the processing, transfer, and exchange of information and communication services. Osterwalder and Pigneur (2013) stress that IT covers all areas related to processing, manipulation and managing information. People access information via computers, the Internet, phones, televisions and other devices; therefore, IT is significantly changing people's lives by ensuring that information about disaster preparedness is available to prepare them before disasters occur.

According to Zemp (2010), in times of emergency, ICTs make it easier to access official disaster information and have advantages over traditional media for disaster communication agencies. He further states that information delivered directly by the disaster agency and via ICT is not subject to the gatekeeping mechanism used by traditional media outlets. Disaster authorities and various role players, with the help of ICT, are able to create their own web pages and manage information to address communities directly. Authorities in the event of a disaster can quickly send important content, give information in a variety of languages, and show information in a variety of formats. This information may be more reliable than that obtained through the media, and it can provide specific information about local, national, and international services to help people prepare for flood disasters.

People share a massive amount of information via social media, which can be used to help in crucial moments to boost pre-disaster operations. Phones, short message systems, radio, data sharing, email, social media, and GIS data are just a few of the ICT applications and technologies that responders and rescuers rely on during disaster planning (Al-Taie and Ali, 2017). Social networks in disaster preparedness are critical in assisting communities and individuals in dealing with disasters. It is

evident that the widespread use of ICT has paved the way for critical information to be received about disaster preparedness and the multiple communication channels mentioned above are important to ensure that as many people as possible receive disaster warnings so that they can take necessary precautions to lessen the disaster effects.

Beynon-Davis (2009) cited in Ngang (2010) defines IT as any technology used to support the gathering, processing, distribution, and use of information. It also includes hardware, software, data, and communication technology. ICT and IT systems are referred to in this study as the internet by authors such as Zaman and Biswas (2014) and Wilson et al. (2018). Therefore, this study focuses on the impact and importance of these systems on disaster preparedness. Ardiansyah and Munadi, (2016) are of the opinion that the exchange of information between the disaster mitigation stakeholders and the community will be effective if the mechanisms and tools are available, they further stress that even before a disaster occurs, society and disaster mitigation stakeholders require current information, which is usually associated with geospatial information for rapid decision-making and taking correct disaster preparedness action to reduce vulnerability and exposure to protect people and property from a disaster.

Several countries such as South Korea, Denmark, Switzerland and Sweden emphasised the role of media and telecommunication providers who may be able to assist in the delivery of an early warning system and related services. In some countries awareness from the media and telecom sector of disaster risk and how they play a role are non-existent. As a result, the government must encourage the development of these sectors' capabilities. In addition to television and radio, the widespread availability of mobile and internet services increases the possibility of timely emergency outreach. Social media and short message services (SMSes) are being used by an increasing number of countries as tools for disseminating early warning messages (ISDR, 2014; Brynielsson, 2018; Budhimir, *et al.,* 2019). The necessity of strengthening human resources and institutional capacity in the use of ICT cannot be overstated in the quest to bridge the digital divide. ICTs are simple tools, but the question remains: do people know how to effectively utilise them during

the disaster preparedness phase? Therefore, disaster institutions should constantly train and re-train, impart skills and upskill disaster management officials to effectively use ICT during disaster preparedness in order to reduce disaster impact or recover from losses. In addition, ICT has become a transformative driver to accelerate socio-economic development and effect beneficial changes (Roztocki, *et al*. 2019). ICT plays a critical role in all disaster risk aspects by providing early warning prediction and information dissemination to populations, particularly those at risk.

Chesango and Lesame (2017) agree that the availability of ICT people may profit from technology like e-education, e-health, and various communication platforms. They further state that living in rural areas that are poorly connected in terms of ICT not only is access to information restricted, but citizens' rights to interact and participate in democratic processes are also restricted. Bjerge *et al.* (2016) state that the challenge in ICT is to establish an information infrastructure that is flexible enough to manage the dynamic exchange of information among the participating entities in an inter-organisational system but organised enough to ensure that the relevant information reaches the responsible parties in a format that is understandable and timely enough to support effective action. And they believe that one way to accomplish this is through the effective use of ICT platforms. Communication technology can be effectively applied in mitigation, preparedness, response, and recovery and should be recognised as being integral to disaster management in particular disaster preparedness (Islam, 2010; Mohan & Mittal, 2020). Through information and communication technology disaster management teams distribute flood messages and release new updated information for preparing the society to take necessary precautions before a disaster occurs to reduce the negative impact of disaster events.

From the above, it is evident that ICT is a crucial element for communication as it plays a vital role in conveying flood information through the network of forecasting stations in the disaster-prone areas, it also provides a disaster prevention platform. Communications and IT helps to raise awareness of the devastation caused by disasters among society, the general public, and individuals and to share the responsibility of minimising the impact of disasters. Recently, information technology

has increased its capacity for disaster response by introducing new and improved technological solutions at various stages of disaster management. (Idowu *et al.*, 2003; Thomas, 2017; Laurence & Delina, 2019) believes that ICT has changed the aspect of the world in which we live, they further emphasised that it makes it possible for people to communicate with their family, friends and colleagues and people around the world to share flood early warning messages.

Hurricane Rita struck Mexico on 22 September 2005 causing massive damage. Prior to the hurricane Rita, citizens were asked to take hurricane preparation measures, some residents in the area had evacuated because warnings were issued prior, but Sexton *et al.* (2007) revealed that complex demands for communication were not met as was hoped, for example, some information communication technology devices proved to be inoperable which led to less preparedness to respond to the disaster. Mayer *et al.* (2008) reported that prior to Hurricane Rita, only 39.3 percent of people took extensive precautions; the majority of people (60.7 percent) took only a few or limited precautions. According to a media reports on Disaster Centre (2005), 113 people died, and 44 993 single-family dwellings were destroyed. If the early warning system was enhanced, it would have increased the preparedness awareness and the society's preparedness level. Due to the lack of preparedness strangers from all around the country came together to reunite separated families and organised aid through blogs and forums (Membele *et al.,* 2021).

2.4. Disaster Management

Among many complicated issues, natural disasters are one of the most serious challenges confronting our society today, with devastating consequences. Severe natural disasters, such as earthquakes, floods, tsunamis, and storms have struck the world in recent decades (Ritchie & Roser, 2019). The yearly death toll from disasters was high in the early to mid-twentieth century, typically exceeding one million per year (EM-DAT- the International Disaster Database, 2020). Prasad *et al.* (2017) stated that natural hazards are increasing and will continue to increase as a result of global warming.

Climate changes as well as additional issues such as poverty, an increase in the number of people and hastened urbanisation are difficult to address, particularly in developing countries that lack the resources to prepare for and mitigate natural hazards. Although natural hazards cannot be prevented, they can be managed through disaster management components which are: preparedness, mitigation, response, and recovery. The next paragraph illustrates the relationship between the phases of emergency management, known as the disaster management cycle.

2.4.1 Disaster Management Cycle

According to Rafi *et al.* (2018) Disaster management is the process of acquiring, managing, and utilising disaster information in order to effectively manage disaster risk and management situations. There are four stages in disaster management: mitigation, preparedness, response, and recovery (OoTha, 2020). The disaster management cycle consists of these four phases of emergency management (as illustrated in Figure 1).

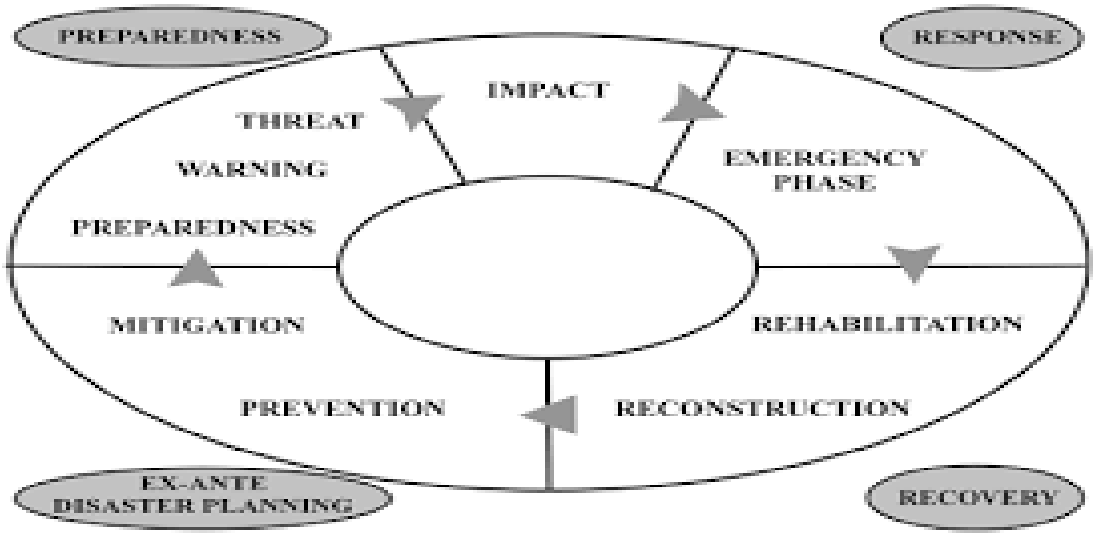

Figure 2.4.1.1 Disaster management cycle.

Source: (Cerqua & Rapicetta, 2014).

Tad and Janardhanan (2014) define a disaster as a significant disturbance of life in a society caused by nature and man-made situations. They go on to say that it interferes with the operation of a system, posturing a serious and widespread threat to human life, property, and the environment. Disasters are the result of how societies structure themselves economically and socially, how societies interact, and how relationships between decision-makers are maintained (Sena, 2006; UNISDR, 2019). Mung'ou (2009) says although it is not always possible to avoid calamities, the suffering can be minimised by employing adequate disaster management methods. A disaster happens when a hazard affects a susceptible population, causing disruption and destruction as a result of a combination of danger, vulnerability, and a lack of capacity or risk-reduction measures. Natural hazards include floods, cyclones, landslides etc. Everywhere disasters strikes, both developed and developing countries are dealing with massive devastation and human suffering.

Risk is typically associated with a person's inability to deal with a given situation. Risk in disaster management can be defined as the likelihood of negative consequences or expected losses such as death, injury, property damage, and environmental damage. Disaster management in a South African context is defined by section 1 of Disaster Management Act, no. 57 of 2002 as a continuous and integrated multi-sectoral, multidisciplinary process of planning and implementation of measures aimed at:

a) Preventing or reducing the risk of disasters,
b) Mitigating the severity or consequences of disasters,
c) Emergency preparedness,
d) Rapid and effective responses to disasters, and
e) Post-disaster recovery and rehabilitation.

Disaster risks can be managed or minimised by disaster management efforts aimed at preventing or limiting hazards negative consequences (UNISDR, 2009, 2015b). The disaster management cycle consists of four phases in which these activities are carried out. The Disaster management cycle as presented in figure 1 illustrates the

ongoing process and the sequence of actions which includes mitigation, preparedness, prevention and recovery stages of the disaster which assist organisations and civil society to reduce the impact of natural hazards. The **Mitigation stage** focuses on acquiring knowledge concerning the nature of hazards, vulnerability, and capacities. The **Preparedness stage** includes among other ways to increase personal and social protection. The **Response stage** seeks to take suitable and immediate actions with diverse parties as soon as possible after a disaster occurs in order to prevent future harm to those that are affected and the environment, and the **recovery stage** aims to assist affected people in returning to their normal lives after a disaster occurs.

Pre-disaster mitigation measures aimed at avoiding or reducing the impact of disaster are required for an effective approach to disaster management (Asian Disaster Preparedness Centre n.d:2). Public awareness initiatives aiming at transmitting and exchanging information about community safety are part of the pre-disaster risk reduction phase. Kolanchu (2011) believes that during the pre-disaster phase, the general public and organisations should gather information on preventative measures and put it to use while learning to work together. Poyarkov (2005) says in order to avoid misunderstanding and facilitate information flow, information should be clear and succinct. Preparedness plays an important role in disaster management within the cycle since it is preparation for all necessary actors involved in disaster management including the community ahead of time (Lakein, 2014). During the preparedness phase, governments, organisations, and individuals develop plans such as training and educational activities for things that cannot be mitigated to save lives and lessen the effects of natural disasters.

From the illustration in figure 1, it is clear that no phases are mutually exclusive to other activities they link to one another. EM-Queensland *et al.* (2015) point out that during the disaster event, response and recovery efforts will be prioritised over mitigation and preparedness efforts. However, mitigation and preparedness activities are more common and focused before a calamity takes place than response and recovery activities. Floods are natural hazards that can happen anytime and anywhere and cannot be predicted, they cause disruption to property and even to the

soul. In order to reduce the damage, it is important to prepare some kind of preventive measures against all possible disasters; therefore, disaster preparedness is the planning of reducing the damage that can be caused by natural hazards. Preparedness entails those necessary provisions such as organised personnel, funding arrangements, other resources and equipment, including early warning systems are available.

2.4.2 Mitigation

Mitigation is defined in section 1 of the Disaster Management Act, no. 57 of 2002 as “measures taken that aims to reduce the impact of the effects of a disaster”. Its goal is to strengthen capacity in two main areas that are: structural and non-structural prior disasters (Victoria, 2013 cited in Chou *et al.*, 2015). Natural disasters, environmental deterioration, and technological hazards have a detrimental impact on vulnerable areas, communities, and households, and mitigation refers to the application of both structural and non-structural methods to decrease the impact (Disaster Management Act, no. 57 of 2002). These efforts can be directed at the source of the hazard or threat, a fire break, for example, prevents a fire from spreading near residential areas. This is referred to as structural mitigation because it necessitates infrastructural or engineering measures to keep the hazard away from the most vulnerable people. Disaster mitigation efforts can also target vulnerable people by making them less vulnerable to a specific threat, such as encouraging community responsibility for fire risk management in an informal settlement. This is known as 'non-structural mitigation' because it promotes risk-aversion behaviours and attitudes. Structural mitigation refers to activities relating to construction projects, and engineering work that reduce the effects of disasters. Non-structural mitigation refers to activities such as disaster management programmes, education, training, and so on that raises disaster awareness.

Prevention and mitigation are concerned with eliminating or lowering the long-term risk of disasters and their repercussions on people and property by deliberate measures. According to Sena and Michael (2006); Omieno and Khabamba (2012) and He∗ and Zhuan, (2019) Mitigation is the permanent reduction of a disaster's risk

and it includes all actions performed in advance of the onset of a potentially catastrophic event. These authors further state that mitigation entails accepting that a disaster will occur and making efforts to minimise the negative consequences of a disaster and its influence on human suffering and economic assets. Disaster mitigation efforts can also target vulnerable people by lowering their susceptibility to a specific danger; it encourages risk-aversion behaviours and attitudes. Mitigation is critical in disaster management because it reduces the number of victims in terms of both lives and property. Disaster preparedness is urgently needed everywhere, in all places and in all countries (UNISDR, 2015). Therefore, Information and communication technologies play an important role and they can be used as instruments to provide early warning information, as well as track and communicate during emergency circumstances and post-disaster periods, and they can help with disaster prevention, mitigation, and management.

Mitigation recognises that disasters will occur at any point in time, and efforts are designed to lessen the negative impacts of a disaster and reduce the impact on human suffering and economic assets. Mitigation measures are taken pre- and post-tragedy. Mitigation reduces the risk and severity of disasters by taking long-term measures to reduce or eliminate long term risk. Long-term mitigation options based on location and hazard could be shared with disaster-affected communities for informed decision-making where the use of ICTs is a useful tool to communicate and create, disseminate, store and manage information. ICT allows stakeholders to solve real-world problems and to have a global view of issues and ideas affecting the people. Action needs to be taken or incorporated into a disaster preparedness plan in order to avoid or substantially reduce disaster impacts on communities as a phase of disaster management that takes place before a crisis occurs and as a part of what is collectively termed “disaster risk reduction” which focuses on the identification, assessment and reduction of disaster risks. Disaster mitigation seeks to avoid or reduce disaster-related damage such as damage to property, a reduction in available funds, as well as a personal injury or illness massive population migrations can occur in less-developed countries as a result of a loss of resources, security, and shelter progress towards the adoption of mitigation practices require community

commitment, especially those residing in flood-prone areas awareness and education programmes need to be fostered due to lesson learned from previous disasters to avoid more disaster damages.

2.4.3 Disaster Risk Reduction

According to Zaman and Biswas (2014), the proactive procedures and efforts done to avert future hazards owing to a disaster are known as risk reduction. Disaster risk reduction can be defined as a systematic development and implementation of policies, strategies, and practices to decrease vulnerabilities and catastrophes throughout society in order to prevent and limit the negative consequences of hazards in the context of long-term development (ISDR 2015). In South Africa, disaster risk reduction is an integral and important part of disaster management. It aims at reducing people's vulnerability to dangers and lowering their disaster risk (Vermaak *et al.*, 2004). The International Strategy for Disaster Reduction (ISDR, 2009) defines disaster risk reduction as the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including procedures for reducing exposure to hazards, reducing the vulnerability of people and property, wise land and environmental management, and improved preparedness for adverse events. The emphasis is on "improved preparedness for adverse events". The impact of natural hazards is affecting communities globally, therefore establishing focused international efforts such as the Sendai Framework for 2015-2030: Disaster Risk Reduction Risk reduction refers to proactive efforts and actions made in advance of a tragedy to avert future hazards.

Globally, the impact of flood disasters brought great harm to humans, economies, and the environment. According to the United Nations Office for Disaster Risk Reduction, climate-related disasters have increased in the last 20 years. Between 1980 and 1999 there were 3 655 climate-related occurrences and between 2000 and 2019 the number of floods has doubled to 6 681. Over the last two decades through a set of global policy frameworks, the world has concentrated on how to best mitigate these effects. In 2005, ISDR hosted a The Hyogo Framework of Action (HFA) adopted during the World Conference on Disaster Reduction. Its goal was to

encourage the effective integration of catastrophe risk factors into all levels of sustainable development policies, planning, and programming (UNISDR, 2005). The conference focused on reviewing progress made in implementing the Yokohama Strategy and identifying specific gaps and challenges to be addressed in the coming years by ensuring more systematic action to address disaster risk in the context of sustainable development and building resilience through enhanced national capabilities to manage and minimise local risk. Those gaps were the basis for their new position paper, which was organised into seven key areas:

- Governance, organisational
- Legal and policy framework
- Risk assessment
- Monitoring and early warning
- Knowledge development and education
- Reducing underlying risk factors
- Preparing for effective response and recovery (UNISDR, 2005).

In 2015, ISDR promoted another World Conference on Disaster Risk Reduction (DRR) at which the Sendai Framework for Disaster Risk Reduction was adopted. The DRR framework that governs the timeframe from 2015 to 2030 was adopted in Sendai, Miyagi, Japan on the 18 March 2015 and was therefore named the ‘Sendai Framework for Disaster Risk Reduction 2015-2030’. While recognizing the HFA's positive work, the Sendai Framework aims to address the shortcomings in its implementation by refocusing the 'Priorities of Action' on disaster risk rather than the HFA's priorities of education, institutionalisation, and early warning systems as separate priorities. The framework also encourages country members to improve disaster preparedness so that when a disaster occurs, necessary steps are taken to avoid or reduce the disaster impact.

One of the Sendai Framework commitments is the priority that best recognises the importance of ICTs in DRR, ranging from forecasting and early warning systems to emergency communication systems, database management, and case registries. Over the last few years, there has been a growing recognition of the contribution that

ICTs can provide to disaster risk reduction. According to UNISDR (2016) in many countries, ICT has had a positive impact on the various stages of disaster management by providing relevant information about risk and vulnerability and ensuring that reliable information is available to support sound decision-making. The prevention of losses caused by flood disasters can clearly be done through the use of media information that is currently popular and widely used by the community, such as mobile phone communications.

Satellite-based communication linkages can consequently assist greatly in the planning and implementation of catastrophe risk reduction measures, thanks to advancements in information and communication technology such as the Internet, GIS, and remote sensing. These technologies are crucial in developing early warning systems and enforcing the preparedness, reaction, and mitigation processes. Therefore, an effort must be made to provide knowledge about disaster mitigation to grow the culture of safety. The Sendai Framework for Disaster Risk Reduction 2015-2030 has seven global targets, including significantly lowering global disaster mortality per 100 000 from 2020 to 2030 compared to 2005 to 2015; significantly lowering the number of affected people to a lower average global figure per 100 000 from 2020 to 2030 compared to 2005 to 2015; and significantly lowering disaster-related economic losses based on a global gross domestic product from 2020 to 2030 compared to 2005 to 2015 (GGDP) by 2030 (UNISDR, 2015). To achieve the aforementioned goals, understanding disaster risk, improving disaster risk governance to manage the risk, investing in disaster risk reduction for resilience, and improving disaster preparedness and "Building Back Better" in disaster recovery, rehabilitation, and reconstruction were among the four action steps recommended at the conference (UNISDR, 2015). To achieve a substantial reduction of disaster risks and loss of lives, disaster preparedness is critical to increasing the knowledge and attitude of people regarding flood disasters to be able to prevent or cope with their adverse effects.

2.4.4 Preparedness

Disaster preparedness refers to the ability of governments, organisations, and communities to respond constructively to dangers to reduce the negative impact on people and property (UNISDR, 2008a, 2017). It strives to improve governments, organisations, and communities technical and managerial competence to attain a suitable degree of preparation in response to any disaster event (Ofrin & Salunke, 2006 cited in Burke and Kent, 2014). Before, during, and after a disaster, the stage of readiness is essential to the success of disaster management operations (Coetzee, Van Niekerk, & Raju, 2018). Disaster preparedness is a stage in the disaster management process that consists of actions that allow individuals, households, organisations, and communities to be able to respond more swiftly and efficiently in the event of a disaster. All stakeholders involved must ensure that all required resources for disaster response are in place and people called upon to respond know how to use them. Disaster preparedness aims to improve life safety while also improving response activities and coping capabilities. It serves as a link between the pre- and post-disaster phases.

In view of the above during disaster preparedness it is important that disaster management authorities ensure information about natural hazards is used as a tool to encourage community preparedness behaviour.

The nine components of disaster preparedness are as follows: vulnerability assessment, disaster plans, institutional framework, information system, and emergency response, database of resources, mechanisms of response, public education as well as training (Lakein, 2014; Twigg, 2004; UNISDR, 2009). Pre-disaster preparations are crucial for predicting and reducing catastrophic impacts because it focuses on identifying risks, hazards, vulnerabilities, and capacities to plan effective responses. Individual disaster preparedness has been found to be influenced by a wide range of psychological, socioeconomic, and cultural factors that interact in complex ways (Paton *et al.*, 2008; Prior & Eriksen 2013). These factors

mentioned above can shape a community's preparedness if sufficient knowledge about hazards is provided.

Disaster planning is planning for the unexpected; it is a matter of "when" not "if". As individuals and as a community, we accept that disasters will occur at any time, we accept their consequences, and we work to reduce them through planning and preparation. Zaman Biswas (2014) states preparedness requires plans or preparations intended to safeguard lives and property while assisting response and rescue efforts. Narvaez (2012) believes that disaster preparedness planning does not always result in an effective emergency response. In most major disaster events, there is a disconnect between what is planned and what is really done. For example, the global coronavirus pandemic was an unexpected disaster that took many people's lives, and a global issue that emphasised the significance of public preparedness in responding to and recovering from disasters and emergencies and also revealed the importance of information communication technology in disaster management as most countries underwent the lockdown. ICT played a key role in the spread of early warning messages to people and preparing them to take the necessary steps to avoid contracting and spreading the virus and prevent the loss of lives.

When critical on-the-ground infrastructure is damaged, ICT provides dependable and quick communication, observation, and positioning tools. ICT-based data is also useful for risk assessment, disaster mitigation, and risk reduction.

Natural and man-made disasters in many countries in recent years have created a public demand for a higher level of preparedness and competency. Section 1 of the Disaster Management Act, no. 57 of 2002 refers to preparedness as:

> A state of readiness, which enables organs of state and other institutions involved in disaster management, the private sector, communities and individuals to mobilize, organize, and provide relief measures to deal with an impending or current disaster or the effects of a disaster.

Preparedness activities include planning, resource identification, a warning system, training, risk communication, public awareness, education and exercising, all of which are undertaken to improve community safety. Preparedness is critical because it helps save lives, reduces injuries, limits property loss, and minimises all of the disruptions that disasters cause (Mileti, 1999; Said *et al.,* 2011). Many countries have identified individual citizen preparedness as a critical component in civil protection and disaster management to manage disasters. Disaster preparedness improves disaster prevention to mitigate potential hazards by taking proactive measures by making the public aware of the risks it faces.

Disaster preparedness entails making plans to ensure that all resources and services required to deal with the aftermath of a major incident can be quickly mobilised and deployed. Currently, no country or community is immune to the ravages of natural disasters, it is a global issue. However, the effects of these occurrences can be mitigated through risk-aversion management strategies. The local community bears the primary responsibility for emergency preparedness planning and response (Simpson, 2008). Citizen preparation initiatives, such as those aimed at improving individuals and community's ability to respond in the event of a natural catastrophe play a critical role in lowering the effects of hazards that cannot be controlled (Bronfman *et al.,* 2019).

Disaster preparedness studies have discovered that, while people may be aware of the disaster risks that they face, there are numerous misunderstandings about preparedness and families are found to be unprepared. Previous studies such as an overview of Disaster Preparedness Literature by (Simpson, 2006; Sena, & Michael 2006) report high educational levels, house ownership, length of residency at current address, perceived vulnerability, and previous catastrophe exposure were also found to be predictors of disaster preparedness behaviour. Individuals who are more educated may be more aware of risks because they have more information sources at their disposal and are better able to assess risk information.

Lindell *et al.* (2016) cited in Tang and Feng (2018) believe that families with vulnerable family members have higher levels of disaster preparedness (e.g., the

elderly, children, and the disabled). Children may be more vulnerable to disasters than adults, or they may have different needs that necessitate special attention. Statistics show that more than half of those affected by disasters worldwide are children (IFRC 2019 annual report on global disasters). The International Federation of Red Cross and Red Crescent Societies emphasise that seniors and disabled people are especially vulnerable in times of crisis due to a variety of factors such as mobility issues or chronic health problems.

People with health issues cannot evacuate fast enough because they are very young or very old or they do not receive the disaster warning early enough. Most seniors are less likely to listen to evacuation warnings and are more hesitant to leave their homes. Therefore, with disasters happening more frequently, it is even more important that their families take steps to reduce risk hazards.

Maduz *et al.* (2019) discovered that in Switzerland being female, being older, living in municipalities with fewer than 10 000 inhabitants, having a higher perceived risk, and actively seeking disaster preparedness information all positively correlate with preparedness. Other factors influencing preparedness behaviours vary greatly depending on factors such as socioeconomic and demographic factors. Individuals from various social groups receive and assess risk information in different ways, and they have unequal resources to implement risk mitigation strategies. Tang and Feng (2018) believe that the types of preparatory actions undertaken by women and men are different. A lot of people are terrified of the devastating consequences that a natural disaster could have on them, their families, and society; as a result, they need encouragement to participate in disaster preparedness. On the other hand, this demonstrates that having the infrastructure in place such as an early warning system does not guarantee that people would react effectively in the event of a crisis.

Disaster preparedness is concerned with providing the arrangements that facilitate the proper response to emergency situations. Past experience has shown that preparedness plans do not automatically lead to action, but the residents need to adopt a culture of constant preparation, anticipation and more importantly decisive action by both response institutions and communities is crucial. The role of ICTs in

disaster preparedness can be viewed as a tool to facilitate preparedness by giving Information on disaster avoidance, early warning of disasters, and communicating and giving disaster information to populations in order for them to prepare for emergencies.

From the above discussion, it is evident that effective preparations are required before implementing effective interventions to mitigate disaster impacts because only effective preparation potentially reduces the severity of future disasters' effects on human lives, health, and property.

2.4.4.1 Preparedness and Early Warning System

Storms, droughts, floods, and other natural disasters affect a large number of people worldwide (UNISDR, 2018). Some losses are unavoidable, however, when appropriate preparedness measures such as Early Warning Systems (EWSs) are in place the impact on human lives can be avoided (Breaker, 2012; Zia & Wagner, 2015). Disaster preparedness focuses on warnings and forecasts of imminent disasters, and it frequently comprises dynamic processes that culminate in a "fast onset" disaster (Mukhopadhyay & Bhattacherjee, 2015). The aim of preparedness is to reduce residual risk by implementing Early warning system methods to limit the effects of flooding catastrophes. An early warning system is a set of capabilities required to develop and disseminate timely and meaningful warning information about probable extreme occurrences or disasters that jeopardise people's lives (such as floods, droughts, fires, earthquakes and tsunamis) (UNSDR, 2015).

Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters, makes a clear reference to the necessity of people-centred early warning systems particularly those whose warnings are timely and understandable to individuals who are in danger. Early warning systems that are centred on people rely on direct participation from those who are most likely to be affected by risks. An effective early warning system that is people-centred defines a communication system that reaches those who are at risk. People-centred early warnings must be clearly understood by people, easily and readily accessible to

people timely and linked to response actions to be taken by people prior to, during, and after the event. The researchers such as Budimir *et al*. (2021) have also indicated that in an effective warning system, messages should:

- Be focused on people at risk
- Be reliable.
- Be meaningful to be understood by its recipients
- Be timely so that people can have enough chance to protect themselves.

The Early Warning System (EWS) is an important part of disaster preparedness because it provides people at risk with accurate and timely information. An early warning system is made up of four key components: risk awareness, monitoring and warning, dissemination, and communication (UN, 2006b; UNISDR, 2006a). To achieve effective early warning system operation, all elements must be integrated and community participation is required (UNISDR, 2006a). According to Sithole (2012), an early warning system is a collection of data and policy analysis that allows for the forecast of developing crises and the implementation of actions to either avert or reduce their impacts. EWS are the important components of disaster risk management strategies, it has more potential to save the lives of communities, but for it to be effective, it must actively engage at-risk populations, encourage public education and risk awareness, effectively communicate messages and warnings and maintain a continuous state of preparedness to lessen the impact of natural hazards on a vulnerable population. Being prepared can save lives and the disaster impact can be minimised compared to what would have happened if the individuals were not prepared when the disaster occurred. The damage would have been greater. Communities need to receive clear and relevant messages regarding natural hazards, therefore, an early warning system is a key successful measure for disaster preparedness.

Flood early warning systems are important in the context of disaster risk reduction because they are low-cost methods of mitigating flood disaster damage. People who are at risk can use warnings to help them take the required steps to save lives avoid injuries and preserve their property. In order to maximise risk message distribution to

vulnerable populations, collaboration across multiple channels is necessary (Schroeder, Whitmer & Sims, 2016; Seng, 2012). The creation and execution of EWS for natural hazards has been repeatedly cited as a key area in disaster risk reduction where an early warning is provided to people living in hazard-prone areas through various means (https://www.unisdr.org). In the past, before a disaster occurs what we refer to as old technology such as sirens and radio communications to broadcast disaster alerts and information was widely used. In developed and developing countries for decades people have used landlines to communicate, and local governments and the authorities have set up emergency calls to send out warnings. Over the last two decades, the rise of cell phone and internet communications have proven a new possibility for catastrophe warning information sharing and communicating pre-disasters is the change that has been brought about by the fourth industrial revolution.

The use of mobile cell phones and the Internet has increased over the years. Mobile communication technology has been the most rapidly adopted technology in recorded human history. Billions of people worldwide have access to the Internet, with most of them accessing the Internet via mobile phones (Thomas, 2017). Cell phones can assist in reducing deaths by facilitating the distribution of warning information that allows people to take precautions as part of preparedness.

Toya and Skidmore (2018) state that not all researchers agree that using cell phones to disseminate disaster warning information is the most cost-effective method. Toya and Skidmore (2018) cited in Collin and Kapucu (2008), who examined the literature on tornado warning methods and decided that local governments should employ weather radio warning systems to share tornado warning information since it is the most cost-effective method. The short message service (SMS) should be provided to alert relevant individuals and it should also be extended to the community so that flood event information reaches them more effectively. According to Sukeri *et al.* (2015), cell phone messages are a reliable system of notification because they are used to communicate with a bigger number of individuals and have a functional level of hazard resilience. However, the message must be delivered in a language that the

target audience understands particularly in rural areas where the majority of residents are illiterate.

As stated by Bertot (2002), the majority of people in rural areas notably Africans are illiterate. Males were assigned to work on farms or go to cities in search of work in African culture, while females were assigned to stay at home and care for the household and children. Most people spend their time in agriculture to survive rather than attending school. The standard of education is low, and those who have obtained a formal education, migrate to urban areas in search of better prospects.

In support of the above statement, Gupta (2006) claims that elderly persons who left school before computers were included in the standard curriculum or who live in rural areas with a lower level of education are computer illiterate and this illiteracy precludes them from using ICT tools. Relevant stakeholders responsible for disseminating information regarding floods should understand the needs of their targeted audience to ensure that there is no miscommunication and mis-understating of the messages. Clear communications conveying basic, practical and useable information are essential for communities to be able to prepare in a way that protects lives and livelihoods.

In order to create an effective early warning system, it is crucial to assess and evaluate the vulnerabilities of different groups depending on their culture, gender and other important features. Community Engagement (CE) in Early Warning Systems is defined as involving a community in the observing and gathering of hazard risk information, the distribution of warning messages to persons at risk, and the facilitation of emergency reactions to limit the risk of harm or loss as a result of hazard events (IFRC, 2012). Every vulnerable community should have an information and early warning system that meets their needs. EWS are only successful if they are extensively shared and conveyed effectively, in order for communities to be alerted to impending hazardous events. It is critical that the information be easily comprehended, trustworthy and consistent across a wide range of people. While cell phones and the Internet can facilitate communication prior to disasters on their own, the efficiency of warning systems that are connected with ICT

is enhanced. To ensure that the greatest number of people are warned to prevent any single route from failing and to reinforce the warning, many communication channels must be employed. Furthermore, different hazards necessitate the use of different EWS. The following section analyses the early warning system framework and its importance in disaster preparedness.

2.5 The Effective Early Warning System Framework

An early warning system must be people-centred, a multi-hazard early warning system that requires a working framework based on accepted core principles, and it must integrate and span four parts as outlined by the ISDR model: (a) an understanding of the dangers; (b) technical monitoring and warning service; (c) the broadcast of meaningful warnings to individuals who are at risk; and (d) responses that are dependent on public awareness and preparedness (ISDR). These four elements appear to be in a logical sequence and they also link and interact with each other (as shown in Figure 2).

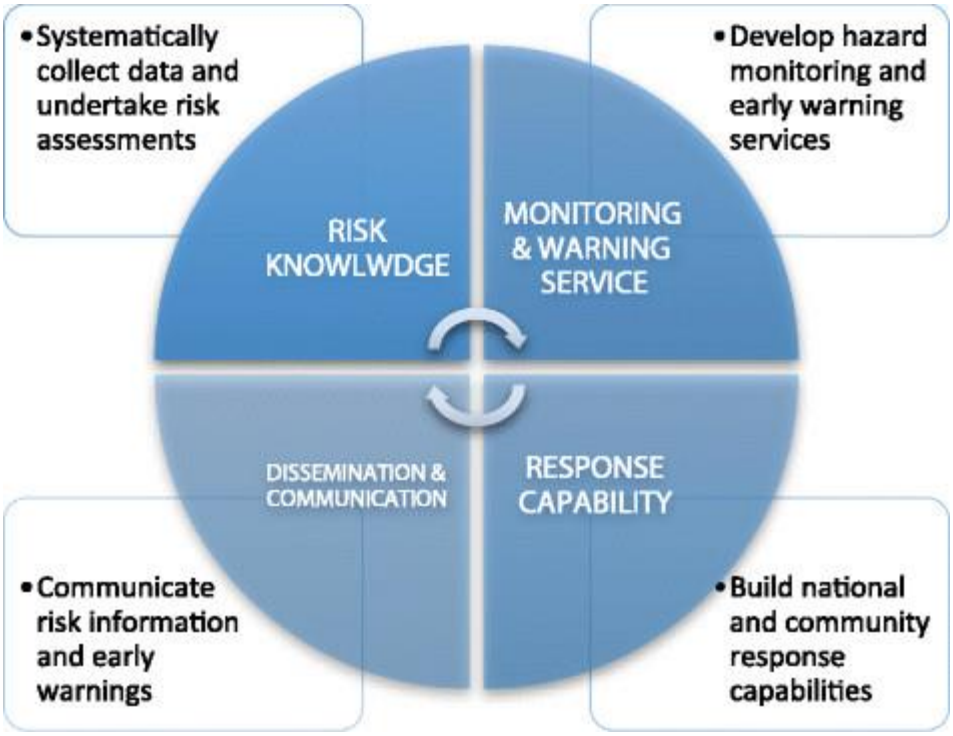

Figure 2.5.1: The four elements for an effective EWS framework.

Source: (UNISDR, 2006).

The fundamental goal of establishing a EWS is to protect people's lives and livelihoods from known threats while minimising negative economic and environmental consequences. Individuals and communities who are threatened or at risk must be empowered by EWS to act quickly and appropriately to prevent the risk of personal harm, death, and damage to livelihoods and property.

2.5.1 Risk Knowledge

Risk knowledge is comprehensive information on all aspects of disaster risks such as hazards, exposure, vulnerability and capacity as they relate to communities and organisations. The Sendai Framework for Disaster Risk Reduction 2015–2030 addresses knowledge-related issues and emphasises the value of knowledge in disaster risk reduction. The goal of risk knowledge in EWS is to enable better planning and timely notification to the public. This can help to save lives and reduce the social, economic, and health consequences of disasters. Risk awareness helps to motivate people to understand risks and prioritise the needs of early warning systems.

2.5.2 Monitoring and Warning Service

Continuous monitoring of hazard parameters and precursors is required to generate accurate warnings in a timely manner. Wherever possible warning services for various hazards should be coordinated to take advantage of shared institutional, procedural and communication networks (https://www.undrr.org). Systems that can monitor and predict possible threats to communities, businesses and the environment give timely estimations. Communities are ex posed and vulnerable to disaster risks posed by a variety of hazards. It is vital that members of the community are informed of such dangers and vulnerabilities. Risk assessment and risk mapping exercises can assist to prioritise which threats an early warning system should focus on and guide community response preparations.

2.5.3 Communication and Dissemination

Communicating with the community about hazard risks that are threatening them becomes critical. Communications and dissemination of information include alerts and warnings, directives about evacuation if needed and other self-protective actions. Those at risk must be given clear and understandable warnings. To ensure that people are aware of the warnings they must include information that is clear and valuable that allows for appropriate retorts.

2.5.4 Response Capability

It is critical that communities are aware of the risks they face, that they respect the warning system and that they know how to respond. Building a prepared community necessitates the involvement of both formal and informal education sectors, while also addressing the broader concept of risk and vulnerability. Education and preparedness programmes are critical in dealing with emergency situations (The White Paper on Disaster Management 1999). It is also critical to have disaster management plans in place that have been practised and tested. The community should be well informed about safe behaviour options, available escape routes and how to avoid property damage and loss. When there is a response capability, the risk is contained and controlled.

Basher (2006) says that to sustain these four elements, strong political commitment and long-term institutional capacities are required which are dependent on public awareness and appreciation of the benefits of an effective EWS. A flaw or failure in any part of the chain or link could cause the entire system to fail. The best practice of EWS has a strong inter-linkage between all elements in the chain, failure of one of these interconnected key elements of EWS could result in system conflict. For example, a lack of communication and dissemination of information can ultimately lead to a low level of preparedness as information would not accurately reach the targeted people and the response capability element would fall through the cracks.

Governance and multi-institutional arrangements include legislative, policy frameworks, institutional capacities and government funding to support the

implementation and maintenance of effective early warning systems. The multi-hazard approach, involvement of local communities and consideration of gender perspectives and cultural diversity are also cross-cutting issues (UN/ISDR-MHEWC-II, 2019).

Institutions must secure and maintain political commitment, capitalise on and apply existing scientific knowledge, assess risks and manage system investment, globalise and systematise EWSs and guide and fund scientific research (Basher, 2006). According to the United Nations Development Program (UNDP) report Reducing Disaster Risk (DRR): A Challenge for Development, the critical cross-cutting issue of governance remains a key unresolved and challenging problem and there is a need to strengthen institutional and legislative systems for disaster risk management.

On that note, it was emphasised that governance areas such as political commitment, policy priority, legal and regulatory frameworks, institutional frameworks and structures, multi-stakeholder participation, disaster reduction capacities, and financial resources are increasingly recognised as critical for the success of long-term disaster preparedness and risk reduction. Governments are increasingly recognising that disaster risk reduction is a prerequisite for successful sustainable development and that disaster risk is a cross-cutting issue requiring action across multiple sectors. On this note, government and other stakeholders must ensure that there is an adequate political commitment and responsibility, a strong legal framework and appropriate links between disaster risk reduction and sustainable development. DRR is an integral part of social and economic development effectively reducing the damage caused by disasters and is necessary for the achievement of sustainable development that introduces activities, lessons learned and the way forward for education in disaster preparedness.

2.6. Response

As stated in section 1 of the. Disaster Management Act, no. 57 of 2002 disaster response is the measures taken during or immediately after a disaster to bring relief to people and communities affected by the disaster. This is the period immediately following the occurrence of a disaster when exceptional measures are taken to

search for and find survivors as well as to meet their basic needs for shelter, water, food and medical care. The White Paper on Disaster Management (1999:73) defines response as activities that are organised to deal with emergency situations and can include people being evacuated, dealing with incidents such as fire extinguishing and so on. During the response phase, the focus is on ensuring the safety of the community and meeting their basic needs until more permanent and sustainable solutions can be found. Its goal is to act quickly and appropriately with diverse role players in the event of a tragedy in order to avert further implications for the people and the environment that are affected. Specific activities during this phase include:

- Determining the extent of the crisis and coordinating search and rescue operations.
- Caring for injured persons and meeting their basic needs and hygiene/sanitation, and
- Establishing emergency shelters and so on.

ICT disaster preparedness plays a huge role in facilitating the flow of information in a timely manner to prevent disasters, minimise their impact on vulnerable communities and effectively respond to their consequences.

2.7. Post-disaster recovery and rehabilitation

The operations and decisions made after a disaster are referred to as recovery and rehabilitation. They seek to return the affected community to its pre-disaster living conditions while encouraging and facilitating the necessary adaptations to the disaster's changes (Van Niekerk *et al.,* 2002:52). The disaster management cycle depicted above depicts the ongoing process by which all multisectoral organisations plan for and reduce the impact of disasters, as well as take steps to recover after a disaster has occurred. For the purpose of this study, various activities in this phase include:

- Providing short-term or long-term community housing;
- Clearing the debris, removing and deconstructing damaged structures;
- Reconstructing and rehabilitating damaged infrastructure;

- Rehabilitating the injured and offering a counselling programme for post-traumatic syndrome cases, and
- Rehabilitating community livelihoods (EM-Queensland 2014, 2015).

Recovery is seen to be the best time to analyse or re-evaluate disaster plans to recommend improved future disaster preparedness strategies. Recovery actions include those that help a community reclaim a sense of normalcy following a disaster. It is a long-term post-disaster assistance programme for community reconstruction and rehabilitation. ICT can provide all stakeholders with the necessary information and connect people and institutions for recovery measures. Effective coordinating services based on ICT-based technologies could be beneficial for evaluating disaster and risk reduction efforts, policies, and long-term disaster preparedness planning to prepare for natural disasters in advance.

2.8 Knowledge transfer

In the event of a disaster, the public becomes reliant on the media for information from relevant public authorities and news, which may be critical for survival. The Sendai Framework for Disaster Risk Reduction 2015-2030 addresses knowledge-related issues and provides an opportunity to emphasise knowledge's critical role in disaster risk reduction. Knowledge transfer refers to the sharing or dissemination of information and offering input to issue solutions. The availability and accessibility of risk knowledge are factors that can contribute to disaster reduction. This knowledge is critical for keeping people informed and prepared for impending disasters (Ardiansyah and Munadi, 2016). According to the IFRC (2018) carrying out risk evaluations with an awareness of risk insight as well as the community's coping ability will boost early warning efforts. Risk assessment helps to identify risk hazards and raise awareness about hazards and the risks they pose to society and allows for action to be taken to minimise risk impact by disseminating early warning to provide information alerting individuals and communities to the need to protect their lives and property.

Risks are created by the grouping of hazards and exposures in a certain region. Performing risk analyses helps all interested parties gain a better understanding of hazards and vulnerabilities, as well as their adaptive capacities (IFRC, 2009b). Hazard awareness about the frequency, severity and types of hazards that have occurred in a community, area, region or country is essential for adapting individual disaster preparedness to the local context. Despite the fact that risk data is collected and communicated on a huge scale, there is no data on how far it reaches. Weichselgartner and Pigeon (2015) argue that one cannot rely on the transmission of knowledge from one individual to another or presume that knowledge transfer will result in the intended outcome. Garcia and Fearnley (2012) believe that it is essential to examine recent information from experts and individual who have been exposed to risky situations, hazards and vulnerabilities. The perception of risk is higher in affected communities using the experience to determine risk awareness, knowledge and comprehension. Lara *et al.* (2017) conducted a study in Talcahuano city where citizens were affected by a tsunami and found that residents expressed their feelings and certainty about more than one hazard, as it is believed that the tsunami will be a recurring phenomenon. This viewpoint was certainly swayed by the tsunami experience and as a result, they have put all preparedness measures in place to avoid or reduce its impact on their lives and properties.

The purpose of risk assessment in the context of early warning systems is to inspire and help others in prioritising early warning system requirements and preparing for disaster avoidance and response. Local communities as well as their knowledge can play an important role in risk assessment (IFRC, 2012). This information is essential for keeping people informed and prepared for impending disasters (Ardiansyah & Munadi, 2016). Disaster Management Studies on topics such as disaster risk reduction initiatives and disaster management (Vermaak & Van Niekerk, 2004; Sithole, 2014; Rahman & Munadi, 2019) have revealed that communities residing in disaster-prone areas are directly affected when disasters occur and as a result, they need adequate information about hazards and the risks that they are facing, during disasters. Quick and precise information can make them more alert and better prepared to take mitigation and emergency actions after the disaster. Collins and

Kapucu (2008) cited in Scolobig, Prior & Schroter (2015) stated that incorporating local knowledge into risk assessment and management processes can improve risk knowledge and comprehension at the community level while also enriching risk assessment outcomes. Being aware of local exposure levels to an impending hazard is an important prerequisite for mitigating the hazard's potential and economic, physical and psychosocial consequences (Eriksen *et al.* 2020).

Garcia *et al.* (2014) argue that risk perception has a range of effects on the effectiveness of early warning systems. Despite being aware of the numerous threats that they confront, people can have a low-risk perception, which may result in the reduced ability to pay attention to the alerts. Furthermore, some people believe they are underprepared and as a result, they may seek measures to improve their preparedness. Others such as authorities or reaction agencies have a proclivity to shift risk management to others. As a result, they exaggerate the risk making them more vulnerable (Alcántara-Ayala & Moreno, 2016). As most organisations use the traditional "top to bottom" approach to disaster preparedness in which citizens tend to delegate sole responsibility for disaster preparedness and response to the government, but Mohanty *et al.* (2018) believe that local communities, civic groups and traditional structures can all help to reduce vulnerability and strengthen local capacities using a "bottom to top" approach.

Simpson (2001) emphasises the importance of disaster preparedness beginning at the local level and using a consensus-building approach to foster local resiliency to and responsibility for disasters. The World Meteorological Organization (WMO) (2018) stresses that over the last two decades, it has been repeatedly demonstrated that "top-down" approaches to disaster risk reduction have ignored aspects such as community roles, capabilities, vulnerabilities, needs and preparedness. Van Niekerk and Coetzee (2017) state that there still are challenges when it comes to the implementation of community-based disaster risk management (CBDRM) programmes in Africa. African governments find themselves in a position where resources are becoming increasingly limited and budgetary constraints hinder development initiatives. When local authorities in charge of disaster preparedness ignore the local community, preparedness success may suffer as a result of the

target population's lack of participation in the process. The Hyogo Framework for Action 2005-2015 emphasises that both communities and local governments should be empowered to manage and reduce disaster risk by having access to the necessary information, resources and authority to implement disaster risk reduction actions. Participation and community involvement in risk management can both improve disaster preparedness. People should be encouraged to take part in the development, design and implementation of local public policies that include preparedness and risk reduction. When people are excluded from the formulation and implementation of policies, they become reluctant to adopt the policies.

The difficulties in conducting risk assessments for EWSs entail risk changes throughout time and challenges in assessing and taking into account vulnerability and hazard developments such as climate change exacerbating and posing threats. Climate change alters the characteristics of weather, climate and hydrological hazards. Further severe incidents may occur far more often in the future as a result of climate change which is a global issue. However, the nature of vulnerability is constantly changing as a result of urbanisation, poverty, population growth, and disease (IFRC, 2009b). Furthermore, while some attempts have already been completed to analyse vulnerability in terms of physical, social, economic, and environmental aspects that raise a community's susceptibility to hazard consequences, these factors are far more dynamic and difficult to define than the hazards themselves (UNISDR, 2004). Another issue is that if hazards occur in countries where they have not previously occurred, these countries may not have anticipated developing EWSs for these new hazards. Participation of the community in risk mapping and risk analysis can improve the understanding of risk knowledge (IFRC, 2008; Scolobig *et al.*, 2015). Risk maps help communities to understand the hazards and risks that are threatening them, and this knowledge allows for better planning and notification in a timely manner to encourage everyone in the community to take action to prevent a possible disaster or reduce its effects.

2.9 Involvement of Local communities in disaster preparedness

A local 'bottom-up' approach to early warning systems with active community participation allows for a multi-dimensional response to problems and needs. Local communities, civic groups and traditional structures can all help to reduce vulnerability and strengthen local capacity. The National Disaster Management Act (South Africa, 2002) serves as the legal framework for disaster management implementation in all three spheres of government. For disaster preparedness to be effective, informed action is required in and across many sectors including health, education and infrastructure as well as environmental management. People-centred early warning systems focus on the direct participation of those who are most vulnerable to hazards. According to Mohanty *et al.* (2018) government and institutional interventions and responses to hazard events are likely to be insufficient unless local authorities and communities at risk are involved. Their close involvement will go a long way toward preparing people to deal with natural disasters as well as involving them in all possible preventive and protective activities reducing the impact of the disasters and allowing people to save their lives and property.

Risk arises from the combination of hazards and vulnerability at a particular location such as flood disasters in the case of Amaoti and KwaMashu townships that demand more investment in disaster preparedness and disaster risk initiatives to ensure the safety of the community and also to build better relations with stakeholders to engage in disaster preparedness processes. Furthermore, it is critical to actively engage the community as an important factor in Community-based Disaster Risk Management (CBDRM) programmes to raise the community's understanding of its own vulnerabilities and to define potential preparedness solutions to mitigate these risks in their current location (IFRC, 2016a, 2012, 2009).

The involvement of the community in disaster preparedness is crucial, but people need to be trained and educated to enhance their behaviour when receiving disaster warnings. This will be discussed further in public awareness of disaster risks.

2.10 Public Awareness of disaster risks

Public attention is drawn to disasters because of their nature and no one knows when and where the next disaster will happen. Increasing the importance of raising public awareness through education to reduce the danger of disaster has long been acknowledged (Aunap *et al.,* 2020). Public awareness is regarded as one of the most innovative disaster management tools and best practices used to reduce disaster risk. It assists society in becoming resilient by raising awareness of the issues that affect them. An important component of disaster preparedness plans is designed to educate and train not only community members who may be impacted by a disaster, but also persons or personnel who provide disaster relief (Alim *et al.,* 2015). As a result, all parties concerned can be well-prepared with the necessary information and abilities to carry out their duties in the event of a crisis. The purpose of disaster preparedness public education and training is to build the capacity of all key parties including citizens to respond to disasters effectively (Burke & Kent, 2014). Twigg and Lavell (2006) cited in Iguchi *et al.* (2017) point out that another important goal of public education and training is to foster a culture of safety in which risk awareness and the implementation of risk-reduction measures are routine. According to Seeger (2018), public communication will be most effective if the organisation makes public communication campaigns a central component of its strategic management process. The National Disaster Management Framework calls for the implementation of effective public awareness campaigns to increase community awareness of the risks they face and the risk-mitigation actions they can take (National Disaster Management Framework South Africa, 2005). During times of climate-changing situations, effective risk communication with communities, families and individuals, it is critical for everyone to be better prepared when disasters and crises strike. Knowledge is empowerment when it comes to preparing for mitigating the impact and responding to risk hazards. In changing climate with increased risks, the general public will need to be more aware of the dangers they face and what they can do to prepare (http://media.ifrc.org). In disaster management, public awareness is the process of educating and empowering the public by extensively spreading knowledge and information about various sorts of catastrophes and their possible risks so that people respond correctly when a

disaster occurs. The following major areas of public awareness should be prioritised: hazard risk and behaviour awareness.

2.11 Risk awareness

An effective risk communication strategy is required to maximise the impact of risk awareness on risk management (Paton and Johnson, 2001). People must have a thorough understanding of the risk including the characteristics that they may encounter at this stage. They must be knowledgeable about how the danger may affect them and why they are at risk, where and when the risk is most likely to happen, and effective ways to remove or decrease the hazards (Arru, Mayag & Negre, 2016) such as adopting the culture of effective disaster preparedness.

It is important to make better judgments to effectively address risks, implement effective risk management policies, reassure and empower the public, avert critical situations, and respond to critical events when they occur (Alseiari, 2015). The provision of information alone is ineffective in preventing disasters (Weichselgartner & Pigeon, 2015). Therefore, it is important to consider risk awareness to the public in order to learn the necessary steps to follow when disaster information is delivered to ensure the required steps are administered to minimise the effects of a disaster.

The way people interpret and respond to risk information has a big impact on how prepared they are. Previous studies on early warning systems from topics such as *Challenges for integrated early warning and disaster management in the UAE* (Hmoudi & Aziz, 2015) have shown that in most disaster occurrences, people's lives would have been saved if they acted on disaster risks alarming. That also comes back to the question, are the affected people educated about what actions to be undertaken on disaster risks alarming? Alseiari (2015) believes that risk communication messages and strategies become successful in achieving an end only when they have the trust of the public. The above discussion clearly demonstrates that communities need to be prepared to take necessary steps as soon as they receive warnings from warning services, especially for the victims of the vulnerable age or children because they often do not know how to deal with flood disasters.

2.12 Behaviour

The vast majority of individuals are aware that floods can cause significant damage to the environment, property and people. The public attitude and first responders during floods are a result of their readiness which is significantly impacted by a variety of behavioural characteristics such as perceived benefits, risk awareness and even denial. Kuppuswamy (2014) cited in Lumbroso *et al.* (2016) states that there is a need for people to be more aware of their behaviour in the face of disaster risk includes:

- Pre-disaster risk reduction behaviour: people who fall into this group are already familiar with a potential hazard and are aware of how to deal with it.
- Pre-disaster preparedness behaviour: people must be educated about what they can do before a disaster occurs.

Since disasters are recurring events, encouraging community members to participate in the development of the preparedness plan to ensure safety and act in a timely manner when a disaster occurs is very important.

Action that needs to be taken includes stockpiling specific materials and developing action plans for individuals, families, and communities. People in pre-disaster preparedness must learn how to respond to dangerous events that are about to happen. For example, they must comprehend warning messages and know how to respond appropriately within the context of this study to lessen the disaster impact to save lives. Relevant theoretical frameworks for this study are discussed in the next section in order to show how disaster preparedness information is facilitated and adopted by societies at risk.

2.13 Theoretical Framework

The researcher has identified a theoretical framework for guidance in order to develop an academic context for the study. A theoretical framework is a conceptual model that describes how a researcher makes logical sense of a relationship between several factors that have been identified as being important to the problem (Sekaran, 2000).

Information and communication technology systems are widely used in organisations and communities. A social theory focuses on how humans and technology affect each other and how decisions are made with humans and technology. Several theoretical frameworks have been developed by different authors, however, the technology acceptance model (TAM), theory of reasoned actions (TRA) and diffusion of innovation (DOI) are the most cited theories on ICT system implementation and adoption that the researcher is going to touch on. The main focus would be on Diffusion of Innovation (DOI) to justify the study. The choice of DOI is motivated by the fact that it persuades people to accept a new concept, behaviour, or product as part of a social system and spread it to the entire community. It is also motivated by the fact it highlights the role of local community members and opinion leaders as a node of influence in a communication network. DOI focuses on a group or an organisational level as this study consists of both community members and employees from the eThekwini Municipality to obtain views on the use of ICT by the eThekwini Municipality.

2.13.1 Technology Acceptance Model (TAM)

TAM is a theory of information systems that describes how users accept and use technology. Davis (1989) proposed a theoretical model aimed at predicting and explaining ICT usage behaviour, for instance, what causes potential adopters to accept or reject the use of information technology. According to the model, users are introduced to new technology on various aspects according to the model and the impact of their discretion on how and when to utilise it most notably. The two main constructs of TAM are perceived ease of use and perceived usefulness.

Perceived Usefulness (PU) –

This was defined by (Davis, 1989) as "the degree to which a person believes that using a particular system would enhance his or her job performance". It relates to whether or not a piece of technology is considered useful for the task at hand.

Perceived Ease-of-Use (PEOU)

Davis defined PEOU as "the degree to which a person believes that using a particular system would be free from effort" (Davis, 1989). If the technology is simple to use the hurdles will be overcome. No one has a positive opinion of something if it is difficult to use and has a convoluted interface. External influences, such as social influence have a significant role in determining attitude. People will have the attitude and intention to use technology once these items (TAM) are in place. However, because everyone is different perceptions may fluctuate depending on age and gender.

This theory is not appropriate for this study because it focuses on the individual 'user' of a computer, with the concept of 'perceived usefulness,' with extensions to include more and more factors to explain how a user 'perceives' 'usefulness,' and ignores the essential social processes of information system development and implementation, and the social consequences of information system use.

2.13.2 Theory of Reasoned Actions (TRA)

The theory of reasoned action (TRA) sheds light on organisational attitudinal behaviour connected to technology acceptance, use and adoption. TRA was developed by both Fishbein and Ajzen way back in 1975 and 1980 from previous studies on attitude and behaviour in organisations towards performing certain actions. TRA was developed to define the connections between people's beliefs, attitudes, norms, intentions and behaviours. According to the theory, a person's behaviour is determined by his or her behavioural intention to perform it which is governed by the person's attitudes and subjective norms about the behaviour. It aims to describe how attitudes and behaviours interact in human action. It is most commonly used to predict how people will behave based on their prior attitudes and intentions. The theory comes from the field of social psychology.

According to the theory, the intention to perform a specific behavioural action is influenced by both attitude and subjective norms. As a result, when a positive purpose is formed, a person is more likely to become actively involved in carrying out

the action. However, with reference to leading arguments on ICT and disaster preparedness covered in this chapter, one of the theory's flaws is that it cannot be applied to non-volitional behaviours like those that become mandatory. When a government agency endorses the use of ICT as a new method of doing work, it becomes a non-volitional act that everyone must follow to complete tasks. That is why this theory was not picked for this investigation.

2.13.3 Diffusion of Innovation theory

A more suitable theoretical framework for ICT in disaster preparedness is DOI. Our society is faced with innovations, new technologies and new ideas. E.M. Rogers developed the diffusion of innovation idea in 1962, which is one of the oldest social science theories. The process of domesticating technological advances within a certain community, frequently through advertising or general publicity is known as diffusion of innovation (McQuial, 2005). Diffusion of innovation is a general theory that attempts to describe how communication channels and opinion leaders impact the adoption of new ideas in a community. This theoretical framework was chosen since it prescribes a number of aspects that should be included in disaster preparedness to help with diffusion. The role of local residents and opinion leaders as communication network nodes is emphasised by DOI. Communication, the first step in disaster preparedness should be to persuade the most powerful individuals of a target group.

The fundamental goal of DOI is to track how an innovation spreads across target populations. It began in communication to clarify how an idea or product grows in popularity over time and diffuses (or spreads) through a specific population or social system to inform and alter behaviour. The definition of communication is the sharing of information (McQuial, 2005). Innovation can be anything that was borrowed from another society or something that was created entirely from scratch. DOI's practical effectiveness in identifying elements that influence adoption, as well as its broad applicability to a range of contexts make this theory, particularly, appealing to scholars interested in learning how communities and individuals respond to innovations and make adoption decisions (Rogers, 2003).

(Mung'ou, 2009) confirms invention as the process whereby a person or a group makes use of innovations that already exist, putting them together into some new pattern. People adopt a new idea, behaviour, or product as part of a social system as a result of diffusion. Adoption means that a person does something differently than what s/he had doing been previously. When a large number of people decide to embrace something new and it becomes widely used in a society, we say the invention has diffused, which is a reference to new technology or concepts. Innovation is propagated through several channels to reach the populace in a community. Individuals must take up or embrace an invention through a communication channel, which is the way through which messages are passed from one person to the next.

Information moves through a diffusion network, which is primarily a two-step communication flow, in the diffusion of innovation. It was revealed by Seeger (2018) that people who resort to other people for information about situations were the primary source of information and influence. The research looks at this theory to refer to the general usage of ICT by users involved in disaster management. Those competent in the use of ICT tools can influence the rest of society by sharing what they have learned in the mass media, which could be in the form of the latest news from the radio, television, the Internet and warning systems given on mobile cell phones about the current issues on disaster preparedness.

The study considers particularly the idea of how new ideas in a community are propagated and assimilated, how ICT communication channels are used during a disaster and how opinion leaders shape the adoption of new ideas. Disaster preparedness aims to equip people for collaborative emergency response activities. Individuals embrace innovations through communication channels which are the means by which messages are conveyed from one person to another. Therefore, social interactions may positively contribute to the well-being of individuals by sharing information through ICT about risk preparedness. The pre-disaster stage may be more efficient and quicker by using social networks which will increase the effectiveness of group efforts undertaken by people during emergency situations. The study seeks to examine the role of ICT in disaster preparedness by the

eThekwini Municipality and make suitable recommendations on the ICT that will be effective and enhance disaster preparedness of eThekwini Municipality.

This DOI model is helpful in disaster preparedness, especially in situations whereby flood warning messages need to be received by the entire population in the community within the shortest space of time. For the purpose of disaster preparedness, early warning messages would be diffused by disaster authorities throughout the community to address flood threatening situations. Flood warning messages will initially be received and adopted by a minority of individuals who are familiar with ICT tools such as mobile cellphones and the internet, and gradually, as more people pick up the preparedness behaviour, others will follow and the entire community will adapt to disaster preparedness to minimise the disaster impact.

2.13.3.1 Elements of Diffusion of Innovations

The diffusion process has four key parts according to Rogers (2003). These elements are the innovation itself, the channels through which the innovation is conveyed, the time period during which the process occurs and the social system through which the innovation is disseminated. Rogers (2003) defines innovations as “an idea, practice, or project that is perceived as new by an individual or other unit of adoption”. Mung’ou (2009) confirms innovation as the process whereby an individual or group makes use of an element that is already exists in the culture, putting them together into some new pattern. DOI also lists a number of qualities of an innovation that may be highlighted in messaging to increase the likelihood of an innovation being adopted. Relative advantage, compatibility, intricacy, trialability, and observability are some of them (Rogers, 2003).

The degree to which a potential adopter views the innovation as superior to the idea or technology it replaces is referred to as **relative advantage**. For an innovation to be embraced, it must be viewed as having a benefit over existing ideas or technologies. The degree to which an innovation is consistent with a potential adopter's values, norms and needs is referred to as **compatibility**. The apparent difficulty of understanding using or implementing a new idea is referred to as

complexity. Simple and easy-to-apply innovations have a higher chance of being accepted. **Trialability** is a criterion that describes how much an innovation can be tried out before making a decision. Before completely adopting an invention, the adopter can use a trial application to investigate it and see what value it may provide. Finally, the degree to which the value generated by adopting an invention is evident to other possible adopters is referred to as **observability** (Rogers, 2003).

Rogers (2003) identified diffusion of innovations as occurring through both mass media and interpersonal channels. Innovations often move from mass media to interpersonal channels through opinion leaders because what opinion leaders think about an innovation shapes the attitudes of others towards that innovation. Opinion leaders provide an interpersonal channel for innovations to diffuse throughout a social system. During the knowledge stage of the innovation-decision process when people are deciding whether or not to embrace a new idea, mass media channels are especially crucial. When individuals are assessing the benefits and drawbacks of adoption, interpersonal channels are increasingly significant during the persuasion stage of the innovation choice process.

Mass media and interpersonal communication channels can be further described as either cosmopolite or localite. Potential adopters can connect with sources outside of their social structure through cosmopolite channels. Potential adopters are connected to sources within their social system via localite channels. Information regarding innovations usually enters a system through mass media and cosmopolite channels. However, as the innovation spreads, localite channels become more extensively employed. It is worth noting that while all mass media channels are cosmopolite, not all interpersonal ones are. According to Rogers (2003), interpersonal channels may be either local or cosmopolite while mass media channels are almost entirely cosmopolite. A potential adopter may communicate with someone outside of their social structure on a personal level.

The study particularly considers the idea of how new ideas circulate and get accepted in a community, how ICT-based communication channels are used for disaster preparedness and how opinion leaders shape adoption. Disaster

preparedness aims to get people ready to work together in the event of a disaster. Innovations are adopted by individuals through communication channels which is the means whereby messages are passed from one individual to another. Therefore, social interactions may positively contribute to the well-being of individuals by sharing information through ICT about risk preparedness. The pre-disaster period could be more efficient and effective by using social networks which will enhance collective actions undertaken by people during emergency situations. The study seeks to examine the role of ICT in disaster preparedness by eThekwini Municipality.

Disaster authorities should facilitate the process of diffusion, adoption and implementation of disaster preparedness in the communities and ensure a high level of preparedness to minimise natural hazard impact. Relevant public authorities should work with influential individuals in targeted communities to diffuse flood warnings and encourage people to adopt the culture of preparedness and promote it to the rest of the community. Shiels (2018) believes that the diffusion of innovation theory proved valuable in measuring the impact of communication and overall preparedness.

2.13.3.2 Diffusion of Innovation Process

McQuial (2005) claims that diffusion of innovations is the process of domesticating technological innovations within a given population, often on the basis of advertising or general publicity. Innovation can be anything taken from another society, or it might be a creation. Rogers (1995) defined innovation as an individual's perception of a novel idea, practice or object. It is a term used to describe a new technology or concept. Invention is the process through which a person or a group uses components from the culture's existing components to create a new pattern. Diffusion of innovation occurs when a large number of people decide to embrace an invention and it becomes widely used in a community. The population is exposed to innovation through a variety of sources. Rogers (1995) clarifies that the process of adoption occurs in five stages:

a) Awareness stage: the person becomes aware of the new item's existence but lacks comprehensive knowledge with regards to it.

b) The stage of interest: The individual is intrigued by the innovation and wants to learn more about it.

c) The evaluation stage: the person considers the new item in relation to his or her current and anticipated future circumstances before deciding whether or not to try it.

d) Trial stage: the person tests the new idea on a limited scale to see if it works.

e) Adoption stage: the person uses the new item or concept on a regular basis.

Individuals adopt innovations through a communication channel, which is the way messages are passed from one person to another. For example, mobile phones provide relevant and accurate disaster preparedness information to increase community awareness. The diffusion of information is determined by the level of people's interest where reports of obscure events of little inherent interest such as the instability of the country's economy diffuse slowly and reach only a few people, but news of a vital event regarding the community such as disaster preparedness spreads quickly to reach a high percentage of the population, especially those that are affected by the disaster. In this study, ICT serves as a source of information to spread the natural hazard awareness and disaster preparedness practices before floods. People who have risk knowledge act as the media of connectivity to new individuals who have no idea about risk. The study, therefore, intends to examine the use and the role of ICT in disaster preparedness by eThekwini Municipality by reviewing the practice or status of ICT tools used by the Disaster Management Centre of eThekwini Municipality and its effectiveness.

2.13.3.3 Diffusion of Innovation in the context of disaster management

Death, loss of property and the natural environment, and disruption are all common outcomes of natural disasters. In disasters, social networks play an important role in assisting communities and individuals. DOI provides clear procedures that may be used to examine the efficacy of disaster preparedness communications. DOI can be used as a framework for disaster preparedness to promote technological innovations. The major goal of the DOI is to track how an innovation spreads throughout target audiences. While operating from an organisational standpoint, this technique may be useful as a tool for disaster preparedness evaluation seeking to facilitate the diffusion of innovation. Communities and their social networks are very important in disaster preparedness.

DOI's practical utility in finding factors influencing adoption as well as its broad applicability to a range of contexts make it particularly appealing to scholars interested in learning how communities and individuals respond to innovations and make adoption decisions (Rogers, 2003). The DOI theory outlines how communities propagate and adopt new ideas, technologies and procedures as well as the role communication plays in this process. People with well-connected social networks are more likely to recover from flood disasters than those whose networks have been annihilated or are non-existent according to studies. Diffusion of innovation theory proved valuable in measuring the impact of communication and overall preparedness in natural hazards (Shiels, 2018).

The impact of the Internet, email and instant messages on early warning is totally dependent on its adoption by a community and use by professionals such as first responders, coordinating bodies and others (Mung'ou, 2009). These social networks such as Facebook, Twitter and others can be used as a platform for sharing and discussing information on disaster management issues. This theory is a product of decades of research in diffusion across a variety of academic disciplines, most notably within the fields of communication. The study therefore, examines the use of ICT in disaster management by eThekwini Municipality. The ICT tools used for disaster management serve as communication channels.

This theory is relevant to the study because people who know how to use ICT tools can affect the rest of society by explaining and interpreting what they've learned about disaster preparedness through the media. This could be in the form of early flood warning dissemination on radio, television, or mobile phones.

2.14. Conclusion

This chapter presented a thorough explanation of the importance of ICT in disaster preparedness including disaster management activities. Pre-disaster activities are vital among the four disaster management components, and an early warning system is required for efficient disaster preparedness and appropriate responses according to this literature analysis. It looked at how individuals are exposed to risks, hazards and vulnerabilities as a result of global warming and other difficulties such as poverty, population growth and greater urbanisation.

It also emphasises the need for people-centred early warning systems and a bottom-up approach to strengthen the local capacities. In order to lessen disaster risks, it is necessary to recognise the relevance of groups of people as complex and dynamic entities.

Despite the fact that many countries recognise the value of ICT in disaster planning, particularly early warning systems, many countries, especially developing countries, still require improved ICT tools for more effective disaster communication. Furthermore, the potential of most current technologies must be utilised in the early warning and readiness phases, with sufficient focus placed on human capacity development to employ these tools and technology. In terms of the various stages of communication, ICT may be particularly useful in raising public knowledge about hazards and motivating risk-mitigation behaviour prior to the occurrence. Different authors from the reviewed literature recommended the use of ICT tools in disaster preparedness to disseminate early warnings in order to minimise the loss of lives. However, these tools are unlikely to cater for all citizens of KwaMashu and Amaoti area within the eThekwini Municipality as the source of information depends on who has access to it at that particular time of natural hazards.

This chapter provided a synopsis of public awareness of disaster risks and risk awareness to inform communities on how risks may affect them as well as when the hazards will likely strike, solutions to eliminate or reduce risks, and the community's response during disaster preparedness. Furthermore, the chapter reflected on knowledge transfer, whereby those who are informed about threatening risks communicate them to others, and the involvement of local communities in disaster preparedness to mitigate the risk impact has been looked at.

The participation of people at various levels in disaster management activities is important for the success of government initiatives and efforts. It is critical to understand the public's level of readiness knowledge, its information demands, and how these elements in particular impact individual preparedness behaviour. It is also necessary to integrate disaster management activities with other government programmes wherever appropriate. This can be done by providing valuable information, for example, through digital education programmes for children and adults, as well as online communities where experts share their own flood experiences, but also through playful interactions.

This chapter also covers four aspects of the effective Early Warning System Framework. This chapter discussed the background of various theoretical frameworks in ICT, but the main focus was on the diffusion of innovation (DOI), including the elements and processes of DOI. DOI within the context of disaster management was also discussed within the framework to elaborate on how flood warnings are diffused throughout the community and how people share information to others during disaster preparedness stage. Furthermore, DOI also emphasises the significance of social networks in the disaster preparedness phase. The next chapter discusses the research methodology of this study and the ethical considerations.

CHAPTER THREE

Research Methodology

3.1 Introduction

This chapter presents the description of the research process. It contains information on the study approach as well as justification for its use. This chapter describes the research methodology and data collection methods that allowed this study to achieve its goals. The chapter also covers many steps of the research, such as participant selection, data collection and data analysis. The research results presented in this chapter are based on the interviews conducted with eThekwini Municipality disaster management officials and public authorities of the KwaMashu and Amaoti townships. The chapter also discusses the role of the researcher in qualitative research in relation to flexibility and trustworthiness. The chapter concludes with a discussion of qualitative research validity and reliability, as well as how these two conditions were accomplished in this study.

The aim of this study was to examine the importance of ICT in disaster preparedness by the eThekwini Municipality. During the interviews, the participants' experiences were shared and knowledge was gained. The researcher drew on the diffusion of innovation theory to inform certain aspects of this study within broader social communication.

This research examined the experiences encountered by participants during flood disaster preparedness.

The objectives of the study are as follows:

- To review the practice or status of ICT tools used by the Disaster Management Centre of the eThekwini Municipality and their effectiveness.
- To determine the challenges experienced in disaster risk management using ICT within the eThekwini Municipality.
- To make suitable recommendations on the ICT that will be effective and enhance disaster preparedness of eThekwini Municipality.

3.2 Research Design

Methodology according to Polit and Hungler (2004:233) refers to methods for gathering, organising, and analysing data. The nature of the research question influences methodology choices. Methodology in research can be considered as a theory of how the inquiry should proceed (Schwardt, 2007). The methodology used in this study pertains to how the research was conducted and the order in which it was completed. According to Denzin and Lincoln (2018), the nature of the research topic and the issue being examined determines the research approach or plan. As a result, the study design should be viewed as an instrument for addressing the study problem. The three approaches to research are qualitative research, quantitative research and mixed method research.

3.2.1 Qualitative research

Leedy and Ormrod (2016) believe that qualitative studies are studies that make use of verbal, visual and non-numeric information. Qualitative research is a sort of scientific research that seeks answers to a topic, employs a specific set of techniques to answer the question, collects data, and presents findings that are not predetermined (Family Health International, 2015:01). Many natural features, according to qualitative experts, cannot be represented in quantitative terms; they would lose their realism if expressed just in terms of frequency. As a multi-perspective technique, qualitative research makes sense of interpreting or reconstructing this encounter in terms of the meanings that the subjects attribute to it.

This approach deals with data that is principally verbal, Saunders *et al.* (2009) suggest that qualitative is commonly used as a term for any non-numerical data collecting approach (such as an interview) or data processing procedure (such as categorising data). It is a method in which processes are not as rigidly specified as in quantitative research, the scope is more likely to be ambiguous and a more philosophical operation is used.

According to Creswell (201:03) the structure of a qualitative research final written report is customisable. Those who engage in this type of research promote an approach to research that values an inductive approach, an emphasis on the individual meaning and the necessity of rendering a situation's complexity.

3.2.2 Quantitative research

According to Saunders *et al.* (2007:145) any data gathering tool such as a questionnaire or data analysis procedure such as graphs or statistics that creates or uses numerical data is commonly referred to as quantitative. Quantitative research is a technique for investigating the relationship between variables to test objective theories. These variables can then be monitored with instruments, allowing statistical methods to be applied to numbered data Creswell (2014). Quantitative research allows the researcher to ask the same questions over and over again, resulting in data that is simple to analyse.

3.2.3 Mixed methods research

Creswell (2014) states that mixed methods research is a type of research involving the collection of both quantitative and qualitative data, the combination of the two forms of data and the use of various designs which may contain philosophical assumptions and theoretical frameworks. The primary idea of this research approach is that integrating qualitative and quantitative methodologies offers a more comprehensive grasp of a research subject than either strategy alone. Ingham-Broomfield (2016) and Yin (2018) agree that a mixed methods study requires a protracted amount of time and that was not feasible for this study.

The purpose of this study was to examine the role of ICT in disaster preparedness, hence qualitative research was judged appropriate for this topic. The researcher chose a qualitative approach for this study because the qualitative methodology allows respondents to bring up concerns that the interviewer may not have anticipated, as well as the intent that underpins human interaction. Semi-structured interviews were used to collect data. The following paragraphs provide a detailed justification for the approaches and methods chosen.

The purpose of qualitative interviewing is to establish a safe environment for subjects to express themselves freely in their own words regarding a situation that the researcher has brought to their attention (Sithole, 2014). However, issues such as ambiguous wording, misunderstanding and a lack of trust may have an impact on the outcome. To establish a good relationship between the interviewer and the interviewee and to keep the interview moving forward, the researcher urged the participants to come up with their own ideas, as well as the ability to respond in a flexible manner leading the person without influencing or constraining them. The goal of this research was to discover and understand the participants' experiences during disaster preparedness.

The following research questions served as a guide for this study:

- What are the disaster management practices and the status of ICT tools used by the eThekwini Municipality and how effective are they in disaster preparedness?
- What challenges does the Disaster Management Centre of eThekwini Municipality face in the use of ICT tools in disaster preparedness?
- What can be done to improve the effectiveness of the existing ICT tools of the eThekwini Municipality?

The qualitative method was deemed most suitable for this study because its dialectic and interpretive nature. It was easy to learn about and understand participants' experiences on disaster preparedness without focusing on specific concepts because the experience's original setting is unique and rich information and insight are developed in depth to give a vibrant picture of the participants' reality and social context.

The research aim was to examine the importance of ICT through municipal officials and public authorities in disaster preparedness by the eThekwini Municipality. This research aimed at contributing to the existing knowledge hence it focused on bringing new understanding and meanings of ICT in disaster preparedness. As the researcher illustrated in Chapter Two most research studies concerning ICT has

been done, but mainly focusing on the use of ICT tools in disaster response, and little has been done focusing on ICT in the pre-disaster stage.

3.3 Target Population

Burns and Grove (2003:43) define the term population as referring to potential human respondents or participants in the study. Sithole (2012) notes that some demographic groups such as village schools and factories are organically bounded and share a physical location. The study included 30 eThekwini Municipality Disaster Management Centre (planning section) officials who are involved in Disaster Management Planning on the daily basis and the two eThekwini Municipality areas which consisted of 37 respondents. The Amaoti area included one councillor as per the local government structures and 10 ward committee members (WCMs). KwaMashu Township included of six councillors as per the local government structures and 20 ward committee members. These two areas/communities were chosen because they have been frequently affected by flood disasters. The study targeted respondents from management to officials of the eThekwini Disaster Management Unit as they are responsible for disaster management planning, and ward councillors and ward committee members from selected communities as they receive early warnings from ward councillors and spread it to the people in their respective wards.

3.4 Sampling Method

Ideally, one wants to study the entire population. However, it is frequently impossible or impractical to do so therefore, one must settle for a sample. According to Hesse-Biber (2014:50) sampling means taking any portion from a populace which is considered to be demonstrative of that populace. Sampling is the process of selecting a subset of a population to represent the full population in order to collect information about a certain phenomenon. There are two types of sampling procedures. The first produces probability samples which guarantee that each respondent will be chosen. The other produces non-probability samples which have an undetermined selection probability (Polit & Hungler 1995).

Hesse-Biber (2014) states that a qualitative sample is usually non-random and purposive or judgemental. Purposive and non-random sampling entailed a deliberate selection of participants for the focus group.(Burns & Grove 2001; Polit & Hungler 1997). Sekaran (2006) stressed that the reasons for using a sample rather than collecting data from the entire population are self-evident. During the research investigation, there are several elements involved it would be practically impossible to collect data from or test or examine every element. This study used a convenience sampling method of the non-probability sampling design to select participants and a purposive sampling method was utilised for the selection of Disaster Management Centre officials who are involved in disaster management planning of the city. This approach was chosen because it allowed quick access to the responders. The sample consisted of sixty-seven (67) participants who met the inclusion criteria. The participants that were sampled gave their consent to participate in the study.

The researcher selected participants according to the specific characteristics they possess. The participants included managers and officials who deal with disaster management planning as well as ward councillors and ward committee members of KwaMashu and Amaoti who receive floods early warnings from the municipality and cascade it down to communities. The researcher included them in the focus group to achieve the objective of the study. Sekaran (2006) urged that if the population size is around 500, 50% should be sampled. However, an excessively high sample size (say, above 500) may be an issue since we would be more likely to make mistakes.

3.4.1 The table below illustrates the target population

Target Population	Total Population	Sample Size
Disaster officials working in the planning division	30	30
Ward councillors for the KwaMashu area	6	6
Ward councillors for the Amaoti area	1	1
Members of the Ward Committee for the KwaMashu area	20	20
Members of the Ward Committee for the Amaoti area	10	10
Total	67	67

3.5 Delimitation of the Study

The study's main focus was on the importance of Information and Communication Technology in disaster preparedness by the eThekwini Municipality, it centred on pre-disaster management. The sample population was selected from the KwaMashu and Amaoti areas and the Disaster Management Centre of the eThekwini Municipality. These townships were selected because they were often affected by flood disasters. The study was conducted in KwaZulu Natal Province, South Africa.

3.6 Data Collection

Data collection is “a systemic way of gathering information, which is relevant to the research purpose or questions” (Burns & Grove 1997).

3.6.1 Pilot study/pretesting

A pilot study is a trial run of the research (Nieswiadomy, 2012). The purpose of pretesting is to determine whether your questions are in line with what you are

intending to investigate, what needs to be added or removed from the interview questions, to determine acceptable and non-acceptable words and see if you can find the right responses and participation. For this study, a pretesting was done by arranging informal meetings with ward committee members and disaster management officials of eThekwini Municipality. This was done to learn as much as possible about their experience of floods disaster accidents that occurred in the past and how the information about floods was communicated. The pretesting assisted in identifying the most suitable participants to assist in the data collection and the appropriate officials for the interview. The pretesting assists in ensuring that errors in interview questions are being identified before they are taken to the sampled participants. One disaster management official was selected to be part of the pre-test and from the ward committee members of each targeted community. This was done to determine if the question at hand made sense to them and if they did not lose interest while responding to the questions.

3.6.2 Data Collection Process

The researcher created the interview schedule as one of the data collection instruments for this study. After the pilot study and all necessary modifications, the interview questions were administered upon receiving consent from the chosen sample for the study to be interviewed, each participant was scheduled at a time that was convenient for them and the interviewer. The first meetings with committee members were held in March and April of 2021 to persuade them to agree to take part in the study. After outlining the study's nature and scope, the researcher invited them to participate. Interviews were held between April to June of 2021. The interviews took place at the participants' places of work and the non-office-based workers' interviews were conducted in their homes and lasted approximately 20 to 25 minutes. The study's aim was conveyed to participants, and ethical considerations about participation were taken into account. The interviews were conducted by the researcher and in their preferred languages. Since some participants preferred to be interviewed using their home language, the interviews that were conducted in isiZulu needed to be translated before transcribed. The researcher was able to transcribe the interviews that were conducted in English

immediately. Notes were taken during the interview to assist the researcher in the analysis of the data, the conversations proceeded smoothly and pleasantly.

3.7 Research Instrument

Interviews were conducted using a structured questionnaire for data collection aimed at eliciting participants' thoughts and ideas Creswell (2014). This instrument provided the researcher with the opportunity to clarify questions that were not clear to the respondents, and it also allowed the researcher to develop an exceptionally expressive relationship with the people about their own experiences as well as their perceptions about natural hazards. When the data reached saturation, the researcher classified it into categories and analysed it in view of the objectives of the study in the next section.

3.8 Data Analysis

According to Hesse-Biber (2014:190) the key data analysis is to search for meaning within the data. Data analysis is the process of categorising, arranging and summarising data in order to answer research questions. Qualitative data analysis must be done with attention and rigour (Coffey & Atkinson 1996). For this study, the data acquired from personal interviews was analysed using NVivo. The data was organised into themes so that it could be compared. The primary benefit of NVivo analysis is that it helps in data collected being organised into themes to make the retrieval of data quicker and more efficient.

The interviews were taped with a voice recorder and each completed interview was transcribed manually by the researcher. The participants were given pseudonyms to preserve their privacy while sharing information about their histories from the transcripts. The recorded interviews were transcribed within 24 hours of the interviews. The goal of this rapid transcription process was for the researcher to become as familiar with the material as possible. Analysis was a continuous process in which the conversations were read and re-read to gain a deeper understanding and a sense of what was being said until the researcher was convinced that there were no misinterpretations from the text. During the analysis phase, the researcher

regularly reviewed questions asked during the interviews and the responses provided by the participants so as to avoid formulating analyses that would not achieve the study's objectives. As interviews were completed, the data was analysed ensuring the findings' consistency and veracity (to be discussed in the chapter that follows).

3.9 Validity

According to Saunders *et al.* (2007:81), validity is defined as the extent to which data collecting methods accurately measure what they were designed to measure. The authors also emphasise that validity refers to whether the findings are truly about what they appear to be. It determines how accurate the research findings are.

Validity is used frequently in quantitative research and is taken into account in the qualitative research paradigm. In qualitative research, validity does not have the same meaning as it does in quantitative research, and the results cannot be generalised Creswell (2014). Creswell goes on to say that the accuracy of data and the extent to which data can be generalised are the most important aspects of quantitative research. Qualitative research on the other hand challenges the notion of generalisability, arguing that meaning is historically situated and hence no two people can experience the same situation in the same way. Validity, according to Creswell and Miller (2000) is influenced by the researcher's view of validity in the study and his/her paradigm assumption. According to Denzin and Lincoln (2005), quantitative research is concerned with the consistency of results across time (reliability) and if the research genuinely measures what it was intended to assess (validity).

The purpose of this study was achieved because the questions were written in plain English to ensure clarity and easy understanding. The respondents were given clear instructions and the researcher only repeated the questions if there appeared to be a misunderstanding. Validity was verified through a pilot study. Interviews included a variety of questions on the knowledge of floods disaster preparedness and the use of ICT. Validity refers to whether or not findings are exactly what they claim to be

(Saunders *et al.,* 2007). The extent to which the analysis reflects what the participants indicated was used to determine the validity of this study.

3.10 Reliability

According to Hesse-Biber (2014:85), reliability refers to the consistency of the measure, meaning the data collection technique should produce consistent findings. The extent to which research findings will remain consistent throughout multiple studies in diverse conditions with different investigators and the extent to which such findings are generalisable are both measured in quantitative research (Gibbs, 2002). Golafshani (2003) suggests that the research instrument is considered reliable if the study's conclusions can be repeated using comparable methodologies. Stanbacka (2001) argues that since the reliability issue concerns measurements it has no relevance in qualitative research. She adds that the issue of reliability is an irrelevant matter in the testing of qualitative research. The researcher is the data collector in qualitative research. If the researcher’s bias and competency are unchecked, it may influence the trustworthiness of the data.

To test the reliability of this study, a pre-test was conducted on three participants to ensure understanding, consistency and sequence of the findings. The field notes and the tape-recording devices were intact for the purpose of verification. The researcher ensured the reliability of the study through the examination of the trustworthiness of the participants (Scale, 1999).

To ensure reliability, the researcher tried to be as precise and careful as possible while writing each question to minimise ambiguity and lead respondents to a certain answer. The aim of the interview was explained to the participants, as well as the importance of giving honest answers.

3.10.1 Trustworthy

Gunawan (2015:04) believes that the study is only trustworthy if the reader of the study concluded as such after evaluation of the research. When qualitative research accurately captures the experiences of study participants, it is considered

trustworthy. The validity and reliability of qualitative research are determined by their trustworthiness (Talbot 1995). When the participants' experiences are adequately portrayed, the research establishes its reliability (Speziale, Streubert & Carpenter 2011). Credibility, dependability, transferability, and confirmability are the four criteria used to assess the trustworthiness of data. Guba's model for demonstrating the trustworthiness of qualitative research was used in this study because it is well-developed theoretically and has been widely utilised by qualitative researchers for a number of years (Lincoln & Guba 1985).

3.10.1.1 Credibility

Participants recognise the stated research findings as their own personal experiences, which demonstrate credibility (Speziale, Streubert & Carpenter 2011). It is the reality of how the participants perceive and understand the phenomenon (Talbot, 1995). To improve the study's reliability, the researcher ensured that individuals with disaster preparedness expertise were appropriately recognised and characterised.

3.10.1.2 Transferability

The likelihood that the findings of a study will be useful to others in similar conditions is referred to as transferability. The term "fittingness" refers to how well the findings fit into or can be applied to similar scenarios (Speziale, Streubert, & Carpenter 2011). As previously stated, the study's reliability and validity were followed (Saunders *et al.,* 2007). The research findings can be implemented across the country at all local government levels.

3.10.1.3 Dependability

In qualitative research, another factor used to assess trustworthiness is dependability. According to Holloway (2005:143), the consistency of findings is related to dependability. This suggests that the results would be consistent if the study was repeated in a comparable setting with the same individuals. The researcher and the participants are the tools to be evaluated for consistency in qualitative research. External checks and audits should be used to make certain that

a study's results are reliable. To examine and evaluate the process by means of analysing data to make sure the findings are of an appropriate nature.

The auditor reviews the data, results, interpretations and suggestions and certifies that they are data-driven and internally consistent, allowing the "bottom line" to be believed. This procedure creates the veracity of the investigation. As a result, reliability and confirmability can be determined using a single audit. This activity was used to establish the research's confirmability in this study.

3.10.1.4 Confirmability

Confirmability is a non-biased measure for assessing qualitative research's dependability. Confirmability is defined as a study's ability to demonstrate credibility and fitness (Speziale, Streubert, & Carpenter 2011). It is a tool for assessing data quality that refers to the data's neutrality or objectivity as determined by an agreement between two or more dependent parties that the data is comparable (Polit & Hungler 2004). It means the results are not manipulated in any way. The term "neutrality" in qualitative research refers to the facts rather than the researcher's impartiality. Audit techniques are a methodical gathering of materials and documentation that allow independent or external auditors to reach equivalent conclusions regarding the data. The goal of conformability is to show that the facts and cognitive processes lead to the same results in another researcher as they did in the original study (Speziale, Streubert and Carpenter, 2011). Confirmability, in this study, was ensured by considering findings to be based on the responses of the research respondents and not the personal motivations of the researcher.

3.11 Ethical Consideration

Akaranga and Makau (2016) define ethical as conforming to the standards of conduct of a given profession or group. The researcher was aware of all the ethical issues relevant to the research. During the research study, participants were informed that they had the option of declining to participate in the study if they so desired, ensuring that they did so willingly and without being pressured. The research participants were also asked to complete the consent forms and all the

Durban University of Technology’s ethical procedures were adhered to. The consent forms informed participants that their participation is voluntary and that they are free to withdraw from participation at any stage and for any reason whatsoever. The participants were informed of the purpose of the study and told that they could withdraw at any time throughout the interview with no negative effects. Likewise, there would be no objective benefits to them if they chose to participate. The participants gave their consent to record the interview, they did not have any problems with the interviews being tape-recorded. Permission to conduct the study was obtained from eThekwini Municipality Disaster Management Centre.

3.12 Confidentiality and Anonymity

Sieber (1992) says confidentiality refers to the researcher's agreements with people on what they can do with their data. Anonymity is one technique of maintaining confidentiality, which is a key ethical principle. During the data collection process, respondents were assured of their right to privacy in terms of anonymity and confidentiality. The necessary steps and ethical considerations were adhered to, to ensure that the study was conducted in an appropriate manner. Anonymity was achieved by not revealing the individual's identity while presenting research findings, and by not mentioning identifying factors such as their workplace, personal features and occupation that could expose their identities. As a result, it was easier for participants to participate in the study since their names were not going to be revealed. Confidentiality will be ensured by keeping their records secure through the use of password protected files.

3.13 Conclusion

This chapter described how the study was carried out, including the method used to select participants, gather data and analyse the texts. The purpose of this research was to learn about the participants' perspectives on the use of ICT in disaster preparedness. The research adopted a qualitative research methodology, and the sampling table was presented, and data analysis methods were outlined. The chapter was completed with an explanation of ethical issues. The following chapter of this study will present the data analysis and interpretation of the findings.

CHAPTER 4

Data presentation and analysis

4.1 Introduction

The research methodology of this study with an in-depth review of the data collection process was clearly explained in Chapter Three. The findings of the study are presented and discussed in this chapter. It is important to emphasise that the study was set to achieve four main objectives. The first objective was to review the current status of ICT tools used by the Disaster Management Centre of eThekwini Municipality and their effectiveness while the second objective was to determine the challenges experienced in the use of ICT in disaster risk reduction within eThekwini Municipality and finally, to make suitable recommendations on the ICT that will be effective and enhance disaster preparedness within the eThekwini Municipality. To achieve these objectives, a qualitative methodology approach was adopted as discussed in the previous chapter. Qualitative data was collected from eThekwini Municipality Disaster Management Centre officials, Municipal ward councillors and Ward committee members of the KwaMashu township and Amaoti area through interviews. The main purpose of this research was to examine the importance of ICT in disaster preparedness by the eThekwini Municipality.

The data was recorded by using the voice recorder and transcribed manually by the researcher for each of the completed interviews. The data was analysed by using the NVivo tool, NVivo is a software programme that is used for qualitative research methodology. NVivo analysis was used by the researcher because it helped to organize data into themes for faster and more efficient retrieval.

Various themes emerged in terms of data analysis and the study objectives. The data was analysed from a descriptive point of view and the outcomes from data analysis were presented using a pie chart. These themes were analysed to obtain the findings and recommendations of the study. The key area of the discussion focuses on a brief highlight of the Municipality's Disaster Management Centre as a key role player in disaster preparedness, the pie chart presents the percentages of

various risks within the eThekwini Municipality followed by aligning the research questions, study objectives and theoretical framework.

4.2 eThekwini Municipality Disaster Management Centre

The Disaster Management Centre aims to prevent or reduce the risk of disasters, mitigate the severity of disasters, plan and prepare for an emerging crisis, novel events or disasters and respond rapidly and effectively to disasters (eThekwini Municipality IDP: 2016/ 2017:529). The eThekwini Municipality established the Corporate Disaster Management Plan; the purpose of this plan is to confirm the organisational and institutional arrangements to effectively prevent disasters from occurring and to mitigate the impact of those hazards that cannot be avoided (eThekwini Municipality IDP: 2016/ 2017:532). The plan establishes the operational procedures for risk reduction planning as well as emergency procedures to be implemented in the event of a disaster occurring or threatening to occur.

Disaster management officials (DMO) were asked whether the ICT tools are user-friendly and the DMO1 stated that:

> *The staff is academically qualified to do the job hence they are employed based on their qualification, necessary skills and capacity required to manage pre-disasters (DOM1).*

The above response was evident during the management of the recent Durban floods in 2017 and 2019, whereby staff were able to cope with the stressful situation by promptly disseminating the necessary information to the affected communities to alert of the impending emergency. Officials stated that CCTV (closed-circuit television) cameras that are installed across the city are of the great help to detect major incidents such as emerging storms and floods and South African Weather Services (SAWS) and FEWS enables them to prepare for these hazards in advance and distribute flood warnings to the affected communities to be prepared and take necessary action to minimise the impact of flooding.

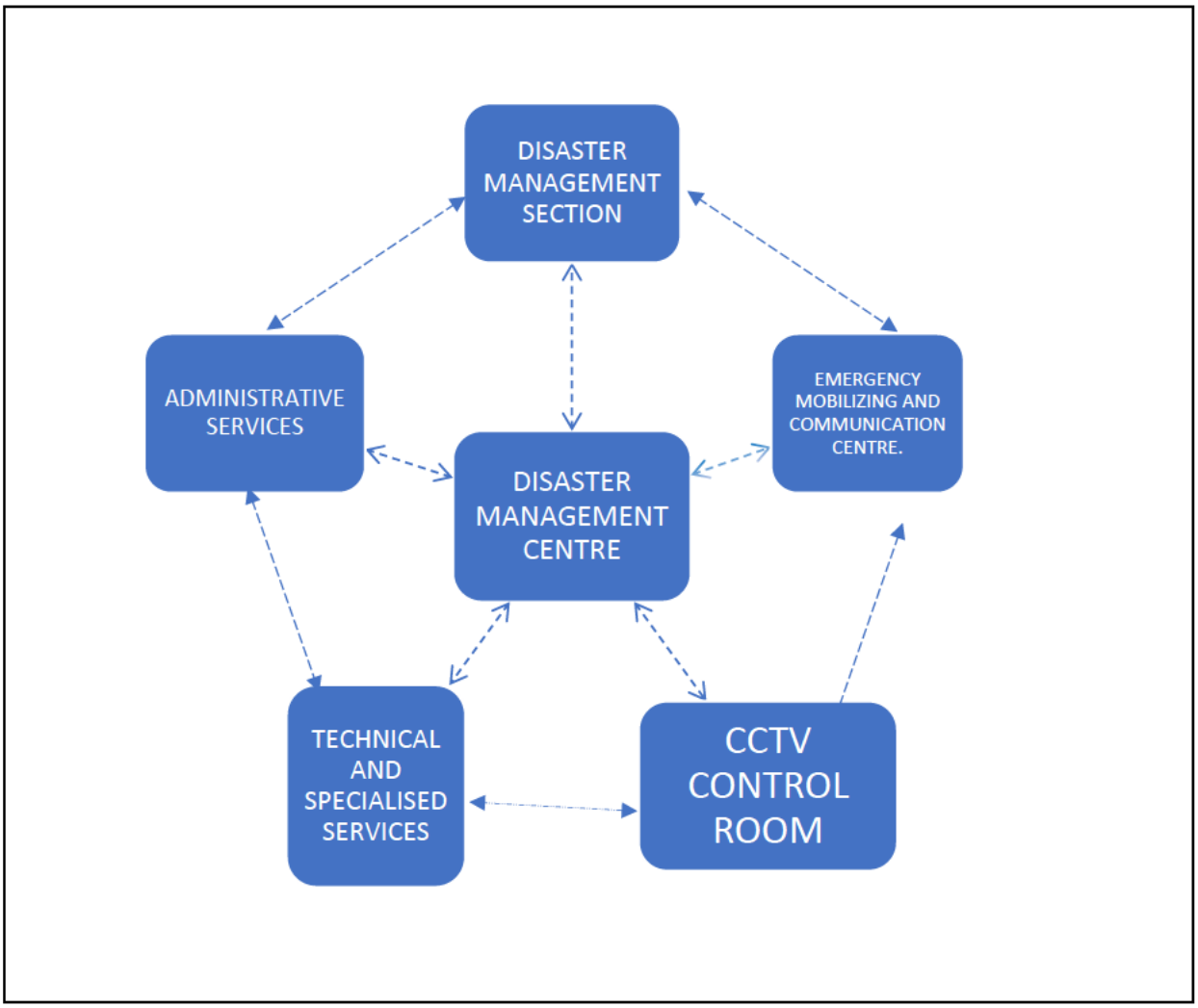

Figure 4.1 Structure of Disaster Management Centre.

Source: Own elaboration.

The above figure illustrates the structure of the eThekwini Municipality Disaster Management Centre. This centre is supervised by the Disaster Management and Emergency Control Unit. The Disaster Management Section is responsible for the coordination and management of major incidents and disasters that may occur within the eThekwini municipal jurisdiction area (eThekwini Municipality IDP: 2016/17:350). The Disaster Management Centre comprises five key sections as shown in Figure 4.1. According to disaster management officials, these sections work together in a collaborative and coordinated manner to ensure the provision of disaster prevention,

preparedness, response and recovery services. The Disaster Management Centre works jointly with Emergency Mobilizing and Communications Centre (EMACC) for communication and notifications of major incidents. It is evident that there is a close working relationship between these sections of the Disaster Management Centre. During the interview, officials noted that the Disaster Management Department works with other sections to enforce the safety of the citizens. The centre was established in 2011 to provide emergency services across the entire municipal area on a 24/7 basis. Emergency services in terms of call taking and dispatching for all emergency situations of fire, floods, and storms. It also provides Metro Police, CCTV crime surveillance and traffic monitoring as well as disaster management operations and programmes, risk assessment and reduction programmes (eThekwini Municipality IDP: 2017/18:85).

An Emergency Mobilizing and Communications Centre (EMACC) is responsible for providing and supporting the Disaster Management Centre with a communication facility for the notification of major incidents and any subsequent communication needs as determined by internal Standard Operating Procedure (SOP). During the interview municipal officials revealed that there is a bulk SMS system to disseminate early warnings to all disaster management role players. The call centre operates 24 hours a day and 7 days a week. The CCTV section and CCTV control room are closed-circuit television systems that monitor crime hot spots and assist with traffic management across all major routes within the city. Cameras are installed at various points within the eThekwini municipal area.

Another Disaster Management official mentioned that through CCTV cameras officials receive information about any problem that arises as they also serve as a communication system. From the above, it is evident that there is a workflow and collaboration between the Disaster Management Centre and these sections. The activities carried out within all these sections are directed towards preparedness, mitigation and prevention of the impact of disasters. This highlights the importance of disaster risk communication as a key strategy for reducing the worst effects of disasters (Rahman *et al.*, 2019).

4.3 Disaster Management Section

The Disaster Management Centre has a Disaster Operation Centre (DOC), during major incidents, disasters, or planned events, the Disaster Management Centre is responsible for activating the DOC. The DOC is a fully functional command, control and coordination centre that enables multi-agency participation in managing a major event/incident or a disaster. The DOC has a network infrastructure which facilitates linkage and integration of CCTV, communications, incident logs and other systems display onto a video wall.

Disaster management officials were asked about the status of ICT tools used by the Disaster Management Centre and their effectiveness and DMO2 mentioned that …:

> *Currently within the city there is an excess of over 300 CCTV cameras that helps to identify life-threatening situations and 52 radio channels for communication before, during and after disaster occurrence (DOM2).*

They also mentioned that there is a voice logger system that allows citizens to report hazardous situations including incidents such as floods. The system records all voice communication, including radio communication. The DOC has a network infrastructure which facilitates linkage and integration of CCTV, communications, incident logs and other systems display onto a video wall.

It is clear that in the disaster management section, ICT facilities are important to ensure the management of disasters. It is also evident that ICT plays an important role in the eThekwini Municipality's disaster preparedness to take necessary action to alert the vulnerable communities about potential hazards so that these communities may take necessary precautions when they receive flood warnings and follow the media and news for further flood information updates.

4.4 Common Disasters within the eThekwini Municipality

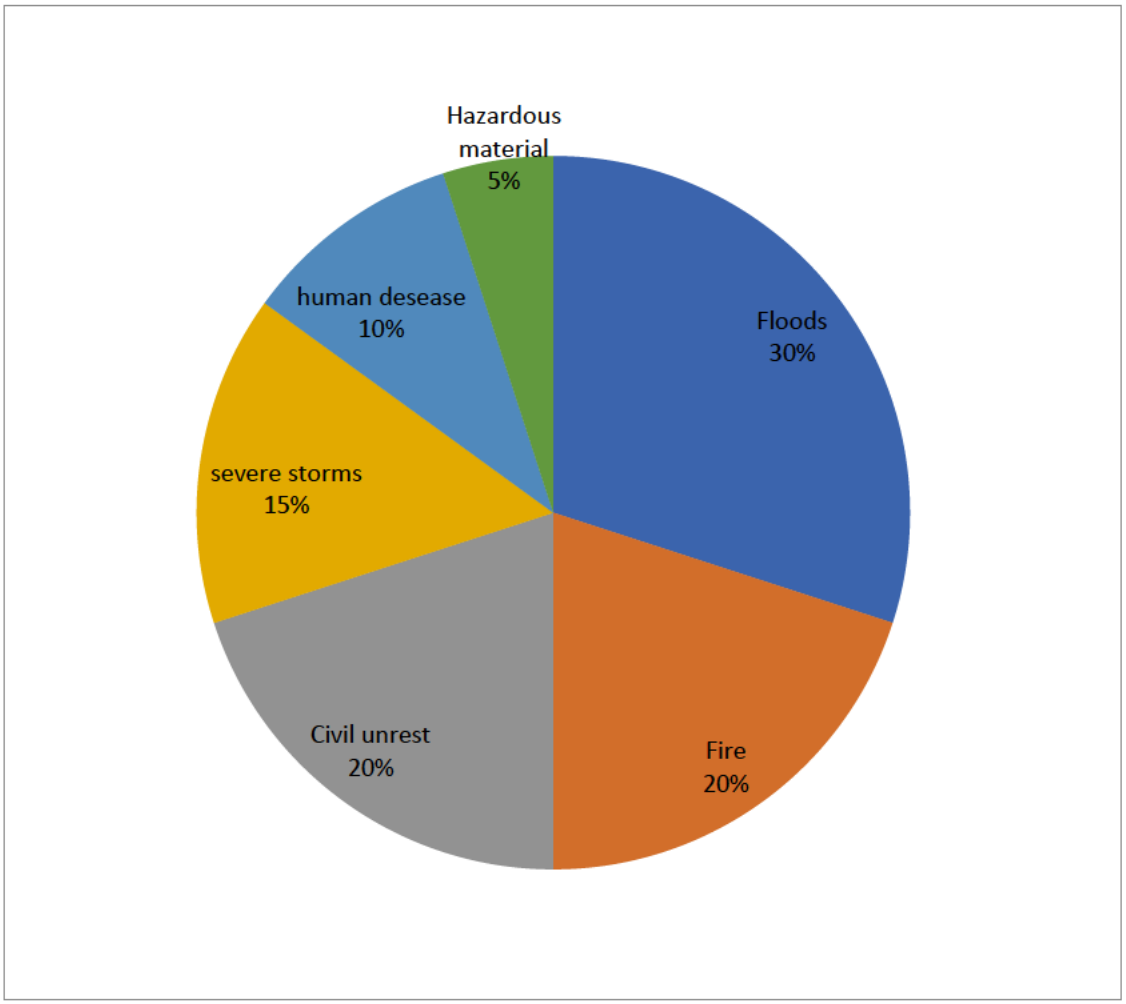

Figure 4.2 Major threats and hazards affecting communities within the eThekwini Municipality.

Source: Own elaboration.

The above figure shows the percentage of responses to the various risks that occur within the eThekwini Municipality. These risks include floods, fire, civil unrest, severe storms, human disease and hazardous materials as shown in this pie chart. Thirty percent (30%) of the responses indicated that floods are a high risk within the eThekwini Municipality and 20% of the responses indicated that fire is also a common risk. During the data collection period, civil unrest which is a common phenomenon within the city posed the same high risk as fire. This may be attributed to the fact that during the data collection period there were many incidents of civil

unrest within the municipality. Other percentages of responses recorded were 15%, 10% and 5% for severe storms, human disease and hazardous material, respectively. This reveals that these risks are much lower and do not constitute a major threat to the communities.

The research findings show that floods are high risk within the eThekwini Municipality. Therefore, vulnerable communities need to be alerted when flood hazards are threatening to occur so that they will take preparedness measures to lessen the impact caused by floods. During the interview, 30% of respondents indicated that flood risks have the worst effect on the community and the loss of lives leave the communities devastated and unable to cope with the situation. Floods were rated as a relatively high risk in comparison to other risks and that indicates that the municipality needs to do all in its power to encourage citizens to implement a culture of preparedness and mitigation when it comes to natural hazards to lessen their impact. Prasad *et al.* (2017) states that natural hazards are increasing and will continue to increase due to global climate change and Mung'ou (2009) emphasise that their impact cannot be avoided but can be minimised.

It has emerged that in the past 10 years, the incidents of flood hazards have been the highest followed by fire. This argument was supported by a Municipal ward councillor 3 who explained …

> T*here are number of disasters particularly in South Africa, and in our area, we are faced by floods and fire, and they cause death to people*. *The other floods are not popular and severe compared to others; when floods occur, their scale is so high in such a way that it's uncontrollable and causes a massive damage" (MWC3).*

The results indicate that floods occur more frequently in the eThekwini municipality area. In as much as the extent of disasters can be minimised, natural hazards are unavoidable. Therefore, it is the responsibility of both the municipality and communities to lessen the impact of disasters by taking the necessary actions. Flood disaster impact on the Amaoti and KwaMashu areas is most prominent, especially in

the crowded spaces where water drainages are few and too small to handle the high volume of water flow.

4.5 Practices or Status of ICT Tools that the Disaster Management Centre of eThekwini Municipality Use in Disaster Preparedness

Disaster management officials were asked during the interview about the practices or status of ICT tools that the Disaster Management Centre of eThekwini Municipality use in disaster preparedness, and this is the second objective of the study which sought to determine the challenges experienced in the use of ICT in disaster risk reduction within the eThekwini Municipality and they explained that eThekwini Municipality has a good ICT infrastructure to facilitate different ICTs within. The literature on (eThekwini Metro Connect: Broadband for the community 2017) is saying that the municipality has invested in various projects of ICT to ensure better connectivity. The availability of well-functioning PCs or laptops, reliable internet connections, and competent technicians and IT specialists demonstrate a strong municipal ICT core. GIS and early warning systems are examples of essential ICT applications to ensure the effective implementation of ICT within the municipality. In order for an ICT to function effectively, the staff must be well trained and have the capacity to utilise the ICT tools. On the question of practices and status of ICT in disaster preparedness in eThekwini Municipality, a disaster official explained that the centre’s staff has the necessary skills and capacity required to execute disaster management activities. This statement responds to the first objective of the study and provides answers to the key questions as raised in chapter three about the application of ICT in disaster preparedness.

The eThekwini Municipality began laying a next-generation fibre optic cable network throughout the municipal area in the early 2000s as part of a strategy to transform Durban into a "Smart City". To achieve this goal, the city began laying a next-generation fibre optic cable network throughout the municipal area because the availability and quality of ICT infrastructure were requirements. According to eThekwini Municipality IDP: (2020/2021:283, for a few years, the municipality has been gradually installing fibre in the eThekwini Municipal area. The goal is to link all municipal offices to the IT network, making services more accessible to citizens. In

locations where getting fibre optic cables laid is difficult, point to point wireless connectivity were also utilised to supplement the infrastructure to areas such as the eNkanini informal settlement. In the KwaMashu area where is not properly electrified, it is a challenge to get information on social media platforms due to the network connectivity. This has a negative impact on disaster preparedness as citizens in these areas might be not aware of the disseminated early warnings regarding the impending flood hazards.

In addition, the municipality has provided free Wi-Fi to 83 municipal libraries and launched a project to provide free Wi-Fi to the general public, which has resulted in the deployment of 828 public Wi-Fi hot spots (eThekwini municipality IDP 2021/2022:314). Various units have deployed private communication networks to support operational technologies for the monitoring and control of mission-critical assets. For example, eThekwini Electricity Unit has rolled out fibre optics or copper communication cables to all high voltage substations within the eThekwini Municipal area. The unit is currently expanding its footprint via a host of new communication technologies to connect to a medium voltage distributor (eThekwini Municipality IDP: 2020/2021:287). It has 288 substations to improve the reliability, quality and security of the electrical distribution network.

This indicates that eThekwini municipality has a good ICT infrastructure and the potential to grow further. The access to the internet on computers and mobile phones through Wi-Fi shows the improvement and the reach of ICT. This was evident after the 2019 Durban floods when many Facebook users responded by indicating that they were safe from floods on this platform. The use of ICT can improve or increase the effectiveness of disaster reduction and preparedness operations as well as the delivery of early warnings to populations affected by such crises allowing them to be better prepared.

ICT can be utilised in disaster preparedness to lessen the effects of natural disasters and save lives and infrastructure (Mukhopadhyay and Bhattacherjee, 2015). ICT enables the coordination of disaster risk reduction such as planning, early warnings and communication among stakeholders or role players. During the interview, two

main themes which are Early Warning Systems and Community Awareness campaigns emerged through the interaction with disaster management officials and they are linked to flood disaster preparedness and disaster risk reduction as raised earlier in the study. These were mentioned several times by the respondents and are related to the first objective.

These themes became popular during the interview as they were referred to as important features in disaster management communications for the purpose of disaster risk reduction and preparedness and have a significant role in minimising the losses from disaster events as they empower communities to take the necessary steps in the wake of flood disasters.

These findings are consistent with Thomas (2017:12) who believes that ICT can help gain insight through data, increase communication while improving coordination, increase responsiveness to clients on the ground, increase situational awareness among affected populations and responders and much more while Orsnes (2013:11) believes that ICT has the potential to improve and enhance the effectiveness of information management, and hence play a key role in disaster management.

The above reveals that enhanced ICT plays an important role in the pre-disaster phase to empower communities and organisations to be more effective and efficient in dealing with stressful disaster situations. Hence it can be deduced from the findings and the review of literature that ICT in disaster management is crucial given the current advancement in technology and digitization. After all, ICT serves as a valuable tool in promoting and further enhancing the various activities of disaster and risk management.

4.6 Early Warning Systems

ICT is commonly employed to construct early warning systems in disaster mitigation and preparedness efforts. The EWS may employ a variety of ICT tools, including classic (radio, television and telephone) as well as modern (computers, SMSes, cell broadcasting and the Internet). Before disaster strikes, the media is also critical in delivering timely disaster information. People who live in disaster-prone locations

now have alternate ICT connectivity thanks to the advancement of modern technology. The identification, detection and risk assessment of danger as well as the precise identification of vulnerable populations are all part of a disaster warning. Disaster information regarding the threatening situation must be communicated to people who are most vulnerable in a timely and clear manner so that they can take steps to mitigate the impact.

The South African Weather Service issues early weather warnings which are then transmitted to important role-players and decision-makers via the Emergency Mobilizing and Communications Centre (EMACC). This is done through bulk SMS notifications to keep principal emergency service staff up to date on major situations. Social platforms such as the municipal Facebook and websites are also used for disseminating warning messages to the community (eThekwini Municipality IDP: 2021/22.234).

According to the South African Weather Service Act, No 8 of 2001, EWS plays a significant part in the country's DRR programmes because it is the only source of extreme weather alerts in South Africa.

During the interviews, officials revealed that the city had established Flood early warning system (FEWS) which is a new technology that is used to detect flood hazards prior to occurrence. The Coastal, Storm water and Catchment Management Department (CSCM) of the Engineering Unit provides internal early warnings through FEWS. Rain gauges and radar in catchment areas are used by the FEWS system to monitor rain and sea-level rise. The CSCM Department works closely with the South African Weather Service in monitoring weather conditions to provide essential weather information.

The above indicates that effective communication is crucial to delivering a clear and easily understandable set of warning messages about climate change and weather conditions to alert communities about emerging hazards. In order to achieve this, different stakeholders need to work together in disaster management. It also reveals that communication between FEWS, SAWS and disaster management teams results

in the information that is required to coordinate early warnings when flood threats are identified or suspected.

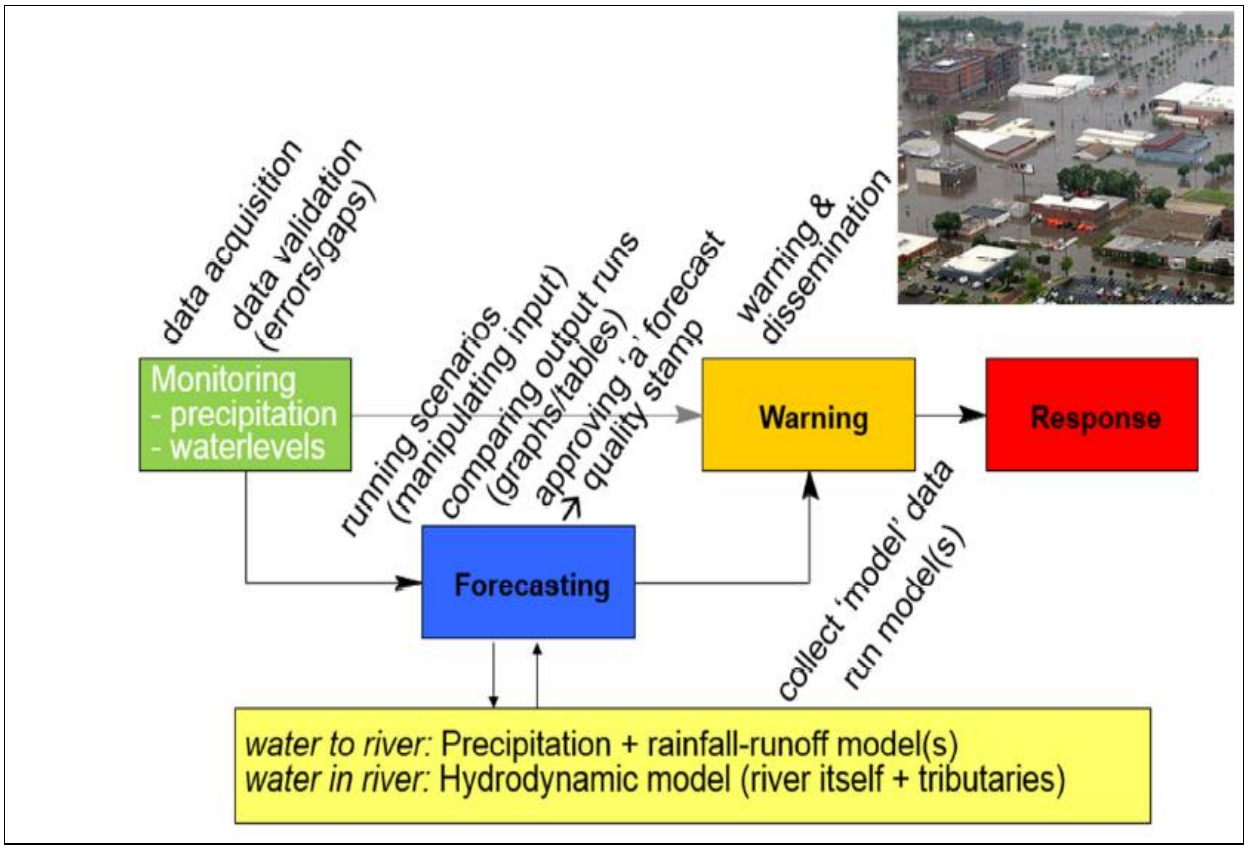

Figure 4.3 Flood Early Warning data management

Source: Chrystal *et al.* (2015) eThekwini Municipality development of flood early warning system, paper 11.

Budhimir, *et al.* (2019) stress that more complex early warning systems supported by forecast can provide an additional lead time for preparation. FEWS forecasts the consequences of natural disasters in advance, allowing adequate time for information to reach emergency responders. Launched on 13 November 2020, the system's objective is to enable and persuade people, communities and organisations to be flood-ready and take the essential steps to ensure safety, minimise flood impacts, strengthen the city's readiness and encourage localities to take flood-prevention measures when they occur by simulating flood scenarios, environmental

water quality, coastline erosion and wave behaviour. It enables the city to better manage and minimise the effects of flood-related calamities.

During the interaction with the disaster management officials, they mentioned that the centre had also partnered with the water department. As the water department is mandated and responsible for the water catchment areas, they have an instrument that they use to measure the amount of water that is expected to come down and to determine which targeted population is likely to be affected by floods. This information helps disaster management officials to raise awareness in targeted communities through public awareness campaigns on what they should expect and do when a disaster strikes. This system can detect flood incidents before it occurs and warnings are circulated to vulnerable communities prior to the flood disasters.

The above indicates that flood early warning systems are currently operational and are assisting the eThekwini Municipality to manage potential flood disasters, understand what is going to happen, who is going to be affected, how severe it can be and when is it going to happen. The most significant instruments for reducing flood risks and minimising the impact on life and property are flood forecasts and warning within the municipality. FEWS is currently operating effectively to detect flood hazards, but the challenge is that there are still people living in disaster-prone areas. Some of those areas do not have a digital network coverage which makes it difficult for people living in these areas to receive early warnings through social media platforms to be prepared for flood hazards.

4.7 ICT Tools used in Disaster Preparedness by eThekwini Municipality

Various questions were asked about ICT tools that are used in disaster preparedness by the eThekwini Municipality to disseminate early warnings during the interview with disaster management officials. Different digital technologies that are used by eThekwini Municipality to reduce disaster risks were mentioned, which are briefly highlighted below. Participants shared their different perspectives on the effectiveness of ICT tools and mentioned that it is dependent on the nature of the crisis and the geographic location of the impacted communities or people.

4.7.1 Radio and Television

Radio and television remain the traditional media, they are examples of media which existed even before the rise of the internet. They are used in disaster management overall, the reason being many households own them because it suits their specific needs and they cater for different languages they want to switch to and follow. These examples of communication media allow people to select the language of their preferences and most importantly, they cater for those who are not comfortable with the print media and may prefer to follow communication through audio or television broadcasts.

4.7.2 Broadcast Radio

Broadcast radio is used to disseminate early warning messages, raise awareness and for community education. For example, Ukhozi and Igagasi FM radio has been used successfully to raise awareness on disaster-related threats and through listening to it some people take action to prepare for disasters. The KwaMashu and Amaoti public authorities explained during the interviews that in their communities most people listen to radio stations, this tool allows them to choose the language they prefer. Therefore, to them, the radio is a tool to get news containing early warning information when there are threatening flood hazards. The radio reaches out to many people in the area. A Ward committee member added that most people living in the area get important natural hazards information via the radio stations.

During the interview, it was ascertained that communities listen to the local radio stations for more information pertaining to threatening hazards and urged by the news anchors to follow instructions from disaster authorities and remain indoors during heavy rainfall until authorities announce that it is safe to be out. Notifications and precautionary measures are broadcast via the following local radio stations:

• East Coast Radio – from FM 93.9 MHz to 96.95 MHz.

• Ukhozi – from FM 90.8 MHz to 107.4 MHz.

• Lotus – from FM 87.6 MHz to 90.6 MHz.

• Gagasi – FM 99.5 MHz.

Ward committee members highlighted the role played by radio stations during the 2017 Durban floods about bad weather conditions. Flood warnings were shared on radio news and the community was encouraged to be cautious.

> *We heard on radio news that in this area (Amaoti area) the riverbank is flooded and one of the homes built near has been swept away with the members inside, the matter was reported to the Ward councillor (WCM2).*

Other respondents mentioned that the community relies on radio and TV news and further stated that they remained indoors until it was safe to be outside, and the municipality only arrived later to investigate the damage caused. From the above, it is clear that community radio stations play an important role in disaster management by fostering disaster preparedness, serving as an advocacy tool to deliver weather and climate information, having the potential to benefit end users and saving the lives of those who follow the news.

During the interview, the disaster management officials (DMO) reported that the Disaster Management Centre works with various stakeholders to mitigate the disaster impacts. The centre depends on South African Weather Service centre for natural disaster warnings as it is mandated to provide some indication regarding areas that are likely be affected by floods and action needs to be taken.

A radio is the most accessible ICT tool; it is portable, people listen to it at home, at work, on their way to and from home, matter what mode of transportation they use, via headphones. The DMOs mentioned that the EMACC team sends warnings to local radio stations within the eThekwini Municipality to immediately disseminate warnings to vulnerable populations. The disadvantage of this medium is that its effectiveness is decreased in the poorest communities, especially for those residing in disaster-prone areas and illegally occupying land that does not have electricity and depend on battery-powered radios.

In the Durban, 2019 floods, the KwaMashu and Amaoti areas were the worst affected areas. Many houses were affected and many informal dwellings were destroyed by the intensity of the rains resulting in the loss of property and many injuries due to floods. This reveals that had the warning messages about the impending disaster reached the affected community timeously the impact would have been minimised.

It also reveals that communities in disaster-prone areas, especially the informal settlements are not likely to receive early warnings due to the lack of other municipal services such as electricity. Msimang (2017) states that because such structures are informal and unplanned, they cannot be provided for, and there is little to no access to basic amenities and the level of preparedness in these areas is very low. People living in informal settlements such as Nkanini in KwaMashu township, which is in a disaster-prone area, are reluctant to move from this place because they came from rural areas to live in the area for job opportunities and they have no other place to move to.

4.7.3 Mobile Technology

Mobile technology is a portable device that goes where the user goes, it has grown rapidly over the past few years. Mobile internet is used by about half of humanity. This trend is expected to continue in 2019, with a population of 250 million more joining the network for the first time (GSMA- State of Mobile Internet Connectivity Report-2020). The report revealed that illiteracy and a lack of digital skills persist as the main barrier to the use of smart phones and among mobile users who have access to the internet via their phones.

The Municipal Community Survey for 2016 indicates that 83% of people have access to a cell phone (eThekwini Municipality IDP 2016/2017.128). This study employed. Diffusion of Innovation theoretical framework as it is most notably within the fields of communication, especially on technology innovations. The goal of the diffusion of innovation theory is to raise awareness through information dissemination among the target audiences. This theory was measured to determine the diffusion of early

warnings to promote disaster preparedness in the KwaMashu and Amaoti areas. Municipal Ward Councillors 5 and Ward Community Members 8. weighed in on the flow of early warnings. The responses were …

> *"People use voice and short message service (SMS) to share disaster warnings to others these messages circulate until they reach most people" (MWC5 & WCM8).*

Respondents mentioned that people who own smart phones receive early warnings rapidly because they use social media such as Facebook and WhatsApp. They share warning messages with community members when they get them. The information diffuses from person to person until it reaches the entire population.

Mobile phone technologies allow people at risk to be notified as soon as possible and can be diffused quickly, lowering the amount of time the information takes to reach many people. Therefore, it provides time for community to act or prepare in advance of a disaster with the goal of lessening the damage. These findings are consistent with Zemp (2010) who believes that in times of catastrophe, ICTs make disaster communication more accessible and offer advantages over traditional media. Budhimir *et al.* (2021) noted that in emergency situations, direct access has proven to be more effective than standard instrumentation and communication procedures in terms of information transmission speed and number of persons reached.

From the above, it is clear that the use of ICT proves to be the backbone in disaster preparedness and mitigation to reduce the impact of the disaster on lives through the use of a combination of communication tools. The eThekwini Municipality uses a combination of communication tools such as media platforms, SMS media broadcast, print media and pamphlets to cater for different people according to their needs. For example, elderly people rely on radio and television while the youth are active on social media. SMS messaging is generally utilised by persons, who are overwhelmed by catastrophes, to share knowledge on flood disasters and to alert others to take necessary precautions to reduce the disaster impact. Mobile

technology is the fastest-growing technology tool for speedily disseminating flood information to the connected people. Public authorities were asked how communities are briefed about impending natural hazards. They stated that …

> *People who own smart phones and are on social media they are able to spread developing knowledge about upcoming flood hazards that threatened to claim people's lives to prompt quicker response and preparedness interventions (MWC2).*

One of the most important features of social media is that it can be accessed on both desktops and cell phones. Social media is used for social interaction and access to news and information; it is a communication tool to share and spread information. It can also influence society to make decisions, particularly in disaster preparedness, but that might depend on what people know about hazardous events and how they perceive them. The purpose of early warnings is defeated if people do not know what to do when they receive warnings. Communities must be taught what to do when they get early warnings so that they may take preparedness action and minimise the impact of the hazard.

During the interview, it was determined that social media such as Facebook, Twitter, Instagram and WhatsApp create active and efficient platforms to share the information about hazards. The eThekwini Municipality disaster authorities dispatch flood hazard information through the combination of ICT tools to alert vulnerable communities when flood hazards are threatening to occur so that these communities take the appropriate action to reduce hazard impact. These social networks have a huge influence on trending of information and increase awareness. The pace, reach, and penetration of social media platforms are astounding. This was evident at the onset of the novel coronavirus-2019 (COVID-19) outbreak. The use of social media platforms to disseminate information has been critical during the outbreak. COVID-19 is the source of a new global pandemic that is threatening millions of lives. Social media is an important tool in managing the current pandemic and changing aspects of preparedness.

4.7.4 Internet/Email

The Internet is a global computer system that allows access to a vast amount of information and its use is spreading quickly globally. The role of the Internet and messages plays a huge role in flood disaster warnings and depends on the diffusion of information within the community.

DMO stated that the municipality also circulates hazard information through internet websites to people who have access to the Internet and those who own computers and smart phones can access early warnings through social media platforms. SMSes are also sent to municipal ward councillors to disseminate them to their respective wards to alert affected communities about flood hazards and this method of disseminating early warnings cater for people who are not on social media, do not own smart phones and do not have access to the Internet.

According to Census 2011 data, 58.8% of people do not have access to the Internet; 11.7 percent have direct access from their homes, and 19.1 percent have access through their mobile phones. The community survey for 2016 that was conducted by the eThekwini Metropolitan Municipality about citizens who have access to internet is as follows: 9% access the Internet at home, 21.4% at the office, 52% access the Internet via mobile devices and 15% use internet cafes, or educational facilities (eThekwini municipality IDP 2016/2017.128).

This clearly shows that the use of the Internet has increased in recent years compared to the years prior to 2011. Therefore, early warnings shared via the Internet are likely to be received more instantly on smart phones since a higher percentage of people access the Internet using their cell phones.

4.8 Community Awareness Campaigns

The importance of education and creating awareness in the communities are vital so that they are able to respond with appropriate actions timeously. The integration of emergency preparations at all levels of government and non-government involvement is required for effective disaster management. The municipality is

vulnerable to a variety of natural and human-caused dangers resulting in widespread hardship and loss of lives. The community has little control over natural hazards, they are frequently terrifying and difficult to comprehend (eThekwini municipality IDP 2021/2022.245). The eThekwini Municipality Community Awareness campaigns focus on disaster preparedness and risk avoidance, especially in the most vulnerable areas such as informal settlements, as well as running public awareness programmes about disaster risk reduction (safe from fires and emergencies) within the municipality. The awareness campaign is aimed at reaching those who are most vulnerable to the impacts of floods. It focuses on residents in informal settlements and primary school learners. A combination of ICT tools when gathering data has become useful for effective information management. This includes things like reaching the intended recipient, being comprehensible utilising a variety of sources and technologies, being relevant, on time and dependable and having information that is standardised (Stolzenburg, 2007).

Public awareness is regarded as one of the most innovative disaster management techniques and best practices for reducing catastrophe risk. It aids society's resilience by raising awareness of challenges that affect it. The DMO1 mentioned …

> *We do conduct public awareness to educate the communities about disasters in terms of what to and not to do when floods arrive. Firstly, we liaise with the councillor's office, the office will then redirect the department to community structures that are within the municipal settlement to advise them that we are coming to conduct public awareness campaign. (DMO1).*

Public awareness is a crucial aspect of disaster management. It is not only important to make the public aware of threats, but it is also important to keep the public informed. It is also a part of empowering communities with disaster knowledge for achieving successful disaster preparedness. During the interviews, it was revealed that a community awareness campaign is one of the methods to deal with disaster risk reduction. Disaster management officials noted that they educate communities about hazards, and it is the responsibility of the community to put into practice their key learning, to prevent or minimise the impacts of hazards.

The level of community preparedness to withstand nature induced hazards is critical for communities to cope. In this regard, communities must be made aware of and educated about the hazards that exist in their locations as well as what to do in the event of a disaster. Fraser (2005) stresses that to improve public awareness, collecting and disseminating relevant and adequate information and knowledge is important and establishing effective educational programmes for the general public is a step to take.

The Disaster Management Unit is involved in a number of public awareness campaigns and makes use of various platforms to disseminate disaster awareness messages. The public awareness campaigns target vulnerable facilities such as old age homes, children's homes and schools, and communities such as informal settlements and are crowded community areas such as clinics and taxi ranks. The DMO3 stated that …

> *When we arrive to the communities, we educate them about disaster preparedness through activities and presentations about precautions to be taken prior disaster incidence and distribute pamphlets for them to read. (DMO3).*

Community outreach programmes such as Sukuma Sakhe, Masakhane and War rooms are also used for promoting disaster risk avoidance behaviour. These programmes are rolled out at ward levels to ensure that public awareness programmes reach the targeted population.

4.9 Theme 1: Responses to ICT's Early Warnings System

This theme is linked to the first objective of the study which aimed at establishing the current tools used to disseminate flood early warnings to affected communities. Municipal ward councillors and ward committee members were asked how they are briefed about flood early warnings. Ward committee member 1 stated that…

We tune onto radio stations news to get weather focus and warning session by broadcast employees especially when there are unusual disasters (WCM1).

While ward committee members 1, 3 and 17 expressed that they used to receive messages from their ward councillor that informs them as ward committees about natural hazards, but currently that is not practised. While ward committee member 4 mentioned that they only rely on watching TV news broadcasts and listen to the radio for warnings. Ward committee member 5 revealed that in this community (Amaoti area) the most vulnerable people are the children and elderly people, flood early warning is not communicated. Only after the disaster, instructions to go and count houses that were destroyed by the calamity are received.

From the above responses, it is clear that most people from these communities rely on radio and TV to get flood early warnings. If there is no internet connection or there is a power failure that means that these communities will not get warnings and they will not be prepared for the impending flood hazards as it was mentioned by a ward committee member that even the SMSes are no longer circulated. Municipal ward councillor 1 stated that …

We get notifications via SMS, circulars and posts and make them available to ward committees to warn people to stay indoors (MWC1).

This statement contradicts what ward committees have observed as they mentioned that they are not aware of flood early warning SMS from the municipality**.** It is clear that other municipal ward councillors do not bother to pass the early warnings so that the rest of the community will be alerted. It was mentioned that:

People who have smart phone and are on social media they get warning about upcoming disasters through social media platforms others follow the news on Radio and TV (MWC4).

The above responses show that people who do not own smart phones, TV or radio do not receive flood warnings as the ward committee member 2 explained that they

are not aware of the bulk SMSes that are disseminated by the municipality to warn people about flood hazards. It was also discovered by the researcher during the study that the most important source of information and power could be those individuals who obtain flood hazards information through social media and the Internet and share it with others until the rest of the society is aware of the hazards but that might be too late for others because any delay in receiving such important information puts people in a dangerous situation.

These responses revealed the significant information on the use of ICT tools in disaster preparedness in KwaMashu and Amaoti, which was the objective of the research. Participants mention various tools used to disseminate early warning messages. In reference to the reviewed literature, it was noted that the availability of ICT tools can enables the effective communication in disaster preparedness. A number of scholars in the reviewed literature expressed that social media and short message services are being used by an increasing number of countries as tools for disseminating early warnings and that the exchange of information between the disaster mitigation stakeholders and the community will be effective if the mechanisms and tools are available (ISDR, 2014; Ardiansyah and Munadi, 2016; Brynielsson, 2018; Budhimir, *et al.,* 2019). For the current situation in Kwamashu and Amaoti in relation to ICT tools both primary and secondary data were concurrence in answering this research objective. Therefore, this study found no divergences in information about ICT tools used disseminate flood early warnings.

4.10 Theme 2: Community Awareness campaigns through the use of ICT

This theme emerged during the interaction with the municipal officials, and it is linked to the first objective which sought to establish the current practice of ICT in disaster preparedness and then municipal ward councillors and ward committee members were asked if they know of any public awareness campaigns offered by the Municipality and ward committee member stated …

> *We know that municipality do educate people through public awareness programmes about floods and other disasters, but they have never been to our community (WCM3).*

This indicates that these community awareness programmes do not reach all the affected communities and the municipality needs to make sure that all affected communities receive awareness as part of disaster risk reduction. Municipal ward councillor mentioned 2…

> *I am aware that there are community awareness programmes that are conducted by the Metro using social media like Facebook. However, people have no interest in such post (MWC2).*

This response was similar to the Municipal ward councillor 4 who indicated that the municipality issues awareness posts containing warning messages on social media to warn people in advance, but people have a tendency of ignoring warnings.

The above responses reveal that not all age groups are catered for in terms of receiving hazard awareness notifications, for example, elderly people are not familiar with the usage of smart phones, which means they are being left out of these programmes.

Other public authorities seemed to be confused when asked about community awareness programmes related to flood hazards. Municipal ward councillor 5 and ward committee members 6 and 7 responded by saying that they did not know anything about awareness campaigns regarding educating communities on floods and related natural hazards that are offered by the municipality, what they did know is that the municipality once came to the community to educate people about fire hazards. This statement was supported by ward committee member 9 who mentioned that the municipality visits clinics and schools to conduct awareness programmes to educate women and children about fire hazards preparedness.

Ward committee members 6 stated

> *There are no Community Awareness Campaigns in terms of floods taking place in this area the action is being taken after the incident happen (WCM6).*

While the Municipal ward councillor 7 expressed:

We as councillors we normally experience some challenges when disaster occurs because people do not take preparedness measures, and they seem to have no idea about what to do when disaster strike (MWC7).

We stand on our feet and respond to disaster. We have to go to people that are affected, inspect the damaged and take the victims details down and that list we send it to disaster management department (MWC3).

From the above responses it is clear that public awareness campaigns offered in these communities only focus on fire hazards.

Public authorities had a different perception regarding awareness programmes, Ward committee members 8 said:

I know that the department come to the schools to educate children about hazards and provide reading materials for kids to read at home (WCM8).

While Municipal ward councillor 6 stated:

As far as I know those awareness programmes you find them on municipal website it's not helping since some people in this area does not have access to internet (MWC6).

According to municipal disaster officials, they conduct public awareness campaigns in vulnerable communities about fire and floods to educate these communities about risk hazards, but the above responses shows that there is little or no knowledge about flood awareness programmes in these communities, as respondents revealed that action is usually taken after flood incidents have occurred. The National Disaster Management Framework of South Africa, 2005 demands for effective public awareness to raise community awareness of the risk they face and the risk-reducing steps they can take.

From the above discussion, it is evident that the level of flood hazard preparedness is very low in the KwaMashu and Amaoti areas.

4.11 The use of ICT tools in disaster risk reduction

ICT tools can contribute to raising awareness for developing a culture of DRR. Knowing the risks and informing others about them as well as having access to pertinent information relating to risks for the purpose of minimising these risks in a timely manner is crucial.

Municipal ward committee members of the Amaoti and KwaMashu areas highlighted that those warnings often do not reach the targeted population and, especially the elderly and disabled persons. Yap (2011) cited in Abu (2015) maintain that because of various factors and some of which may hinder people from getting early warnings because some information is sent through certain sources targeting only certain people because of age, gender, culture or poverty. For example, it could be men who are on the database who get early warnings and women do not get warnings or the youth do get early warnings because mostly they are on social media but do not share warnings with their parents and these people continue to be the weakest link in the communication network, resulting in a large number of casualties. The primary causes are mostly due to a lack of resources and chances for people to cope with flood dangers. According to Yumarni *et al. (*2014,765) the access to resources and due to historically and culturally formed patriarchal institutions that create male dominance in economic and political responsive roles, opportunities may be gendered, leading to the social construction of gender that relegates women to a subservient status in society.

EThekwini Municipality uses an array of available ICT tools to disseminate flood early warnings about impending natural hazards to vulnerable communities. These tools include the Internet, mobile phones, social media, television, and radio.

The eThekwini Municipality provides an emergency telephonic service such as call receiving and forwarding life-threatening circumstances warnings via bulk SMS. In case of an emergency, communities can dial an emergency number on 031 361 0000 to report all emergency incidents. The emergency call centre operates 24 hours a day and 7 days a week.

The disaster operations centre (DOC) prepares emergency warning messages and updates about risks, which are then faxed or emailed to local radio stations and the public media. Messages are dispatched from their emergency operations centre (EOC) if the circumstances constitute an urgent threat to an impacted area. Broadcast warning messages advise the public about the danger, what they should do, and what they should avoid doing. These emergency messages include the initial warning of an imminent disaster, message updates as the situation evolves notification of evacuation and transportation plans if necessary, and eventually, the all-clear. As a result, local radio stations today are the primary means of communication with the general public.

The nature and conditions of the emergency occurrence are taken into consideration when creating warning messages. Emergency warning messages and updates are prepared and ready to be faxed or sent to local radio stations and the general public and are tailored to the nature and circumstances of each emergency occurrence. All essential stakeholders' contact information is updated on a regular basis so that information can be communicated quickly and effectively.

Below is a sample of an emergency message. The first message warns the affected communities about the hazard threatening to occur so that they can prepare themselves. The second message is message during a hazard updating communities about the current situation. Thirdly, an evacuation message is issued when the circumstances force the communities to leave the area or their homes and move to the safe shelters. Lastly, the all-clear message to return home after interventions have been done and the incident has passed is issued.

4.12 Hazard Announcements.

FIRST WARNING

The Emergency Operations Centre/Disaster Operations Centre has just issued notification of emergency situation or impending major incident in the _____area. The affected area encompasses_____ [road names], _____ [metres/kilometres from the] _____ [facility]. Residents in the affected area are advised to take immediate shelter in their homes or in any public building until the danger has passed. Stay tuned to this station for more details.

Initial message must indicate when updates will be given. [Hourly/half-hourly and thereafter]

UPDATE MESSAGE

The Emergency Operations Centre/Disaster Operations Centre has advised that the emergency response crews are dealing with the emergency situation or impending major incident in the _____area. The emergency is under control; however, you are advised to remain indoors. Stay tuned to this station for more information.

The Emergency Operation Centre/Disaster Operations Centre has just issued notification of an emergency situation or impending major incident in the _____area. The affected area encompasses _____ (road names) _____ [metres / kilometres] from the _____facility. Residents in the affected area are instructed to evacuate immediately. If you have your own means of transport, then proceed to the designated reception shelters at_____. Keep unnecessary cars off the road. Additional information will be provided at the reception shelter /s. Please evacuate immediately. Should you not have access to transport then make your way to the Public Assembly Area located at_____where the authorities will assist with transportation to a Reception Shelter. Should you require assistance then you must phone 031-361 0000. Transportation arrangements will be communicated over this radio station immediately after each emergency update notification.

EVACUATION ALERT

If the hazard poses an immediate risk to residents, then the EOC is to determine which public protective strategy to implement.

If the DOC has been activated and is in operational mode then the decision will be taken by the DOC in consultation with the EOC.

The method of alerting the public regarding protective action will be dependent upon the time available, hazard area, and resources available. The primary means of alerting the public would be by radio, but other available options are: [subject to sufficient early warning and the hazard not posing a threat to emergency services personnel]

 Police / Fire vehicles using vehicle mounted public address systems

 Door to door visiting / notification

ALL CLEAR

The Emergency Operations Centre / Disaster Operations Centre have announced that the emergency situation or impending major incident at the_____facility is now under control. All residents who have been evacuated can now return to their homes.

Figure 4.4 First warning, update message and evacuation alert

Adapted from the eThekwini IDP: 2015/16 Disaster Management Unit.

The above figure is an example of emergency messages prepared by the eThekwini Municipality Disaster Management Centre for different purposes to make the affected communities aware of what is going to happen before, during and after the disaster occurred. Emergency messages are communicated via radio stations when hazards are imminent. The disaster management official stated that they send hazard warning announcements to local radio stations to broadcast them on air.

On the question of the effectiveness of these ICT tools employed by the eThekwini municipality, respondents had a different view in this regard. A disaster management official explained that ICTs are effective. The problem is that the municipality is facing an influx of people who are moving to the city seeking job opportunities; areas become overpopulated and as a result, more shacks are being built in disaster-prone areas.

> *We send warning and conduct awareness on hazard associated to the area, but people ignore (WCM8).*

It was expected that the municipal officials will have a positive view regarding their ICT in disaster preparedness and the other parties will hold a different view. During the interview, it was revealed that people are building poor housing structures in high-risk places as they flood to the city for job opportunities and seek vacant land to dwell in. It was ascertained from municipal disaster officials that there are many vulnerable communities residing in disaster-prone areas, in particular, informal settlements and the municipality has warned communities to refrain from building houses near rivers.

A disaster management official also noted that poverty brings people to the townships with the intention of getting employment and better opportunities. They end up erecting risky houses near riverbanks. FEWS detect hazards prior to occurrence, and communities receive warnings on time about the high volume of water flow. Unfortunately, during floods some of their houses are washed away.

The eThekwini Municipality is aware of the growing number of illegal land invasions and is doing everything to prevent and demolish the building of new informal settlements. This is with reference to the incident that occurred in the Cato Crest area whereby approximately 40 unlawful constructions were still under construction and they were dismantled during the operation to prevent the illegal invasion of land. A DMO1 said the issue of land invasion is a serious issue, people are warned through municipal websites, municipality bids and other forms of communications not to build houses in disaster-prone areas but they do not heed the instructions.

This reveals that people are aware of the unsafe locations and the possible risks confronting them, but they continue to erect houses near the rivers. This may be attributed to various socio-economic factors in affected communities.

4.13. The Effectiveness of ICT tools in disaster preparedness

The following ICT tools are used by the eThekwini Municipality in disaster preparedness.

4.13.1 TV and Radio

On the question of the effectiveness of TV and radio Municipality Ward councillor 7 stated that radio and TV are effective and they are most accessible to low-income households. Early warnings reach many listeners and viewers. While ward committee member 10 mentioned that it takes time to get an early warning at night because the use of the radio and TV is limited at night because the majority of people do not sleep with their radio and TVs switched on.

4.13.2 Mobile technology

Ward committee members 1 and 7 stated that most people own cell phones and people receive early warnings rapidly, but it requires a person who can read and write and communicate effectively. Municipal ward councillor 6 said: People who do not have registered numbers on the database do not get early warnings through cell phone.

4.13.3 Internet/Email

Ward committee member 11 highlighted that the Internet is fast and reaches multiple sources quickly, but it requires literacy and most people in this area do not have access to emails. Furthermore, the emails are limited to the English language, and this creates a major language barrier for people who do not understand English. This prevents the flow of communication to these vulnerable communities as they may not understand the early warnings disseminated through the Internet.

4.14 Timely and Effective Delivery of Early Warnings

When the researcher asked the public authorities if they receive the early warnings, they expressed different opinions. Municipal ward councillor 4 stated that …

> *Disaster preparedness is very low because of lack of communication and added that even if a flood warning is successfully sent prior to flood events, but the public does not act because they do not understand what the warning means or what they should do (MWC4).*

This statement was supported by Ward committee member 15 who also mentioned that there is a lack of clear communication when comes to natural hazards such as floods. Unlike fire, people are taught how to prevent further damage that might be caused by a fire and know what to do when fire breaks out, but when it comes to floods, people are so confused about what to do.

This shows that public awareness is lacking; communities are not educated about flood hazards. There is a need to educate the public on the importance of ICT in disaster preparedness so that they will familiarise themselves with ICT tools and follow the information that is delivered with importance. Municipal ward councillor 5 and Ward community member 6 responded similarly …

> *I am not aware of municipal warnings regarding floods we don't receive floods warnings, but I won't speak for others. In this ward, we have people who live near that river they do not know what to do when flood disasters strike* (WCM6).

Ward committee member 13 revealed …

> *There is a river down there in (Amaoti area) it gets full during summer season due to heavy rainfalls and water is flooding into people's houses that lives nearby. The municipality knows about it when there were flood disasters in the past years, I just can't remember the exact year properly, municipality came and promised to move people away from that place and build proper*

houses for them but till today people are still there. Even if they get warning they don't know what to do (WCM13).

These statements are contradictory, according to disaster management officials ICT tools are effective while communities have a different opinion regarding the ICT tools used by eThekwini municipality in disaster preparedness to disseminate early warnings. This indicates that there is a gap regarding the disseminated information about flood early warnings to the public through ICT tools and receiving flood early warnings disseminated by the public.

Ward committee members 16, 9 and 2 shared similar responses.

We don't know we rely on radio and TV news to get warnings, but what happens if you miss the news? I think there should be another way of communicating such emergencies (WCM2, 9&16).

Ward committee member 12 stated …

I don't think they are effective if warnings are communicated in time the damages would have been minimised (WCM12).

Ward committee member 14 said …

I think they are timely and effective, but I think an emergency outdoor warning like siren system would be more effective to warn targeted population of potential hazards everyone would pay attention to it (WCM14).

The above responses show that as much as the municipalities distribute warning messages as stated during the interview, it is evident that not all people from these two communities receive or are aware of those early warnings and that is the reason why these two communities have divided thoughts about the current ICT used by the eThekwini Municipality on disaster preparedness.

4.15 Role players in the city’s disaster preparedness

4.15.1 The eThekwini Municipality

The eThekwini Municipal disaster management plan's main focus is to confirm the organisational and institutional structures needed to effectively prevent disasters from occurring and to minimise the effects of those hazards that cannot be prevented, such as natural catastrophes (Municipal Disaster Management Plan: 2016). The municipality is very important as it provides services to the community working with the councillor of that ward in meeting the community demands.

4.15.2 Ward Committees

Ward committees represent a variety of community interests and meet on a regular basis under the leadership of the ward councillor as chairperson. There is a link between the municipality and the community. A ward committee is an effective vehicle to get the word out about what the community wants from the municipal council.

> **WCM 15**: *We meet on a regular basis to draft reports about issues affecting the community and present it to the councillors to take it to the municipality but nothing happening regarding those issues.*

> **WCM 18:** *Look, we are just helping the community as we are part of it, we do much, yet we are not getting paid for it we are doing the work because we want to see the development in our area. We report issues, the only time we see municipality is only when the incident happens then you will see them coming to the area and make empty promises to the citizen and people worry us about responses.*

Ward committees mentioned that they have a crucial role to play in bridging the gap between the municipality, its councillors and the community. They record all issues affecting the community regarding flood preparedness and report to the ward councillors and give feedback to the community. Ward committee members work closely with the people taking note their concerns, challenges, and experiences.

They mentioned that they meet with community members regularly to listen to their needs and opinion regarding issues affecting them in terms of what can be done to minimise the incidents caused by floods to those who live in disaster-prone areas, and they report those issues whenever there is any to the municipality through ward councillors and provide feedback to the community. This response is linked to the second objective of the study to determine the challenges experienced in the use of ICT in disaster risk reduction in the eThekwini Municipality**.**

A ward committee member mentioned that they worked tirelessly in 2019 when a house in this area (Amaoti) cracked and the middle wall collapsed due to floods. Luckily, nobody was injured. They did not know about the flood warning otherwise they would have evacuated the house in time. The family was moved to the community hall. They contact us regularly as they were promised an RDP house.

4.15.3 Municipal Councillors

Municipal ward councillors can act both as the voice of the community within the council and vice versa. Councillors are expected to host regular meetings with the community to address issues affecting the people. During the interaction with councillors, it was discovered that they host community gatherings to discuss different issues related to the safety of the communities.

From the above, it can be deduced that ward councillors are both the municipality and community's servants; thus, it is expected of them to provide necessary information to communities to prepare for impending flood hazards to minimise their impacts they also host community meetings and engage with communities on an ongoing basis to ensure that community members are well informed and prepared in the event of a natural hazard.

4.15.4 Community Members

Members of the community play a crucial role in reducing the disaster's impact. Respondents emphasised that communities need to be trained so that they can participate in disaster preparedness. As reflected in Figure 4.2 that 30% of the

responses indicated that floods are a high risk within the municipality. The communities of KwaMashu and Amaoti are the most vulnerable to flood disasters and experience flood impacts. In order to increase the level of disaster preparedness, when the majority receive early warnings, they must share that information with others to minimise the impact of flood disasters. People who have access to email, internet and smart phones must diffuse flood hazard information until it is received by the entire population within the affected community in the shortest space of time in order for community members to take the necessary action to eliminate the impact of the disaster before it occurs.

A community-based disaster mitigation programme is most successful when the individuals most likely to be affected by natural disasters are directly involved. Ward committee members mentioned that they also help and rescue each other before and during floods.

> Ward committee member 20 said "*During 2019 floods two people in Amaoti went missing and as a community we searched for their bodies in the river and reported them missing" (WCM20).*

Community members are the key stakeholders in preparedness, mitigating and preventing disasters to save their lives and infrastructure. Communities need to engage in risk awareness and should be the first responders before the flood begins and change their behaviour of waiting for the government to assist during floods; they need to adopt the culture of preparedness. Communities are the key role players in disaster preparedness, but they need accurate and timely flood hazards information in order to be prepared. It is the municipality's obligation to ensure that communities are alerted when floods are threatening to occur.

4.16 Conclusion

This chapter provided an analysis of primary and secondary sources. A qualitative methodology approach was used to collect data from eThekwini Municipality disaster management officials, municipal ward councillors and ward committee members of the KwaMashu and Amaoti areas through interviews and the data was analysed

using the NVivo tool. The structure of the Municipality's Disaster Management Centre as well as its core functions was discussed in this chapter. The percentages of responses on various risks within the Municipality were explored.

The purpose of the research was to examine the importance and the use of ICT and its impact on disaster preparedness by eThekwini Municipality. This was followed by the alignment of the research questions and study objectives. The data analysis revealed a linkage between the research findings and the diffusion of innovation theoretical framework of this study.

Role players in eThekwini Municipality's disaster preparedness were explored and their responsibilities in flood disaster preparedness were discussed. In conclusion, the chapter presented and analysed data to fulfil the study purpose of examining the role of ICT in disaster preparedness by eThekwini Municipality. The findings and conclusions are further discussed in Chapter Five of this study. Possible recommendations to enhance ICT and to improve the dissemination of flood early warnings to vulnerable communities within the eThekwini Municipality will be discussed. The next chapter provides recommendations, areas for future research and conclusions to the study.

CHAPTER FIVE

Conclusion and Recommendations

5.1 Introduction

The recurring pattern of natural hazards, notably floods, in the eThekwini municipality between 2017 and 2019 leaving the Amaoti and KwaMashu areas unable to cope with the devastation led the Municipality has established the flood early warning system to predict the floods before they occur so that there will be an advanced preparation for floods and an effective response when floods arise. If all the necessary information is received on time, communities can play a crucial role in mitigating, preventing, and being prepared for natural hazards.

This study examined the role of ICT in disaster preparedness by eThekwini Municipality. This chapter provides a summary of results and findings based on the interviews conducted with the eThekwini Municipality's disaster management officials, municipal councillors, and ward committee members of the KwaMashu and Amaoti areas.

In Chapter One, the introduction and the background of the study were presented. In Chapter Two, the literature review explored the literature on disaster management and concentrated on the importance of ICT during the pre-disaster management stages and explored the ICT theoretical framework. Chapter Three constituted the research methodology of the study, while Chapter Four discussed the research findings and data analysis for the study. This chapter presents findings that were identified from the study as per the study's objectives; proposes recommendations for future research and provides conclusion derived by the researcher.

5.2 Summary of the Key Findings

This section provides a summary of the study's findings based on the study objectives.

5.2.1 Objective 1 of the study was to review the practice, status and the effectiveness of ICT tools used by the Disaster Management Centre of the eThekwini Municipality

The findings of this research study revealed that the Disaster Operation Centre has a network infrastructure which facilitates the linkage and integration of CCTV, communications, incident log, and other systems displayed onto a video wall.

Further to that, the city has in excess of over 300 CCTV cameras that help to identify life-threatening situations and 52 radio channels for communication before, during and after disaster occurrence. There is an Emergency Mobilizing and Communications Centre (EMACC) for communication and notifications for major incidents such as flood disasters and this is done through a bulk SMS notifications system to disseminate early warnings to all disaster management role players.

According to eThekwini Municipality IDP: 2021/2022:314, free Wi-Fi has been a rolled out to 83 eThekwini Municipality libraries and a project to provide free Wi-Fi was initiated, which resulted in 828 public Wi-Fi hot spots to assist the public accessing the internet. The study found that social media outlets such as the municipal Facebook page and the websites are also used for disseminating warning messages to the community. However, the study noted a few challenges regarding the access to information through this platform by the KwaMashu and Amaoti communities. As a result, some people in these communities rely on radio and television to receive flood early warnings, especially the elderly people because they do not access social media and the Internet. The results revealed that people who receive early warnings are the youth because they are active on social media platforms and most of them can read, write and have effective communication skills.

The study uncovered that in case of emergencies the Disaster Management Centre has a voice logger system that allows citizens to report hazardous situations including incidents such as floods. Findings revealed that the city has established a flood early warning system (FEWS) which is a new technological strategy which is currently operational and used to detect flood hazards prior to occurrence to prevent

flood destruction and save people's lives. According to the Disaster Management Centre officials, the ICT is effective in disaster preparedness. However, the study found that there is limited effectiveness of ICT to enhance disaster preparedness in the KwaMashu and Amaoti areas due to the lack of flood disaster preparedness within these communities and the low response to flood hazards. In reference to the reviewed literature and research question for this objective, the use of ICT tools was noted as crucial in disaster preparedness disaster to provide information about natural hazards in a timely manner. As such, in relation to the empirical data findings, the study found no deviations in information about ICT tool used in disaster preparedness stage. In the reviewed literature scholars indicated that ICT can be effectively applied in mitigation, preparedness, response, and recovery and should be recognised as being integral to disaster management in particular disaster preparedness (Islam, 2010; Mohan & Mittal, 2020).

5.2.2. Objective 2 of the study was to determine the challenges experienced in the use of ICT in disaster risk reduction by eThekwini Municipality

The study found that there is a bulk SMS notification system to disseminate early warnings in case of an emergency to all disaster management role players. However, it was noted that ward committee members of KwaMashu and Amaoti used to receive warning notifications from their ward councillors to alert their respective communities, but that no longer happens. This research revealed that eThekwini Municipality Disaster Management Centre has public awareness programmes that are run by the city which focus on disaster risk reduction such as (safe from fire and emergencies). These programmes are run through various platforms such as Sukuma Sakhe, Masakhane and War rooms to educate communities on disaster risk avoidance behaviour.

Flood early warning systems are regarded as disaster prevention because it provides the municipality with flood information to act in advance, it also serves as an awareness initiative within the city. However, some challenges have been identified in the study. It has been noted that as much as the disaster management centres conduct public awareness programmes, there seems to be a lack of

education and awareness in the KwaMashu and Amaoti areas. The study revealed that these communities do not take preparedness measures as they have no idea what to do when disasters occur; this is problematic because after the disaster, the communities rely on ward councillors to intervene. The KwaMashu and Amaoti ward councillors expressed the concern that they encounter challenges when a disaster occurs because people are not educated about flood hazards as a result, they do not take disaster preparedness measures to avoid flood disaster impact.

The study noted a further challenge; the people in KwaMashu and Amaoti are building unsafe houses in disaster-prone areas. These areas are in the danger zones of KwaMashu and Amaoti, close to the riverbanks with no network connectivity, therefore they cannot access flood information through the Internet and related media.

5.2.3 Objective 3 of the study was to propose suitable recommendations on the ICT that will be effective and enhance disaster preparedness of eThekwini Municipality

The results noted that many different recommendations were provided by the interviewees and these recommendations were perceived as a solution to disaster preparedness in the KwaMashu and Amaoti areas. Ward committees wished that the municipality would work with them to ensure that warning messages reach affected individuals before natural hazards occur so that everyone will be aware and take necessary steps to lessen the impact of the flood. These echoed the response from ward councillors that municipal officials only come to investigate the disaster incidents after they happen. The results revealed that municipalities should explore other ways of communicating flood hazard information, which vulnerable communities may be familiar with, and that disaster preparedness should be a priority to minimise disaster impacts and save lives. There is a need to educate communities about flood hazards so that they will know what to do when they receive the early warning notifications from the authorised source.

5.3 Recommendations emerging from the study

As indicated by the findings of this study, the accompanying recommendations have been suggested to enhance disaster preparedness within the eThekwini Municipality.

5.3.1 Practice or Status of ICT Tools used by the Disaster Management Centre of the eThekwini Municipality and its Effectiveness

The municipality should consider an effective communication network for disaster information dissemination by developing a mobile flood alert App which is linked to Flood Early Warning System (FEWS) and information from South African Weather Services. All respective role-players including ward councillors and ward committee members who serve as a conduit between disaster management unit and affected communities must be involved in the creation of this App so that they will understand how it works, including their role and responsibilities within the community in ensuring the diffusion of flood early warnings to the community. The role of the Disaster Management Centre will be to send out early warning information through this app to the respective disaster management role players including ward councillors and ward committee members. Ward councillors and ward committee members will then diffuse the information to their respective communities, this will allow the flood early warning to reach everyone in the KwaMashu and Amaoti areas and enhance disaster preparedness. In reference to the reviewed literature and research question for this objective, the use of ICT tools was noted as crucial in disaster preparedness disaster to provide information about natural hazards in a timely manner. As such, in relation to the empirical data findings, the study found no deviations in information about ICT tool used in disaster preparedness stage. In the reviewed literature scholars indicated that ICT can be effectively applied in mitigation, preparedness, response, and recovery and should be recognised as being integral to disaster management in particular disaster preparedness (Islam, 2010; Mohan & Mittal, 2020).

5.3.2 Challenges Experienced in the use of ICT in Disaster Risk Reduction by eThekwini Municipality

The eThekwini Municipality should improve their ICT system, specifically by developing a bulk SMS system and keeping it updated and current with all the necessary information and contact details of all disaster management stakeholders so that they are able to verify all the necessary information such as the contact details of all the respective role players in disaster preparedness to ensure that the bulk SMS notifications reach all the intended recipients.

The municipality should also invest in other communication methods such as a public warning siren, bell or whistle, as some of the communities still rely on simple yet practical and traditional means with which they are familiar. This can work as effectively as other sophisticated technological interventions hence it will address the issue of having to use the combination of more traditional communication tools with more recent technological ICT tools, addressing the peculiar communication and information needs of different target populations in the community. In so doing that will allow the targeted group to understand it better and be able to respond accordingly. Participants stated that there are challenges in the use of ICT in their area which was the objective of the research. In the reviewed literature, scholars indicated that the challenge in ICT is to establish an information infrastructure that is flexible enough to manage the dynamic exchange of information among the participating entities in an inter-organisational system but organised enough to ensure that the relevant information reaches the responsible parties in a format that is understandable and timely enough to support effective action. And these authors believe that one way to accomplish this is through the effective use of ICT platforms (Burke & Kent, 2014. Bjerge *et al.*, 2016) for the current situation in KwaMashu and Amaoti in relation to challenges on ICT both primary and secondary data were concurrence in answering this research objective.

5.3.3 Recommendations on the ICT that will be Effective and Enhance Disaster Preparedness of the eThekwini Municipality

Effective communication channels such as those that cater for vulnerable people should be established and early warnings should be communicated and understood by vulnerable people in affected communities for them to respond to the emergency of flood hazards.

The municipality should raise floods awareness through regular workshops, awareness campaigns and ongoing capacity development interventions for ward councillors, ward community members, disaster champions and vulnerable communities to address issues of flood preparedness. For communities within the eThekwini Municipality to be able to mitigate and prepare for natural hazards and react appropriately when early warnings are issued, relevant and ongoing information, communication and public awareness programmes must be undertaken to develop the capacity of the local community.

5.4 Recommendations for Future Research

- Future research should focus on the role of **ICT** implementation in disaster risk reduction and acceptance by disaster vulnerable communities.
- Future research should focus on disaster experience and the mitigation strategies for future hazards.
- Future research should focus on the source, message, channel, and receiver perception of the early warning process.
- This study focused on eThekwini Municipality (KwaMashu and Amaoti Area) future research should focus on all local municipalities within the KwaZulu Natal.

5.5 Conclusion.

This chapter provided a summary of the dissertation chapters, the summary of the findings for the study as well as the proposed recommendations. The chapter further

suggests areas for further research. This section of the chapter provides the study conclusion.

The results of the research revealed that there is a lack of preparedness in the KwaMashu and Amaoti areas due to the lack of knowledge of flood hazards. The study revealed that the vulnerable communities of the KwaMashu and Amaoti areas are left out of early warnings that are disseminated through the Internet and social media, as a result, they rely on television and radio news to get warnings about flood hazards. Challenges regarding the access of information through the internet and social media platforms are as follows: warning disseminated through ICT tools such as the Internet and social media do not cater for people who do not own smart phones, especially children and elderly people. This results in the lack of preparedness in many households in the communities of the Amaoti and KwaMashu. The study also revealed that early warnings disseminated through the bulk SMS system do not reach the vulnerable communities of KwaMashu and Amaoti and this needs the municipality's attention.

The study also found that the communities of KwaMashu and Amaoti do not know what to do and how to respond when early warnings are issued because of the lack of education and awareness regarding flood disasters.

Based on the results yielded by this study, recommendations were proposed to enhance the flood warning communications to ensure that the affected communities receive early warning information timeously and take appropriate actions when early warnings are issued. This will increase the level of preparedness in the KwaMashu and Amaoti communities and minimise the loss caused by flood disasters within the eThekwini Municipality.

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APPENDICES

Appendix A: Gatekeeper letter: eThekwini Municipality Disaster Management Centre

ETHEKWINI MUNICIPALITY

COMMUNITY AND EMERGENCY SERVICES
Disaster Management and Emergency Control Unit
Disaster Management Building, 3 Cliff Taylor Crescent, Durban, 4001 PO Box 3685, Durban, 4000
Tel: 031 367 0001, Fax 031 367 3744
www.durban.gov.za

17 February 2021

To whom it may concern

RE: CONFIRMATION LETTER FOR PERMISSION TO CONDUCT RESEARCH STUDY

This is to confirm that Goodness Ntokozo Sibiya has been granted permission to conduct a research study on Information and Communication Technology in disaster preparedness in the Disaster Management Department at eThekwini Municipality.

She is hereby requested to share the findings and recommendations of the study with the Department once concluded.

Thank You

VB Ngubane
Head of Disaster Management & Emergency Control

17 February 2021

Appendix B: Letter of information.

LETTER OF INFORMATION

Information and Communication Technology in disaster preparedness by eThekwini Municipality.

Dear Respondent

You are herewith invited to participate in an academic research study conducted by Goodness Ntokozo Sibiya, student no. 21120094, currently studying towards Master's Degree of Management Sciences in Public Administration specialising in Disaster Management at Durban University of Technology (DUT). I am hereby writing this letter to seek your consent and participation during my research project. My research topic is about the Information and communication technology in disaster preparedness by eThekwini Municipality.

Disaster preparedness help to saves lives taking appropriate measures in advance to ensure effective response to the impact of hazards. This study will focus on the importance of Information Communication Technology in disaster preparedness. Your participation will consist of interview which will encompass questions that will be asked to you depending on your position. The questions and answers provided during the interview will be treated with confidentiality, anonymity as well as trustworthiness. Your name or identity will be not disclosed as well as the data collected during the study will remain confidential. Before the interview commences, I will advise that you are entitled to confidentiality, trustworthy and anonymity during the interview. The information received during the interview will be kept confidential and it will be stored in a safe and secured to ensure that there is limited excess to it. With the research I am undertaking, the purpose is to examine the role of ICT and its use on disaster preparedness, identify gaps and draw recommendations.

By you participating during the study it will allow me to analyse your views anonymously, taking into consideration that you have knowledge in disaster preparedness and how is it important to ensure that the information is being disseminated to relevant recipients. In allowing the researcher to collect data I a form of the interview that will help the researcher to gain an insight on the study and draw recommendations.

Yours Sincerely,

Goodness Ntokozo Sibiya

Cell no. 082 642 1143; Tel: no. 031 3111 550; Email address: Ntokozo.Sibiya@durban.gov.za

Dr. Maliga Reddy

Tel no. 031 373 5612; Email address: reddy@dut.ac.za

Appendix C: Consent Letter to Participate.

CONSENT

Statement of Agreement to Participate in the Research Study:

- I hereby confirm that I have been informed by the researcher, Goodness Ntokozo Sibiya about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _____.
- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.
- I am aware that the results of the study, including personal details regarding my sex, age, date of birth, initials and diagnosis will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by the researcher.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.
- I understand that significant new findings developed during the course of this research which may relate to my participation will be made available to me.

Full Name of Participant	Date	Time	Signature / Right Thumbprint
Sifiso Mthenjwa	09/03/2021	11:00	

I, Goodness Ntokozo Sibiya herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full Name of Researcher	Date	Signature
	09/03/2021	

Full Name of Witness (if applicable)	Date	Signature
Nokwazi Cele	09/03/2021	

Appendix D: Interview Schedule

INTERVIEW SCHEDULE

Section A. Please complete the following details.

1.	Gender	☐ female	☐ Male
2.	Age	_____	
3.	Qualification	_____	
4.	Position	_____	

Section B. Questions.

(Disaster Management Centre Employees)

Questions.

5. What communication tools are used for disaster warnings?
6. Are the communities aware that ICT is used in disaster preparedness?
7. Are the ICT tools user friendly to you?
8. Are the ICT's used by eThekwini municipality effective?
9. What Challenges does the disaster management centre of eThekwini Municipality face in the use of ICT tools in the disaster preparedness?
10. What impact does ICT have on disaster management especially in the preparedness stage?

Section C (Management of Disaster Management Centre).

Questions.

11. How are ICT tools used in disaster preparedness and how effective are they?
12. What Challenges does the disaster management centre of eThekwini Municipality face in the use of ICT tools in disaster preparedness?
13. What eThekwini Municipality Disaster Management Centre can do to improve the effectiveness of the existing ICT in disaster preparedness.

Section C (KwaMashu and Amaoti ward councillor and committee members)

Questions.

14. What is your role in disaster early warnings?
15. How do you get briefed of early warnings?
16. What kind of communication technology is used to acquire the early warnings?
17. Do you think communication technology is effective to warn about disasters?
18. What other methods would you suggest delivering messages about early warnings?

Appendix E: Permission Letter MDMC

Faculty of Management Sciences

Department of Public Management & Economics

Disaster Management Centre

3 Jelf Taylor Cres, Stamford Hill

Durban 4025

10 June 2019

Gate keeper's letter: Request for permission to conduct the research.

Dear Sir/ Madam

My name is Goodness Ntokozo Sibiya, I am a registered student for the Master of Management Sciences: Public Management at the Durban University of Technology. I am conducting the research for master's dissertation on the topic "The importance of Information and Communication in disaster preparedness by eThekwini Municipality."

I am hereby seeking your consent to undertake my research in eThekwini Municipality under Disaster Management Centre in order to complete my studies and add value to the municipality by drawing recommendations. I have provided you with a copy of my proposal which includes copies and the letter of consent and questions to be asked during the process. I am also hopeful to receive an approval letter from the Institutional Research Ethics Committee (IREC).

If you require any further information, please do not hesitate to contact me on 031 3111 550 or on 082 642 1143. Email address: sibiyantokozo5@gmail.com or Ntokozo.sibiya@durban.gov.za Thank you in advance.

Yours sincerely,

Goodness Sibiya

Appendix F: Ethical Clearance Letter

MANAGEMENT SCIENCES: FACULTY RESEARCH ETHICS COMMITTEE (FREC)

3 March 2020

Student Name: **Miss GN Sibiya**
Student No: **21120094**

Dear Miss GN Sibiya

MASTER OF MANAGEMENT SCIENCES: PUBLIC ADMINISTRATION

TITLE: Information and communication technology in disaster preparedness by eThekwini Municipality

Please be advised that the FREC Committee has reviewed your proposal and the following decision was made: **Approved – Ethics Level 2**

Date of FRC Approval: 3rd March 2020

Approval has been granted for a period of two years from the above FRC date, after which you are required to apply for safety monitoring and annual recertification. Please use the form located at the Faculty. This form must be submitted to the FREC at least 3 months before the ethics approval for the study expires.

Any adverse events [serious or minor] which occur in connection with this study and/or which may alter its ethical consideration must be reported to the FREC according to the FREC SOP's.
Please note that ANY amendments in the approved proposal require the approval of the FREC as outlined in the FREC SOP's.

Yours sincerely

Prof JP Govender
Chairperson: Faculty Research Ethics Committee

Appendix G: Editor's Report

Sury Bisetty Academic Editing Services –

The pen is mightier than the sword

To whom it may concern,

I have edited a dissertation entitled: **INFORMATION COMMUNICATION TECHNOLOGY IN DISASTER PREPAREDNESS BY eTHEKWINI MUNICIPALITY** by **Goodness Ntokozo Sibiya** student number: 21120094, submitted in partial fulfilment of the requirements for the degree **Master of Public Management** in the Department of Public Management and Economic, Faculty of Management Sciences at the Durban University of Technology.

Professional Language and Technical Editor
11 June 2022

CONTACT DETAILS
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NB – in keeping with POPIA regulations all work related to this thesis will be deleted 3 months after completion.

Appendix H: Turnitin similarity report

ICT in disaster preparedness by the eThekwini Municipality

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