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# A Report On

**INTERNET OF THINGS AND BIG DATA FOR DISASTER MANAGEMENT**

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# CHAPTER 1

**INTRODUCTION**

# Introduction

From a larger perspective, no natural process can be a disaster by itself; it just occurs as a result of the causal effects. For example, the movement of plates gives rise to earthquakes and tsunamis; climate processes give rise to cyclones, floods and droughts. When such a resultant process interacts with the human populations and their belongings so as to cause a widespread loss of lives and property, we call that a disaster. The term “disaster management” comprises both natural and man-made disasters. These disasters result in disruption through damage to property, physical injury and death, psychological distress, displacement of individuals and families, and prolonged disruption to a broad range of services upon which communities rely.

Highly pervaded with various types of sensors, our environment generates large amounts of data. Plenty of work is done and data is collected to analyze the cause and the consequences of these disasters. These have been occurring and will keep occurring through time. Then isn’t it ill-advised to not seek some modern technology to comprehend the earth’s natural processes that occur on a regular basis? It is always easier said than done. But to continue with the same set of procedures even after not getting hundred per cent results is a sign of laxity. There have been enough talks about using Internet of Things (IoT) and Big Data for this purpose. So much advancements have been made in science and it is ought to be applied more in the fight against disasters. After all, no one knows how many more lives can be devoted to the advancement of science.

When discussing disaster management, there are a few processes that form the links in the chain and work in tandem to complete the emergency management lifecycle. The process starts with identification of risks, disaster preparedness, emergency response, resources allocation, reaction planning, and lastly disaster recovery. To minimize the damage or loss of

lives in the aftermath of a disaster, it is important that rescuers are able to track the trapped victims and perform coordinated relief efforts immediately. The traditional telecommunication system (e.g. a landline or cellular network) may be either partially or entirely damaged by a disaster incident. So, the thought process of looking at some new technologies to tackle these disasters should be encouraged.

# Purpose of the study

Considering all the above factors, the aim of the project is to highlight the scope of IoT and Big Data for Disaster Management. The Internet of Things describes physical objects, that are embedded with sensors, processing ability, software, and other technologies, and that connects and exchange data with other devices and systems over the Internet or other communications networks. Similarly, Big Data is extremely large data sets that may be analyzed computationally to reveal patterns, trends, and associations, especially relating to human behaviour and interactions.

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The question that immediately comes to one's mind is what is the need of introducing these two technologies in the field of disaster management? Is Big Data Applications (BDA) and IoT-based disaster management still an under-investigated research area? Is it possible to increase the level of disaster preparedness in real life situations using these two technologies? Can real-time big data processing tools assist decision makers with quick and accurate results? Do studies show an improvement when disasters are comprehended using IoT and BDA? Do they show greater improvement in saving lives than the methods still in use? To what extent can IoT and Big Data impact the current methods of handling disasters so as to lead to a paradigm shift in disaster management systems?

In order to find answers to the above questions, it is necessary, to look at the IoT and Big Data for Disaster Management. For example, a conceptual reference model can be made for the deployment of BDA- and IoT-based disaster management environments. The reference model with its proposed integrated parameters can provide guidelines to harvest, transmit, manage, and analyze disaster data from various data sources to deliver updated and valuable

information for disaster management. The ultimate goal is to enhance the data gathering, managing, processing and visualizing phases of disaster management systems for timely and accurate decision-making.

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Feasibility of defining a standardized framework that deploys IoT and BDA for time critical and performance demanding application like disaster management is far from reality. However, it is theoretically feasible to direct the designing process in this new and dynamic environment towards the deployment of a realistic architecture. Disaster management systems requires to be shifting to state-of-the-art environments that are supporting multiple data sources and are equipped with latest technologies offering broader range of capabilities for enhanced connectivity, storage, real-time analytics and cost-effective applications. These environments can be successful deployed by indulging BDA and IoT technologies together for disaster related operations.

Effective utilization of the available opportunities that the BDA and IoT collaboratively offer to predict, understand and monitor disaster situations can prove to be the best possible solution to disaster management issues. Most of the conventional disaster management systems lack the support for multiple new data sources and real-time big data processing tools that can assist decision makers with quick and accurate results. The large metropolitan cities with increasing population are highly disaster vulnerable regions of the world. This is because their authorities lack situational information in case of a disaster, as they are largely constrained by shortage of resources. Both natural and man-made disasters require preventive and reactive measures that need to be pre-planned for effective applications to reduce the chances of causalities and environmental/infrastructure damage. Therefore, disaster management systems need to effectively extract affirmative knowledge, monitor and analyze the ground situation, facilitate evacuations and predict the occurrence of disasters.

# Objective

The convergence of BDA and IoT technologies can set a new meaning to the overall objectives of disaster management. One of the main objectives of this system is early warning

generation, which can save lives and reduce infrastructure damage. Real-time disaster monitoring involves the extraction of information from the system to make informed and timely decisions. It is important for the system to accurately estimate the damages caused and logistics required. Moreover, it should figure out the evacuation routes quickly in emergency response. Effective and timely decision-making needs a reliable, fast processing and data resourceful system that integrates different state-of-the-art technologies to improve its operations.

Our project report is basically going to pave the way for predicting future disastrous events with the evolution in the latest technologies. This is becoming a reality with technologies such as low-powered sensor networks, reliable wireless technology, sophisticated algorithms and advanced data analytics. The concept of smart city is being widely considered as an ideal solution to attain high-quality collaborative multimedia services. Cities can be equipped with the latest digital infrastructure of networks, sensors and smart devices that generate an enormous amount of data; which contains rich streams of contextual, spatial and temporal information. Smart city incentives can play a major role in reducing fatalities by providing information and new insights for resourcefully managing the disaster scenarios.

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BDA and IoT, disaster management systems are expected to provide fast and cost-efficient data processing tools that can potentially be utilized to assist decision-making in all four phases of a disaster (i.e., rescue, response, mitigation and preparedness). The report throws light on the use of IoT in disaster management, helping us in predicting calamities, alerting authorities at an early stage, and rescuing people affected by disasters, thus potentially saving lives, money, and resources. IoT devices hold the power to transform the reactive disaster management techniques into predictive ones.

Disaster management related government authorities, researchers and practitioners have been endeavoring to enhance the disaster management processes by considering new ideas from various research gatherings, such as information technology, cartography, health sciences, and environmental sciences. Then how is IoT used in the process of disaster management?

They can be used for the following purposes like Monitoring seismic activity in which smart sensors can be attached to buildings, bridges, and other places. Moreover, big data generated in the IoT environments can be used for performing data analytics, monitoring, forecasts and generating alerts for unusual events. Therefore, we argue that the joint exploitation of BDA techniques and IoT technologies can lead to the development of an innovative, effective and highly-needed disaster management environment.

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# Conclusion

Big Data Analytics (BDA) and the Internet of Things (IoT) based disaster management is an under-investigated research area that includes many interesting opportunities and challenges. IoT technology possesses the potential to be incorporated in disaster management and can provide a positive impact on every phase of emergency response. BDA on the other hand, is known to facilitate the real-time processing of IoT and other related data streams and is capable of providing meaningful results for understanding the situations persisting in the disaster-affected areas, hence based on the analytical results the deployment of resources is optimal and effective. It can be said that combined use of IoT and BDA technologies contributes to developing a disaster management environment which is innovative, effective and highly needed.

In the next chapter, we begin with the literature review which tells us about the recent developments in big data analytics and the Internet of Things for disaster management. The chapter takes us through the importance of choosing this topic. The important researches made in the field of BDA and IoT and their comparisons have been dealt with in greater detail in this chapter 2. The report then goes on to the next chapter, Research Methodology, wherein the kind of work done by researchers has been explained. From, what tools they used, to the possibilities of using some specific time frame for carrying out experiments, if any, has been talked about. We have the next chapter, i.e., Experiment and Results, especially dedicated for apprising everyone of the experimental part of our topic. Then we have given the readers an insight into what all we have thought about the researches mentioned in our hitherto completed chapters with a chapter named ‘Discussion’. We conclude our report not before contemplating about the future scope of our topic in the last chapter.

# CHAPTER 2

**LITERATURE REVIEW**

# Introduction

# The recent development of big data analytics (BDA) and the Internet of Things (IoT) technologies create a huge opportunity for both disaster management systems and disaster-related authorities (emergency responders, police, public health, and fire departments) to acquire state-of-the-art assistance and improved insights for accurate and timely decision-making. These are some of the research papers we have referred for our project report.

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# Research in disaster management using IoT and Big Data

[1] S. Shah, D. Seker, S. Hameed, D. Draheim, “The Rising Role of Big Data Analytics and IoT in Disaster Management,”. This research paper highlights that the recent development of big data analytics (BDA) and the Internet of Things (IoT) technologies create a huge opportunity for both disaster management systems and disaster-related authorities (emergency responders, police, public health, and fire departments) to acquire state-of-the-art assistance and improved insights for accurate and timely decision-making. The motivation behind this research is to pave the way for effective utilization of the available opportunities that the BDA and IoT collaboratively offer to predict, understand and monitor disaster situations. Most of the conventional disaster management systems lack the support for multiple new data sources and real-time big data processing tools that can assist decision makers with quick and accurate results. This paper also highlights the importance of BDA and IoT for disaster management and investigates recent studies directed towards the same. The reference model with its proposed integrated parameters can provide guidelines to harvest, transmit, manage, and analyze disaster data from various data sources to deliver updated and valuable information for disaster management.

[2] The potential and utility of the big data paradigm is growing for disaster management as mentioned in the work of M. Khalid, A. Roxin, C. Cruz, D. Ginhac, “A Review on Applications of Big Data for Disaster Management,” Big data generated from geo-informatics and remote

Sensing platforms can contribute to early warning systems for disasters. Geographical Information Systems (GIS), Global Positioning Systems (GPS) and environmental monitoring sensors with cloud services have a potential to predict disasters such as snowmelt floods and earthquakes. Geo-informatics information along with transportation network data can benefit to understand human mobility patterns during disasters whereas social media (e.g. Twitter) offers autonomously distribution of disaster awareness and can provide near to real time information of the occurrence of disasters. A multi-sourced social media data can be used to track hurricanes. However, to implement a fully integrated disaster information management system, integration of datasets along with the providing the access to information through a web based system to agencies managing disasters is most crucial to enable effective decision making.

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[3] Ko Ko Lwin; Yoshihide Sekimoto; Wataru Takeuchi; Koji Zettsu, "City Geospatial Dashboard: IoT and Big Data Analytics for Geospatial Solutions Provider in Disaster Management ''. Geospatial information generated from satellites, drones, GPS trajectory data, wireless sensor network, and IoT (Internet of Things)) are important to all processes in disaster management such as disaster mitigation, preparedness, response, and mitigation. The emergence of a global navigation system and wireless communication technology changed the way we live and how we collect geospatial data in the field. Moreover, collection, sharing and visualization of all collected geospatial data are a crucial task for effective disaster planning and mitigation. Proper information needs to reach appropriate disaster management teams in minimal time to reduce loss of life and property. In this paper, we discuss the establishment of a City Geospatial Dashboard, which can collect, share and visualize geospatial data collected from satellites, IoT devices, and other big data. It also explains geovisualization of big data analytical results such as near-real-time rainfall profiler, hourly grid population, link population and flow direction estimated from mobile CDR, and hourly link speed computed from bus/taxi GPS trajectory data in order to improve spatial thinking and planning processes in disaster management by providing a set of spatial analysis tools known as geovisualization.

[4] Pieman Alipour Sarvari; Mohammad Nozari; Djamel Khadraoui, “The Potential of Data Analytics in Disaster Management”. This paper suggests that technology has to make more contributions to help nimble decision making in response to severe disasters, both natural (including climate-related extreme events) and manmade, by providing the right solutions.

Different reports and experiences originating from recent disasters and their crisis management processes have highlighted the need for a resilient and innovative disaster decision support system, even at the modern, developed and well-equipped communities working upon real-time big data. The aim of this paper is to propose a tool to foster preparedness, response, recovery, and mitigation as the fundamental steps of catastrophe management via innovation for disaster-resilient societies. The proposed tool consists of a novel conceptual hybridization of virtual experiments, machine learning, block chain, and database management technologies to overcome limitations of currently used technologies. This tool will utilize innovation in information registration and distribution, data exploration and discovery for generating reliable solutions.

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[5] Akil Ramesh, S Rajkumar, Jenila Livingston L M ``Disaster Management using IoT and Big Data“. IoT and big data enableddisaster prevention and management systems can help governments preserve human life during times of unforeseen disasters. In areas where forest fires are common, IoT sensors can be set up in forests to detect fires in their early stages to curb their spreading and the consequent devastating effects. IoT Devices are sensors used for collecting real time data sets from the environment (structured data) and twitters are used to get non structured data. IoT allows communication within the devices via the internet, as it will increase the data collection and data transferring procedure efficiency. But the problem with IoT devices in disaster management technique is they collect the data or parameters daily, therefore the data storage and management tend to be very challenging. In order to avoid this situation, we use Big Data analysis as the back end for processing data for the IoT data. In recent years, the literature on disaster management mostly focused on the potential that lies in using specific kinds of data for natural disaster management.

[6] Manzhu Yu, Chaowei Yang ID and Yun Li I “Big Data in Natural Disaster Management”. According to this research paper, the disaster management cycle comprises four distinct phases, which are “mitigation”, “preparedness”, “responses”, and “recovery”. The goal of the mitigation phase is to minimize the effects of a disaster (building warning codes and risk zones, risk analysis, public education). The main focus of the preparedness phase is on planning how to respond to a disaster. It includes preparedness plans, emergency exercises, and training, but also the Early Warning System development and implementation. Response activities pertain to providing the required disaster management services to save lives and safeguard property and

protect the environment during disaster management situations. “Recovery” is the process of returning systems to normal levels after a disaster. In recent years, the literature on disaster management mostly focused on the potential that lies in using specific kinds of data for natural disaster management. It is in this context that this paper makes a review of major big data sources, the associated achievements in different disaster management phases, and emerging technological topics associated with leveraging this new ecosystem of Big Data to monitor and detect natural hazards, mitigate their effects, assist in relief efforts, and contribute to the recovery and reconstruction processes.

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[7] Partha Pratim Ray, Mithun Mukherjee and Lei Shu “ Internet of Things for Disaster Management ” Adoption of new techniques could reduce the chances of losing human lives as well as damage to large-scale infrastructures due to both natural and human-made disasters. IoT which allows communication within the devices via the internet and provides various solutions for disaster management. By applying data analytics and artificial intelligence tools, IoT enabled disaster management systems are used for early warning about the mishap. Since the impact of any disaster is enormous, the IoT enabled disaster management systems can be applied to find the victim and possible rescue operations. IoT based disaster management systems that help us to understand past research contributions and future research direction to solve different challenges in disaster management systems. This research paper summarizes the available IoT based technologies for disaster management and their suitability to apply into the disastrous situations. This article describes the role of IoT in disaster management. More precisely, it presents IoT-based disaster management for different kinds of disaster with a comparison between some solutions that are available in the market. It shows an implementation of some examples of the application of IoT such as an early-warning system for fire detection and earthquake and represents some approaches talking about the application, IoT architecture, and focusing on the study of different disasters.

[8] Nowadays, every country and human is prone to natural and artificial disasters. Early detection of disasters such as earthquakes, fire, storms, and floods can save thousands of people's lives and preventive measures can be taken for public safety. The work by Ashish Rauniyar; Paal Engelstad; Boning Feng; Do Van Thanh in “Crowd sourcing-Based Disaster Management Using Fog Computing in Internet of Things Paradigm” in which are providing the information of a certain geographic region are analyzed in a cloud platform. But, by the time the

crowd sourced data makes its way to the cloud for analysis, the opportunity to act on it might be gone. Moreover, thousands of people's lives will be lost. Therefore, fog computing is the new and efficient way to analyze such critical crowd sourced IoT data of disasters. In this paper, in order to detect and take necessary steps for public safety during a disaster, they propose a crowd sourcing-based disaster management using fog computing (CDMFC) model in IoT. Further, this paper also proposes a data offloading mechanism for our CDMFC model to send disaster-related IoT data to the fog even if a direct link to the fog is not available.

[9] IoT deals with intricate systems that integrate multiple dispersed components towards their synergetic use. In this paper by Prabodh Sakhardande; Sumeet Hanagal; Savita Kulkarni their work on “Design of disaster management system using IoT based interconnected network with smart city monitoring system” is developed as a way to enable centralized data acquisition as well as provide an interlinked network for transmission of data in absence of any existing infrastructure. Emphasis is given on how sensing and communication technologies of IoT can effectively be used in smart city monitoring as well as in case of disaster management. The hardware of the module used for this purpose is studied and elaborated in a detailed manner.

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[10] In this paper on “Towards Disaster Resilient Smart Cities: Can Internet of Things and Big Data Analytics Be the Game Changers?” by Syed Attique Shah; Dursun Zafer Şeker; M. Mazhar Rathore; Sufian Hameed; Sadok Ben Yahia; Dirk Draheimwe. In this paper, we propose and discuss the novel reference architecture and philosophy of a disaster resilient smart city (DRSC) through the integration of the IoT and BDA technologies. The proposed architecture offers a generic solution for disaster management activities in smart city incentives. A combination of the Hadoop Ecosystem and Spark are reviewed to develop an efficient DRSC environment that supports both real-time and offline analysis. The implementation model of the environment consists of data harvesting, data aggregation, data pre-processing, and big data analytics and service platform. A variety of datasets are utilized for the validation and evaluation of the system to detect and generate alerts for a fire in a building, pollution level in the city, emergency evacuation path, and the collection of information about natural disasters (i.e., earthquakes and tsunamis). The evaluation of the system efficiency is measured in terms of processing time and throughout that demonstrates the performance superiority of the proposed architecture. Moreover, the key challenges faced are identified and briefly discussed.

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**CHAPTER 3**

**RESEARCH METHODOLOGY**

* 1. **Introduction**

# In the literature review process, we followed a systematic approach on selecting research papers related to “big data” and “disaster management”. Firstly, we searched in Google Scholar with the two key words and obtained more than 4000 results. Secondly, we manually selected papers that were most relevant to our topic. This step led to a total number of 220 articles. Thirdly, we filtered the list of articles to only include journal articles from the last 5 years (2016-2020) which includes the information related to the latest research made on our selected topic “IoT and Big Data for Disaster Management” , out of which 10 research papers are reviewed. It is very likely, though, that we missed several articles that are on the same topic. These articles were reviewed individually for analysis. Starting from one article in 2016, the number of articles in the review field started to grow gradually, with two articles in 2017, a single article from 2018, 3 articles in 2019 and the last research paper from 2020. The peak of the topic “big data” in combination with “disaster management” occurred in the year 2015, and researchers might be directed to other related topics or emerging technologies benefiting disaster management. These research papers mainly discuss three perspectives based on:-

(1) Major data sources

(2) Big data contributions in different disaster phases

(3) Emerging technologies benefiting from big data and disaster management.

The research approach adopted for this work is based upon the principle of induction. The approach initiates with gathering specific observations leading to the identification of patterns. These patterns are further articulated into hypothesis on the basis of which, final conclusions are developed. The participants in our group were briefed about the characteristics of the IoT technology and its applicability in the disaster management scenarios. Also, short sessions were conducted to explain the functionality of the IoT based technical solution proposed in this paper. This helped in gaining the knowledge required to answer the survey questionnaires. The survey was conducted over a period of two months.

This section of the project report explains the development of the appropriate measurement scales for empirical evaluation of the IoT based solution in light of the proposed hypotheses. It also provides a detailed insight into the demographic profiles of the target audience employed for the survey.

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# Data collection

For any disaster management, there should be a proper methodology to be followed by emergency managers and any individual. The National Governor’s Association has set a methodology of disaster management which are its four phases known asmitigation, preparedness, response and recovery. The main types of disasters that occur in nature includefloods, hurricanes, [earthquakes](https://www.sociologygroup.com/different-earthquake-types-waves-characteristics/), volcanic eruptions, fires, mudslides, typhoons, tsunamis, etc*.* These affect human health and life, shelter and land. As we cannot stop most of the natural phenomena that occurs around but we can reduce the damage caused by them. Management is everything about how to be prepared in advance, so that the damage and loss that is caused can be lowered to a greater extent. Here is few disaster management techniques that can be useful in reducing the damage caused:

1. Prevention is better than cure. Disaster prevention is the first and foremost thing one can do. Be prepared according to the natural disasters that may occur according to the locality/area. Know the hazards in your area and know the risk. The information about natural hazards, their occurrence and effect should be known according to the location, region, etc. Geographical information systems (GIS) play a crucial role in this criterion.
2. Social media is a great tool now-a-days, make use of it. Social networking sites can help in communicating with those who are aware and can help you, before or during a disaster.
3. Know about your nearby community officials and government servants who can help you and your neighbors in evacuating the place and also announce a ‘mandatory evacuation’ in the hazard prone area.
4. Identify your nearest local media sources so that they provide valuable information and useful safety measures to people living in the area.
5. Make sure you have a stock of first aid kit or a go-kit that helps you and your family during a disaster. If possible make sure you have a stock pile of medication, food and enough water for at least 3 days during the disaster.
6. In order to make sure you are not affected by the hazards, be in touch with any of your friends or relatives who stay far from you or from the disaster hit area. So that when you are evacuated, you are least affected in any terms.
7. Raising your home, buying flood insurance, securing heavy furniture to the walls all are a part of mitigation, and these help in reducing or eliminating the impact caused by the disasters.
8. Make sure you are adaptable to the environment or surrounding that you are evacuated to, so that no day of your work is missed out in case it takes a long time for your previous area where you have lived to cope up from the disaster effect.
9. Making use of Remote sensors in natural hazard assessments with the help of satellites or sensors mounted to aircrafts. They are very helpful in showing the evidence for occurrence and presence of the disasters according to the geographical, geological and hydrologic and natural phenomena.
10. Public awareness is the most important one in disaster management. Development, planning and management will only be possible with the people being aware of the natural hazards and safety measures that are to be followed during or before a disaster. The study or knowledge on disaster management helps in taking good decisions regarding buying homes, building and living in hazard-prone areas.

# Materials and Procedures

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The adopted research model incorporates nine constructs, out of which three constructs identify the task requirements, one construct refers to the characteristics of the proposed IoT based solution, four different constructs measure the Requirements-Technology Fit and the remaining one construct denotes the strategic value. Due to the lack of measurement items of the identified constructs, the work of Gilbert and Churchill (1979) is followed to formulate new indicators of these constructs. Based on the review of existing literature about disaster management the initial indicators the project report have been proposed. These items are reviewed by the experts associated with disaster management and faculties having comprehensive knowledge about the

IoT technology. The survey is developed both in English and Hindi language, to ensure the consistency of the meanings conveyed to the participants having no or little knowledge of either language. These scales are refined using Exploratory Factor Analysis (EFA) and then Confirmatory Factor Analysis (CFA). This resulted in the development of new indicators for assessing the adopted research model.

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The task requirements construct consists of three reflective latent indicators, namely: disaster impact, tracing and tracking and information reliability. These constructs are measured using the newly proposed indicators. IoT characteristics are a formative construct and its measurement scales include the functionality and other attributes of the proposed IoT based solution. The indicators of the requirements-technology fit reflect the fit between task requirements and the functionality of IoT based solutions for disaster management. This construct is again of second order and is measured by the four underlying reflective constructs: situation awareness, consistency, reliability and monitoring. The overall benefit derived with this collaboration of task requirements and IoT characteristics is measured by the items of the strategic value construct. The items are formulated and are presented in “Appendix”.

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**CHAPTER 4**

**EXPERIMENT AND RESULTS**

Disasters are the most vulnerable factors which are affecting the human life and environment. Smart cities are mainly affected by disasters. This shows the requirement of an efficient disaster management system in smart cities. So, we took this topic of “Disaster Management in Smart Cities using IoT and Big Data” by Akil Ramesh, S Rajkumar\*, Jenila Livingston L M. This paper deals with disaster management technique used in smart cities to detect disasters like building fire, pollution in atmosphere, route blockage using Big Data Analysis and Internet of Things (IoT).

**Introduction:**

Big Data analysis as the back end for processing data for the IoT data. For BDA its important task is to find hidden values from data sets having big size of various data types. Big Data analysis is a modern efficient way for processing data. In this paper, they use Hadoop environment and spark platform to aggregate and segregate data according to the similarities in their behaviour in the storage place by processing the obtained data.Hadoop and spark system involved in data processing and various IoT devices which are used to collect data sets from real time system and unstructured data from social media and their interconnections. This paper focuses on how an IoT device and Big Data analysis can be grouped to create an efficient disaster management system. The proposed work mainly focused on pollution control, building fire control and traffic management system.

The implementation model consists of five layers such as data resource layer, data transmission layer, data aggregation layer, data analytics and management layer and application and support services. In data resource layer collection of structured and unstructured data will be collected from IoT devices and social media mainly Twitter data. In data aggregation layer real-time data are aggregated using spark streaming platform and unstructured data are aggregated using apache flume and structured data using apache scoop. In data analytics and management layer it will segregate the data using Hadoop and spark environment. In application and support service layer, it will compare given mean value of parameters with threshold and if it exceeds, it will send an alert message to public service systems. Data transmission layer is used to intercommunicate with each of the above layers using LAN, WAN and PAN. Each layer has its own functionality which is dependent to each other layer. This makes the system more efficient disaster management system of modern times. To improve the data resolution efficiency, we use spatial clustering technique. Spatial clustering technique is basically worked in fog computing environment which is an intermediate layer below cloud. Usually network connection loss will occur, in order to overcome that there is Emergency Communication Network (ECN) is used. Also, it has some mobile base station called Movable Base Stations (MBSs) which come into play when disaster alert occurs. Spatial clustering analysis is a technique used BDA to aggregate and cluster data efficiently based on their similarities in the feature.

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**Proposed Work:**

The proposed system of disaster management in smart cities using IoT and big data analysis provides a system in which data collection using IoT devices from the real time environment. There are two different types of data which can be collected such as structured data that is collected from various devices and unstructured data which is collected from social media and human sources can be used in this system. After the data is collected it is provided with Big Data analysis using Hadoop framework. In this paper, mainly evaluation of three disaster condition is examined in a smart city such as pollution in a city due to high number of certain gases like carbon dioxide, carbon monoxide, sulphur dioxide, building fire due to increased temperature, traffic which can be caused due to disaster. This disaster environment uses Hadoop framework in Big Data analyzation to analyse the data collected from various sources because these data will be in large volume so it is very difficult to analyse data in other environment and to store these data will also become a challenge.

This large volume of data can’t be evaluated or analyzed as it is because it is very difficult to analyze this huge volume of data and there will be many noises and variation in these data which leads to wrong results. Therefore, to overcome this problem we are using map-reduce technique with Z-Score normalization technique. The drawback of normal mean normalization does not contain any attribute to calculate the deviation in the data thus causing challenge for accurate results. Hence, the normal mean normalization is not used in this work as it takes the average of the data and plot. But it will not remove the noises or evaluate the deviation in the data. Hence, to overcome this challenge we are introducing Z-score normalization technique for the normalization of data. Z-score normalization will calculate the value by dividing the standard deviation of the data set.

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**Result:**

In this paper, the disaster management system is developed by using IoT and BDA with Z-Score normalization. The results show this proposed approach is more accurate and efficient comparing with a system using normal mean normalization because it doesn’t involve any deviation of data. In the earlier systems there can be large chances of results deviating from the original data. In the existing system, mainly they followed normal mean normalization which computes the mean value of the data set as threshold value. But, the data from IoT will be very large in quantity and even there will be some noise data in the collected data set. It is not easy to understand the noise data from this large volume of data. This will lead to deviation of data, which will cause inaccurate analysis. In the existing system, the threshold value changes based on readings, so early prevention is impossible. Hence, in the proposed system we will use Z-Score normalization where there is a fixed threshold after calculating the deviation in the data sets. Therefore, comparing both existing and proposed system, the proposed system helps to reduce the deviation of data and helps to early analysis of disaster condition.

In normal mean normalization, only the average value of readings will be taken. But, in this reading there can be many unwanted values such as outliers. Therefore, the average value that we take as threshold value will not be the accurate and after data interpretation will also be wrong, which leads to false analysis of disaster condition. This can confuse public services and people with false information. So, with all these information it is evident about the advantages of Z-Score normalization over normal mean normalization for the disaster management system using BDA and IoT.

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**CHAPTER 5**

**DISCUSSION**

Disaster management is one of the key use cases for IoT in India given our vast diversity and complexity in our geography and hence the varying levels of vulnerability to both natural & other disasters. The power of real-time information availability together with real-time analytics associated with IoT can be a game-changer in planning for prevention and response to disasters. It is seen that such efforts on generating awareness will go a long way in the creation of sustainable and useful solutions in the Long Run.

**THE ROLE OF IOT IN DISASTER MANAGEMENT**

Disaster management aims to mitigate the potential damage from the disasters, ensure immediate and suitable assistance to the victims, and attain effective and rapid recovery. These objectives require a planned and effective rescue operation post such disasters. Different types of information about the impact of the disaster are, hence, required for planning an effective and immediate relief operation. Now looking at the requirements in disaster management like spreading awareness, planning of rescue operations, IoT has posed a great help. The Internet of things offers disruptive potential in prevention, preparation, response, and recovery phases of disaster management.

IoT can be a game-changer in the prevention of disasters. Throughmonitoring we can be greatly facilitated by using real-time sensor-based data, exampleslike vehicles using telematics and water levels using sensors. Sensors are used to detect wildfires, tornadoes, earthquakes, cloudbursts, and volcanic activities. Critical infrastructure protection can be done through predictive maintenance of disaster management assets. Hazard mitigation is performed through monitoring of the environment using sensors for pollutants and contaminants including radioactive scenarios.

IoT has the potential to streamline preparation efforts. Using sensor technology to address real-time stock and supplies replenishment spares planning, and automated indent processing. Use of complex event processing for notification of an action based on capturing streaming sensor data resulting in predictive resource deployment. IoT can facilitate response planning and actions through, vehicle tracking and GIS integration, use of sensors to monitor the movement of key personnel, using NFC for geofencing and parameter fencing. Situational awareness and incident management through streaming data, unstructured data handling, predictive analysis, big data, complex event processing, and social media analytics can be done.

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IoT can be a great enabler for recovery efforts and activities through, use of sensor technology for identification and authentication of beneficiaries, use of sensor technology for identification and authentication of beneficiaries, use of smart cards and RFIDs for relief disbursal, creating a virtual logistics network that allows hub operators and others to monitor traffic towards and within a hub in real-time and facilitates communication between all involved parties. After going through all the ways IoT can be used in disaster management, we should have a look at the benefits too.

**BENEFITS OF IOT IN DISASTER MANAGEMENT**

Agencies gain a clear picture of operations with real-time visibility of data. Theyalso can extract current and historic data from multiple sources; transform it into rapidly accessible, actionable intelligence for faster and better-informed decisions. It helps in creating a single, federated information hub. Agencies can build an information backbone that all parties including government agencies, NGOs, infrastructure operators, and the community can contribute to and work from. It increases collaboration and interoperability. It allows all stakeholders to work together more effectively by creating consistent and shareable workflows, processes, forms, and plans that address disasters and emergencies of all kinds. Agencies gain by leveraging cutting-edge technology through the harnessing of the power of Big Data, cloud computing, mobile technology, and sophisticated yet intuitive analytics to streamline and optimize all emergency management processes. We discuss about the main open research challenges that need to be explored in the future to have better understanding and development related knowledge of the desire research area.

**DISASTER DATA QUALITY**

The quality of the collected data is very critical for disaster management, as noisy, incomplete and error-prone data can lead to serious problems and wastage of precious time in a disaster scenario. This factor is an additional overhead for BDA- and IoT-based disaster management environments, which requires to be solved prior to any kind of analysis. Data quality parameter plays a major role in determining the accuracy of the analysis carried out on a particular dataset.

Five proposed parameters of data quality that are commonly recognized and are suitable to formulate the disaster data in the filtration process. Each dataset needs to satisfy the conditions describe against the specified parameter in order to be eligible for further processing. Many filtration algorithms and data format converters are being proposed on a regular basis; however, it remains an open research challenge for disaster management where data quality should have the highest priority.

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**WHERE IS DISASTER DATASET’S METADATA?**

Metadata extraction from multiple heterogeneous data sources for a time-sensitive and data quality critical application like disaster management is an important challenge. The essential metadata information about the datasets, i.e., data source, content, time stamps, spatial reference are very important to be identified, in the context of this environment. With effective extraction of metadata, a lot of data quality concerns and integration issues can also be solved at the grassroots level, and reliable datasets can be provided for the disaster management operations.

**BUT WHICH DATA ANALYTICS APPLICATION?**

Selecting the type of analysis to be performed on the newly acquired big datasets within the scope of disaster response or management can be a challenging task. The choice of a particular analysis method will determine the effectiveness and performance of the overall environment and hence will eventually affect decision making. Moreover, the desirable analysis and results may demand a combination of different analytical methods that can increase system work load and affect performance. Another challenge is to identify and analyse what data sets can support smooth and effective processing in real-time and hence provide accurate results.

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**CHAPTER 6**

**CONCLUSION AND FUTURE SCOPE**

The fusion of BDA and IoT promises a new and more effective approach for carrying out the core operations of disaster management processes. With state-of-the-art big data analytical tools and well-managed IoT, we can not only harvest large volumes of valuable data from multiple data sources but can also generate required results in real time for an effective decision-making. However, a lot of research is still required to productively model and implement these two paradigms, keeping in view the time constraint and accuracy demands of disaster management processes. In this survey paper, we identified the benefits of BDA- and IoT-based disaster management and investigated the state-of-the-art literature conducted regarding BDA and IoT applications for disaster management.

We classified the related literature by presenting a thematic taxonomy that unearths the main attributes of BDA- and IoT-based disaster management environments. We also presented a thorough overview of the overall architectural deployment of BDA- and IoT-based disaster management environments through a reference model having dedicated layers, such as data generation, harvesting, communication, management and analytics, and applications. We discussed and compared some indispensable use cases to show the role of BDA and IoT in different disaster management phases. Moreover, we sketched out the key requirements for the successful deployment of the environment and the challenges that need to be resolved. We conclude that this survey can be used as a guideline to understand the overall functionalities for productive utilization of the opportunities associated with BDA and IoT towards the construction of an effective disaster management environment.

In analyzing the recent achievements associated with leveraging Big Data to disaster management, this paper has presented the findings of several researchers on varied scientific and technological perspectives that have a bearing on the efficacy of big data in facilitating disaster management. It has become apparent that in the present age of information technology, a major objective of scientists is to analyze the varied aspects of big data and find ways of making the best of the available technologies in storing the available information in well-integrated structures and using it for the welfare of human societies, particularly in the context of using bid data to effectively deal with natural disasters. The paper has analyzed major big data sources that are valuable in disaster management. A detailed analysis has been conducted to highlight the significance of different big data sources in various disaster management phases.

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The main challenges pertain to effectively dealing with data collection and management technologies and developing efficient systems of mitigating the adversities associated with natural disasters and managing disasters in ways that result in minimum losses to human lives and property. Other challenges pertain to developing algorithms by way of systems that can be used in resolving operational issues and attaining greater accuracy in predicting disasters. The paper has highlighted the need for further research on big data applications in enhancing the efficiency of the public sector in further developing technology to mitigate the adverse effects of natural disasters. Overall, further research efforts need to be made to look into the challenges emerging from Big Sensing Data, particularly in the context of the emerging data volume of streaming videos, including efficient data management, fast data transfer, and intuitive data visualization.

The next scope is to handle the disaster management using the artificial intelligence and machine learning in order to deal with these statistical and behavioral processing features, and the automated decision support infrastructure and real-time evaluations of artificial intelligence and machine learning approaches should be applied together. Soft AI is another interesting field to promote the use of soft robotics to victimize, however, soft robots which are helpful in such situations to find out the location for example drones and processing engines and communication protocols, and they accurately find the real location of the victim. In the various disaster management systems, different types of data are simulated in the context.

Due to various factors, it is the need of possibility for selection of the data mining algorithm which will improve the performance of the IoT based on system. As in hillside monitoring, the data analysis predicts the behavior of the ground, and thus all potential occurrences of the disaster incident, including the landslide, are predicted in time series. This being the case, there are times when a natural disaster dataset has occurred without any prior knowledge. IoT nodes need to be connected to the time series database. This is implemented, for example, in the Tata pipeline DB and KDB flow.

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✓ Integration with artificial intelligence and Machine Learning: With the advancements in the AI/ML technologies, it has now become possible to analyze and predict certain values of importance. In the case of the proposed framework, the count of persons located at various locations within a commercial complex at any given time has to the made available to the rescuers. This data can prove immensely useful in the event of a disaster-like situation by enabling the rescuers to plan the rescue and evacuation operations in a better manner. However, this ready-made data can be used to train a machine-learning system that can then be used to predict the concentration of people at a particular location on specific days such as weekends, public holidays or vacations. This information can enable the management to beef-up the security arrangements in anticipation of a large number of visitors on specific days.

✓ Integration with Microlocation Technologies: There is an opportunity to integrate the user interface with indoor person localization services through available techniques such as the Bluetooth Low Energy (BLE) beacons, RFID, etc. This would act as a useful tool in enabling the rescue team members with specific information and help them reach the nearest point of reported disaster within the complex building. Effective disaster management is a global challenge. This paper presents a review of big data applications in disaster management. It gives an overview of what kind of data is used in existing systems for managing disasters, which specific phases of disaster management a system is targeting to and what are the enabling technologies that have been used along with big data technology to supplement disaster management decision processes.

After a systematic review, it has been observed that big data research remains in its developing phase into existing workflows and practices for disaster information management. There exists a major gap particularly in seamless integration of different data sources as number of datasets kept limited in stated applications. Furthermore, there is a need to investigate data mining challenges as well for disaster management. Efficient data mining methods will help to discover various associations, correlations and trend analysis in order to reduce the future reoccurrences of disasters. Finally, security as well as privacy issues in data transmission and storage also need to be under constant investigation to ensure the authenticity of disaster data while keeping the confidentiality of people`s sensitive information.

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**APPENDIX**

**Appendix A**

Comparison of IoT and BDA assisted disaster management use cases

**Appendix B**

Algorithm-1: Pollution alert

Begin

Input: gases data

Output: pollution alert/no pollution

1. for each gases loop

2. if gases value > 0.5 (threshold value from z-score normalization)

3. pollution alert

4. else

5. Go to (Step1)

6. End if

7. End loop

Algorithm2: Fire alert

Begin

Input: Temperature data

Output: fire alert/normal

1. for each temperature value loop

2. if temperature value > 0.5 (threshold value from z-score normalization)

3. fire alert

4. else

5. Go to (step1)

6. End if

7. End loop

Algorithm 3: Blockage Alert

Begin

Input: blockage data

Output: blockage alert/normal

1. for each blockage value loop

2. if blockage value > 0.5 (threshold value from z-score normalization)

3. blockage alert

4. else

5. Go to (next reading)

6. End if

7. End loop

**Appendix C**

 Benefits and Requirements of BDA- and IoT-based Disaster Management Environments:

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