TECHNOLOGIES FOR EFFECTIVE DISASTER MANAGEMENT SYSTEMS: A STATE OF THE ART SURVEY OF CURRENT CHALLENGES AND OPPORTUNITIES

Bishwajeet Pandey
Gyancity Research Lab, India.
E-mail: gyancity@gyancity.com

Jason Levy
Gyancity Research Lab, India
E-mail: jlevy@hawaii.edu

Yousef Abubaker Mohamed Ahmed Al-Abiary
UniSZA, Malaysia
E-mail: yousefelebiary@unisza.edu.my

Bhagwan Das
Department of Electronic Engineering, Quaid-e-Awam University of Engineering, Science and Technology, Nawabshah, Sindh, Pakistan.
E-mail: engr.bhagwandas@hotmail.com

Arifa Bhutto
Insittute of Information and Communication Technology, University of Sindh, Pakistan.
E-mail: arifa.bhutto@usindh.edu.pk

Arjumand Bano
Insittute of Information and Communication Technology, University of Sindh, Pakistan.
E-mail: arjumand@usindh.edu.pk

ABSTRACT

Disasters constitute devastating phenomena that result in the large scale loss of human life and critical infrastructure, often severely disrupting critical societal sytems and the built environment. Robust emergency management can protect human lives and ensure for resilient and resistant cities. Effective disaster management systems are essential to protect human lives and to promote the development of less brittle and vulnerable critical infrastructure systems. The use of leading edge technologies for Effective Disaster Management systems are discussed and analyzed. Early technologies for Disaster Management systems include Sirens, Amateur and Community Radio, and Short Message Services (SMS). More recent approaches inlude Satellite Radio, Information and Communication (ICT) Devices, the Internet of Things (IoTs), Big Data and Deep Learning. The strengths and weaknesses of possible solutions for Effective Disaster Management using Multi-Technologies are herein discussed. Key conclusions are highlighted to promote more efficient and effective disaster management.

KEYWORDS

Effective Disaster Management (EDM), Disaster Response, Multi-Technologies, Internet of Things (IoTs).

1. INTRODUCTION

A disaster is a severe disruption that often occurs in a short span of time. Natural disasters are usually considered to constitute geological events that yield large losses to humans, natural systems or infrastructure. These natural disasters include storms (Hurricanes, Tornadoes, and Tropical), floods, Earthquakes, Wildfires and etc. In natural disasters, emergency decision makers and their respective response units initiate the disaster response and recovery phases to protect lives and critical assets. Other types of disasters are health-related, intentional and na-tech disasters. Disaster examples can include environmental pollution crises, industrial catastrophes, wars and terrorist attacks. The nature of the disaster must be considered in order to provide disaster risk reduction. Disaster risk management and sustainable hazard mitigation and resilience planning are essential. Disaster management has several definitions, as proposed by various researchers. This work focuses on Effective Disaster Management (EDM). EDM can be described as providing systems, technologies and tools to thoroughly organize and manage the information from various disciplines in order to protect human lives and critical assets and key resources. The EDM can also be well described as Effective Disaster Response (EDR). This involves responding to crises and supporting survivors after a disaster strikes. A wide number of technological tools and practices of available for EDM and EDR. EDM can offer a robust technological solution in terms of Information and Communication Technologies (ICTs) and other technologies.

2. PREVIOUS WORK

There are many systems, technologies and innovations that have been proposed recently for disaster management and in the recent past. Each disaster management system was designed and developed to meet specific goals and criteria. The strengths of weaknesses of these systems are now discussed below.

Spencer (2019) discusses how entertainment and leisure are related to goods and service via ICT. ICT helps to increase provide new services, products and breakthroughs for productivity growth. Spencer (2019) discussed the case of Caribbean Tourism based

on ICT in order to market tourist destinations and attractions. This can be done by updating social media and websites to include travel advisories and visitor safety information. The information is available on social media handles using Twitter, Facebook, and Instagram for real-time updates. Lee, Park and Lee (2019) have proposed to study the implementation of citizens' adoption of digital government services.

Alazawi, Altowaijri, Mehmood and Abdljabar (2011) discussed the importance of emergency response systems. The study notes that the impact of disasters can be reduced by implementing the Telecommunications and ICT systems to reduce the human losses and as well the disruption of critical infrastructure systems. This study discusses an innovative emergency response system for disasters by capitalizing on Intelligent Transportation Systems (ITS) including VANETs (Vehicular Ad hoc Networks), mobile and Cloud computing technologies. In this way an intelligent disaster management system can be proposed. The collects information from the point of accident and generates an action plan to reduce disaster damage. In an ICT, the disaster can be controlled via Vehicular Ad hoc Networks (VANETs) as well as by Machine to Machine Communication technologies (Drake, 2009). The author also describes that in disaster management the Cloud Computing has emerged as an innovative solutions in several models of business continuity planning and disaster recovery. These ICT disaster management systems are able to collect information from different locations to make appropriate decisions. Cloud computing is a centralized system to collect and store information via server services. Users pay to avail these services instead of using, buying and installing the software or hardware (Chee & Franklin Jr., 2010). In the Figure 1 a disaster management architecture based on different layers is put forth. This is based in part on a real-time environment and an intelligent layer to support incident response. M2M, VANET and other technologies are also are proposed to support disaster management.
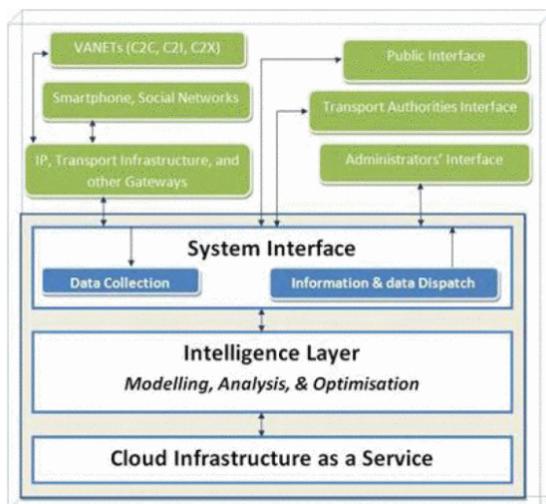
Figure 1. Disaster Management Architecture. **Source:** (Alazawi *et al.*, 2011).

Islam, Sheikh, and Islam (2018) discussed a disaster management scheme based on a cognitive radio ad hoc network (CRAHN). A new solution for disaster management is provided based on a multi-layer perceptron (MLP) based disaster detection scheme. This system proposes the use of WSN and a real-time GUI to provide shared situation awareness to rescue survivors and enable better decision making.

Park *et al.* (2018) discuss an augmented reality (AR) based Smart Building and Town Disaster Management System. It allows for rapid guidance and supports initial response via AR. Fajardo and Oppus (2010) discussed a rescue system which was designed using an Android application known as "MyDisasterDroid". The system offers the best routes for volunteers so that they can reach the disaster zone as rapidly as possible so that the maximum number of lives can be saved. This system of disaster management is designed and developed via a Genetic Algorithm (GA) which allows for the optimization of the system by managing routes and volunteer information.

3. MULTI-TECHNOLOGY

This paper highlights the timely and important use of Multi-technologies for providing Effective Disaster Management. The proposed innovations can help to

reduce the impact and likelihood of disasters in order to reduce disaster losses. Based on the information discussed above it is shown that a wide range of systems have been proposed. It is shown that the most promising solutions include GIS, mobile system, IoT based systems and Android-based approaches. ITU communications motivates researchers to use ICT systems including leading edge devices, communication systems and geospatial approaches to provide maximal safety for volunteers during a disaster and to mitigate disaster threats (Domnori, Cabri, & Leonardi, 2011).

Figure 2. A Demonstration of Multi-Technologies for Disaster Management. **Source:** (Thomas, 2018).

A sophisticated communication system design is often used to address disaster management related issues. The phases of emergency management are shown in Figure 3.

Figure 3. Multiple Phases of Effective Disaster Management. **Source:** (Carter, 2008).

4. CONCLUSION AND FUTURE SCOPE

In this paper, the use of Multi-technologies for Effective Disaster Management systems are proposed. The Multi-Technologies include ICT, IoT and others. A multi-stage approach for Effective Disaster Management has been put forth. Disasters constitute an unexpected, abrupt or gradual phenomena that results in a large scale loss of human life, often disrupting critical societal sytems and the built environment. Robust emergency management and timely evacuations from the affected area can protect human lives. Effective disaster management systems are essential to protect human lives and critical infrastructure systems. A wide range of technologies for Effective Disaster Management (EDM) are put forth. The use of leading edge technologies for Effective Disaster Management systems are discussed and analyzed. Early technologies for Disaster Management systems include Sirens, Amateur and Community Radio, and Short Message Services. More recent approaches inlude Satellite Radio, Information and Communication (ICT) Devices, Internet of Things (IoTs), Big Data and others. The strengths and weaknesses of possible solutions for Effective Disaster Management using Multi-Technologies are discussed. Key conclusions are highlighted to promote more efficient and effective disaster management.

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