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Universal Design of ICT

Mitigating Situational Disabilities in Information Systems for Situational Awareness in Flood Situation with Universal Design:

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Abstract

Natural Disasters have been affecting humans for centuries. It remains a fact that we are living in a world where different kinds of terrible natural disasters occurred that have created a mess in the socio-economic sphere of the affected areas. Despite the availability of early warning systems, it is impractical to live in an area without natural disasters. The effect of climate change catalyzes the occurrence and severity of natural disasters including floods. Floods are one of the major natural disasters that contribute to the high disaster death rate in the global south, especially in Nigeria. This requires an effort of collaboration from all stakeholders in designing, building, deploying, and maintaining inclusive disaster management systems. This effort can never be achieved without the application of universal design principles in designing rescue applications.

In this research work, we have studied situational disabilities and their effect on situational awareness based on the data collected from victims in Nigeria. Moreover, we have evaluated the accessibility of a mobile application called SETY that is used to report an emergency incident at the time of natural disasters in Nigeria. The research work contributed to identifying situational disabilities and their corresponding accessibility barriers based on difficulty experiences collected from the research participants in Nigeria. Moreover, this study proposed a framework that guides the design and development of rescue applications that can work without the Internet to regain or attain situational awareness.

Keywords: Universal Design, Universally-designed Rescue Applications, Inclusive Disaster Management Systems, ICT for Situational Awareness

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CHAPTER ONE: INTRODUCTION

1.1. Overview

Natural Disasters have been affecting humans for centuries. It remains a fact that we are living in a world where different kinds of terrible natural disasters occurred that have created a mess in the socio-economic sphere of the affected areas. Communication facilities have been used for managing emergencies in natural disaster situations. Information Communication Technology (ICT) artifacts have been used in the emergency management landscape and their accessibility and usability in a disastrous situation through the application of universal design principles has become a scientific discussion topic.

Universal Design principles are applied in many areas to ensure that products and services are usable for the broadest possible diversity of users. However, there is still an open area when it comes to Emergency Management in flood Scenarios to mitigate situational disabilities that might hinder situational awareness. This work aims at providing an in-depth systematic understanding of the possible situational disabilities experienced by various individuals in flood situation which hinders situational awareness and of how current research is going on in Universal Design of Information and Communication Technology (ICT) for Emergency Management. It also highlights high-impact scenarios where a universal design approach can be used to enhance situational awareness in such situations.

This chapter outlines the background of the study, the research problem, and how the research seeks to address the problem through objectives and research questions. The chapter also outlines the justification of the study and the scope of the research.

1.2. Background of the Study

Floods are one of the most common natural disasters, with 30-50 million people affected each year (Platform, 2020). In Nigeria, flood accounts for the most frequently occurring natural hazards, with great consequences on life and property (Magami, Yahaya, & Mohammed, 2014). The causes of floods are both natural and anthropogenic, in the last

decades, for instance, many states and cities have witnessed unusual and devastating floods (Magami et al., 2014). Devastating flood events in Nigeria were first officially recorded in 1963 in Ibadan city when Ogunpa River overflowed causing loss of lives and property; these hazardous events reoccurred in 1978, 1980, and 2011, with estimated deaths of over 100 people (Komolafe, Adegboyega, & Akinluyi, 2015). Between 2011 and 2012 alone, Lagos state recorded at least 8 major floods with more than 30 deaths and much damage to properties (Komolafe et al., 2015).

Although flood hazards occur nearly every year and the huge risks associated with them, little work appears to have been done recently on effective emergency management through Information Technology artifacts to enhance situational awareness by mitigating situational difficulties associated with the usage of the ICT artifacts in such situation.

Research work has shown that Individuals in a disaster situation are often unable to access information through the use of technologies in their environment as a consequence of situational factors (Gjøsæter, Radianti, & Chen, 2019). Situational awareness is an important factor for effective decision-making, especially when it comes to crisis management (Stanton, Chambers, & Piggott, 2001). Situational awareness is an everyday term that you hear often. It's the ability to be aware of one's surroundings and identify potential hazards or dangers (Endsley, 2001). Natural disasters such as floods have the potential to produce life-threatening situations and in certain cases reduce situational awareness in identifying the hazards within one's environment in the process. Individual's experiences in Natural disasters can be a state of shock, trauma, or being unable to move to safety or use available technology to seek help due to floods all around them. In these cases, the individual is said to be situationally disabled.

Situational disability is a term used to describe the difficulties that people face when they are in conditions that make it difficult for them to be aware of what's happening around them or to plan the appropriate action to take (Gjøsæter et al., 2019). By understanding situational disability in a flood situation, affected individuals can be able to mitigate it and enhance situational awareness to handle difficult situations with more ease. Situational

disabilities are those that vary depending on the environment, situation, or activity. Examples include impaired vision in fogged environments, limited mobility in flooded areas, and hearing impairments in noisy areas. These types of disabilities can pose challenges when carrying out certain tasks or navigating spaces. Individuals might not be able to utilize available means like ICT emergency services, warning announcements, and evacuation plans for evacuation or seeking safety in time. Mitigating situational disabilities in the use of ICT devices provides an opportunity to create a more inclusive emergency management system that benefits all users. It is therefore imperative to proffer means to accommodate individual needs or experiences in a flood emergency.

This research explores this means in the field of universal design (Gjøsæter et al., 2019). This paper will also review the literature around situational disabilities in information systems for situational awareness and how they can be mitigated with universal design by examining the ways various factors trigger situational disability and its impact on situational awareness in flood emergencies in Nigeria through gathered Data from flood victims. It will also introduce some universal design guidelines and considerations for designing ICT technologies to improve accessibility in flood situations by answering the following research questions.

A: What are the situational disabilities at play in the use of ICT within a flood scenario?

B: What are the effects of situational disabilities on situational awareness in a flood scenario?

C: How can situational disability effects be mitigated?

1.3. Objective

The core objective of this research work is to identify situational disabilities in a flood situation and study their effect on situational awareness and how these situational disabilities can be mitigated through the application of universal design principles for better accessibility and usability of technological artifacts in a flood situation.

1.3.1. Specific Objective

To accomplish the general objective stated above, the following specific objectives are identified:

- Comprehensive literature review of the research domain;
- Assessing existing applications used in disaster management as a point of reference;
- Examine how situational disability affects situational awareness using information communication Technology in Nigeria;
- Collect and analyze situational difficulties that occurred in flood situations through the survey;
- Understand the effectiveness of the incorporation of Universal Design guidelines in ICT in mitigating situational disability for situational awareness in a flood scenario in Nigeria.
- Develop a conceptual framework to mitigate situational disabilities that affect situational awareness in a flood situation.

1.4. Ethical Considerations

The research will be conducted in accordance with the research ethics guidelines stated in "Ethical Guidelines for Research at Oslo Metropolitan University" and "The Nigerian National Code of Research Ethics".

All participants in the data collection of this research work will be informed about:

- The purpose of the research;
- A right to decline and to withdraw from participation in any situations and phases of the research work.
- The consequences (if any) of participating in the research work.

1.5. Organization of the Thesis

The rest of the chapters are organized as follows. Chapter Two reviews existing related research works in the research domain. Chapter Three focuses on the methodology of the research work. Chapter Four deals with the analysis and results of the study. The discussion and proposed conceptual framework are covered in Chapter Five. Conclusion and future works are included in the final chapter-Chapter Six.

CHAPTER TWO: LITERATURE REVIEW

2.1. Overview

In this chapter, literature works will be reviewed that mainly focus on the flood, situational disabilities, disaster management applications, and universal design approaches for disaster management to understand the research topic clearly. This chapter consists of sections including climate change and the case of flood, understanding the impact of flood, the notion of situational disabilities and contextual awareness, and universal design approaches for disaster management.

2.2. Prevalence of Flood

According to the global survey conducted by the UN published on 10 October 2013, the top hazards or disaster risks faced by survey respondents were floods, with 54% in all hazardous occurrences (UNISDR, 2014). Developing countries are more prone to disasters or hazards due to various challenges like poverty, lack of resources, lack of educational opportunities, poor infrastructure, and lack of trained manpower, lack of awareness and knowledge of disaster mental health (UNISDR, 2014). Disasters annually ravage numerous African countries. Research has shown that flooding is the most severe and prevalent adverse event and has serious implications for sustainable development (Pauver, Twigg, & Sagramola, 2016).

2.3. Flood Management Framework

As the world is currently facing the COVID-19 pandemic, disasters such as flooding are still occurring, but limited attention is being paid. The United Nations 2030 agenda for sustainable development calls for a global partnership in addressing problems to achieve sustainable development. Intending to highlight areas of possible partnership on disaster-risk reduction, Nigeria like most sub-Saharan African nations is prone to perennial flooding and advocates for national cooperation in managing flood risks. The country acknowledges the risks of flooding and welcomes initiatives as evidenced by its adoption of the Sendai framework for disaster risk reduction (SFDRR). The SFDRR adoption was intended to drive invention, foster collaboration, and promote the research necessary to

design evidence-informed policy for disaster response and resilience-building (Bucher et al., 2020).

The Sendai Framework for Disaster Risk Reduction (SFDRR) came into effect in 2015 as a follow-up to the Hyogo Framework for Action (HFA) which lapsed in the same year (Rivera, Ceesay, & Sillah, 2020). It is aimed at reducing the mean per 100,000 global disaster-related deaths and the number of people affected by disasters by 2030 (Platform, 2020) through the prevention of the occurrence of new disasters and lowering current disaster risk by applying a mix of integrated measures focused on various dimensions: environmental, political, legal, health-related, structural, and technological.

2.4. Inclusive Disaster Management Frameworks

Flooding is of particularly great concern because of the frequency of its occurrence and the impact on affected victims. The Sendai Framework emphasizes that DRR and risk-aware development are instruments to slow the hazard-perpetuating wheel of disaster exposure like a flood. Disaster risk mitigation would reduce the negative impact of disasters on individuals. The infusion of disability-related terms and concepts such as accessibility, inclusion, and universal design throughout the SFDRR document was significant. These concepts, which have their origin in disability studies, are used in the SFDRR document to refer to the needs of all in disaster, not only people with disabilities. These disability-related concepts will now serve the field of disaster risk reduction as important overarching disaster-related principles.

Additionally, the Disability Inclusive Disaster Risk Reduction (DIDRR) commits to ensuring that people with disabilities have the same opportunity to access emergency preparedness information, participate in emergency preparedness programs in their community, and be included as a valuable stakeholders in all phases (preparedness, response, and recovery) of local community disaster risk reduction (Gartrell, Calgaro, Goddard, & Saorath, 2020).

2.5. Accessible ICT Artifacts in Disaster management

Disaster risk management involves information-driven activities and tasks (Bennett, Baker, & Mitchell, 2016). ICT has been seen to have played a major role in community disaster resilience plan more especially in supporting people with disabilities and other vulnerable groups (Alexander, 2015). Universal Design guidelines can play a great role in DIDRR Initiative in creating ICT Designs for emergency management that can be used by everyone with or without adaptation in many cases such as in flood emergencies. ICT Systems and tools should be developed to be more accessible and usable among a wide range of diversified users to the greatest extent possible. A prerequisite for this type of product development process would be giving attention to diversity among users so that the needs of all types of people may be considered in its conception.

From the perspective of Universal Design, research shows that universal design in ICT an Emergency Management context might not only be important for people with disabilities but also to a wide range of stakeholders who may also be affected by situational disabilities caused by social and environmental barriers that can occur during emergencies (Gjøsæter et al., 2019). Introducing a universal design approach will make it more likely to develop an effective and efficient system, one which supports decision making while at the same time mitigating situational disability. It becomes even more necessary when dealing with complex systems- ones where there is always lots of information changing rapidly, or hard to obtain (Endsley, 2001).

2.6. Understanding the Impact of Flood on Human Lives.

Empirical research on the effects of disaster on people, though sparse, confirms that individuals with disabilities are at higher risk of death (Aldrich & Benson, 2008) and injury (Alexander, Gaillard, & Wisner, 2012). The impacts of floods are catastrophic and most times very difficult to forecast with precision and can subsequently leave people uninformed and subject to surprise amid their daily activities(Shrestha & Takara, 2008). A study has shown, that the major floods in Nigeria are river floods, coastal floods, and urban floods (Olajuyigbe, Rotowa, & Durojaye, 2012). These flood types are the major and most frequent flood disasters that have occurred over the years. Among these, river

flooding is the most enormous and destructive. River flooding occurs in the floodplains of the larger rivers, while sudden, short-lived flash floods are associated with rivers in the inland areas where heavy rainfall can change them into destructive torrents within a short period and is much more widespread in its catchment area.

The study by Ruin, Creutin, Anquetin, Gruntfest, and Lutoff (2009) has described Flash floods as high-impact, occasionally catastrophic events that result from the intersection of hydro meteorological extremes and society at small space–time scales, generally on the order of hours. It is further stated that flash floods are much localized in space and time, they are very difficult to forecast with precision and can subsequently jeopardize situational awareness. A study by Jonkman and Kelman (2005) has shown that the type of flood and especially its space-time dynamics affect the level of harm suffered. According to the study, different types of floods have different impact levels as shown by their different mortality rates. The difference between these two kinds of floods does not just contribute to the magnitude and type of harm they cause but also plays a role in the emergence of vulnerabilities that do not occur with other flooding phenomena such as general flooding (Jonkman & Kelman, 2005).

Studies have shown that extreme flooding events could trap people in their cars or outside. They mostly happen during rush hours when a lot of commuters are on the road (Ruin, Creutin, Anquetin, & Lutoff, 2008). Road networks, for example, most often lead to fatalities with these types of floods. On the other hand, large hydrological scales typically cause building damage and prevent individuals to take action (Ruin et al., 2008).

2.7. The Notion of Disability

It is critical to define the concept of disability in the light of situational disability. Historically disability was conceptualized as a medical condition, this is known as the medical model of disability(Lancet, 2009). The Medical model sheds light on disability as a body limitation to function as a consequence of disease and other mishaps (Shapiro & Baglieri, 2012). This concept of disability has been widely adopted in data collection which classifies disability based on body impairments and only takes into consideration the presence of impairment or absence of it. Identifying disabilities according to impairments would not capture all the diversified group of flood victims who might undergo different situational limitations in accessing and usage of ICT in a flood emergency (Hosseinpoor et al., 2013). Obtaining data using medical diagnoses as a definition of disability, will result in under-reporting as not all limitations can be defined by body impairment (Palmer & Harley, 2012), the less educated victims or who lack information on their state of health may not have an adequate understanding of their medical condition, more also an aged woman who would classify her functional limitation due to age as not disability. Viewing disability with this model (medical model) is inconsistent as persons with the same type of body impairment may not experience the same functioning ability that may not be identified using only medical evidence (Palmer & Harley, 2012).

The relational gap model addresses the limited concepts of the medical model by viewing disability as a situation where a person's life is significantly limited because of the barrier between the person's ability and the demands of the environment (Fuglerud, 2014). Understanding and utilization of these concepts in diversity and inclusion studies have yielded more prevalence rate for the latter and broadened the scope of disability in new ways of measurement equally accommodating more diverse groups who might have been insignificant in proportion(Häikiö & Hvinden, 2012).

The relational model approach is observed in the example of the WHO framework the international classification of Functioning, Disability, and Health ICF. The ICF framework gives insight into the health and health-related indicators, it makes consideration on the

level of functioning and context of occurrence paying attention to other multidimensional factors(Cerniauskaite et al., 2011). The ICF sees data as a continuum, from full functioning or not functioning at all using Washington group short questions to describe disability data as a continuum of functioning. Concepts of ICF promote the recognition of barriers other than physical impairments and help to identify inequality in disability situations. ICF data collection perspective of functional abilities is made possible by the Washington Group Short Set on Functioning (WG-SS), which describes disability data as a continuum of functioning categories from no difficulty to some difficulty, a lot of difficulties, and unable to do at all. The WGQ has been used globally in developed and less developed regions of the world. Data acquired in national surveys are internationally comparable. The countries where the WGQ questionnaire was used recorded a high prevalence rate of disability compared to using other sets of questions as the case of Zambia census in 2000 which saw to the replacement of the WG short set of functional limits to using a medical model set of questions such as “Are you disabled in any way? Yes/No; What is your disability “, it recorded a 2.7% prevalence rate compared to its 2006 census that recorded an 8.5% prevalence rate using the Washington group of short questions (Loeb, Eide, & Mont, 2008).

2.8. Situational Disability in Flood Scenario

Disabilities can occur in different forms. Conceptualization in its meaning by the GAP model or social model which views disability as a gap or mismatch between a person's ability and the demands of the environment or society to function properly, in such situations people’s practical lives are significantly limited. Disability is not limited to body impairment rather it is as pointed out by (Vanderheiden, 2000), that people might frequently find themselves in situations that will constrain some of their functional abilities similar to an impaired individual would (Fuglerud, 2014).

Situational disability is a term used to describe the challenges faced by individuals and groups in an emergency situation. These challenges can include difficulties in obtaining information, making decisions, or taking action. Situational disability can be caused by the

physical environment, communication breakdowns, or psychological factors such as stress or fear (Ono, Devilly, & Shum, 2016). Understanding situational disability in flood situations is the first step towards mitigating it also and enhancing situational awareness in difficult situations with more ease in the future. Situational disabilities can range from reduced vision to no vision at all in low light environments or blackouts, limited mobility in crowded areas and blocked hearing in noisy areas, etc. These types of disabilities can pose challenges for people when carrying out certain tasks or navigating spaces.

Recent studies by Gjøsæter et al. (2019) have shown that more awareness has been raised for disabilities, and more efforts are being made to improve the lives of those with disabilities, but also have identified that in many cases, especially in disaster situations, people can suffer from a situational disability which include social and environmental barriers. An example of a flood scenario can be a motorist not being able to see water flooding the streets due to low visibility at nightfall, which can be likened to blindness. Another example could be an individual who is trying to flee to dryland and, due to his legs immersed in the flood, gives a condition comparable to someone with limb impairment. Situational disability can also be that of an individual suffering from a short-term injury. Context may also affect how someone interacts with their environment. People's abilities may change as they move through different environments, which can be a result of stress or trauma (Ono et al., 2016).

To fully understand the impact of flood disaster and its effects on emergency management Gjøsæter, Radianti, and Chen (2021) established frameworks that are crucial to analyze the interaction between different stakeholders and tools in different scenarios of a flood and development of such tools to mitigate a situational disability. According to their paper potential stakeholders involved in a flood scenario and situational disabilities they might encounter. The Role of various stakeholders in a flood scenario differs in needs, methods of interaction with ICT technologies, and environmental challenges. We see stakeholders in form of First responders who are first on the scene, Local members of the general public who might be victims affected by a

flood, and Control Room Personnel who are in control of observation, recording, and interpretation of data for decision making and Decision Makers responsible for allocation of resources, logistics, government agencies and NGOs who are responsible for pre-post-disaster analysis, offering knowledgeable expertise and allocation of resource, etc.

2.8. The Notion of Situational Awareness

A study by Stanton et al. (2001) show that Situational awareness (SA) originated in military research during World War I and has become one of the key factors in contemporary disaster management (Hagen, 2013). SA can be defined as the cognizance of entities in the environment, understanding of their meaning, and the projection of their status in near future (Endsley, 2001). Endsley (1995) has shown that many a lot of disastrous incidents were caused by a lack or inadequate perception, comprehension, and projection of an action. she further argued that overcoming the challenge of acquisition and understanding information that comes through data is important and can distinguish the difference between success and failure in many situations. Situational awareness is crucial in disaster scenarios and is often difficult to come by due to the challenges in coherently obtaining the necessary information and organizing it.

The fundamental point of gaining situational awareness is familiarity with elements in the environment, as well as understanding what those elements mean(Endsley & Rodgers, 1994). In other words, when people grasp the information they receive and understand its significance-they have gained situational awareness (Mendonça, Jefferson, & Harrald, 2007). Situational awareness (SA) is critical to mobilizing a rapid, efficient, and effective response to disasters. Limited by time and resources, response agencies must make decisions about rapidly evolving situations, which requires the collection, analysis, and sharing of actionable information across a complex landscape in the case of a flood. However, when there are emergencies, people need to be able to process the status of a hazardous agent, the level of damage, means or ways to locate evacuation centers or proper cognitive ways to help everyone in such a situation. SA knowledge can serve as a

strategy in decision-making such that the information will contribute to an understanding of the emergency situations and can help them decide what actions to take.

2.9. The Issue of Situational Awareness Attainment

Many studies have addressed situational awareness through many concepts in regard to the approach to attaining SA. Endsley (1995) depicts many ways to look at what it means to have situational awareness. For example, some people see it as located "in the mind" and others view it as situated in the environment. Human factors and ergonomics come from an interaction between an individual and their surroundings that can be sensed with different methods or levels of analysis - one level being on the individual, another on groups (Ernstsen, 2014).

By assessing SA on an individual level (Endsley, 2001), in what might be one of his most cited papers, defines SA as the perception of elements in an environment within a volume of time and space. It also described it as comprehension of their meaning and projecting their status for the future. This three-level process is part of cognitive processing which is integrated into every individual's situation assessment. In essence, then, Endsley claims that SA can only exist if it reflects what has been processed before by an individual since this leads to more understanding of how to respond to new information about a given challenge or event. This individual assessment study by Klein, Calderwood, and Macgregor (1989) has shown that Short-term and long-term memory is necessary for the speed at which our brain can process information. The basic mechanisms that constitute SA are short-term sensory memory, perception, working memory, and long-term memories which are based on a Mental model of SA. This is known as described by Doyle and Ford (1998) to play a vital role in determining what is going on with any given situation - they provide context to what we perceive by defining "*the purpose of a system as well as its functioning*". This definition gives insight into why the psychological aspect of SA is so important: it's because mental models form such an integral part of understanding anything!

The activity theory model by Doyle and Ford (1998) represents another way to examine SA. This approach combines consciousness with diverse "in-world" activities and subscribes to a process perspective of SA, they argue that the extent to which information-processing methods are involved in achieving SA is dependent on the nature of the task and goals of an individual.

2.10. ICT for Situational Awareness

Recent disasters and crises have shone a spotlight on the role that Information and Communication Technologies (ICT) can play in gaining situational awareness by connecting people to relevant information, people to rescue workers and resources, and people to people in the immediate aftermath and recovery communication is one of the most important aspects of emergency management (Vieweg, Hughes, Starbird, & Palen, 2010).Gjøsæter et al. (2019)

However, the usage or accessibility of some of these real-time communication devices often is limited due to situational factors at play such as Fog, wetness, cold, ground, flowing water, noise, and internet inaccessibility. Findings have also described situational disabilities accruing from the usage of ICT by first responders ranging from cognitive, auditory, Motoric, visual, speech, and diversity of abilities (Gjøsæter et al., 2019). In a case of emergency, communications can be affected in interaction and conversation quality due to connection and noise coming from the background (Misra, Cheng, Genevie, & Yuan, 2016) this can have a poor impact on the speech and audio output. Visual distortion can ensue from fog hindering visibility or wetness on the individual palms which in turn can prevent or limit simple mobile device operational gestures. Cold and stiffness of joints limiting simple motoric movements to carry out operations.

On the other hand evidence from a variety of sources indicates that wearable and mobile technologies can lead to distraction and accidents in both the general population and emergency responders (Yager, Dinakar, Sanagaram, & Ferris, 2015). The contradictory nature of wearable and mobile information technologies most times comes with the

increased multiple streams of information and the associated reduction of attention to those sources of information due to stress and anxiety (Lindsay & Norman, 2013).

2.11. Factors Influencing SA in Disaster Management

It can be challenging and complicated to maintain sufficient SA levels in an emergency. A study looking at the SA through a universal design approach has shown that situational disabilities in the form of SA demons can affect operators and individual SA through the interaction between information infrastructure characteristics, factors related to system operators, and their environment that causes errors (Gjøsæter et al., 2019). ICTs, expertise, and workload are all key factors in disaster management- because they make people more or less aware of what's going on around them. Recurrent disasters are linked to various complicated tasks and cooperation between different agencies. Poor resource management can also be a liability during these crises, where time and resources are scarce. Knowledge about factors that influence SA is valuable in disaster management. ICT use, expertise level, and workload affect the three levels of situation awareness according to Endsley's model which proposes that there are external factors like task demands or environmental layout as well internal ones like stress, and fatigue which can incur situational disabilities and subsequently cause a decline in situational awareness. Gjøsæter et al. (2019) examined Endsley's SA-Demons and their relationship with situational disabilities that can arise in a disaster situation and make it more difficult to establish SA by increasing the chance of human error due to usability or accessibility barriers present in the technology.

In large-scale operations such as disaster management, many different parties work collaboratively. In emergency collaboration, most communication is bound to happen via ICT since agencies may be located over a large geographical area. This means that those who use these types of forms of ICT for their communications receive less information than in face-to-face discussions because implicit or nonverbal cues like body language and environmental stimuli are left out from these events (Sonnenwald, Maglaughlin, & Whitton, 2004).

Furthermore, these negative emotions or stress can also lead to a Requisite memory trap. Memory processes can be profoundly affected by life experiences. Stress has been proved by Sandi (1998) to be a major modulator of memory function. Stressors are stimuli that impact individuals. In such situations as flood disasters, Humans tend to have limitations to hold short-term memory and information, and therefore ICT systems should not rely on short-term memory that is easily disrupted. On the other hand, Humans' capabilities decrease when having fatigued, stressed, and high workload (Gjøsæter et al., 2019). These factors all act to reduce already limited working memory and disrupt information acquisition. Intuitively, the impacts of extreme stressors (such as a real-life threat, in the case of a flood disaster) can cause an increase in mental workload (a more demanding task in using ICT tools) could eventually lead to a decrease in SA, which, in turn, could lead to worse performances (Berggren, Prytz, Johansson, & Nählinder, 2011).

2.12. Digital Disaster Management: the Case of Nigeria

The Use of ICT in response to the fact that Nigeria has experienced shocking disasters in recent years, which led to a lot of loss of lives and property for the nation this led to the establishment of the National Emergency Management Agency (NEMA) was established in March 1999, this national act has since then birthed a lot of other agencies in the forefront of emergency and disaster management. NEMA was created with a single objective of coordinating disaster management activities in the country. Given the huge impact of natural disasters on society, comprehensive national disaster risk management strategies have been adopted by NEMA known as the National Disaster Response Plan (NDRP). NDRP was established for the purpose to process, structure, and systematically, coordinate an effective response plan for disasters or emergencies in Nigeria.

Nigeria is one of the countries combating this menace of disaster and has adopted and encouraged the usage of ICT in its NDRP objectives and private partnerships as part of its call to MDGs goals to protect lives and properties among its citizens. This has given rise to a few of many common ICT emergency response platforms that have found their usage in the recent flood disaster that has been witnessed in the country. The advancement of

ICT in Nigeria has over the years played an important component in disaster risk management in Nigeria (Abimbola, Bakar, Mat, & Adebambo, 2020). These ICT tools have been utilized by NEMA and other emergency agencies in all stages of the disaster management cycle. SETY mobile application is one of the ICT tools used in Nigeria to help the public in gaining and attaining situational awareness of any danger during disaster events by leveraging community reporting. It gives alerts about what is happening near the user (within a mile radius) and lets the user report danger zones.

2.13. Universally-designed Emergency Management Systems

The notion of a universally-designed system has been studied in the computing research sphere for decades. Most of these studies were focused on understanding the diversity of interactive system users and how accessibility gaps can be reduced to make the interactive system usable by a diverse range of users (Meiselwitz, Wentz, & Lazar, 2010). The notion of universally-designed emergency management systems also took significant attention since such kinds of systems involve diversity in gender, situational disability, digital skill, ability, the context of use, the context of a situation, and so on.

In most Sub-Saharan African countries, users facing natural disasters are not in a condition they can be aware of their situations due to situational disabilities resulting from different factors such as digital literacy issues (Mutula, 2005), Internet-connectivity issues (Yang et al., 2020), poor system and infrastructure design issues (Enakrire & Onyenania, 2007), and so on. The cumulative result of these issues creates different kinds of barriers and requires consideration of universal design principles in the design and development of emergency management systems.

CHAPTER THREE: METHODOLOGY

3.1. Overview

In this research work, we have followed a mixture of qualitative and quantitative research methodology in collecting and analyzing the research data. We will use a literature review to clearly understand the research domain.

3.2. General Research Approach

In general, the research methodology will involve two dimensions which are discussed below.

i. To understand how universal design principles have been applied to Nigerian emergency management mobile applications, the study adopts a Heuristic evaluation approach by evaluating the major emergency management mobile application called SETY that is being used in Nigeria. The Heuristic evaluation will check for accessibility barriers and how this commonly used online application adheres to Universal Design principles and to understand other potential barriers that might exacerbate situational disability to attaining situational awareness while using this mobile application.

ii. An online interview was conducted among the victims and individuals who have experienced flooding, this was made possible by NEMA (The Nigerian National Emergency Management Agency). Questionnaires were sent out through emails. Consent forms for Interviews were drawn for participants who consented to be contacted by phone for an oral interview. Based on this emphasis this study adopts an online questionnaire methodology using SurveyMonkey as an accessible questionnaire tool to accommodate more diversified groups of participants.

3.3. Literature Review

We conduct a comprehensive literature review to understand the research domain and to answer the identified research questions. We will review books to get a clear picture of situational disability and its effect on situational awareness. We review articles and

conference proceedings papers to get a clear understanding of the research area. We review online global reports to get a figure about the prevalence of floods and their impact in Africa, especially in Nigeria.

In general, our literature review activities include:

- Assessing the notion of situational disability;
- Assessing the notion of situational awareness;
- Assessing the impact of situational disability resulting from a natural disaster in situational awareness;
- Assessing the role of universally-designed ICT artifacts in mitigating the effect of situational disabilities on situational awareness.

3.4. Questionnaire Design

The questionnaire was designed based on essential disaster management functionalities through questions about difficulties participants may have experienced in performing a task with an ICT device in a flood emergency scenario. Scales were set to ascertain the level of accessibility of using ICT devices in a flood situation. This task covers Visual, Audio, speech, cognition, and mobility abilities.

3.5. Data Processing

The information received from the 56 respondents is Processed utilizing data processing which involves transforming information that has been collected into data. The Data collected enters the data preparation stage. Data preparation is also referred to as pre-processing phase and is the phase in which raw data is cleaned up and organized for the following stages of processing. During this step, the raw data are checked carefully for any errors that might have occurred during collection or storage such as redundant, incomplete, or incorrect information. The purpose of this step is to eliminate bad data or data with errors so that high-quality data can be achieved at a later stage.

After the data cleanup, the data is Coded using a set of meaningful, cohesive categories. This stage in the process summarizes and represents the data to provide a systematic

account of the situation of this research being observed. In this research, the identified variables and questions under it are coded as follows

Vision: VG_1, VG_2, VG_3

HEARING: HR_1, HR_2, HR_3

MOBILITY: MB_1, MB_2

SPEECH: SP_1

COGNITIVE: GG_1, CG_2, CG_3, CG_4

This Codes act as tags that are placed on data about situational disability variables being observed in this research work.

3.6. Accessibility Guidelines

We have used WCAG 2.0 and W3C/WAI accessibility guidelines to evaluate the accessibility of selected functionalities of the SETY mobile application used for response management in a disaster situation in Nigeria.

3.7. Accessibility Evaluation Method

Heuristic evaluation will be used since the background of this research work branches into HCI (Human-computer Interaction) or interaction design. Hence the evaluation is done manually to evaluate whether the SETY mobile application is complying with some sort of accessibility principles based on the accessibility guidelines mentioned in 2.4.

The SETY mobile application enables users to report on-the-ground situations, receive updates about the disaster, receive alerts about critical situations, and receive updates about the response activities of relevant response agencies. We used the WCAG 2.0 framework to assess the accessibility of the SETY mobile application in terms of its: (1) permeability, (2) operability, and (3) understandability.

In terms of permeability, we assessed the suitability of color contrast, font sizes, and other visual characteristics of the SETY mobile application. In terms of operability, we assessed

the ease of use of the SETY mobile application, including the language of the content, the number of steps for completing a task, and the placement of required fields. In terms of understandability, we assessed the clarity of content and the consistency of terminology in the SETY mobile application. In terms of reliability, we assessed the reliability of the SETY mobile application in terms of its availability and the steps to troubleshoot issues.

3.8. Assistive Technologies

VoiceOver will be used as assistive technology to evaluate the point of reference emergency management application-SETY. AssistiveTouch will be used to validate the easiness of touching 'SOS' screen to press the 'SOS' or 'Rescue Me' button.

To validate the voiceover, the narrator will read the SETY screen options and then the application will be frozen. Then, the narrator will try to navigate SETY and read the SETY screen options

CHAPTER FOUR: ANALYSIS AND RESULT

4.1. Overview

In this chapter, the presentation of the analysis part of the research work to identify accessibility barriers resulting from the situational disability and how this barrier affects situational awareness is conducted. The analysis includes both quantitative and qualitative approaches to address the research questions of this study.

4.2. Data Collection and Analysis

4.2.1. Research Participants

An online interview was conducted among the victims and individuals who have experienced flooding, this was made possible by NEMA (The Nigerian National Emergency Management Agency). The participants were selected according to NEMA flood emergency records from different backgrounds, economic classes, literacy levels, demography, and age. Questionnaires were sent out through emails. Consent forms for Interviews were drawn for participants who consented to be contacted by phone call for an oral semi-structured interview.

4.2.2. Survey/Interview Management

Rabionet, Silvia E. in her journal (Rabionet, 2011), suggested a six-step interview process and we follow the suggested procedures since it is efficient in terms of structure and simplicity to achieve the goal of our questionnaire. The steps (Rabionet, 2011):

a) Selecting the type of interview

b) Questionnaire Design

c) Establishing ethical guidelines

d) Crafting the interview protocol

e) Conducting and recording the interview

f) Analyzing and summarizing the interview

g) Reporting the findings

As per the above procedures, we design an online questionnaire attached in Annex-A based on the Preamble of the Washington Group Short Set on Functioning (WG-SS) that suggests preparing survey questions with an emphasis on functionalities. We have sent the questionnaire with questions about difficulties experienced by participants in their interaction with ICT devices in a flood situation. The questionnaire is comprised of thirteen functionality questions in consideration of visual, hearing, speech, mobility, and cognition abilities. The questionnaire started by explaining in detail what was meant by situational disability for each of the functionality variables in order not to confuse respondents on the question being asked. The Quantitative survey Participants are given a single answer questionnaire ranging from a scale of; No difficulty; Some difficulty; A lot of difficulties; Cannot do at all; Refused; Don't know. From the total of 100 flood victims that we sent out the questionnaire a total of 56 participants responded.

4.2.2. Survey Data Analysis

The information received from the 56 respondents is coded using a set of meaningful categories for further quantitative analysis based on the code book attached in Annex-C. Later, the data is analyzed based on the research questions of this work. We have considered the WCAG 2.0 accessibility guideline principles when we analyze the data. This is because of the rational benchmark provided by the accessibility principles that help us to quantify experienced accessibility barriers due to situational disabilities in a better and more scientific way.

4.2.3. Interview Analysis

We have also conducted semi-structured recorded interviews based on the guideline attached in Annex-B with 5 participants for qualitative thematic analysis and interpretation of users' experience in a flood situation and to identify situational barriers of the victims of flood disaster.

4.2.3.1. Familiarization and data cleaning

In thematic analysis, the first step always involves a careful understanding of the data at hand. Since the data was recorded in an audio mode in this research, data transcription

is therefore needed to have a full grasp of the whole audio transcripts in text mode. The Data transcript requires multiple revisions over time to be able to understand and deduce the kind of themes involved in the transcript. We took the recommendation of taking notes at this stage as it can be used in the next stage of deeper analysis to have a better understanding of the research analysis(Dey, 2003).

The participants of this research were all Nigerians and they spoke English however some accents were not correctly transcribed Into English. This affects the literal meaning of some sentences, but with careful listening to the audio recording repeatedly during data in this stage of data familiarization, these data errors were corrected thereby enhancing unbiasedness in the data. The texts of all the participants are then read to understand how this data answers the research questions and a basic form of codes were generated.

4.2.3.2. Generating Codes and Searching Themes

The researcher will code the data during this phase. Researchers go through the codes and extract themes by reviewing them, which helps them find a pattern. The validity of these themes is then determined to see if they connect with data and research questions as suggested in Braun & Clarke (2006). The steps in the evaluation process are to first identify themes or groupings of ideas and opinions throughout the texts. Second, one should refine specific themes into topics that reflect those particular ideas and opinions. Third, a researcher should find out whether their arguments pertain to certain concepts across all texts- these are called "generalizations." The final step is making interpretations of what's been found through evaluating each text individually while also comparing them between themselves.

This research involved analyzing 15 quotes from the interview text and dividing them into five themes. During this process, related quotes were grouped to form a theme. This was done by how relevant each theme seemed to be when answering the research questions. After grouping all of the themes, some edits had to be made because it became clear that a quote or two didn’t fit well within its corresponding theme; this was mainly due to understanding what they meant after revisiting their original transcripts and finding out

where they belonged to each topic being studied differently afterward as an attempt at verifying how much a specific quote contributes towards addressing

our data-oriented question. Overall, repeated rounds of generating codes for groups and including different revisions have proven fruitful as we are now able not only to classify our data but also to answer more specific questions about the research work.

The responses and opinions were analyzed thematically to shape the pattern of the responses (Braun & Clarke, 2012). As a result, 15 codes from the interview text were identified and later divided into five themes presented in Table 1.

Themes	**Codes/Quotes from Interviews**
Situational Barriers to ICT usage	Visual difficulties Cognitive Difficulties mobility difficulties hearing difficulties speech difficulties
Effects of barriers on situational awareness	Poor danger identification Poor decision making Poor location-awareness Poor communication
ICT design barriers	Internet issues Device issues System design issues

Table 1: Themes and Codes

Participants were asked questions about the situational difficulties they encountered using an ICT device in a flood situation. Responses were affirmative on several difficulties experienced.

Participant 1 responded that:

“It was hard to even use my phone at that moment even though I had so much need for it, but it was not easy to see through the phone because of haze from vapor. When I wanted to call my mother, I tried so hard to wipe the phone screen but there was still water on my hands, so it was difficult seeing anything through my phone”

Participant 2 responded That:

“I experienced a bit of communication difficulty, I was a bit loss of words, and even though I tried and succeeded to put out a call the person I was calling seem not to hear me quite clearly when I spoke. I had to more effort into raising my voice practically I was like shouting on phone to be heard.”

Participant 3 responded that:

“I was unable to make a call or anything on my phone, my hand was so numb with cold. I had to jump off the car and rush to the pharmacy to get some gloves to keep my hand warm. As I was not able to hold the phone with my hand, I was unable to make a call with my phone. I was so helpless and disturbed by the scenario. I was very close to having a nervous breakdown. I thought to myself, what if I am in a situation where I am unable to make a call with my phone? What if I am unable to reach anyone?”

Participant 4 responded that:

“Even though I tried using my phone often, but I was not able to concentrate or do any task I was used to even to simply search for a phone contact was not so easy”

It is somehow difficult, and a lot of echoes were heard from the background and breakings in the conversation, strange noises were obstructing the signals, and the network signal was so much interfering. I was so tensed up that I wasn’t able to hear properly because I was struggling to get to safety”.

Participant 5 responded that:

“It was raining heavily at the same time it was very hard to say anything as we were both overcome with shock to even hear what was around even to think more of hearing anything with a phone. I was extremely scared; I did not know what would happen next and I was very scared of what would happen to me again”.

4.3. Analysis Results

4.3.1. Survey Analysis Results

The main purpose of the evaluation is to identify situational disabilities and their level of impact on situational awareness. As a result, we analyze the situational difficulties the respondents experienced based on the level of difficulties across all diverse groups and summarized the result through the chart in Figure 1.

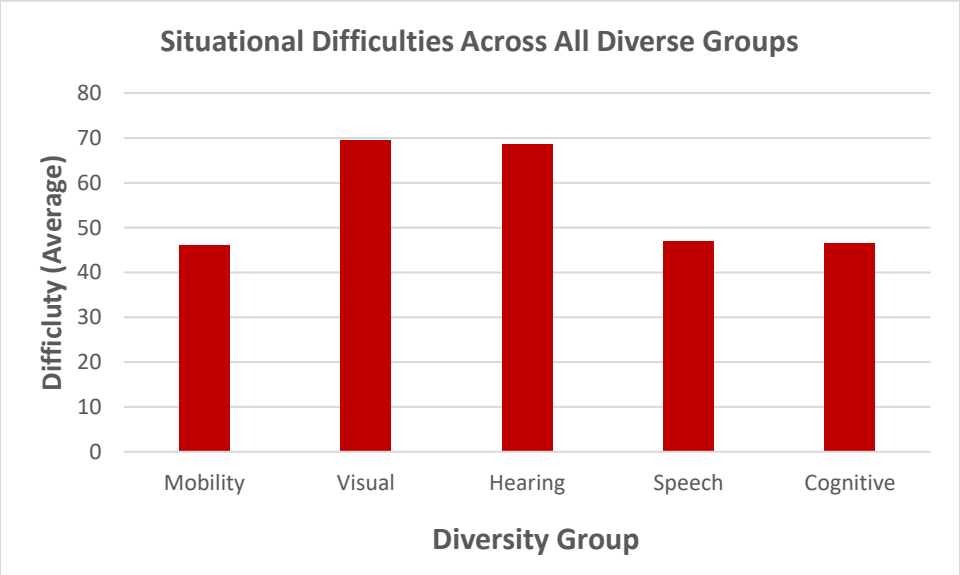

Figure 1. Situation difficulties across all diverse groups chart

However, if we want to answer which diversity group experienced more difficulties (accessibility barriers) or any form of difficulty, we get the result depicted in Figure 2.

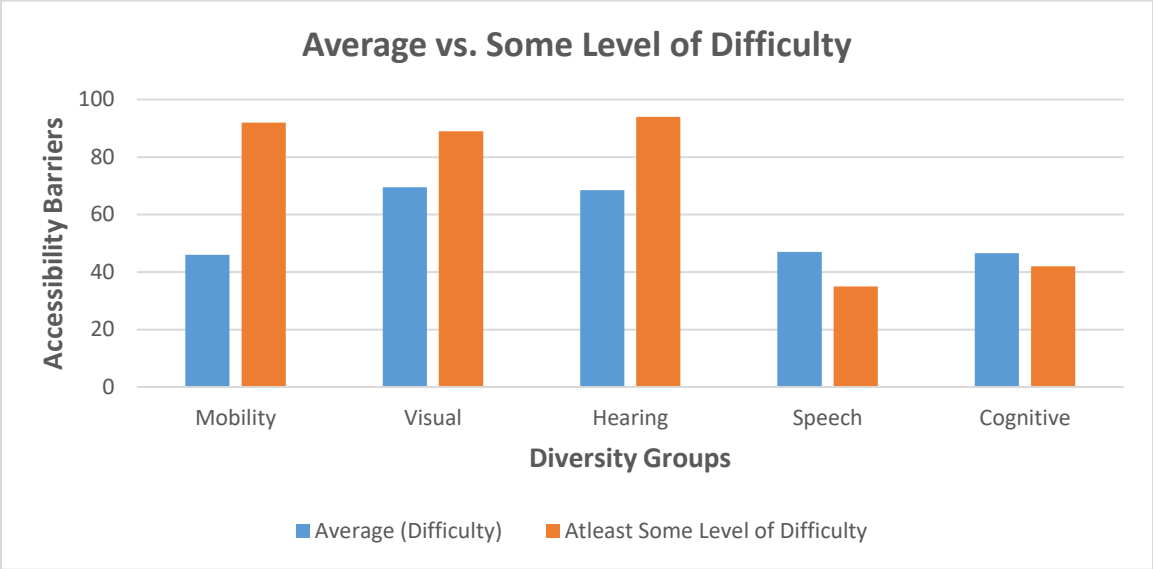

Figure 2. Average vs. Some level of difficulty comparison chart

If we analyze the mobility barriers that the research participants experienced in a flood situation based on the operability accessibility principle, we get the result summarized in Figure 3. We prefer to analyze experienced situational disabilities in consideration of operability because of the direct correlation between mobility and the following issues:

- Performing input tasks without a keyboard are often required in a flood situation.
- Performing tasks with enough time.
- Performing simple navigation techniques to find contents that are critical in a flood situation.

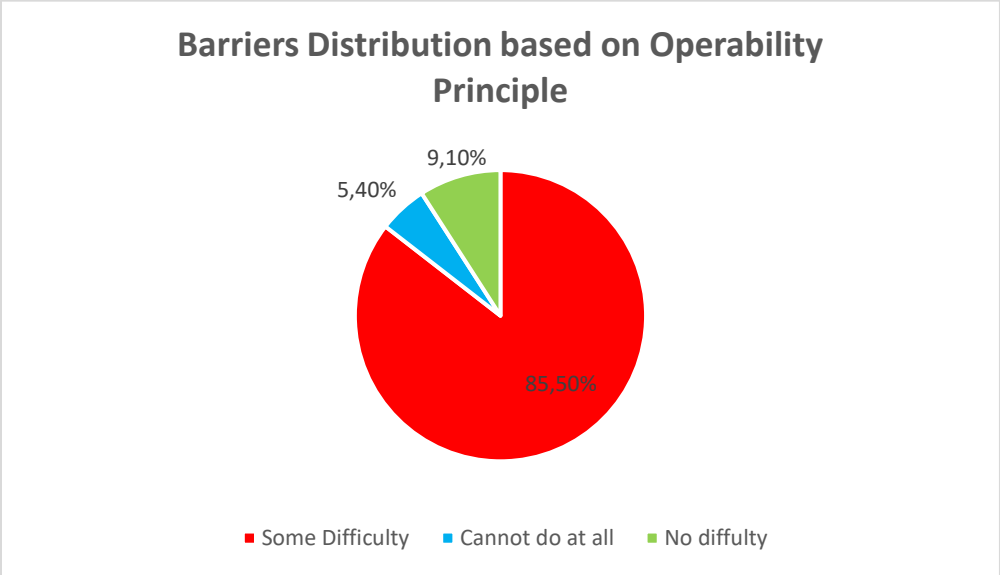

Figure 3. Mobility barrier distribution based on Operability chart

4.3.1. Interview Analysis Results

We summarize the result of our thematic analysis based on the responses of interviewees in consideration of the thematic codes in Table 1 and presented it in Figure 4.

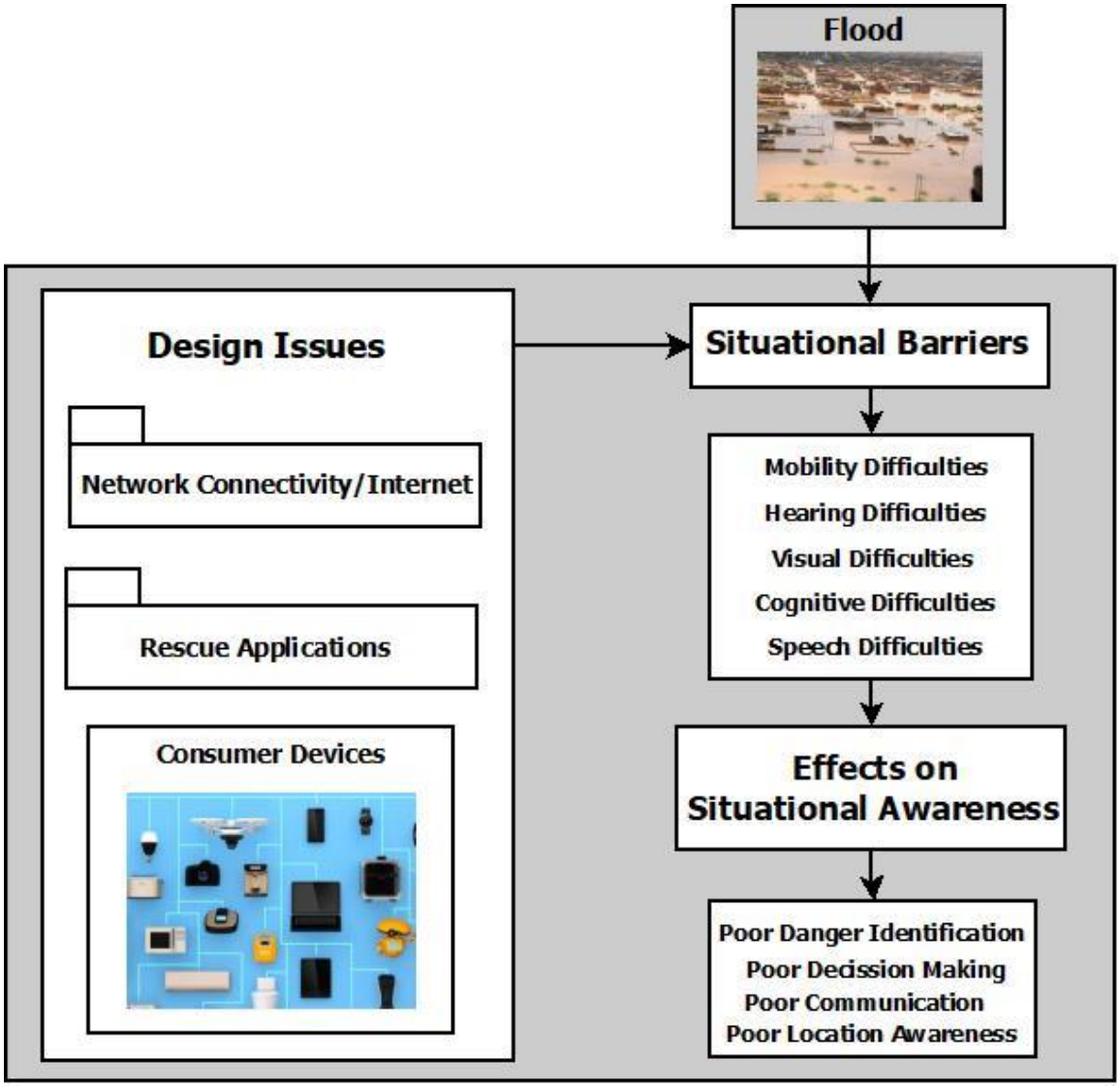

Figure 4. Thematic Analysis Result

4.4. Accessibility Evaluation of SETY App

For a better quantitative study of situational disabilities experienced in a flood situation, we have evaluated the accessibility of the SETY mobile application based on WCAG 2.0 and W3C/WAI accessibility guidelines. The accessibility evaluation is conducted on selected functionalities of the application used for SOS (Save Our Soul/Save Our Ship) calls in disaster situations in Nigeria. In doing so, we have defined heuristics in consideration of flood scenarios and used VoiceOver as assistive technology. The defined heuristics are summarized in Table 2.

Heuristics ID	Name	Explanation	Problem
H001	Image Content Perception	It is about evaluating whether image contents are accessible for people with visual impairment using VoiceOver as assistive technology.	Images without alternative text
H002	Incident Report form perception	It is about evaluating whether a mobile application form is accessible for people with visual impairment using VoiceOver as assistive technology.	Content is different or inaccessible when it is presented using an auditory channel
H003	Communication overloading	It is about information overloading during reporting an incident.	Information Overloaded to the user.
H004	Alternative data entry method.	It is about evaluating how an incident report is entered into the application via different alternative channels (through a mobile mic, hand gestures, etc.).	No alternative communication channel.
H005	Error detection and correction	It is about evaluating how errors are detected, communicated, and corrected.	Inaccessible placeholder, poor input validation, No automatic error correction

Table 2. Heuristics definition for SETY

4.4.1. Selected Functionality of the SETY App

We have selected basic functionalities of the SETY app that are used for incident reporting and emergency circle creation in a disaster scenario. The screenshot of the incident reporting user interface is presented in Figure 5 whereas the SOS (Save Our Sols/Save Our Ship Morse code) user interface is presented in Figure 6.

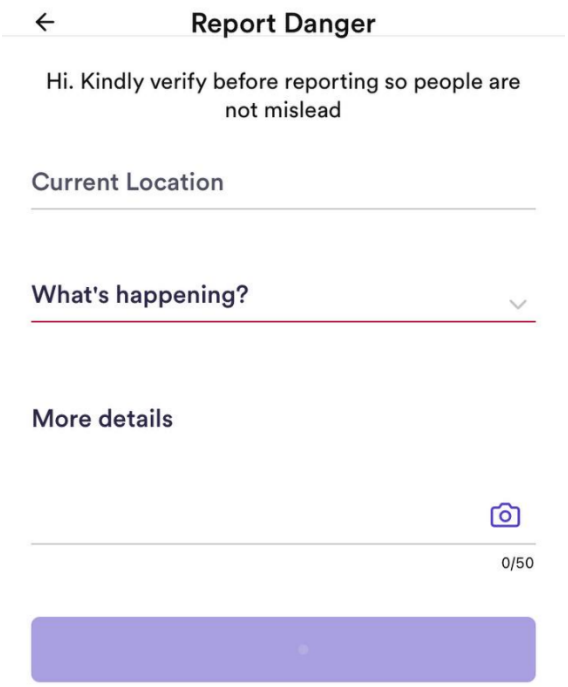

Figure 5. Screenshot of Incident Report Feature of SETY

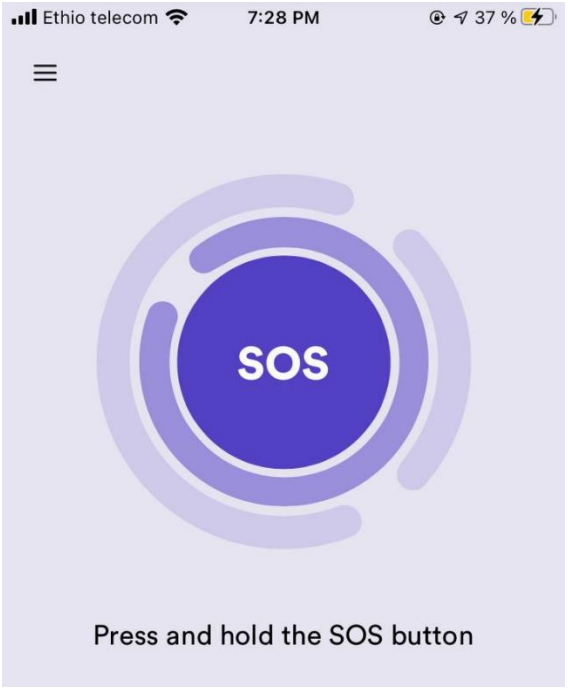

Figure 6. Screenshot of SOS of SETY

4.4.2. Selected Situational Disability Group and Assumptions

A number of researchers (Magami et al., 2014; Ruin et al., 2008; UNISDR, 2014) has revealed that people often experienced situational disabilities related to mobility, and cognitive and hearing abilities in a flood scenario. As a result, we have considered situational difficulties related to mobility, cognitive, hearing, and vision in evaluating the SETY application. Moreover, we have assumed that the user-facing difficulties have a working Internet connection and know how to use the application in normal circumstances.

4.4.3. Accessibility Evaluation Result of SETY App

According to the heuristics defined in Table 2, the following results are discovered and summarized in Table 3.

Heuristics	Accessibility Barrier	Affected Diverse User Group
H001	The camera picture/icon has no auditory image description in the mobile app for people with visual impairment	People with visual impairment
H002	UI components seen and read by VoiceOver are different.	People with visual impairment
H003	Too much information overloading after the user press “SOS” as it is shown in Figure 7.	People with cognitive impairment
H004	No alternative communication with incident report functionality except typing.	People with visual impairment, People with motoric impairment, People with cognitive impairment
H005	Poor error correction in the ‘What’s happening’ textbox.	People with motoric impairment, People with cognitive impairment,

Table 3. Heuristic Evaluation Result

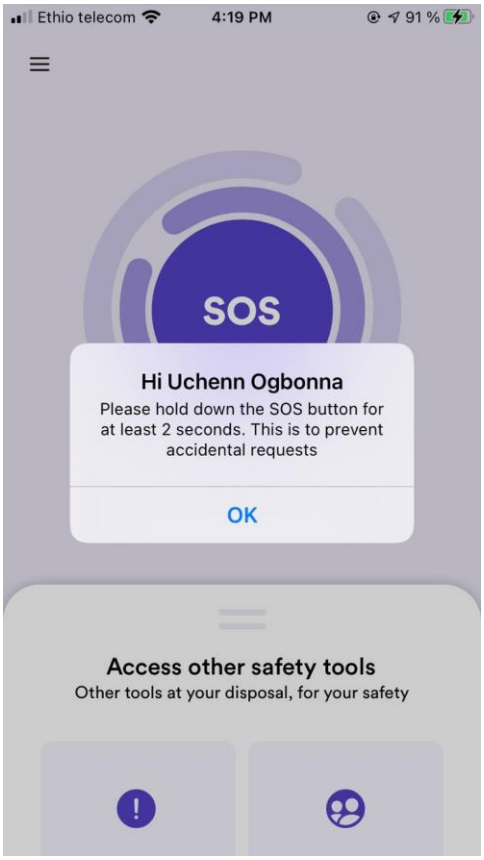

Figure 7. Information Overloading Scenario of SETY

As it's shown in Figure 7, the user is communicated a lot of information in a flood situation whenever he/she wants to send 'SOS' Morse code to the emergency response team. This communication overloading pattern is persistent in other interaction schemes with the SETY application.

CHAPTER FIVE: DISCUSSIONS AND PROPOSED CONCEPTUAL FRAMEWORK

5.1. Overview

This section will try to highlight the major findings of the research work in consideration of the research questions. We will also present a conceptualized framework that may serve as a guideline to develop accessible rescue applications in the global south where power and Internet connectivity disruptions often occur during floods and other natural disasters.

5.2. Remark on Situational Disabilities Experienced in Flood Scenario

As per the result in Section 4.3.1, people may experience accessibility barriers that are highly related to mobility and hearing. This is because of the environmental change (Ruin et al., 2008) and the stressful psychological condition (Ono et al., 2016) that resulted from the flood situation. The result depicted in Figure 1, indicates that people may encounter a serious number of visual accessibility barriers because of the situational disability created by the flood. This puts a user who is interacting with an ICT device in a condition that is hard to perceive and understand his/her surrounding situation and hinders the overall process of rescuing and response management. This implies that rescuing applications must adhere to provide interaction with alternative channels including auditory and gestures.

The other finding is that 83.4% of respondents encountered situational disability related to mobility and 84% of respondents encountered situational disability related to speech. This implies that the users who are interacting with an ICT device at the time of the flood couldn't able to interface with the device as the channel from the user to the device is interrupted. This implies the need for alternative interaction channels/devices that triangulate the usage of fingers, tactile devices, hand gestures, and speech recognition systems.

5.2. Remark on Effects of Situational Disabilities on Situational Awareness

As per the result depicted in Figure 4, the regaining and attainment of situational awareness are not only affected by the ICT device that the user is interacting with but also

by the networking infrastructure that the device is connected to and the design pattern followed to develop the interactive systems or applications. This shows the challenge we are facing to develop an accessible product through universal design principles and reduce the existing digital divide, especially in Nigeria and other Sub-Saharan African countries. The challenge requires the inclusive orchestration among Information Technology infrastructures, interactive rescue systems, and consumer electronic devices used to access the rescue systems. Moreover, the result in Figure 4 also reveals the requirement to continue or reinitiate emergency communication between the rescuing application and the user without an Internet connection.

5.3. Remark on Mitigating Effects of Situational Disabilities

In the global south, especially in Nigeria and other sub-Saharan African countries, flood and even heavy rain results in disruption in power and Internet connections (Magami et al., 2014; Rivera et al., 2020). This makes it difficult for the public to use Internet-based online rescue applications. As per our thematic analysis result depicted in Figure 4, most of the effects (eg. poor communication, poor location awareness) resulted from situational disabilities that occurred due to Internet connectivity disruptions. As a result, in this research work, we propose the framework in section 5.5 for better accessibility and usability of rescue applications.

5.4. Remark on SETY Accessibility Evaluation

The SETY mobile rescue application is playing a significant role in providing emergency management service from the user/victim perspective. But, it lacks accessibility features that hinder rescue operations and create a digital divide among the diverse Nigerian community. As per the heuristic evaluation result (H003) shown in Figure 7, simple and intuitive communication is required to mitigate situational disability and attain situational awareness instead of overflowing information. This can be achieved through less number of user interface components that are relevant (Case, 2008; Vanderheiden, 2000) for the emergency response interaction.

5.5. The Proposed Conceptual Framework

Recording, maintaining, and contacting emergency lists or circles are one of the techniques used in emergency response management systems. Whenever an incident is reported, the respondent attempts to rescue the incident reporter in collaboration with people who are listed in the emergency contact list or circle. As is shown in Figure 8. The same applies to SETY application where users preregister emergency contact circles at the time of registration and the circle will be notified at the time of the disaster/incident. In Nigeria and even in most Sub-Saharan African countries, people tend to register their immediate families including brothers, sisters, parents, daughters, and sons in their emergency contact list. If a natural disaster happens in the same geographic area where the incident reporter and the people on the emergency list live, the concept of emergency contact doesn't work well.

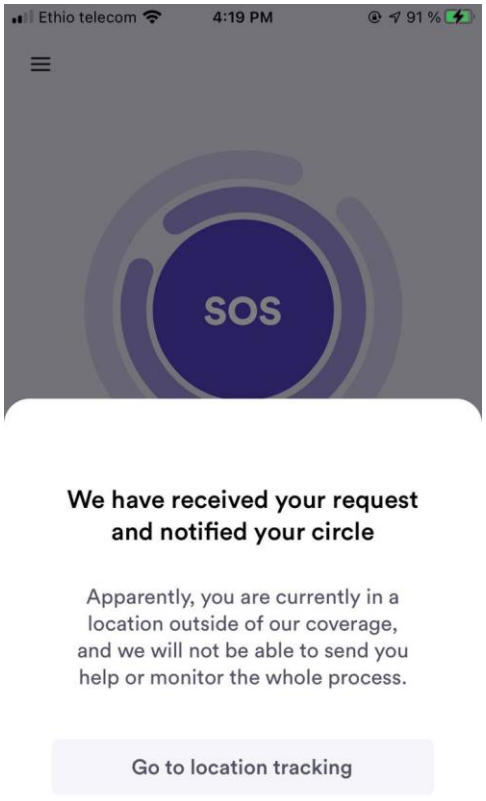

Figure 8. Incident reporting and Emergency Circle notification scenario

We propose a conceptual framework that dynamically creates and maintain emergency circles based on the spatiotemporal data of the respondent. Besides, in Africa, natural disasters cause power and Internet disruptions and this framework is required to support the logging of emergency circles dynamically through the calculation of the device's proximity.

The proposed framework is depicted in Figure 9 that can be implemented to mitigate the effect of situational disabilities by regaining or attaining situational awareness that plays a significant role (Gjøsæter et al., 2019; Jonkman & Kelman, 2005; Ono et al., 2016; Stanton et al., 2001; Yager et al., 2015) in rescuing operations where there exists Internet disruption in the Information System infrastructure.

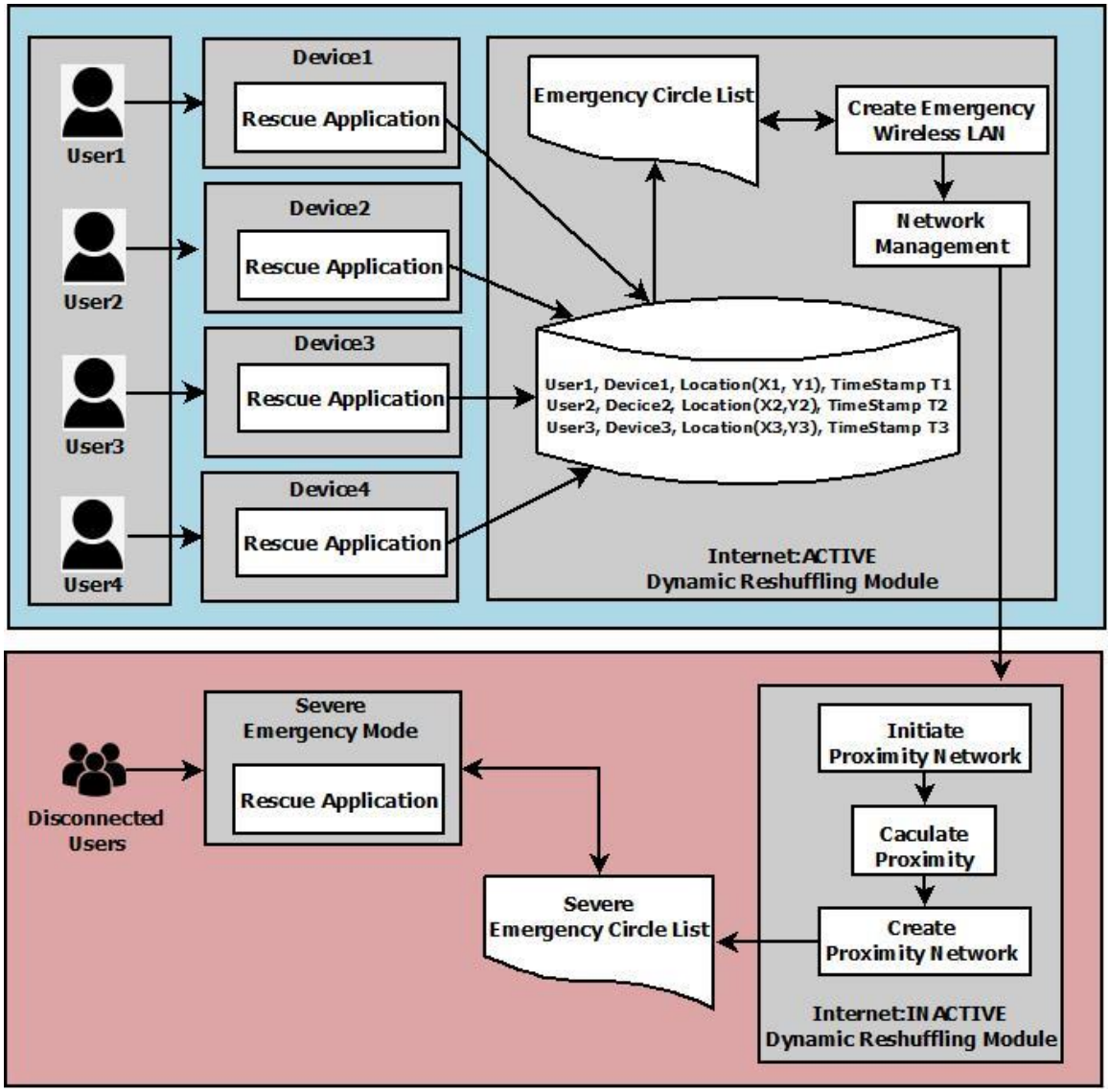

Figure 9. Conceptual Framework

CHAPTER SIX: CONCLUSION AND FUTURE WORK

6.1. Conclusion

Despite the availability of early warning systems, it is impractical to live in an area without natural disasters. The effect of climate change catalyzes the occurrence and severity of natural disasters including floods. Floods are one of the major natural disasters that contribute to the high disaster death rate in the global south, especially in Nigeria. This requires an effort of collaboration from all stakeholders in designing, building, deploying, and maintaining inclusive disaster management systems. This effort can never be achieved without the application of universal design principles.

In this research work, we have studied situational disabilities and their effect on situational awareness based on the data collected from victims in Nigeria. Moreover, we have evaluated the accessibility of a mobile application that is used to report incidents at the time of natural disasters including floods in Nigeria.

This research work contributes in two directions. Our first contribution is the identification of situational disabilities and their corresponding accessibility barriers based on difficulty experiences collected from the research participants. Secondly, we have proposed a framework that guides the design and development of rescue applications that work without the Internet to regain or attain situational awareness.

6.2. Future Works

The notion of situational disability, its effect on situational awareness, and how to mitigate its effect is a broad concept and requires further study.

We have summarized some of the future directions in this topic as follows:

- Universally designed intelligent systems that consider the cognitive and mobility difficulties of users experienced in natural disaster situations require further study.

- The regaining and attainment of situational awareness involved real-time Spatio-temporal data and the analysis of big Spatio-temporal data for inclusive emergency management require further study.

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Annexes

Annex-A: Survey Guideline

Enhancing situational awareness In flood situation using ICT

A research Survey to understand the situational disabilities at play in the use of ICT in flood situation

VISION

In a flood situation victims might encounter numerous visual impediments to attaining SA, using ICT tools and applications in its usage context. The factors in flood situation impeding vision might be as result of using the device on the move and water droplets on the device causing blurry screen which can reduce image and text quality,

Did you have difficulty seeing letters or images on your device in a flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

Did you have difficulty seeing application Features on your device in flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

Did you have difficulty clearly distinguishing colors on an ICT device in flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

HEARING

In a flood situation Audio communication in ICT devices might be suppressed or in some cases not responsive at all due to incessant sounds and noise coming from the affected surrounding.

Did you have difficulty hearing when listening to news or broadcast with an ICT device in a flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

Did you have difficulty hearing what is said in a conversation with an ICT device in flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

Did you have difficulty hearing Alarms or other alert sounds on your ICT device in flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

MOBILITY

Flood situation can cause severe effect on the use of the limbs to perform activities or limit motion, limiting an individual to use his ICT device. This can be because of cold from the water, wetness of hand, stress or injuries. The effect can be in form of a trigger fingers, Wrist tendinitis, strain, or sprain etc.

Did you have difficulties typing with your fingers using an ICT device in flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

Did you have difficulty carrying out hand gestures on an ICT device in flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

SPEACH

In different cases of flood, speech can be affected when trying to communicate with an ICT device. Stress can also affect an individual to speak coherently or not at all with an ICT device. This barrier can be because of aggravating noise, stress or network issues affected by the flood situation

Did you have difficulty speaking with an ICT device in a flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

COGNITION

Stress and anxieties from a Flood disaster can exacerbate an individual functional cognitive state, leading to temporary attention disorder, memory loss, intellectual or adaptive functioning disorder etc. This mental situation can affect the use of ICT device in flood situation.

Did you have difficulty remembering how to perform a task you are previously accustomed with using an ICT device in a flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

Did you have difficulty concentrating on a task using ICT device in a flood situation?

- ○ No difficulty
- ○ Some difficulty
- ○ A lot of difficulty
- ○ Cannot do at all
- ○ Refused to answer
- ○ Do not know

Annex-B: Qualitative Survey Guideline

Qualitative Questionnaire Design

The questionnaire was designed according to the Preamble of the WG-Which focuses on functionality by asking questions about difficulties participant may have performing task with an ICT device in a flood Emergency scenario. The questions were set to ascertain the level of accessibility of using ICT devices in a flood situation. This task covers Visual, Audio, speech, cognition abilities.

VISION

In a flood situation victims might encounter numerous visual impediments to attaining Situational awareness, using ICT tools and applications in its accessibility context. The factors in flood situation impeding vision might be as result of using the device on the move and water droplets on the device causing blurry screen which can reduce image and text quality,

VS_1

What was your experience in a flood situation pertaining to the use of ICT devices, did you experience any difficulty seeing letters, images, distinguishing colors, or application features on an ICT device in a flood situation?

HEARING

In a flood situation Audio communication in ICT devices might be suppressed or in some cases not responsive at all due to incessant sounds and noise coming from the affected surrounding.

HR_1

Did you have difficulty hearing when listening to news, broadcast, alarms or hearing conversation with an ICT device in a flood situation?

MOBILITY

Flood situation can cause severe effect on the use of the limbs to perform activities or limit motion, limiting an individual to use his ICT device. This can be because of cold from the water, wetness of hand, stress or injuries. The effect can be in form of a trigger fingers, Wrist tendinitis, strain, or sprain etc.

MB_1

Did you have difficulties typing with your fingers or carrying out hand gestures on an ICT device in flood situation?

COMMUNICATION

In different cases of flood, speech can be hampered when trying to communicate with an ICT device. Stress can also affect an individual to speak coherently or not at all with an ICT device. This barrier can be because of aggravating noise, stress or network affected by the flood situation.

COM_1

Did you have difficulty speaking with an ICT device in a flood situation?

COGNITION

Stress and anxieties from a Flood disaster can exacerbate an individual functional cognitive state, leading to temporary attention disorder, memory loss, intellectual or adaptive functioning disorder etc. This mental situation can affect the use of ICT device in flood situation.

COG_1 Did you have difficulty understanding, concentrating or navigating around web or app features due to stress or anxiety in a flood situation?

Annex-C: Questionnaire Code Book

The questionnaire was designed according to the Preamble of the WG-Which focuses on functionality by asking questions about difficulties participant may have performing task with an ICT device in a flood Emergency scenario. The questions were set to ascertain the level of accessibility of using ICT devices in a flood situation. This task covers Visual, Audio, speech, cognition abilities.

VISION

In a flood situation victims might encounter numerous visual impediments to attaining SA, using ICT tools and applications in its accessibility context. The factors in flood situation impeding vision might be as result of using the device on the move and water droplets on the device causing blurry screen which can reduce image and text quality,

VIS_1: Did you have difficulty seeing letters or images on ICT device in a flood situation?

1. No difficulty

2. Some difficulty

3. A lot of difficulty

4. Cannot do at all

7. Refused

9. Don't know

VIS_2: Did you have difficulty seeing application Features on your device in flood situation?

2. Some difficulty

3. A lot of difficulty

4. Cannot do at all

7. Refused

9. Don’t know

VIS_3 Did you have difficulty clearly distinguishing colors on an ICT device in flood situation?

1. No difficulty

2. Some difficulty

3. A lot of difficulty

4. Cannot do at all

7. Refused

9. Don’t know

HEARING

In a flood situation Audio communication in ICT devices might be suppressed or in some cases not responsive at all due to incessant sounds and noise coming from the affected surrounding.

HR_1: Did you have difficulty hearing when listening to news or broadcast with an ICT device in a flood situation?

1. No difficulty

2. Some difficulty

3. A lot of difficulty

4. Could not at all

7. Refused

9. Don’t know

HR_2: Did you have difficulty hearing what is said in a conversation with an ICT device in flood situation?

1. No difficulty

2. Some difficulty

3. A lot of difficulty

4. Cannot do at all

7. Refused

9. Don’t know

HR_3: Did you have difficulty hearing Alarms or other alert sounds on your ICT device in flood situation?

1. No difficulty

2. Some difficulty

3. A lot of difficulty

4. Cannot do at all

7. Refused

9. Don’t know

MOBILITY

Flood situation can cause severe effect on the use of the limbs to perform activities or limit motion, limiting an individual to use his ICT device. This can be because of cold from the water, wetness of hand, stress or injuries. The effect can be in form of a trigger fingers, Wrist tendinitis, strain, or sprain etc.

Annex-D: Consent Form

Title of Research Experiment: A research Survey to understand the situational disabilities at play in the use of ICT in flood situations

Researcher Name: Ogbonna Uchenna: Department: Universal design of ICT

Contact: S339958 @oslomet.no

Supervisor Name: Terje Gjøsæter: **Contact:** tergjo@oslomet.no

Supervisor Name: Cristina Paupin: **Contact:** cristpa@oslomet.no

I am a student in Applied information communication Technology doing my masters in Universal design of ICT in Oslo Metropolitan University. This course requires us to gain applied experience in designing and conducting research. I have designed a research project to understand the situational disabilities at play in the use of ICT in flood situation using Nigeria as a case study. In the survey you will be asked to answer several survey questions concerning your personal experience on the difficulties encountered using ICT devices in a flood situation.

In this survey you will not be required to provide any personal information in other to maintain confidentiality. As such no data regarding age, gender, education qualifications will be recorded or used in this research.

Your participation will require approximately 30-40 minutes of your time.

All audio records of the participants will be kept strictly confidential, such that I and only my supervisors will have access to it. All electronic Data collected in this research will be destroyed or deleted at the end of this research work. The Outcomes from this Survey will be reported in a written research report. Information about the project will be made confidential in ways that will not identify individual participants.

Participant Signature Date

_____ _____