Disaster logistics management in Pasaman after 2022 earthquake

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Abstract. Indonesia is a disaster-prone country and at high risk. Reducing risk can be carried out by minimizing disaster logistics problems during an emergency stage. On 25 February 2022 an earthquake occurred in Pasaman area which caused 27 fatalities and forced 19,221 people to become refugees. Humanitarian logistics management is found to be the main problem. This study aims to investigate how the management of disaster logistics during the emergency period of the earthquake disaster in West Pasaman Regency and to identify the problems that occur in the management of disaster logistics. Data collection was carried out through interviews with stakeholders related to disaster logistics and data was analysed using thematic analysis. The research produced a flowchart of disaster logistics management. From the flowchart, it can be seen the unnecessary and/or repetitive activity, as well as processes that are inconsistent. The problems were also identified. Opportunities for improvement in the disaster logistics management process can also be seen from the results of this study. It is hoped that this research will be useful for various stakeholders related to disaster logistics management, for the West Pasaman Regency, as well as other disaster-prone areas in Indonesia.

1 Introduction

Indonesia is a disaster-prone country [1]. Its geographical location along the Pacific Ring of Fire makes it highly susceptible to various natural disasters, ranging from earthquakes, tsunamis, and volcanic eruptions. Other frequent hazards that hit Indonesia are floods, landslides and forest fires.

Indonesia experiences frequent seismic activities due to the movement of several tectonic plates beneath its surface, such as the Indo-Australian Plate, Eurasian Plate and Pacific Plate. This volatile geological setting not only leads to devastating earthquakes but also increases the likelihood of other interconnected disasters. The dense population and inadequate infrastructure in some regions further exacerbate the impact of these calamities, making Indonesia one of the most vulnerable countries in the world when it comes to natural disasters.

Earthquakes pose a significant threat to Indonesia’s community. The country often struck by powerful earthquakes, shaking the land and, in turn, triggering tsunamis. The devastating 2004 Indian Ocean tsunami, which claimed hundreds of thousands of lives, remains a haunting reminder of Indonesia’s vulnerability. Earthquake in Yogyakarta (2006), West Sumatra (2009), Lombok (2018), Palu (2018) and recently in Pasaman Regency in West Sumatra (2022) have devastated hundreds of thousands of houses and forced the survivors lives in tents and needed humanitarian relief.

In the aftermath of a disaster, humanitarian logistics becomes an essential lifeline, often deciding the difference between life and death for survivors [2]. Efficient and well-organized logistics are essential for the timely delivery of aid, food, clean water, medical supplies and shelter to affected areas [3-5]. Properly coordinated logistics operations can ensure that aid reaches those in need promptly, maximizing the chances of survival and minimizing suffering. The complexities of disaster-stricken regions, with damaged infrastructure and disrupted supply chains, make the task even more challenging. Humanitarian organizations must navigate these obstacles swiftly and effectively.

As a result, research related to humanitarian logistics plays an important role in enhancing disaster response efforts. The objectives of this study are to investigate how the management of disaster logistics during the emergency period of the earthquake disaster in West Pasaman Regency and to identify the problems that occur in the management of disaster logistics.

2 Literature review

Literature review is a crucial step in research for gathering data and theories relevant to the research problem.

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2.1 Disaster management

According to UNDRR [6], disaster is a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts. Disasters can come in various forms, natural disasters, non-natural disasters, or combination between them. They include earthquakes, tsunamis, floods, landslides, hurricanes, extreme temperature, pandemics, industrial accidents, and terrorist attacks. Understanding disasters involves recognizing the interplay between the hazard (the potentially damaging event), vulnerability (the susceptibility of a community to the event), and exposure (the population or assets at risk) [7, 8]. Proper disaster management involves assessing these factors comprehensively to mitigate risks and enhance preparedness.

Disaster management is a multifaceted process comprising several stages, namely mitigation, preparedness, response and recovery [9, 10]. Mitigation involves activities aimed at reducing or preventing the impact of disasters, such as building codes, early warning systems, and land-use planning. Preparedness focuses on developing plans, training responders, and raising public awareness to ensure a rapid and effective response when a disaster strikes. Response involves the immediate actions taken during and after an event to save lives, protect property, and meet basic human needs. Recovery focuses on restoring the affected area to its pre-disaster state or better, including rebuilding infrastructure, providing psychosocial support, and revitalizing the economy. These stages are interconnected and often overlap, forming a continuous cycle of disaster management aimed at reducing vulnerabilities and enhancing resilience.

Response is an important phase in disaster management as it directly addresses the immediate needs of affected populations [11]. During this stage, emergency services, humanitarian organizations, and community volunteers work tirelessly to rescue survivors, provide medical care, distribute food and clean water, and offer temporary shelter. A well-coordinated and swift response can significantly reduce casualties and prevent further harm, instilling a sense of security and hope among the affected communities. Effective response efforts also lay the foundation for the subsequent recovery phase, ensuring that the transition towards rebuilding damaged infrastructure and restoring normalcy is as smooth as possible.

2.2 Humanitarian logistics

Humanitarian logistics is an essential component of disaster response and has gained significant attention in recent years. It focuses on efficiently managing the flow of aid resources to affected areas. This involves coordinating the procurement, transportation, storage, and distribution of essential supplies such as food, water, medical supplies, and shelter materials. Humanitarian logistics ensures that aid reaches the right people at the right time, maximizing its impact on saving lives and alleviating suffering [12].

In the face of increasing frequency and intensity of disasters globally, humanitarian organizations have recognized the crucial role logistics plays in ensuring the rapid response and recovery of affected regions. This literature review explores its key challenges, and the innovative solutions that have emerged to address these challenges.

One of the primary challenges in humanitarian logistics is the unpredictability of disasters [13]. Unlike commercial logistics, which deals with relatively stable and known demand patterns, humanitarian logistics must contend with sudden and often unforeseeable events. This unpredictability poses challenges in terms of demand forecasting, procurement, transportation, and inventory management. Furthermore, humanitarian operations frequently occur in environments with inadequate infrastructure, political instability, and security concerns, complicating the logistics process. Coordination among various stakeholders, such as governmental agencies, non-governmental organizations (NGOs), and international bodies, also presents a significant challenge, requiring efficient communication and collaboration.

Over the years, advancements in technology and logistics strategies have led to innovative solutions in the field of humanitarian logistics. Geographic Information Systems (GIS) and remote sensing technologies have been employed for better risk assessment, aiding in preparedness efforts. Real-time tracking and monitoring systems utilizing GPS and IoT (Internet of Things) devices have significantly improved the visibility of relief shipments, ensuring timely and accurate deliveries. Additionally, predictive analytics and machine learning algorithms are being applied to enhance demand forecasting, allowing organizations to pre-position resources in strategic locations before disasters strike. Collaborative partnerships between humanitarian organizations and private sector entities have also resulted in creative solutions, such as sharing transportation and warehouse resources, optimizing routes, and improving overall supply chain efficiency.

3 Methodology

3.1 Data collection

The Pasaman area was hit by powerful earthquake on 25 February 2022, caused 27 fatalities and forced 19,221 people to become refugees. Data collection was carried out through interviews with stakeholders related to disaster logistics in West Pasaman Regency. Interviews are conducted to gain information regarding humanitarian logistics management and its obstacles. Respondents are decision-maker related to policies and implementation of disaster logistics of Pasaman earthquake. In the data collection, seven respondents are interviewed (2 respondents from Disaster Management Offices of Pasaman Barat Regency, 1 respondent from Disaster Management Offices of Padang City, and 4 respondents from Social Office of Pasaman Barat Regency).
3.2 Data analysis

The first step of data processing is develop transcript of interviews conducted. All information from respondents are written in documents for the purpose of data analysis. A thematic analysis of the transcript was carried out. Thematic analysis is an analysis method that is most used in qualitative data to identification the pattern or theme on the data. This method is suitable for descriptive, explanatory, or overview research [14, 15]. Based on the theme determined, some keywords in the transcript which are match to the theme are grouped and its relevance to research objectives is analysed (define the process of humanitarian logistics management and its problems). In this research, a software for qualitative data analysis is used, that is NVivo software.

4 Results and discussion

4.1 Disaster logistics management in Pasaman Earthquake

The activities in emergency period is started as the official issue of emergency is announced by government. An emergency team is formed to handle all the problems in emergency period including the problems of disaster logistics. For humanitarian logistics, there are two types of team which are have different tasks just after disaster happens. The first team is called rapid reaction team (Tim Reaksi Cepat) that have task to evaluate exposure to the impact of disaster occurred. The second team is the team tasked with managing disaster during emergency period. In the case of Pasaman earthquake, the second team, particularly the team that managed disaster logistics, was divide into the team in charge of the main warehouse of logistic and the team in charge of managing the warehouse at the post in the remote area of refugees.

There are three flows that must be considered in the activities of delivering goods to end-users (survivors) in logistics management, that are financial flow, products or goods flow, and information flow [16-18]. In disaster logistics, product flow and information flow are the important flows to be define.

4.1.1 The flow of relief goods

The flow of goods usually comes from the upstream stages of suppliers. In the case of Pasaman earthquake, the donators who gave relief goods are the first layer of suppliers at the upstream stage. Some donators put the goods at the main warehouses located at the regent’s office of Pasaman Barat Regency whereas other send their relief goods to post ware house at the refugee’s area. The goods then distribute to the refugees based on the information from the community leader (wali nagari) and the member of team at post-warehouse who assess the needs of the refugees. On the other hand, some donators sent the goods straight to the refugees without the information of the type and quantity of goods that refugees needed. It causes some demand of a particular goods can be fulfil in some refugee’s area but it was not happened in other area. The flow of relief goods can be seen as Figure 1.

4.1.2 The flow of information

The information regarding types and the quantity of relief goods needed by refugees were flows from downstream stage (the victims) to upstream stage (main warehouse), vice versa. The donators do not get this information, thus the kind donations were not depend on demands of the refugees in terms of kind of goods and its quantity. In the case of Pasaman earthquake, the information regarding demand of relief goods was obtained from the refugees. This information were reported to the leader of community (Ketua Jorong) or the leader of district (Walinagari). Ketua Jorong and/or Walinagari then gave the information to post warehouse team. The team at main warehouse will receive the information and send the relief goods to the post warehouse. The information about the kind and the quantity of the goods is sent to the post warehouse and also the information whether they can fulfil the demand or not. If main warehouse cannot fulfil the demand, they will also give information about the reason why they cannot make it to the team at post warehouse and then to the leader of community (Ketua Jorong) or the leader of district (Walinagari). This information will be one aspect to be consider for delivering relief goods for the most needed survivors. The flow of information can be seen as Figure 2.
4.2 The problems of disaster logistics management in Pasaman Earthquake

Based on thematic analysis of the information from interviews conducted, it is found that some problems in managing disaster logistics of Pasaman earthquake.

4.2.1 Warehouse

There are two types of warehouses for disaster logistics needed. The first is pre-disaster warehouse, located in some government offices such as Local Disaster Management Office (BPBD) and Social Office. This type of warehouse is designed for the goods that have long expire date, for example tents, mattress, blanket, baby-kit, family-kits and instant noodle in order for preparation before disaster happens. In Pasaman Barat District, this type of warehouse is not available in proper condition, even some government offices do not have the warehouse. Second, is the emergency warehouse to stock the goods when disaster happens. This type of warehouse is designed for the goods needed for the disaster victims such as foods, clothes, blankets, family-kits, baby-kits, etc. Usually, there is a main warehouse to stock the goods from donators and some warehouses located in refugees area managed by the team. Since this type of warehouse made for emergency situation after disaster, and the demand pattern of goods is very fast-moving demand, it is difficult to control by the team. Besides that, it is not clear who is the person in charge to handle these warehouses.

4.2.2 Stock

Pasaman earthquake disaster evacuees really needed tents, mattresses, blankets and foods when disaster occurred. These types of goods were the main needs of refugees at that time. On the first day of the disaster, the need for these goods is taken from the stock in pre-disaster warehouse. However, because the BPBD Pasaman Barat Regency does not have a proper pre-disaster, the quantity of goods that can be stored is very limited and it is not sufficient to fulfil the demand of the refugees. After the first day of disaster, incoming relief goods came from donators. The type of goods received from donators cannot be determined and the quantity cannot be adjusted to the needs of the refugees. In the case of Pasaman earthquake, mostly the demand pattern of relief goods is fast-moving demand. Fast-moving demand the type of demand which is have a higher consume speed and the goods called fast-moving consumer goods (FMCG) [19].

4.2.3 Human resources

Lack of human resources is a problem in disaster logistics management of Pasaman earthquake. Both in term of the quantity of human resources and human resources which are have knowledge regarding how to manage logistics, especially in disaster situation is very limited. Besides that, human resources that have skills, such as skill to forecast the demand of the goods needed and skill how to operate the vehicles and tools of material handling to carry the goods, is also needed. Skills of logisticians are a necessity to effectively manage logistics, especially for humanitarian logistics [20]. Skills needed by logisticians in Pasaman earthquake is in line with a study conducted for Haiti earthquake which is stated that humanitarian logisticians need a functional skill (procurement, warehouse, distribution and transportation management) [21].

4.2.4 Rules and Standard Operational Procedure

Standard Operational Procedure (SOP) is available. However, they are only some common procedures which are difficult to implement in real disaster situation. Some common procedures are not appropriate for some case due to uniqueness of the case in disaster. In the case of Pasaman earthquake, more simple SOP was develop after disaster. For example, procedure for stock control of goods in the warehouse and procedure for ordering the goods needed by the victims.

4.2.5 Information system

Information system plays an important role in humanitarian logistics management [22]. The effectiveness of logistics support could be improve by deploying information technology [23]. By using humanitarian logistics information systems, an accurate and timely information regarding the goods are required, what supplies have been delivered and in which locations can be provided [22]. Besides that, information system can help the decision-maker in humanitarian logistics management to track the goods in delivery process. Traceability is a crucial factor in logistics performance [24]. An application or software is used to manage stock control at main warehouse of logistics of Pasaman earthquake. This software is used to help the team to control incoming and outgoing relief goods. However, since the flow of data and information to be entered to the software is not valid, thus the information as the output of the software is not describing rill condition. Besides that, feature and menu on the application should be improve to accommodate all the data and information to be updated. In addition, internet connection was off when Pasaman earthquake happened, thus the information from remote area cannot be sent.

4.2.6 Culture

Pasaman earthquake caused chaos and panic in the community. The victims try to get relief as soon as they can get. Moreover, since there is a huge uncertainty regarding the availability of relief goods in logistics warehouse, the victims tend to stock goods and asked more than they needed. This phenomenon is called shortage gaming. This phenomenon can be explain that
when the consumers feel that the demand will not be fulfilled or shortage is imminent, then rationing will be occurred, then the costumers tend to increase the size of demand [25]. In other words, shortage gaming occurred when customer’s order do not reflect the real demand pattern [26]. There are many academic literatures discussed the problems under uncertainty in stochastic environment, for example, Long, et al. [27] introduce a general division rule that focuses on waste and deficit issue and a model claim uncertainty using individual demand as a cumulative distribution function. Moreover, another study the rationing rules in scenario where individuals have state contingent claims over a resources [28]. This situation makes the information about kind and quantity of relief goods actually needed cannot be determine. Furthermore, since the demand quantity of relief goods for each refugees area is not clear, the demand cannot be fulfilled in some areas while there are stock of relief goods in other areas of refugees. From the side of donators, it is indicated that many donators do not trust the team to put their relief goods to the right place. Thus, they send the goods straight to the victims that they choose. Some of them report their relief activities, but some do not gave the information to the emergency team.

4.2.7 Equipment and tools

Equipment and tools as material handling to carry the goods such as forklift and wheelbarrow are very limited. Thus, the process of moving goods takes quite a long time. The problem became more complicated since the human resources who has skill to operate the equipment are also very limited.

5 Conclusion

Pasaman earthquake in 2022 was a major disaster that shocked the community in West Sumatra Province, especially in Pasaman Barat Regency. In this research, humanitarian logistics management after Pasaman earthquake happened is discussed. There are two flows of logistics identified, that are the flow of relief goods and the flow of information in humanitarian logistics management. Moreover, there are some problems in managing logistics in disaster of Pasaman earthquake. The unavailability of ware house and there is of clear procedure how to manage logistics are the main problem in managing humanitarian logistics of Pasaman earthquake. These problems have impact to stock control of logistics management. Other obstacles such as lack of human resources who has knowledge, experience, and skills regarding humanitarian logistics management, limited equipment and tools to support material handling processes of relief goods are also found in the case of disaster logistics of Pasaman earthquake. Moreover, it is indicated that, due to uncertainty of availability of relief goods, the survivors always feels the goods giving to them is not sufficient, thus they tend to ask more goods.

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