Proceedings of the 5th NA International Conference on Industrial Engineering and Operations Management
Detroit, Michigan, USA, August 10 - 14, 2020

Designing Inventory Information System for Humanitarian Logistics in the Merapi Disaster Management in Sleman, Yogyakarta

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Abstract

Disasters are events that can threaten and disrupt people's lives and livelihoods. Indonesia is a very high geological disaster threat, so it is vulnerable to tectonic earthquakes and volcanic eruptions. Mount Merapi is one of the most active volcanoes in Indonesia, located in Sleman Regency, Yogyakarta Province. Management of disaster emergency response needs to be supported by the availability of humanitarian logistics. However, some problems often occur in the handling of humanitarian logistics. It is the mismatch of the number and type of disaster relief goods, the time of distribution of humanitarian logistics, the distance between the logistics warehouse and the location of the barracks, and the management of relief goods from donors. During the emergency response period, the distribution and management of relief items from donors need to be done quickly and on time, type, and amount. For this reason, there needs to be an accountable and transparent humanitarian logistics management system supported by an information system that facilitates the management of the relief items. This research aims to develop a web-based humanitarian logistics management information system that connects donors, BPBD as a logistics center warehouse manager, and evacuation posts. The database in this information system is designed using MySQL, and the information system design uses the PHP programming language.

Keywords

Distribution of Relief Goods, Humanitarian Logistics, Information Systems

1. Introduction

Disaster refers to a disturbance that physically affects the system as a whole and threatens its priorities and objectives. Based on the cause, disasters can be divided into a natural and man-made disaster. Whereas based on predictability and speed of occurrence, disasters differ into a sudden-onset and a slow-onset disaster (Cozzolino, 2012). Sudden-onset disasters are earthquakes, tsunamis, volcanic eruptions, mass movements, floods, and storms. While slow-onset disasters are epidemics, drought, and extreme temperature.

Indonesia is traversed by an active volcano path called the Ring of Fire and has 400 volcanoes, of which 129 are active. Mount Merapi is one of the active volcanoes located in Sleman Regency, Yogyakarta Province, Indonesia and has varied eruption cycle periods. The danger level of Merapi is very high, due to the density of the population living around the slopes of Mount Merapi. The death toll in the Merapi eruption in 2010 reached 353 people (Handayani, et al, 2015; Rinawati, et al, 2018). To avoid a high number of victims, disaster management needs to be improved. Disaster management consists of four phases, namely mitigation, preparedness, response, and reconstruction (O'Brien, et al, 2010). The mitigation phase refers to rules and mechanisms that reduce social vulnerability. The preparation phase refers to various operations that occurred during the period before the disaster occurred. This phase prepares strategies that enable the implementation of successful responses. The response phase refers to the various operations that were carried out immediately after the disaster occurred. The reconstruction phase refers to operations carried out

due to the disaster. The mitigation phase (emergency response) is a series of efforts to reduce disaster risk, both through physical development and raising awareness and capacity to face the threat of disaster. Disaster emergency response is an activity carried out as an effort to reduce risk or disaster victims, both casualties and property. Uncertainty over natural disasters often leads to aiding operations that focus more on response than readiness, so the system is more reactive than proactive and the supply chain structure will determine the effectiveness of the response (Roh, et al, 2015).

Based on interviews with the head of the Sleman BPBD disaster logistics section, the Merapi eruption in 2010, the handling of humanitarian logistics during the disaster mitigation period was not yet effective and efficient. The supply of relief goods is often delayed because of the distance between warehouse logistics and the disaster refugee locations which is quite far and difficult access to locations. Based on interviews with victims, the main complaint from the Merapi eruption disaster management activities in 2010 was the delay in logistics delivery and the type and amount of aid items that were not appropriate. For this reason, Sleman requires a humanitarian logistic management system that can support the emergency response period quickly and efficiently. The process of distributing aid to victims is at the core of Humanitarian Logistics (HL) (Kaynak & Tuger, 2014). Four things become problems in dealing with HL. First, increased uncertainty for non-traversable routes, security concerns, changes in facility capacity, and demand uncertainty for logistical needs. Second, the complex communication and coordination resulting from damage to communication lines, the involvement of many parties to the disaster, both from the government and civilians, as well as the inaccessibility of accurate real-time request information. Third, it is difficult to achieve efficient and timely delivery. Fourth, limited resources are often overwhelmed by the scale of the disaster situation (Beamon & Balcik, 2008).

One obstacle in the disaster logistics process in Indonesia is the limited access to information regarding the needs and inventory of relief goods. Delay in accessing information has led to disaster management being ineffective and inefficient. For example, related parties are often late in identifying the scale of the disaster, the amount and type of assistance in terms of goods and services needed, and the allocation of refugee locations (Rossum and Krukkert, 2010). For this reason, the Regional Disaster Management Agency (BPBD) tasked with handling disasters in the areas needs to have an integrated inventory information system (IIS) between the main aid warehouse in the Sleman Regency BPBD and all refugee barracks. IIS needs to be supplemented with an inventory database per item/type of relief item, so that related parties can find out the type and number of relief items available in the main warehouse. In addition, IIS can be used as a means of communication between BPBD, donors, and those in charge of refugee barracks (users). Donors can find out the type of relief items needed so that they can assist by following the necessities of the victims, while users can provide data about the needs of relief items in each barrack. Therefore, the distribution of disaster relief items can be done according to their requirements, namely in terms of time, quantity, and type.

The previous study on disaster management information systems in Indonesia is still limited. Hadiguna, et al (2014) developed a decision support system to assess the extent to which public facilities could be used as evacuation centers for victims of the earthquake and/or tsunami. Howden (2009) researched how humanitarian logistics information systems can improve humanitarian supply chains. Humanitarian logistics information systems improve information flow, which integrates logistics units more efficiently with non-logistics units in the humanitarian supply chain and provides better feedback to donors, ensuring more effective operations. Humanitarian logistics activities transpire during the entire disaster management cycle. The humanitarian logistics information system not only improves logistics activities in each phase but can enhance the sustainability of humanitarian operations by sharing information throughout the developments of the various phases of the disaster management cycle. Through collaboration between organizations, humanitarian logistics information systems also have the potential to diminish corruption and market distortions that can occur during humanitarian operations. Nevertheless, this study has not yet originated an inventory information system. For this reason, this research intends to build an inventory information system to support humanitarian logistics management.

2. Research Methods

2.1 Humanitarian Logistics

Various types of disasters necessitate being managed with different solutions. Logistics are an essential element in humanitarian relief efforts. How will organizing humanitarian aid logistics determine whether the disaster response operation was successful or failed? Nonetheless, logistics are often the most costly activity of any disaster relief. Based on research, it is approximated that the logistics expenses for disaster management are around 80% of the total costs in disaster relief (Van Wassenhove, 2006). Logistics management for disaster management is known as humanitarian logistics or often attributed to humanitarian assistance logistics. Humanitarian logistics is the planning,

implementation, and control of the flow of humanitarian aid in the supply of efficient, cost-effective humanitarian assistance, and is supported by information about the distance and location of the main warehouses and refugee barracks to reduce the distress of disaster victims (Thomas and Kopczak, 2005). Optimizing the logistics performance of humanitarian assistance requires that all links between parties or actors involved in disaster management are managed through an integrated approach that is efficient and effective in organizing inter-organizational performance, eliminating redundancy, and maximizing efficiency throughout the emergency supply chain. Disaster management is usually portrayed as a process that consists of several stages, namely: mitigation; preparation; response; and reconstruction (Cozzolino, 2012). These four stages are termed the disaster management cycle. The involvement of disaster logistics management in the preparation, response, and reconstruction stages as shown in Figure 1.

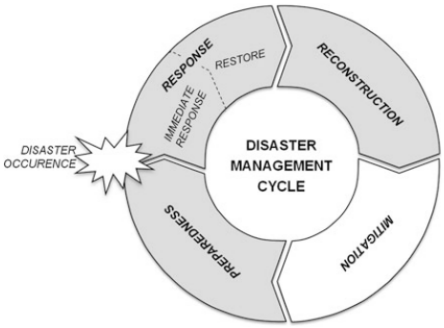

Figure 1. Disaster management cycle (Cozzolino, 2012)

2.2 Stakeholders in Humanitarian Logistics

Humanitarian logistics includes several activities and involves many parties, covering preparation, planning, procurement, transportation & distribution activities, storage, tracking, and customs. Stakeholders in humanitarian aid logistics activities are (Kovacs, and Spens, 2007): a. Domestic and foreign donors, governments, companies, citizens, and NGOs; b. National NGOs, PMI, and BNPB / BPBD; c. Transportation service providers: land, air, sea, river, and train; d. Warehousing service provider; e. Transportation management company; f. Customs and Excise, g. Beneficiary.

2.3 Information System

According to Romney and Steinbart (2015), a system is a series consisting of two or more components that are interconnected and interact with each other to achieve the goal where the usual system is divided into smaller sub-systems that support larger systems. While information is data manifested in a form that is useful for decision-making activities (Gellinas, Dull, & Wheeler, 2012). Hence, an information system is a collection of components that collect, process, store, and provide the output of any information needed in business processes and applications that are used through software, databases, and even associated manual processes (Satzinger, Jackson, & Burd, 2012).

In addition, Gellinas and Dull (2012) also described that information system are systems that are made in general based on a set of computers and manual components that can be collected, stored, and processed to provide output to the user.

Therefore it can be inferred that the information system is a combination of organized modules obtained from components related to hardware, software, databases, and networks based on a set of computers to be able to collect, store and process data and provide information output to the user to achieve certain goals.

2.4 Inventory Information System

System is a series consisting of two or more components that are interconnected and interact with each other to achieve goals. Systems are usually divided into smaller sub-systems that support larger systems (Romney and Steinbart, 2015). While information is data that is displayed in a certain form to help make decisions (Gellinas, Dull, and Wheeler, 2012). Therefore, information systems are a combination of components that collect, process, store, and provide the output of any information needed in business processes, information systems in the form of applications consisting of software, databases, and related manual processes (Satzinger, Jackson, and Burd, 2012). Inventory information systems provide detailed data about available goods, suppliers, quality of goods, the number of goods to be ordered, and the number of goods that have expired (Romney and Steinbart, 2015). Information systems for the inventory of

disaster relief items are required to facilitate access to information among stakeholders so that disaster logistics management becomes more effective and efficient (Rossum and Krukkert, 2010).

3. System Analysis and Design

3.1 User Characteristics

User characteristics are the characteristics of the parties who will carry out activities in this information system. These entities include super admins, admin of refugee stations, and donors.

1. Superadmin is the head or employee of a natural disaster management agency that is tasked with managing and overseeing logistical assistance found at the command posts when natural disasters befall. Superadmin can control user data, user assistance posts, user refugee posts, goods, refugee posts, aid posts, and transaction reports contained in the system.

2. Admin of a refugee post is a worker/employee/volunteer who is at a refugee post whose job is to manage the demand for logistics goods/materials and validate the goods that have been received.

3. Donors are parties involved in administering voluntary assistance to the community, both individuals and groups of people without the intention to benefit from its activities.

1.2 Device Requirements

Minimum specification requirements on Merapi's assistance inventory information system consist of minimum specification requirements for hardware, software, and human resources (brainware).

Hardware that is applied as a supporting tool in the form of:

1. Computers with minimal specifications of Intel Pentium IV processor, 512 MB RAM (Random Access Memory), and 80 GB Hard disk.
2. Monitor, keyboard, and mouse.
3. Modem or similar tool to connect computers to the internet network.

The software required to run the information system created is:

1. Microsoft Windows XP as the minimum operating system on a computer or other similar operating system.
2. Web browser to operate the information system.
3. XAMPP is software that incorporates Apache as a web server, MySQL as a database server, and PHP as a web programming language.

1.3 Functional Needs

Functional requirements are conditions that are related to the business process of the system made. From conducted observations, functional requirements in the system are made, the following is a list of the system functional requirements.

1. The system can add, change, delete and display user data at the refugee posts handled by Superadmin

2. The system can add, change, delete, and display user data on donors conducted by the Super admin.

3. The system can add, change, delete, and display data of aid items carried out by Superadmin.

4. The system can add, change, delete, and display refugee post data conducted by Superadmin.

5. The system can display reports on the delivery of relief goods carried out by Superadmin, and the refugee post administrator

6. The system can display a report on the receipt of aid goods carried out by the Superadmin and the admin of the refugee post

7. The system can add, change, delete and display data on the stock of relief goods carried out by Superadmin, refugee post administrators and donors

8. The system can add, change, delete and display data on requests for relief goods made by the refugee post admin

9. The system can add, change, delete and display request data from refugee posts made by Superadmin

10. The system can add, change, delete and display data of shipments made by the refugee post admin

11. The system can add, change, delete and display purchases of relief goods through the government funding budget carried out by Superadmin

12. The system can add, change, delete and display the entry of aid items taken from donors made by Superadmin

13. The system can display reports of goods received and items transmitted over a certain period conducted by Superadmin.
14. The system can add, change, delete, and display items granted by donors.
15. The system can add, change, delete, and display data items that have been acquired by Superadmin by donors.

1.4 User Menu Structure

The menu structure is the initial design for software applications and website systems that focus on interaction with users. In the user menu structure, some features can be accessed by each type of user. The login menu structure is a page for users to access the information system. Users can log in according to the user's access level. Access levels in this system include super admin, admin, and donor. Superadmin menu structure can be accessed after logging into superadmin users. Login is done by using the email and password from super admin, then super admin will enter the dashboard which has a menu list on the side. Menus that can be accessed by superadmin include:

a. Add, change and delete admin data for refugee posts and donors.
b. Add, change and delete system user group data.
c. Add, change and delete item category data.
d. Add, change and delete funding source data.
e. Add, change and delete warehouse data.
f. Add, change and delete post data.
g. Add, change and delete item data.
h. Add, change and delete inventory data.
i. Add, change and delete incoming order data.
j. Add, change and delete donation data.
k. Add, change and delete item request data.
l. View reports of incoming orders and goods requests.
m. View and change BPBD office data.
n. View and change account data such as names, emails, and passwords.
o. Exit the system

Admin menu structure of posts can be accessed after logging in with email and password from the admin, then the admin will go to the dashboard that has a menu list next to the one that matches the access authorizations. Menus that can be accessed by superadmin include:

a. See admin data for refugee posts and donors.
b. View data group system users.
c. Add, change and delete item category data.
d. View funding source data.
e. View warehouse data.
f. Add, change and delete post data.
g. Add and change unit item data.
h. Add, change and delete inventory data.
i. Add and delete item request data.
j. View and change BPBD office data
k. View and change account data such as names, emails, and passwords.
l. Exit the system

The donor menu structure that can be accessed after logging in using an email and password from the donor, the donor will enter the dashboard that has a menu list on the side. Menus that can be accessed by superadmin include:

a. Look at the item category data.
b. View warehouse data.
c. See post data.
d. Look at item data.
e. View inventory data.
f. Add and delete donation data.
g. View and change account data such as names, emails and passwords.
h. Exit the system

4. System Plan

4.1 Website Design Plan

Website design is a manifestation of a system that has been outlined in the information system design stage. The system that has been designed can be operated in the actual state at this stage.

1. *Login* Interface

Login to the information system can be classified by level of access. The access levels included in this system are 3 access levels, namely superadmin as an administrator at the Sleman BPBD holding post, admin as an officer at each evacuation post and donors. Every level of access has different access rights according to duties and authority. The login page interface can be seen in Figure 2.

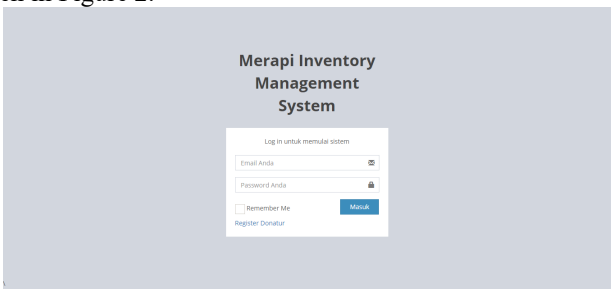

Figure 2 *login* page interface

2. Superadmin Page Interface

Superadmin has access rights to add, change, and delete user data or refugee post admin. Then, superadmin can also access user groups to add, change, and delete access rights held by other users. Superadmin can add, change, and delete data relating to the order of items such as categories, sources of funds, warehouses, posts, and units of items. Superadmin can also add, modify, and delete data on inventory, entry orders, and item requests. Finally, superadmin can create reports associated to incoming orders and requests for items. The superadmin page interface can be seen in Figure 3.

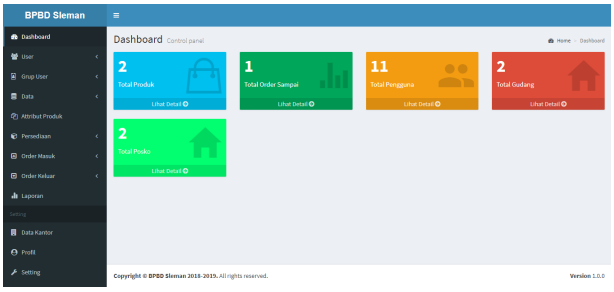

Figure 3 superadmin page interface

3. Admin Page Interface

Admin has access rights to view user data. Next, the admin can also see user groups, funding sources, warehouses, and BPBD data. Admin can add, change, and delete data relating to the order of goods such as categories, posts, and units of items. Admins can also add, change, and delete inventory data and requests for items. In addition, the admin can also adjust settings for the account such as the name and change the password. The admin page interface can be seen in Figure 4.

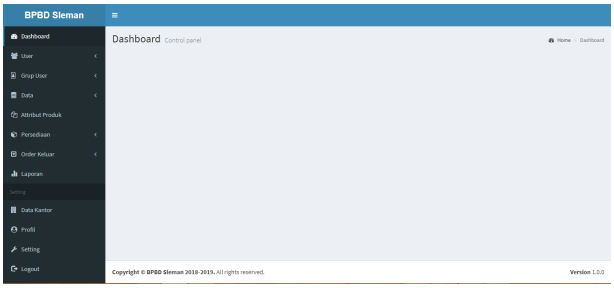

Figure 4 Admin Page Interface

4. Donor Page Interface

Donors have access rights to view data, item category data, warehouse data, post data, unit data, inventory data. Donors can also add and delete data related to donations. Also, donors can adjust settings for their accounts such as names and change passwords. The donor page interface can be seen in Figure 5.

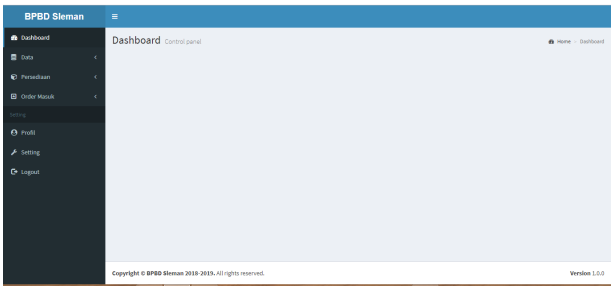

Figure 5 Donor Page Interface

4.2 Database Design

Database design is a display of databases created by information systems. The database used in the information system utilizes MySQL software. This information system database uses 17 tables i.e user tables, user group tables, group tables, category tables, fund source tables, warehouse tables, post tables, unit items tables, inventory tables, entry order tables, incoming order tables, request for goods tables, item request table, donation table, donation item table, office table.

5. Conclusion

BPBD Sleman as a disaster management unit is the main actor in the humanitarian supply chain. Inventory information systems can help establish logistics capacity and strengthen better relationships with other units, integrate logistics more reliable in the humanitarian supply chain. Humanitarian logistics information systems can enhance the effectiveness of humanitarian supply chains by implementing timely, type, quantity, and accurate information regarding inventory items that are required and have been distributed, enabling donors to be more responsive to the needs of recipients. Humanitarian logistics operate at every stage of disaster management and help provide sustainability for humanitarian operations. Humanitarian logistics information systems present opportunities for better corruption prevention and market control through collaboration between various humanitarian organizations. Thus, the humanitarian logistics information system is expected to strengthen the logistics unit and integrate it with other units at the stage of disaster management so that the humanitarian supply chain can be operated more effectively and efficiently. The inventory information system developed in this study has been able to assist humanitarian logistics management in terms of information access and coordination between the central warehouse and refugee barracks so that relief goods can be distributed on time, type, amount and accuracy, and allows donors to know their requirements and inventory. However, the developed IIS has not considered the integration of data with freight forwarding equipment so that delivery is only in the form of data of goods sent, it has not paid attention to the mode of transportation used. In addition, IIS also does not have a post location mapping feature in the information system so that it can facilitate the delivery of goods to the refugee location because drivers can see the location of the post in the system. Further research will add features that will overcome the flaws of the information system.

Acknowledgements

This research was financially supported by Applied Research Grants from the Directorate of Research and Community Service (DRPM). Ministry of Research, Technology, and Higher Education, Republic of Indonesia.

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