DIGITAL SOCIETY : A REVIEW OF E-SERVICE AND MOBILE TECHNOLOGY IN EARTHQUAKES RELIEF OPERATIONS

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ABSTRACT

Developing countries lacking technology infrastructures experience most disasters such as tsunami, hurricane Katrina, earthquakes. Even though, many lives are saved in developed countries through the use of high-level or sophisticated technology, only the technology that is easy to use, inexpensive, durable and field-tested should be introduced and used during the relief operation. The effect of climate change and rapid population growth are probably exposed people inhabiting areas to substantial environmental risks. The authors highlight and identify current practices, particularities, and challenges in earthquakes relief operations with the aims of reviewing the roles E-Service and Mobile Technology tools in real-life situations and practices could do to help in disaster operations. This study focuses on victims of earthquakes worldwide. The study will review and provide insights into the roles of E-Service and Mobile Technologies in earthquakes relief operations and how the internally displaced person could benefit from these services. The limitations of these services will be discussed and how the technology could be used to further predict natural disaster such as earthquakes is also considered.

KEYWORDS

Digital Society, E-Service, Mobile Technology, Earthquakes, Disaster Operations

1. INTRODUCTION

Natural disasters such as earthquake though not new strike nations, countries and this is causing massive damages, generating sufferings for habitats and creating negative impacts on economies worldwide. Disaster is a tragic interruption to the development process. Many lives are not spare, capital investments are demolished and social networks are interrupted. Disaster permeates every corner of human settlement. It does not spare the rich neither does it spares the poor. It affects individuals, businesses and organizations. The economic losses due to disaster can be both direct and indirect [2].

These disasters are so prominent in the areas vulnerable to heavy volcanic and seismic activity and in the coastal regions where life-threatening weather actions and flood are likely to occur

DOI : 10.5121/ijmit.2016.8202

with growing frequency. Humanitarian crises will likely increase in such tensed condition, assistance are usually got worldwide from individual and private bodies including the United Kingdom military [2]. Disasters nowadays such as earthquakes are both natural and artificial which are caused by human as they are normally measured to be events on the spatial and sequential parameters such as wildfires, public unrests, terrorist attacks, epidemics, oil spillages, famine [2] and this turned most inhabitants to internally displaced person (IDP).

Effect of the earthquakes could result in the collapse of communications infrastructure, antennas, buildings, power are always affected etc. But, immediately after the disaster, due to the emergency, communications are vital. There are two aspects in this scenario, the first is to instantly trace the affected persons in order to offer emergency assistance and the second scenario is to provide earthquakes relief operations during and after the incident. It should be noted that most of the local communication infrastructures might not be unavailable in both described scenarios. A typical example is the destructions of some base stations by the earthquakes [2].

The most rewarding aspect of the technology is that government and the public have started to appreciate and accept e-Service as the values are being demonstrated considering the effectiveness, cost cutting, accountability and transparency [17]. E-Service and mobile technology will provide the avenue for developing new services that will enhance the disaster relief operations and aid in quick and effective re-settle of the displaced citizens.

This paper reviews the roles of E-Service and Mobile Technologies in disaster relief operations and how the internally displaced person could benefit from these services. The limitations of these services will be discussed and how the technology could be used to further predict natural disaster is also considered. The paper has a well-laid structure; they are Introduction, Literature Review, Research Method, Finding and Analysis, Limitations, Technology in Future Prediction, Conclusion and Future Work, Acknowledgement and Reference.

2. LITERATURE REVIEW

2.1 INTRODUCTION

There are related research papers on e-service and mobile technology, disaster relief operations such as relief operations for the earthquake's victims [7]; [14]; [16]; [18]. The roles of non-governmental organisations (NGOs), public and private organisation's in giving assistance to the earthquake victims and the equipment needed to facilitate the operations will be discussed. At present, there is no research paper that specifically and majorly focus on E-Service and Mobile technology in earthquakes relief operations, this shows the important of this study within the research domain.

2.2 E-SERVICE AND MOBILE TECHNOLOGY

The interactive information service nature of E-Services have made it broadly accepted as the services are being provided electronically or via internet based equipment [17]. The accessibility of these services through mobile for organisations and consumers to use information accessed in creating a better experience [17].

The effective delivery of E-Services electronically and through the use of mobile has smoothed the interaction among individuals, organisations, general public and earthquake's relief operations staff [17]. While the aims of disaster relief are to alleviate the results of calamity, safe life, limit damages and the restoration of important services to some level, the need e-Service and mobile tools to succeed in the operations.

The services also help both the private relief organisations and the local authority to quickly resettle the displaced or injured citizens in any natural disaster. Instead of the internally displaced person (IDP) who is forced to flee his or her home but who remains within his or her country's borders, the can be resettled within the shortest period with the availability of e-Service and mobile equipment [15].

2.3 DISASTER RELIEF OPERATIONS TECHNOLOGY - EARTHQUAKES

The disaster which could be termed as an event causes injuries, destructions, hardships even death to people, it could be natural or man-made disasters and regardless of the causes, it bring sadness to people [18]. Among the most devastating natural disaster in the world today, earthquakes are known as a leading natural disaster. According to [18], earthquakes in the society happen when the enormous plates that make up the earth's surface slip over or crash into each other. Moreover, [14] substantiated the claims in their paper analysis about the two earthquakes that occurred in Indonesia in 2009.

The earthquakes of 7.6 and 6.2 magnitude on the Richter scale smashed off the coast of West Sumatra occurred within 22 minutes apart and it affected estimated inhabitant of 1.2 million people. In Africa, despite the continents are being the most rapidly urbanizing nations, the disaster is now increasingly becoming a phenomenon worldwide [16]. The bottom line here is that the strongest earthquakes could open a deep crack in the earth's surface causing massive and destructive landslides. It can tear down buildings and when this happen, it could be difficult to contain as only a few people who are lucky enough may survive it [18]. The use of e-service and mobile technology will help in giving quick relief and it will reduce the loss of many lives. The next section of this paper will review various E-Service and Mobile Technology tools, their use, approach and effectiveness in disaster relief operations, they are:

2.31 GPS

Global Positioning Systems are the inexpensive hand-held tools that are based on satellite technology. It consists of a network of twenty-four orbiting satellites that are eleven thousand nautical miles in space and in six different orbit paths [12]. They use signals from three or more satellites rotating around the earth to track down the geographical location (in terms of latitude and longitude coordinate) of a person, vehicle, house, road etc. anywhere on the earth during earthquakes relief operations [8]. The satellites are constantly moving, making two complete orbits around the earth in less than twenty-four hours. Most GPS receivers can store up to hundred data recordings. In order to display accurate maps at the end of the day, GPS data needs to be applied to Geography Information System (GIS). It is on the record that the first GPS satellite was launched in February 1978 with the transmitter power of about fifty watts [1].

2.32 BLUETOOTH

Bluetooth is a short-range (up to 10m) radio technology for Wireless Personal Area Networking (WPAN-802.15) operating in the 2.4 GHz ISM (Industrial-Scientific-Medicine) frequency band. It was developed by Ericsson and originally intended to replace cables. A total of 79 RF channel is present where the raw data rate is 1Mbits/s. "A time division multiplexing (TDD) technique divides the channel into 625µs slots and with a 1 Mbits/s symbol rate a slot will transmit up to 625 bits [13]".

A Bluetooth Personal Area Network consists of piconets. Every piconet is a cluster of up to eight Bluetooth devices. The devices are either a master or a slave according to their designation. Master device will intermittently poll the slave device and slave is allowed to transmit only after receiving the poll from the master. The master for a specific set of connections is defined as the device that initiated the connections [13]. During the earthquakes relief operations, two piconets can be connected through a common Bluetooth device, gateway or bridge, to form a scatter net. The interconnected piconets will form a backbone for the Mobile Ad Hoc Networks (MANET), and can enable devices which are not communicating with each other directly, or out of range of another device, to exchange data through several hops in the scatter net [13].

2.33 VSAT

VSAT stands for Very Small Aperture Terminal. VSATs have the capability of simultaneously handling multiple telephone calls and providing a connection to the Internet, they are therefore ideally suited to larger scale operations such as when relief gets underway. TDM/TDMA star network is the most common VSAT configuration, with a high bit rate outbound carrier (TDM) from the hub to the remote earth stations. Also, it has one or more low/medium bit rate Time Division Multiple Access (TDMA) inbound carriers. Interactive VSAT technology is appropriate for any organization with centralized management and data processing considering its star configuration network architecture, and this is very useful during the earthquakes relief operations [2].

2.34 RFID

The Radio Frequency Identification (RFID) technology is a technique to remotely store, retrieve data using a small microchip with an antenna called the RFID tag [5]. Each tag holds a unique identification and other information. This makes the identification, authentication of objects and people possible without any physical contact between a tag and its reader during earthquakes relief operations. This also uses radio waves to read an object's marking in the form of a unique identifying number stored on the embedded or attached silicon chip [5].

An RFID system includes three components:

1. A tag is also known as transponder located on the object to be identified [11].
2. An interrogator (reader) which may be read or write/read device, and
3. An antenna that emits radio signals to activate the tag and read/write data to it. [11].

Operating frequency ranges could be used to distinguished RFID systems. There are four frequency ranges:

- Low (LF) frequency band -125KHz and 134.2KHz
- High Frequency (HF)band-13.56MHz
- Ultra High Frequency (UHF)band- 869MHz, 915MHz, 950MHz
- Microwave band -2.45GHz and 5.8GHz [21].

RFID system can be further classified into two categories, depending upon their source of electrical power-Active and passive. Active RFID tags contain their power source, usually an onboard battery. Power is obtained from passive tags from the signal of an external reader [23].

2.35 GIS

Geographic Information Systems (GIS) and Remote Sensing is considered to be an improvement in Information Technology in the form of Internet, GIS, Remote Sensing, satellite communication, etc. It plays important roles in the planning and implementation of hazards reduction measures in earthquakes relief operations. GIS can improve both the power of analysis, quality of natural hazards assessments, guide development activities, assist planners in the selection of mitigation measures during the implementation of emergency preparedness and response action. Furthermore, remote sensing is a tool that effectively contribute towards the identification of hazardous areas, it helps in monitoring the planet for change on a real time basis and early warning is giving to many impending earthquake disasters [1].

3. RESEARCH METHOD

Research Methodology approach in information system has been given a lot of discussions, as making a good approach choice by the researchers will have a major impact on the study. Most researchers in the literature review made use of either the qualitative or quantitative approach while some researchers prefer combining both approaches in their studies known as mix-method to obtain better results which could also serve as triangulation in evaluating results of their studies [3].

In the light of the above, the researchers, therefore, choose to use systematic literature review. The method of investigating relevant conference papers and journals from many research engines including science direct and google scholar was adopted as there is a need to use a robust search method which led to the use of systematic literature review. Researchers adopted the literature review analysis and techniques used by [22] because of the uniqueness in the process, synthesis and participation in presenting evidence.

4. FINDING AND ANALYSIS

The finding and analysis section provide the authors the opportunity to elaborate further how these technologies emphasised in the literature review are used in disaster relief operations. They are:

4.1 GPS can be used in many ways during disaster relief operations which includes:

4.11 Tracking: GPS is used to track people in disaster operations so that an accurate estimation of people affected by the disaster could be collated. This device was used by the "U.S army where they developed a GPS Truth Data Acquisition, Recording, and Displaying System (TDARDS) for its operation and it helped in tracking down personnel during earthquakes relief operations" [4]. This mobile technology GPS-based tracking system uses up-to-date GPS data, radio data link, and computer technology to provide highly accurate, real-time, time-space position information (TSPI) on up to ten test objects such as ground vehicles, helicopters, and fixed-wing aircraft [4]. The system is highly flexible and is built with commercial off-the-shelf hardware, it is easily adjustable to meet any special needs of individual testing and tracking applications during earthquakes relief operations [4].

4.12 Rescue and Emergency Response: GPS is used to determine the location of casualties during earthquakes relief operations which make the emergency response teams to reduce response time. The US air force for an example developed a GPS-based technology called a Combat Survivor Evader Locator (CSEL) system, this new technology integrates the GPS receiver with a communication radio so that search and rescue teams can trace downed aircrew members faster and more accurately to give immediate assistance [1]. The GPS receivers will locate the survivors during earthquakes relief operations and at the same time allows the rescue and emergency teams to obtain physical location information such as latitude, longitude, altitude, velocity, and precise time traceable to Coordinated Universal Time (UTC) [6].

4.2 **Bluetooth:** The continued call for the use of wireless technology in relief operations has been on the increase especially with recent disasters such as terrorist attacks on September 11, Tsunami [24]. Wireless ad-hoc networking such as Mobile Ad Hoc Network (MANET) could be effectively deployed in the lack of fixed communication systems [24]. Ad-hoc networking is defined as communication concept in which users willing to communicate with each other form a temporary network without help or existence of any infrastructure or centralized administration [24]. The variety of nodes that can be used in an ad hoc network is great for PDAs, laptops, as well as medical equipments, sensors, actuators, etc. The node has a wireless access interface-Bluetooth, WLAN, HiperLAN2, for communication, Bluetooth features are very useful in setting up ad hoc networks [10]. The possible ways in which the blue technology can be employed in disaster situation are as follows:

- ✓ Telemedicine - Information regarding a victim like his present state can be communicated to an expert via the satellite communication device on the ambulance to seek advice.

- ✓ It can help in locating survivors trapped in the rubble of structural collapse during the earthquakes relief operations through sensitive listening devices or through signals from their mobile phones.

- ✓ The Bluetooth technology can also be used by the rescue team to transmit audio and voice data to communicate with each other [9].

Other possible application of Bluetooth technology can be ambulatory wireless medical monitoring. It can help in connecting medical monitoring devices to a patient wirelessly. This would make the patient more at ease. This also reduces the risk of cable's infection in earthquakes relief operations.

4.3 Very Small Aperture Terminal (VSAT): Remote user sites have a number of personal computers, dumb terminals and printers connected to the VSAT terminal, which connects them to a centralized host computer either at the organization's head office or data processing centre in a typical VSAT network settings. VSAT terminal receives data from the DTEs and later buffered, transmitted to the hub in packets [2].

It has the capability of simultaneously handling multiple telephone calls during the earthquakes relief operations and it provide a connection to the internet in order to retrieve and collect data from other partner relief agency during this operation. They are therefore ideally suitable for large scale operations such as when relief assistance gets underway [2]. In practice, they can as well form the basis of a communication centre or 'Cyber Café' which many different agencies and other workers can make telephone calls and connect to the internet during relief operations [2]. Internet bandwidth can be provided to a site at any data rate required. Telephone traffic can be routed in and out of the International Public Switched Telephone Network (PSTN). Alternatively, a privately directed link can be established between the site and the coordination centre or NGO's headquarters during relief operations [2].

As a result of the above, there are two types of satellite internet connections namely:

- ✓ One-Way satellite internet connection
- ✓ Two-Way satellite internet connection

The One-way connection is also known as offline connection because in one way we can only download the files like, movies, pictures, sounds etc. Meanwhile, in a one-way system, internet content like webpage could be distributed by "pushing" them out to local storage at end user sites [2].

The Two-way satellite internet connection service is absolutely autonomous setup and it does not require any IP connectivity from the subscriber. It can provide satellite internet access anywhere within the satellite coverage map. This is best explained that almost in any point on the planet, there is a chance to get a high-quality, affordable broadband Internet access [2].

The two-way satellite internet access subscribers are required to purchase and install the earth station equipment which is generally known as VSAT (Very Small Aperture Terminal) equipment [2]. The VSAT earth station, consequently, creates two-way radio circuit with the satellite spacecraft and is used both for downloading and uploading data from and to the internet [2] as shown in Fig. 1 below.

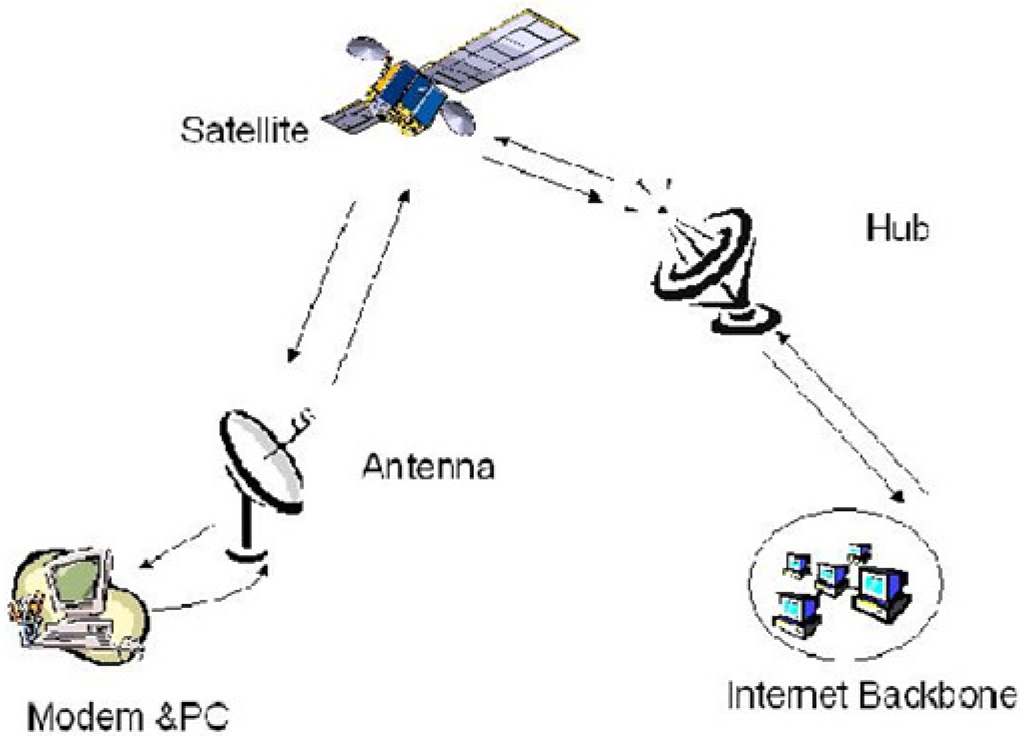

Figure 1. Two-way Satellite Internet [2]

4.4 RFID: The following are the potential applications of RFID technology during earthquakes relief operations:

4.41 Victim and resource tracking: Rescue personnel can be supplied with PDA's equipped with radio-frequency (RF) cards and interrogator attachments. They can attach the RF tags to victims during earthquakes relief operations. This enables instantaneous tracking of victims. In addition RF tags can be attached to resources like equipments, supplies, responding personnel etc., to track them as well. These tags can also be used in the hospitals and emergency centres to keep track of medical equipments and medicines [21].

4.42 Medical care in hospitals: Paramedics on the field can use identification tags to store primary data about his medical condition during earthquakes relief operations and upload this data to a hospital or an emergency centre. Whenever the victim arrives at the emergency centre, he can get appropriate medical care as data about him can be accessed through his identification tag [21].

4.43 Location of disasters survivors: RFID tags can be used to track missing persons and disasters survivors. Recently, the Japanese government has decided to sprinkle RFID-tagged sensors over disaster-prone areas. The sensors scattered in disaster areas will make up a mesh network that shall detect heat and vibration in a particular place [21].

4.5 Geographic Information Systems (GIS) and Remote Sensing: This device can be used effectively in any earthquakes relief operation by providing the first-hand information about the damage magnitude, the areas affected and to give direction to the rescue and earthquake relief operations staff [8]. In a hypothetical earthquake event, the first information that would be needed is the location of the epicentre and the extent of the worst affected areas. According to [8], the Internet GIS and its applications would assist the emergency managers to have the knowledge and map of the affected area with other statistics such as a number of houses, the population, estimation of the causalities and damage were done. The online information stored becomes widely available to the concerned agencies and people, and with interconnections through a wide area network, control rooms can be established [8].

Hazard mapping as GIS applications in the field of risk assessment will assist in showing earthquakes, landslides, floods or fire hazards [8]. Cities, districts or even countries and the tropical cyclone could use this map. Remote sensing makes an observation of any object from a distance and without coming into actual contact. Remote sensing can gather data much faster than ground-based observation, can cover a large area at one time to give a synoptic view [8]. Remote sensing comprises aerial remote sensing which records information such as photographs and images from the sensor on aircraft, satellite remote sensing which consists of the remote sensing system can be used to integrate natural hazard assessments into development planning studies [8]. These are SPOT Satellite, Landsat, Satellite Radar System, and advanced very high-resolution radio [1].

5. LIMITATIONS

E-Service and Mobile Technology tools in earthquakes relief operations have setbacks just like many other types of equipment and research studies. However, despite the important roles these tools offer in disaster relief operations, they have the following limitations.

5.1 GPS: There are many technical limitations facing GPS as a technology used in disaster relief operations which includes:

5.11 Multipath: This is as a result of the radio signal being reflected off an object. Multipath also causes ghost images on a television set, though not common on television technology of today as most new televisions make use of cable and not old days antennas [12]. Multipath is caused when the signal bounces off a building before the GPS receiver's antenna and could add errors to the overall positioning of GPS receiver [12].

5.12 Satellite Geometry: The location of satellites relatively to each other from the perspective of the GPS receiver is called satellite geometry. Satellite geometry may be poor if GPS is locked into four satellites and all facing north r west of the receiver [12]. This is due to the fact that all the distance measurements coming from the same general direction, which makes triangulation be poor and the common area where these distance measurements intersect are fairly large [12].

5.13 Positioning: GPS positioning information occasionally contain errors [1]. GPS errors primarily depend on both physical and artificial errors such as selective availability [1].

5.2 BLUETOOTH: The following are some of the numerous limitations of Bluetooth technology, they are:

5.21 Capacity Limitations: The interference in Bluetooth wireless communication should increase the number of piconets. This is so because Bluetooth communication uses a frequency hopping system that hops randomly from amongst a total of 79 frequencies. As the number of piconets increase, the probability that two frequencies in adjacent piconets are the same increases. This leads to packet collisions requiring retransmission [19].

5.22 Device Discovery in Bluetooth: In a Bluetooth environment the procedure of device discovery must be performed before communication can be done. The device discovery includes inquiry and paging procedures. Sometimes it can take a long time before devices are discovered and data transmission begins [19].

5.23 Low Battery life: Bluetooth devices normally have a very short a battery life.

5.24 Short-range: Bluetooth is a short-range technology, it can work up to a range of 10m.

5.3 Very Small Aperture Terminal (VSAT): The principle perceived drawback is that there is an ongoing cost element for using the service. The limited battery power of laptops, satellite mobile phones and other handheld devices issues about power for VSAT devices [2].

One of the few drawbacks with satellite internet is that there is high latency or a transmission delay. The distance between the satellite and end user is usually around 22,000 miles compared to the distance between antenna and end user [2]. The satellite's transmissions must traverse this distance coming from the user and go back down to the hosting facility. This usually causes a delay of around 1 second [2].

5.4 RFID: This technology has the following limitations, they are:

- ✓ The carrier frequency bands for RFID systems are limited.
- ✓ A distortion in RFID tag antenna degrades the performance of an RFID system.
- ✓ The read range of RFID tags is too small.
- ✓ Lack of uniform standard poses some problems in integration of RFID into existing systems.
- ✓ RFID technology has a low tolerance to fluid and metal environments.
- ✓ Reader collision occurs when two readers simultaneously try to read the tags [11].

5.5 Geographic Information Systems (GIS) and Remote Sensing: A major problem with Geographic Information System getting an accurate date and it is being reported [8]. Vital and accurate information about victims of earthquakes disaster could be difficult to obtain and this is a big setback for the relief operations [8].

6. TECHNOLOGY IN PREDICTING FUTURE NATURAL DISASTER

To achieve the aim of fast and reliable natural disaster prediction such as earthquakes, a software utility is needed that must be able to do many things. The effects of disaster must be displayed pictorially on geo-referenced maps, photographs, satellite images etc. to determine their spatial and temporal extents [20]. Therefore, researchers will review the Consequences Assessment Toolset technology that can be used in prediction of further natural disaster.

6.1 CATS: The Consequences Assessment Toolset was created in response to the need to predict damage and analyse consequences from natural and technological disasters. According to [20], CATs was created by the science applications international corporation (SAIC) in conjunction with the Federal Emergency Management Agency (FEMA) and the Defence Threat Reduction Agency (DTRA) in America. CATs, a user-friendly and PC-based software package offers a wide range of capabilities includes the latest communications, satellite, and weather analysis technologies, computer modelling of natural and technological hazards, and a Geographic Information System (GIS) [20].

The CATs system combines damage prediction models and databases in a customised GIS as displayed in Fig. 2 below to allow for a broad range of consequence assessments. It takes advantage of existing ground-based and satellite communications networks for receiving hazard/disaster warning messages, meteorological data, and site reports; and for distributing the hazard/disaster damage predictions and estimated resources reports to the local area commanders and emergency operation centres [20].

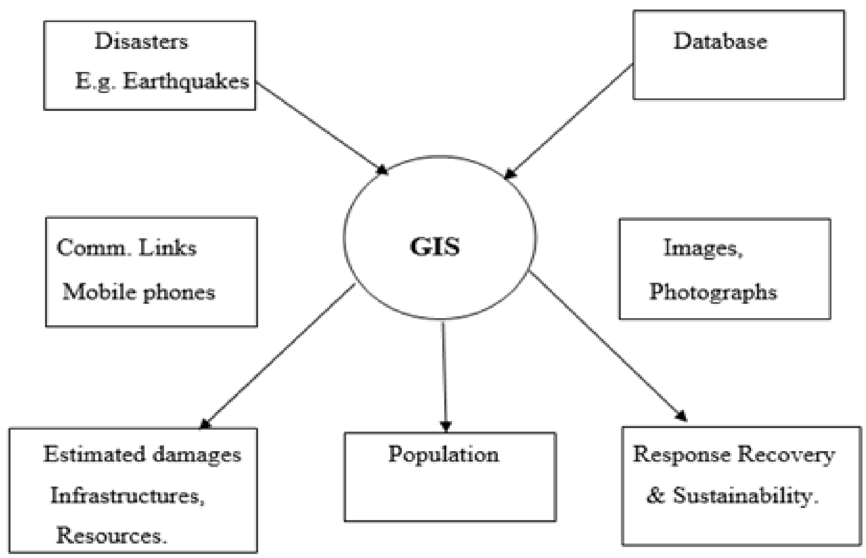

Figure 2. Conceptual View of powerful Analysis Tool (CATs) [20]

7. CONCLUSION AND FUTURE WORK

Earthquake disasters cannot be prevented, if the accurate procedures in giving proper warnings and disaster after recovery are used, the effects could be reduced. More research work is required to establish more advanced ways in which the use of E-Service and Mobile technology is encouraged in disaster relief operations. Future research is needed to identify and implement cost-effective and timely earthquakes disaster relief operations worldwide. Decent leadership management, awareness and availability of e-services and mobile technology devices are recommended in order to have a more robust and effective earthquakes disaster relief operations [16]. More indicators of good governance could be added to these ideas for a new realistic finding and further acceptable outcomes. A secured and effective Geographical information system (GIS) database is needed for environmental and disaster such as an earthquake, this will aid effective monitoring and management [16]. Above all, a strong political will and technological knowledge are required to cope with current disaster relief operations.

ACKNOWLEDGEMENT

Special thanks to the co-authors for their usual assistance, School of Computing, the University of Portsmouth, United Kingdom, Tai Solarin University of Education, Ijagun, Nigeria and Michael Otedola College of Primary Education, Noforija, Epe, Nigeria for providing the enabling environment for this research study.

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