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Design and implementation of a decision support system for flood management

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Abstract

This work deals with the design and implementation of a decision support system for flood management. In the society today emergency issues arises due to terrorist attack, flood disaster, epidemics, widespread massive riot etc. In other to handle this situation government has established a number of agents supported by Non-governmental organization (NGO). Due to non-existence of integrated database and communication support system for managing flood emergency has resulted to poor handling, huge losses and reoccurrences. This work involves managing the inter operations/ interlinks of flood incidents sources by the handling agents, design of database report format and communication media for the system automation. In other to solve this problem waterfall methodology was adopted in this study. The programming tool adopted was adobe dreamer. Its host has front end and back end. The front end is the user interface and serves as a channel through which users communicates to the system. Adobe dreamer being the tools used for building such web-based application supports many mark-up languages like HTML, CSS and Java script. The most common available tools for the development of this system is the Adobe Dream waver which is IDE (integrated Development Environment. It is a creation management tool and requires no programming language and good enough for experienced website developers.

Keywords: Decision Support System; Flood Management; Flooding; Decision Making Process

1. Introduction

The world today has changed greatly since the last decades due to flood emergency that arises in every nook and crannies of the society. The term flood and flooding are often used in different ways. According to Schultz [1], flood is not a permanent condition of surface water (river, lake, sea) where the water level and /or discharge exceed a certain value, thereby escaping their normal confines. Flooding is the overflowing or failure of a river, stream, lake, canal, or buildup of water beyond the normal bounds of these bodies of water due to or as a result of severe precipitation if drains are absent or their discharge capacity is exceeded. Flooding may be devastating in semiarid locations as well, where high rates of runoff after storms cause widespread flood damages down valley. Flooding is a severe risk in humid climates. The nature and occurrences are governed by diverse factors like rainfall characteristics, properties of the drainage catchment and land and water use and management in the catchment. Due to technological advancement, it has been easier to manage flood like natural and artificial or manmade. This is easily managed using information technology features like the internet, geographic information systems (GIS), and remote sensing satellite communication, which aid in the planning and implementation of hazards, assessments, and guide development activities that aid planners in the selection of mitigation strategies and the implementation of flood preparedness and response strategies.

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Remote sensing machine also contribute effectively towards identification of hazardous areas, monitors the planet for its changes on real time basis and give early warning to impending disaster or emergencies like flooding.

Also, communication satellites have become vital for providing timely, useful information and communicate effectively on any issue of societal emergencies.

As a result of this technological advancement or electronic communication, the internet provides useful platform for crises mitigation communities launching of a well-defined website that is a very cost effective means of making intra-national and national presence felt in the society. It equally provides a new and potentially revolutionary option for rapid, automatic and global dissemination of flood management information. Flood risk are on the upsurge every day and Information Technology for flood management has become very advanced, but efforts may still be inhibited by issues in response. This is accurate because, information is a combination of the people, data, processes, and information technology that work together to gather information. The term flood management emergency should not be treated casually especially when it has to do with the life of individuals in the society.

GIS and remote sensing technology are capable of flood risk management since it takes into account spatial variability of flood hazard (Qi &Altinakar) [2]. The important aspect of DSS is flood forecasting, which is one of the most effective non-structural flood mitigation measures. It leads to reduce flood damage and the loss of people's lives. However, Hafiz et al [3] used both real-time flood forecasting and flood forecasting in the creation of their flood forecasting and warning system.

In Design of a decision support system for the mitigation of damage caused by flood events using forecast rainfall data, the rainfall data which is used for real time flood forecasting is from either ground rainfall station or real time satellite rainfall and the lead time available for flood warning alert is not long. However, information systems are systems that serve as a means of notification to the handling agents. Therefore a noble information system should and must possess a complete information and knowledge about the event that is about to report. Thus, such information must be valid, correct, on time, and so on. An information system that reports when the information is not required is not a good information system.

2. Literature Review

There are many researches on the methods, techniques and technologies for the design and implementation of a decision support system for flood management. However, there are few articles that takes care of the impact of a decision system support system for flood management. To a layperson a decision support system is simply an information system. In the field of information technology/ manufacturing systems automated data acquisition and development of technological innovations like manufacturing execution systems, resource planning etc has giving rise to decision support system technologies. A decision support system in this situation combines human expertise with computer capabilities to enable effective management of data, reporting, analysis, modeling, and planning difficulties.

Akintola Adesuji et al. [3], in their research on improved flood hazard modelling in the Ogunpa river basin, Ibadan, south-western Nigeria, used hydraulic and analytical processes as well as height above nearest drainage. Utilizing integrated hydraulic modeling, height above nearest drainage (HAND) models, and multi-criteria decision analysis, their work is examined (MCDA). In order to determine the magnitude of the inundation in the Basin, an event-based flood simulation was conducted using the FLO-2D model throughout the 28 hours of the flooding event. Using the analytical hierarchical process (AHP) to identify probable hazard zones in the study area, seven flood-causative elements were also integrated.

However, a decision support system is defined by (Felsberger et al.) [4] As a system that distinguishes between organized, semi-structured, and unstructured data. A decision support system is defined as a computer system that deals with a problem where at least some stage is semi-structured.

Decision making process transform information into instructions that are intended to effect system behaviour in such a way that they improve system performance.

Additionally, catastrophes like ongoing homicides, terrorism, flooding, etc. have grown to be a significant problem in today's society. In light of the nature of the contemporary business or organizational environment, which is driven by the impact of globalization and high market dynamics, underlined that Crisis Management has become a common content for the decision makers or Managers of an organizations. In this world today a crisis can be considered more or less permanent.

Abebe and Price [5] talked about a decision-support system for controlling urban flooding. Using design tools like hydrologic/hydraulic forecast models together with data collecting networks, they placed emphasis on the creation of a decision support system (DSS) for flood warning and the implementation of operations in an urban region.

Runoff rates frequently exceed those of other flood types because of the catchment's quick reaction to severe rainfall. Flash floods are associated with brief, high-intensity rainfall rates. Agbola *et al.* [6] noted that while the rainfall of August 2011 was not the highest in the recorded history of the city, the monetary value of damages to the property that resulted from the event was so far the costliest. The 2011 Ibadan flood made the Nigeria government to approach World Bank for assistance on long term major flood response Management projects in Ibadan city. Nigeria's rapid and growing urbanization has resulted in an increase in the number of flood-prone areas and resources

Having realized the need to study the decision-making process, in conjunction with the great technological evolution, it has now become possible not only to identify the parameters that affect the decision making, but also monitor the situation in real time, without Manager being present, thus allowing a faster and more conscious decision-making.

Buba et al. [13] integrated geospatial tools with a participatory vulnerability study strategy for a proactive bottom-up approach to flood management in their research on the evaluation of flood vulnerability in some areas.

Egbinola *et al.* [16] in their research stressed up on the factors or challenges of flood management in Nigeria today. Their analysis suggests stepping up non-structural flood management tactics. The literature mentioned above makes a case for the value of a decision support system in helping decision makers by giving them information and facts and speeding up the decision-making process.

Furthermore, according to Sprague and Carlson [29], a decision support system is "a class of information system that draws on transactions processing systems and interacts with other parts of the system to support the decision-making activities of managers and other knowledge workers in an organization." A decision support system is an interactive computer-based system that assists users in using computer communications, data, documents, knowledge, and modes to solve problems and reach decisions.

3. Material and methods

The methodology adopted in this research is object oriented analysis and design methodology (OOAD) with waterfall approach.

The Software Design tool for the proposed system is adobe dreamer that uses Xamp as the apache host. And has two ends, thus front-end and back –end and each having its own design tools.

3.1. Information Collection Methods

The sources of information for this work are incident victims, people on the sport, internet, Textbooks, Face book, YouTube, Instagram, geographic information system, WhatsApp, developed information from the flood handling agents.

3.2. The Model for the Proposed System

The model for the proposed system is an improvement on the existing system. This system improves on the ways emergency handling agents deals with flooding emergency by developing an automated system that gives signals on time to the emergency respondents through internet, phone set, geographic information system, geographic maps, Facebook, You tube to showcase information gathered from on the sport victims, emergency handling agents to government for decision making. The figure below is the model for the proposed system

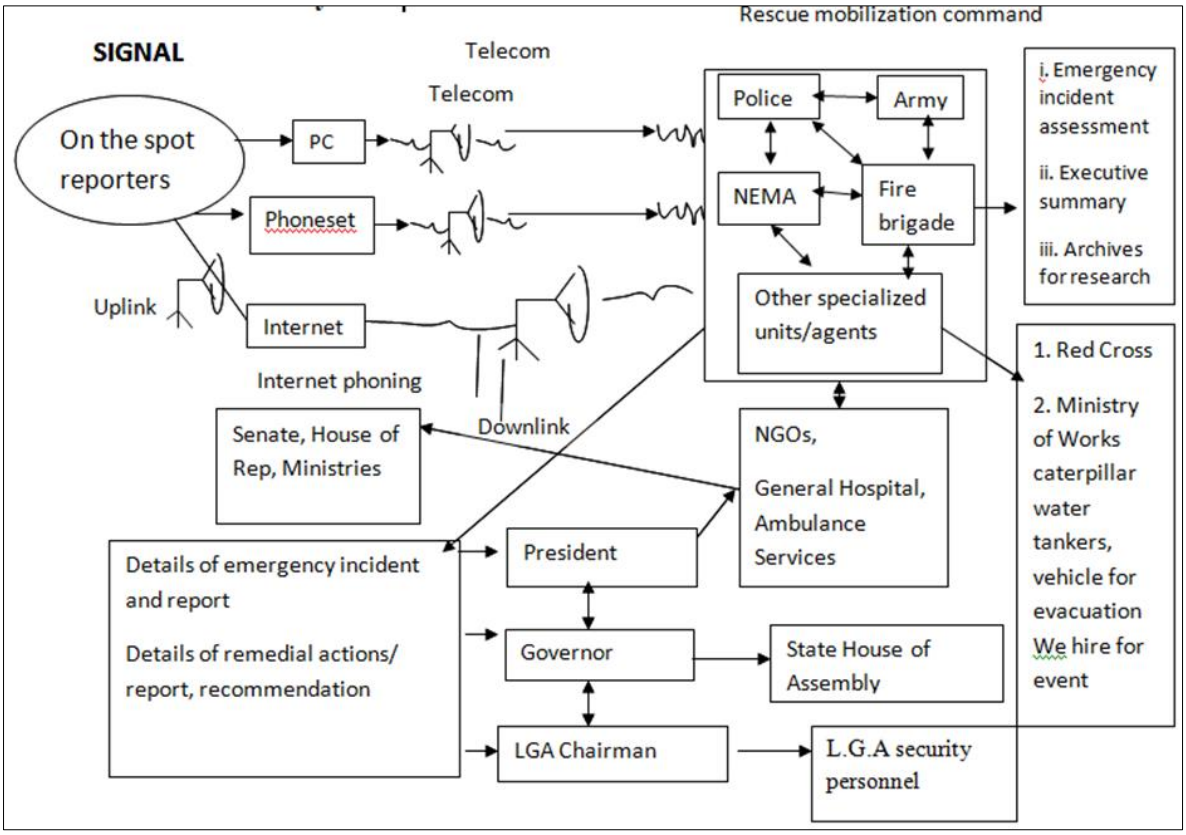


Figure 1 Model for the proposed system

4. Results and discussion

Table 1 Flood Emergency respondent database file

Field number	File name	Field type	Size/ character
1	Respondents name	Text	30
2	Respondents phone number	Text	14
3	Gender	Text	4
4	Age	Text	999
5	Nationality	Text	8
6	State	Text	7
7	Incident site/location	Text	10
8	Voice message	Object	8 kilobyte
9	Incident type	Text	5
10	Report date	Text	8
11	On the sport report time	Text	3
12	Email address	Text	20

Table 2 Flood Incident details files

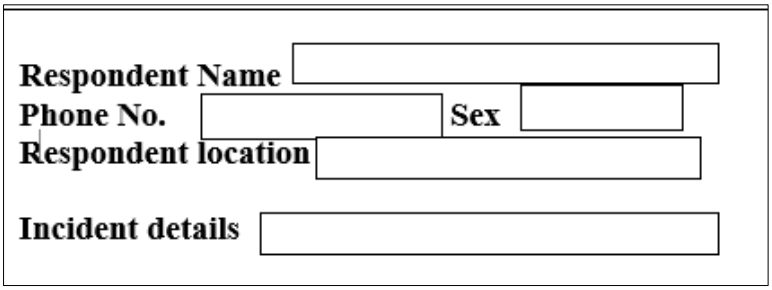
Field number	File name	Field type	Size/ character
1	incident type	Text	30
2	Incident address	Text	30
3	Affected persons count	Numeric	7
4	State	Text	15
5	Incident details	Linked memo	1 megabytes
6	Incident image captured	Linked picture object	50 megabytes
7	Reporters name	Text	25
8	Reporters phone no	Text	14
9	Email address	Text	25

Table 3 Flood Emergency Management Agencies file

File number	Field name	Field type	Size
1	Agency name	Text	30
2	Agency Address	Text	30
3	Agency Phone no.	Text	14
4	Agency Report	Text	1 megabyte
5	General commander	Text	20

OUTPUT: to achieve the objective and the result, the key output of the design for flood management is to get an intelligent information system that could be used to solve the problem of flood in our schools, localities or Nation.

Table 4 The Template for the Design



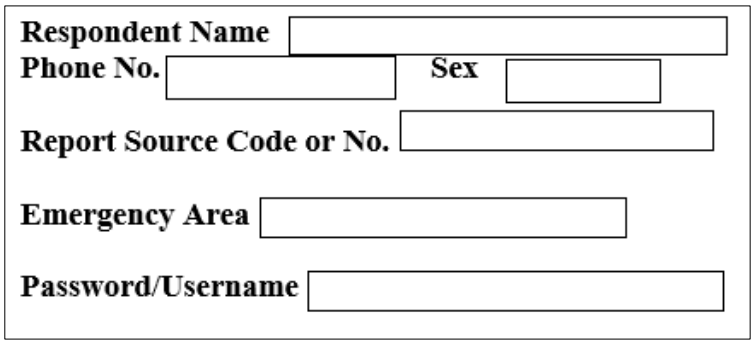


Table 5 Design Template

4No of states affected	_____
Area declared as flood disaster	_____
States under red alert	_____
LGA affected	_____
No of people affected	_____
No of people injured	_____
No of people died	_____
No of people displaced	_____
No of people hospitalized	_____
Estimated cost of flood disaster	_____

Table 6 Report Format for Epidemic Outbreak like malaria due to flood

Type of persons	_____
Places affected	_____
Area affected	_____
States affected	_____
Internally displaced persons	_____
Remedial action taken by flood management agents	_____

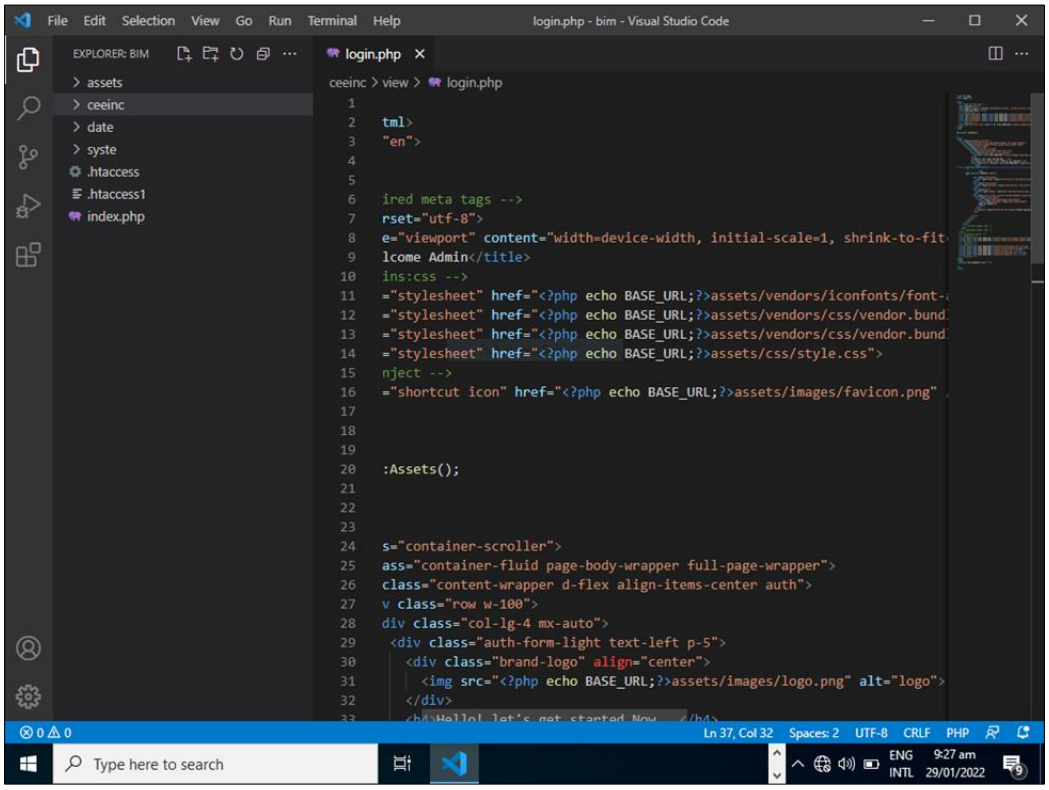


Figure 2 Back-end design

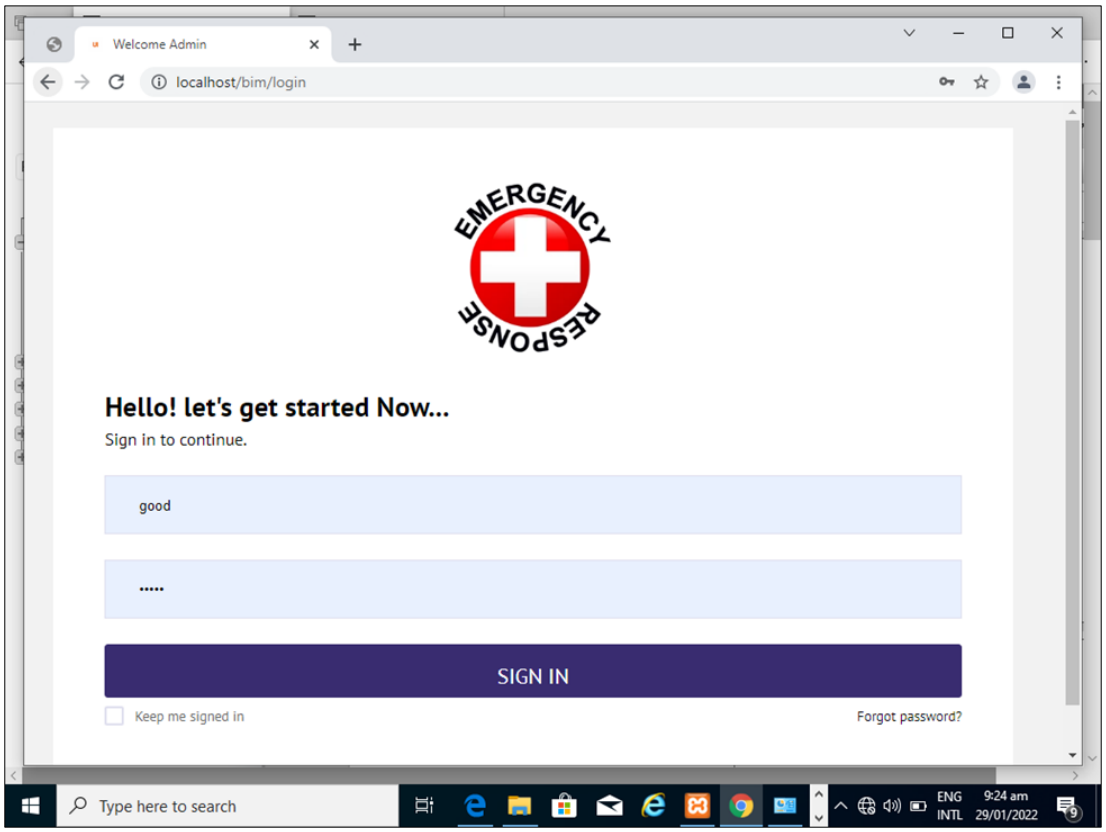


Figure 3 Emergency Response System

5. Conclusion

This work design and implementation of a decision support system was carried out to solve the problem of flood emergency in our society today using adobe dreamer as programming tool to design a good website or information system for management decisions. Also this computer era has really exposed the students a lot in searching for information from online using internet, geographic map., geographic information system, reading news on daily publications on line using their android phones, Facebook, Instagram, YouTube etc. for instance some android phones displays your location as user of the phone in any area you are instantly.

This research work is useful in academics for formulating model for weather Forecasting, used for statistical analysis and collection of data, checking the rate of rainfall in a specified area using geographic information system and geographic map.

In conclusion, this research, design and implementation of a decision support system for flood management has helped decision makers to respond to flood emergency on time, giving signals to people residing in flood prone area to be at alert every point in time. For instance in FUTO about many years back there was a time when many students going to fetch water in the river got drawn, management now decided to keep a sign post as strong signal to warn the student to stop fetching water from that river.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest. As this is the contribution of the aforementioned authors.

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