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Disaster management and application of different methods: A systematic review

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ABSTRACT

Disaster management methods help in planning, organising, coordinating and implementing measures for preventing the loss due to disasters. These methods also help in reducing the effect of disasters by providing effective resolving techniques. In this paper we have conducted a systematic literature review on various different methods which have been used in phases of disasters. A total of 153 published research and review articles have been chosen from the search for analysis. Different disaster management methods are reviewed and summarized. Also highlighted are the contributions of various authors, their methodological focuses, and additional findings of the reviewed works. It is noticed that most of the papers with different methods analysed prevention techniques, preparedness during disasters, mitigation phase and recovery phase. In recent years, studies have focused on advanced technological methods like remote sensing and using drones for managing disaster; however, in the literature, few papers have applied technological methods in the area of disaster management. The contribution of the review paper to the literature is by looking over the present research, and putting forward new opportunities for future research in the area of disaster management by applying different methods.

Keywords: Disaster Management, Effective Decision Making, Disaster Risk Reduction, Disaster Preparedness, Geographic Information System, Remote Sensing

1. INTRODUCTION

Historical data analysis reveals that worldwide disasters and catastrophes have become more frequent and more severe in recent decades. This fact is applicable to only natural disasters as well as terrorist attacks. According to (Farahani et al., 2020) 1.3 million people lost their lives and 4.4 billion people were injured or became homeless due to natural disasters between 1998 and 2017.

According to the International Federation of Red Cross and Red Crescent Societies (IFRC), a disaster is defined as the sudden occurrence of a dangerous event that can significantly affect all of the community's members and result in a number of unfavourable outcomes (such as life-threatening situations, financial loss, etc.) that the community is unable to manage on its own. (What Is a Disaster? / IFRC, n.d.)

Everyone in the society is known to disasters and catastrophe, as they are occurring since ancient times till today. The world has seen many mega disasters and catastrophes due to natural and human activities. Combination of these disasters has increased the impact on the society (e.g., In 2011 Japan faced series of disasters which included underwater earthquake that gave rise to tsunami further damaging the Fukushima Daiichi nuclear plant leading to hydrogen explosion) (Fukushima Nuclear Disaster - Wikipedia, n.d.). Disasters have resulted in increased loss of lives as well as permanent damage to physical and mental health along with huge economic loss to countries around the globe. Disasters that have caused major loss to the world in this century include Covid-19

pandemic which the world recently faced, tropical cyclones, floods, tornadoes, earthquakes, tsunamis, droughts, fires, industrial technological disasters, aviation disasters, volcanic eruptions and terrorism.

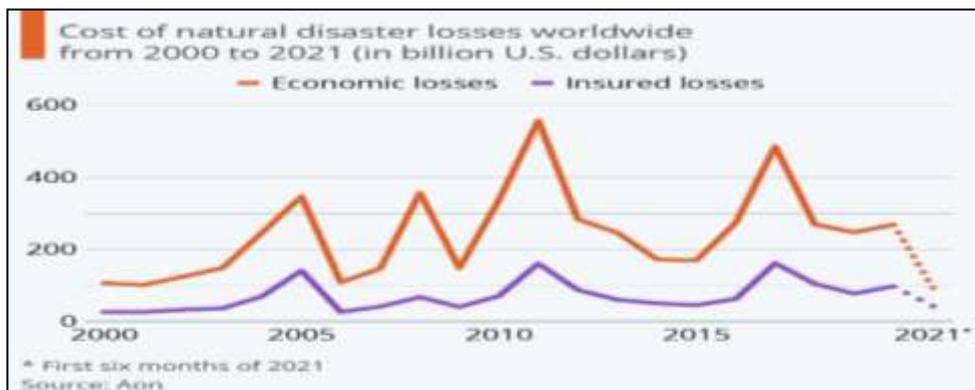


Figure 1. Cost of Natural Disasters in 21st Century (• Chart: *The Cost Of 21st Century Natural Disasters* | Statista, n.d.)

Figure 1. tells us about the cost incurred during natural disasters, it indicates that the cost has not been decreasing and the losses faced by the countries in the period 2010-2015 has been the highest.

Policy decision and operational activities relating to various stages of disasters are involved in disaster management. The various stages involve pre-disaster stage, disaster occurrence stage and post disaster. Aim of disaster management is (Vaz & Vaz, n.d.):

- to avoid or minimize the potential losses,
- ensure prompt and reasonable assistance to disaster victims
- achieving effective recovery

The process of disaster management involves the following phases:

- Mitigation – It is the process of taking efforts to lessen the deaths and damage to property by reducing the effect of disaster. The focus of this phase is on long-term strategies for lowering and removing risk.
- Preparedness – This phase involves measures which are designed to organize and make possible timely and effective rescue, relief and rehabilitation operations.
- Response – This phase involves the mobilisation of the required emergency services. There are three phases of response in managing disaster:
 - Pre-disaster response
 - Response during disaster
 - Post disaster response
- Recovery – This phase focuses on restoration of the affected areas to its previous state. Recovery is of two types:
 - Short term recovery
 - Long term recovery

The paper is assembled as follows. In [Section 2](#), overview of the previous published papers has been discussed. The review of various methods in disaster management has been directed in [Section 3](#). [Section 4](#) gives the statistical evaluation of published articles. Finally, conclusions and directions for research in future articles are given in [Section 5](#).

2. SCOPE OF THE LITERATURE REVIEW

Science Direct served as the repository for the pertinent research and review articles. The words "disaster" and "disaster management" as well as "optimization" or "casualty management" were used in the article's title, abstract, and keywords. [Figure 1](#) shows the results of the preliminary literature search, which revealed that practically all research in the field of disaster management had been published since 2000. In light of this observation, the literature on various methods is reviewed in this paper. In accordance with this observation, in this paper, the literature on various methods like disaster operation management (DOM), casualty management (CM), optimization of cost during disasters, mass casualty incident (MCI) etc. applied in the field of disaster management is reviewed beginning from 2000 till 2022.

After the search in Science Direct, the following standards were used to improve the search database:

- Document type: Research and Review Article
- Source type: Journals
- Year: 2000–2022
- Language: English

We also used other websites, such Z-library and Google Scholar, to broaden our search. The final batch of 250 relevant papers was chosen for review after the articles were first filtered (by title, abstract, and keywords). The major requirements for including these articles were that they concentrate on all aspects of crisis management, casualty management, recovery planning, and disaster management, and that the search term appears in the body text. Following the selection of the final list of articles, an extensive analysis of the application of various management and optimization techniques in disasters was carried out, and a statistical evaluation was finished using the group of articles that had been chosen.

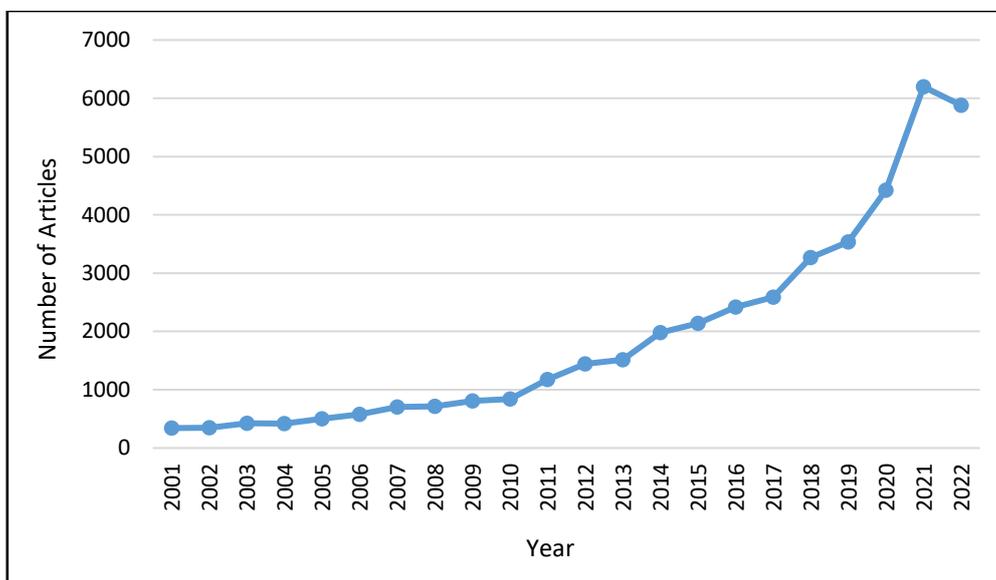


Figure 2. Number of articles published on disaster management

As a starting point for determining the necessity for a new and updated study, we give the most pertinent research and review publications that examined the use of operation research approaches for disaster management in this area.

Following is the method wise article review form 2000-2022

- In 2000, A mathematical model of calculation of optimised resource schedule was given using Geographical Information Systems (GIS), search-and-rescue (SAR), heuristics Simulated Annealing. The model allocates: Representation of the disaster area, Components of the goal function, Fatalities due to secondary disasters, duration of the rescue operation lack of rescue attempts, delayed transport, duration of transport, lack of transport 3 Resource restrictions due to local conditions.(Fiedrich et al., n.d.). The paper examines and evaluate application of GIS for cyclone disaster risk management practical application of GIS for natural hazard risk management and to: assess the appropriateness of spatial data layers for cyclone hazard management, examine the utility of GIS software for decision-making in crisis situations and assess the spatial data needs of emergency managers in a crisis situation.(Zerger et al. n.d.).
- Later in 2002, a new system of traffic management in an earthquake disaster was introduced with the view of using (ITS) Intelligent Transport System in managing large scale earthquake. Also, the challenges faced while implementing the model is also discussed.(IIDA et al., 2000).
- Another paper in 2003 was published on MCI i.e., managing a situation in limited resources. Due to lack of coordination between MCI and Disaster medicine management mass casualties are not managed properly. The success of MCI is measured from good implementation of emergency medical services (EMS). For a success of MCI, we should follow: Immediate response, Reorganisation and Lesson learning.(Peleg et al., 2003). In 2008, a Research was conducted (using questionnaires) A survey of 128 medical professionals was done to evaluate the efficacy of their knowledge base and how it influenced their choice-making in response to an MCI following a terrorist bombing.(Ashkenazi et al., 2009).
- In this study, the authors have concentrated on Casualty Management (CM) for catastrophes where the five steps listed below are implemented: Resource shipping/find and rescue, local teams, local medical aid, hospital transfer, and thorough care are just a few of the services offered. With use of operation research techniques, they have categorised the already published research articles and case studies in each of these steps.(Farahani et al., 2020).
- For proper selection of disaster recovery plan (DRP) the research has developed a decision support system by using OR modelling. The objective of this research in multiple restriction is to maximize the coverage within limited resources.(Bryson et al., n.d.).
- In the year 2006, a review of the literature was written using Cross functional DOM research with relevant articles, and surveys after 1980s to pinpoint prospective areas for disaster operations management research, talk about related concerns, and offer a place for interested researchers to start.(Altay & Green, 2006). A Research paper from 2013 is a unique analysis of the most prevalent presumptions seen in recent DOM OR/MS literature. Future research directions are given based on the findings in order to improve the areas where there is a shortage of investigation. Analysis of Filtered research papers fitting in the DOM domain using probability and statistics.(Galindo et al. 2013).
- This research article of 2008 talks about the large number of critically ill disaster victims who had put a strain on health-care systems' ability to provide standard critical care services to all those in need. Regarding that this article suggested medical equipment, treatment space expansion ideas, and staffing models for EMCC.(Rubinson et al., 2008).
- An article published in 2001 tells us about floods in the United Kingdom and continental Europe that were examined. This paper also suggests the problem areas which were benefited from additional research. Procedures were: consolidate knowledge by promoting consistency, networking, and learning, Pay close attention to connections across international borders, take advantage of fire services' abilities as they play a larger role in flood response, and make sure risk analyses are carried out and residual risks are not disregarded in areas that are ostensibly protected by structural protection works.(Handmer, 2001).
- Helicopters were being used for rescuing people during natural disasters, which became a very important part of disaster management. Therefore, A methodology has been developed which is useful in disaster management by way of multi-criteria analysis of helicopters.(Barbaroso glu et al., n.d.).

- A paper was published for child mental health professionals during disasters preparedness and recovery in 2003. Objective of this paper was to provide a child-oriented system to reduce the challenge for child mental health professionals and provide a systematic approach.(Laor et al., 2003).
- This research paper of 2006 states that one step in responding to a transportation disaster is believed to be evacuation analysis. In order to learn more about how people react to tsunami warnings in the future, this article conducted a behavioural analysis to identify evacuee response patterns (rapid, medium, and slow) under various scenarios (four preparation and response time intervals, i.e., 60 minutes, 45 minutes, 30 minutes, and 15 minutes).(TSUNAMI EVACUATION BEHAVIOR ANALYSIS-One Step of Transportation Disaster Response-Thai CHARNKOL Yordphol TANABORIBOON, n.d.).
- A paper published in 2007 highlighted that biological attacks can cause an outbreak of infectious disease as well as an outbreak of fear and panic. Both types of epidemics can be represented using epidemiological triangle chain models. The primary prevention of biological attacks should include preventing terrorists and biological agents from entering the territory. Internal surveillance of potential sources of agents and terrorists should be part of the primary prevention level.(Radosavljević & Jakovljević, 2007).
- Nearing the end of 2009, an article with an aim to outline a straightforward and unbiased strategy for evaluating medical performance during functional exercise events using a specially curated 3 step evaluation tool in order to identify the disaster response's strengths and weaknesses and to offer data that could ultimately result in systemic response system changes.(Ingrassia et al., 2010).
- Research from 2012 critically highlighted that how ineffective Haiti's healthcare system was at the time of the earthquake by conducting interviews and online surveys with selected orthopaedic surgeon volunteers.(Sonshine et al., 2012).
- The paper on Flood management, published in 2012 has laid emphasis on how a combination of natural and human factors contribute to the risk of flooding. Planning for flood management measures across administrative and sectoral lines is necessary, and listed flood prevention measures must be used.(Tingsanchali, 2012).
- A paper published in 2014 focused on disaster management training to improve the technical skills of disaster workers and volunteers as well as the leadership of people and teams. In addition, disaster risk management coordination and the skills and availability of disaster management tools needed to be improved.(Nazli et al., 2014).
- A paper was published in 2015, aim of it was to analyse the current situation and make suggestions for improving the wind disaster management system in Latvia by examining sources such as various scientific literature, various normative laws and concrete examples. This paper provided a brief overview of how the Latvian system of wind disaster management can be improved through interactions between business, society and the state(Silovs et al., 2015).
- The purpose of this article was to examine the characteristics of freely available geographic information systems and software in the context of disaster management. Effective disaster management requires the use of geospatial data at every stage, from planning to response and recovery. However, trustworthy software was necessary for the effective pre-, during-, and post-disaster use of the data and information supplied.(Nekoei-Moghadam et al., 2016).
- This paper considered designing relief logistics networks as one of the most important disaster preparedness activities. In emergency situations, rescue operations can be performed on nodes if they are within the rescue radius. Therefore, the proposed model contained cusp problems. At the same time, they designed the relief transport network based on the hub placement problem. Furthermore, a Lagrangian relaxation method had been proposed to find a suitable lower bound for the large-instance problem(Erdelj et al., 2017).
- The paper explains that the emergency transportation network design problem is put forth in an effort to identify the best network for carrying out high priority emergency response trips in the wake of earthquakes. To determine the best course for emergency vehicles taking into account length, travel duration, and the number of paths, there are three objectives with specified functions.(Nikoo et al., 2018).
- A paper published was to identify the existing difficulties in developing practical and useful optimisation models in the context of shelter site and evacuation routing, with the ultimate aim of defining a research plan for this area.(Esposito Amideo et al., 2019).
- This article talks about the use of drones for managing disasters and few of the optimal control issues that can arise when using drone systems to aid in search and rescue efforts following disasters like earthquakes, floods, tsunamis, and extreme weather occurrences, among others.(Pereira, 2021). This 2022 study had offered a focused literature analysis of the OR contributions to the coordination of the healthcare system during catastrophes. An overall descriptive statistic of the evaluated articles is given after a study of the research problems, disaster types, and developed methodology. The main characteristics of models for healthcare coordination were described. We propose future research directions in the context of existing model extensions, as well as the application and development of other methodologies, with the goal of providing a solid foundation for OR research in healthcare disaster management.(Tippong et al., 2022).

3. RESEARCH METHODOLOGY

This section has reviewed the articles on different methods used during and post disaster. The sub-section reviewing the applications of various methods in detail are as follows:

Applications of Different Methods

- i. Disaster Risk Reduction
- ii. Remote Sensing
- iii. Geographic Information System (GIS)
- iv. Casualty Management
- v. Mass Casualty Incident (MCI)
- vi. Humanitarian Logistics
- vii. Crisis Management
- viii. Decision Support System

ix. Disaster Operation Management

3.1. Disaster Risk Reduction

A theory and method for lowering disaster risk through joint efforts to research, analyse, and mitigate disaster-causing factors(<https://en.unesco.org/disaster-risk-reduction>, n.d.). Between 2000 and 2021, this method is applied in a total of 15 papers in our study.

Disaster risk reduction was used as a method to focus on reconstruction and prevention of earthquake disasters(Xu & Lu, 2018). A policy was developed by the Sri Lankan government to reduce disasters through disaster risk reduction, this policy is the Sri Lanka National Disaster Management Policy (SLNDMP). There were three disasters during 2016-17 and to avoid any further damage this method was used to reduce the casualties(Nikoo, Babaei, Mohaymany, et al., 2018). In 2011, The second deadliest disaster was Tropical Storm Washi. This method was applied to identify the future challenges of typhoon related disasters preparedness and reduction(Rasquinho et al., 2013).

3.2. Remote Sensing

A method of acquiring information without physical contact through satellite or high-flying aircraft(https://en.wikipedia.org/wiki/Remote_sensing, n.d.). Between 2000 and 2021, this method is applied in a total of 5 papers in our study.

Remote Sensing is used for stratification and mission planning purposes. This method was used to collect information on buildings characteristics by using technology to optimize cost as the cost of collecting information can be costly(Montoya, 2003). Geospatial data is not so effective for disaster management. To make efficient use of data pre, during and post disaster remotely sensed images were used(Leidig & Teeuw, 2015). Remote sensing provides information on disasters which helps in formulating strategies to reduce the impact of disaster.

3.3. Geographic Information System (GIS)

This method is used by many studies for effective decision making in case of disasters.

The study has evaluated the usefulness of GIS in cyclone disaster risk management in urban area. The research focussed on observations of real-time emergency management in Australia(Zerger & Smith, n.d.).The study has used GIS for disaster recovery process for management of debris. The system was used to find temporary debris management site(Kim et al., 2018). This paper has examined the effectiveness of GIS for effective management of disasters in preparedness, response and recovery phase by efficiently using available data(Leidig & Teeuw, 2015). This paper has used GIS for determining the risk in case of ecological consequences(Ni & Xue, 2003). This paper has examined GIS for finding flood risks in urban areas which are at risk of cyclone induced storms(Zerger et al., 2002). This paper used GIS was used for study of landslide vulnerability in Himachal Pradesh(Rautela & Lakhera, 2000).

3.4. Casualty Management

Operations for managing casualties after disasters have become crucial for lowering the number of fatalities. It helps in development of optimization models to allocate emergency units to affected sites and casualty groups in the initial hours after sudden-onset disasters to minimize any sort of damages(Rezapour et al., 2018).Casualty management helped in the identification of those patients who are at risk of vomiting following burn injury and who therefore might be suitable for oral resuscitation from a survey conducted from a database of patients from 1990-2001(Brown et al., 2003).Casualty management helps in presenting trends, gaps and innovative directions for future research by analyzing past data on disasters which could result in better and efficient risk reduction for the future(Farahani et al., 2020).

3.5. Mass Casualty Incident (MCI)

This paper used MCI for determining the principles of emergency management in case of disasters(Peleg et al., 2003).This paper has examined the effective knowledge MCI to physicians. A survey was conducted to measurement of knowledge of physicians about MCI(Russo et al., 2015). This paper examined the injury management of trauma centres in case of MCI. They focused on the readiness and expertise of hospitals in case of MCIs(Gabbe et al., 2020). This paper focuses on decision making in case in complex MCIs(Berndt & Herczeg, 2019). This paper examines the education, expertise of decision making in case of MCI(Ingrassia et al., 2010).

3.6. Humanitarian Logistics

A research pointed out the value of considering several actors in models for humanitarian logistics to provide a more comprehensive tool for decision-maker for improvement for the decisions currently being made in practice by incorporating a better preparedness system(Rodríguez-Espíndola et al., 2018).A study in the area of humanitarian logistics proposed an integrated facility location-inventory allocation model for a disaster affected region where drones can be considered as a potential mode of transportation to transport emergency supplies to the demand points(Chowdhury et al., 2017).Humanitarian Logistics Theory helps to analyze how humanitarian assistance planning can benefit from risk management in the context of pre-positioning through the analysis of relief supply shortages(Condeixa et al., 2017).MAXQDA software program was designed for qualitative and mixed methods data, text and multimedia analysis of various disaster lifecycle phases in order to minimize loss with better humanitarian logistics supply allocation(Goldschmidt & Kumar, 2016).

3.7. Crisis Management

The process of anticipating, solving, and learning from the consequences of numerous significant failures that have an impact on groups of people, including organisations and local, national, and international communities, is referred to as crisis management. This method is applied a total of 6 times in this study.

Crisis management has been studied to analyse the workflow typical in a disaster scenario and discusses the design considerations for a virtual information centre VIC that can both efficiently and effectively coordinate and process large number of information requests for disaster preparation management and recovery teams (Bui & Sankaran, 2001a). Crisis management in this paper helps in earthquake disaster prevention. reconstruction has been focused on disaster risk reduction planning, disaster mitigation knowledge, participatory disaster governance, and community resilience building (Ogurtsov et al., 2008). The paper shows that psychological stress disturbs decision making during technological crisis and disaster, and how to prevent this from happening by crisis management (Weisaeth et al., 2002). This paper uses crisis management to provide with preparedness of organisations to war and terrorist attacks (Anderson, 2006). This paper analysis the workflow typical in a disaster scenario using crisis management (Bui & Sankaran, 2001b).

3.8. Decision Support System

A decision support system (DSS) is a software application that organisations and businesses use to support decisions, judgments, and plans of action during a disaster or crisis. This method is applied a total of 4 times in this study.

In this paper the main research into earthquake disaster prevention and reconstruction has been focused on disaster risk reduction planning, disaster mitigation knowledge, participatory disaster governance, and community resilience building by a decision support system (Ogurtsov et al., 2008). This paper briefly expounds emergency decision contents in different stages of natural disasters (Zhou et al., 2018). This paper shows the usage of decision support system for the management of natural disasters risk (Spartalis et al., 2007).

3.9. Disaster Operation Management

Disaster operation management helps in removing the inadequacies in strategic planning by suggesting new strategies to the disaster and emergency response managers which they can consider during bushfire preparedness and for response planning (Oloruntoba, 2013). Disaster operation management aids in identifying recent research and offers direction for additional study in this developing area. It helps in benefiting Humanitarian organizations in their ability to respond to disasters with greater importance as in the case of HOCM (Goldschmidt & Kumar, 2016). Disaster operation management helps to provide emergency transportation network design problem to determine the best network for performing emergency response trips with high priority in the aftermath of earthquakes (Nikoo, Babaei, & Mohaymany, 2018). Disaster operation management helps in procurement of relief supplies and preventing human sufferings. With providing attention to the topic of supplier selection (SS) (Hu et al., 2022).

4. BIBLIOMETRIC ANALYSIS

This section presents a bibliometric analysis of different methods used in disaster management. From the literature search above in Section 2, we can note a lack of reviews, with only three studies reviewing particular topics such as: (i) Reliable transport for supplies (Hamedi et al., 2012); (ii) Pre disaster planning (Crowley, 2017); (iii) Psychological impact of disaster (Mao et al., 2018). In total, 203 contributing articles applied different methods to understand disaster management issues better; this means, **Figure 3** represents the keyword network that was created using the keywords found in each of the contributing articles. It is evident that disaster management, humanitarian logistics, disaster operation management, emergency management, disaster risk reduction, and disaster recovery are the top keywords.

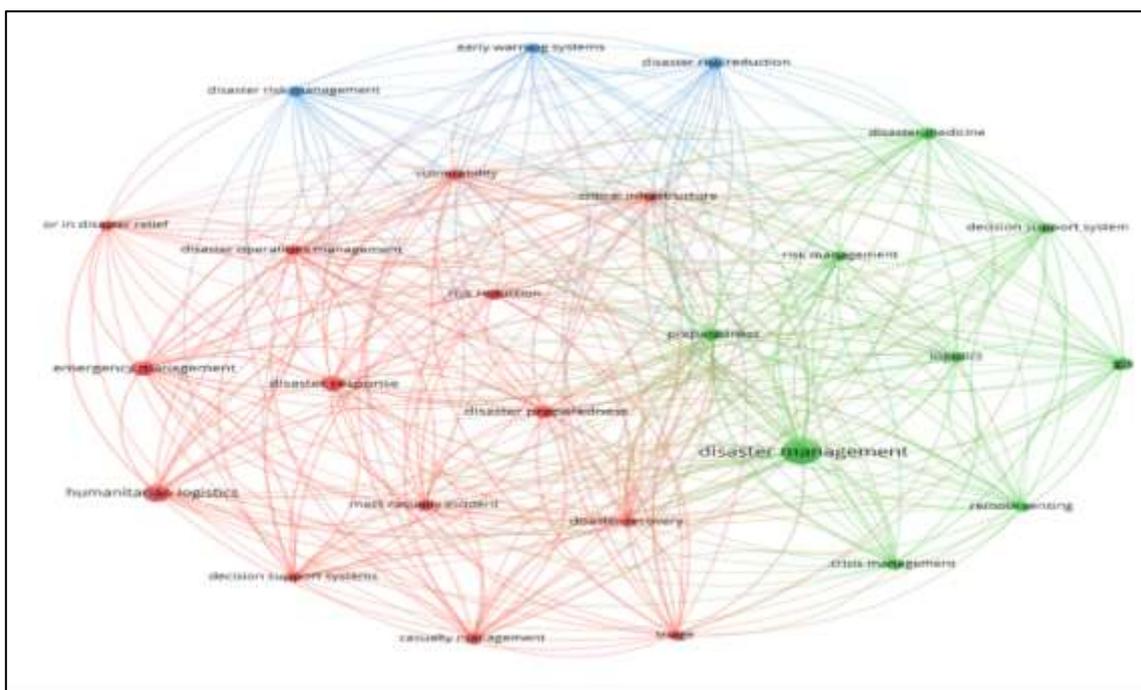


Figure 3. Co-occurrence of keywords used in the selected contributing papers (source: VOSviewer).



Figure 4. The link between the authors and co-authors of researchers. (Authors who have published two or more papers were considered.)

Table 1: - Top authors and co – authors respectively that have published 2 or more than 2 papers and their total link strength

Author	Documents	Total Link Strength
Cheung, k. f.	2	22
Dodd, n.	2	22
Douyere, s. h.	2	22
Liao, s.	2	22
Liu, p. j.	2	22
Lynett, p. j.	2	22
martino, c. d.	2	22
Nakazaki, e.	2	22
Phadke, a. c.	2	22
Rojas, r.	2	22
Wei, y.	2	22
Christian, Michael d.	2	16
Curtis, j. randall	2	16
Devereaux, asha v.	2	16
Dichter, Jeffrey r.	2	16
Geiling, james a.	2	16
Hick, john l.	3	16
Medina, Justine	2	16
Rubinson, lewis	2	16
Talmore, Daniel	2	16
Baghaian, atefe	2	8
Farahani, reza zanjirani	2	8
Lotfi, m. m.	2	8
rezapour, Shabnam	3	8
Ruiz, ruben	2	8
Akbari, vahid	2	4
Alamdard, farzad	2	4
Ding, yulin	2	4
Hettiarachchi, s. s.l.	2	4
Jayasiri, g. p.	2	4

Kalantari, Mohsen	2	4
Lin, hui	2	4
Petrovic, sanja	2	4
Rajabifard, abbas	2	4
Siriwardana, Chandana s.a.	2	4
Tipping, danuphon	2	4
Zhu, qing	2	4
Amaratunga, dilanthi	4	2
Goldschmidt, kyle h.	2	2
Haigh, Makarand	2	2
Kim, joohe	2	2
Kumar, sameer	2	2
Alam, edris	2	0
Faulkner, bill	2	0
Filippi, maria Evangelina	2	0
Govindan, kannan	2	0
Handmer, john	2	0
Liu, yang	2	0
Lu, yi	2	0

Table 1, shows the list of authors and co – authors who have written 2 or more than 2 papers, as this helps us to know which authors and co – authors have worked on disaster management as a topic more thus this led to more contribution from their end. Their link strength suggests that the authors have worked with various number of co – authors on their papers, such that Cheung and k. f. have worked collaboratively with 22 authors in total on their papers and so on. Further researchers can refer to the papers published by these authors to conduct their own research on disaster management.

The quantity of papers published from contributors 2000 to 2022 are shown in **Figure 5**. From 2012, researchers began releasing more and more articles applying various methods in disaster management. The “International Journal of Disaster Risk Reduction” has published the greatest number of articles (32 articles) (Publisher: Elsevier), which was then followed by “European Journal of Operational Research” (Publisher: Elsevier), “Tourism management” (Publisher: Elsevier), “Procedia - Social and Behavioural Sciences” (Publisher: Elsevier), “Procedia Engineering” (Publisher: Elsevier), and the “International Journal of Production Research” (Publisher: Taylor and Francis, Oxfordshire, UK). The number of articles published in each of these journals is presented in **Figure 6**.

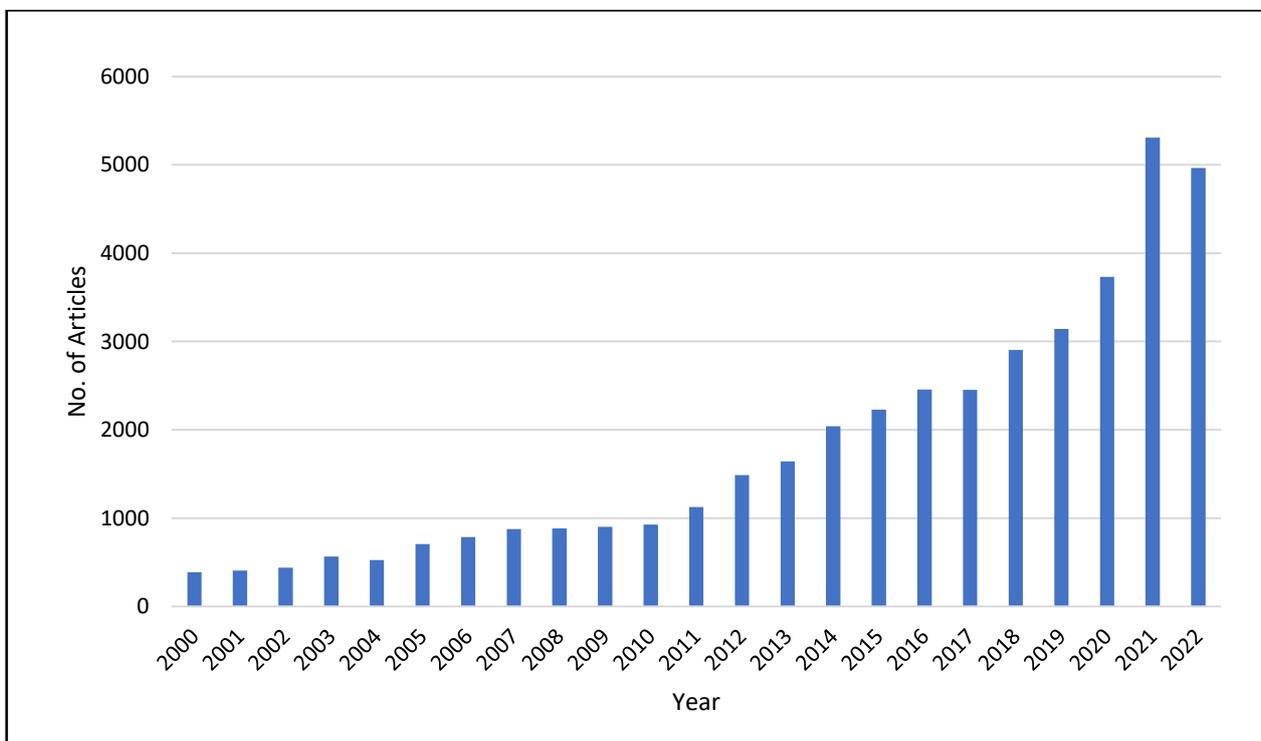


Figure 5. Number of articles published from 2000 to 2022

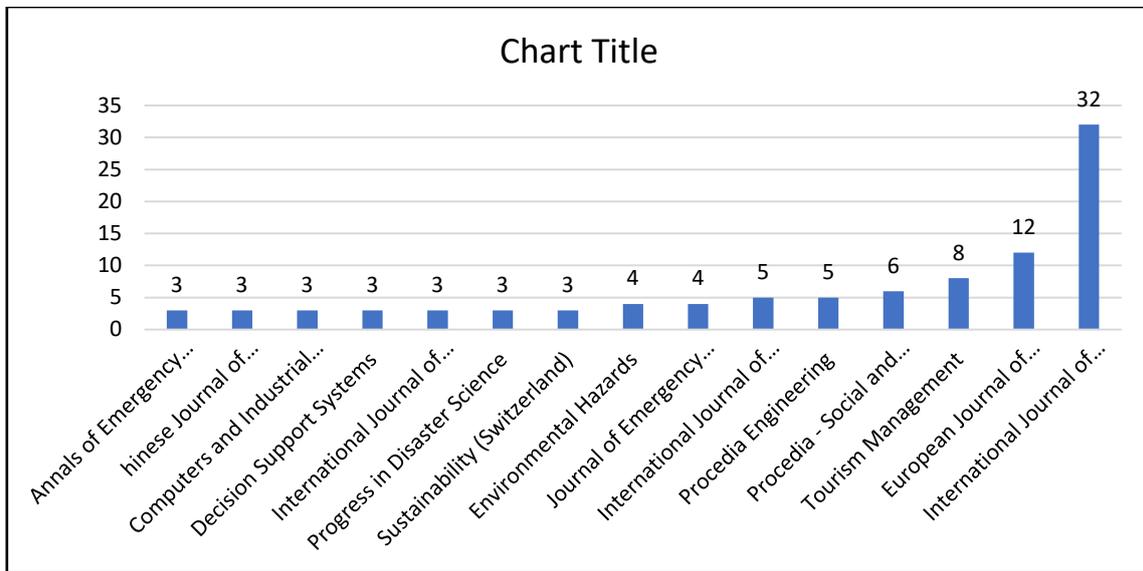


Figure 6. Number of articles published in different journals (N ≥ 3)

Figure 7. represents the name of authors who published the most articles in the field of disaster management. Dilanthe Amartunga is at the top of the list, with 8 published articles, followed by Shabnam Rezapour with 6 Published articles in this domain and Gerald Reiner and John L. Hick both had published 5 papers each. The affiliated countries which published most articles are presented in **Figure 8.** China is at the top of the list with 37, proceeded by United Kingdom (35) and United states of America and Australia sharing the third place with 27 articles each, whereas India published only 13 articles with the average papers published by each country around this topic comes out to be 8 in number.

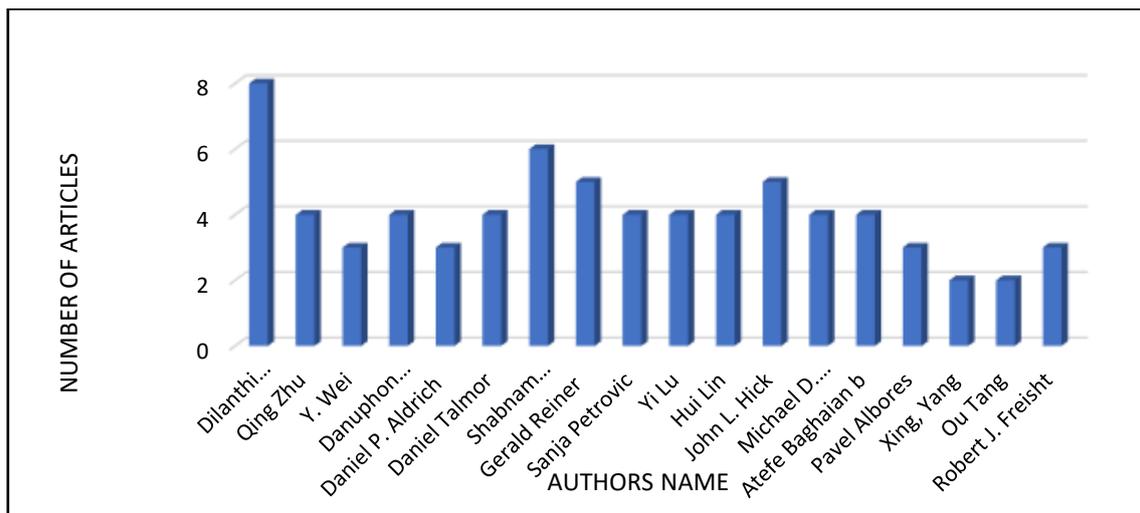


Figure 7. Articles published by different authors

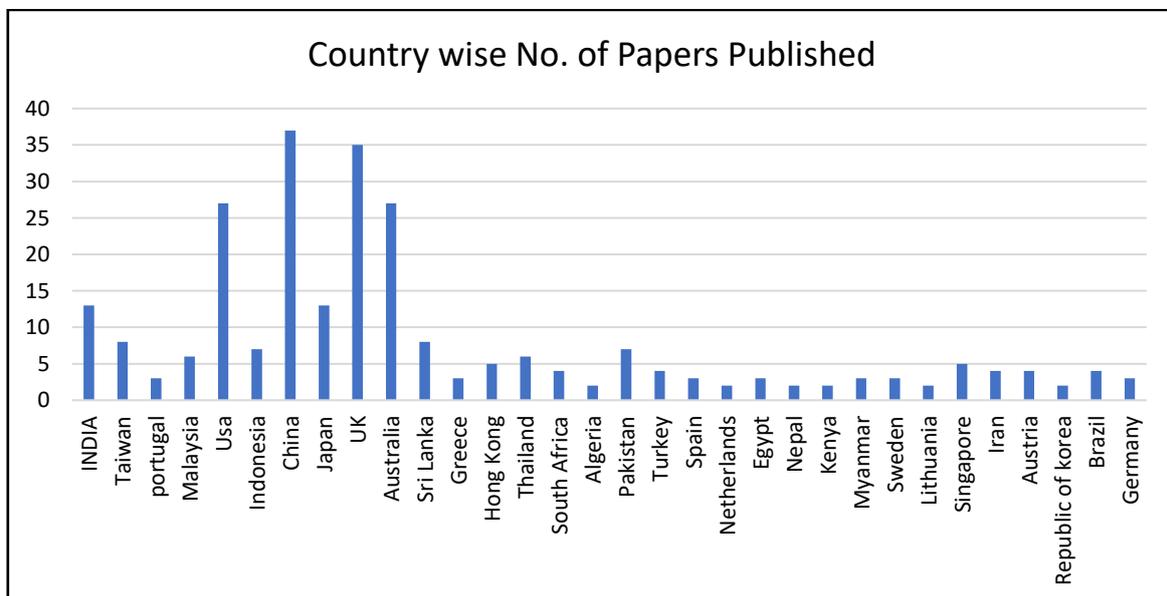


Figure 8. Articles published in different countries

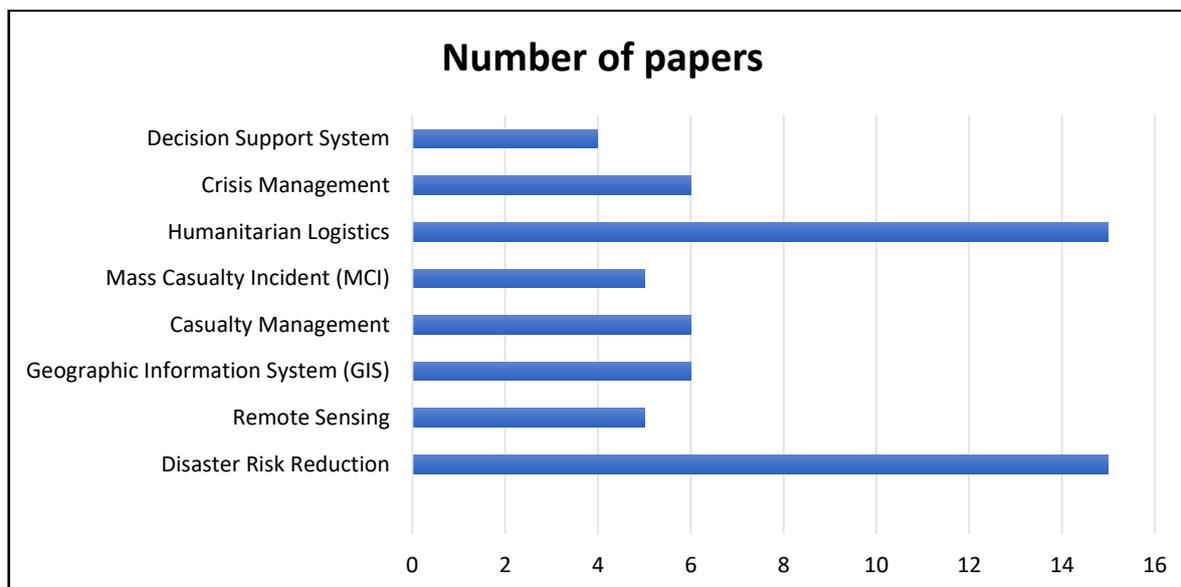


Figure 9. Distribution of contributing articles under different Disaster Management methods.

Around 200 articles were used for this particular analysis. **Figure 9.** indicates different types of research methods of disaster management used namely disaster risk reduction, remote sensing, Geographic Information System (GIS), Casualty Management, Mass Casualty Incident, Humanitarian Logistics, Crisis management and Decision Support System. Out of these eight methods: Disaster risk reduction, Humanitarian logistics and remote sensing are the top 3 methods used in this literature.

5. CONCLUSION

This study presents a review of the literature on multiple methodologies used in pre and post disaster management. Although there have been many articles published in the area of disaster management method application, there are hardly many written reviews. A thorough research and analysis of the literature to determine the application of various disaster management methods was lacking. This is the first attempt to analyse different methods used in different areas of disaster management, adding something to the intellectual conversation on the subject. Findings shows us the following crucial elements of earlier research:

- i. Largely the research was used in Disaster Operation Management (DOM), Geographic Information System (GIS), Mass Casualty Incident (MCI), Humanitarian Logistics. Major application of the methods of disaster management started after 2010.
- ii. Since 2010, number of natural as well as manmade disasters have increased the importance of using various methods in disaster management. (Hyperlink introduction and table in literature review). In recent years, Disaster Risk Reduction, Decision Support System (DSS), Disaster Operation Management were also applied in disaster management.
- iii. Most of the methods examined prevention techniques, preparedness during disasters, mitigation phase and the last and the most important recovery phase.

In the conclusion, we would like to acknowledge some of the study limitations and suggest few potential future research directions. Science Direct, Sci-Hub, and Google Scholar are the only three databases currently used in the study. We also referred to some books on the subject. As a result, it has led to the exclusion of potential additional sources of information and knowledge, such as conference proceedings, that are not identified in these databases. Furthermore, the study focused solely on texts published in English, excluding local contributions in other languages.

Internet of Things (IOT) which has transformed Disaster management seeks to lessen the harm that could result from disasters., provide victims with prompt and appropriate aid, and hasten the recovery process. Following such calamities, a planned and successful rescue operation is necessary to achieve these goals.

The internet is expanding quickly. Internet usage in emergency situations has developed more slowly. using the Internet for disaster operations has been limited. The Internet can be used for disaster relief in a lot more ways.

Among the catastrophes where the Internet was employed, the Kobe earthquake stands out. Initially, it served as a news source for the earthquake. As soon as possible, a website was created (SONY Computer Science Laboratories, 1995) to give the general public with information such as official notifications, damage information, including maps and photos, information on relief efforts.

Various businesses and improved efficiencies by making everything being controlled by software. Many research Papers were all about development of certain Technology based models for Disaster risk reduction or improving casualty management -by preparing to carry out better rescue operations for Loss minimization.

For example-A Research involved development of a software modules that can be linked to provide an integrated system for managing casualties

The Internet of things presents disruptive potential in the phases of disaster management that include prevention, planning, response, and recovery:

1. Prevent

IoT has the potential to fundamentally alter disaster preparedness by:

- Real-time sensor-based data can substantially simplify monitoring. Examples of this:
 - Telematics-equipped automobiles, sensor-based water levels
 - Sensors to identify volcanic activity, earthquakes, tornadoes, wildfires, and cloudbursts
 - The early warning monitoring system's activation

2. Preparation

IoT for preparation has the ability to automate preparation processes.

- Real-time stock replenishment, spares planning, and automated indent processing can all be handled using sensor technology

3. Response

The Reaction IoT can assist with response plans and activities in the following ways: Vehicle tracking and GIS integration

- Sensors to follow the movements of important individuals
- NFC for geofencing and parameter fencing
- Situational awareness and incident management using streaming data, unstructured data handling, predictive analysis, big data,

4. Recover

- The use of sensor technologies for beneficiary identification and authentication
- Use of smart cards and RFIDs for relief disbursement
- Establish a virtual logistics network that enables hub operators and others to track traffic to and within a hub in real-time and to simplify communication between all parties involved

Models developed over the coming years could be implemented after successful tests and trials for their in-depth evaluation and degree of effectiveness needs to improved constantly, which would make handling of such a situation at much ease and would ensure the entire process has been carried out efficiently.

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