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Flood Disaster Relief Operation: A Systematic Literature Review

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Abstract. A flood is natural disaster that often occurs in many regions. Flood has a significant impact on the nature conditions, local communities, and regional economic losses. The flood can happen due to a damaged environmental system; therefore, it needs deeper study and extra effort to prevent it. Thus, an appropriate and right Disaster Relief Operation (DRO) is needed in responding to flood disaster. In this research, 50 articles categorized in "flood disaster relief operation" published in the range 2012 to 2022 have been reviewed. This review is conducted by using the Systematic Literature Review (SLR) method. This study aims to explore and analyze flood DRO. The findings reveal that the flood DRO still has several weaknesses in the current system that should be improved: the lack of an integrated information system, not enough collaboration of the stakeholders, the lateness of information exchange, and unplanned relief operations through the preparation. For further research, it is recommended to implement the proposed system in the relief operations execution.

Keyword: Flood, Disaster, Disaster Relief Operation (DRO), Disaster Management

Abstrak. *Banjir merupakan bencana alam yang kerap terjadi di berbagai daerah. Banjir memberikan dampak yang besar terhadap kondisi alam, masyarakat setempat, dan juga perekonomian daerah itu sendiri. Banjir dapat terjadi dikarenakan oleh sistem lingkungan yang rusak, sehingga untuk mencegah terjadinya banjir perlu dikaji dan membutuhkan usaha yang besar. Oleh karena itu, dibutuhkan sistem tanggap bencana yang tepat dan benar dalam merespon bencana banjir. Dalam penelitian ini, telah dilakukan pengkajian 50 artikel mengenai "tanggap bencana alam banjir" yang diterbitkan dalam tahun 2012-2022. Pengkajian ini dilakukan dengan menggunakan metode Systematic Literature Review (SLR). Penelitian ini bertujuan untuk mengeksplorasi dan menganalisa mengenai tanggap bencana alam banjir. Hasil penelitian menunjukkan beberapa kelemahan sistem tanggap bencana saat ini, seperti tidak adanya integrasi sistem informasi, tidak cukupnya kolaborasi antar pihak berkepentingan, keterlambatan pertukaran informasi, dan tidak adanya persiapan dalam merespon bencana. Untuk penelitian yang akan datang, disarankan untuk mengimplementasi sistem pada tanggap bencana banjir.*

Kata Kunci: Banjir, Bencana Alam, Tanggap Bencana, Manajemen Bencana

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1. Introduction

Flood disaster is one of the natural disasters that often happened in several areas. It occurs because the environmental system could not hold more water [1]. On the other hand, flood is also considered as one of the disasters that could be predicted since it is caused by the level of rainfall in the area. Although it is predictable, floods still occur frequently and highly impact the local communities, economy, and nature itself [2]. It requires the right and quick Disaster Relief Operations (DRO) to overcome the disaster and save more lives [3].

DRO is defined as the set of activities to perform rescue operations and provide needed service of first aid for the victims from the disaster. DRO is also the emergency response during the disaster [4]. It is required since disaster could not be avoided, thus, DRO is important to reduce the negative impact of disaster to affected people [5].

The vulnerability to disasters can be caused by slow DRO and a lack of proper disaster management. The occurrence of disaster is getting higher if the environmental system is not fixed or the human's behaviour worsen the environmental condition, such as littering garbage in the waterways [6]. The resulting losses depend on the community's capacity for disaster resilience. Therefore, the proper way to manage and respond to the disaster should be deeply analyzed to understand better.

Proper flood disaster management may not altogether remove the risk of flood occurrence, but it could be used to reduce the risk and impact. Moreover, the DRO for flood needed to be prepared well to anticipate the flood through appropriate and effective procedural steps [7]. The higher the preparedness, the higher the chance to reduce the environmental impacts and local communities.

Currently, many papers have researched flood DRO, including the current DRO analysis regarding the strengths and weaknesses and proposed improvements to increase the effectiveness in delivering DRO to tackle flood disasters. This paper aims to provide a systematic literature review on the Flood DRO by analyzing, exploring, and explaining the concept of DRO to reduce the impact of the flood.

2. Method

This paper aims to explore the Disaster Relief Operation (DRO) researchs, especially for the flood disaster. The Systematic Literature Review (SLR) method is employed in this study. It begins with determining the topic. After the topic is firmed, it proceeds to collect, screen, and analyse the paper related to the topic. Collecting related papers is using Open Knowledge Maps and Research Gate to map the paper. Those databases were chosen because it provides open access papers and high-quality papers.

The following is the systematic stages in conducting the research.

- First stage: Collecting relevant papers.

  Relevant papers will be collected from open-access databases, such as Open Knowledge Maps and Research Gate. The collecting process starts by searching using the keywords "Flood Disaster Relief Operation"; and "Flood Disaster Management". A total of 18,545 papers collected were related to Disaster Relief Operation and published from 2012 to 2022. The year range are set to ensure the papers is still relevant to the topic research.

- Second stage: Screening Papers by Topic

  The second step is to screen the papers and filter out the papers unrelated to the topic, which is the Flood Disaster Relief Operation. After removing irrelevant papers, about 79 papers are selected based on the topic, abstract, and purpose of proceeding to the following process.

- Third stage: Deeper Screening

  A Thorough screening is also conducted to obtain more relevant papers on the topic. ThE screening is done for 79 papers from the previous process by filtering the full-text content. From this step, 50 papers are obtained and used for further analysis.

- Fourth stage: Paper Summary

  The final 50 papers will be summarized in this step. The summary will consist of the papers' general information, such as the paper identity, purposes, and also the brief results of each paper.

- Fifth stage: Flood Disaster Relief Operation

  Deeper analysis and review for the flood disaster relief operation is conducted for the papers. The analysis will consist of identifying relief operation research for flood disasters.

- Sixth stage: Gaps and Future Research

  Identify the gaps from the paper's summary and give a recommendation for future related research.

The detailed process stages on the SLR in this paper is shown in Figure 1.

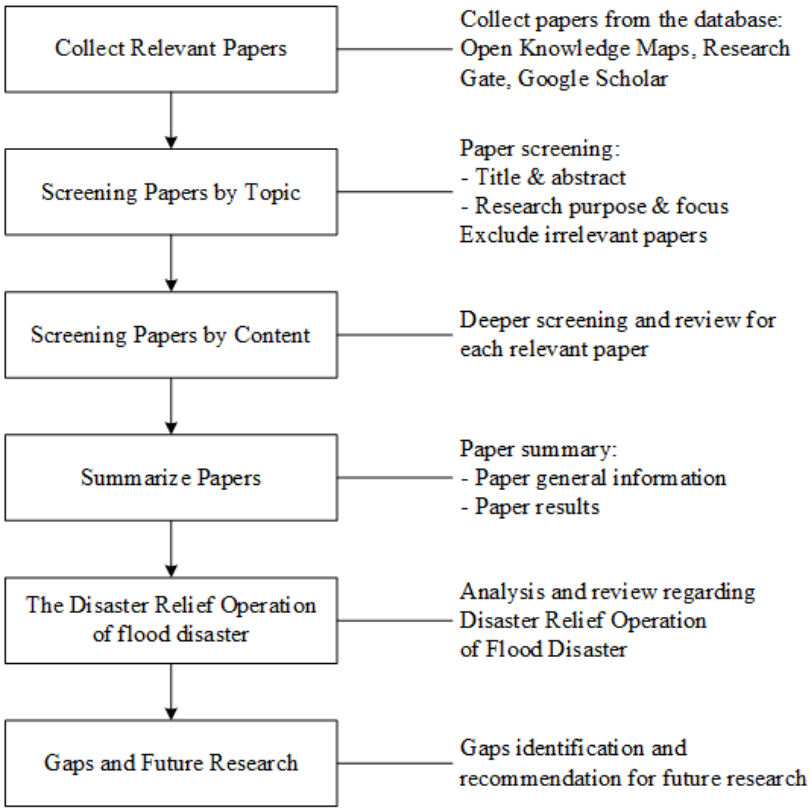

Figure 1 Literature Review Framework

3. Results and Discussion

3.1. Paper Summary

The summary process is conducted for 50 papers extracted as the most relevant papers to the research topic. These papers were then reviewed one by one to obtain a deeper understanding of the paper's content. The review will consist of the paper identify, purposes, and the paper's results. The summary of each paper is shown in Table 1.

Table 1 Literature review of Flood Disaster Relief Operations

No	Paper Identity	Title	Results
1	Wismnadanikung & Hardono (2014) [8]	Tindakan Penanggulangan Bencana Secara Berkelanjutan	Flood DRO during the disaster is medical and non-medical help, evacuation, warning for aftershocks, and the response for the disaster itself.
2	Fekete (2021) [9]	Motivation, Satisfaction, and Risks of Operational Forces and Helpers Regarding the 2021 and 2013 Flood Operations in Germany	Things to be improved for disaster relief operations: command and control, coordination, equipment, demand and supply, lack of information, lack of preparation, and infrastructure failure.
3	Thiruchelvam et al. (2017) [10]	Development of Humanitarian Supply Chain Performance Conceptual Framework in Creating Resilient	Supply chain logistics for flood disaster response is developed with the operational performance of disaster relief, tactical and operational level in tracking progress, facilitate clear communication, and the

No	Paper Identity	Title	Results
		Logistics Network	logistic.
4	Yin et al. (2021) [11]	Flood Disaster Risk Perception and Urban Households Flood Disaster Preparedness The Case of Accra Metropolis in Ghana	In response to the disaster, the essential things to have is the infrastructures and communication among all stakeholders in the community.
5	Zakariah & Kismartini (2018) [12]	Community Participation in Flood Disaster Management in Sumbawa Regency (case study in Songkar Village)	Disaster relief should have high government support and good basic education for the community; all stakeholders should have good coordination.
6	Rachmawati et al. (2018) [13]	The Flood Disaster Management Model in Wonosari Village Semarang City	During the disaster, it needs a rapid and accurate assessment of flood location, damage, loss, resources, status of emergencies, and rescue and evacuation. Fulfilling basic needs, protecting vulnerable groups, immediate recovery of vital infrastructure and facilities.
7	Islam et al. (2016) [14]	A Review on Mechanism of Flood Disaster Management in Asia	The emergency response to flood disasters requires quick study of the location, impacts, and resources. The emergency status should be determined so that the rescue and evacuation for the affected community is immediately fulfilled.
8	Shafiai & Khalid (2016) [15]	Examining of Issues on Flood Disaster Management in Malaysia	Emergency response should be developed and well-planned, consisting of the rescue and evacuation team. Currently, it is lack of utilities and a lack of government and community involvement.
9	Bria et al. (2021) [16]	Disaster management of Malaka district government in flood disaster management	The relief operations for flood is done by the emergency officers that stand by 1x24 hours at the location to save the victims. Besides that, the team also provides temporary residence, food, cloth, health, sanitation, and clean water.
10	Izham et al. (2019) [17]	The River Basin Spatial Informative Nesting (EBASIN) framework as an alternative approach for flood disaster management	The EBASIN technology framework is created with light and easy visualization, warning and report of flood disaster, the societies and agencies about the flood location.
11	Yodsuban & Nuntaboot (2021) [18]	Community-based flood disaster management for older adults in southern of Thailand: A qualitative study	For older adults, the flood DRO includes the public warning communication for older adults, providing the temporary residence with elder support, evacuation with prioritizing older adult, and providing the elder's needs.
12	Rehman et al. (2019) [19]	Applying systems thinking to flood disaster management for a sustainable development	The flood DRO should be executed by an appropriate framework of action, rehabilitation programs, policy, and well-funded by the government.
13	Zakaria et al.	Knowledge integration	The knowledge and information during

No	Paper Identity	Title	Results
	(2018) [20]	among flood disaster management team: Lessons from the Kemaman district	flood DRO should be integrated among the rescue team. Social media will be useful for communication because it enables fast and quick responses.
14	Rustinsyah et al. (2020) [21]	Social capital for flood disaster management: Case study of flooding in a village of Bengawan Solo Riverbank, Tuban, East Java Province	The social capital could benefit the disaster response time, where social capital bonding improved the mental and physical rescue during an emergency. Social capital also accommodates volunteers and links them with support and assistance.
15	Yang et al. (2018) [2]	A Derivation of Factors Influencing the Successful Integration of Corporate Volunteers into Public Flood Disaster Inquiry and Notification Systems	The disaster relief could be faster and more accurate if there is a system that integrates by providing disaster information, so the rescue team could quickly decide to deliver helps.
16	Hammood et al. (2020) [22]	Factors influencing the success of information systems in flood early warning and response systems context	The information system in flood response is influenced by system quality, information quality, user satisfaction, service quality, use, perceived usefulness, intention to use, and the net benefits.
17	Zaw & Lim (2017) [23]	The Military's Role in Disaster Management and Response during the 2015 Myanmar Floods: A Social Network Approach	Military role in disaster response: information sharing, resource sharing, searching for missing and rescuing victims, providing humanitarian assistance to victim.
18	Wisentjindawata et al. (2014) [3]	Planning Disaster Relief Operations	DRO involved victim, government agency, NGO, logistic company, donor. The first thing to do is to calculate the resource requirement based on historical data, then by coordination of government and logistic company to deliver the helps.
19	Chowdhurya et al. (2017) [24]	Drones for disaster response and relief operations: A continuous approximation model	Transportation is one of the most important thing in DRO, therefore drones are proposed to supply emergency commodities to disaster-affected regions.
20	Sharma et al. (2018) [25]	Review of flood disaster studies in Nepal A remote sensing perspective	A real-time flood mapping is conducted by using high-resolution satellite data product to respond to flood disaster.
21	D'Uffizia et al. (2015) [26]	A Simulation study of logistics for disaster relief operations	Logistics in flood DRO is simulated with different typologies of vehicles to find best solution. The result is to develop a cloud-based system and sensor network to plan the best relief strategies.
22	Atanga (2019) [27]	The role of local community leaders in flood disaster risk management strategy making in Accra	An effective flood DRO should have well-planned strategies, and the DRO implementation needs active participation of the affected community.
23	Munawar et al.	A review on flood	The application of image processing or

No	Paper Identity	Title	Results
	(2021) [28]	management technologies related to image processing and machine learning	machine learning for flood DRO is limited where both systems should be combined to ensure effectiveness across the phases.
24	Bhuvanaa & Aram (2019) [29]	Facebook and Whatsapp as disaster management tools during the Chennai (India) floods of 2015	Using Facebook and Whatsapp chats are proved helpful for the flood-affected area to help the fast information regarding the help needed and resource distribution during responses.
25	Ghaffari et al. (2020) [30]	Emergency supply chain scheduling problem with multiple resources in disaster relief operations	Particle Swarm Optimization (PSO) algorithm is developed to perform supply chain scheduling of multiple resources and destinations in DRO.
26	Dutt et al. (2019) [31]	Utilizing microblogs for assisting post-disaster relief operations via matching resource needs and availabilities	The microblogs are used for relief operations that provide the need for help, the availability of resources, and the location of need and resources. It helps the rescue team to address the aids more accurate.
27	Berariu et al. (2015) [32]	Understanding the impact of cascade effects of natural disasters on disaster relief operations	To respond to flood disasters, this research analyses the impact of floods, such as fires, contaminated drinking water, and pushed houses off foundations. The DRO could be planned more accurately for the help providers by these results.
28	Sarma et al. (2019) [33]	Uncertain demand estimation with optimization of time and cost using Facebook disaster map in emergency relief operation	Using a Facebook disaster map could help the rescue team determine the help to be addressed. But, the affected victim is not specified; therefore, it becomes uncertain.
29	Behl & Dutta (2020) [34]	Engaging donors on crowdfunding platform in Disaster Relief Operations (DRO) using gamification: A Civic Voluntary Model (CVM) approach	The gamification is applied in DRO to make a crowdfunding to help the victims affected by the disaster. It is proved more effective than donors' activity.
30	Rahman et al. (2021) [35]	Development of flood hazard map and emergency relief operation system using hydrodynamic modeling and machine learning algorithm	The humanitarian Aid Information System (HAIS) is proposed to specify the hazard information and the quantity needed for emergency aids for victims. It is proved effective as an emergency response tool.
31	Putonga & Leon (2018) [36]	A Modified Balcik Last Mile Distribution Model for Relief Operations Using Open Road Networks	Open Road Networks is used to logistics in DRO to minimize the routing costs and the unsatisfied demand penalty cost.
32	Lia et al. (2017) [37]	Automatic near real-time flood detection using	The flood detection technology is used to monitor and determine what kind of relief

No	Paper Identity	Title	Results
		Suomi-NPP/VIIRS data	should be given to the affected victims.
33	Singkran (2017) [38]	Flood risk management in Thailand: Shifting from a passive to a progressive paradigm	This research stated that progressive response is better and more effective than passive response, where it requires non-structural measures and collaboration of government and all stakeholders.
34	Luua et al. (2018) [39]	Flood risk management activities in Vietnam: A study of local practice in Quang Nam province	Flood disaster relief operation has two approach, proactive and reactive, proactive included mitigation, preparedness and response. While reactive included response and recovery.
35	Othman et al. (2014) [40]	COBIT principles to govern flood management	The Emergency Response Plan (ERP) is conducted and included the warning for local authorities and the evacuation routes to respond to the flood disaster.
36	Mercado et al. (2021) [41]	Fuzzy based multi-criteria M&E of the integrated flood risk management performance using priority ranking methodology: A case study in Metro Manila, Philippines	Based on the research, the response to floods is to have rescue operations, relief activities, and evacuation responses for the affected victims.
37	Paciarotti et al. (2018) [42]	The management of spontaneous volunteers: A successful model from a flood emergency in Italy	This research proved that the spontaneous volunteers' model is successful in emergency response to the flood in Italy.
38	Mohanty & Karmakar (2021) [43]	WebFRIS: An efficient web-based decision support tool to disseminate end-to-end risk information for flood management	WebFRIS is a web-based tool using Google Map, PHP, MySQL, and JSON. It illustrates flood location, social vulnerability, and the risk in the area.
39	Tan et al. (2016) [44]	Agent-as-a-service-based geospatial service aggregation in the cloud: A case study of flood response	In emergency response to floods, the Agent-as-a-Service (AaaS) is proposed to have a more effective system in response to the disaster.
40	Garrido et al. (2015) [45]	A stochastic programming approach for floods emergency logistics	The stochastic programming approach is conducted to maintain the flood DRO, such as allocation of rescue budget, equipment, and human resources. The decision is made by the stochastic programming model.
41	Delgado & Iniestra (2014) [46]	Flood Risk Assessment in Humanitarian Logistics Process Design	Humanitarian logistics is important to facilitate rescue activities; therefore, the tools and decision support systems are needed to avoid negative impacts for the stakeholders related to the disaster.
42	Nair et al. (2017) [47]	Usage and analysis of Twitter during 2015 Chennai flood towards	Twitter usage toward flood response is analyzed by Random Forests, Decision tree, and Naive Bayes to prove it is useful

No	Paper Identity	Title	Results
		disaster management	for managing and planning disaster relief.
43	Atmojo & Sachro (2017) [48]	Disaster management: selections of evacuation routes due to flood disaster	The Geographic Information System (GIS) is used to analyze the effective evacuation routes and safe from flood disaster.
44	Rana et al. (2021) [49]	Disaster management cycle and its application for flood risk reduction in urban areas of Pakistan	The important things in flood DRO is the engagement of each stakeholders, such as victims, volunteers, NGOs, and local authorities. The inefficient coordination will affect the relief and rescue activities.
45	Anbarasan et al. (2020) [50]	Detection of flood disaster system based on IoT, big data and convolutional deep neural network	IoT technology is applied to monitor, track, and control the data to detect the flood disaster and use big data and a convolutional deep neural network (machine learning) to respond.
46	Goyal et al. (2020) [51]	Recommendation based rescue operation model for flood victim using smart IoT devices	Recommendation Based Rescue Operation (RBRO) model is applied with IoT devices that could recommend the response to rescue flood victims. It is proved more effective since the system verifies the step.
47	Mai et al. (2020) [52]	Defining flood risk management strategies: A systems approach	The flood response should invest in infrastructure, technology advances, capacity improvement, and shift in the system, management, and behavior practices.
48	Wan et al. (2014) [53]	A cloud-based global flood disaster community cyber-infrastructure: Development and demonstration	The web server is used to send request and responses between the requestor and the providers of help. It is built by HTML and JavaScript to have cyber-infrastructure.
49	Songchon et al. (2021) [54]	Quality assessment of crowd sourced social media data for urban flood management	Using binary logistic regression and fuzzy logic, the crowd sourced social media data from Twitter is assessed and proved to be effective in monitoring and directing emergency response.
50	Iqbal et al. (2021) [55]	How computer vision can facilitate flood management: A systematic review	Using computer vision to respond to flood, such as flood mapping, surface water detection, and structural damage mapping.

Based on Table 1, it is shown the detailed summary of each paper from 50 papers that related to the DRO for the flood. From the summary, these papers were grouped into several classifications based on their publication year, country of publication, the integration method, and the publisher. The following subchapter will explain each group.

3.2. Classification of Papers

The classification for the papers is conducted by considering paper's aspects. The first aspect is the publication year. In this research, the obtained papers were published from 2012 to 2022. The classification of papers by the publication year is shown in Figure 2. Based on the reviews

from the papers last ten years of publication, DRO of the flood is still relevant to be rinvestigated since many regions are still affected by flood disasters and have not found a way to respond appropriately. DRO is the most important thing when there is a disaster; it responds to rescue affected people in the location. Therefore, DRO for flood needs deeper study and the technology and integrated system that could be implemented in the relief operations.

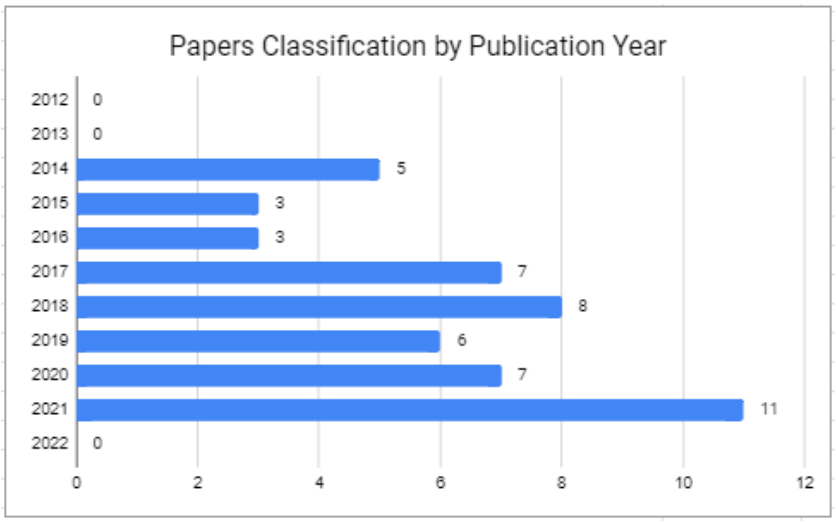

Figure 2 Papers Classification by Publication Year

Besides the classification by using publication year, the papers were also classified by using the region and publisher. As shown in Figure 3, India has the largest publication of flood DRO with eight papers in total, followed by Malaysia with seven papers. The third-largest publication is Indonesia, with five papers. The analysis found that the country that published most related papers are the country that is frequently affected by flood disasters.

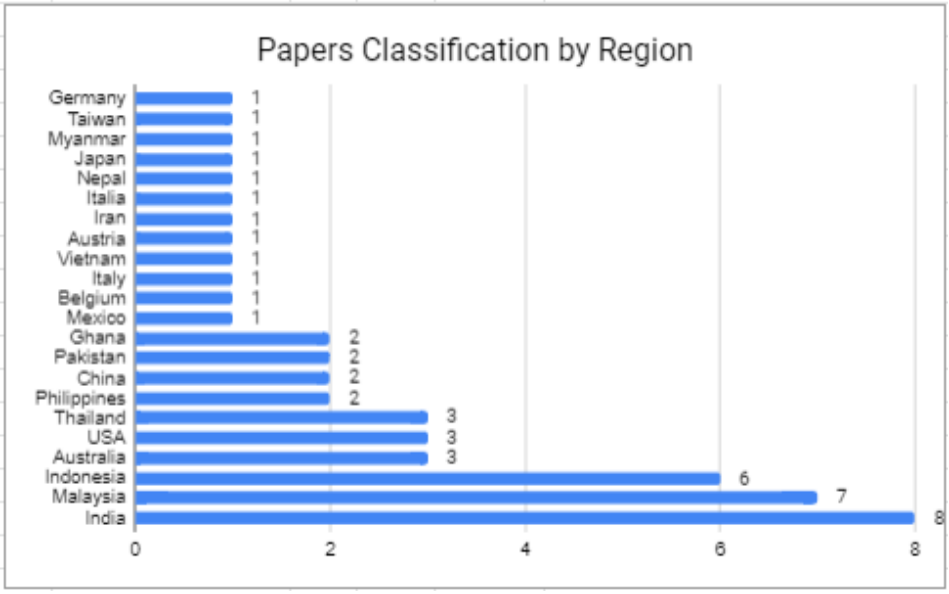

Figure 3 Papers Classification by Region

Another classification is done for the Publishers, where based on Figure 4, Elsevier publisher is the most supplier of papers in this research. Elsevier publisher has 29 papers related to flood DRO, therefore this publisher is recommended in this research.

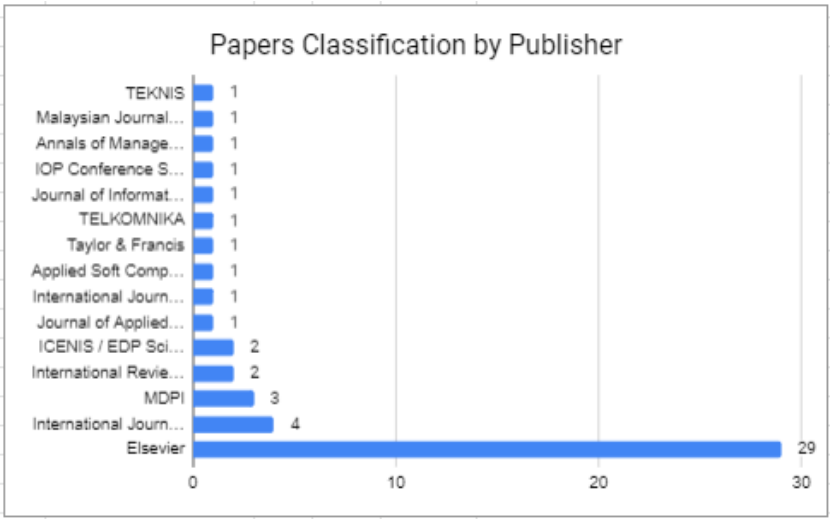

Figure 4 Papers Classification by Publisher

3.3. Flood Disaster Relief Operation

The current flood DRO still not maximally planned and executed. Many region which affected by flood ignored the impact and not focus to tackle the disaster. Based on the analysis, emergency response that needed for the flood disaster victims are:

- Medical and non-medical helps, including food and clothing [8], [16], [18], [23].
- Evacuation transportation and temporary shelter [3], [18], [24], [41].
- Warning about aftershocks for the local community [8], [14], [18], [40].
- Searching and rescuing victims [8], [33], [41].

On the other hand, there are several weaknesses of current flood DRO which explained as below.

- Lack of demand and supply integrated information system [2], [13], [19], [20], [22].
- Not enough collaboration of the stakeholders [9], [11], [12], [21], [49].
- Unplanned relief operations and not enough preparation [3], [9], [15], [32].
- Lack of government support and funding [3], [15], [19], [52].

On several papers, new technologies and flood DRO system improvement is proposed. The improvement of the flood DRO is explained below.

- Integrated web-based information system [2], [19], [31], [35], [43], [54].
- Using social media as the data source and communication platform [19], [20], [29], [33], [47], [54].
- Real-time satellite monitoring and cloud-based flood location mapping [13], [14], [17], [25]–[27], [37], [44].
- Strengthen the relationship of all stakeholders [9], [11], [12], [49].
- Shifting from passive to a progressive response [38], [39].
- Using optimization method to get best routes of transportation or logistic for DRO [30], [36], [45], [46], [48].
- Using gamification for crowdfunding from the community [34].
- Implement machine learning and IoT to monitor, track, and control flood disaster [28], [35], [50], [51], [55].

3.4. Gaps and Future Research

Flood DRO is the emergency response to rescue the victims; it requires fast and quick movement to deliver the right help to the suitable receivers. By having a well-planned flood DRO, the negative impacts of the flood could be reduced, and more lives could be saved. This literature review shows that many papers discussed the basic needs to be delivered during flood DRO activities and the weakness of current flood DRO implementation.

In addition, several papers have discussed the technologies that could be implemented based on the studies and analysis of the weakness. But, there is still not much paper explaining the actual implementation and the study of how the technologies could positively impact society through flood DRO. It becomes the gap in this research. For further research, it is recommended the study the use of technologies for flood DRO. IoT, web-based and mobile-based applications, blockchain, satellite, and many more technologies can be the key to a successful flood DRO.

4. Conclusion

A flood is one natural disaster that has significant negative impacts on the victims, while this disaster is also often being ignored by the government and the local community. Many regions affected by floods still did not get proper DRO to respond. As a result, flood still has the same effect in the past 10 years based on the reviewed papers. Thus, this paper aims to accommodate the current flood DRO's weaknesses and the improvement that could be implemented in flood DRO. Based on the analysis, the recent flood DRO lacks the integrated information system, the collaboration of government, NGOs, volunteers, and local community, and the lateness of information exchange between help providers and help requestors. To improve the DRO,

several technologies have been proposed, such as an integrated web-based information system, real-time satellite monitoring and flood mapping. The collaboration of the help providers are strengthened to address the relief for the disaster victims. Further research is recommended to implement the technologies in the actual case.

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