



**RECOMMENDED CONCEPTUAL FRAMEWORK FOR
A COMMUNITY-BASED FLOOD MANAGEMENT SYSTEM
IN THE GAMBIA**

AMADOU SANNEH

**MASTER OF SCIENCE
IN
INFORMATION TECHNOLOGY**

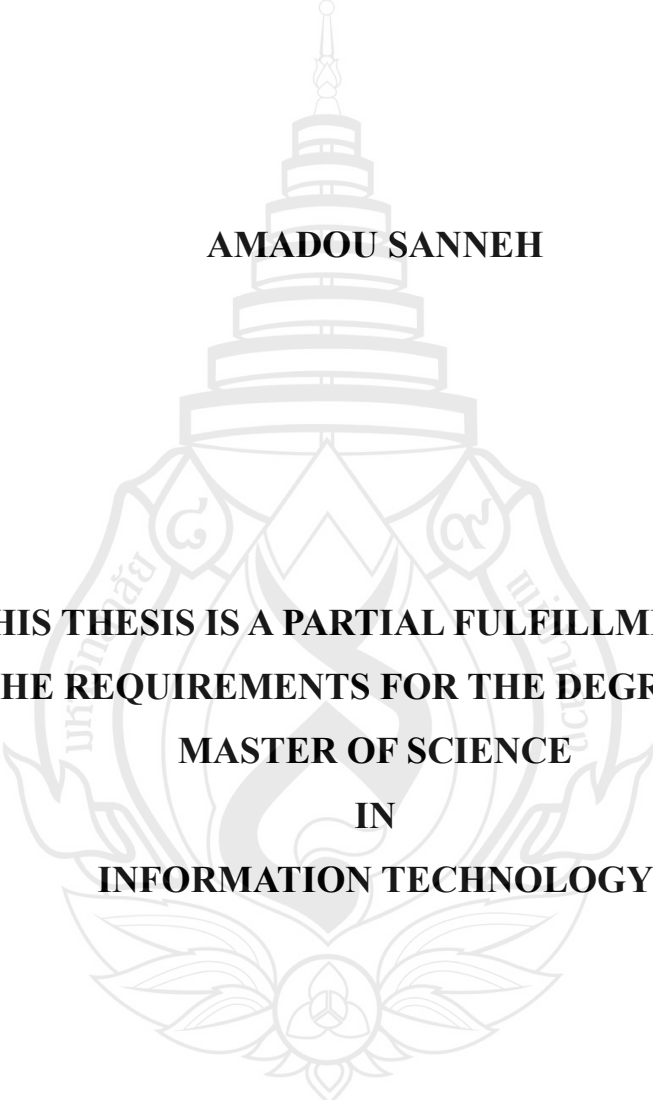
**SCHOOL OF APPLIED DIGITAL TECHNOLOGY
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**THIS THESIS IS A PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
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THESIS APPROVAL
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Thesis Title: Recommended Conceptual Framework for a Community-Based Flood Management System in The Gambia

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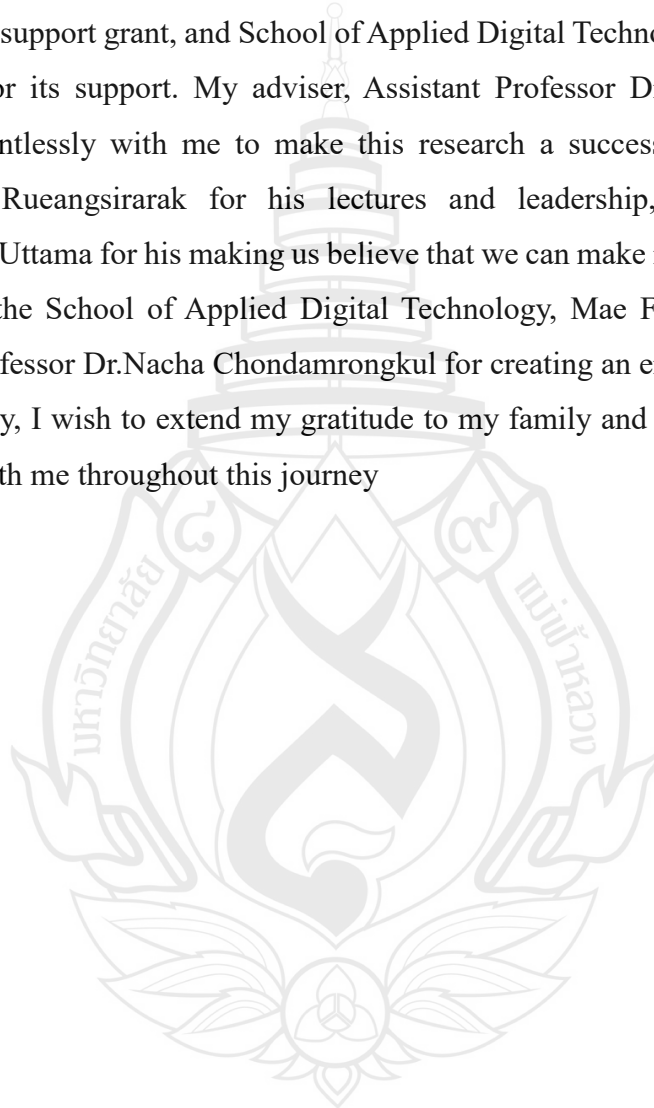
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Amadou Sanneh



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ABSTRACT

Due to its frequency and severe impacts on lives and livelihoods, flooding stands as the primary hazard in the Gambia.

This research investigates the standard of the various flood information systems in the Gambia. Both primary and secondary data were used; 385 respondents, including humanitarian workers and community members, administered a questionnaire on the quality of the heterogeneous flood information systems in the Gambia based on the constructs of the Delone and Mclean Information System Success Model (D & M IS Success Model). Data collection was done using Google form and was analysed using SPSS. On average, Humanitarian Workers and Community members were 59% satisfied with the overall quality of the existing flood information Systems. System. Recommendations were made for developing a community-based flood information system, which should empower a multi-sectoral, all-inclusive, and participatory approach for flood risk information management. Based on the findings of this research, a road map was outlined for the development of a Community Centred Flood Information

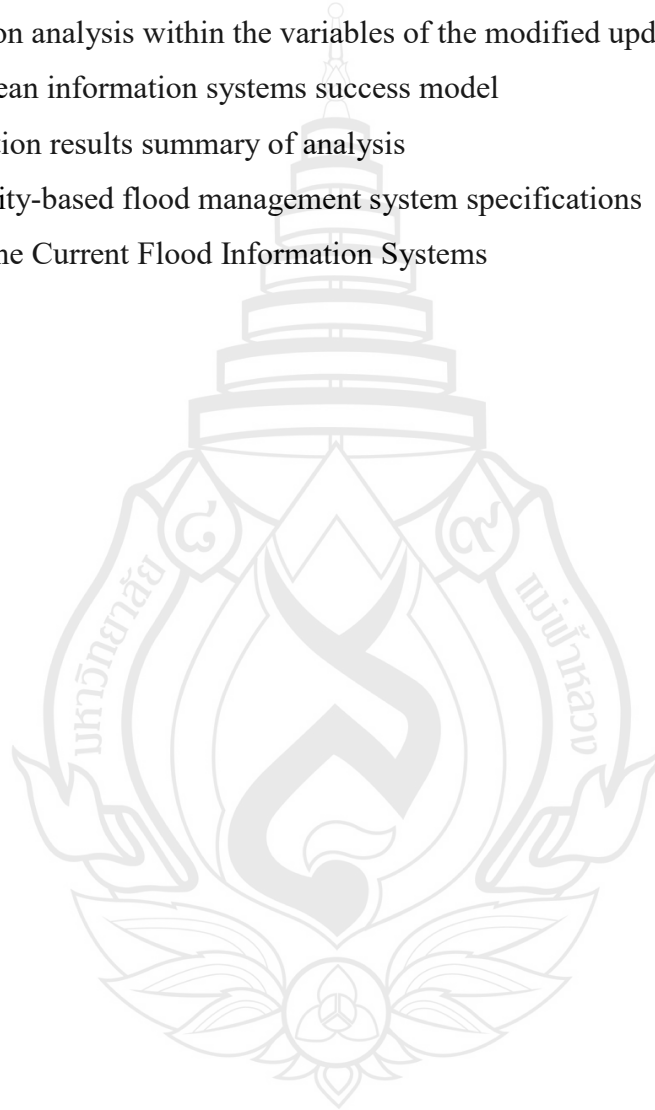
Keywords: Gambia, Flood, Delone and Mclean Information System Success Model

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CHAPTER 1

INTRODUCTION

1.1 Background: Importance of the Research Problem

The Gambia is a West African country located in the western part of Africa, at latitudes 13°00'N and 14°00'N and longitudes 13°00'W and 17°00'W. Approximately 48.6% of its inhabitants live below the poverty line. Its Human Development Index (HDI) was at 0.496 in 2019, ranking it 172 from a total of 189 countries (UNDP, 2019). The Gambia is among the smallest countries in Africa; its land area is 11,000 km². National Environment Agency (Ceesay, 2020). The Gambia lies within the tropical sub-humid eco-climatic zone. It usually experiences a long dry season from October to early June and a short rainy season from mid-June to early October. It has an average annual rainfall range from 850 mm to 1,200 mm.

Almost 50% of the total land area of the Gambia is less than 20 m above sea level, and 33% below 10 m above mean sea level. This has been one of the factors making the Gambia vulnerable to climate shocks (Baldeh et al., 2018). Flooding has been recognised as a hazard that causes almost 50% of the world's natural disasters (Hammood et al., 2021). The Gambia is not an exception among countries vulnerable to floods. Flooding, mainly pluvial floods, usually affects the poor, vulnerable and marginalised members of society, those with little or no coping capacity to its impacts. Several areas are known to be the source of flooding in the Gambia. All of them are connected to the main river through a channel. During the rainy season, these channels are filled with water and flow to communities, causing fluvial floods. About 20% of the land of the Gambia is covered with salt marshes and freshwater swamps (The Gambia National Disaster Management Agency, 2022). This is one of the factors that leads to riverine flooding in the Gambia. The Gambia is considered to be among the ten main countries vulnerable to sea level rise due to its topography. It is forecasted that approximately 92 km² of the land area of the Gambia will be flooded if there is just 1m of sea level rise (Amuzu et al., 2018). Despite floods being a natural hazard, their

consequences are exacerbated by human activities such as poor encroachment of settlements by building structures along floodplains, drainage systems that are narrow and shallow, illegal dumping, and urbanisation.

A population of 254,970 individuals were affected by floods from the year 1999 to 2021 (The Gambia National Disaster Management Agency, 2022). Flash floods and windstorms affected a population of 522,515 individuals from 1948 to 2021 (The Gambia National Disaster Management Agency, 2022). Floods have been recurring in the Gambia, affecting lives, and livelihood and interrupting essential critical sectors such as health education and Agriculture.

Disaster Risk Reduction DRR is now a global priority. Governments, United Nations Systems, and Non-Governmental Organisations have realised this and have been trying to integrate DRR in all sectors. However, a lot of countries are faced with several challenges, but this research will be limited to the technological gaps of the Gambia when it comes to the provision of Data on floods and also on the inclusion of Community members in the generation of flood risk information. Although the National Disaster Management Agency NDMA of the Gambia has invested in technology to provide risk-informed decisions for the Government, it still needs to work on these challenges. The NDMA usually publishes a hazard profile every three years. In 2022, going through the data, it presents the number of people affected by floods from 1948 to 2021. It can be realised that there were a lot of data gaps that need to be narrowed. The NDMA, due to the infancy of its establishment, did not use its database alone in providing the aforementioned data. The Agency used its database together with data from EM-data to cover the population affected by floods in a span of 73 years, 1948-2021 (The Gambia National Disaster Management Agency, 2022).

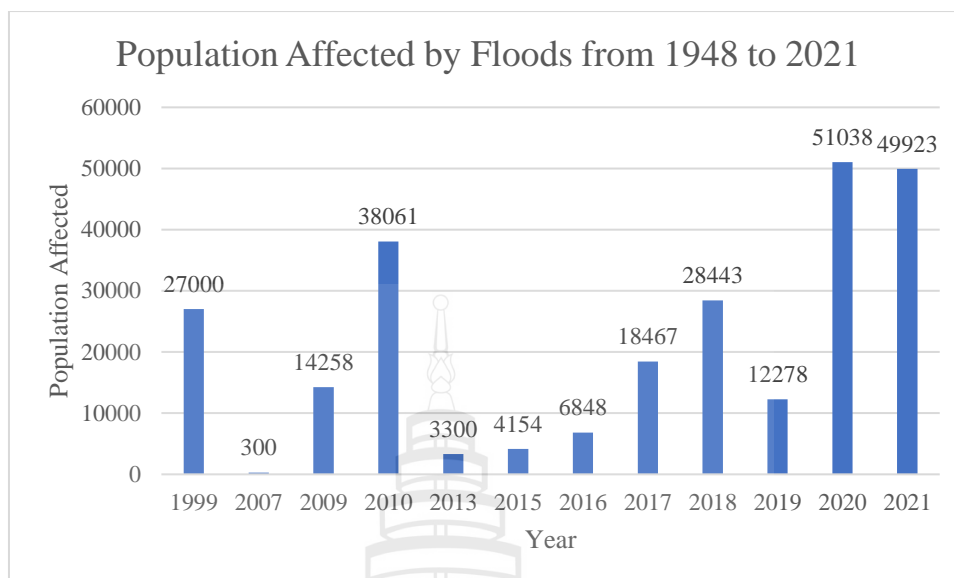


Figure 1.1 Population affected by Flood in The Gambia from 1999 to 2021

Figure 1.1 illustrates the population affected by floods in the Gambia using the NDMA Disaster Management Database and the EM-Data.

The NDMA was able to provide data for the 12 years, excluding 2022, in an unordered manner.

The NMA was not able to provide for periods not captured in Figure 1.1. This shows a lot of data gaps, which will affect early warning and flood prediction. This is one justification for the flood being immensely underreported, and hence the need to do further investigation of flood risk information systems for the Gambia. Floods are ranked as the number one hazard affecting the lives and livelihoods of Gambians due to their impacts and probability (The Gambia National Disaster Management Agency, 2022).

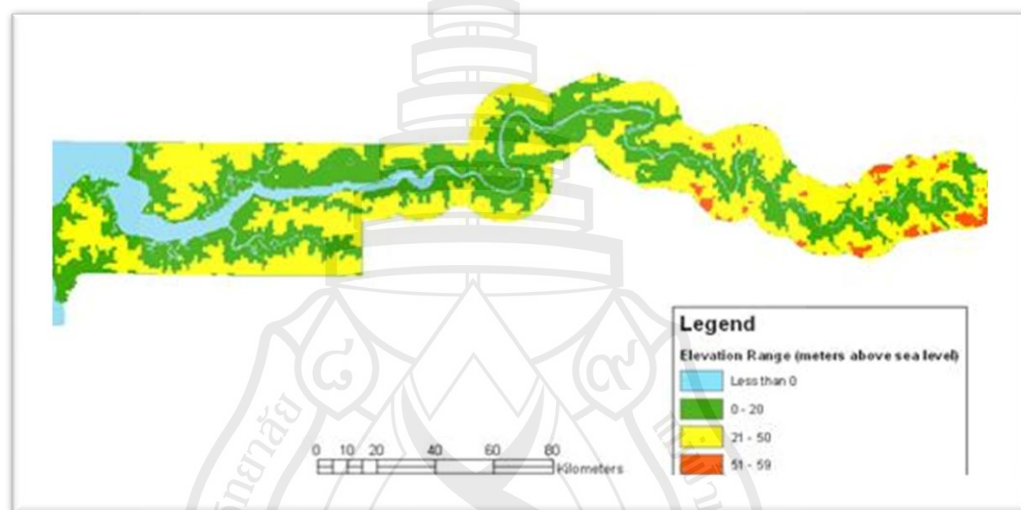
Table 1.1 Hazard risk ranking

Hazard	Frequency	Impact	Risk score
Flashflood	4.11	3.98	16.3578
Windstorm	4.02	3.89	15.6378
Fire Outbreak	4	3.87	15.48
Epidemic	3.35	3.78	12.663
Drought	3.85	4.18	16.093
Pest Infestation	3.05	3.66	11.163

Hazards were ranked and prioritised based on their associated risk. The risk for a hazard is the product of its impact and probability.

Table 1.1 shows the ranking of several hazards for the Gambia; flash-flood is ranked as the number one due to its associated risk score.

The probability of floods is high due to the geomorphology of the country, and their impacts are also high due to the vulnerability of the individuals in the country. The whole of Gambia is vulnerable to floods because it is a lowland country with none of its areas 60 meters above sea level (Jaiteh & Malanding, 2018).



Source Jaiteh and Malanding (2018)

Figure 1.2 Topology map of the Gambia

Figure 1.2 shows that there is no part of the entire Gambia 60 meters above sea level; this is one of the main reasons the Gambia is recurrently affected by floods.

The impacts of floods will continue to be an issue the Gambia has to face every year if the Government is not provided with evidence-based flood information, which should be transformed into policies. Government and other relevant stakeholders cannot act without data, hence the establishment of the Geographic Information Systems and Data Management unit of the National Disaster Management Agency in 2015, through a recommendation by the World Bank (The Gambia National Disaster Management Agency, 2022). The main term of reference of this unit is to provide the Government, stakeholders, and other relevant decision-makers with data on disasters in the Country.

Flood information is needed in all the phases of the disaster management cycle, but is more relevant in the preventive stage. A flood incident should be forecasted before striking communities, hence the need for a community-centred flood early warning. The Flood Information System should forecast a flood incident before communities are affected. The forecast data, the sectors or households affected data should be disseminated with partners and community members, for they are the ones living with the hazard and can serve the national disaster management agency in ground truthing, verification and also can at times inform the agency when a flood strikes.

1.2 The Current Flood Information System for the Gambia

The National Disaster Management Agency is responsible for coordinating all disasters in the Gambia. The NDMA is mandated to prevent, make preparedness, mitigate, and build resilience to flooding, also respond to the needs of those affected, and to some extent relocate affected households. The Current Flood Information System for the Gambia comprises various systems, namely:

1. Flood Management System
2. Flood Forecast System
3. National Emergency Call Center
4. Community Members

The NDMA intends to have interconnected Systems to provide informed and timely flood risk information for community members. Unfortunately, none of these systems is connected. The current flood information System of the Gambia; it comprises the flood management system, which is hosted by the National Disaster Management Agency, the Flood Forecast System, which is hosted by the Department of Water Resources, the national emergency call center, and the community members, who are the main beneficiaries of the generated information. The current flood information system is captured in Figure 5.1.

1.2.1 Flood Forecast System

Through the Flood Forecast System, the Department of Water Resources provides flood predictions and shares them with the National Disaster Management

Agency via reports, emails, and social media platforms. The Flood Forecast System is not connected or linked to the flood management system and the National Emergency Call Center of the National Disaster Management Agency. Data from the Flood Forecast System cannot be accessed using the Flood Management System of the National Disaster Management Agency. In the same vein, Data from the Flood Management System is not accessible using the Department of Water Resources flood forecast system. This disconnection between both systems retards flood warning dissemination and hence affects overall flood preparedness. This affects the timeliness of the data, which has an impact on the quality of the Flood data.

1.2.2 Flood Management System

The Flood Management System of the National Disaster Management Agency is the main system for storing, managing, and analysing flood data in the Gambia. The National Disaster Management Agency does share reports on the impacts of floods in situational analysis reports with stakeholders, but not with community members.

The Flood Management System is not connected to the Flood Forecast System and is also not connected to the National Emergency Call Center. This is a weakness in the current flood information systems, which can lead to the inclusion or exclusion of affected households.

1.2.3 National Emergency Call Center

One of the responsibilities of the National Disaster Management Agency is to disseminate flood information to community members in a format they can understand. This was the main reason for establishing the National Emergency Call Center NECC. However, the NECC is dormant; the agency has not been using it. It could have been very useful in connecting the Agency to community members. Through the NECC, the Agency can be informed by the communities once they are affected by floods, and the agency can also share flood warnings and flood data with community members. The NECC is the most important part of the Emergency Operating Center; it should serve as an interface between the Agency and stakeholders, organisations, and, most importantly, affected individuals or communities. The NECC helps in coordinating real-time actions, sharing, and dissemination of flood and other risk information. The NECC should serve as a hub between humanitarian workers and community members. There cannot be a community-centred flood information system without NECC. The NECC

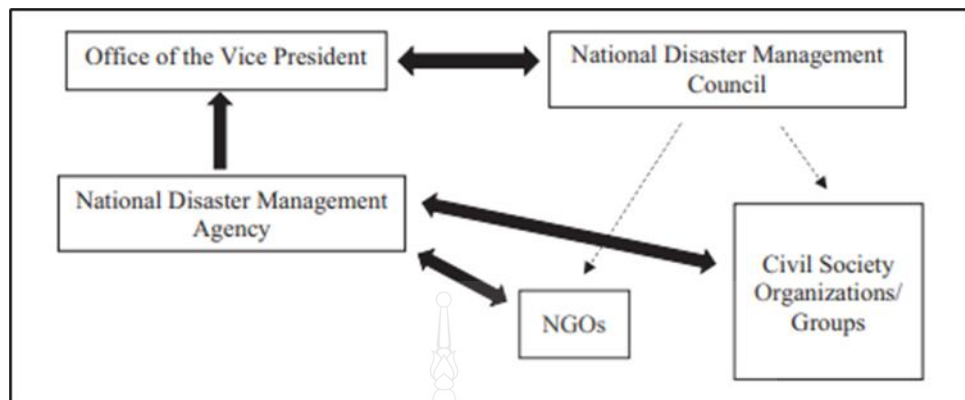
should complement the flood information system since it disseminates data on the impacts of floods, flood early warnings, and updates on activities at the community level. The NECC will enable community members to log their complaints on inclusion and exclusion errors during flood data collection and complaints or satisfaction during flood response activities. If people are affected and the Disaster Management Agency and partners are not informed, flood data will not be collected and hence will not be captured by the flood information system. This adds some limitations to its data reliability, integrity, and accuracy.

1.2.4 Community Members

The Community Members are the main beneficiaries of the Flood Information System, the flood management system, the flood forecast system, and the national emergency call center, which were created to provide flood risk information to save lives and properties, and the livelihood of community members. Unfortunately, as of now, limited flood information is shared with community members, and community members are not included in flood data collection and analysis.

1.3 Overview of the National Disaster Management Agency NDMA

The NDMA was established by an act of parliament in 2008 to coordinate disasters in the Gambia. Disasters are multifaceted, hence making coordination difficult. Disasters affect many sectors, and their impacts cannot be mitigated by a sector alone. Coordination of disasters requires multi-sectoral cooperation, collaboration, and communication on hazards and their impacts.



Source Rivera et al. (2020)

Figure 1.3 National disaster management framework

Disasters are a concern for all, and their impacts can only be mitigated using a multi-sectoral approach. Figure 1 displays the national disaster management structure. The National Disaster Management Agency serves as the secretariat for disaster risk reduction. The agency is directly under the office of the vice president. This is to gain political willingness, especially when it comes to policy implementation. The Agency reports to the Office of the Vice President. The office of the vice president has two-way communication with the National Disaster Management Council. The National Disaster Management Council serves as the governing body for disaster risk reduction in the Gambia (National Disaster Management Act, 2008). It comprises almost all the heads of government institutions.

As disaster risk reduction is expensive and requires a lot of capacities, both human and financial, the agency is not limited to working with other government institutes, but also with Non-Governmental Organisations and Civil Society organisations. The Agency reports to both non-governmental organisations and Civil society organisations and vice versa.

The integration of disaster risk reduction in the activities of other government institutes, non-governmental organizations, and civil society organizations is one of the goals of the national disaster management policy (UN Office for Disaster Risk Reduction, 2021).

Disasters in general, mainly flooding and its impacts, cannot be managed by one institute. Some of the floods in the Gambia are due to illegal dumping, and the agency

responsible for waste management is the National Environment Agency; some are due to poor road and drainage systems, which are the responsibility of the national road authority. Due to floods, households are displaced and most of the time are lodged at schools, hospitals, and farmlands are washed away. These are just a few of the impacts of floods, and as highlighted, many sectors are affected; hence, in building resilience against floods, various institutions are needed. This cross-cutting nature of disasters is a challenge to existing disaster policy. There are various policy cycle models, but the most common model is the five-step Laswell's policy (Sinclair, 2019). All the stages of this policy cycle, from problem definition, agenda setting, policy development, implementation, and policy evaluation, require a multisectoral consolidated effort. The National Disaster Management Agency's role is to take leadership when it comes to disaster risk reduction. This is no easy task. It is always challenging in a humanitarian setting to coordinate. Organisations and individuals want to coordinate but hate to be coordinated. Applying the institutional theory on how the national disaster management agency withstands pressure from partner institutions and community members, it will be revealed that the agency has been significantly influenced by both partners and community members. Disaster risk reduction is not a solo responsibility. The national disaster management agency, since its inception, has been working with stakeholders in all stages of the disaster management cycle to save lives and livelihoods. The stakeholder theory dates back to the 1960s, the Stanford Research Institute highlighted stakeholders, elaborating that organisations need not only support from stakeholders but also stakeholders to survive (Mahajan et al., 2023). Without stakeholders, the agency would not perform as expected.

The current flood management system, mainly the flood management system hosted by the National Disaster Management Agency and the flood forecast system hosted by the Department of Water Resources, has been developed with significant inputs from partner organisations, but is still challenged by the heterogeneous needs of these organisations. Their performance is impacted by the environment and by community members.

Connecting the National Disaster Management Agency's challenges in terms of flood management to the system theory, it can be concluded that the only way forward is an all-inclusive approach.

The system theory takes into consideration three variables, which are the environment, the organisation, and the staff within organisations (Lai & Lin, 2017).

Flood data collections are impacted by the environment; some communities are remote, hard to reach, have no internet connections, and some are not motorable.

All these factors affect flood data collection and, overall, the quality of the flood data. Organisations' commitment and input can also affect a flood management system; humanitarian actors are also working in the best interest of their organisations.

The government provides financial support for the National Disaster Management Agency, and hence, additional funds from partner organisations are required to deliver as required. Most of these organizations in exchange for the funds they provide, command the agency to capture their indicators in their database. The staff of the organisation and community members are the most important part of the system; without their input, the data would not be available to inform flood policy decision-making. Over the years, the agency has been engaged in flood data collection and flood information sharing with partner organisations and community members. Initially, during the inception of the agency, whenever a flood is forecasted, community members find it very difficult to accept the belief, and they are usually asked whether the agency was told by God. New technologies are always confronted with this challenge. The diffusion of innovation is defined as a doubt mitigation cycle (García-Avilés, 2020). In the beginning, people were skeptical about the information shared, but with time, many are trying to adapt. This paper uses an action research theory by involving those affected by floods, specifically community members, in coming up with a community center flood information system for the Gambia. The National Disaster Management Agency, partner institutions, and most importantly, community members were engaged in identifying the bottlenecks of the current flood management system. The gist of the national disaster management policy is to create safe and resilient communities by increasing the sharing of information in disaster risk reduction and management of societies (UN Office for Disaster Risk Reduction, 2021).

The national disaster management agency, in the execution of its mandate, always includes partners from both the private and public sectors, non-governmental organizations, and community members. According to (Ansell & Gash, 2008), collaborative governance brings together both public and private sectors in a joint

forum with public agencies in decision-making. This is exactly what the National Disaster Management Agency does when it comes to flood management; stakeholders and community members are both engaged in collecting evidence-based data for informed policymaking.

1.4 Global Context

Globally, this paper is in line with the Sendai Framework for Disaster Risk Reduction 2015-2030. The Sendai Framework for Disaster Risk Reduction is an agreement to direct disaster Risk Reduction Efforts globally.

The focus of the Sendai Framework is on being proactive instead of reactive to disasters.

The Sendai framework highlights that to mitigate the occurrence and impact of disasters, a better understanding of disaster risk reduction and risk governance is needed to minimise the associated risks that could lead to disasters. This is only possible by conducting regular assessments and data collection (Mizutori, 2020).

1.4.1 Sendai Framework Priority One

The Sendai Framework Priority One emphasises the understanding of risk (United Nations Office for Disaster Risk Reduction, 2015). This can only be achieved if data is collected on the impact, frequency of hazards, and vulnerability of communities.

1.4.2 Sendai Framework Priority Two

The priority area two is Strengthening Disaster Risk Governance. This can only be attained if data is available, reliable, and up to date, and also by involving community members in the collection of data, during verification of affected households, and data sharing with community members, among other relevant partners.

1.4.3 Sendai Framework Priority Three

Sendai Framework Priority 3 is on investing in Disaster Risk Reduction. This highlights the cost-effectiveness of Disaster Preparedness, such as having a community-based Flood Information System, which will provide flood warnings and flood risk information compared to the high cost of disaster response and recovery

1.4.4 Sendai Framework Priority Four

The fourth Priority of the Sendai Framework is Enhancing Disaster Preparedness for Effective Response (United Nations Office for Disaster Risk Reduction, 2015). It will be difficult to achieve Priority Three without an Early Warning System and historical data. In a nutshell, priorities 1,2, 3, and 4 of the Sendai frameworks emphasizes the need to have a reliable disaster database.

Having an Ideal community-centered flood information system will significantly help the Gambia in achieving priorities 1, 2, 3, and 4 of the Sendai frameworks when it comes to the occurrence and impact of floods.



CHAPTER 2

LITERATURE REVIEW

2.1 Previous Related Studies

Flooding has been recognised as a hazard that causes almost 50% of the world's natural disasters (Hammood et al., 2021). Despite the severity of the impacts of floods globally, it is immensely understood and understudied in developing countries (Nkwunonwo et al., 2020). Conducted a study on urban flood risk management using various flood models and compared their strengths and weaknesses (Wagner et al., 2021). Conducted research on flood risk management in Africa, confirming when the flood risk becomes residual. It confirms that countries like Cape Verde, The Gambia, Sierra Leone, Mali, and Guinea-Bissau were featured less than three times in the list of selected articles. Countries with the most related articles were Nigeria and Ghana (Onifade et al., 2014), who wrote on the impacts of floods in Ibadan, Nigeria, looking critically at various flood management options (Long'or Lokidor et al., 2024). Conducted a study on the implementation of nature-based solutions for lasting flood management in East Africa, using a systematic review approach from 2012 to 2020, and only 14 articles are related to this research. This indicates how immensely flood and its impact are understudied in some countries.

When it comes to the application of technology in flood risk management, several studies were conducted (Bakhtiari et al., 2023). Conducted a review of the application of Cutting-edge digital visualisation tools for urban flood management (Bakhtiari et al., 2023) highlights that cutting-edge digital visualisation tools are used mainly in developed countries and less in developing countries (Koontanakulvong & Santitamnanon, 2013). Conducted a study on the usefulness of information technology in the 2011 Thailand flood (Koontanakulvong & Santitamnanon, 2013) highlights how flood information was shared with community members for flood prevention (Gomez et al., 2020). The Gambia is ranked among the 10 countries prone to sea level rise globally. Flooding has contributed to 33 per cent of natural disasters globally from 1960

to 2006 (Birkholz et al., 2014). The population affected by riverine floods is forecasted to increase from 65 million to 132 million from the year 2020 to 2030 (Hill et al., 2023).

The World Bank reports that over the past 20 years, over 1.65 billion people have been affected by floods (Gosset et al., 2023). Over 7 million individuals lost their lives, and an economic loss of almost USD 9.6 trillion was incurred due to floods from 1900 to 2022 (Abunyewah et al., 2023).

Flood resilience assessments are vital because they enable communities to know whether they can respond to the impact of a flood or not (Hussain et al., 2023).

2.2 Similar Studies Conducted in Countries with the Same Socio-economic Conditions

When considering countries with socio-economic conditions comparable to The Gambia, we typically look at factors such as GDP per capita, population size, human development index HDI, poverty rate, economic structure agriculture-driven vs. industrialised, and regional context. Based on these indicators, several countries in West Africa and other regions can be considered comparable. To cope with or mitigate the impact of any hazard, especially flooding, a country should have a good socio-economic condition. In Sierra Leone (Koroma et al., 2024), a flood vulnerability assessment was conducted for Freetown, Sierra Leone, using geographic information System tools and AHP-based Multi-Criteria Decision-Making MCDM analysis to assess the temporal and spatial variation in flood risk. The objective of this study was to detect vulnerable flood zones using criteria like the Digital Elevation Model, drainage density, road distance, and distance to river, among other factors. In Liberia (Koffa, 2018), a study using Barton's collective stress theory and Edwards' varied response theory, to know how flood victims gauge the significance of the Liberian Government's Flood Management strategies. Twenty-five individuals conducted an open-ended semi-structured survey. A total of twenty individuals were flood victims, and five were managers of government and non-government organisations. The result from the data analysis suggested that the government and community need to have a zonal regulation polices to mitigate the impact of flooded drainage. This paper also

suggested the provision of funds and support for disaster management institutions, decentralising and supporting local government agencies for disaster management and empowering communities by providing funds and training their members. In Togo (Blakime et al., 2024), this study explores the application of remote sensing, geographic information systems GIS and analytical hierarchy processes AHP for flood hazard mapping in Greater Lomé. Maps of seven 7 drivers of flood hazards, namely flow accumulation, rainfall intensity, geology and soil, land use, slope, elevation and distance from the drainage network, were prepared by integrating remote sensing data into a GIS environment. The weight of each factor was analysed using the analytical hierarchy process and was used to analyse the flood risk index.

A total of 210 respondents were selected randomly to evaluate how flood-prone households are in Kasse Municipality, Kasese District, Uganda, using a Principal Component Analysis (Tibara et al., 2023).

Conducted a study in Guinea-Bissau to evaluate and map out areas exposed to coastal floods using Sea Level Rise scenarios for the years, 2041,2083 and 2100 (Fandé et al., 2022).

Three coastal flood hotspots of the region| Bissua, babaque, and Suzana were used as a case study.

At each of these hotspot areas prone to coastal flooding, the water levels were evaluated in a geographic information system. It was confirmed that for each of the coastal flood-prone areas, land exposure escalates significantly and exponentially with increasing Sea level rise scenarios. In Niger (Fiorillo et al., 2018), conducted research to provide decision makers and the scientific community with a timely and reliable data source in relation to floods in Niger from the period 1998 to 2015 at all levels. Accurate flood data were generated from the national official flood damage database. This database captures the impact of floods in the country. During this research period, a significant flood event regarding flood impacts was found.

2.3 Similar Studies Conducted in the Gambia

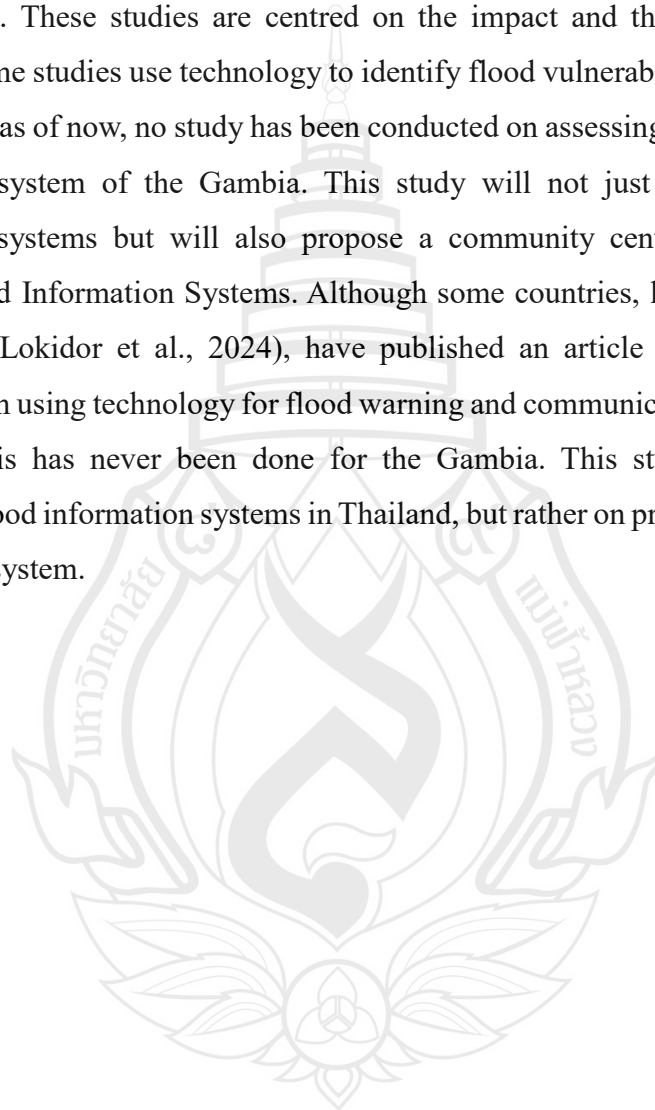
Several studies were conducted in the Gambia on floods and their impacts. Unfortunately, none of these studies were on the proposal of a community-centred flood information system. (UNDAC, 2022) Conducted a study, highlighting Segregated Flood data collection systems. After the multi-sectoral assessment implemented by the National Disaster Management Agency, the United Nations and partners, it was recommended that there be a unified system for the training of data collectors. Direct assessments of economic damages caused by natural disasters in the Gambia are limited. The Gambia does few Cost analyses on the economic impact of natural disasters on the lives and livelihoods of its citizens. The existing flood information Systems are not capturing the economic value of the disaster losses (Han & Kirabaeva, 2024). (Acaps, 2022). highlighted in his study that due to challenges in getting to impacted communities, scarcity of fuel and inadequate fund data collection has been difficult and hence hindering response. (Ettritch et al., 2018) affirmed in this study that average resolution digital elevation models are used for mapping and, hence, challenging flood mapping applications. During the 2022 flood, the NDMA reported that approximately 1961 households were affected as of 31 July 2022. After a verification by GRCS on 02 August 2022, it was confirmed that 606 households were affected (IFRC, 2022).

There is a weak dissemination of flood warnings to those at the community level, inter-governmental and authority level (UNDP, n. d.). The Gambia is considered to be among the 10 countries with the worst internet speed and quality.

This is a factor which affects real-time data submission and emergency response (Sanna Camara). Flood Data is not shared with community members who are affected the most (Jonga et al., 2021; Yengoh, 2024). Conducted a flood risk assessment using Geographic information systems. This assessment was done mainly to identify flood-prone areas, to know the vulnerability of road networks, health facilities, key infrastructures, and settlements to flooding.

Although many countries have conducted several studies on using technology for flood risk management and other flood-related studies, this is not the case in the

Gambia. Based on the awareness of this research, not a single paper was published on the role of flood information systems and the inclusion of community members in the management of floods in the Gambia. Although there are a few papers written on floods in the Gambia, none of them were on using technology for flood management. Almost all of the studies conducted were on floods and their impacts on the lives and livelihoods of Gambians. These studies are centred on the impact and the causes of flooding. Although some studies use technology to identify flood vulnerability. To the awareness of this study, as of now, no study has been conducted on assessing the fragmented flood information system of the Gambia. This study will not just evaluate these flood information systems but will also propose a community centre flood information system. Flood Information Systems. Although some countries, like Thailand, as cited in (Long'or Lokidor et al., 2024), have published an article on flood information technology on using technology for flood warning and communication with community members, this has never been done for the Gambia. This study was also not on evaluating flood information systems in Thailand, but rather on proposing an ideal flood information system.



CHAPTER 3

RESEARCH METHODOLOGY

3.1 Overall Methodology

Before starting this research, brainstorming on the topic of floods was conducted with flood experts and agencies responsible for flood management, and then identifying why the frequent occurrence of flooding in the Gambia.

After identifying why occurrence of flooding at an alarming rate in the Gambia, a literature review on floods and their impacts was conducted.

3.2 Research Design

This study used a mixed-method research design using both quantitative and qualitative approaches to evaluate gaps in the existing flood information systems in the Gambia. This method is used to include the inputs of community members. A structured questionnaire was developed using the constructs of the Delone and Mclean Information Systems, and it was shared with humanitarian workers using Google Forms to evaluate the technical aspect of the existing flood information systems in the Gambia. A Focus Group discussion was also held with community members to get the social aspect of the existing flood information systems in the Gambia. The objective of this study is to evaluate the gaps of the existing flood information systems in the Gambia and to propose a homogeneous community-centred flood information system, a flood information system that will link various flood information systems and a system which will be community-centred.

3.3 Study Area

This study was conducted in all the administrative regions of the Gambia. There is no part of the Gambia 60 meters above sea level. The entire country is vulnerable to floods. In addition to the varying topology of the regions, floods are exacerbated by other factors such as population density, road construction, amount of rainfall recorded, institutional capacities and poor drainage systems. Due to these factors, this research was conducted in all the regions of the Gambia.

3.4 Sample Sizing and Targeted Population

This study was conducted with two main groups: humanitarian workers and community members.

The humanitarian workers work with the Government, United Nations Systems, non-governmental organisations and other partners in disaster management. The community members are those living in the communities, including women, youth and the old.

A sample size is a fraction of the population selected to represent the characteristics of a whole group (Cochran, 1977). Sampling is important because collecting data from an entire population will take time, will be expensive and unfeasible. To have accurate data at a lower cost, this study used the Cochran formula to determine an ideal sample size. The Cochran formula is ideal for large populations and helps to determine a sample size with high confidence and a small margin for error

This formula is ideal for sampling large populations. If a sample size is chosen randomly, the information provided will be more accurate for smaller populations than for larger populations. This formula can minimise this error if the population is relatively small. The larger the sample size, the higher the cost of data collection, and the smaller the sample. Size the less accurate information generated (Hasan & Kumar, 2024).

In order to provide precise data and also to minimise cost, this paper uses the Cochran formula for the determination of an ideal sample size. The Cochran formula is

utilised to give an appropriate sample size for research when you want to estimate a proportion or a mean for a population with high confidentiality and precision (Cochran, 1977).

The Cochran formula is given as:

$$n_0 = Z^2pq / e^2$$

where:

n_0 = initial sample size estimate

Z = standard normal deviation 1.96 at 95% confidence level

p = estimated proportion of the population, 0.5 for maximum variability

q = 1 - p

e = desired level of precision 0.05

Substituting the values:

$$n_0 = 1.96^2 \times 0.5 \times 0.5 / 0.05^2 = 385$$

Since the population of The Gambia, based on the 2013 census, was 1,800,000, the formula was adjusted for a finite population using:

$$n = n_0 / [1 + n_0 - 1 / N]$$

$$\text{Substituting the values: } n = 385 / [1 + 385 - 1 / 1,800,000] \approx 385$$

Therefore, the final sample size was 385 respondents. This number was deemed sufficient to achieve a 95% confidence level and a 5% margin of error, providing reliable and generalizable results.

3.5 Research Concept

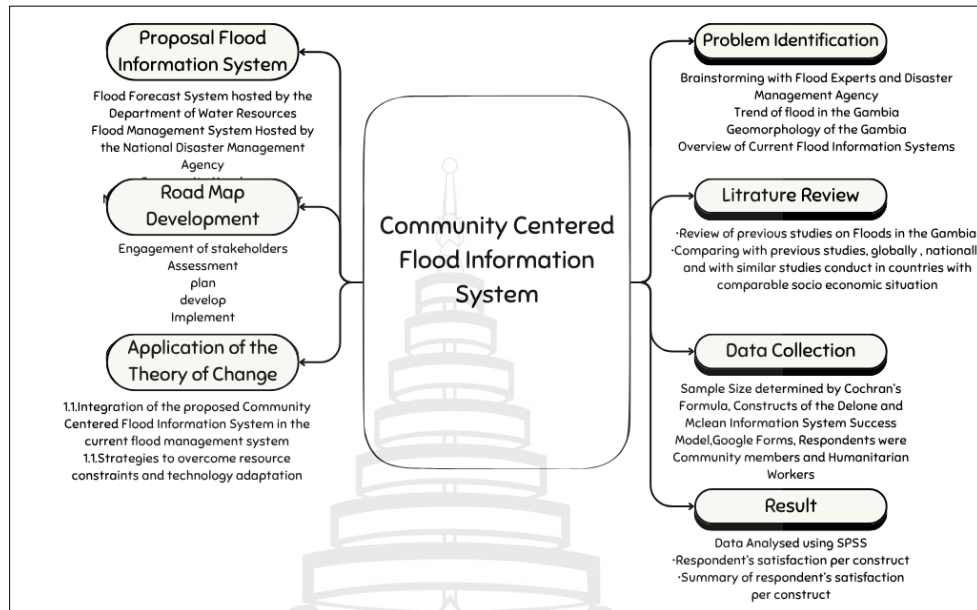


Figure 3.1 Research concept

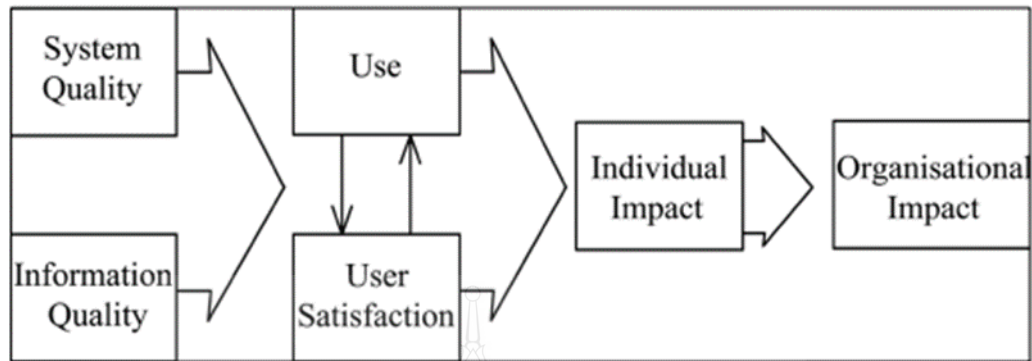
Figure 3.1 illustrates the main variables captured in this paper. Initially, there was a problem identification done by a series of consultations with flood experts and the agencies responsible. A literature review centring on floods and their impacts was conducted. Data collection was done in all the 7 administrative areas of the Gambia. Respondents were humanitarian workers and Community Members. A questionnaire was developed using the construct of the Delone and McLean Information Systems. Google Forms were used. The sample size was determined using Cochran's Formula, and SPSS was used for data analysis. An ideal community-centred flood Information System was proposed based on the gaps in the existing Flood management system.

The creation of a roadmap for the development and implementation of the community-centred flood Information System and finally, applying the theory of change to sustain the proposed community-centred flood Information System.

3.6 Investigation of Different Information System Models

Flood Information Systems are mainly developed to provide flood information and flood risk information to help prevent, mitigate, and build resilience against flooding. Users are a critical component of a technology. The success of a technology does not depend on the technology alone but also on its users, their attitudes, and behaviour towards it. Over the years, there have been several technology models and useful theories to measure the acceptance and adaptation of a technology and also to predict behaviours. The Diffusion of Innovation DOI theory was reviewed in 1980, but most of its models were developed in 1970 (Meade & Islam, 2006). This theory measures how the adoption of a technology spreads over time. DOI Theory was developed on the qualities of a technology and users' attitudes towards an innovation. The perception of organisations is not captured by the DOI theory (Amini & Jahanbakhsh Javid, 2023). The Technology Organisation Environment Framework was developed originally in 1990 (Oliveira et al., 2019). This framework looks into the adaptation and implementation of technology by considering organisation, environmental factors, and the characteristics of the technology itself. The TOE does not capture the adaptation of individuals, but rather it captures the adaptation of organisations. The theory of reasoned actions and its successor, the theory of planned behavior predicts people's behaviour based on their attitude and beliefs.

In 1989, the Technology Acceptance Model was developed by Davis, and he proposes that based on the perception of the ease of use of a technology and its usefulness, a particular technology will be accepted and adopted (Sanneh et al., 2022). This model was extended several times from 1989 to 2003 when the unified theory of technology acceptance and adaptation model was developed. Technology Acceptance models include the TAM, TAM2, UTAUT, and UTAUT2. All these different Technology Acceptance models predict the acceptance and adaptation of a technology based on various constructs. The DeLone and McLean Information System Success Model uses six dimensions to measure the success of an Information System. These dimensions are System Quality, Information Quality, Usage intention, System use, user satisfaction, and net system benefit.

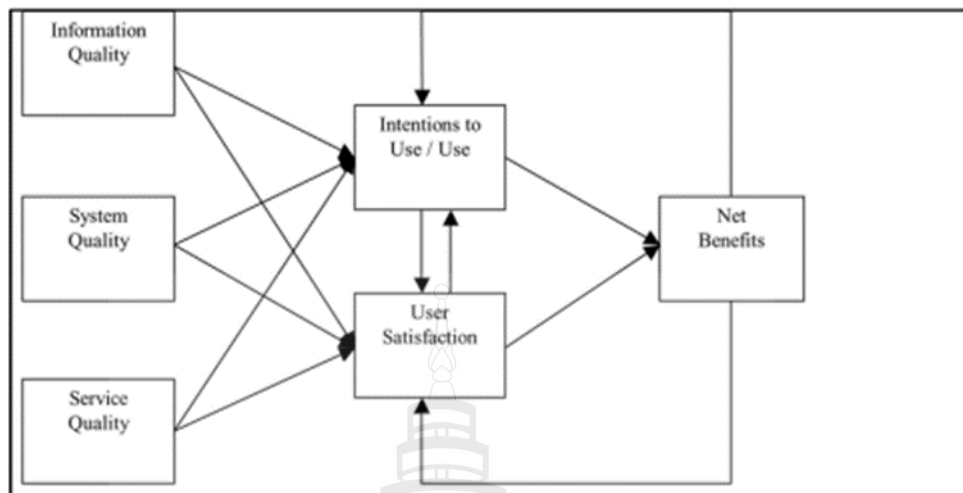


Source Delone and Mclean (2003)

Figure 3.2 Delone and Mclean IS success model Delone & Mclean, 1992

3.6.1 Delone and Mclean Information Systems Success Model D & M IS SUCCESS Model

The D & M IS Success Model was developed by Delone and Mclean in 1992 to determine the success of Information systems. Originally, it had 6 dimensions as shown in Figure 3.2. These dimensions are System Quality, Information Quality, Use, User Satisfaction, Individual Impact, and Organisational Impact (Seliana et al., 2020). System quality and information quality both influence the use of a system and user satisfaction. The use of a system and user satisfaction influence each other. Both the use of a system and user satisfaction influence individual impact, which in turn influences organisational impact.



Source DeLone and McLean (2003)

Figure 3.3 Updated Delone and Mclean IS Model, 2003

The Delone and McLean Information Systems Success Model was updated in 2003 (Urbach & Müller, 2012). Delone and Mclean extended the model by adding service quality as a dimension and also joined the individual impact to the organisational impact as the net benefit.

Figure 3.3 shows the updated Delone and Mclean IS Model; it also has 6 dimensions. The system quality measures the flexibility of the system, reliability, portability, integration, and importance of the system. Information quality measures the accuracy of the information generated, timeliness, consistency of the information, completeness, and relevancy of the information. Service quality measures empathy, responsiveness, and reliability. The net benefit is the most important dimension; if it is positive, then the system will satisfy users, and they will use or have the intention to use it.

This research uses a modified version of the updated Delone and Mclean Information System model to investigate the current flood information systems in the Gambia. This modified Delone and Mclean Information System model is similar to the model used by Hammood et al. (2021). This modified model is used as a concept model for this research. The six constructs of the updated Delone and Mclean Information Systems model are used to identify gaps, challenges or room for improvement in the current Flood Information System. A modified D&M Information Systems Success

model was selected as the benchmark for this paper since it was tested and confirmed by Mohammadi (2015). According to Hammood et al. (2021), after conducting a systematic review, concluded that the Delone and Mclean Information System success model is the most suitable model to ensure the success of the Flood Early Warning and Response System

3.6.2 Research Mode

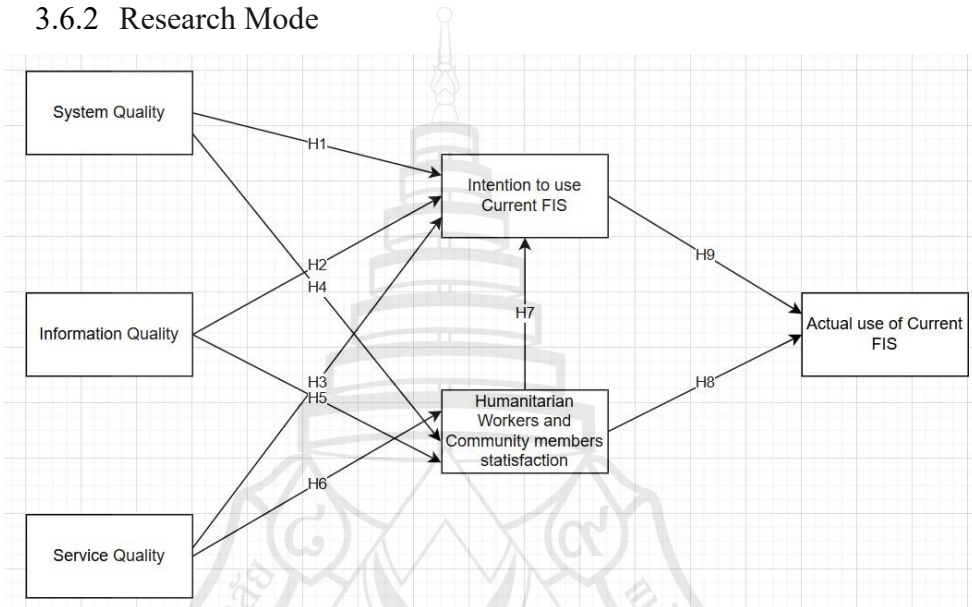


Figure 3.4 Research model

This research used a modified version of the updated Delone and McLean Information System model. The variables of this model were used to identify gaps in the current flood management System.

System Quality looks at key characteristics of the Flood Management System, such as whether it provides real-time flood data, whether it is reliable, whether its data collection tool is portable, and whether the flood information system is user-friendly. System quality will influence user satisfaction and intention to use the Flood Information System. System quality has a positive influence on the actual use of a system and user satisfaction (DeLone & McLean, 2003). Thus, this study formulates the following hypothesis

H1: System Quality has a positive influence on the intention to use the current Flood Information System

H4: System Quality has a positive influence on the satisfaction of humanitarian workers and Community members.

Information Quality: This determinant looks at the validity of the information generated by the flood information system.

It looks at variables like data dissemination, accuracy, information clarity, completeness of the flood risk information, and communities' access to flood information. Information quality influences users' satisfaction with and intention to use the proposed Flood Information System (FIS). Information quality has a positive influence on the actual use of a system and user satisfaction (DeLone & McLean, 2003). Thus, this study formulates the following hypothesis:

H2: Information Quality has a positive influence on the intention to use the current Flood Information System

H5: Information Quality has a positive influence on the satisfaction of humanitarian workers and Community members.

Service Quality consists of variables like real-time data collection, portability, flexibility, reliability, and ease of use. An ideal FIS should allow for real-time data collection, and its assessment tools should be portable and flexible. FIS data collection should be possible even without the internet, as many mobile data collection tools, such as Kobo Collect and Open Data Kit. System quality, Information Quality, and Service quality can also influence users' satisfaction and intention to use the proposed FIS. Service quality has a positive influence on the actual use of a system and user satisfaction (Pitt et al., 1995). Thus, this study formulates the following hypothesis:

H3: Service Quality has a positive influence on the intention to use the Current Flood Information System

H6: Service Quality has a positive influence on the satisfaction of humanitarian workers and Community members.

Humanitarian workers and Community satisfaction are how the Humanitarian workers and community members appreciate the current FIS. User satisfaction influences the use of the system (Mahande et al., 2019). User satisfaction influences actual use of the system (Catedral, 2023). Thus, this study formulates the following hypothesis:

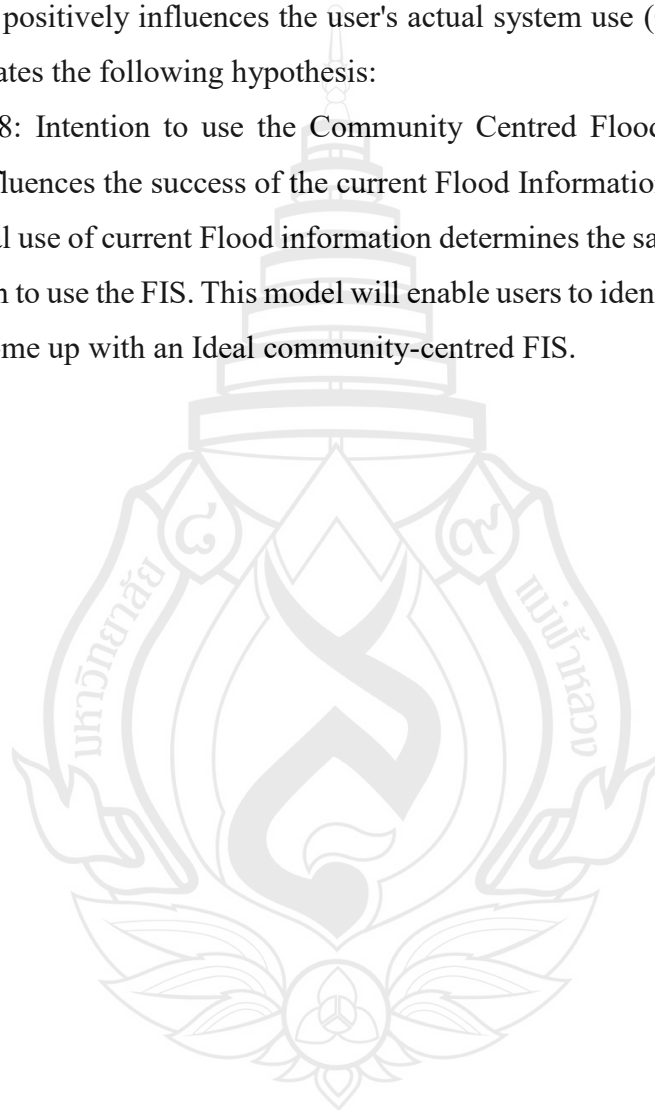
H7: Satisfaction of Humanitarian Workers and Community members positively influences the use of the current Flood Information System

H9: Satisfaction of Humanitarian Workers and Community members positively influences the success of the current Flood Information System

The user's Intention for the FIS is their willingness to use it. User's intention to use a system positively influences the user's actual system use (Ojo, 2017). Thus, this study formulates the following hypothesis:

H8: Intention to use the Community Centred Flood Information System positively influences the success of the current Flood Information System

Actual use of current Flood information determines the satisfaction of users and their intention to use the FIS. This model will enable users to identify gaps in the current FIS and to come up with an Ideal community-centred FIS.



CHAPTER 4

DATA COLLECTION AND ANALYSIS

4.1 Data Collection

Data collection was done using both primary and secondary data to gauge the quality, gaps, or limitations of the existing flood management systems in the Gambia. This research uses a holistic approach by not only limiting its findings to the evaluation of flood management systems but also analysing the satisfaction of the people for whom the flood management systems were developed.

This research uses the constructs of the modified updated Delone and Mclean Information Systems success model in identifying gaps within the current flood information systems in the Gambia. Research questions were developed using Google Forms for 385 respondents.

The respondents were humanitarian workers, mainly working in organisations/Institutions that are the main users of the flood information systems, and community members in the communities. These respondents were from all the regions of the Gambia. The humanitarian workers filled out the form online, and the community members filled out the form during a Focus Group Discussion.

The survey was not limited to the quality of the flood information systems but also covered communities' evaluation of their satisfaction with the flood information generated by the organisations hosting the flood information systems.

The degree of satisfaction of respondents was measured with a Likert scale question type. The scale is between one and seven, in which one represents highly strongly disagree" and seven represents strongly agree.

4.2 Data Analysis

Data was analysed using the SPSS package SPSS version 11.0 for Windows, SPSS Inc., Chicago, IL, USA. Inferential and Descriptive statistical methods were used in summaries and showed the relationship between variables of the Community Centered Flood Information System. Descriptive statistics techniques were used in getting the frequencies and percentages of the age bracket of data Collectors, status of data collectors, and work experience. Inferential statistical techniques were used in establishing the relationship between the variable of the Community Centred Flood Information System. SPSS was used mainly because it can analyse and compute large datasets, its accurate data entry and cleaning capabilities. Its statistical functions enable it to store data systematically and organise it accordingly, conduct statistical testing and visualise data. The results of the data analysis were used in proposing an ideal community-centred flood information system for the Gambia.

4.3 Results

As previously highlighted, this is not limited to the evaluation of flood information systems in the Gambia but also extends to finding out the satisfaction of the community members with the flood information generated on the impact of floods in their communities. This research was conducted between two groups of individuals, the humanitarian workers and the community members. The satisfaction level of respondents was measured using a Likert-scaled questionnaire on the variables of a modified, updated Delone and McLean information systems Success model. The characteristics of these respondents are captured in the table below.

Table 4.1 Characteristics of respondents: number of respondents =385

Variables	Per cent of Sample
Gender	
Male	57%
Female	43%
Age	
18-30	34
31-43	25
44-56	24
57-69	17
Status	
Humanitarian Worker	46%
Community Member	54%
Work Experience	
0	37%
1-5 years	30%
6-10 years	18%
Greater than 10 years	14%

Table 4.1 shows 57% of the respondents were male, 43% were female. 34% were between the ages of 18 and 30 years old. 25% were between 31 and 43 years old, 24% were between 44 and 56 years old, and 17% were more than between 57 and 69 years old.

46% of these respondents were humanitarian workers, 54% were community members, 37% of them had no work experience, 30% of them had 1 to 5 years of work experience. 18% of them have 6 to 10 years of work experience, and 14% of them have over 10 years of work experience.

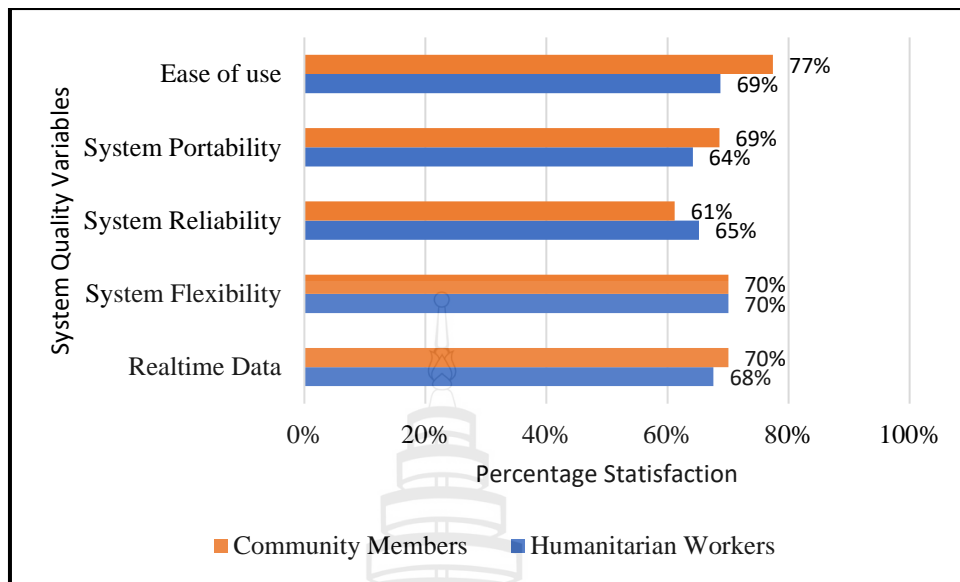


Figure 4.1 System quality

The evaluation of the quality of flood information systems in the Gambia is illustrated in Figure 4.1.

Factors used in the assessment of the quality of the flood information systems were timeliness of the data generated, illustrated as real-time data, system flexibility, the reliability of the flood information System, System portability, and Ease of use of the system. The humanitarian workers were 68% satisfied with the ability of the flood information systems to generate real-time data, while community members were 70% satisfied with the timeliness of flood data. Humanitarian workers are 70% satisfied with the flexibility of the system, while community members are 70% satisfied with the flexibility of the current flood information System.

Humanitarian workers were 65% satisfied with the reliability of the flood information systems, and community workers were 61% satisfied with it. Humanitarian workers were 64% satisfied with the portability of data collection tools in the current flood information System, and community workers were 69% satisfied with the portability of data collection tools in the current flood information system.

Humanitarian workers were 49% satisfied with the ease of use of the current flood information system, and community members were 51% satisfied with the ease of use of the flood information system. In general Humanitarian workers are 69% satisfied with the quality of the current flood information system, while community

workers are 77% satisfied with the quality current quality of the current flood information system.

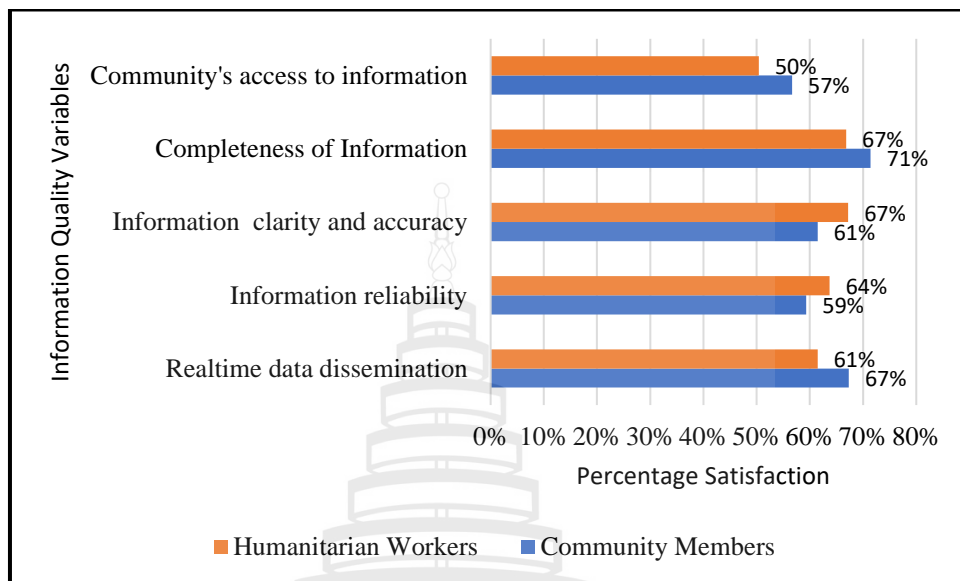


Figure 4.2 Information quality

Figure 4.2 shows the evaluation of respondents on the quality of the information generated from the flood information systems. This was done considering real-time data dissemination, information reliability, information clarity, accuracy, completeness of information, and the community's access to information. Humanitarian workers were 67% satisfied with the real-time data dissemination, while community members were 61% satisfied. Humanitarian workers were 59% satisfied with the reliability of the information, while community members were 64% satisfied. When it comes to information clarity and accuracy, humanitarian workers were 61% satisfied, and community members were 67% satisfied.

Humanitarian workers were 71% satisfied with the completeness of the information generated by the flood information systems, and community members were 67% satisfied. Humanitarian workers were 57% satisfied with communities' access to flood information, and community members were 50% satisfied.

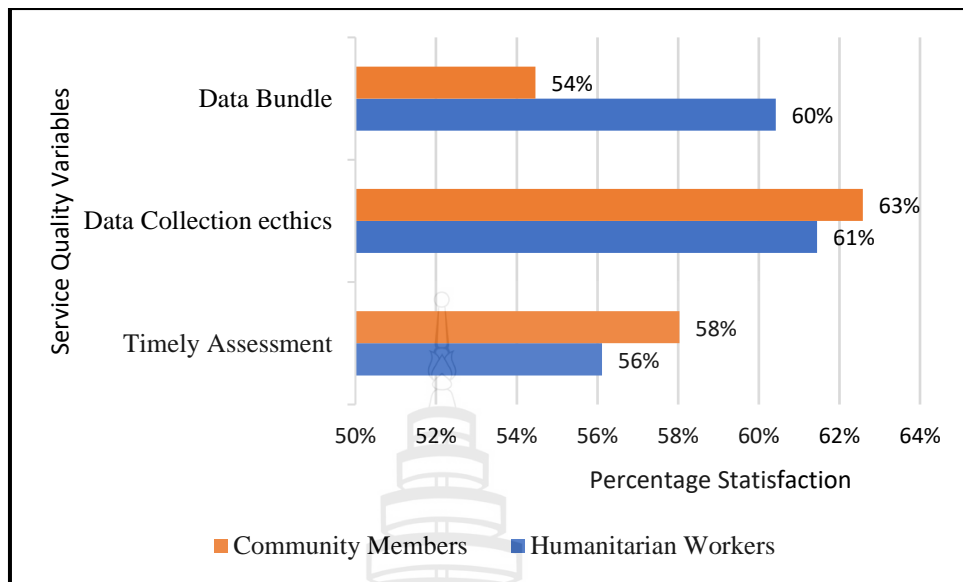


Figure 4.3 Service quality

Figure 4.3 shows the respondents' evaluation of the quality of service provided by the agencies hosting flood information systems in the Gambia. This was done taking into consideration Timely assessment, data collection ethics, and data bundles. Humanitarian workers were 56% satisfied with the timeliness of flood assessments, and community members were 58% satisfied.

Humanitarian workers were 61% satisfied with the data collection ethics of the agencies hosting flood information systems, and community members were 63% satisfied. When it comes to the data bundles given to data collectors, humanitarian workers were 60% satisfied, and community members were 54% satisfied.

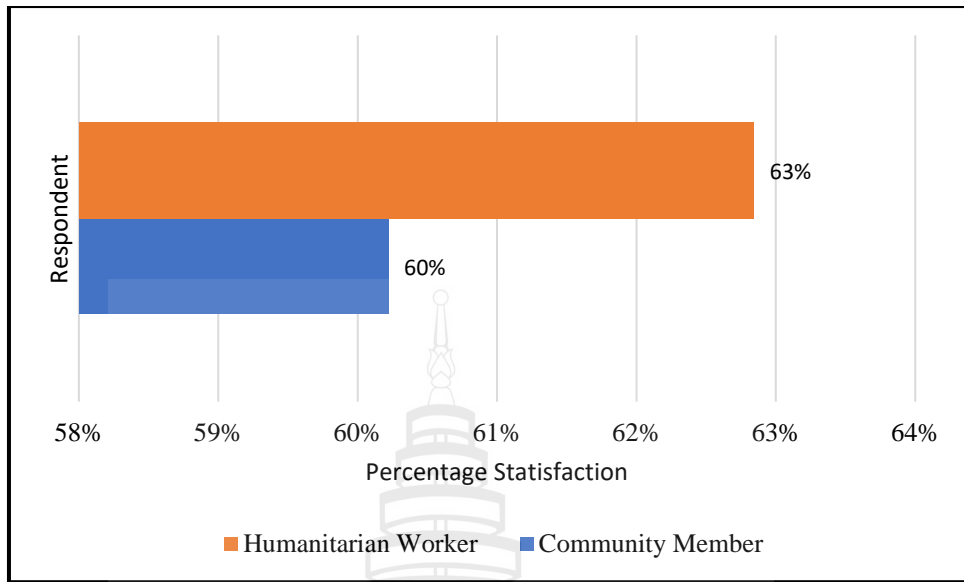


Figure 4.4 Intention to use the current flood information system

Figure 4.4 shows the percentage intention of respondents to use the current flood information system. Humanitarian workers have a 60% intention to use the current flood information systems, and community members have a 63% intention to use the current flood information systems.

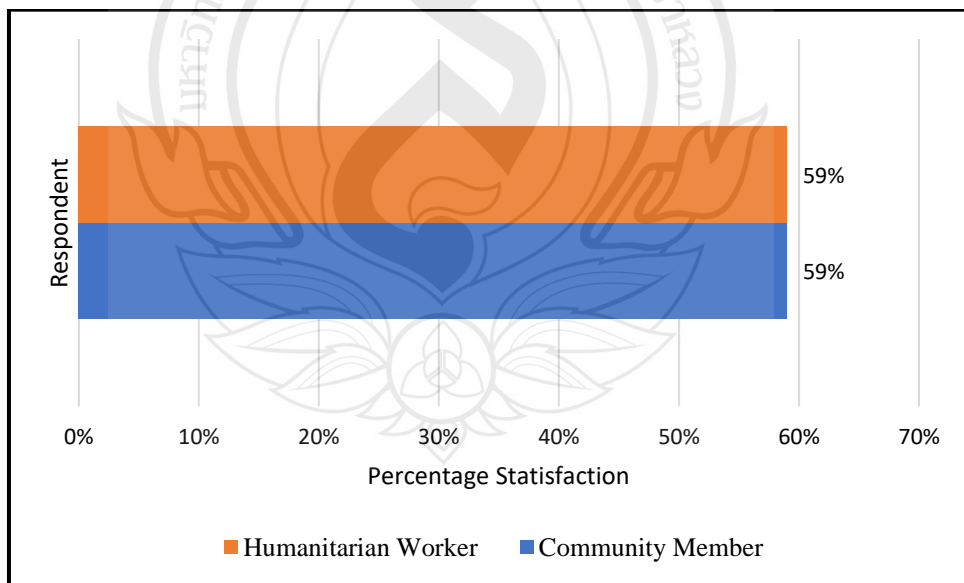


Figure 4.5 User satisfaction

Figure 4.5 shows that both humanitarian workers and community members are 59% satisfied with the current flood information systems in the Gambia.

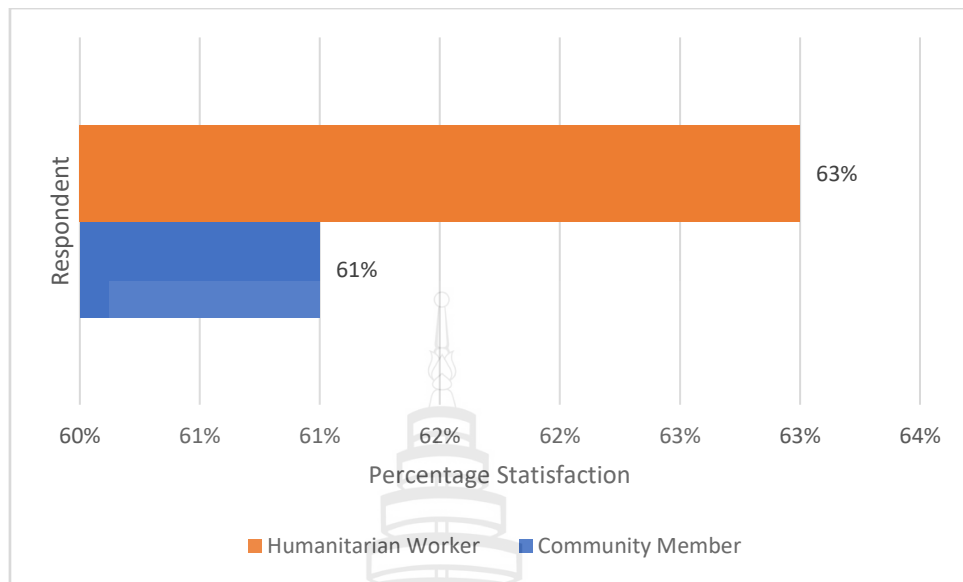


Figure 4.6 Actual use of current FIS

Humanitarian workers are 63% satisfied with the actual use of the flood information system, while community members are 61% satisfied.

Table 4.2 Correlation analysis within the variables of the modified updated Delone and McLean information systems success model

	System Quality	Information Quality	Service Quality	Intention to use FIS	User Satisfaction	Actual System use
System Quality	1	.083	.052	.766**	.056	.617**
Information Quality	.083	1	.514**	.096	.508**	.080
Service Quality	.052	.514**	1	.050	.981**	.058
Intention to use Current FIS	.766**	.096	.050	1	.055	.846**
Humanitarian Workers and Community Satisfaction	.056	.508**	.981**	.055	1	.087
Actual System use	.617**	.080	.058	.846**	.087	1

Note ** Correlation is significant at the 0.01 level 2-tailed

Table 4.2 shows the correlation within the variables of the modified, updated Delone and McLean Information Systems Success model. The correlation between the variables ranges from 0.50 to 0.981, which indicates a moderate positive correlation to a strong high positive correlation.

Table 4.3 Contribution results summary of analysis

Variable	Humanitarian Workers Satisfaction %	Community Members Satisfaction %
System Quality		
Real-time Data Generation	68%	70%
System Flexibility	70%	70%
System Reliability	65%	61%
System Portability	64%	69%
Ease of Use	69%	77%
Information Quality		
Real-time Data Dissemination	67%	61%
Information Reliability	59%	64%
Information Clarity and Accuracy	61%	67%
Completeness of Information	71%	67%
Community's Access to Information	57%	50%
Service Quality		
Timeliness of Flood Assessment	56%	58%
Data Collection Ethics	61%	63%
Data Bundles for Submission	60%	54%
Intention to Use Current FIS	60%	63%
Overall Satisfaction	59%	59%
Actual Use of the Current FIS	61%	63%

The Delone and McLean Information Systems Success Model is widely used to evaluate the quality and performance of information systems based on six key dimensions: system quality, information quality, service quality, use, user satisfaction, and net benefits. This model was applied to assess the flood management systems in The Gambia, highlighting strengths and areas needing improvement.

4.3.1 System Quality

Humanitarian workers expressed higher satisfaction with system quality, particularly in aspects like system flexibility 70% and ease of use 69% as highlighted in Table 4.3. Community members also echoed satisfaction with system flexibility and ease of use, but were less satisfied with system reliability and the system's ability to generate real-time data. This difference could stem from community members' limited access to advanced technologies.

4.3.2 Information Quality

The quality of the information, particularly in terms of its accuracy, completeness, and reliability, scored lower for both groups. Notably, community members scored the system lower on the access to information 50% as highlighted in Table 4.3, which points to challenges in communicating flood risks effectively at the local level. This issue could hinder timely responses to floods, especially in areas with poor infrastructure.

4.3.3 Service Quality

Service quality, measured through aspects like the timeliness of assessments and data collection ethics, was more appreciated by humanitarian workers 64% and 69% than by community members 46% and 55% as captured in Table 4.3. Lack of resources, such as data bundles for mobile reporting, emerged as a barrier to community-level data collection and submission.

4.4.4 Humanitarian workers and community Satisfaction and Intention to use the existing flood information system

Both respondents, humanitarian workers and community members, are 59% satisfied with the current flood information system. On average percentage of satisfaction of respondents in having the intention to use the current flood information system is 62% for community members, 64%. The level of satisfaction of respondents and intention to use the current flood information is relatively low due to factors highlighted in the system quality, information quality, and service quality. On average, respondents are 62% satisfied with the actual use of the current flood information system. This means that the existing flood information system is good, but there are some improvements.

Due to the limitations of the existing flood information systems in the Gambia, this paper proposes an ideal community-centred flood information system for the Gambia.

Table 4.4 Community-based flood management system specifications

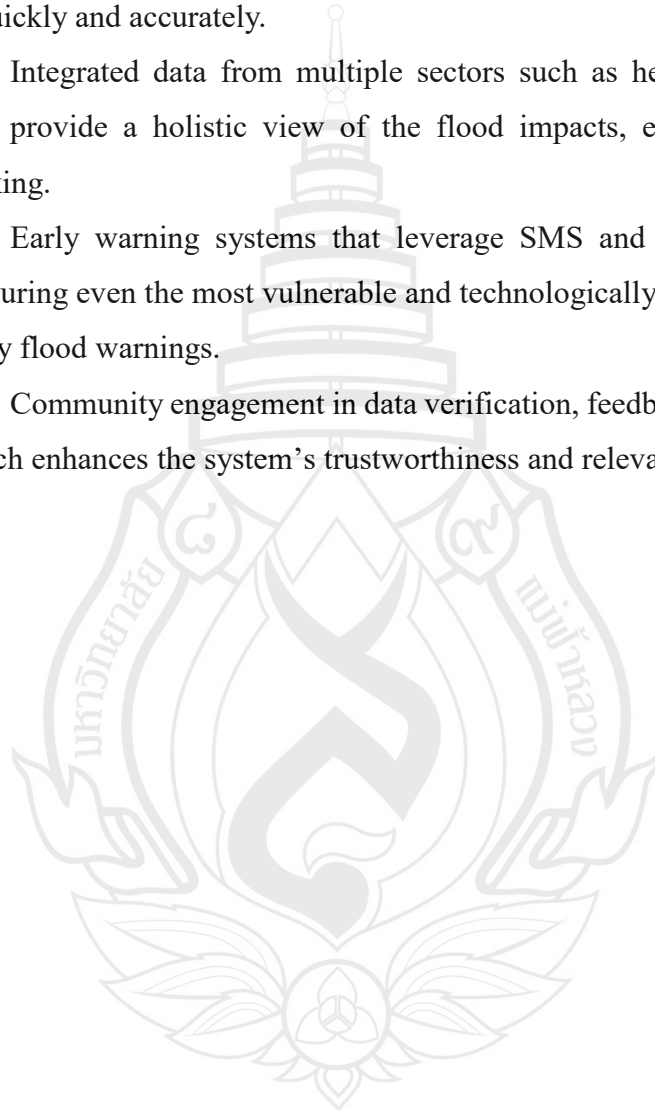
Component System Quality	Specification	Objective
Real-time Data Collection	Mobile-enabled system for collecting flood data in real-time using tablets and mobile phones	Ensure real-time, accurate, and efficient flood data reporting from community members.
Flexibility	System adaptable to different data formats, spatial, non-spatial, and multimedia	Accommodate various types of data, such as geographic information and media collected by communities.
Reliability	Data validation protocols to ensure accurate, reliable flood information	Ensure the trustworthiness and reliability of flood data provided by the community
Portability	Offline data collection tools with later synchronisation to the central server	Enable data collection in areas with limited or no internet access.
Ease of Use	User-friendly mobile app interface designed for low-literacy users	Improve adoption by community members and ease of use in data collection
Information Quality Data Dissemination	Flood warnings and data are shared via SMS, local radio, and social media platforms.	Ensure timely delivery of flood warnings to vulnerable communities.
Data Accuracy	Use of community verification mechanisms, cross-validation by local leaders	Enhance the accuracy of flood data collected at the community level.
Data Clarity	Flood information is simplified for understanding by non-technical community members.	Ensure clarity and comprehension of data by local populations.
Completeness of Information	System integrated with other sectoral data, agriculture, health, and sanitation	Provide comprehensive flood impact reports across multiple sectors.
Community Access to Information	An open-access platform allowing community members to review flood reports and responses.	Increase transparency and community engagement in flood response efforts.

Table 4.4 (continued)

Component System Quality	Specification	Objective
Service Quality		
Timely Assessments	Deploy local disaster response teams for rapid assessments of post-flood events.	Improve the speed of response to flood events in vulnerable areas.
Ethical Data Collection	Ensure ethical guidelines for data collection, respecting community privacy.	Build community trust and ensure ethical data handling.
Resources for Data Submission	Provide adequate mobile data bundles and internet access to community volunteers.	Facilitate smooth and continuous submission of flood data.
Community Participation		
Local Collaboration	Engage local disaster committees, VDCs and community leaders in flood management planning.	Foster collaboration between local communities and national disaster management agencies
Community Training	Regular training sessions on data collection and flood early warning protocols	Build capacity within the community for better flood management and data collection
Feedback Loops	The system incorporates feedback from community members on flood responses.	Ensure continuous improvement of the system based on community input.
Technology Integration		
Geographic Information Systems GIS	Integrated GIS for mapping vulnerable areas and flood zones	Enhance flood prediction accuracy and response planning
Early Warning System EWS	SMS-based early warning alerts with community-specific flood risk notifications	Improve preparedness and mitigation efforts at the community level.
Humanitarian workers and community Satisfaction and Adoption		
Incentives for Use	Offer incentives for consistent and accurate data reporting e.g., mobile credit	Encourage active community participation in the flood data collection process.
Regular System Updates	Frequent system upgrades based on user feedback and technological advancements	Ensure the system remains relevant, functional, and user-friendly.

From Table 4.4, this Community-Based Flood Information **System** focuses on decentralising flood data collection and management, with the active participation of local communities. Key aspects include:

1. Real-time data collection through mobile platforms that are easy to use and adaptable to low-technology areas, ensuring that communities can report flood conditions quickly and accurately.
2. Integrated data from multiple sectors such as health, agriculture, and sanitation to provide a holistic view of the flood impacts, essential for informed decision-making.
3. Early warning systems that leverage SMS and local communication channels, ensuring even the most vulnerable and technologically isolated communities receive timely flood warnings.
4. Community engagement in data verification, feedback loops, and regular training, which enhances the system's trustworthiness and relevance to local users.



CHAPTER 5

DISCUSSIONS AND CONCLUSION

5.1 Discussions

The evaluation of the current flood information systems in The Gambia, based on the Delone and McLean Information Systems Success Model, highlights the critical strengths and limitations of existing Flood information systems in The Gambia. The integration of community-centred flood information systems, as proposed in this study, emphasises the importance of localised, real-time data collection, information dissemination, and participation by local stakeholders.

The community-based flood information system specification developed from this model offers a holistic approach to address the gaps identified in the existing flood information systems.

5.1.1 System Quality

On average, humanitarian workers are 67% satisfied with the quality of the flood information systems in the Gambia, while community members are 69% satisfied. Neither respondent was fully satisfied with the flood information system. Critically looking at their satisfaction per system quality variable, it can be confirmed that respondents are the least satisfied with the reliability of the flood information systems. Humanitarian workers are 61% satisfied with the reliability of the flood information systems, while community workers are 65%. On average, respondents are 63% satisfied with the reliability of the existing flood information systems.

Definitely, for a system to be reliable, it should generate accurate data, which can help in making informed policy decisions. Unfortunately, it is reported that during the 2022 flood incident in the Gambia, an assessment of affected households was done in the urban areas (UNDAC, 2022).

This will lead to the exclusion of affected vulnerable households, especially those in rural areas, and affect the accuracy of the overall flood data.

5.1.2 Information Quality

There was an average of 63% satisfaction with the quality of information generated by existing flood information systems. Respondents were least satisfied with the community's access to flood information. On average, they are 54% satisfied. Flood warnings are provided by the Department of Water Resources using National Television, Emails, and national Radio. The most important aspect of any flood information system is the information it generates for informed actions by policymakers, stakeholders, and community members. The result from the research conducted by the International Federation of Red Cross (IFRC) (2011) shows that few individuals have access to information about imminent floods.

5.1.3 Service Quality

Results from the findings of this paper confirmed that respondents are 60% satisfied with the quality of service rendered by the enumerator and the data bundles provided by the National Disaster Management Agency for flood data collection.

Amongst all the service quality variables, respondents were least satisfied with the Timely flood assessment. On average, respondents were 57% satisfied. In a report by the Gambia Red Cross Society, it was reported that assessments happened a month after the flood incident (IFRC, 2022). This will affect the validity of data as disasters are time-bound. The period from Assessment to Disaster Response should be 72 hours.

5.1.4 Community Engagement and Participation

A central aspect of the proposed community-based flood management system is the active engagement of local communities in both data collection and decision-making processes.

The feedback loops incorporated into the system allow communities to provide input on the effectiveness of flood responses, fostering a sense of ownership and responsibility among local stakeholders. Regular training sessions and collaboration with local disaster committees can significantly improve the accuracy and reliability of the data collected, as well as the community's overall preparedness for flood events.

5.1.5 The intention to use the current flood information systems

This is notably higher among humanitarian workers 83% than community members, 64%, suggesting that the system is more tailored to the needs and capacities of disaster management professionals than to the general population. Bridging this gap

requires making the system more accessible and relevant to the everyday needs of community members, particularly by simplifying the information presented and ensuring that it is culturally and contextually appropriate.

5.1.6 Humanitarian Workers and Community Satisfaction and Future Use

Overall, the system shows moderate levels of user satisfaction, with humanitarian workers rating their satisfaction at 69% and community members at 61%. These figures suggest that while the system is functional and has a positive impact on flood management efforts, there is room for improvement in terms of user engagement, particularly for community members. The intention to use the system in the future is also moderate, indicating that further refinement of the system, particularly in addressing the needs of community members, is necessary to ensure continued and expanded use.

5.1.7 Gaps of the current Flood Information System from studies conducted in the Gambia

Table 5.1 Gaps in the Current Flood Information Systems

Gaps in the Current Flood Information System in previous studies	Constructs of Delone and Mclean Information Systems Success Model
Stakeholders rely too heavily on data for flood management, which results in inaccurate models and uninformed decisions, some of which can lead to loss of lives (UNESCO, 2023).	Information Quality
Segregated flood data collection systems, a unified system was recommended by UNDAC during the 2022 flood (UNDAC, 2022).	System Quality
Direct assessments of economic damages caused by natural disasters in the Gambia are limited. The Gambia does few Cost analyses on the economic impact of natural disasters on the lives and livelihoods of its citizens (Han & Kirabaeva, 2022).	Information Quality

Table 5.1 (continued)

Gaps in the Current Flood Information System in previous studies	Constructs of Delone and Mclean Information Systems Success Model
Due to challenges in getting to impacted communities, scarcity of fuel and inadequate fund data collection has been difficult and hence hindering response (Acaps, 2022)	Service Quality
Average resolution Digital Elevation Models challenge flood mapping applications (Ettritch et al., 2018)	Information Quality
During the 2022 flood, the NDMA reported that approximately 1961 households were affected as of 31 July 2022. After a verification by GRCS on 02 August 2022, it was confirmed that 606 households were affected (IFRC, 2022).	Information Quality
There is a weak dissemination of flood warnings to those at the community level, inter-governmental and authority level (UNDP).	Service Quality
Flood Data is not shared with community members who are affected the most (Jonga et al., 2021).	Service Quality

5.1.8 Proposed Flood Information System

This research proposes an ideal flood information system that integrates all existing Flood information Systems, the National Emergency Call Centre, and community members.

The following are the improvements of the proposed community-centred flood information system to the current flood information system.

1. Systems are connected, hence enabling the generation of a reliable, comprehensive flood risk information
2. Information is filtered to the community level.
3. National Emergency Call Centre is operationalised and equipped.
4. Community members are included from data collection to decision-making

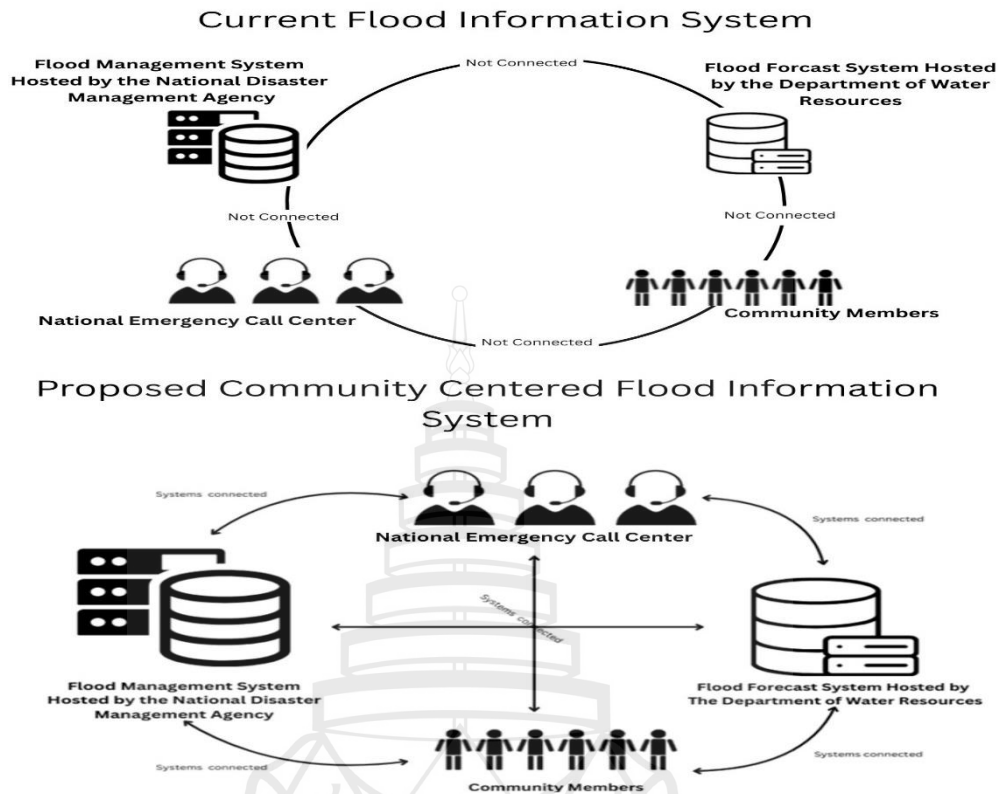


Figure 5.1 Proposed flood information system

Figure 5.1 illustrates the Proposed Community-Based Flood Information System and Current Flood Information Systems for the Gambia

As illustrated in Figure 5.1.8, all the components of the Proposed Community-Based Flood Information System should be connected. The Flood Management System of the National Disaster Management Agency should be connected to the Flood Forecast System of the Department of Water Resources. Data generated by the Flood Forecast System of the Department of Water Resources should be accessible using the Flood Management System of the National Disaster Management Agency for real-time dissemination and warning. In the same vein, data generated by the Flood Management System of the National Disaster Management Agency should be accessible using the flood forecast system of the Department of Water Resources.

Information generated from both flood management systems should be shared with the call center database for agents to share with community members. Community members should also be able to share information directly with agents at the call center and log their complaints and observations during a flood incident or flood response.

Community members should also get updates on data generated by both flood management systems, and should also be included in the Data Management teams of both flood management systems. This interconnection between the components of the Proposed Community-Based Flood Management System will ease the provision of real-time data and improve the reliability and accuracy of the flood data.

5.1.9 Road Map for the Development of an Ideal Community-centred Flood Information System for the Gambia.

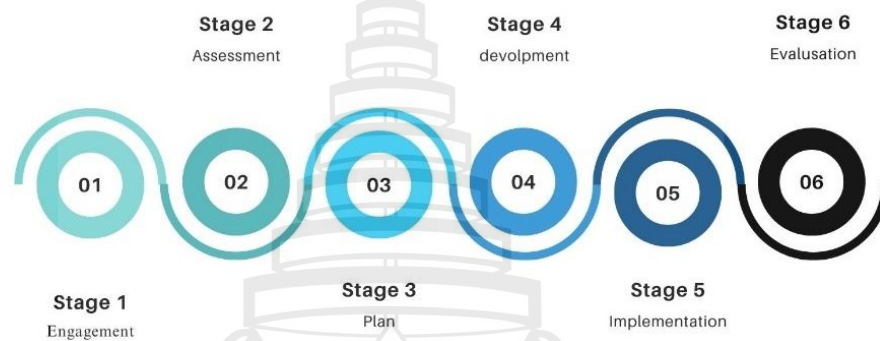


Figure 5.2 Road map for the development of a community-centered flood information system

Stage 1 Engagement: All stakeholders, mainly community members, should be informed, involved, and engaged throughout the implementation cycle of the community center Flood Information System

Stage 2 Assessment: An assessment should be conducted on the gaps and strengths of the current flood information system. The respondents should include stakeholders and community members.

Stage 3 Plan: After knowing the gaps in the current flood information system, the agency should still engage stakeholders and community members in planning for an ideal, improved, community-centred flood information system. During the planning stage, the required budget for the implementation and sustenance of the community-centred flood information system and funding partners will be identified.

Stage 4 Development: The agency should work with all experts from relevant stakeholders, and community members should be involved in the development of the community-centred flood information system.

Stage 5 Implementation: After the development of the Community Flood Information System, it should be deployed for real-time flood assessment. This should be communicated to all stakeholders, mainly community members. Stakeholders and Community members should start using the flood information system whenever there is a flood or for flood forecasting.

Stage 6 Evaluation: As the flood information system has been implemented, there should be a continuous evaluation of the flood information system. This can be done by using the Theory of Change, which will help in identifying gaps in the newly developed community-centred flood information system and also serve as a guide for the development and implementation of an improved community-centred flood information system in the future.

Overall, the analysis reflects a well-functioning flood information system that excels in system portability and ease of use but needs improvements in service quality and information dissemination, particularly for the community members who are most affected by floods. A more community-centred approach, coupled with resource allocation for communication, could enhance the system's effectiveness in real-time flood management and early warnings.

Based on the study, the following table outlines the specifications for a Community-Based Flood Management System using the insights from the Delone and McLean Information Systems Success Model, and a community-centred approach was designed for the Gambia flood management system.

5.1.10 Applying the Theory of Change for the Community Centred Flood Information System

The Theory of Change defines how a specific programme is expected to be implemented successfully (Connell & Kubisch, 1998). The theory of change will evaluate the pros and cons of developing the Community-Centred flood Information System, from inputs, activities, outputs, to outcomes, and, most definitely, long-term impact.

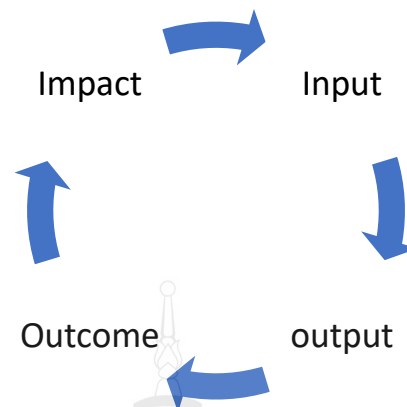


Figure 5.3 Applying the theory of change

Input: Coordination with Stakeholders, including community members, conducting flood assessments, and developing flood mitigation plans.

Output: Having a community-centred flood information system, with funding strategies, guidelines for training and training materials.

Outcome: Provide timely flood data, flood warnings, increased flood risk information, successful flood response, and reduced flood vulnerability.

Impact: Reduced Flood Risk, reduced loss of lives and livelihoods and reduced economic loss due to floods.

5.1.11 Integration of the proposed Community Centered Flood Information System in the current flood management system

5.1.11.1 Link the proposed Flood Management System with the flood forecast system, National Emergency Call Center and provide access for the community members to collect, monitor and access analysed flood data.

5.1.11.2 Harmonise with the Ecowas Early Warning System protocols for cross-border flood risk.

5.1.11.3 Provide real-time flood data.

5.1.11.4 Use the National Emergency Call Center, community Radios to provide flood warnings and flood data for community members.

5.1.12 Strategies to overcome resource constraints and technology adaptation

5.1.12.1 Use local technicians to upkeep the Flood Information System

5.1.12.2 Use user-friendly, mobile-friendly platforms in local languages.

5.1.12.3 Conduct orientation, training of data collectors and community members on how to collect flood data and how to use the flood information system.

5.1.12.4 Use local knowledge, such as traditional warning methods, drums, bells, and religious houses, to complement the flood information system.

5.1.12.5 Encourage universities and other institutions to use the system in the Gambian context.

5.2 Conclusion

In conclusion, the analysis and proposed specifications for a community-based flood management system demonstrate the importance of a multi-sectoral, inclusive approach to flood risk management. By integrating real-time data collection, improving information dissemination, and fostering community participation, the system can more effectively mitigate flood impacts in vulnerable areas. Additionally, providing logistical support and ensuring the ethical handling of data will build trust and increase system adoption at the community level. This holistic approach is essential for creating resilient communities that are better prepared to face the challenges posed by frequent and severe flooding. This community-based model aligns with the needs for localised, participatory flood management strategies and offers a blueprint for enhancing the existing systems in The Gambia.

The NDMA should not limit itself to developing a community-based flood information system but should also apply the theory of change approach to evaluate it. Weiss 1995 describes the Theory of Change clearly as a theory of how and why initiatives are as intended (Clark-Wilson et al., 2021). This theory will use a holistic approach to evaluate the flood information system by determining whether the intended outcomes of the Community-based Flood Information System are met. The Theory of Change will enable the NDMA and Partner to identify possible gaps in the proposed community-based flood management system. This will enable them to improve and eliminate existing limitations of the community-based Flood Management System, Community and stakeholder inclusion, and flood data quality and decimation. Systems are never perfect and are never developed to stay forever; there will always be room for

improvement. Using the theory of change approach, the agency will have an ideal community-based flood management system.



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