CHAPTER I
INTRODUCTION

This chapter contains of the introduction about the research to design the geographical information system as a tool for disaster relief distribution of earthquake and tsunami in Padang City. This chapter consist of the background of the research, problem formulation, research objectives, research scope, and outline of the report.

1.1 Background

Indonesia is a nation prone to natural disasters based on data released by the United Nation Office for Disaster Risk Reduction (UNDRR). Indonesia located in the Ring of Fire area, Indonesia is not spared to tectonic activities in the form of earthquakes and tsunamis. Geologically, Indonesia located on the three big plates of the world, namely: Indo-Australia, Eurasia, and Pacific Slots which triggered major natural disasters. Besides, Indonesia located between three mountain systems, namely: Alpine Sunda, Circum Pacific and Circum Australia. Therefore, according to Hermon (2015), various phenomena such as earthquakes and volcanic eruptions often occur in Indonesia.

Based on the Indonesian Disaster Information Data (DIBI) by the National Disaster Management Authority (BNPB) 1,250 disasters in Indonesia have caused fatalities and damages to facilities. Meanwhile, according to the National Earthquake Center for Meteorology, Climatology, and Geophysics during 2018, there has been an earthquake activity of 11,577 times with various magnitudes and depths. The amount of earthquake activity in 2018 increased by 4,648 times compared to 2017.

West Sumatra is one of the provinces in Indonesia which is disturbed to natural disasters. Based on DIBI during 2018 there have been more than 20 disasters

that claimed lives in West Sumatra. The 2012 West Sumatra Tsunami Contingency Plan states that West Sumatra has a very complex geological order. **Figure 1.1** shown the geological structure of West Sumatera. This condition is due to the area of West Sumatra located in the collision area of 2 large tectonic plates namely the Indo - Australia Plate in the south and the Eurasia plate in the north. So that the Mentawai Islands and surrounding areas became centers of tectonic earthquakes.

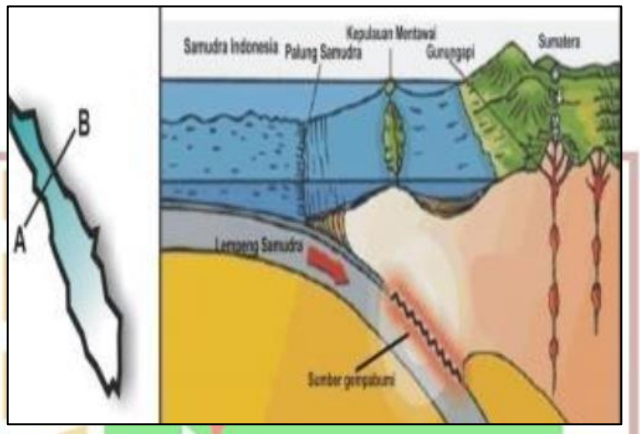

Figure 1.1 Geological Structure of Sumatera Barat
(Source: Contingency Plan for Tsunami of Padang City 2012)

Geologically, the negative impact of the West Sumatera is the region has the potential for natural disasters with geological aspects such as tectonic earthquakes. This potential happened in the area around the Sumatran fault (Semangko Fault) and centered on the sea such as region on the West part of West Sumatra. Sumatran Fault can be seen on **Figure 1.2.**

Figure 1.2 Sumatran Fault (Semangko Fault)
(Source: Contingency Plan for Tsunami of Padang City 2012)

According to the Contingency Plan for Tsunami in Padang City 2017, it is stated that the impact of the Aceh earthquake and tsunami on December 25, 2004, raised public concerns about the earthquake and tsunami on the west coast of Padang City. One of the worries is that Padang City is directly confronted with the Indonesian Ocean. Based on the digitization results, it is known that the coastline of Padang City reaches 68,126 kilometers. A total of 6 districts in Padang City will be affected by the implications of the tsunami. The tsunami prone areas in Padang City can be seen on **Figure 1.3** and **Figure 1.4** will explain about the percentage of the tsunami prone area on every villages in Padang City

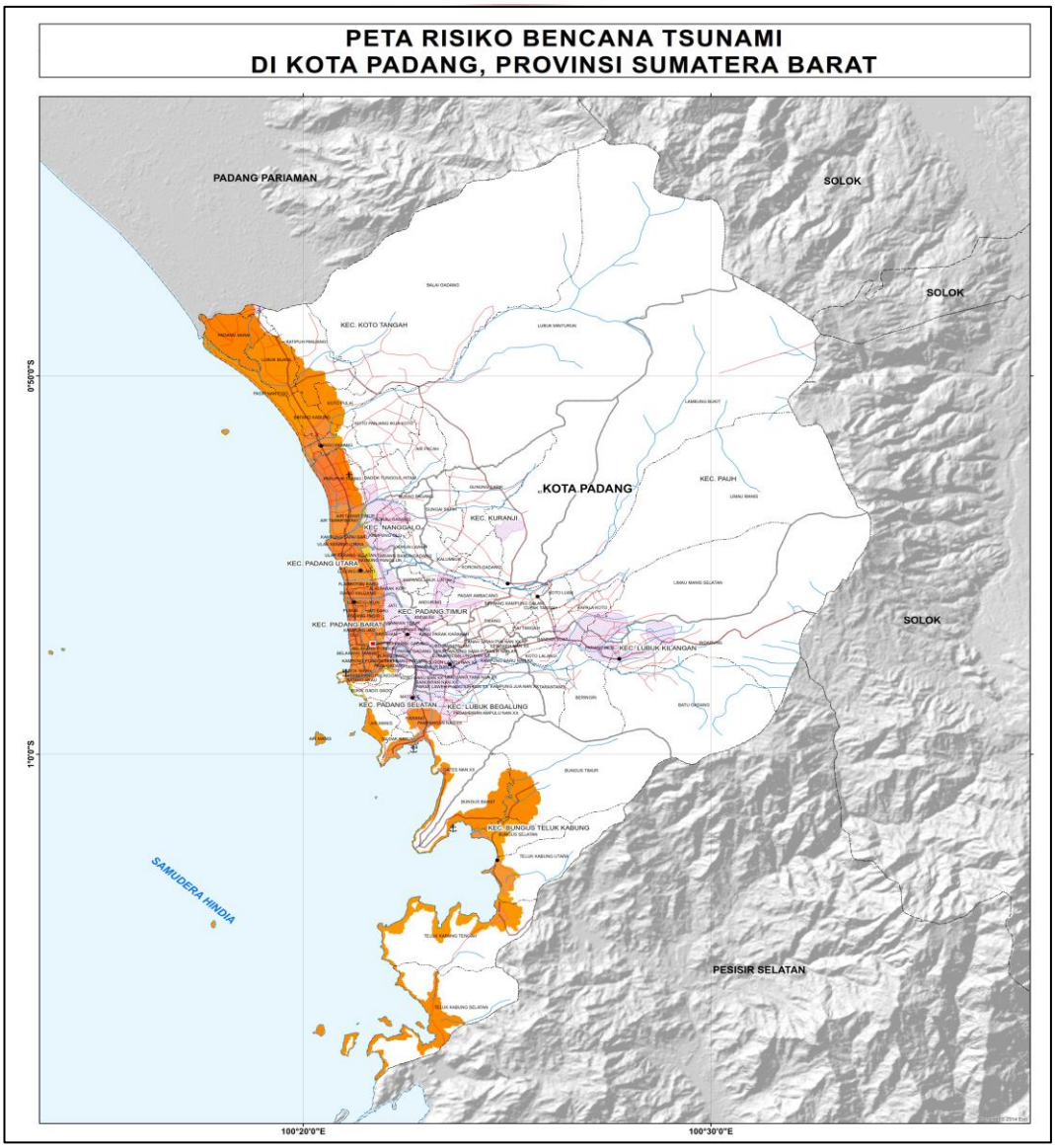

Figure 1.3 First Sector of the Tsunami Prone Area in Padang City

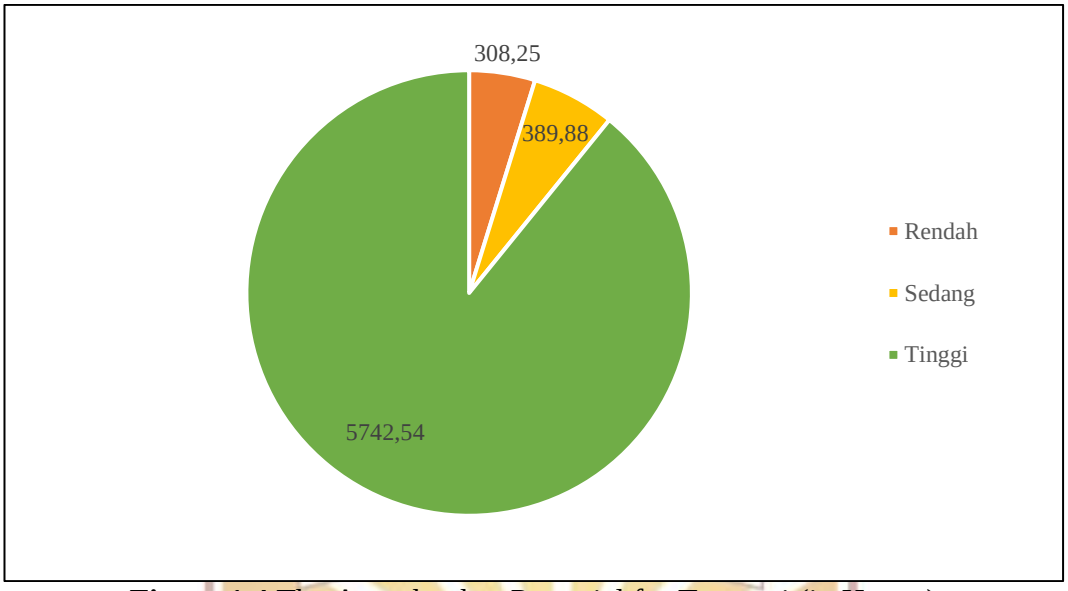

Figure 1.4 The Area that has Potential for Tsunami (in Hectar)
(Source: Padang City Disaster Risk Study 2016)

The data on the graph came from the area that has potential for the tsunami. There are 104 villages in Padang City and 50 of them has potential from tsunami. the area that describe on the graph above is the total of area from that 50 villages. There are 44 out of 50 villages have a high potential for tsunamis. Compared to the total area of the village, a total of 5,742.54 hectares or around 89.1% of the Padang City area is threatened by a high potential tsunami.

The possibility of a tsunami disaster that might have occurred in Padang City was triggered by the earthquake from the Mentawai megathrust. Also, the historical records show two tsunamis that once hit the mainland which is now called the City of Padang in 1797 and 1833. Earthquakes are events that release several energies in the Earth's lithosphere. One of the energies released is seismic waves. This wave is emitted from its source and spreads in all directions, so it can be detected by seismic sensors (Wahyuni, 2018). While the tsunami is a series of giant sea waves that arise due to a shift in the seabed due to earthquakes (BNPB No.8 of 2011). Based on the disaster risk assessment carried out in the 2012 Padang City Tsunami Contingency Plan, the level of potential disaster hazards in the City of Padang is as shown in **Table 1.1**

Table 1.1 Padang City Disaster Risk Assessment

No	Disaster Risk	Probability	Impact
1	Earthquake	4	5
2	Tsunami	4	4
3	Flash Flood	4	2
4	Flood	3	1
5	Landslide	3	1
6	Storm	3	1

(Source: Contingency Plan for Tsunami of Padang City 2012)

Based on the history of earthquakes that have occurred in the city of Padang, one of them was an earthquake on September 30th, 2009 with the strength of the earthquake about 7.6 Richter Scale (SR). According to West Sumatra regional government data, 1,125 victims died, 2,329 others were injured, 135,448 houses were severely damaged, 65,380 houses were moderately damaged, and 78,604 houses were slightly damaged.

Before September 30th, 2009 Padang City also experienced an earthquake on August 16th, 2009 with magnitude 6.7 SR. Before 2009, Padang City also rocked by an earthquake with a magnitude 6.7 SR that could be felt up to Kuala Lumpur, Malaysia on April 10th, 2005.

Two years after April 10th, 2005, on March 6th, 2007 an earthquake with magnitude 6.4 occurred. This disaster caused 4 deaths and 55 people needed serious care. The damage from this earthquake shows that the damaged buildings were worth a total of Rp146.1 billion.

At the beginning of 2019, specifically on February 2nd, 2019, the city of Padang experienced earthquake sourced from the Mentawai Islands. The earthquake occurred 52 times since the first earthquake that occurred. Earthquakes with magnitude 5 - 6 SR occurs 6 times.

According to the Head of Earthquake Information and Tsunami Early Warning of BMKG, Daryono said that consecutive earthquakes that occurred in Mentawai on February 2nd, 2019 were earthquakes with shallow depths. The

earthquake that occurred was a type of Megathrust earthquake. Head of the National Agency of Disaster Countermeasure (BNPB) Lieutenant General Doni Manardo stated that the resident of Padang must prepare to face the Megathrust earthquake on the Mentawai Siberut Island with the magnitude of 8.8 that can cause a tsunami. Also, according to Deputy I Prevention and Preparedness of BNPB, Bernard Wisnu Widjaja, the megathrust segment has an energy magnitude of 8.8 equivalent to 32 earthquakes with magnitude 7. Earthquakes with magnitudes 6 and 7 caused minor damage while earthquakes with magnitude 8 can cause severe damage even cause a tsunami.

The high risk of disasters occurring in Indonesia and Padang makes the National Disaster Management Authority (BNPB) at the central level and the Regional Disaster Management Authority (BPBD) for each region has an important role in helping the Indonesian populace in facing the upcoming disasters. This disaster management agency plays an important role in the disaster management process, starting from the preparedness, emergency response, recovery and reconstruction phases.

The emergency response system in Padang City has been refined in the 2017 Contingency Plan. Changes are focused on the division of zones handling the management of the Padang City emergency operation and the improvement of the Padang City Disaster Management Command (SKPDB) Structure. **Figure 1.5** showed the division of the emergency response zone for the Padang City disaster. Zoning is done based on the characteristics of regional disasters, demographic and topographic characteristics, and availability of resources.

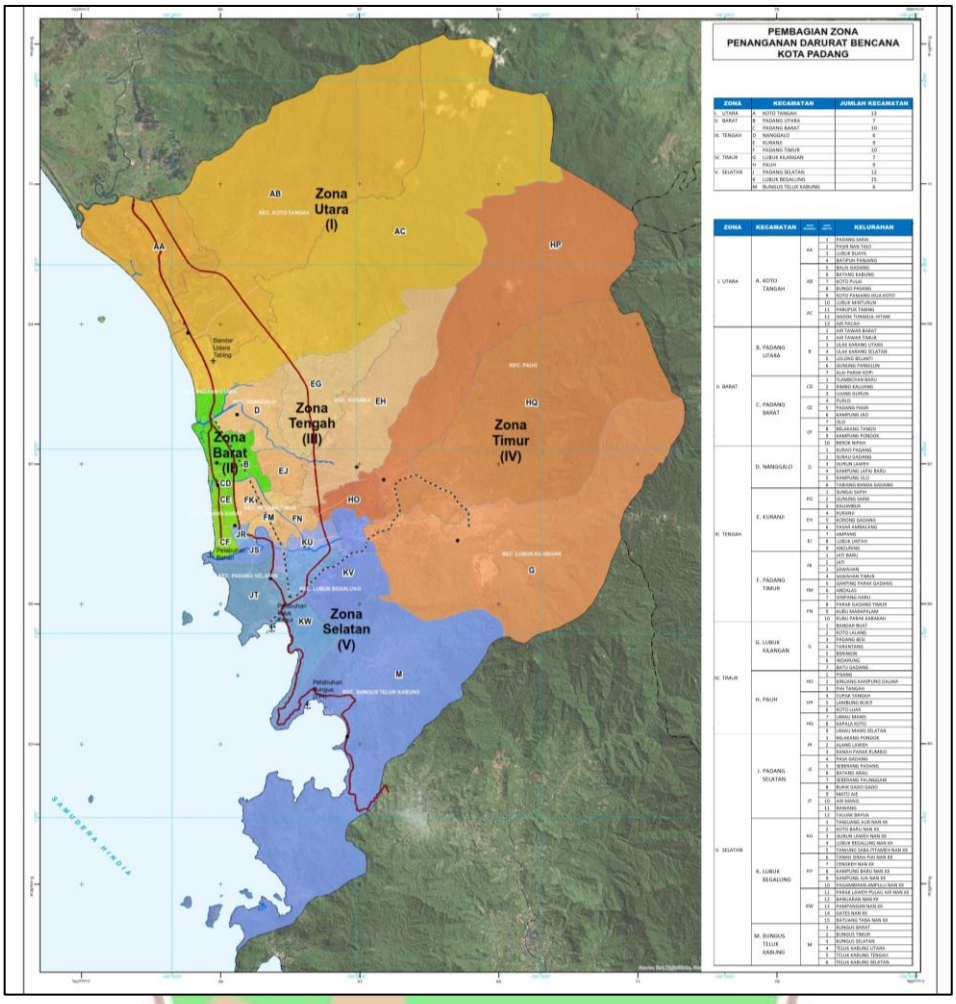

Figure 1.5 Emergency Disaster Handling Zone of Padang City
(Source: Contingency Plan for Tsunami in Padang City 2017)

According to PP No. 21 of 2008 Article 47 states that the implementation of disaster emergency response in a state of disaster is regulated in a command system. The explanation of the Disaster Emergency Management Command System (SKPDB) is regulated in BNPB Regulation No. 3 of 2016. The Disaster Management Command System is a unified structured effort in one command that is used to integrate emergency management activities effectively and efficiently in controlling threats/causes of disasters and mitigating impacts during disaster emergencies.

In the command structure there are several operating units that work in disaster management. **Table 1.2** shows the operating units under SKPDB along with the functions of each operating unit.

Table 1.2 Operation Unit of Disaster Emergency Management

Code	Operation Unit	Task	Task Scope
T1	**Rapid Reaction** (Automatically active when a disaster occurs in the sector or activated by the PB Emergency Operation Central for further under the command of the Sector Head)	Ensuring an overview of the situation developing in one region	Sector
T2	**Evacuation** (Automatically active when a disaster occurs in the sector or activated by the PB Emergency Operation Central for further under the command of the Sector Head)	Providing support when the community conducts independent evacuations to a safe place.	Sector
T3	**Shelter** (Automatically active when a disaster occurs in the sector or activated by the PB Emergency Operation Central for further under the command of the Sector Head)	Provide temporary shelter facilities support to refugees.	Sector
S4	**Search and Rescue** (In times of crisis it can be activated by T1, henceforth under the command of the Field Zone Commander in its operational area)	Search and Rescue the victims	Branch
T5	**Protection of Vulnerable Groups** (In times of crisis it can be activated by T3, henceforth under the command of the Field Zone Commander in its operational area)	Give special treatment in saving and handling vulnerable groups.	Branch
T6	**Medical Services** (In times of crisis it can be activated by T3, henceforth under the command of the Field Zone Commander in its operational area)	Providing medical services to all affected communities.	Zone
T7	**Transportation** (Activated by the Commander of the Special Cluster Post)	Providing transportation services for the mobilization and demobilization of resources, officers and victims.	Zone
T8	**Critical Facilities** (Activated by the Commander of the Special Cluster Post)	Ensure the functioning of critical facilities affected in the exposed area.	Zone
T9	**Public Facilities** (Activated by the Commander of the Special Cluster Post)	Ensure the functioning of public facilities affected in the exposed area.	Zone
T10	**Localize Exposure** (Activated by the Commander of the Special Cluster Post)	Trying to avoid widespread exposure to disasters and prevent hereditary disasters	Zone

(Source: Contingency Plan for Tsunami in Padang City 2017)

The unit teams that will help the distribution process is the Evacuation Team (T2), Shelter Team (T3), and the Transportation Team (T7). Shelters are buildings built with earthquake and tsunami resistant construction intended as temporary evacuation sites for the community during a tsunami disaster before being evacuated to the evacuation post. Whereas the evacuation post is the final location of the evacuation which has the function as a gathering place for post-disaster family members, and where the refugees get help and carry out daily household activities until the recovery process begins. Activities in the evacuation were carried out for people who lost property after the tsunami disaster (BNPB, 2014).

Disaster has affected the living of the human. To minimize the effects the disaster management must be managed properly. Based on the O' Brien on Dyah (2018), he said that the are four stages for disaster management. The first is mitigation and then preparedness, response and recovery. The logistics characteristics of disaster management are certainly different from the characteristics of commercial logistics in general, one of the characteristics is the main purpose of disaster logistics activities is to fulfill the refugee needs because they are lack of goods.

Based on UU No. 24 of 2007 article 26 on the paragraph 2 regarding disaster management states that everyone who is a victim of a disaster has rights to get the disaster relief. According to the Government of the Republic of Indonesia regulation No. 22 of 2008 concerning funding and management of disaster relief article 28 oh paragraph 1 that disaster relief that is given to the disaster victims in the form of temporary shelter, food aid, clothing, clean water, sanitation and health services. The central and regional governments are obliged to provide assistance to alleviate the suffering of disaster victims.

During the distribution process there are several problems that occurs on the process. For example, the assistance provided is not fully distributed so that disaster relief piles up at one point while other posts lack disaster relief. There is a

shortage of certain commodities or vice versa the assistance provided is too much, and not very useful. The existence of the problem above is caused by the lack of information regarding disaster victims data, assistance data that have been given, and information about donors who provide assistance.

Based on the explanation from Mr. Tommy Susanto as KOGAMI employee in Padang who was active in helping the disaster evacuation process, the main problem in the evacuation process and distribution of disaster relief was lack of refugee data who were in the evacuation post and the condition of the affected area. The number of displaced refugees is unknown so that the volunteers do not know exactly how much assistance will be sent. Besides, abnormal road conditions after a disaster make the process of distributing disaster relief.

In disaster evacuation, the distribution of disaster relief for the refugees is the most important thing. Refugees who are in evacuation post are in a state of lack of needs due to the lack of goods carried while evacuating. Therefore, the distribution of disaster relief is needed for the refugees to survive in the evacuation post. However, based on the historical disaster evacuation, the distribution of the disaster relief is often hampered due to the difficult conditions of the transportation field and the lack of vehicles to distribute aid. Thus, the assistance obtained by refugees is not in a condition that can be used or consumed which causes new problems such as poisoning.

Besides, the need to collect data effectively and efficiently as a reference for distributing assistance so that logistical assistance can be recorded and distributed more quickly. Visualization of the optimal distribution channels will help volunteers in the process of distributing disasters. Utilization of technology can be used to facilitate data processing, one of which is the use of Geographic Information Systems.

Geographic Information System is a technological information system regarding geography that is highly developed. GIS has a very good ability in

visualizing spatial data and its attributes, modifying shapes, colors, sizes, and symbols (Marlena, 2018). Sawano (2007), revealed that the Geographic Information System can handle all aspects of disaster to help disaster management activities, when, where, how, by whom, to whom and what they have done.

The function of Geographic Information Systems, the evacuation process can be more easily done. The design of the geographic information system that will be carried out is expected to help the evacuation team to find the optimal disaster relief distribution route, to recapitulate the needs of disaster relief more effectively, and to get information on the lack of disaster relief from the field quickly.

Research on the disaster has been done a lot before. One of them is the research by Mahdia (2013) that discussed about the geographic information system design to determine the location of the post, the distance of the post, and the needs of the post for disaster. Another research by Ndahawali (2012) that doing research about the use of information systems to determine the shortest path for tourism routes with minimum distance and transportation costs. Route determination using Dijkstra's Algorithm which is implemented into geographic information systems. Display of the results of research in the form of a website that can be updated by the admin or user. A similar study was also conducted by the Officer (2011) that doing research to determines the shortest path to visit 12 tourism sites in Sawahlunto. So that tourists can save time by traveling shorter distances. The system is made in the form of a website that can be accessed by tourists. Research from the Dyah (2018) talks about the problem occurs during the distribution of the disaster relief process because of lack of the data so it’s needed to design a logistics information system to give solution to this problem.

The basic difference between GIS and other Information Systems is that GIS can process spatial data and non-spatial data as attributes of spatial data, whereas other information systems do not use spatial data. GIS for disaster preparedness is effective as a means to determine the location as a shelter outside the disaster zone, identify alternative evacuation routes based on different disaster

scenarios, the best route to hospitals outside the disaster zone, specialization and capacity of hospitals, etc. GIS can provide an estimate of the amount of food, water, etc. (bpbd.probolinggokab.go.id, 2016). Therefore, based on previous research, further research on the Geographic Information System for disaster is more appropriate for the disaster evacuation process because GIS can be used to enter, store, manage, analyze and reactivate data that has spatial references. So that data entered during emergency response operations can be directly given financial references so that other officers can find out locations to be evacuated appropriately.

1.2 Problem Formulation

Based on the problems obtained from the background, the formulation of the problem in this study is how to design a Geographic Information System as a tool for the process of distributing earthquake and tsunami disaster relief in Padang City. Because based on the logistics distribution that have been done, the lack of information of the disaster relief needed. So, the system is designed to be able to display the optimal distribution route of disaster relief at the evacuation post display data on the location of shelters in Padang City, as well as provide information about the disaster relief needs data at the evacuation post in Padang City.

1.3 Objective of the Research

The purpose of this research is to design a web-based Geographical Information System that provide data about the optimal route of the distribution process and the information about the disaster relief needs on the evacuation post. So, the process distribution can be done in more effective because of the system will give information about the disaster relief needs data in the right places, in the right quantity and as needed.

1.4 Scope and Limitation

Limitation problems in this study are as follows:

1. There is only one optimal route on this system.
2. The distribution network was designed to distribute the disaster relief only to the evacuation post.
3. This system only provide information for the evacuation, shelter, and transportation unit team.

1.5 Outline of The Report

The writing systematics of this research are as follows:

CHAPTER I INTRODUCTION

This chapter consists of a background regarding the application of geographic information systems in the repetition of natural disasters, the formulation of research problems, the purpose of conducting research, limitations in conducting research and systematic writing in research.

CHAPTER II LITERATURE REVIEW

This chapter contains the literature that supports research that includes theories about natural disasters, information systems, geographic information systems, Dijkstra algorithms, system development methods, object-oriented methodologies, and databases.

CHAPTER III RESEARCH METHODOLOGY

This chapter discusses about the steps that will be taken in solving the problems in the research. Consist of preliminary study, research objective, data collection,

method selection, data processing, system specification, verification and validation.

CHAPTER IV SYSTEM DESIGN AND DATA COLLECTING

This chapter consists of the design of the system that will be implemented in the system. Consist of distribution networking design, data collection, and system design.

CHAPTER V IMPLEMENTATION AND SYSTEM TESTING

This chapter consist of the implementation of the system, verification of the system, and validation of the system.

CHAPTER VI CONCLUSION AND SUGGESTION

This chapter consist of conclusion about the research and suggestion about the system development.