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Design and Development of a Web Based Emergency Management Information System (EMIS) for Zambia Disaster Agencies

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Abstract

Disaster management is a critical area that requires efficient methods and techniques to address various challenges. The effectiveness of disaster management depends heavily on Information Systems (IS) during disaster response. Systems which collect and process vital data distribute information to help officials make decisions promptly. GIS together with remote sensing tools and data analytical methods helps responders to develop clear understandings of disaster impacts through visualization while simplifying the distribution of resources. During preparations information systems enhance risk evaluation through analytical models alongside historical data usage. Real-time data acquisition from IoT devices together with social media feedback enables expeditionary response decisions. After disasters, ISs track recovery progress by processing damage reports

while developing efficient stakeholder communication routes. This project is about Emergency Management Information System (EMIS) which is developed to make the functional areas in Disaster Management more efficient and effective. This study also considers the adoption of the EMIS as an important component in the delivery of disaster relief services to the general public. The methodology I used for the project development is the Agile Development Methodology. This methodology was used because the project is needed to deal directly with the stakeholders so that I as developer will know what they really want and how they want the system to function from the feedback they give after each iteration. The 21st century has witnessed so many great inventions in science and technology that have led with great potential to solve existing problems.

Keywords: Information Systems (IS), Disaster, Recovery, Response, Disaster Risk, Hazard, Disaster Risk Management (DRM), Disaster Risk Reduction (DRR), Disaster Management and Mitigation Unit (DMMU), Decision Support Systems (DSS), District Disaster Management Committee (DDMC), Geographical Information Systems (GIS), Emergency Management Information System (EMIS), Information and Communications Technology (ICT)

1. Introduction

Disasters such as floods, terrorist attacks, or epidemics pose severe threats to the wellbeing of modern societies (Ansell *et al.*, 2010; Quarantelli *et al.*, 2018) ^[2, 26]. A major challenge of managing disasters is they are often transboundary, that is, they cross national, political, and organizational boundaries. Transboundary crises spread quickly around the globe, their origin is often unclear in the beginning, they bring a large number of direct and indirect victims, and traditional approaches from local response organizations may not necessarily work (Quarantelli *et al.*, 2018) ^[26]. To respond to such new threats but also “traditional” disasters (e.g., flooding, forest fires), emergency responders use information systems hereafter referred to as emergency management information systems (EMIS) that help them to manage a disaster effectively.

An EMIS is an information system that supports activities in disaster mitigation, preparation, response, and recovery by storing, processing, or exchanging emergency-related information (Tuoff *et al.*, 2004) ^[29]. Examples of EMIS are professional response software, databases, or radio equipment (e.g., Allen *et al.*, 2014; Chen *et al.*, 2008) ^[1, 6], emergency apps (Tan *et al.*, 2017; Fischer-Preßler *et al.*, 2020) ^[28, 14], or open-source software (e.g., Currian *et al.*, 2007) ^[8].

Alongside these technologies dedicated to emergency management, technological progress in recent years broadened the spectrum of technologies that have been used in emergency management, such as social media (Ling *et al.*, 2015) ^[19] and crowdsourcing platforms that also enable the public to act more visibly. A growing number of papers in recent years shows how the use of EMIS can assist with disaster response.

In contrast to emergencies, disasters cannot be handled by the resources (e.g., human, material) of the affected community

only, rather resources from outside the community are necessary to cope with the event. Emergency, instead, are events that responders are fully skilled to handle as they are relatively routine (McEntire, 2006) [20]. However, the distinction between emergencies and disasters is blurred in the Information System discipline. This means EMIS research indistinctively includes areas that have been referred to as “emergency”, “crisis”, or “disaster” management. Despite its name, research in emergency management- at times also referred to as crisis or disaster management (e.g., Boin *et al.*, 2005) [4] often focusses on disasters rather than emergencies because responders are fully skilled to address most needs in routine emergencies. Emergency Management is the “managerial function which arranges counter measures and coordinates involved organizations, resources, and information to prevent, mitigate, respond to, recover from, or prepare for a disaster and therefore reduce the overall vulnerability of communities and infrastructure to known and unknown threats” (Vogt *et al.*, 2011, p. 2) [32]. Response organizations involved in professional emergency management are from law enforcement, public authorities, firefighting, or paramedics. Scholars distinguish four phases of emergency management: mitigation (prevention), preparedness, response, and recovery. Most of the literature in EMIS focusses on response and short-term recovery phases, which constitute the core of “emergency management” (Fischer *et al.*, 2016) [13]. In this paper, we, concentrate on the response phase and the functions EMIS provides to support professional emergency responders to handle the situation.

The major hazards the country experiences include drought, floods, pest infestations, epidemics (both human and animal), hail storms and landslides. Further, it experiences man-made hazards such as fires, transport and industrial accidents. Also of significance is the increase in trans-boundary risks that are being progressively exacerbated by, among other things, population growth, eco-system degradation and un planned urbanization. This coupled with poverty and un sustainable land use management has worsened the current situation thereby reducing the coping capacity and resilience of communities. In addition, climate change and variability has made it more difficult to predict the behavior of hazards. In view of this, the need to enhance the integrated disaster risk management has become necessary and urgent if the country is to protect its citizens and asserts from the adverse effects of disaster risks. Currently, Zambia’s emergency management system consists of the following key components:

▪ **Legal and Institutional Framework:**

The Disaster Management Act of 2010 provides the legal basis for disaster risk management, establishing the National Disaster Management Council (NDMC) as the highest decision-making body.

▪ **National Disaster Management Council (NDMC):**

The National Disaster Management Council coordinates disaster management efforts at the national level.

▪ **Provincial Disaster Management Committees (PDMC):**

These committees facilitate decentralized disaster management and coordination at the provincial level.

▪ **District Disaster Management Committees (DDMC):**

Similar to PDMCs, DDMCs operate at the district level to enhance local coordination.

▪ **Disaster Management and Mitigation Unit (DMMU):**

The DMMU, under the Office of the Vice President, is responsible for coordinating disaster risk reduction activities and implementing the National Disaster Management Policy.

▪ **National Disaster Management Policy:**

This policy, launched in 2005 and revised in 2015, provides a framework for managing risks, hazards, and disasters, and integrates disaster management into national development. Africa Program of Action for the Implementation of the Sendai Framework (2015-2030).

▪ **SADC Disaster Preparedness and Response Strategy Fund (2016-2030)**

▪ **Paris Agreement on Climate Change, and**

▪ **Sustainable Development Goals.**

Though the country has recorded minimal deaths directly arising from natural disasters, the recorded deaths have mainly been from marine, technological, industrial and, road traffic accidents. Table 1 shows the disaster statistics for the country.

Table 1: Zambia - Disaster Statistics

Events	No of People Affected/Deaths	Comments
Natural Disasters- 1978-2013	5,158,258	Affected
Technological Disasters 2008-2015	1,051	Affected
Natural Disasters- 1978-2012	411	Death
Total No. of deaths (Epidemics only)	272	Death
Total Economic Damage (US\$):	200,000(1978-Lusaka) 20,700,000(1998-Northern)	Damage only from floods

Source: EM-DAT, CRED, University of Louvain, Belgium

1.1 Motivation and Significance of the study

Disaster management functions as an essential domain dedicated to reducing disaster consequences that affect population groups combined with public services and ecological systems Its importance can be highlighted through several key aspects:

a) **Protection of lives and property**

Disaster management approaches effectively protect people’s safety by providing efficient arrival and readiness systems. Disasters become more bearable to communities when they prevent high numbers of casualties.

b) **Economic Stability**

Governmental and organizational implementation of disaster management systems allow both economic damage mitigation and faster restoration operations.

c) **Community Resilience**

The presence of a robust disaster management system helps communities to build resilience level that improve their ability to face and recover from catastrophe.

d) **Coordination and Collaboration**

When disaster management takes effect, it helps diverse entities including government agencies, NGO groups, and local communities work together. Through effective coordination, assets are directed properly and responses appear structured.

e) **Data-Driven Decision Making**

Modern disaster management functions through extensive data analysis together with information systems. The use of well-structured information enables leaders to understand potential weakness and then make data driven choices that enhance their emergency readiness and reaction abilities.

1.2 Scope of the study

This research is aimed at developing an information repository for disaster related information. Among the disaster management systems discussed above, this research focusses on the Emergency Management Information Systems functions with features for emergency data collection and sharing as well as coordination of response efforts among agencies and responders. Overall, the system includes functions for:

- a. Emergency case registration by users
- b. Agency registration
- c. Volunteer registration
- d. Resource mobilization
- e. Camp or emergency center creation
- f. Needs repository for each relief camp
- g. Missing persons register
- h. Registration of people in a camp

1.3 Problem Statement

Disasters pose significant threats to communities, economies, ecosystems, necessitating effective preparedness, response, and recovery measures. Zambia's informatization of emergency management is still in its infancy, with limited time to accumulate, leading to a lack of unified technical standards and coordination mechanisms. When dealing with large scale emergencies across various regions of the country, the government has difficulties in unifying the command and effectively scheduling various departments which affect the timeliness and efficiency of emergency response. In addition, the lack of clarity in authority and responsibility between departments has further weakened the overall connectivity of the emergency management systems and created the phenomena of "Information Islands". The lack of synergy in information acquisition, coordination, and communication in response to public emergencies has seriously reduced the crisis management efficiency of government departments. Emergency Management is inherently complex and dynamic task, requiring quick knowledge sharing and decision coordination among parties involved (Becerra-Fernandez *et al*, 2008. According to Rao *et al* (2007), "Making good decisions and taking appropriate action during extreme events require having access to communication, data, and computational resources that can be used to effectively coordinate a large number of geographically dispersed participants and assets, to exchange a wide variety of types of information, and to evaluate many scenarios and responses, all of which are changing dynamically".

1.4 Objectives

To study the influence of the Emergency Management Information System (EMIS) on implementation and effectiveness of emergency service delivery in the Disaster Management and Mitigation Unit (DMMU) of Zambia.

1.4.1 General Objectives

The aim of this project is to develop and implement an Emergency Management Information System (EMIS) to

control and allow complete reporting and registration of all emergency cases which are related to disaster management by the domain users thus members of the public, who can register cases, disaster agencies who can update status, Volunteers/Responders who can request for resources and donors who can donate badly needed relief. The flow of information provides communication and notification between the courts and public.

1.4.2 Specific Objectives

1. To implement an Emergency Management Information System (EMIS) for disaster/emergency case registration which are related to disaster management and mitigation, and creation, modification and updating through user interface.
2. Develop features that enhance command and control: Clarify roles in the command chain based on the type of disaster.
3. To provide members of the public with a dedicated platform for reporting disasters.

1.5 Research Questions

1. What are the benefits of using Information Systems in Disaster Management?
2. How can a disaster management information system be designed and developed to effectively facilitate coordination and information sharing among different stakeholders e.g., government agencies, NGOs, and local communities during disaster events in Zambia?
3. How can MIS be applied to improve disaster response and recovery?

2. Review of the Literature

Before the 1970s, globally, civilian usage of ICT in disaster management was limited to educational institutions, governments, and large companies (Levius *et al.*, 2017) ^[18]. In the 1970s, computer revolution took place with the invention of microprocessors. This invention made computers physically smaller but faster. It improved computing capability and storage capacity at both individual and organizational levels. Real-time emergency data, program and project planning, and decision support systems were added to the operational activities of computer and technological platforms. Nevertheless, the availability of these computing facilities was delayed and confined to a particular scope. It was only until the 1980s that computerization and associated applications became more popular and available for common purpose. In the late 1980s, personal computers became more popular and with network capabilities added to the computers, desktop computers became more portable. Stephenson and Anderson started looking at the development and possible medium-term future of information technology (IT) in disaster management in 1997 "Disasters and The Information Technology Revolution review. In that review, a set of key technologies were focused on to guide disaster planning, preparedness, disaster controlling, and further disaster research for more than 10years. A major change regarding emergency global information access and networking occurred in recent times. It is also stated that, operational and organizational implications would take place in disaster management study (Drabek, 2018) ^[10].

In a disaster situation, as a preparedness measure, it is believed that early and timely warning facilitates people to take preparatory measures for evacuation to shelters in time

which helps to save lives, reduce the loss, and help recover the damage (Dahou *et al.*, 2012) [9]. An effective warning system requires to have better and more successful coordination among disaster management agencies for warning information, people, and community for increasing awareness regarding hazard preparedness and disaster management.

For disasters, the media continuously plays an imperative part in progressing the disaster awareness of the common population and in dispersing early warnings.

For example, social media as a communication tool, spread critical news amid and after a disaster (Porto de Albuquerque *et al.*, 2015) [25]. The media can be the basic channel for giving the warning to the common people. Essentially, nowadays, social media information is broadly utilized for disaster management and data dispersal (Xiao *et al.*, 2015) [33].

Another study on the role of ICT in disaster management found that efficient disaster response requires quick access to reliable and accurate data and the capacity to assess, analyze, and integrate information from varied sources (Van De Walle *et al.*, 2014) [31]. ICT can aid in reducing the impact of acute climate-related events (Haworth *et al.*, 2015) [16]. The note worthiness of the community in handling disaster management is contended whereas recognizing the critical role of governments, epistemic communities, donors, businesses, and NGOs. Most of the time ICT applications are financed remotely making the process reliable and sustainable.

Decision Support Systems (DSS) are one sort of MIS, which is very useful when a large number of images need to be integrated and used in collaborative environment (Collen & McCray, 2015).

2.1 Emergency Management Information System Applications

2.1.1 China

At the beginning of the founding of new China, the disaster prevention and mitigation were independently responsible for the jurisdiction of the rescue and relief. In 1986, the Guangzhou Municipal Public Security Bureau setup China's first 110 alarm service station. In the following 10 years, the construction of the 110-alarm service system was then extended out of the 119 and other special service codes. In 1999, the 911 emergency response system was the first of its kind in China. Premier Zhu Rongji, during his visit to the United

States, was invited to visit the 911 center in Chicago and later proposed that the 911 emergency response system is the symbol of the modernization of a city, and that China should strive to build its emergency linkage system. A similar emergency response system was first introduced in 2002 in Nanning, Guangxi, and was popularized nationwide after the 2003 SARS epidemic. As of December 2008, China's public security system based on the "three stations in one" emergency response system is completed. China's current emergency response platform system adopts a layered

architecture, with the national-level emergency response platform at the top and extending downward to the provincial level, the municipal level, the county level, and the government departmental emergency response platforms at all levels. The national-level system is constructed and maintained by the central emergency management

department, while the local-level system is maintained by the emergency management department of each local government. At present, municipal and county governments are focusing their efforts on developing and applying integrated emergency management systems, which are regarded as key initiatives to strengthen the emergency management capacity of grassroots governments, and their importance and urgency are becoming more and more prominent. Adhering to the emergency management concept of "adequate preparation in normal times and rapid response in times of emergency," the integrated system is regarded as the cornerstone and core driving force for the construction of an efficient emergency management system.

2.1.2 The US Emergency Management Information System

The United States federal government, through the Emergency Support Functional Annexes (ESFs) of the National Emergency Response Plan (NERP), defines in detail the arrangements between the federal government agencies and the Red Cross in terms of the deployment of resources, implementation of policies, organizational structure and division of responsibilities. Each functional annex designates the corresponding federal government coordinating agency, lead agency, and supporting agencies [Shilun, 2008]. Among them, the coordinating agency undertakes preliminary planning tasks, maintains close communication with the lead agency and supporting agencies, and convenes regular coordination meetings with the functional stakeholders. The lead agency, as the core implementer, is responsible for manpower deployment and strives to ensure the adequacy of emergency resources. The auxiliary organizations, on the other hand, provide a full range of support, including manpower, equipment, technology, and information, according to the needs of the lead organization. The activation of these functional annexes is based on the specific nature and needs of the incident, and once activated, the coordinating, lead, and supporting agencies will dispatch emergency response personnel or teams to seamlessly integrate into the overall Incident Command System structure and work together to respond to the emergency, according to their respective emergency support roles. The U.S. Federal Emergency Management Agency (FEMA) has adopted and implemented the "e-FEMA" strategy, which builds a hierarchical architectural model for emergency information systems. This model aims to ensure that the data resources of various emergency information systems can be kept up-to date in real time and at the same time promote information inter-operability and resource sharing among different systems to provide strong technical support for the emergency decision-making process [Jennings et-al, 2017]. Currently, the three major information systems widely used in the United States are as follows.

2.1.2.1 Federal Emergency Management Information System (FEMIS)

This system serves as a comprehensive decision-support platform that comprehensively covers the four key phases of emergency management: preparation, response, and recovery. It is mainly used to manage the core affairs of the emergency management process, such as plan making, coordination and communication, rapid response, professional training, and simulation exercises, and providing comprehensive support for emergency management.

2.1.2.2 Web Emergency Management System (Web EOC)

This system is designed for city-level emergency response, with functions covering incident management, emergency command and dispatch, resource optimization, and document management. Through Web EOC, the city's emergency management department can organize rescue operations more efficiently, optimize resource allocation, and achieve full tracking and recording of emergency events.

2.1.2.3 Disaster Damage Assessment System (HAZUS)

HAZUS system focuses on accurate prediction of damage that may be caused by natural disasters (e.g., earthquakes, floods, hurricanes, etc.) and proposes corresponding emergency strategies and mitigation measures, damage caused by natural disasters (e.g., earthquakes, floods, hurricanes, etc.), and proposes appropriate emergency response strategies and mitigation measures accordingly. By strengthening the management and assessment of buildings and other infrastructure, the system seeks to be fully prepared before a disaster occurs to minimize casualties and property damage and to protect public safety.

2.1.3 Japanese emergency management information system

To effectively respond to sudden-onset major disasters, the Government of Japan has constructed a disaster information integration system in which multiple actors work together (Fei *et al.*, 2012) [12]. The system not only promotes the integration and sharing of disaster information across sectors but also further promotes close interaction between the national and local governments and civil society organizations, realizing a shift from a single-level to a tripartite governance model that involves the collaboration of the national, local and civil sectors in a joint effort to comprehensively integrate and effectively respond to disaster information (Guozhang, 2006) [15]. The emergency management information system currently applied in Japan is the SIP4D system. Based on reflections on the response to the 2016 Kumamoto Earthquake, the Central Disaster Prevention Conference of Japan has recognized that the potential of information and communications technology (ICT) in the field of disaster management has not yet been fully realized. As a result, the conference decided to strengthen data sharing across national and local governments and private companies, and in April 2017, established the "Joint Disaster Information Governance Center" with the Cabinet Secretary for Disaster Prevention at its core, which brings together social organizations including the Keidanren and the Japan Gas Association, as well as Hitachi, Nippon Telegraph and Telephone, Nippon Freight Railway, and others. The center brings together several organizations, including the Japan Federation of Economic Organizations, the Japan Gas Association, and industry giants such as Hitachi, Nippon Telegraph and Telephone, and Japan Cargo Railways. The main task of the center is to build a disaster information center for multiple subjects, such as administrative departments, enterprises, and disaster-affected people, based on the SIP4D platform to strengthen the support capacity for large-scale disasters. The biggest highlight of the SIP4D Disaster Information Center lies in the high efficiency of its information transmission and the flexibility of its modularization, which is specifically embodied in the three aspects (Turoff *et al.*, 2004) [29].

2.1.3.1 Instant Information Sharing

After a disaster, SIP4D can quickly gather and release relief information, such as the affected situation and the location of shelters, to ensure the safety of residents. SIP4D integrates disaster data from central ministries and commissions, local governments, and civic organizations, and then the Disaster Information Support Teams go to the site to collect firsthand information and communicate this information to the government, enterprises, and the public through the Disaster Electronic Map Portal (NIED-CRS) in a visual way to improve the overall response efficiency. Through the NIED-CRS portal, this information is communicated in an intuitive way to the government, businesses, and the public to improve overall response efficiency.

2.1.3.2 Assisting local governments in emergency response

SIP4D provides a series of customized business modules, such as the release of evacuation information, guidance for evacuation of residents, the establishment of emergency headquarters, the operation of shelters and road control, etc. SIP4D can also help local governments quickly build a disaster response system so that even non-professional disaster management personnel can rely on the platform to carry out their work effectively.

2.1.3.3 one-stop information dissemination

SIP4D can centralize and integrate disaster information originally dispersed in various public information platforms, social media, and official government websites to achieve one-stop dissemination. At the same time, the platform supports the online generation of standardized disaster broadcast newsletters and instant delivery of these newsletters to relevant departments to achieve efficient and unified management of both supply and demand of information.

2.1.4 The Zambian emergency management information systems

Over the last decade, Zambia has experienced a number of climatic hazards and extreme flooding that represent significant losses of lives and assets. In 2006 and 2007, the already flood prone areas of North Western and Western Zambia, experienced severe floods which impacted its infrastructure, such as the telecommunications infrastructure, roads, schools, homes, agriculture, water, sanitation and the health of the local population. Subsequently, the 2007 and 2008 floods started earlier than anticipated, affecting the southern half (low lying areas and major river basins) of the country. These floods mainly affected infrastructure such as roads, bridges and culverts. The 2008 and 2009 rainy season saw the Northern, North Western and Western Provinces being the mainly affected regions by the floods. In terms of telecommunication links, the International Telecommunication Union (ITU) provided assistance to the Government of Zambia through the deployment of satellite terminals that were subsequently deployed to assist humanitarian actors which provided relief and basic services to the local population. The effects and damages of the floods ranged from moderate to high in most parts of the country, thereby causing adverse impacts on several sectors. The immediate impact of the flooding included loss of human life, damage to property, destruction of crops, loss of livestock, and the deterioration of the health conditions, mostly due to waterborne diseases.

2.1.4.1 Natural Disaster Early Warning System

In view of the continuous disasters and natural threats experienced in the country, the Government set up several permanent response mechanisms to address this matter. As part of this effort, the Zambian government decided to invest in the establishment of natural disaster early warning systems in flood prone areas. To this end, this project was developed as a pilot and implemented by ITU. The project aimed to provide natural disaster early warning systems in two pilot sites of the Republic of Zambia. The systems are to be used when flooding was imminent, to quickly alert and warn key public officials and the general population, as well as for public safety and sharing information in designated areas. Within the scope of the project, the early warning systems have been installed in Kasaya village, which is located the Kazungula District of Zambia's Southern Province and on Mbeta Island in the Western Province of Zambia. The two areas often experience loss of lives and property as a result of flood waters from the Zambezi River. Despite of suffering from devastating flood events, these villages did not have a system of any early warning mechanisms that would alert the concerned villagers from the occurrence of a disaster. In that respect, the project has helped to address a genuine need in saving lives and livelihood.

Nevertheless, many regions especially in rural parts of Zambia lack comprehensive disaster preparedness plans, leaving them ill equipped to respond effectively when disasters strike. This includes deficiencies in risk assessment, early warning systems, and coordination among stakeholders. Resource constraints often hinder the implementation of effective mitigation measures and the timely response to disasters. This includes insufficient funding, personnel, and infrastructure necessary for preparedness, response, and recovery efforts. Disasters are multifaceted phenomena influenced by a range of factors, including environmental, socio- economic, and political variables.

2.2 Gaps in the Literature

Although research on disaster management information systems has increased significantly over the last decade:

- The studies are still few in numbers
- Only a handful of such systems have been deployed.
- The Zambian case reveals the none-existence of a proprietary system for inter-agency cooperation, resource management, and mobilization.

3. Methodology

The nature of the project recommended agile model of System Development Life Cycle (SDLC). The agile model process starts with a simple implementation of a subset of the software requirements and iteratively enhances the evolving versions until the full system is implemented. The agile methodology gives the need to develop a system based on the requirements of the users, and enable to add up various units of the system pertaining the various feedbacks received from the users. At each iteration and increment, design modifications are made and new functional

capabilities are added. And the phases include: Identifying Problems, Opportunities and Objectives, Determine Human Information Requirement, Analyzing System Needs, Designing the Recommended System, Developing and Documenting Software, Testing and Maintenance of the system.

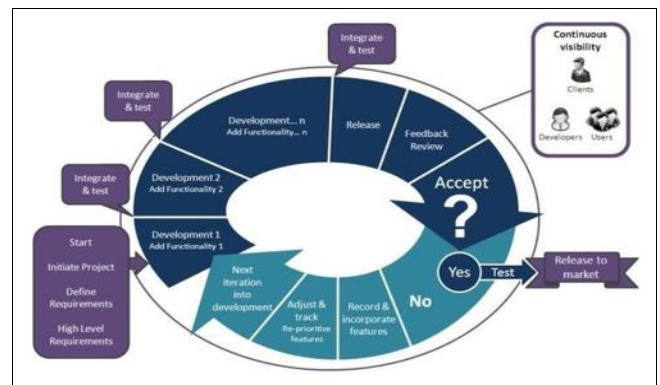


Fig 1: Agile Methodology Illustration

3.1 Data Collection

Application development is the process of creating a computer program or a set of programs to perform the different tasks that a business requires. From the SDLC when building up a system the following are the steps to be followed: gathering requirements, system analysis, requirement analysis designing prototypes, testing, implementation, and integration. That the system analysis has been done, in this section the analyst will focus on system requirement analysis, (Ashi, 2019) [3].

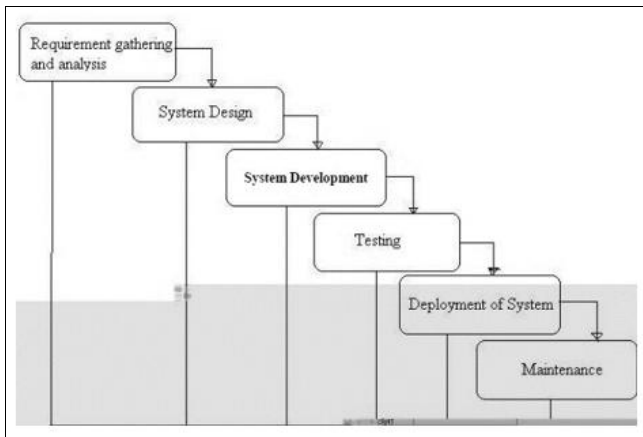
3.2 System Requirement Analysis

Requirement analysis in systems can be defined as activities that help to determine the needs or conditions to meet for a new or altered product or project, taking account of the possibly conflicting requirements of the various stakeholders, analyzing, documenting, validating and managing software or system requirements. It is sometimes known as A System Requirements Specification (SRS) or Software Requirements Specification. (Ashi, 2019) [3]. There are two main groups of specific requirements which were considered. Functional and non- functional requirements.

3.2.1 Functional Requirements

Functional requirements are the product features or its functions that are designed directly for the users and their convenience. They define the functionality of the system. Users can easily perform their tasks up to the needs, (Ashi, 2019) [3]. This document records and provides information about the operations and activities that a system must perform and acts as the brain of documents that defines how everything works together in the software. Details that are included in the functional specifications are categorized as follows:

- a. Output specification
- b. Input specification
- c. Data/files
- d. Hardware and software requirements.



3.3 System Design

Designing is the process of synthesizing or putting together the system components that will address the system requirements. The requirements stated above are arranged in logical order at this stage. The system design is decomposed into subsystems because it too large. On the other hand, the approach will make the system design simplified and efficiency, (Mirriam, 2019) [21].

That the specific requirements have been identified, above, it is possible now to make use of tools like algorithms and flowcharts to develop the design of Web Based Zambia Electronic Perinatal Record system for Rural and Urban Clinics for easily transmission of birth records.

Algorithm:

An algorithm represents the logic of the processing to be performed. It is a sequence of instructions which are designed in such a way that if they are executed in the specified sequence, the desired goal is achieved. It is imperative that the result be obtained after execution of affinity number of steps (Mirriam, 2019) [21].

The following is the flow algorithm designed for the Emergency Management Information System (EMIS);

Start

1. Login Module

- i. If you are either an admin, volunteer, or agency click login on the Emergency Management Information System home page.
- ii. If none of the above, then you must be a user.

2. Admin Login

- i. Click on admin login
- ii. Fill the login form with admin username and password.
- iii. Once logged in, you can add agencies, emergency types, view emergencies, update emergency status, and report emergencies.
- iv. Click logout when done.

3. Agency Login

This module is for emergency agency workers. To login:

- i. Click on agency login
- ii. Fill the login form with username and password.
- iii. Once logged in, you can view emergencies reported to that specific agency, update emergency status, create relief camps, resource analysis, view camp status.
- iv. Click logout when done.

4. Volunteer Login

- i. Click on volunteer login
- ii. If not registered, then click register
- iii. Fill the login form with valid username and password.
- iv. If successfully logged in, the volunteer can view all emergencies, report emergency, create camps, report missing persons, register all people in the camp, request camp needs from the agency responsible, view status about all.

5. User/donor

All un privileged users/members of the general public and donors have un-impeded access to the emergency management information system’s home page. As a user, you do not need to login and one can access the following resources:

- i. View all emergencies reported
- ii. Report emergencies
- iii. Donate resources towards an emergency through filling up a donation form.
- iv. View emergency agency details such as contact details, person in-charge etc.

The algorithm above is going to be represented in a pictorial form.it shows the procedure and the logical sequence of processing using boxes of different shapes. The instruction to be executed is mentioned in the boxes. These boxes are connected together by solid lines with arrows, which indicate the flow of operation.

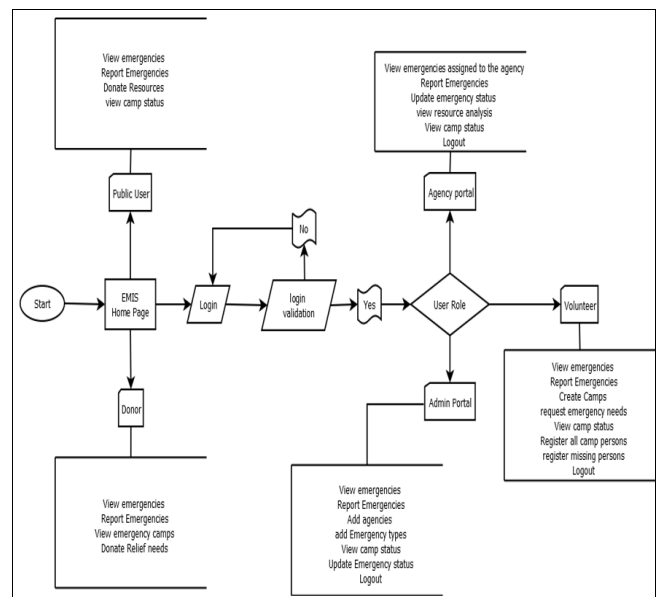


Fig 2: Emergency Management Information System Algorithm

4. Results

The results clearly show that successful registration and management of emergencies can be implemented using Information System as shown below:

The Home login page where users/donors, admin, volunteer, and agencies can view, report, donate, add agencies, add emergency categories, and update emergency status is shown below.

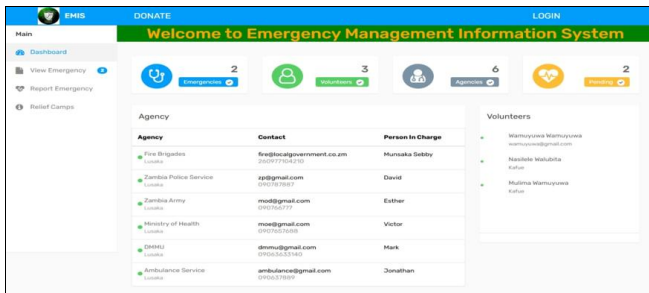


Fig 3: Emergency Management Information System (EMIS), Home page

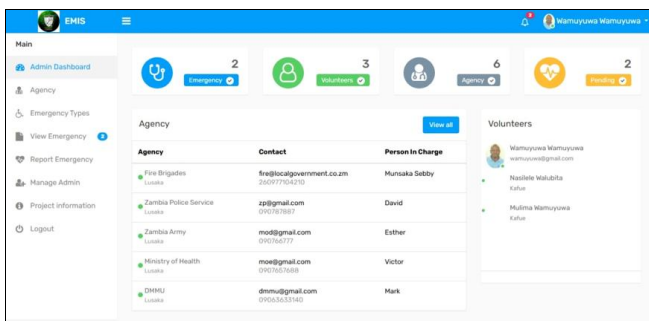


Fig 4: Admin portal

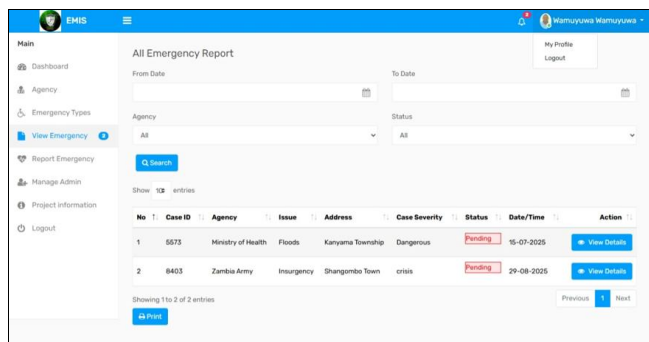


Fig 5: View Emergencies

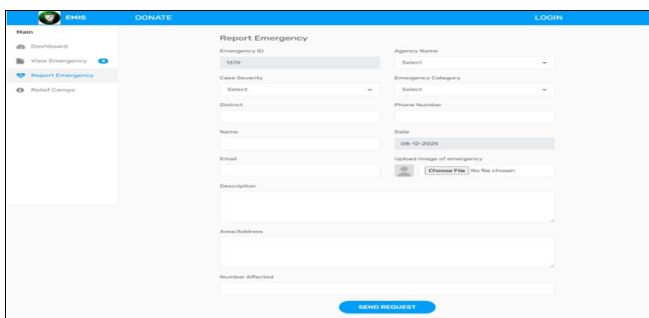


Fig 6: Report Emergencies

System Implementation Summary

Disaster Management Agencies should find ways to increase the use of MIS in disaster management such as:

- information access for disaster management
- strategic planning for disaster management
- operational management for disaster management
- disaster risk assessment for disaster management
- coordination in disaster events
- improve decision-making ability in disaster events.

Focusing on these factors and perceived benefits will enhance the adoption and role of MIS-based services for disaster management in Zambia, thereby contributing to the vision of Digital Zambia. Overall, MIS tools in combination

with the internet, GIS-based systems, Remote Sensing, and satellite observation and communication can play crucial roles in disaster mitigation and risk reduction in Zambia. When internet service is added to a disaster database, MIS becomes more powerful with this dimension of data dissemination, open and free access to the database, and real-time data circulation. Internet connectivity provides pace to satellite remote sensing and GIS. As result, disaster data become faster, and planning, implementing, maintaining, and controlling activities become relatively easier for end-users.

5. Discussion

Natural disasters lead to geographic changes in the lives of people (Fan *et al*, 2018) [11]. The goal of an EMIS is to minimize the impact of a disaster (Bonnie *et al*, 2005) [5]. In a similar manner, the United Nations Office for Disaster Risk Reduction (UNDRR) has defined disaster risk management (DRM) as “the process of using directives, organizations, and capacities to implement strategic policies, and improve capacities in order to decrease the impact of disasters” (United Nations, 2021). This system contains two facets: response, and recovery. Nowell *et al*. (2018) [22], stressed that the success of the EMIS relies on a change in the administrative structure of the system, making all units of the system linked to one administration and receiving orders from only one leader, in addition to linking all units of the system with each other by ICT. Increasing the readiness of citizens towards disasters as well as introducing a platform for reporting emergencies in the form of an EMIS will contribute to reducing the impact of disasters. The researcher agrees with this reflection, and it will be approved after the implementation of the EMIS. Unified modelling language (UML) is used to describe the system structure and behavior. The interaction between different actors in the system is specified with context diagram as part of UML diagram (Cockburn, 2008) [7]. A metamodel-based knowledge sharing system for disaster management based on UML was proposed by Othman, and Beydoun (2016) [24]. They deploy the transformations specified in the meta-modelling framework of MOF, a standard for software metamodeling offered by OMG (2003) [23]. MOF defines an interaction between different actors in the system specified with use cases as part of UML diagram (Cockburn, 2008) [7]. Interlinking every department through EMIS allows to reduce the damages of disasters.

6. Conclusion

I created a web-based application to track and enable the entire emergency case registration by members of the general public, emergency status update by the agency, resource requisition by volunteers/responders as well as agency and emergency type registration by the system administrator who could be DMMU. The flow of information offers agency contacts and notice of the emergency and response status by the agencies and the public. I did my utmost in ensuring that this project achieved the declared objective and that the project was completed because it accomplished the goal.

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