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DESIGNING CRISIS MANAGEMENT MOBILE APPLICATION, A CASE STUDY OF LAGOS STATE IN NIGERIA

MASTER'S THESIS

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LL.M, MSc

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KRIISIOHJAMISE MOBIILIRAKENDUSE KUJUNDAMINE LAGOSE OSARIIGI JUHTUMIUURING NIGEERIAS

Magistritöö

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Author’s declaration of originality

I hereby certify that I am the sole author of this thesis. All the used materials, references to the literature and the work of others have been referred to. This thesis has not been presented for examination anywhere else.

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Abstract

Investment in Societal safety has become paramount as the world gets more exposed to disaster and crisis. In this thesis, the author provided research on the design of mobile-enabled application support for crisis management. The purpose of this thesis is to develop an innovative crisis management mobile application for handling emergencies in Nigeria. The problem statement is premised out of the need to improve the means of communication and provide the best crisis communication system. More so, to create synergy between the citizens and crisis management team for a reduced response time and reduced impact of the crisis. To achieve our aim, the design science research methodology was adopted for its suitability while interviews and surveys were the main instruments for data collection. The result revealed that there is no native mobile application bridging the communication gap during crisis currently, and the challenges around implementing the mobile solution which is addressed in the literature review and considered in the design of the prototype. The result also indicates that the citizens desire a simple, usable, high-performance application with a call feature, pictures, video upload, and message to be able to reach out to the crisis management team.

In the event of these findings, the researcher developed a citizen-centered crisis management mobile application with an information hub to provide information on measures and best practices on how to mitigate certain risk scenarios by different actors. The easy and simple mobile solution will be able to make calls, take pictures, upload videos, send messages, and trigger a notification to the emergency team with location address via an analytical tool that will be connected to the national and state emergency rescue team for a prompt response. This Master's thesis is written in English Language and has eighty pages, eight figures, and five tables.

Keywords: Citizen, Communication, Crisis management, Design science research, Emergency, Mobile application.

Annotatsioon (In Estonia)

Investeerimine ühiskondlikku ohutusse on muutunud paratamatuks, sest maailm satub rohkem katastroofi ja kriisiga kokku. Selles väitekirjas esitas autor uurimistöö kriisiohjamise mobiilse rakendustoetuse kavandamise kohta.

Selle väitekirja eesmärk on töötada välja uuenduslik kriisiohjamise mobiilirakendus hädaolukordade käsitlemiseks Nigeerias. Probleemiavaldus lähtub vajadusest parandada sidevahendeid, sünergiat kodanike ja kriisiohjemeeskonna vahel, et vähendada reageerimisaega ja vähendada kriisi mõju. Meie eesmärgi saavutamiseks võeti vastu projekteerimisteaduse uurimismetoodika selle sobivuse kohta, samal ajal kui intervjuud ja küsitlused olid peamiseks andmekogumise vahendiks. Tulemus näitas, et praeguse kriisi ajal ei ole mingit kohalikku mobiilirakendust, mis ületaks sidevahe, ning mobiilse lahenduse rakendamise väljakutsed hõlmavad energiavarustust, interneti kättesaadavust, bürokraatiat, mida käsitletakse kirjanduse ülevaates ja kõnede koormuses, kuna kõne on peamine vahend kriisiohjamise ohvitseride poole pöördumiseks. Tulemus näitab ka seda, et kodanikud soovivad lihtsat, kasutuskõlblikku, suure jõudlusega rakendust, millel on kõnefunktsioon, pildid, video üleslaadimine, et jõuda kriisireguleerimismeeskonda.

Selle leiu korral töötas teadlane välja kodanikukeskse kriisiohjamise mobiilirakenduse koos teabekeskusega, et anda teavet meetmete ja parimate tavade kohta, kuidas leevendada teatavaid riskistsenaariume erinevate osalejate poolt. Lihtne ja lihtne mobiililahendus on võimeline tegema kõnesid, pildistama, videoid üles laadima, sõnumeid saatma ja käivitama hädaabinumbrile teavituse koos asukoha aadressiga analüütilise tööriista kaudu, mis ühendatakse kiireks reageerimiseks riikliku ja riigi hädaabipäästemeeskonnaga. See magistriteos on kirjutatud inglise keeles ja sellel on kaheksakümmend lehekülge, kaheksa numbrit ja viis tabelit.

Märksõnad: Kodanik, Suhtlus, Kriisijuhtimine, Kujundusteadusuuringud, Hädaabi, Mobiilirakendus.

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List of abbreviations and terms

AIB	Accident Investigation Bureau
DRO	Disaster Response Organization
DSR	Design Science Research
DMU	Disaster Management Unit
FEAP	Fire Emergency Application
FERMA	Federal Road Maintenance Agency
FFS	Federal Fire Service
FMOAvi	Federal Ministry of Aviation
FMOT	Federal Ministry of Transportation
FRSC	Federal Road Safety Corps
IDNDR	International Decade for Natural Disaster Reduction
IFRC	International Federation of Red Cross and Red Crescent Societies
LASEMA	Lagos State Management Agency
LEMA	Local Emergency Management Agency
NEMA	National Emergency Management Agency
NGO	Non-Governmental Organization
NIS	Nigeria Immigration Service
NIWA	Nigeria Inland Water Ways
NPF	Nigeria Police Force
NSCDC	Nigeria Security and Civil Defence Corps
RRS	Rapid Respond Squad
SEMA	State Emergency Management Agency
SMOW	State Ministry of works

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1 Introduction

The world is currently experiencing global crises beyond the dramatic climatic changes, health challenges, environmental challenges, economic disruption, political adversity, and social crisis. Nations of the world have had to compromise other elements of the economy such as tourism, transportation, production among others to minimize risk and safeguard lives and properties. (Adelekan, 2014; Siddiquei & Khan, 2020). The impact of environmental disaster is not limited to a particular society but affects both the developed society and the developing nations of the world. (Orimoloye et al., 2020). Since the nature of crises is usually unpredictable and preparedness cannot be underestimated how then do respective stakeholders react to crisis and crisis response strategy. (Coombs & Laufer, 2018; Hetu et al., 2018).

In reacting to a crisis, effective communication forms a critical component that influences the interaction of members of the society during a crisis. Communication can either mitigate or complicate crisis. (Tan et al., 2017). More so, In crisis management and emergency communication, one of the critical events is an emergency notification, this system helps to support the activities of receiving and disseminating crisis-related information to concerned persons. (Romano et al., 2016). However, it is noted that lack of information or improper communication can lead to wrong decision-making and the ripple effect of proper collaboration of the rescue team and the reporter. (Netten & Someren, 2011).

Unfortunately, Nigeria which is the most populous country in African is not left out in the alarming wave of crisis. Nigeria has 36 states divided into the geopolitical zone with Lagos State as the economic hub, busiest, and the most populous city in Nigeria. Lagos State is within the southwest geopolitical zone with a population of over 14 million of which creeks and water make up 22% because of its congestion, its surrounding bodies of water and gas pipelines make the residents of the Megacity vulnerable to crisis. (Adelekan, 2015; Adelekan & Asiyanbi, 2015). Unlike other states of the country, residents of Lagos state inquire from neighbors the level of the area flood risk among other crisis-related Issues before relocating. Although like other nations of the world Nigeria has a body responsible for coordinating emergencies known as the National

Emergency Management Agency. (NEMA). However, in complex situations, agencies, and organizations such as the police unit Rapid Respond Squad (RRS), NGOs, and other national, state, or local units are added to the response squad. The paramount goal is to safeguard lives and properties. (Netten & Someren, 2011).

In the last years, the changing nature of information and communication systems, coupled with the rapid development experience from the mobile technology industry especially as it involves educating the society and its connectivity to everyday living has influenced broadcasting and empowered incident reports, especially during a crisis. (Civelek et al., 2016). Nevertheless, the nation can leverage the use of smartphones to design a mobile solution that will reduce the impact of the crisis by bringing stakeholders together such as the users who are the citizens, developers, crisis management expert, and technologists to be involved in the delivery of an efficient solution to manage the crisis in the country. (Jayatilleke et al., 2018).

1.1 Problem Statement

Developing countries like Nigeria have been rampaged with disasters and crises but with little attention to management due to lack of integrated data, relevant risk impact assessment of vulnerable locations, lack of a published risk management framework, and the generic constraints on all crises which is information and time. The severe threats of fire and flooding to livelihood and properties have resulted in social disorder. (Onyekwere & Nworgu, 2020). It has been estimated by disaster management experts that the annual fire outbreaks in Nigeria are about 7,000 with resultant deaths of over 1,000 persons. According to the WHO data published in 2018 road traffic accident deaths in Nigeria reached 40,061 or 2.07% of total deaths which contributes to Nigeria ranking 41 in the world adjusting the death age rate to 29.50 per 100,000 of population. The International Federation of the Red Cross and Red Crescent Societies (IFRC) reported a cumulative as of October 19 for the year 2020 of 150 deaths, 826 injuries, 155 fatalities, 24,134 displaced, and 192,594 impacted with river and flash flooding across 22 states in Nigeria. Intriguingly, according to the report published by Statista Nigeria ranks top on the list of African countries based on the share of traffic through mobile with 99.05 million internet users while 169.2 million Nigerians have mobile connections which represent 83 percent

of the population. Since crises are inevitable preparation for its potential threats should be strategic and handy. The incorporation of mobile applications will help reduce the impact of crisis and disaster in the vulnerable environment while bringing information to users at their fingertips.

1.2 Research Objectives and Questions

The research is geared at providing the most efficient crisis management solution in Nigeria with a holistic framework approach to crisis management and coordination during an emergency. Based on the objective the researcher formulated one main question and four sub-research questions. The main research question which serves as the base and centred on how to design a crisis management mobile application would be:

RQ1: How to design a crisis management application for Nigeria?

Four sub-research questions are as followed to support the main research question:

- What kind of crisis management applications are currently available in Nigeria?
- What kind of crisis management applications exist in other countries?
- What are the user expectations towards the crisis management application?
- What are the possible challenges while implementing a crisis management application in Nigeria?

Nevertheless, to understand, actualise and provide an effective crisis management solution the researcher would ensure to treat the research question as mentioned in the following points:

- To analyse the design of a crisis management application for Nigeria in terms of Usability, performance, and accessibility.
- To examine the crisis management applications that exist in other countries or within the country.
- To analyse user expectations towards the crisis management application.
- To identify the challenges in implementing a crisis management application in Nigeria.

I.3 Motivation of Study

The author of this thesis is from Nigeria and the country is currently facing different crises including floods and fire crises among other crises. Citizen participation, timely information, and means of communication as to what to do and how to reach out to authorities by citizens in vulnerable locations would largely reduce the impact of the crisis on lives and properties. The communication gap which has become widened during disasters between the public and the relevant authorities can be alleviated with the intervention of information technology. Therefore, the author is interested in the outcome of this research which would be of immense benefit to the citizens, the government, researchers, and respective agencies responsible for the crisis, disasters, and risk management. (Netten & Someren, 2011). The result of this research would be composed in form of a proposal to the National Emergency Management Agency and possibly published in notable journals in the field of E-governance, Information Technology.

1.4 Overview of the thesis

The entire thesis comprises six chapters. The first chapter introduces the subject, and the case study after which the problem statement was discussed, then the research question and objective, the motivation of study, and the overview of the thesis.

The second chapter reviews literature, which consists of conceptual clarification, discussions, related work, and as well as a theoretical framework for designing a prototype. Furthermore, the third chapter discussed the methodology the author employed in conducting the research, explanation of research question and the method used for data collection which was mainly survey and interview, and analysis of data using NVivo.

Chapter four presents the research findings and analysed the critical consideration in designing a crisis management mobile application, while chapter five presents the development of the artifacts. The conclusions, limitations, and suggestions for further research are presented in Chapter Six.

2 Literature Review

This chapter presents related works and relevant research to our study. The first part examined the cycles, strategy, and available tools for crisis management. Flood in Lagos Nigeria, the formation, responsibilities, and operations of the Nigeria Emergency Management System (NEMA) and Lagos State Emergency Management System (LASEMA) were described. It also features the impact of Social media communication and the web process for crisis information management. Furthermore, by reviewing existing literature, the theoretical framework section describes the main theories of situational crisis management, stakeholder relationship, proactive and reactive crisis management model, and technology acceptance and reasoned action of people to accept crisis management mobile application. Finally, the chapter examines the challenges in implementing a crisis management mobile solution and the inherent benefits.

2.1 Crisis Management Plan and Strategies

Crisis management is a process consisting of a set of activities involved in the prevention of crisis, taking, and applying precautions and learning mechanisms for recovery, from a crisis with reduced impact and loss. (Civelek et al., 2016). Crisis management is a set of planned factors channeled towards the elimination or reduction of the incidence of crisis. These factors include prevention, preparation, response, and revision. (coombs, 2015; 2018). Crisis management attempts to reduce the negative impact or severity of an incident on stakeholders. Crisis communication culture has evolved from the traditional and authority-centric push landscape to the mass media communication.

Over the year's Nigeria, which is the focus of this study had experienced various degrees of crisis from natural to artificial with flooding and epidemic as the natural ones, while we have fire outbreak, terrorism, accidents of all sorts, among others. However, we cannot venture into the discussion of crisis or crisis management without mentioning its element and the interconnection. There are four elements of crisis management mitigation, preparedness, response, and crisis management recovery.(Toyosi & Chioma, 2014).

Crisis Management and Mitigation: This is the first phase of crisis management, which involves the activities undertaken or measures designed with the primary aim of preventing and reducing the impact of the crisis on vulnerable people. The intention is to diffuse potential losses and to minimize social-economic consequences on risk-prone and

vulnerable communities. (Amy & Philip, 2001; Toyosi & Chioma, 2014). F. Bulgecin et al.,(2021) mentioned three mitigating strategies that can be explored for crisis management when researching the COVID-19 crisis. Firstly, the expert endorsement is a crisis management strategy that speaks to crisis management experts providing necessary arguments to support decision-making regarding crisis which is more effective than alternative communication. The second is the civil society consultation, this is focused on raising the risk of privacy breaches and the threat to citizens' rights the NGOs and citizen falls under this category and the third is mediation between opposing interests which speaks to ways of measuring passive legitimacy.

Crisis Management and Preparedness: Crisis Management and Preparedness: Crisis preparation is the second cycle of crisis management this is an activity or solution designed in the short term to respond to the crisis. It is the enhanced readiness of citizens, organizations, and government. (Amy & Philip, 2001). Rayawan, (2020) argues that crisis preparedness is the availability of forecasting system technologies and the quality of monitoring technologies in responding to a crisis. Crisis preparedness is a variety of pre-disaster programs designed to strengthen personnel capability, enhance government and non-governmental organizations both technically and managerially, the media, private sector, researchers, and crisis-prone community to respond to the crisis. The process of preparedness encompasses planning, training, warning systems, emergency communication system, resource supplies, emergency personnel contact lists, and public information. (Toyosi & Chioma, 2014).

Crisis Management, Response, and Recovery: Crisis response and recovery are the immediate actions taken by citizens, government, agencies, and crisis management professionals to meet the basic needs of crisis victims pending a sustainable solution (Warfield, 2008; Khan & Khan, 2008). It is confirmed that citizens are the first responders and engage actively in the humanitarian activities of easing victims' pain, saving lives and property. (Rayawan, 2020).

Response & Recovery refers to activities undertaken immediately after a crisis to provide emergency assistance and return victims of the threat or affected citizens to their pre-crisis condition of well-being. (Amy & Philip, 2001). Response and recovery activities during a crisis include early warning information to the people around the crisis-prone areas, victim's evacuation, search and rescue, impact assessment, resource logistics, and relief distribution, securing the affected area and persons, reintegration, and reform (Hodgson & Palm, 1992; Stephenson & DuFranc, 2002). However, it is important to note

that the success of the four cycles of crisis management is dependent on the effective, clear, and timely dissemination of information among the crisis management stakeholders. (Amy & Philip, 2001). The crisis management cycle is illustrated in the diagram below:

Figure 1.Crisis management strategy flow chart

Crisis management and disaster preparedness in Nigeria depend on government capabilities, citizens, respective agencies and not also undermining the place of humanitarian services delivery. In appraising the performance of the National Emergency management agency which is the agency that coordinates and responsible for the crisis and disaster management in Nigeria, some of the challenges faced are lack of early warning signs and an improved information management system. Crisis management is far beyond the distribution of relief materials to victims but a shift to a more modern and proactive approach rather than a reactive one in Nigeria. As the globe continues to extend its coverage and mobile connection is increasing, then basic connectivity and enabling environment for communication in time of crisis and disaster will reduce the impact of risk. The impact of environmental disaster is not limited to developing nations but also affect developed society (Orimoloye et al., 2020). However, rather than wait for last-minute resorts, it is expedient that appropriate action is taken to find mitigating strategies

or solutions leveraging the numerous technological innovations to enhance crisis management.

Tools available for crisis management and rescue of lives and property during disaster involves (1) a data prediction model where analysis of the related crisis is carried out for forecast (2) risk index based on past events and indicators. (3) Crisis behavioural model and (4) and an interactive program for the prompt response of crisis rescue team (Hetu et al., 2018).

2.2 Technology in Crisis Management

Information and communication system designers and researchers refer to ICT for crisis management as crisis informatics. The complexity of crises and designing crisis management technologies in a dynamic response demands increase research. However, technologies designed to improve crisis response and coordination sometimes become outdated and do not scale up. Disaster Response Organization (DROs) due to the increasing numbers of crises and natural disasters in the past years are faced with the challenge of coping with expanded operations. In developing new technologies to support crisis management stakeholders which are also used interchangeably with disaster and emergency management, the needs of the citizen and DROs should be put into perspective. (Stute et al., 2020)

Recently there has been more research in the use of information Technology for crisis management in coordination, monitoring, prediction, and training. It is useful for the entire process of disaster response management. Information Technology applications used in processing, storing, and distribution of information also help in identifying appropriate resources, development plans, land mapping use. Information technology is also beneficial for improving strategies that focus on preparedness, awareness, learning, evacuation plan, and exercises.

For the response and monitor phase information Technology is required for communication and alert system to target group or affected areas. It is also required for handling evaluation of development plan, activities monitoring, and damage assessment. Although there are technologies challenged with accessibility and availability due to its one-way mode content to all groups and one-way mode communication technology examples include radio, television notwithstanding the ease and speed of broadcasting. (Meechang et al., 2020).

The changing nature of information and communication and the rapid development experience from the mobile technology industry especially as it involves educating the society and its connectivity to everyday living is noteworthy. However, in designing a mobile solution, stakeholders need to be put in perspective in delivering an efficient solution such as the crisis management mobile application this includes the content experts, developers, the users who are the citizens, crisis management technologists (Jayatilleke et al., 2018). Critical positions were considered regarding employing designed-based research-based with a contextual description of the mobile innovation adoption of the crisis management design, illustrating the potential innovation, using crisis management mobile application, and examination the stakeholder's contribution in the designing the mobile application.

However, for mobile application technology, people can reach out to more audiences and target groups within the shortest available time with ease and customize content though with limitation of ownership. Mobile applications software programs are designed to run on small computing devices such as smartphones or tablets. Most of the existing peer support systems are web-based and not everyone has access to computers or a reliable internet connection, especially in developing countries. (Sultan & Mohan, 2012)

The mobile application is in three classifications the first class is the web-based mobile application hosted from a website and then accessed via a mobile device browser. The second class of mobile applications is the one build for a specific platform such as Andriod, I phone, etc. The third class of mobile application is known as a hybrid application, this application comprises the features of the first two types of applications. (van Rensburg & Vermaak, 2017).

Web Process for Crisis Information Management

In the world of crisis management information and communication, there are two fractions information infrastructure of the recovery and relief organizations and the ad hoc information system from the social web generated by crowdsourced data. The world wide web is full of crisis management resources that are possessed by the recovery and relief crisis organization or crowd-sourced information in the social web. Managers of crisis and stakeholders are keen on leveraging how crowdsourced information can be maximized for decision-making despite the flaws. (Jens Ortmann et al., 2011).

Schulz et al. (2012) in their paper on Crisis Information Management in the Web 3.0 Age mentioned the future actions for crisis information management leveraging social media, crowdsourcing, and Semantic Web technologies. The stated actions are information collection, classification, and enrichment. A mobile citizen reporter application was developed for collecting and channelling disaster and crisis-related issues via specialized mobile applications and social media platforms like Facebook or Twitter. Since citizens affected or witnessing an incident will either turn to social media to share their experience with their smartphones or call for help in either way this information communication is usually valuable for crisis management.

Information Collection. The citizen-centred Incident Reporter application accepts the submission of information through images, text description, and audio in an information base however because of the unstructured form it makes it difficult to directly make informed decisions thus requires further processing. **Information Classification.** In the information classification stage, the objective is to analyse and reduce the flood of information to useful reports that are appropriate for the consumption of the command staff. Although it may require some follow-up questions from the rescue team or command staff for proper classification. More so, decision-making from crowdsourcing information can be difficult due to colloquial language, abbreviations, and tying errors use on social networks however in cases like this common tagging and annotation engines are helpful for information sorting. **Information Enrichment.** This is a sort of information extension system that offers further additional information using quotations to objects in a linked open dataset with classified information which helps provide essential knowledge. Present information in a structured way. (Borges et al., 2011; Schulz et al., 2012). The chart below shows the web process for crisis information management.

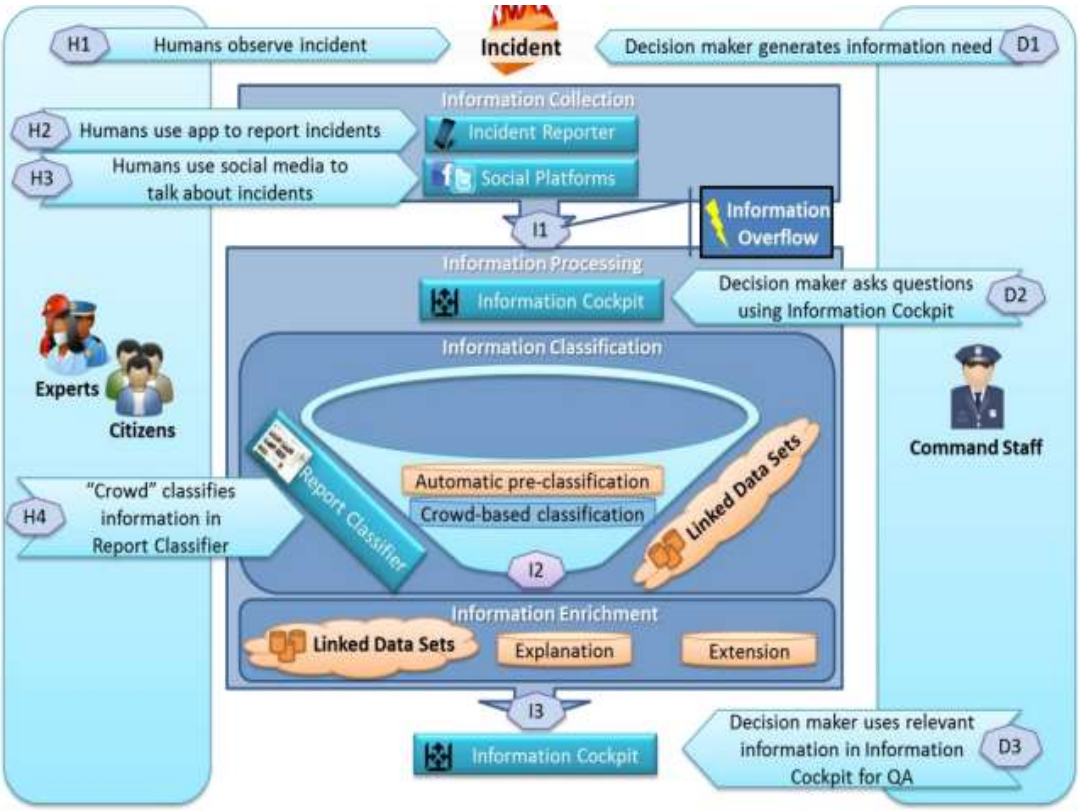


Figure 2: Web process for crisis information management developed by InfoStrom. Schulz et al., 2012

Social Media Communication in Crisis

Advancement in technology has transformed the usual and traditional media of communication such as newspaper, television, and radio to social media and digital platforms (Collins et al., 2016). Social media platforms enable the user to create and share information simultaneously, which includes pictures, audio, and video (Gupta & Brooks, 2013). During a crisis, social media network tools such as blogs, messaging sites like Facebook, Twitter, Instagram, WhatsApp are used in different capacities for interaction and communication (Alexander, 2014; Ahmed et al., 2019; Kavota, et al.,2020).

According to Alexander (2014), a public debate role highlighted some roles attributed to social media which include (1) Situations monitoring (2) covering crisis response and management (3) collaborative development and crowdsourcing (4) creating communal interconnection (5) empower interventions like charitable donation (6) inspires research (7) and gives voice to the people. While Alexander reports the effectiveness of social media, the dark side exists with its negative impacts such as the propagation of rumors

and misleading information shared across the social media platforms, which brings forth issues of trust and privacy. (Toriumi et al., 2013). Social media applications are designed for instant communication, and recently online safety check-ins have been introduced thanks to the growing use of GPS capabilities within mobile applications which makes it more useful for crisis and crisis lifecycle phases. communication (Alexander, 2014; Ahmed et al., 2019; Kavota, et al.,2020). In the quest to reduce speculations and provide timely information, crisis management officials turn to social media to coordinate crisis communication. Since the community members with an understanding of social media interaction have always been part of the response and recovery process during the crisis by volunteering, then maintaining a presence is equally inevitable. (Collins et al., 2016). The current drive on social media and effective use of smartphones can be channelled towards the support and efficient operations of crisis management mobile applications.

Emergency Notification

Emergency notifications are applied in social applications which indicates that there are general social applications and specific social applications and are used to collect information. The general Social application process large scale crises information with specific social application processing small scale events. Although most EN applications process common characteristics and some limitations in terms of text, form photos, applications with a concentration on text and forms. However, a new mobile application for notifying emergencies in crisis with experiments on citizens and crisis management team despite the efficiency of the application and the attestation from the rescue team the citizen prefers the multimedia aspects. (Romano et al., 2016).

2.2 The Nigeria Crisis Management System

In Nigeria, the National Emergency Management Agency (NEMA) is the agency responsible for coordinating crisis and disaster research, inform governments and the public on crisis trends, and directs all disaster response efforts. The Crisis Management System at the National level evolved from the then Fire Brigade commissioned 1906 to fight the fire disaster but went beyond to provide humanitarian services during emergencies thus saving lives and property. In the 1960s and 70s disaster response was

considered a security issue, in response to a drought that claimed lives and property among other events, the National Emergency Relief Agency NERA was established in 1967 to handle the management of disaster victim relief materials. The scope of disaster reduction function of the agency was expanded to align with the UN International Decade for Natural Disaster Reduction (IDNDR) and the status of the agency through a degree setting was raised to an independent body and name changed to National Emergency Management Agency (NEMA) in 1999. NEMA after the amended ACT 12 of 1999 was vested with the management and mitigation of disaster. In fulfilling this mandate, the institution coordinates, maintain communication and respond to emergency or disaster incident.

However, the structural framework was published in 2010 by the National Disaster Management Framework operating across the three tiers of government and built around for levels of governance in Nigeria namely the federal, state, local government, and community levels. There is SEMA at the State level and LEMA at the Local Level and Community at the grass root-based management structures. The disaster management architecture for the country involves both disaster, crisis management, and humanitarian actions with a focus on Research, Planning Policies, Strategies, Communication, Information, Education, Search and Rescue, Prevention and recovery strategies, Relief, Rehabilitation, logistics, resource mobilization, and administration during emergencies.

Lagos State Emergency Management System

SEMA which is the state emergency management agency for Lagos State Government is (LASEMA) Lagos State Emergency Management Agency. The agency was established because of the rapid growth of population in the state, urbanization increase, and industrialization which propelled the increased rate of emergencies. In 2007 LASEMA was formed but her legal framework was signed into law on July 22nd, 2008. The Agency was charged with the responsibilities of providing adequate and prompt response through a crisis or emergency preparedness, prevention, mitigation, recovery, and relief as well as supporting intervention regarding emergency/disaster situations within the territory of Lagos State. The crisis management system in Lagos state can be regarded as the best in Nigeria as the law empowered the agency to coordinate and harmonize the activities of related agencies, NGOs, and other stakeholders for strategic response capability in

managing crisis in the state. Lagos state government introduced the "Safety Arena", where all the departments and agencies liable for the safety and crisis management in the state are synchronized. Undoubtedly, when compared with other states in Nigeria, LASEMA and the Lagos State Fire service readily come to mind for efficiency despite its obvious challenges of increasing population, the rising spate of crime, and emergency incidences, the agency has kept the flag high.

Crisis in Lagos, Nigeria

Great work and heavy research have been done to understand the causes of crises such as fire, flood, and the likes, between the years 2010 to 2012. In Lagos, there was an upsurge in the awareness of the flood crisis due to the experience of disruption of communication, loss of life, damaged properties, and displacement of residents. In 2010 the Ikorodu flood disaster led to the displacement of residents where the Lagos state government had to provide accommodation for over 1700 displaced people for over ten months (Adelekan, 2010; Adelekan & Asiyanbi, 2015). While in 2011, the Nigeria insurance industry paid a claim settlement in history between the US $ 200 Million to over US$300 million couple with damaged properties of middle-income citizens uninsured. (Adelekan, 2010; Ajibade et al. 2013; Adelekan & Asiyanbi, 2015). The flood crisis in 2012, was considered the worst flooding over four decades with over 7 million people been affected. (Ajibade et al., 2013). In recent times in Nigeria, the rate of flood has left many states devastated with a serious impact on the coaster, rural and urban environment with only a few lefts with the undistorted natural state. (Nkwunonwo et al.,2020).

Communication during a disaster is gearing towards the community, which means people can no longer act passively during crisis management but rather communicate as a network, be collectively responsible for their welfare by providing helping hands to each other during a crisis. (Tan et al., 2017). Crisis communications extend to a warning, provision of guidance, and advice for optimal behaviour as to impending disasters like floods, fires, and others. (Reuter et al., 2016; Stepchenkova et al., 2021).

2.3 Crisis Management Applications In other Countries

Recovering from crisis damage is not an easy process, however, nations around the world use the help phone link for assistance and others have deployed customized initiatives such as mobile crisis management initiatives explored in counties around the world in responding and improving the present global crisis.

Estonia

One such initiative is the **HOIA app which means "take care" in Estonia**. HOIA is a health crisis mobile application designed to support the coronavirus crisis, providing preventive measures information to close contacts of victims and advice to seek medical care.

Vietnam

Vietnam is one of the most crisis-prone countries in the world from landslides to fire, earthquakes, and mostly floods due to its long coastline. The disaster management system in Vietnam (DMU) project although not a mobile application but a nationwide web information system connected to the 61 provinces in Vietnam (1) to provide information (2) forecasting of disaster, (3) warning and responding to crisis information on damages (4) rescue and relief and restoration and rehabilitation.

Examples of other similar Applications

Although we have many applications for crisis and disaster management, the researcher picked some of the crisis-mobile applications with comparable objectives found on Google Play Store, amongst others.

Fires Near Me NSW (Australia) – this is a New South Wales, Australia official Mobile application of the rural fire service that manages warning and incident information on bush and crisis fire across New South Wales.

Lebanon Disaster Management – This is a mobile application designed by the Disaster Risk Management DRM of Lebanon to raise awareness and provide information on an early warning sign, preparedness, and response to different disasters to increase the resilience of the Lebanese.

Emergency Ready Application- This is an application designed by the ministry of interior and safety of the Republic of Korea that provides emergency shelters for safe

evacuation and first aid in case of disaster. The application search options for shelter centres, medical centres, fire stations, police stations, safety guide and direct emergency call on the application.

Crisis 360 is also an emergency and incident management application that helps with situational awareness through crisis capture, crisis Impact report, and communication for organizations.

Fire Emergency Application (FEAP)

Umar et al,(2020) designed and developed a mobile Fire Emergency Application (FEAP) which enable the public to alert the nearest fire emergency centre to provide timely support during fire incidents to avoid fatalities and damages to properties using the Software Development Life Cycle phase and Unified Modelling Language for the application visual design. The work highlighted the practical application of design and analysis in developing a two-side application – client and server application software that will aid the effectiveness of the solution in reporting fire incidents. The mobile fire emergency application requires a one-time registration and afterward, the user can log in. In the event of a fire outbreak, the user hits the report fire button, and the application will capture the incidents and location of the user with options for description and send them to the Fire Emergency Department server. The Fire Emergency Department (FED) management will then verify and assign a support team to deal with the fire using the navigation features of the application to locate the venue of the incident. When the situation has been arrested update is provided on the fire emergency employee for a status update. (Umar et al., 2020).

Since requirement analysis is critical to the success or failure of a software project such as FEAP, outlined below are the functional and non-functional requirements of the application.

Functional Requirements

Requirements	**Description Priority**
Report fire	Allows users to report fire accidents

The fire report is confirmed	Fire emergency unit admin verifies and confirms report authenticity
FEU alert notification	Fire emergency unit admin notifies emergency team and the user
Manage delicate location	FEU management can add/delete/query/update sensitive location
Oversee organization	FEU management can add/delete/query/update complex organization
Manage top manager	FEU can add/delete/query/update designated manager of a location
Send emergency team	FEU management assign an emergency team to handle the fire accident
Utilize navigation	The emergency team should be able to navigate their way to the fire location.
Provide status update	FEU management and the Emergency team should be able to provide a fire incident report update.
Manage organization sensitive area	Top manager can manage a sensitive area of the organization
Designate area manager	Senior managers can allocate a manager to a given sensitive area in the organization.
Manage user's	Senior managers can manage both area manager and regular users
Registration	Frequent users must register to gain access to the system
Registration Confirmation	The manager must confirm frequent users' registration for them to access the system
Manage Fire emergency unit	FEU management can add/delete/query/update emergency team in the system
Report Generation	FEU management can generate different reports from the system.

Table 1: Functional requirement for FEAP application

The Non-Functional Requirements stipulates the supposed behavioural properties of the system.

Accessibility is a key requirement since fire incidents are unpredictable the FEAP would always be available to all users.

Usability is another requirement for application like FEAP which requires that it is user friendly and simple to operate in reporting fire crisis.

Performance Speed of the FEAP server would be relatively of high-speed irrespective of the number of users at a point in time.

The Fire Emergency Application would require **authentication** to enhance the security and prevent fake reporting.

Efficiency of FEAP in terms of less memory, slow CPU cycles, connection, and soon.

Robustness of FEAP will handle error conditions and unexpected operating conditions

Notwithstanding, the requirements and the accrued benefit the FEAP however is reports only fire crisis and not a native deigned mobile application more so, it is more admin and response team focused.

2.4 Theoretical Framework

The theoretical framework comprises theoretical perspectives that help interpret relevant work of study. It is important during a study to substantiate arguments and help map guides and provide the scholarly foundation for research. Theoretical frameworks provide structure to investigate and understand the research problem properly. (Kivunja, 2018).

Situational crisis communication theory SCCT

Situational crisis communication theory is one of the most common models that approach an event from the perspective of the influence of stakeholders' responsibility and its impact on citizen or organization reputation responsibility when we consider crisis intervention. (Ma & Zhan, 2016; Sulistyanto et al., 2020) The model by W. Timothy Coombs is a theory that relates how people perceive crises and their strategic response to the threat posed by the crisis. It is an event that is so overwhelming and sudden and requires emergency responders and other crisis interventions. Examples of situational crises include accident, flood, fire disaster, or sudden loss. (Coombs, 2010).

Through situational crisis communication theory, crisis management organization can keep the public abreast of the impending situation and the public are also informed about

how to manage of reach to prevention and recovery team during. Scientist uses this theory to identify and explain the behaviours of citizens and other stakeholders during a crisis which identify the threats and factors that contributes to the crisis. The SCCT evaluates the different stages of crisis threat with a classification of the crisis as the first stage and the second stage determine factors that influence crisis responsibilities and level of threats. As classified in SCCT since natural crises are difficult to prepare for however in a crisis-prone environment one can be proactive notwithstanding, there are varying degrees of responsibility which include.

Responsibility shifting- This involves citizens throwing blame games either on the government, crisis team, or administration outside the crisis. **Argumentation**- This involves citizens rather than act and salvage situations they result in discussions that try to minimize the impact of the crisis. **Anxiety** - Citizens show concern about a crisis in a fearful way. **Compassion**- this is when citizens express their condolence or provide relief materials to the victims of the crisis. **Prosecutor attack**- This is like responsibility shifting, this category of people blames somebody outside the community. (Kyrychok, 2017).

Stakeholder relationships model

To better manage crises there is a need for integration of stakeholders and experiences. The complexities created around crisis management are because of lack of trust and diversity of stakeholders, conflicting demand for resources all this cumulate to the limitations of the effectiveness of the preparation response and intervention towards crisis management. (Hernantes et al., 2013). Stakeholder theory (ST) has been conceptualized into a stakeholder model which theoretically provides an opportunity for organizations to expand their understanding about how they have an impact on and are affected by groups such as citizens, victims, rescue, and recovery teams. Freeman, (1984) postulated that any organization should value and not neglect a stakeholder group, which can impact the organization. If any enterprise is going to be successful, there is a need to value relationships. Relationship with stakeholders forms the perceptions of an organization and therefore influences decision-making during a crisis. Invariably a good stakeholder relationship can stimulate collective responsibility in salvaging situations and organizational reputation during a crisis. (Coombs & Holladay, 2001). Malden Mills

contends that there are two categories of stakeholders, the primary stakeholders, and the secondary stakeholders. Understanding the evolution of stakeholder relationships in crisis management times will limit negative crisis consequences. First, the primary stakeholders are the citizens who are the local community, and workers or employees of the crisis or disaster management agency. While the secondary stakeholders are the media. (Ulmer, 2001).

In dealing with a crisis there are different stakeholders represented from different institutions and agencies in developed and developing countries like Nigeria. Most developed countries have emergency services operated by the government to provide welfare and interventions during a crisis. Nigeria as a country also has agencies and institutions that could respond in cases of emergencies however, NEMA is the coordinating agency saddle with the responsibility of coordinating emergency response and crisis management in Nigeria. The agencies have been classified into the following groups.

- **The Force and the Paramilitary** – these institutions and agencies deal with the security of lives, properties, and can also cover other categories of crisis and emergency. An arm of this institution that forms part of the executive arm of government may also be responsible to punish those whose actions instigated the emergency. Nigeria Police Force (NPF), Federal Road Safety Corps (FRSC), Nigeria Security and Civil Defence Corps (NSCDC), Nigerian Immigration Service (NIS), Nigerian Customs Service (NCS), Nigerian Prison Service (NPS), the Disaster Response Units (DRUs) and the Military which consist of the Army, Navy and Air Force.

- **Special Service** – This institution deals with potentially harmful fires, flood, and are also involved in rescue operations such as road accidents. Their response to unpleasant incident help to prevent damages, salvage life and properties. Federal Fire Service (FFS), Accident Investigation Bureau, (AIB), Nigeria Maritime and safety administration (NIMASA), Nigerian Inland Water Ways (NIWA), National Emergency Management Agency (NEMA).

• **Emergency Medical Service** (Paramedical & Ambulance Service) – These institutions and agencies are responsible for services that threaten health and lives. This service attempts to prevent loss of life and damage to health. Federal/ State Ministry of Health (FMOH).

• **NGOs, and others** – These institutions and agencies are either government parastatal, non-government agencies, private bodies, and the likes that provide first aid and relief to victims during or after the crisis. Private Construction Companies, International Development Partners (NGOs) Federal/ State Ministry of Works (F/SMOW), Federal Roads Maintenance Agency (FERMA), Federal Ministry of Transport (FMOT), Federal Ministry of Aviation (FMOAvi), Federal Airport Authority of Nigeria (FAAN).
(Essoh et al., 2018)

Proactive vs. Reactive Crisis Management Model

Crises are random happenings that can threaten the operations of a state and influence the sustainability of a nation. The general situation in most crisis and disaster management organizations is that situations are largely reliant on reactive indicators. The reactive response offers individuals, groups of individuals, or organizations an advantage of analysing associated variables, be able to detect the root cause of a crisis associated, and ability to be calm and in control of the situation which empowers decision creative and innovative decision making. Learning can occur from those indicators and organizations can change the course of their actions in successful ways based on such indicators. (Singh & Chahal, Woods et al., 2015).

The spokesman from the ministry of information and strategy Alausa Ikeja was interviewed by the Nation newspaper on addressing incidents of fire outbreaks in Lagos state. A gas explosion rocked the Afariogun area of Ajao Estate, Lagos, Southwest Nigeria on July 28, 2020, where two people died because of the incidence and nine shops burnt the issue could have escalated much more but thanks to the bravery of men of the state emergency fire service and first responders who were able to salvage the issue and thereby reducing the damage.

The reactive crisis management model proposed three phases on how to deal with a crisis and how to mitigate the associated risk at the time of occurrence. GET, SET, GO. Just like the phrase used to begin a competition. **GET-** Never Ignore Crisis organizations try

to ignore the crisis and expect it to fade away. Ignoring a crisis or potential crisis will not provide any solution. Rather there is a need for concerned stakeholders to build an understanding of the events to avert or reduce unwanted outcomes. The severity of the crisis also needs to be checked with the financial, human, or other resources to quantify the actual damage incurred which will set the tone for detailed research to understand the cause of the crisis. (Singh & Chahal, 2015).

SET-This second phase of the reactive response strategy is to formulate a crisis management team and crisis management plan. However, a crisis management team is a cross-functional selection of people within an organization, capable of handle crises and establish an effective plan. (Singh & Chahal, 2015).

GO- It is important to mention that irrespective of the events, stakeholders find a way out of the crisis by dealing with the crisis, and proper communication to enable decision making. It is also the responsibility of the team to save the crisis management organization image and accept responsibility and take corrective measures to reassure stakeholders of their safety. Nevertheless, nations of the world are also aware of the limitations related to the reactive crisis management strategy and press for a more proactive approach for safety and crisis management. The proactive crisis management model analyses patterns and relationships that can inform anomalies and provide communication early. (Woods et al., 2015). The life cycle of Crisis management from prevention, preparation, and recovery are the key measures for the reduction of the severity of crises. Proactive and reactive strategies are required to maintain and enhance crisis management resilience. (Hernantes et al., 2013).

2.5.4 Technology Acceptance Models

In designing a crisis management mobile application for Nigeria there are needs to be evaluated on the use of the application and acceptability of the citizens. Technology acceptance models aim at measuring the perceptions and their impact on the adoption of information technology, and the actual usage of the solution. (Davis, 1989). The technology acceptance model (TAM) presents two important factors to be considered in the adoption of any technology (1) the first factor is the perceived usefulness of the crisis management technology as considered by the stakeholders and its refection of situational improvement and efficiency. (2) While the second factor is the perceived ease of use of

the crisis management technology, this illustrates the significant effect of the simplicity of the system by stakeholders.

To evaluate the use of a technology acceptance Instead of the use of the Technology Acceptance Management model, many researchers have embraced the Unified Theory of Technology Acceptance and Use (UTAUT). (Venkatesh & Davis, 2000). Unified Theory of Technology Acceptance and Use (UTAUT) which is the TAM model development has been broadened to incorporate different variables such as variations in the levels of the organization, different users, technology types and design, differences in location, responsibilities, and time. (T Siswanto et al., 2018). Although the expectation of the UTAUT result of usefulness and ease of use is the same as TAM. **Guided** by this model and gaining user's trust in mobile technology may enhance citizen perceptions and participation in crisis management, with secured communication and response to national safety.

2.5 Value of Crisis Management Mobile Solution

The value proposition of crisis management mobile applications can be defined as the net value of the advantages and costs associated with the adoption of mobile applications for crisis management. (Nah et al., 2005). Despite the challenges, according to Nah et al, (2005) and Yu, (2013), there are numerous benefits of mobile e-government solutions such as the crisis management mobile application which include.

Dissemination: This functionality of the mobile application offers an efficient and timely means of disseminating real-time information by the large user population to the crisis management agencies to provide prompt response and recovery during a crisis.

Mobility: This functionality provide convenience and assists to facilitate data collection, information access, and broadcasting of crisis anytime and anywhere.

Engagement: This functionality enhances citizen engagement, increasing social influence and interaction between crisis reporters and the response team.

Inter-organizational interactions: The crisis management mobile application will enhance information classification during the incident report that would facilitate smooth internal operations and inter-agency interactions.

Location Mapping: With the GPS-enabled data and maps functionality on the crisis management mobile application it will help capture the location of an incident without further interrogation of the user.

Efficiency and effectiveness: This will enhance time-saving and minimise delay by instigating timely assistance and support for victims.

Positive image for government: Attainment of high process efficiency in response to service delivery will project the government in good light.

3 Research Methodology

This study aims to design a crisis management mobile prototype and for that reason, the design science research (DSR) has been selected as the appropriate research model to structure the study. The design science research concept has its backgrounds in engineering and the sciences of the artificial and Information Technology artifacts (Simon, 1996; Hevner et al., 2004). Design science research is a research approach that intends to practically solve identified problems. Design science research can be defined as the creation of innovative artifacts that define ideas, practices, technical capabilities, and products through which analysis, design, implementation, management, and use of information systems can be effectively and efficiently accomplished or satisfy a set of predetermined requirements. (Hevner et al., 2004; van Rensburg et al., 2017). Design science is concerned with the designing of objects with an embedded solution to solve a specific problem. (Vaishnavi & Kuechler, 2004).

The design science research framework is a function of product and process Hevner et al, (2004), van Rensburg et al, (2017) which consist of five levels as mentioned by Vaishnavi & Kuechler 2004. The problem identification stage, Suggestion, Development, Evaluation, and the Conclusion stage.

The Problem Identification- This stage is the problem awareness stage for the researcher which enhances the focus of the study.

Suggestion- This is the stage that proffers a solution to the identified problem, bridging the gap between awareness of the problem and solving the problem.

Development- This is the stage where the prototype is built.

Evaluation- This is the stage where the prototype designed is evaluated and reviewed.

Conclusion- This stage the researcher concludes work on the artifact and research work is presented.

Furthermore, Ozdamar & Kuzu, (2015outlined a design-oriented approach model for designing an application. **(1)** Problem analysis of the solution **(2)** Solution development which covers the conceptualization, role of research in developing the crisis management solution, identify the purpose, identify method, develop a prototype **(3)** The iterative cycle and solution testing **(4)** The last phase is the reflection and documentation for the design of the crisis management mobile application for flood and fire risk communication and other emergencies incident. (Ozdamar & Kuzu, 2015).

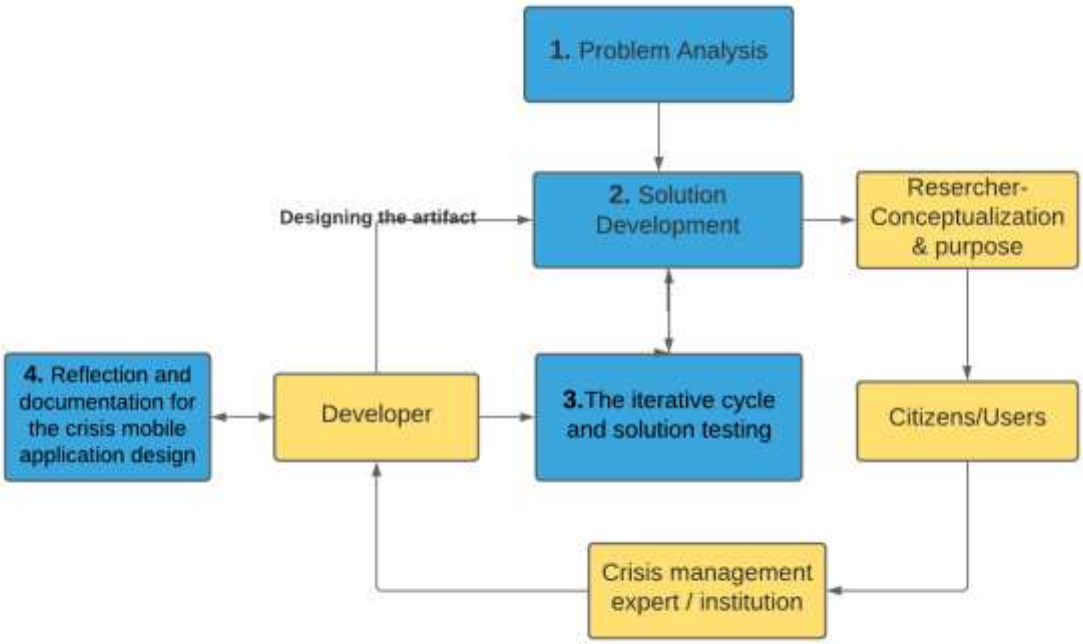


Figure 3: The DSR model design for crisis management application.

Problem analysis of the solution

The analysis of the crisis management problem by the researchers is the first phase of this design-based research. The researcher in this study is a citizen of Nigeria who resides in Lagos, the western part of Nigeria known for crises such as flood and erosion, due to its landslide. The state is also prone to fire incidents and building collapse due to its population. The problem that initiated this study was the researchers' concern on how people take pictures and videos during a crisis to be uploaded on social media rather than get immediate help from crisis management authorities. The researcher felt this problem

was significant to the designing of a crisis mobile application that will be citizen centred. The findings will provide evidence to inform the researcher on the viability of providing this application. More so the researcher formulated research questions in this phase to identify the purpose and resources or tools available for crisis management in Nigeria and to guide the developmental process.

The research questions below were formulated after analysing the practical problem:

RQ1: How to design a crisis management application for Nigeria?

To understand the kind of crisis management applications that are currently available in Nigeria

To understand the kind of crisis management applications that exist in other countries

To understand users' expectations towards the crisis management application

To understand the challenges of implementing a crisis management application in Nigeria

To understand the concept of mobile applications, crisis management and gain insight into the research process of design science research.

Solution development

The smartphone application is becoming essential to the public and emergency responders in relaying crisis conditions. It is suggested that a way to salvage crisis and connect the victims and rescue team for quick response is to design a mobile application that would contain first aid information and other required crisis management information. To determine the requirements for the said proposed artifact, a literature review, citizens, and experts would be consulted. Social interactive attributes inherent to the mobile application were adopted. The research purpose is to develop a crisis management mobile application prototype For the mobile application to be developed, the researcher consulted, crisis management expert, and developers to discuss the overall objectives of this project phase

objectives:

- To distribute questionnaires to citizens and conduct interviews with crisis management and mobile application expert as part of the requirements for the mobile application design.
- To analyse responses gathered from questionnaires and interviews using a method of content analysis called NVivo.

- To understand the use of design science research guidelines for designing a mobile application and consolidate it with crisis management

The iterative cycle and solution testing

This phase is the evaluation and the testing phase, the mobile application is assessed by comparing the research conducted, suggestions gathered in the problem analysis phase, and the design of the artifact. The scope of this study is to design a prototype based on the requirements analysis, feedback from stakeholders, and literature review conducted. More so, to validate that identified requirements in the suggestion phase align with the mobile application designed.

Some features from the feedback gathered from stakeholders were included. Usability testing of the application is considered future research. The objective of the evaluation phase is to identify the different challenges expressed by stakeholders which will be discussed in the result section and to suggest potential research that was not part of the study.

The last phase is the reflection and documentation for the design

The is the last and very important phase of the design-based research where key concepts are documented and guidelines for using the product are presented. This phase reiterates research contribution, its importance, and report on the DSR process followed for the designing of a mobile application for crisis management.

3.4 Data Collection

To design a mobile application for crisis management in a country like Nigeria there is a need to investigate design principles applicable to crisis management. This is achieved by conducting a literature review on crisis management and mobile application with feedback from participants of the survey and interviews for the mobile application design. The researcher conducted interviews and administered questionnaires for suitable data gathering techniques to strengthen the quality of information and cover different areas of investigation for the research. The questionnaire (see Appendix 1) in form of a survey was used to collect data on opinions and perceptions of the citizens concerning crisis management mobile applications in Nigeria while the interview was employed to amass

expert experience, perception, and opinions. The data collected is analysed to respond to the research questions towards achieving the overall objectives of the research. The data collection tools are examined below.

Survey

The survey is a predetermined method of gathering information from a sample of individuals for a specific purpose with the use of a set of questions to provide a source of basic scientific knowledge. Using questions is a measure of the essential process of survey and pivotal for research data collection methodology. (Fowler, 2013)

The survey contains questions that are easy to understand for proper response and better insight. The study population was narrow down due to the large population size of Nigeria using sampling techniques. Sharma, (2017) defined the sampling technique as the procedure employed by a researcher to select a subset from a predefined population, and in this regard, the survey was channelled more to areas that are prone to the crisis in Nigeria. The essence of this selection is to end up with reasonable responses from the sample population under study. 211 respondents participated in the survey.

Interviews

The selected interview questions were designed strictly for experts and professionals of crisis and disaster management agencies and software mobile application developers. Five questions have been prepared for the interview which will take approximately 45 minutes per interview for the respondent to answer the entire questions. The questions are structured but the interview will take a semi-structured form to collect thorough information from the respondent. Questions are divided into two categories such as (1) Introductory level question (2) Developmental analysis question with the focus of addressing the research questions. All interviews are recorded with themes and then transcribed in the word document format so that the file can be analysed through the software. Four interviews were conducted to provide answers to the pertinent questions.

Table 1: Distribution of respondents for interview

S/N	Agency	Position/Area of expertise	Years
1	**Lagos State Emergency Management Agency**	**Director of operations and a certified emergency manager**	**13**

2	**National Emergency Management Agency**	**Director in charge of special duties and a certified emergency manager**	**12**
3	**Software Engineer**	**A Senior mobile application developer**	**6**
4	**Software Engineer**	**A Junior mobile application developer**	**2**

Table 2: Distribution of respondents for interview

3.5 Data Analysis Method

The data collected from the experts of NEMA, LASEMA, and developers were analysed using NVivo, which is an open-source qualitative data analysis software commonly used by researchers. NVivo was purposefully selected, and data collected using semi-structured interviews to explore the perception of interviewers. The interviewers recorded the respondents' statements using themes application and took notes. The first stage of the NVivo data analyses is familiarization, this is a stage where the author went through the transcript and write out interesting ideas and label that supports the data. The next stage is to set up an NVivo project, then coding qualitative data and constructing a thematic framework, conducting analysis, and visualizing data summary results and generating report.. (Hackett, 2018).

3.6 Summary

This chapter focused on the research approach for this study, the comprehensive discussion of design science research, its framework, and the data collection techniques such as survey and interview. It also explains the data analysis process for this study. The views expressed by the respondents in the development of the application will be presented in the next chapter and form a basis for discussion of findings and the design of the application.

4 Presentation of Results

This chapter focuses on presenting the outcome and analysis of the web survey conducted in this study and discusses the findings from the expert interviews on designing a crisis mobile application conducted after using NVIvo to analyse the qualitative data gathered during the interviews. The researcher analysed the result of the web survey using statistical analyses which would form part of the basis upon which the findings of the research would be discussed. The interview was segmented into general, fundamental, and developmental questions. The author started the interview with preliminary questions on job description and years of experience as experts. It is remarkable to know that the average years of experience of all the interviewers are above 8 years.

Interview outcome on the designing of crisis management mobile application

The section reveals the result of the interviews conducted and discussions were made after the thematic analyses using Nvivo software. The procedure for carrying out the thematic analyses was mentioned in the data analyses method. Some codes were identified and generated from transcripts, the codes were categorized into themes to give clarity and sequence to the study.

The selected themes are listed in the table below to help provide answers to the research questions of our study.

Table 3. Thematic Analysis

S/N	Themes
1	Evaluation of the necessity of crisis management
2	Benefits of the application
3	Technical Support
4	Expectation of the crisis management mobile application
5	Challenges of implementing crisis management application

Source: (NVivo analysis from the author, 2021)

Evaluation of the necessity of crisis management

Table 4. Summary of findings from feedback gathered from the need of the application

Q.2 a How would you evaluate the necessity of a crisis management mobile application in a country like Nigeria on a 10-point scale, where 1 means that you did not find the mobile application important and 10 that you find it very important?	
Code assigned	**Answers**
Ratings	"I would rate it around 6 because it depends on where you are"
	"I will go by 8.5 to 9"
	"You can say up to 9 to 10"
	"I can still say within 7 to 8"

Figure 3Graphical illustrating of the respondent ratings

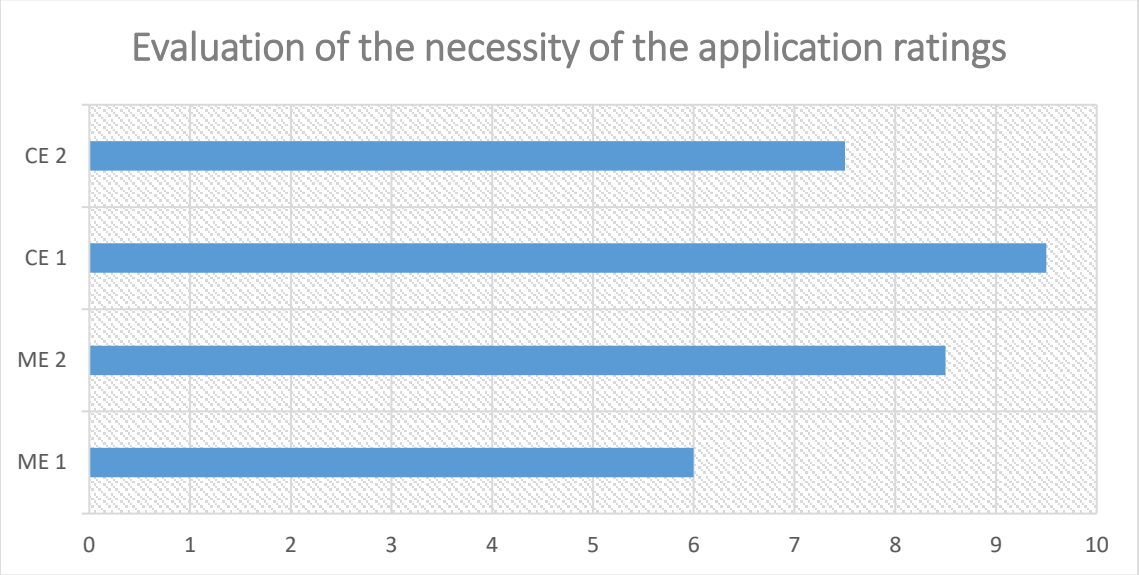


Figure 3: Graphical illustrating of the respondent ratings

This reveals that the application is valuable and that the idea is welcomed by the experts on the field from both the crisis management experts and the mobile developers.

Benefits of the application

With regards to eliciting response of the possible benefits of the application from the crisis management officials was to strengthen the necessity of the application and also incorporate the highlights of the response and make provision for these benefits.

One of the benefits classified is the **dissemination of information**. A responder said, "*If you can look at it well, based on the response you are getting from the field, you are getting a response in terms of warning that something is happening or that it has happened response is required"*. Another responder said "*It will be useful for early warning, OK? It will be. It will be useful for a response. "* This implies that one of the significances of the mobile application is to be able to share timely information that will be useful for both the citizen and the government in managing crisis. **Reporting** is another crucial advantage of the application which is closely related to the dissemination of information but this is from the citizen to the official. The experts mentioned that it is required "for response" while another mentioned that it is beneficial *"specifically in incident reporting"*.

Furthermore, it is said to be capable of **resource management and deployment** *"So, the app will be very useful at the point of preparedness it will tell you, to know that there is an incident that may happen if nothing is done" "It will also help in resource deployment. you understand it will help in resource planning, welding resource management"*. This enhance planning, preparedness, and the right resources to deploy in terms of quality, quantity, human and material resources. Lastly, **record keeping and mining** were it from the experts' side as regards the benefits .... *"then it will be useful for data mining and collation because I'm expecting that once the app gets requests. Do you record it? If it is attached to a server, it will record into the server where you can actually mine data to know how many calls were made, how many responses were made, how many incidents or call came within the period…… Sometimes you can even help for feedback.."*

Technical Support

The theme aimed at evaluating the availability of an integrated technical support and customer relationship Manager that the application can leverage or plug to effectiveness. The code assigned for the analysis of this subject is **Existing technological and customer support. One of the respondents mentioned that** *"Apparently concerning the CRM, you have mentioned that there Is an existing one…. OK, before you probably know what kind of arrangement of facility you must be on ground so you know to technically assess and look at what they have on ground and now will be able to know what level of support. Or you know whatever. Or able to adapt or be able to infuse whatever you have for this"*

while another stated that "OK, yes, call centre is where telephone calls or SMS are sent to let them know that there's an incident. " This reveals that there is an existing customer relationship manager that can be leveraged on however, there might be the need for scalability to accommodate the crisis management mobile application.

The Expectation of the crisis management mobile application

According to the respondents, the major expected functionality is the **Easy to use, information classification, and location service** features of the mobile application. One of the respondents said *"First of all, the app. Should be user friendly. It shouldn't be too technical for the average citizen to understand because it is the citizens that will use it, not even the professionals "* the other said *"Yeah, so it should be simplistic in his views, even if it is going to be a bit compact too. ", "It must be easy to use app…… just like ABC".*Another said, *"They have to consider the user-friendly UI is the user experience and then. OK, that should be easy. Off navigation, they should make the app to be easy to use.".* Moreover, one of the respondents gave further analysis as regards information classification *"But if you have an app, it becomes easier for people to document and give you details through the app so the app will have a GIS element attached to it which will be able to give you. The GPS location looks through there, so you will have precision when you are actually attending to such calls, so the app should have that advantage of having the GPS location…… You can have a Google map that will give you directions to where the incident is taking place. So that it makes it more effective than the existing call system" Moreso, **performance** is also a key ingredient most especially when dealing with crisis and emergency management.* "The performance should be OK. " "if there is another app that also serves the same thing but offers better performance, they will simply switch to that which is brand switching. So, at this point, you just have to know what they want and know what you do. You have to consider them... ". **Size** is another concern raised by the respondents "*So, in building this I think you should consider the size because you're going to have a lot of videos without considering uploading videos and images and audio. So, I think you have to compress the size. You have to compress them so that it will be easier to relate to the user so it is only when the user wants to play them that then you cannot take your time to load them, but in usage and uploading everything should be done on wait time. So, speed and performance are necessary"* "…the uploading weight should not much…" this speaks to video uploads and pictures.

Certainly, this shows that experts may not recommend the application for usage if it is perceived to be slow and the aforementioned features are not considered, which may likely create a communication gap and one cannot take chance when it involves life and property.

Challenges of implementing crisis management application

The question was aimed to address and answer the research question on the challenges of implementing a crisis management mobile application from the expert's size, however, they seem not to see major concern as they believe people have been using other unrelated applications without chaos. Nevertheless, two challenges presumed by two of the respondents are the issue of power supply, bureaucracy, and understanding the political will when it comes to some issues. These and other challenges have been discussed under conclusion.

Survey outcome on Designing Crisis Management Mobile Application

A total number of 211 respondents participated in the web survey administered and carefully designed to investigate and provide answers to the research question through the answers provided to the survey questions. (see Appendix 2).

The survey questions were in two sections the first set was the demography and the other section is. Section one is focused on the background details of the respondents and general questions on crisis management in Nigeria.

as a way of checking the validity of the responses, section two centered on 51 specific questions on BVN while section three focused on Nigerian's perception of digital public services. Afterward, each analysis is followed by statements explaining the responses and observations.

A simple percentage calculation formula is used as shown below.

Formula: Total number of responses multiplied by 100/Total number of respondents

Question one centered on the ratio of the respondent according to their region of residence in the country which was categorized into North, South, East, and West region. The distribution of the (211 respondents) are as follows; North region (19 respondents), South region (35 respondents), East region (12 respondents), and West (145 respondents).

From the distribution above, it can be deduced that there is general participation in Nigeria. (see Appendix 3, Figure 1)

Question two was intended at capturing the gender representation of the respondents that participated in the web survey. It reveals the gender impact of the crisis of the 211 respondents in this order; Female 40.8% (86 respondents), Male 58.8% (124 respondents), and one person prefer not to say which is 0.5% .(see Appendix 3, Figure 2).

Question three was aimed at describing the age distribution of the respondents. The responses were 4.3% (9respondents) shows the ratio of respondents under 21 years, 71.6% (151 respondents) shows the ratio of those within the 21- 34 years, 19% (40 respondents) shows the ratio of the respondents that are within the age of 35-44years, while 5.2% (11 respondent) shows the proportion of the respondents within the age of 45-54years. What can be deduced from these ratios is that a larger percentage of Nigerians are within active age. Also, going by these ratios, indicates that the majority of the respondents are information technology savvy and are conversant with the use of the mobile application. (see Appendix 3, Figure 3).

Question one is aimed at confirming the main emergencies or crises in Nigeria concerning the crisis the researcher focused on. Considering the respondent's reaction to the question 55.9% (118 respondents) of the respondent mentioned Accidents as a major crisis while 40.3% (85 respondents) alluded to flood and erosion followed by Kidnapping which constitutes 35.5% (75 respondents) meanwhile Fire crisis constitute 32.2% (75 respondents) and Building collapse constitutes 22.7% (48 respondents) while theft, robbery, terrorist attacker and religious crisis constitute 6% (12 respondents). Contrary to the focus of the researcher, it can be deduced that accident is a major crisis. More than 90% of road traffic crashes occur in developing countries and people from lower socio-economic backgrounds according to the world health Organisation(WHO) in 2020 which requires speedy intervention followed by flood and erosion, kidnapping is another striving crisis too in the country. (see Appendix 3, Figure 4).

Question two focused on investigating participant's ratio of been in crisis and had called for help from the rescue team, of which a larger percentage which constitutes 57.8% attest to calling for emergency help while 42.2% denied reaching out to the emergency team.

Question three aimed at seeking the views of the respondents on what communication channels were used to get support as this will help inform citizen expectations and functions, they are familiar with to be built in the application. The respondents answered in this order; 70.1% (148 respondents) utilized calls followed by upload to Social media. i.e., Twitter, Facebook, Instagram for emergency team assistance with 29.4% (62 respondents) while 8.5% (18 respondents) prefer to send text messages and 3.5% (8 respondents) prefer to reach out to the Television and radio station for help while 10,7% (13 respondents) did not indicate their view (see Appendix 3, Figure 6)

Question four and question nine were designed to address the research question on the challenges of designing a crisis mobile application in Nigeria. The three major concern raised as challenges when reaching out to the crisis management team for aid was a power failure, internet failure, and call load. With 7.6%, 26.1%,38. 9 % respectfully which further ascertains the response of the majority on the use of call-in assessing support. To further establish the challenges to the success of the crisis management mobile application and the respondents answered in this order; 148 respondents agreed to the obstacle of Network coverage with 144 respondents concurring to issues with the internet. While 74 respondents acceded to power supply/failure and 73 respondents mentioned phone specification. (see Appendix 3, Figure 6).

Question five was intended to consider the importance, acceptance, and usage of crisis management mobile applications in Nigeria. Interestingly 90.5% (191 respondents) would consider using a mobile application during a crisis when available while 9.5% (20 respondents) would not use it if available. investigate if Nigerians have been accessing the public (see Appendix 3, Figure 7).

Question six focused on investigating and addressing the research question on the availability of crisis management mobile applications in Nigeria and other countries. However, out of 211 respondents, 90.5% (191 respondents) indicated their lack of awareness of any crisis management mobile application while 9.5% (20 respondents) shows the ratio of citizens who are aware of crisis management mobile application within and outside the country such as Channels Eyewitness mobile app, Crime Alert and the likes. (see Appendix 3, Figure 7).

Question seven centered on the citizens' expectations towards the crisis management application. on assessing the willingness and acceptance level of Nigerians
This question is key in designing a suitable, acceptable, and user-friendly crisis management mobile application, the reactions of the respondents to the questions are as follows; 82.5% (174 respondents) prefer easy accessibility and navigation, 73.9% (156 respondents) desires high-speed performance coupled with the necessity of the solution, 65.9% (139 respondents) prefers that the application is simple while 49.3% (104 respondents) wants the mobile application to be usable and serve its purpose. (see Appendix 3, Figure 8).

Question nine also stems to highlight the citizens' expectations towards the crisis management application in terms of features. According to the respondents, the most set feature is the call function in the mobile application in other words the ability to make speak to the crisis management agency with 87.7% (185 respondents), followed by 69.7% (147 respondents) that would prefer first aid information and training content on crisis management, 60.2% (127 respondents) Video and pictures functions, to be able to upload pictures and videos, 58.3% (123 respondents) Text messages features and notification, sending messages and receiving messages. Other factors have 6 respondents. (see Appendix 3, Figure 9).

In concluding this chapter, the outcome from respondents both from the questionnaire administered and the interview conducted demonstrated their experience with crisis and their perception about prioritizing the management of certain. Furthermore, it reveals the need for a crisis management system, the support channel, and the salient associated challenges with the mobile application solution in Nigeria. Overall, their responses facilitated the designing of the crisis management mobile application.

A conceptual relationship between stakeholder's design principles and suggested requirement analysis.

The design of the crisis management mobile application should fulfill the requirements as set out in the problem analysis phase also known as the suggestion phase of the DSR framework. According to a design principle for stakeholder engagement are three phases:

Organization (clarity of stakeholder's requirement, value (commitment to the value and objective of stakeholder engagement), and practices (systematic input of gathered stakeholder's requirement). (Annette Boaz et al 2018). The findings in the problem analysis of the solution phase of the DSR framework are to form a conceptual relationship between the theoretical and empirical objectives. In other words, the stakeholder's design principle should support responders' feedback and vice versa.

Table 4: Requirements and Feedback For the Mobile Application Design

Categories of design	**Stakeholder's feedback**	**Description**
Interface design	Simple navigation Call function Text messages Video and picture function	The users need a Simple navigational structure with proper arrangement and easy identity of a communication channel to get in touch with the crisis management team.
Information design	Crisis classification First aid information and training Location capture (GPS)	The users need is that crisis description is communicated without the stress of attending to the description of incident and location. Furthermore, there is a column that can educate people on first aid prescriptions before the arrival of the response team.
Performance design	Size High performance	In line with technology advancement, users need an application with speed and less space consumption.

5 The development phase of the DSR framework for the crisis management mobile application

The intention of the development phase of the design science research necessitates the design of a mobile application for crisis management according to the gathered design proposed in the suggestion phase of the DSR framework. A mobile application was designed for Android operating system following the design guidelines as provided in **Table 4.**

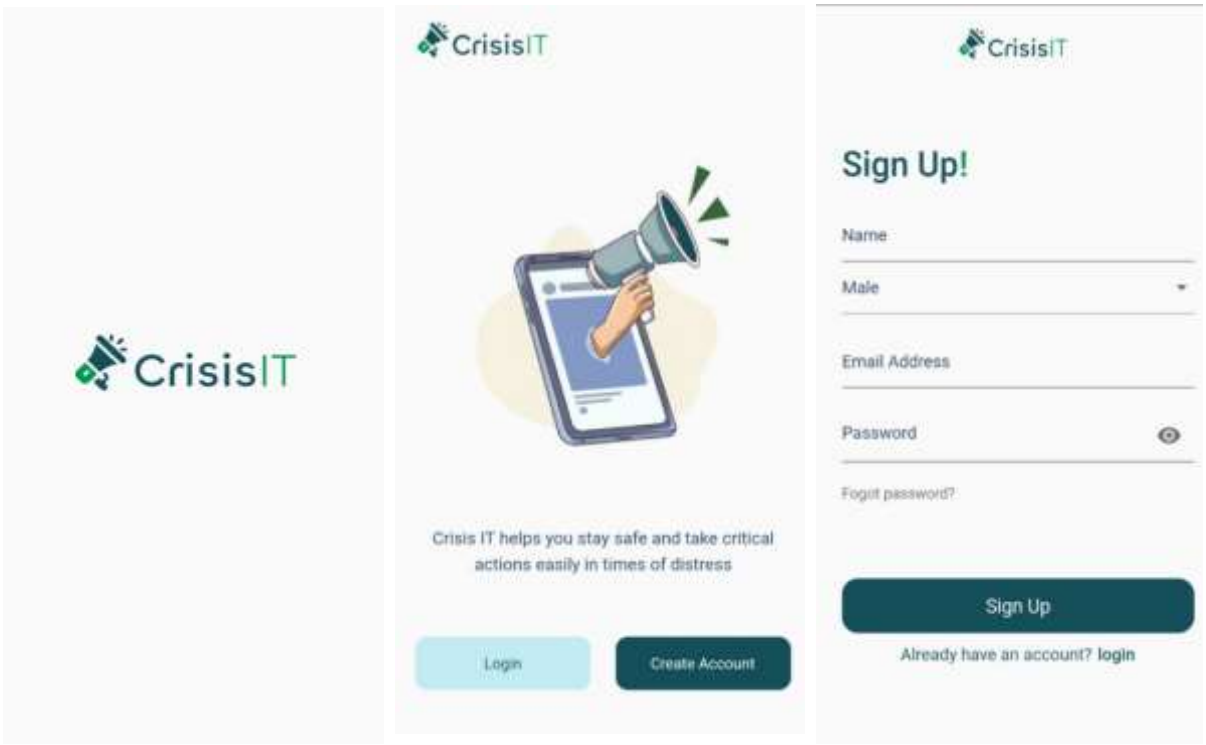


Figure 5: CrisisIT Signup to Report Crisis Incidence

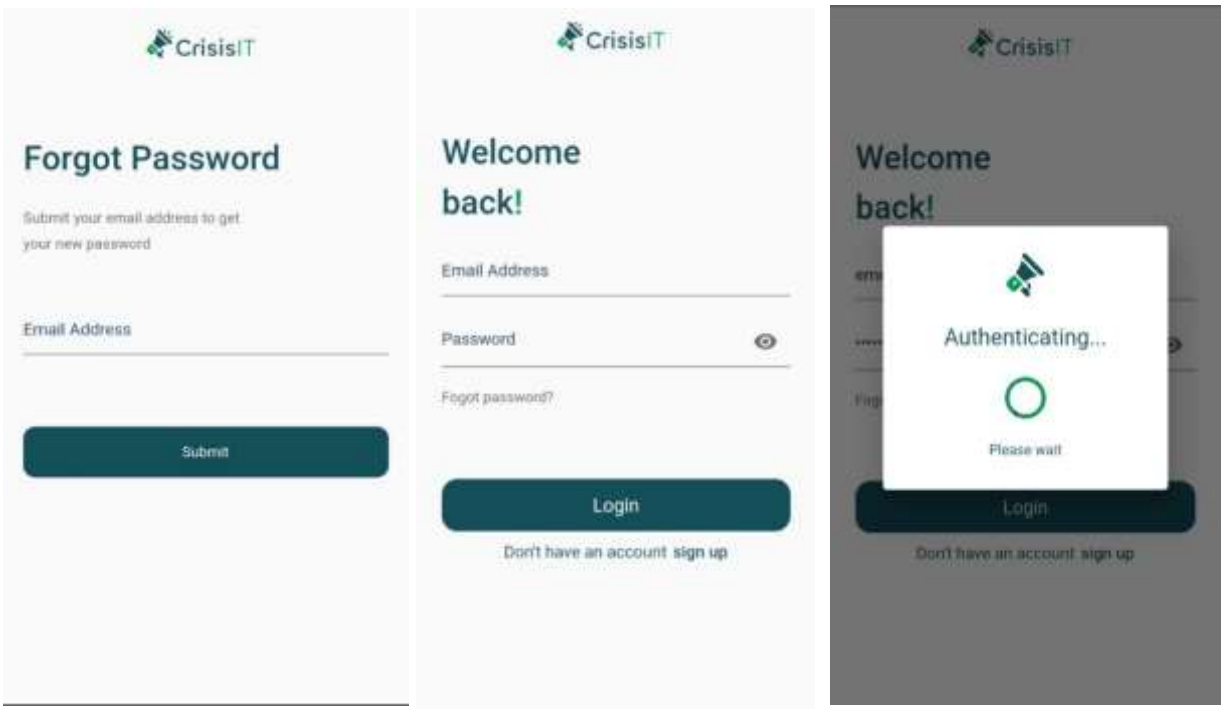


Figure 6: CrisisIT Signup to Report Crisis Incidence

Figure 5 and 6 shows the dashboard of how information is displayed to the user with ease of navigation.

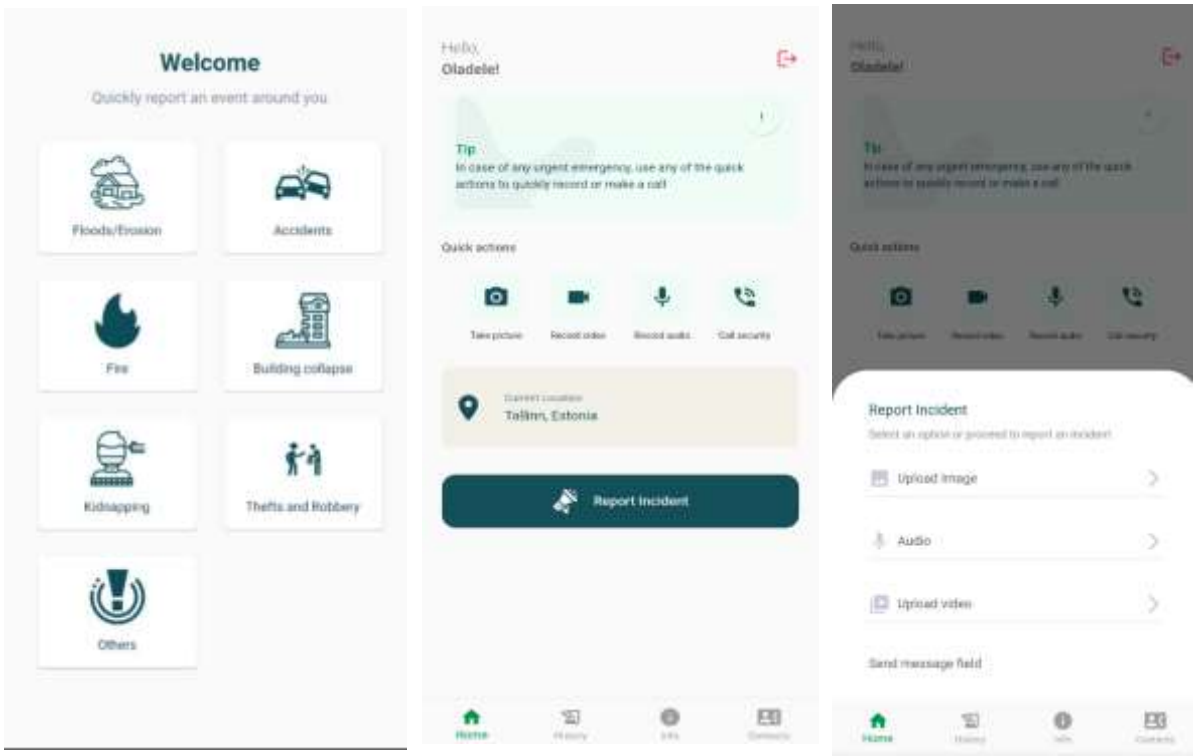


Figure 7: CrisisIT Landing page

Figure 7 displays the crisis classification, video and pictures functions, text messages features, call features, and location capture for the crisis management application

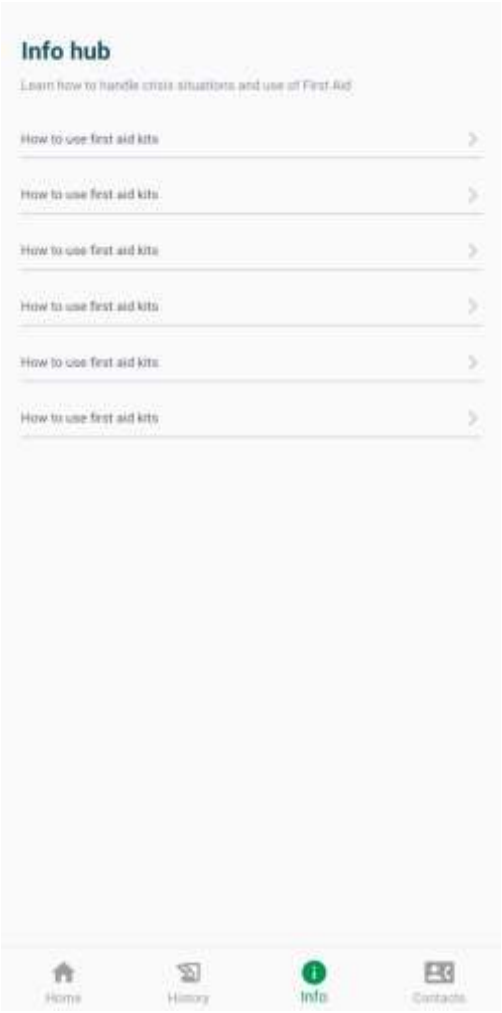


Figure 8: CrisisIT information hub for training and first aid information

Objectives of the iterative cycle and solution testing phase of the DSR framework

The essence and objectives of the iterative and solution testing phase also referred to as the evaluation phase of the DSR framework is to ascertain that the crisis management mobile application meets the requirements set out in the suggestion and problem analysis phase. (i.e., the design standards in Table 7). More so, the objectives also includes that the mobile application is assessed by comparing the research conducted, suggestion gathered in the problem analysis phase of the DSR framework and the design of the application.

Table 5: Requirements evaluation for the mobile application design

Categories of design	**Stakeholders' feedback**	Evaluation of the design requirement for the application.
Interface design	✓ Simple navigation ✓ Call function ✓ Text messages ✓ Video and picture function	Specific visual icons were used to represent different activities of the mobile application and smooth operation.
Information design	✓ Crisis classification ✓ First aid information and training ✓ Location capture (GPS)	There are icons for respective crises and columns for training materials referred to as information hub and with the help of GPS reporter's location is captured and shared with the response team.
Performance design	✓ Size ✓ High performance	The application only consumes 23MB when downloaded and video upload is 15 seconds to save data and enhance speed when transferring video.

6 Conclusions

Objectives Of The Reflection and Documentation Of the DSR Framework

The objective of the reflection and documentation phase which is also term as the conclusion phase of the DSR framework is to report on the DSR process that was followed in the design of the crisis management mobile application. The study was presented according to the phases of the design science research framework of Ozdamar & Kuzu (2015). The primary aim of this research study is to design a crisis management mobile application and propose the adoption of the native application for national use. However, the research study was presented according to the four phases of the DSR framework and specific objectives were implemented within each phase. The mobile application is downloaded and the user registers with an email address as depicted in the screenshot of the development phase. The initial focus was on flood and fire incidents, but other crises were considered based on the feedback from stakeholders. This phase reiterates research contribution, its importance, and reports on the DSR process followed for the designing of a mobile application for crisis management. The research also aims at contributing to the body of knowledge and existing literature highlighting stakeholder principles for mobile application design. There is no such existing crisis management mobile application in Nigeria from stakeholder feedback but there are concerns raised around the implementation of the crisis management mobile application. This needs to be addressed by the government for solutions like this to thrive and contribute to the citizens' welfare improvement.

6.1 Challenges in implementing a crisis management mobile application in Nigeria.

The new patterns of mobile technology for our work and day-to-day lives are fast-growing. (Jayatilleke et al., 2018). This new development added to its growth comes with socio-technical challenges, both with positive and negative implications especially in developing countries like Nigeria.

Citizens' Readiness: One of the pre-requisites for any public mobile service or citizen-centered solution is the peoples' acceptability and attitude towards it. In developing countries, a large proportion of electronic or mobile solutions such as a crisis mobile application requires awareness and education for usability. (Desta Mengistu et al., 2009). Leadership plays an important role in stimulating the acceptance of a product. Leadership is key before, during, and after a project such as the crisis management application. The management of the respective crisis management institutions understands the cost and benefits and can explain to the general public, motivate them, create awareness, and provide the required support in overcoming public resistance. (Gao, 2001; Ndou, 2004).

Employee acceptance: Personality traits may influence the way employees embrace change and new technology. Limitations of mobile devices and their interfaces may sway employees to perceive mobile devices as difficult to use. Therefore, the interface must be user-friendly and simple in terms of size, readable display, configuration, and functionality. Also, employees need adequate training to adopt mobile devices and become proficient in their usage.

Power limitation: Mobile systems are concerned with limited power supply this is evident with the shortage of the load supply in Nigeria primarily because of the increased energy demand stemming from an increasing population. Although there are other related challenges in the power sector despite the transformation in the sector such as technical and non-technical power losses, issues around power management and ineffective distribution, inadequate coverage, and poor voltage stability, among others. However, diversification into renewable energy has been prescribed to alleviate the inadequacies of the power supply. Software and hardware improvements can help reduce power consumption, increase charging capacity, and reduce battery weight.

Internet/network coverage: Although there is an upsurge of internet connectivity in Nigeria which has also given rise to lots of active users, however, one of the main challenges of mobile solutions is mobile network shortcomings most, especially in rural areas. Sometimes there is an experience of delayed delivery of messages facilitated by the fluctuation of network and unreliable GPRS. Other times there are challenges around low bandwidth and download speeds from wireless networks which deliver lower bandwidth than wired networks. There are also technical challenges, cost-related issues,

coupled with environmental challenges of building infrastructure to enhance internet facilities in rural communities in Nigeria. More so internet access providers face regulatory issues that make internet access difficult. However, in improving mobile solutions and e-government information and services there is a need to provide solutions to Internet connectivity problems and offer a more cost-efficient choice for national networking. (Ganesan et al., 2012).

Compatibility: As new opportunities emerge so also new technologies which influence requirements, interoperability as well as capabilities. Mobile services as communication channels work well on different mobile devices depending on the platforms, appliances, features, and environment. So, therefore, validating mobile application compatibility against phone versions such as Android, IOS, Windows mobile, etc. is very important. To reduce this heavy burden and complexity of compatibility on engineers, and ease of downloads and usability of mobile applications, there is a need to adopt a systematic and cost-effective model for selecting mobile appliances across different platforms and configurations. (Tao Zhang et al., 2015).

Bureaucracy and political will: This challenge in a form hinders innovation and technological advancement with excessive administrative and complex procedures in executing projects that should benefit the populace and enhance the welfare of the citizen. This calls for accountability, transparency on the part of the government, and better citizen engagement.

6.2 Limitations of the study

The mobile application initial prototype was presented which implies that it should be tested for any constraint and usability limitations for future research. High cost of developing and implementing a mobile application across diverse platforms and providing technical assistance so the mobile application is only available on the Android system. The research interview was conducted to obtain credibility, validity, and reliability of data collection from 4 experts couple with 211 responses from the survey, however, the most limitation and challenge of this research is not getting more experts to be interviewed. The researcher attempted to collect more interview data to ensure validity and reliability of data but some of the interviewers were unreachable, whereas if a larger

number of interviewers were involved, findings may engender additional information. Another constraint was the analytical tool that was initially planned to be used for the data analyses RQDA was not available which consumed time before resolving to use NVivo.

6.3 Future Work

The solution has leaped and shown potential support from stakeholders through data gathered. However, the prototype designed should be tested for any design limitations, requirements, and functionality and then gather feedback for the improvement of the artifact. Further study can also be employed for the artifact to function on all systems. Conclusively, further research can also be done to consider and introduce screen reader and keyboard acceptance criteria for the benefits and accessibility of users with a physical disability.

References

1) Adelekan, I. O. (2010). Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria. Environment and Urbanization, 22(2), 433–450. https://doi.org/10.1177/0956247810380141

2) Adelekan, I. O. (2015). Flood risk management in the coastal city of Lagos, Nigeria. *Journal of Flood Risk Management*, *9*(3), 255–264. https://doi.org/10.1111/jfr3.12179

3) Adelekan, I. O., & Asiyanbi, A. P. (2015). Flood risk perception in flood-affected communities in Lagos, Nigeria. *Natural Hazards*, *80*(1), 445–469. https://doi.org/10.1007/s11069-015-1977-2

4) Ahmed, Y. A., Ahmad, M. N., Ahmad, N., & Zakaria, N. H. (2019). Social media for knowledge-sharing: A systematic literature review. *Telematics and Informatics*, *37*, 72–112. https://doi.org/10.1016/j.tele.2018.01.015

5) Ajibade, I., McBean, G., & Bezner-Kerr, R. (2013). Urban flooding in Lagos, Nigeria: Patterns of vulnerability and resilience among women. *Global Environmental Change*, *23*(6), 1714–1725. https://doi.org/10.1016/j.gloenvcha.2013.08.009

6) Alexander, D. E. (2013). Social Media in Disaster Risk Reduction and Crisis Management. *Science and Engineering Ethics*, *20*(3), 717–733. https://doi.org/10.1007/s11948-013-9502-z

7) Borges, M. R. S., De Faria Cordeiro, K., Campos, M. L. M., & Marino, T. (2011). Linked open data and the design of information infrastructure for emergency management systems. In 8th International Conference on Information Systems for Crisis Response and Management: From Early-Warning Systems to Preparedness and Training, ISCRAM 2011. Information Systems for Crisis Response and Management, ISCRAM.

8) Civelek, M. E., Cemberci, M., & Eralp, N. E. (2016). The Role of Social Media in Crisis Communication and Crisis Management. *International Journal of*

Research in Business and Social Science (2147–4478), *5*(3), 111–120. https://doi.org/10.20525/ijrbs.v5i3.279

9) C. Nkwunonwo, U. (2020). Flood Risk Analysis for Critical Infrastructure Protection: Issues and Opportunities in Less Developed Societies. *Issues on Risk Analysis for Critical Infrastructure Protection [Working Title]*. Published. https://doi.org/10.5772/intechopen.95364

10) Collins, M., Neville, K., Hynes, W., & Madden, M. (2016). Communication in a disaster - the development of a crisis communication tool within the S-HELP project. *Journal of Decision Systems*, *25*(sup1), 160–170. https://doi.org/10.1080/12460125.2016.1187392

11) Coombs, W. T., & Holladay, S. (2001). An Extended Examination of the Crisis Situations: A Fusion of the Relational Management and Symbolic Approaches. *Journal of Public Relations Research*, *13*(4), 321–340. https://doi.org/10.1207/s1532754xjprr1304_03

12) Coombs, W. T., & Holladay, S. J. (Eds.). (2010). The Handbook of Crisis Communication. *A Developing Field.* Published. https://doi.org/10.1002/9781444314885

13) Coombs, W. T., & Laufer, D. (2018). Global Crisis Management – Current Research and Future Directions. *Journal of International Management*, *24*(3), 199–203. https://doi.org/10.1016/j.intman.2017.12.003

14) Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. *MIS Quarterly*, *13*(3), 319. https://doi.org/10.2307/249008

15) Donahue, A. K., & Joyce, P. G. (2001). A Framework for Analyzing Emergency Management with an Application to Federal Budgeting. *Public Administration Review*, *61*(6), 728–740. https://doi.org/10.1111/0033-3352.00143

16) *Estonia's coronavirus app HOIA - the product of a unique, private-public partnership*. (2020, September 17). E-Estonia. https://e-estonia.com/estonias-coronavirus-app-hoia-the-product-of-a-unique-private-public-partnership/

17) Essoh, G. E., Owoicho, P., & Abutu, P. O. (2018). Managing National Emergency In Nigeria: Prospects and Challlenges. Journal of Good Governance and Sustainable Development in Africa (JGGSDA) (Vol. 4, pp. 68–79).

18) Fowler, F. J. (2013). Survey Research Methods (Applied Social Research Methods) (Fifth ed.). SAGE Publications, Inc. 18(9), 3-10.

19) Freeman, R. E. (1984). Strategic Management: A Stakeholder Approach (chapter 6). Cambridge University Press., Chapter 6.

20) Freeman, R. E. (2004). The Stakeholder Approach Revisited. *Zeitschrift Für Wirtschafts- Und Unternehmensethik*, *5*(3), 228–241. https://doi.org/10.5771/1439-880x-2004-3-228

21) Fricker, R. D., & Schonlau, M. (2002). Advantages and Disadvantages of Internet Research Surveys: Evidence from the Literature. *Field Methods*, *14*(4), 347–367. https://doi.org/10.1177/152582202237725

22) Ganesan, M., Prashant, S., & Jhunjhunwala, A. (2012). A Review on Challenges in Implementing Mobile Phone Based Data Collection in Developing Countries. Journal of Health Informatics in Developing Countries, 6(1), 366–374.

23) Gao. (2001). Electronic Government: Challenges Must Be Addressed with Effective Leadership and Management. US General Accounting Office GAO0 19 5 9 T Wa Shington, 2(0), 0. Retrieved from http://www.gao.gov/new.items/d01959t.pdf

24) Gupta, R., & Brooks, H. (2013). *Using Social Media for Global Security* (1st ed.). Wiley.

25) Hackett A, Strickland K (2018) Using the framework approach to analyse qualitative data: a worked example. Nurse Researcher. doi: 10.7748/nr.2018.e1580

26) Hernantes, J., Rich, E., Laugé, A., Labaka, L., & Sarriegi, J. M. (2013). Learning before the storm: Modeling multiple stakeholder activities in support of crisis

management, a practical case. *Technological Forecasting and Social Change*, *80*(9), 1742–1755. https://doi.org/10.1016/j.techfore.2013.01.002

27) Hetu, S. N., Gupta, S., Vu, V. A., & Tan, G. (2018). A simulation framework for crisis management: Design and use. *Simulation Modelling Practice and Theory*, *85*, 15–32. https://doi.org/10.1016/j.simpat.2018.03.001

28) Hevner, March, Park, & Ram. (2004). Design Science in Information Systems Research. *MIS Quarterly*, *28*(1), 75. https://doi.org/10.2307/25148625

29) Hodgson, M.E., and Palm, R. (1992). Attitude towards Disasters: A GIS Design for Analysing Human Response to Earthquake Hazards, Geo-Information System, July-August, p.41-51

30) Jayatilleke, B. G., Ranawaka, G. R., Wijesekera, C., & Kumarasinha, M. C. (2018). Development of mobile application through design-based research. *Asian Association of Open Universities Journal*, *13*(2), 145–168. https://doi.org/10.1108/aaouj-02-2018-0013

31) Meechang, K., Leelawat, N., Tang, J., Kodaka, A., & Chintanapakdee, C. (2020a). The Acceptance of Using Information Technology for Disaster Risk Management: A Systematic Review. *Engineering Journal*, *24*(4), 111–132. https://doi.org/10.4186/ej.2020.24.4.111

32) Meechang, K., Leelawat, N., Tang, J., Kodaka, A., & Chintanapakdee, C. (2020b). The Acceptance of Using Information Technology for Disaster Risk Management: A Systematic Review. *Engineering Journal*, *24*(4), 111–132. https://doi.org/10.4186/ej.2020.24.4.111

33) Kavota, J. K., Kamdjoug, J. R. K., & Wamba, S. F. (2020). Social media and disaster management: Case of the north and south Kivu regions in the Democratic Republic of the Congo. *International Journal of Information Management*, *52*, 102068. https://doi.org/10.1016/j.ijinfomgt.2020.102068

34) Khan, H. and Khan, A. (2008). Natural Hazards and Disaster Management in Pakistan. https://mpra.ub.uni-muenchen.de/id/eprint/11052 (Accessed 8/5/2021)

35) Kivunja, C. (2018). Distinguishing between Theory, Theoretical Framework, and Conceptual Framework: A Systematic Review of Lessons from the Field. International Journal of Higher Education, 7(6), 44. https://doi.org/10.5430/ijhe.v7n6p44

36) Kyrychok, Andrii. (2017). An impact of situational crisis-communication theory on the efficiency of investigations in the field of crisis communications. 5. 55.

37) Ma, L., & Zhan, M. M. (2016). Effects of attributed responsibility and response strategies on organizational reputation: A meta-analysis of situational crisis communication theory research. *Journal of Public Relations Research*, *28*(2), 102–119. https://doi.org/10.1080/1062726x.2016.1166367

38) Nah, F. F. H., Siau, K., & Sheng, H. (2005). The value of mobile applications. *Communications of the ACM*, *48*(2), 85–90. https://doi.org/10.1145/1042091.1042095

39) Ndou, V. D. (2004). E - Government for Developing Countries: Opportunities and Challenges. *The Electronic Journal of Information Systems in Developing Countries*, *18*(1), 1–24. https://doi.org/10.1002/j.1681-4835.2004.tb00117.x

40) Netten, N., & van Someren, M. (2011a). Improving Communication in Crisis Management by Evaluating the Relevance of Messages. *Journal of Contingencies and Crisis Management*, *19*(2), 75–85. https://doi.org/10.1111/j.1468-5973.2011.00636.x

41) Nkwunonwo, U., Whitworth, M., & Baily, B. (2020). A review of the current status of flood modelling for urban flood risk management in the developing countries. *Scientific African*, *7*, e00269. https://doi.org/10.1016/j.sciaf.2020.e00269

42) Onyekwere, I. A., & Nworgu, K. O. (2020). Threats to Rural Livelihoods in Nigeria: Implications for Social Order and Crisis Management. *Advances in Applied Sociology*, *10*(03), 41–60. https://doi.org/10.4236/aasoci.2020.103004

43) Orimoloye, I. R., Ekundayo, T. C., Ololade, O. O., & Belle, J. A. (2020). Systematic mapping of disaster risk management research and the role of

innovative technology. *Environmental Science and Pollution Research*, *28*(4), 4289–4306. https://doi.org/10.1007/s11356-020-10791-3

44) Ortmann, J., Limbu, M., Wang, D., & Kauppinen, T. (2011). Crowdsourcing Linked Open data for disaster management. In CEUR Workshop Proceedings (Vol. 798, pp. 11–22).

45) Ozdamar Keskin, N., & Kuzu, A. (2015). Development and testing of a m-learning system for the professional development of academics through design-based action research. The International Review of Research in Open and Distributed Learning, 16(1). https://doi.org/10.19173/irrodl.v16i1.1613

46) Rayawan, J., Tipnis, V. S., & Pedraza-Martinez, A. J. (2021). On the connection between disaster mitigation and disaster preparedness: the case of Aceh province, Indonesia. *Journal of Humanitarian Logistics and Supply Chain Management*, *11*(1), 135–154. https://doi.org/10.1108/jhlscm-12-2019-0081

47) Reuter, C., Ludwig, T., Kaufhold, M. A., & Spielhofer, T. (2016). Emergency services′ attitudes towards social media: A quantitative and qualitative survey across Europe. *International Journal of Human-Computer Studies*, *95*, 96–111. https://doi.org/10.1016/j.ijhcs.2016.03.005

48) Romano, M., Onorati, T., Aedo, I., & Diaz, P. (2016). Designing Mobile Applications for Emergency Response: Citizens Acting as Human Sensors. *Sensors*, *16*(3), 406. https://doi.org/10.3390/s16030406

49) Rondan-Cataluña, F. J., Arenas-Gaitán, J., & Ramírez-Correa, P. E. (2015a). A comparison of the different versions of popular technology acceptance models. *Kybernetes*, *44*(5), 788–805. https://doi.org/10.1108/k-09-2014-0184

50) Rondan-Cataluña, F. J., Arenas-Gaitán, J., & Ramírez-Correa, P. E. (2015b). A comparison of the different versions of popular technology acceptance models. *Kybernetes*, *44*(5), 788–805. https://doi.org/10.1108/k-09-2014-0184

51) Sharma,G.(2007). Pros and cons of different sampling tehniques. International Journal of Applied Research, 3(7), 749-752.

52) Siddiquei, M. I., & Khan, W. (2020). Economic implications of coronavirus. *Journal of Public Affairs*. Published. https://doi.org/10.1002/pa.2169

53) Simon, H.A. 1996. The sciences of artificial. 3rd ed. Cambridge: The MIT Press

54) Siswanto, T., Shofiati, R., & Hartini, H. (2018). Acceptance and Utilization of Technology (UTAUT) as a Method of Technology Acceptance Model of Mitigation Disaster Website. *IOP Conference Series: Earth and Environmental Science*, *106*, 012011. https://doi.org/10.1088/1755-1315/106/1/012011

55) Statista. (2021, January 27). *Nigeria: number of online users 2015–2025*. https://www.statista.com/statistics/183849/internet-users-nigeria/

56) Stephenson, R. S., & DuFrane, C. (2002). Disasters and Development: Part 2: Understanding and Exploiting Disaster-Development Linkages. *Prehospital and Disaster Medicine*, *17*(3), 170–175. https://doi.org/10.1017/s1049023x00000418

57) Stephenson, R. S., & DuFrane, C. (2005). Disasters and Development: Part 2: Understanding and Exploiting Disaster-Development Linkages. Prehospital and Disaster Medicine, 20(1), 61–65. https://doi.org/10.1017/s1049023x00002168

58) Stute, M., Maass, M., Schons, T., Kaufhold, M. A., Reuter, C., & Hollick, M. (2020). Empirical insights for designing Information and Communication Technology for International Disaster Response. *International Journal of Disaster Risk Reduction*, *47*, 101598. https://doi.org/10.1016/j.ijdrr.2020.101598

59) Su, L., & Stepchenkova, S. (2021). The Impact of Crisis Characteristics and Media Coverage on the Public's Attitude Toward Tourism Organization Expressed on Sina Weibo. *Information and Communication Technologies in Tourism 2021*, 302–307. https://doi.org/10.1007/978-3-030-65785-7_28

60) Sulistyanto, A., Usmar, U., & Hermiyetti, H. (2020). Model of Crisis Communication Management in the Perspective of Situational Crisis Communication Theory at the Transportation Ministry. *Jurnal Komunikasi Ikatan Sarjana Komunikasi Indonesia*, *5*(2), 232–242. https://doi.org/10.25008/jkiski.v5i2.408

61) Sultan, S., & Mohan, P. (2012). Designing a Peer-Facilitated Self-Management Mobile Application: A User-Centred Approach. *Proceedings of the 6th International Conference on Pervasive Computing Technologies for Healthcare*. Published. https://doi.org/10.4108/icst.pervasivehealth.2012.248707

62) Tan, M. L., Prasanna, R., Stock, K., Hudson-Doyle, E., Leonard, G., & Johnston, D. (2017a). Mobile applications in crisis informatics literature: A systematic review. *International Journal of Disaster Risk Reduction*, *24*, 297–311. https://doi.org/10.1016/j.ijdrr.2017.06.009

63) Tan, M. L., Prasanna, R., Stock, K., Hudson-Doyle, E., Leonard, G., & Johnston, D. (2017b). Mobile applications in crisis informatics literature: A systematic review. *International Journal of Disaster Risk Reduction*, *24*, 297–311. https://doi.org/10.1016/j.ijdrr.2017.06.009

64) Toriumi, F., Sakaki, T., Shinoda, K., Kazama, K., Kurihara, S., & Noda, I. (2013). Information sharing on Twitter during the 2011 catastrophic earthquake. *Proceedings of the 22nd International Conference on World Wide Web - WWW '13 Companion*. Published. https://doi.org/10.1145/2487788.2488110

65) Umar, M. A., Salahudeen, A. S., Okoh, J. E., & Mohamed, M. S. (2020). Analysis and Design of Fire Emergency Application (FEAP). International Journal of Computer Science & Mobile Computing, 9(January), 40–51.

66) Ulmer, R. R. (2001). Effective Crisis Management through Established Stakeholder Relationships. *Management Communication Quarterly*, *14*(4), 590–615. https://doi.org/10.1177/0893318901144003

67) Underwood, S. (2010). Improving disaster management. *Communications of the ACM*, *53*(2), 18–20. https://doi.org/10.1145/1646353.1646362

68) van Rensburg, J. T. J., & Vermaak, C. (2017). Designing a mobile application for agricultural knowledge management. *Proceedings of the 16th World Conference on Mobile and Contextual Learning*. Published. https://doi.org/10.1145/3136907.3136919

69) Venkatesh, V., & Davis, F. D. (2000). A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. *Management Science*, *46*(2), 186–204. https://doi.org/10.1287/mnsc.46.2.186.11926

70) Warfield, C., The Disaster Management Cycle, 2008. http://www.gdrc.org/uem/disasters/1-dm_cycle.html (accessed on May 8, 2021)

71) Woods, D. D., Branlat, M., Herrera, I., & Woltjer, R. (2015). Where Is the Organization Looking in Order to Be Proactive about Safety? A Framework for Revealing whether It Is Mostly Looking Back, Also Looking Forward or Simply Looking Away. *Journal of Contingencies and Crisis Management*, *23*(2), 97–105. https://doi.org/10.1111/1468-5973.12079

72) Youngblood, S. (2010). Ongoing Crisis Communication: Planning, Managing, and Responding, 2nd Edition (Coombs, W. T.) and Handbook of Risk and Crisis Communication (Heath, R. L. and O'Hair, H. D., Eds.) [Book reviews. *IEEE Transactions on Professional Communication*, *53*(2), 174–178. https://doi.org/10.1109/tpc.2010.2046099

73) Yu, C. C. (2013). Value Proposition in Mobile Government. *Lecture Notes in Computer Science*, 175–187. https://doi.org/10.1007/978-3-642-40358-3_15

74) *155 dead, 25,000 displaced after weeks of flooding in Nigeria*. (2020, October 20). Sott.Net. https://www.sott.net/article/443148-155-dead-25000-displaced-after-weeks-of-flooding-in-Nigeria.

Appendix 1- Interview Questions

INTERVIEW WITH THE CRISIS MANGEMENT EXPERTS

Interview questions in English

Approximately 45 minutes is planned for the interview and discussions.

Interviewee is: Public sector representative of NEMA (National Emergency Management Agency or LASEMA (Lagos State Emergency Management Agency.

Introduction:

Q.1. What is your current position and responsibilities with the crisis/disaster management Agency? (including your years of work experience in relation to the field)

(Fundamental Analysis)

Q.2.How would you describe the operations of either NEMA (National Emergency Management Agency or LASEMA (Lagos State Emergency Management Agency as regards your portfolio.

General Question (Developmental Analysis)

Q.2. How would you evaluate the necessity of a crisis management mobile application in a country like Nigeria on a 10-point scale, where 1 means that you did not find the mobile application important and 10 that you find it very important?

Q.2b In your opinion how do you think the application can be beneficial to the government?

Q.2c In your opinion how do you think the application can be of value to the community?

Q.3. Is there any existing CRM (Customer Relationship Manager)? In your view what kind of technical support is needed for the crisis management application to integrate and work effectively?

Q.4. What is your expectation of the crisis management mobile application in terms of features, functionality, content, and others?

Q.5. As an expert in the field are there current or perceived challenges that can stand as an impediment to the implementation of this solution?

Q.6. Is there anything you would like to suggest, add, or comment in designing the crisis management mobile application?

INTERVIEW WITH MOBILE APPLICATION DEVELOPER

Interviewee is: Private sector representative.

Introduction:

Q.1. What is your current position and responsibilities and how many years of experience do you have working as a developer?

Q.2. What kind of mobile application have you developed and what application are you currently working on.

General Question (Developmental Analysis)

Q.3. How would you evaluate the necessity of a crisis management mobile application in a country like Nigeria on a 10-point scale, where 1 means that you did not find the mobile application important and 10 that you find it very important?

Q.4. How can a mobile application system for crisis management be developed to meet the needs of the citizen? (in terms of usability, requirements, speed, device to work on e.t.c)

Q.5. What do you think can be a limitation to a mobile solution for crisis management in a country like Nigeria?

Q.6. Is there anything you would like to add?

Appendix 2 - Survey

Questionnaire on Designing Crisis Management Mobile application

Dear Respondent,

I am a student at Tallinn University of Technology, Estonia currently studying E-governance Technology & Services (Master's). I am working on a research topic titled, "Designing a crisis management mobile application a case study of Lagos state in Nigeria".

Crises are negative events that may affect the society and environment with a need for emergency aid.

Your kind response to the questionnaire is valuable and would be appreciated as it will help to understand the needs and expectations towards the application under design. The questionnaire contains - questions which can take about 3-5mins of your time. The input to this questionnaire is stored and analysed anonymously. Your information is never made public at any time. Also, if you wish to receive the result of this survey, the evaluation can be provided to you directly. You can write to deluxsolo360@gmail.com

Thank you.

Yours faithfully,

Oladele Amola.

QUESTIONNAIRE FOR CITIZENS

Please tick the box that corresponds to your choice of response

General information

I identify my region of residence as

( ) North ( ) South ( ) East ( ) West

My gender is

( ) Male ( ) Female ( ) Prefer not to say

I identify my age as

( ) under 21 ( )21-34 ( )35-44( )45-54( )55 or older

Part B (Fundamental Analysis)

1. What are the most common emergencies or crisis situations that may occur in your region of residence?

() Flood/Erosion ( ) Fire ( ) Accidents ( ) kidnapping ( ) Drought ( ) others

If Others, please specify……

2. Have you ever been or witnessed any situation where there was need for you to call for emergency help before either from the fire service, ambulance , police or any sort?

Yes

No

3. What communication channel(s) did you use to get help?

Call the radio or television station

Call other persons

Snap or record and Upload on social media. i.e Twitter, Facebook, histogram

Send message

If Others, please specify……

4. When you used the communication channel during crisis what kind of problem did you experience?

Power failure

Call load

Internet failure

If Others, please specify…

Part C (Developmental Analysis)

5. Would you consider using a mobile application if available during a crisis situation?

   Yes

   No

6. Are you aware of any crisis management application used either in your region or in other countries ?

   Yes

   No

   If yes, please name….

7. What would be an important experience for you if this crisis management mobile application is designed? You can choose more than one option

( ) Easy accessibility and navigation ( ) Simplicity ( ) High speed performance( ) Usable () Others please specify

8. What are the features you would love to see if this crisis management mobile application is designed? You can choose more than one option

   - Call functions to be able to call or talk to someone
   - Text messages features and notification, sending messages and receiving messages
   - First aid information and training content
   - Video and pictures functions, to be able to upload pictures and videos
   - Others……please specify

9. What do you think would be the obstacle of using crisis management mobile application?

   - Power supply
   - Internet
   - Mobile phone Specification

- Network coverage
- Others… please specify

Appendix 3 - Results of the Survey

(1) Region

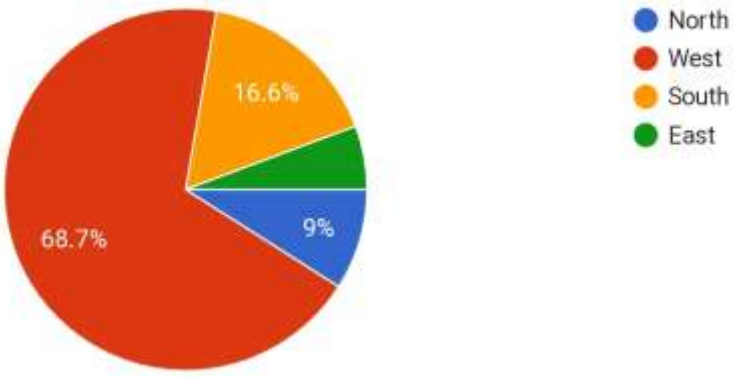


Figure 1: Answers to general question 1

(2) Gender

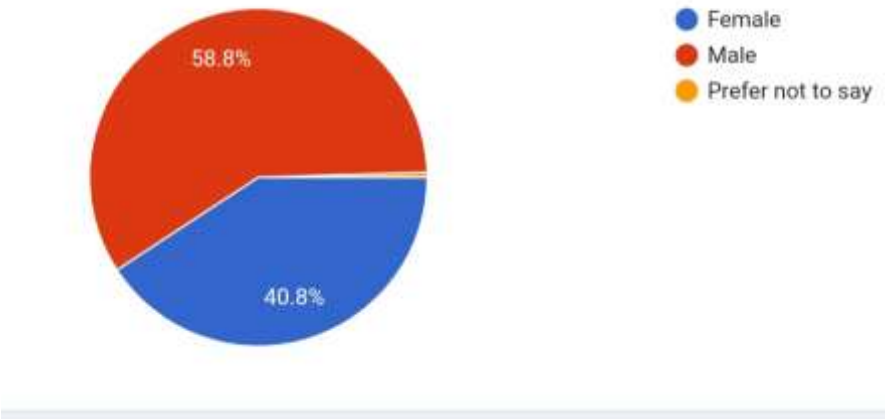


Figure 2: Answers to general question 2

(3) Age

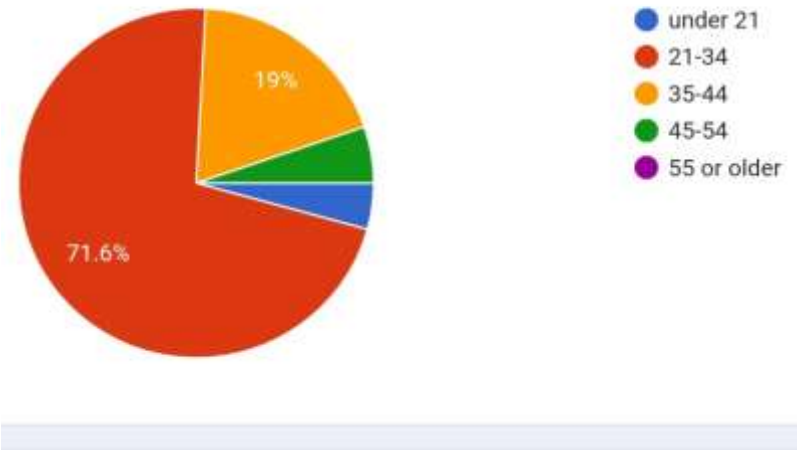


Figure 3: Answers to general question 3

1. What are the most common emergencies or crisis situations that may occur in your region of residence?

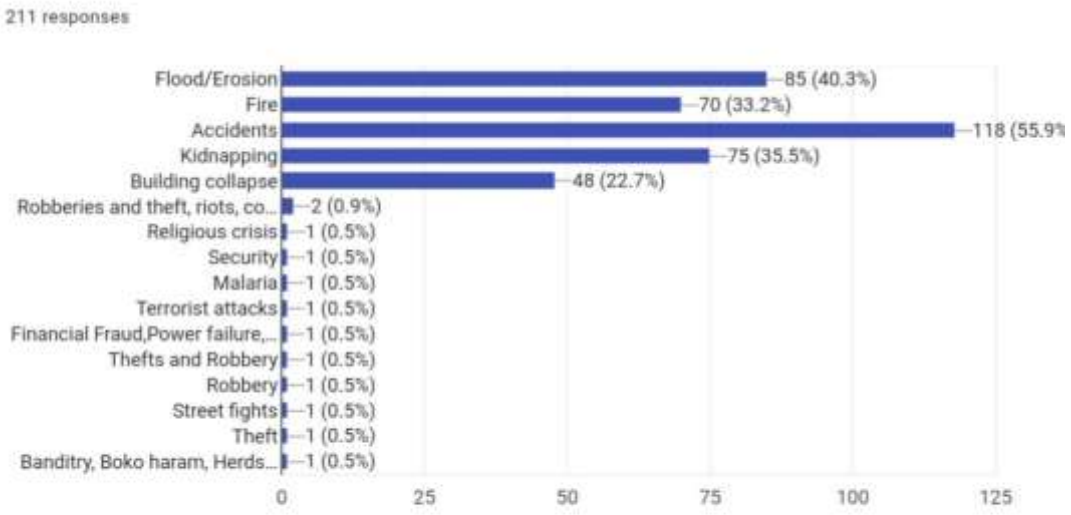


Figure 4: Answers to fundamental question 1

2. Have you ever been or witnessed any situation where there was need for you to call for emergency help before either from the fire service, ambulance , police or any sort?

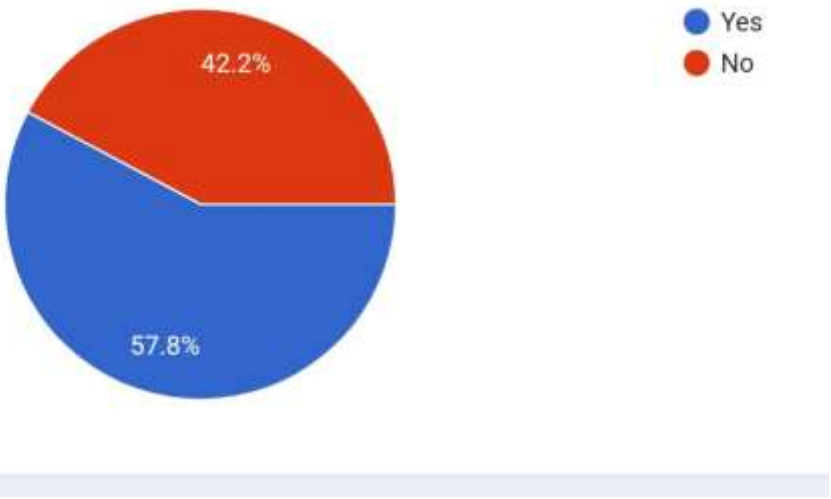


Figure 5: Answers to fundamental question 2

3. What communication channel(s) did you use to get help

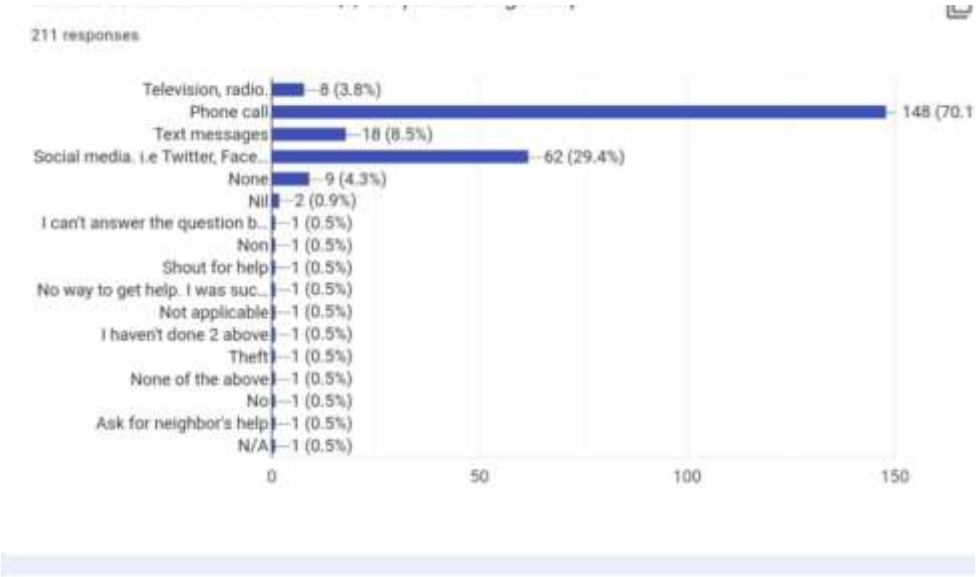


Figure 6: Answers to fundamental question 3

4. When you used the communication channel during crisis what kind of problem did you experience?

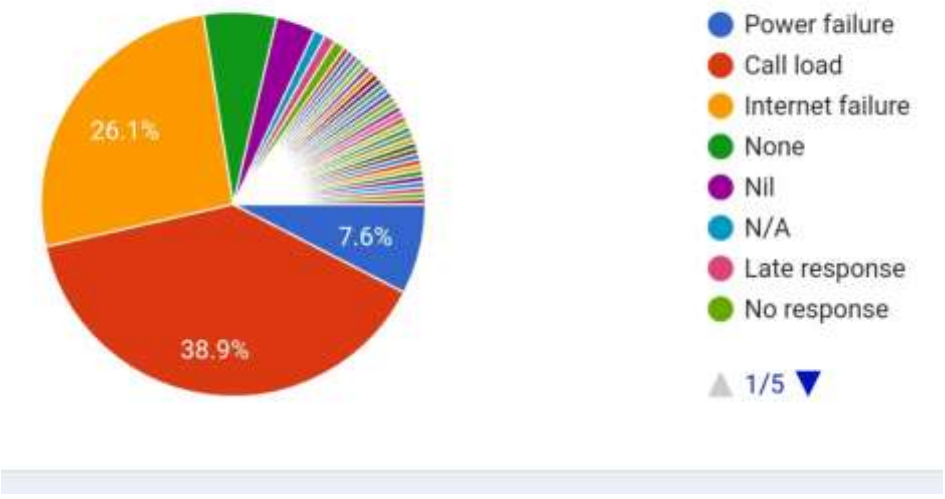


Figure 7: Answers to fundamental question 4

5. Would you consider using a mobile application if available during a crisis situation?

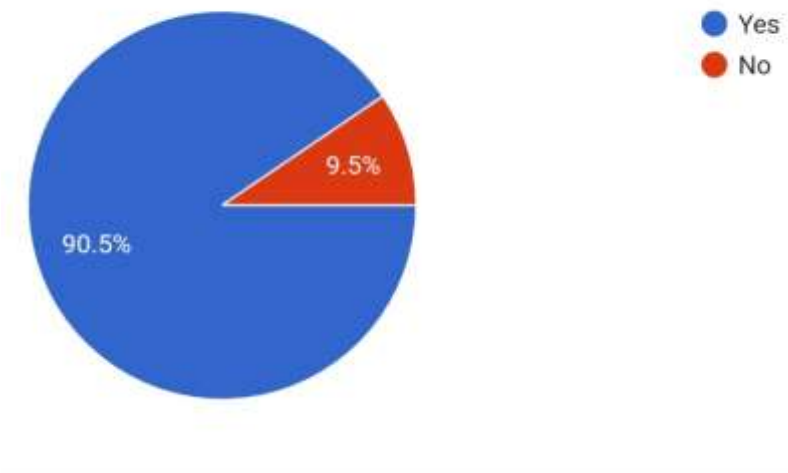


Figure 8: Answers to developmental question 1

6. Are you aware of any crisis management application used either in your region or in other countries ?

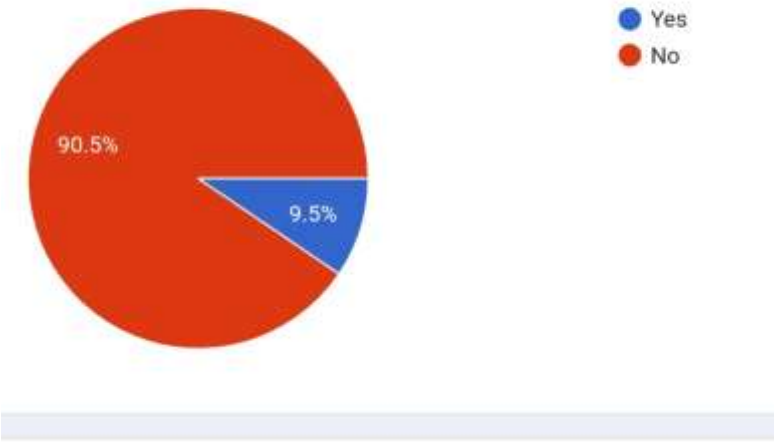


Figure 9: Answers to developmental question 2

7. What would be an important experience for you if this crisis management mobile application is designed?

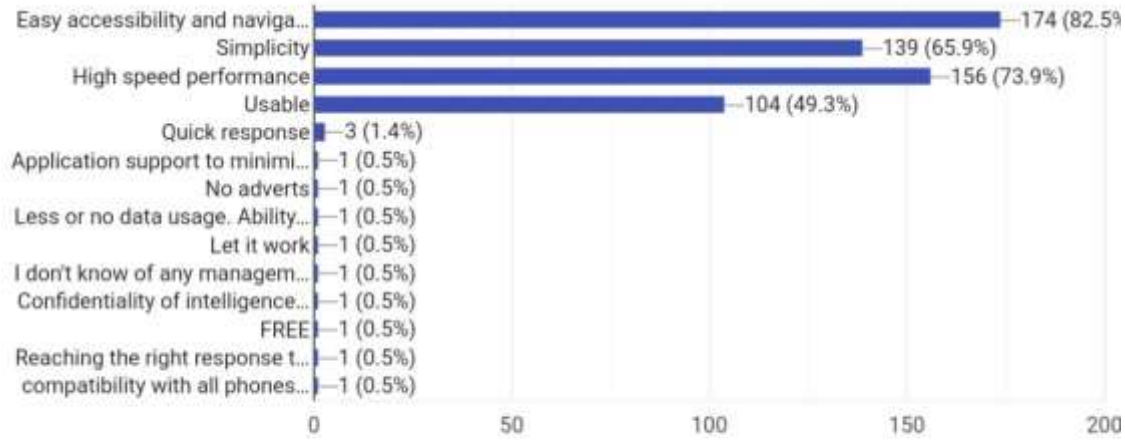


Figure 10: Answers to developmental question 3

8. What are the features you would love to see if this crisis management mobile application is designed?

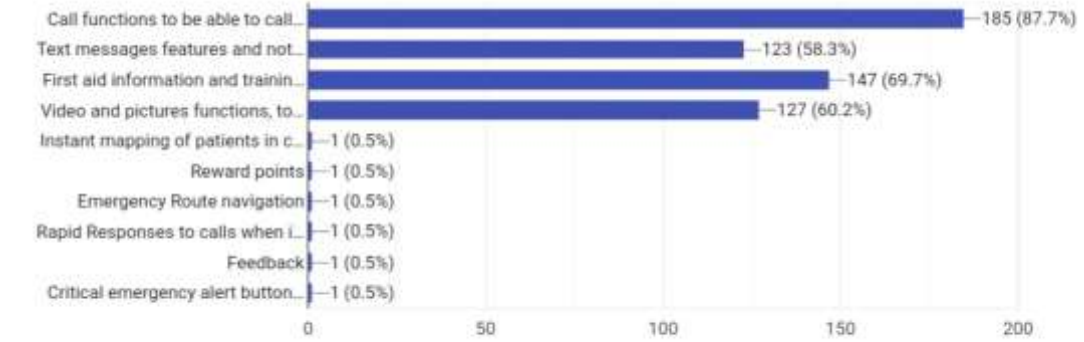


Figure 11: Answers to developmental question 4

9. What do you think would be the obstacle of using crisis management mobile application?

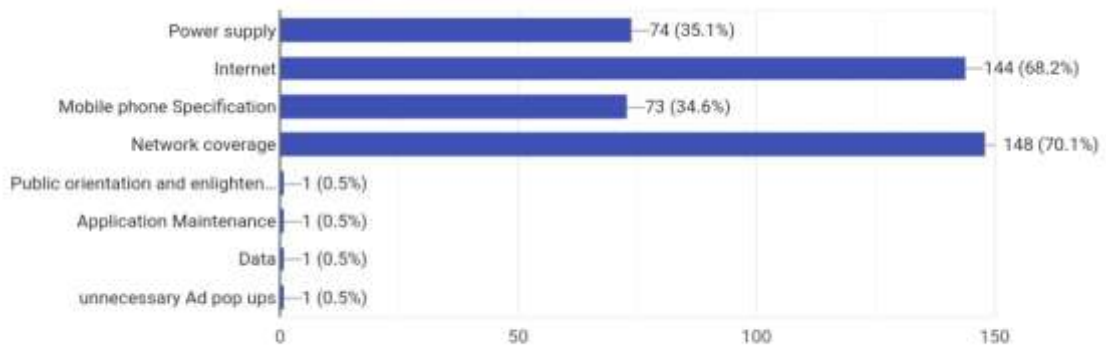
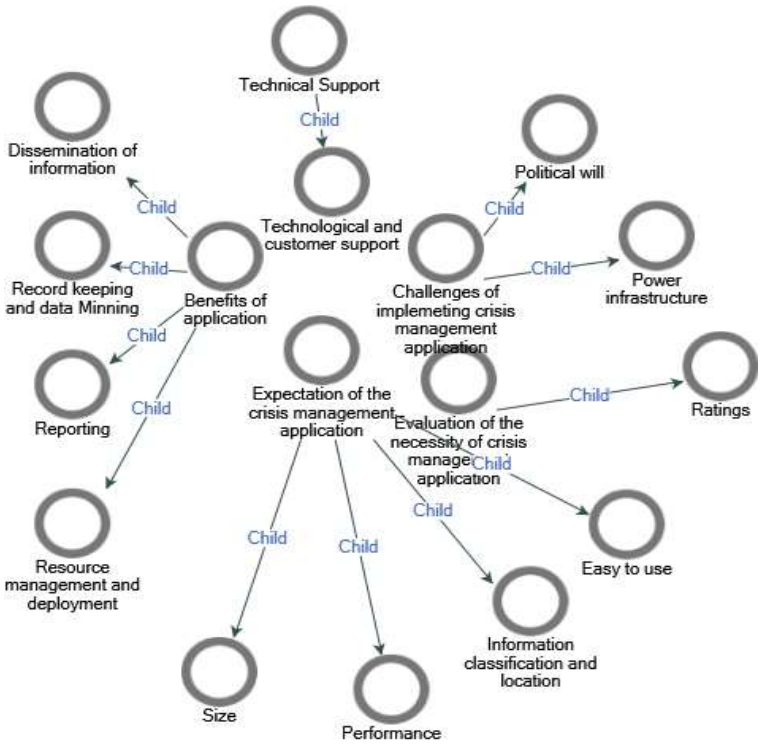


Figure 12: Answers to developmental question 5

Appendix 4 - Thematic project map of all categories and codes



Node of Coding References Using NVivo release 1

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