THESIS

SITE SELECTION AND TRANSPORTATION ROUTES OF TSUNAMI EMERGENCY LOGISTIC WAREHOUSE ASSESSMENT USING (GIS) IN CILACAP REGENCY, CENTRAL JAVA PROVINCE, INDONESIA

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DISCLAIMER

This documents work undertaken as a part of a programme of study at The Graduate School Gadjah Mada University and Faculty of Geo-Information Science and Earth Observation, University of Twente. All view and opinions expressed therein the sole responsibility of the author, and do no necessarily represent those of institutes

Yogyakarta, March 2013

Susan Defi Ariyanti

SITE SELECTION AND TRANSPORTATION ROUTES OF TSUNAMI EMERGENCY WAREHOUSES USING GIS IN CILACAP, CENTRAL JAVA, INDONESIA

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ABSTRACT

Warehouse logistics can be used as an important consideration in disasters management of a region. The design of disaster logistics warehouse is intended to facilitate both the management of logistical needs of disaster so that the logistics distribution process becomes faster to affected area of disaster. Warehouse logistics Cilacap disaster can be designed using three different types of warehouse approach, named Central Warehouse, Warehouse Regional, and Local Warehouse. Based on logistic disaster management system in Cilacap, where Central Warehouse and Regional Warehouse located in BPBD and district office (based on logistic current strategy in Cilacap) respectively. Placement those warehouses aims to facilitate the supply, distribution, and control of disaster relief logistics in Cilacap. Meanwhile, the existence of a local warehouse at the village level can be determined by using the building facilities. The approach used to determine these local warehouse requirements considering the warehouse logistics and accessibility of closest infrastructure (market) as a local supplier of logistics. Both approaches are executed using Network Analyst tools and methods Hiereracy Analytical Process (AHP).

From the research, there are 13 number of building public facilities that can be used as a local warehouse. However, only seven local warehouse that can be used as an effective buffer stock logistic. This is because the local 7gudang can access the tsunami evacuation shelter with the shortest travel time. The capacity of regional and local warehouse warehouse can be determined based on the amount of logistical requirements at each local warehouse refugees in accordance with the capacity of each shelter tsunami.

Keywords: Central warehouse, Regional warehouse, Local warehouse, AHP

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INTISARI

Gudang logistik dapat dijadikan sebagai pertimbangan penting dalam manajemen bencana di suatu wilayah. Perancangan gudang logistic bencana ini bertujuan untuk memudahkan baik dalam manajemen kebutuhan logistik bencana sehingga dalam proses pendistribusian logistik bencana menjadi lebih cepat. Gudang logistik bencana di Cilacap dapat dirancang menggunakan pendekatan tiga macam tipe gudang, yaitu Gudang Pusat, Gudang Regional, dan Gudang Lokal. Berdasarkan sistem managemen logistic bencana di Cilacap, keberadaan Gudang Pusat dan Gudang regional masing-masing ditempatkan pada BPBD dan kantor kecamatan masing-masing. Penempatan gudang tersebut bertujuan untuk memudahkan menyediakan, mendistribusikan, dan mengontrol bantuan bencana logistic di Cilacap. Sementara itu, keberadaan gudang local di tingkat desa dapat ditentukan dengan menggunakan bangunan fasilitas umum. Pendekatan yang digunakan untuk menentukan gudang local ini mempertimbangkan persyaratan bangunan gudang logistik dan aksesibilitas infrastruktur terdekat sebagai supplier logistik dan dilakukan dengan menggunakan *tools Network Analyst* dan metode *Analytical Hiereracy Process (AHP).*

Dari hasil penelitian, terdapat 13 jumlah bangunan fasilitas umum yang dapat dijadikan sebagai gudang lokal. Akan tetapi hanya tujuh gudang lokal efektif yang dapat dimanfaatkan sebagai *buffer stock logistic.* Hal ini dikarenakan 7 gudang lokal tersebut yang dapat diakses shelter evakuasi tsunami dengan waktu tempuh yang paling singkat. Kapasitas gudang regional maupun gudang lokal dapat ditentukan berdasarkan jumlah kebutuhan logistic pada tiap-tiap gudang lokal sesuai dengan kapasitas pengungsi pada masing-masing shelter tsunami.

Kata Kunci: Gudang Pusat, Gudang Regional, dan Gudang Lokal, AHP

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ABBREVATION AND GLOSSARY

BNPB	:	Badan Nasional Penanggunlangan Bencana
BPBD	:	Badan Penanggulangan Bencana Daerah
FEMA	:	Fedearal Emergency Management Agency
GIS	:	Geographic Information System
GITEWS	:	German-Indonesia Tsunami Early Warning System
NGDC	:	National Geophysic Data Center
UNHCR	:	United Nation High Commissioner for refugees (UNHCR)
USAID	:	United States Agency for International Development

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CHAPTER 1. INTRODUCTION

This chapter explains about background of research, problem statement of research, research objectives, research benefit, research structure, and scope and limitation of research.

1.1 BACKGROUND

Indonesia is one of countries located in active tectonic plate; Indo-Australia in west side, Eurasia in north side and Pacific plate east side (see Figure 1.1). These plates always move and collide; generate active faults resulting seismic activity. This position also cause a big number of natural disasters; earthquake, tsunami, and volcanic eruption in Indonesia (Diposaptono and Budiman, 2006). One of tsunami hazardous is Coastal area in Southern part of Java. Cilacap is one of regency located Southern Java Coastal Area and considered as area regarding tsunami hazard in Indonesia. As the part of southern of Java, Cilacap has potency of tsunami disaster where the number of settlement (had dense population) and other landuse dominated in capital city of Cilacap. According to GITEWS research in 2010, Central Java had experienced in earthquake and tsunami disaster in the past (2006). The occurrence of tsunami disaster in Indonesia triggering by earthquake can be seen in Table 1.1

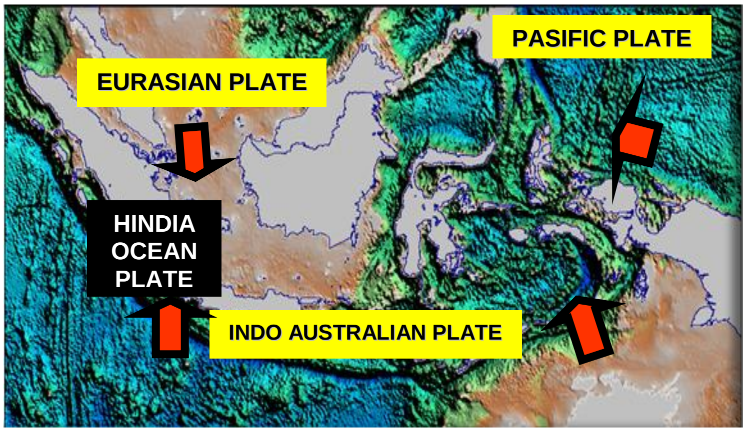


Figure 1.1 The position of tectonic plate in Indonesia, (Sunarto, 2009)

Generally, major causing of tsunami disaster comes from earthquake. Tsunami which triggered by earthquake will can result the movement of ocean floor or landslide that distribute movement of coastal area and probably will impact to human loss and injured (Heitner, 1968; Mardiatno, 2008).

Table 1.1 Historical Record of Tsunami Generated in Indonesia

Year	Epicentre	Run-up (m)	Number of Victim (dead/injured)	Region
1961	8,2 LS – 122.2 BT	No data	2/6	NTT, Flores Tengah
1964	5,8 LU – 95,6 BT	No data	110/479	Sumatera
1965	2,4 LS – 126 BT	No data	71/No data	Maluku, Seram, and Semana
1967	3,7 LS -119,3 BT	No data	58/100	Tinambung (Sulsel)
1968	0,7 LS – 119,7 BT	8 - 10	392/No data	Tambo (Sulteng)
1969	3,1 LS – 119,7 BT	10	64/97	Majane (Sulsel)
1977	11,1 LS – 118, 5 BT	No data	316/No data	NTB and P. Sumbawa

1977	8 LS – 125,3 BT	No data	2/25	NTT Flores, and P. Atauro
1979	8,4 LS – 115,9 BT	No data	27/200	NTB, Sumbawa, Bali, and Lombok
1982	8,4 LS – 123 BT	No data	13/400	NTT, Larantuka
1987	8,4 LS – 124,3 BT	No data	83/108	NTT, Flores Timur, and P. Pantar
1989	8,1 LS – 125,1 BT	No data	7/No data	NTT and P. Alor
1992	8,5 LS – 121,9 BT	11.2 – 26.2	1952/2126	NTT Flores, P. Babi
1994	10,7 LS – 113,1 BT	19,1	38/400	Banyuwangi (Jatim)
1996	1,1 LS – 118,8 BT	No data	3/63	Palu (Sulteng)
1996	0,5 LS – 136 BT	13,7	107/No data	P. Biak (Irian Jaya)
1998	2 LS – 124,9 BT	2,75	34/No data	Tabuna Maliabu (Maluku)
2000	0,6 LU – 119,9 BT	3	4/No data	Banggai, Sulteng
2004	3,3 LU – 95,6 BT	34	>200000 dead	NAD and Sumut
2005	2,06 LS – 97 BT	3,5	-	P. Nias
2006	9,4 LS – 107,2 BT	7,6	668 dead	Jawa Barat, Jawa Tengah, and Yogyakarta
2007	4,67 LS – 101, 3 BT	3,6	-	Bengkulu and Sumatera Barat
2010	3.484 S – 100.114 E		108 dead	Mentawai

Source: Disapto & Budiman (2008) and USGS (2010)

The number of victims due to tsunami disaster can be minimized if disaster logistic management prepared systematically. Preparedness is the key to cope tsunami hazard in disaster management combined with the development of local government. One of disaster preparedness handled by local government is to provide emergency logistic warehouses; central warehouse, regional warehouse, and local warehouses.

Logistic can be defined as the emergency needs which must be fulfilled in order to assure the viability (Oktarina, 2010). The increasing social problem such as starvation, poverty, and illness can be worst since nothing consideration of logistic management in Cilacap (GITEWS, 2010). Determining the site selection of logistic warehouse can be effective way of logistic delivery if combined with disaster logistic managemement. Principally, the basic task of disaster management logistic system aims to deliver the appropriate supplies in good condition, in quantities required for refugees, in the best access place, and in the effective time their needed (Tabbara, 2008). He also empsize the relocation of disaster affected refugees, infrastructure, and transportation activities in to humanitarian aid logistic. Definition of humanitarian logistic conducted by Tabbara:

"humanitarian logistic refers to procurement, distribution, maintenance, and replacement of material and personnel" (Tabbara, 2008).

1.2 RESEARCH PROBLEM

The fact mentioned that the impact of tsunami in Pangandaran on July 2006 had hit and damaged some coastal area in South of Java Island; from West Java, Central Java, and Yogyakarta Special Province (NGDC, 2009). Different information had been reported in reporting death victim of tsunami Pangandaran in Cilacap. Based on report of BPBD of Cilacap (Region Disaster Agency), It was reported that approximately 160 people died and destructed several villages; Pangandaran, Batukaras, Ciamis, and Cilacap (BPBD, 2012).

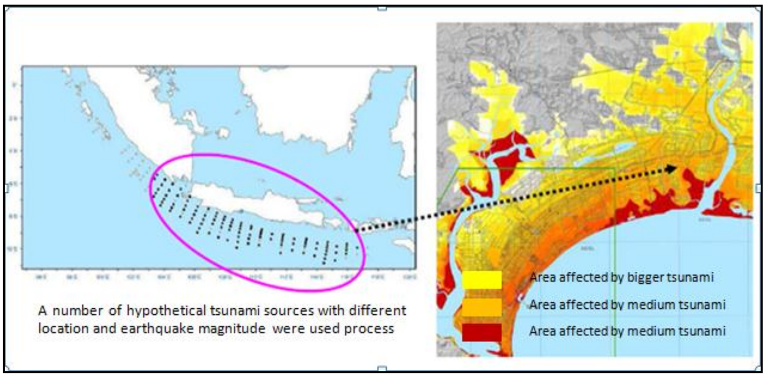


Figure 1.2 Tsunami Hazard in Cilacap Coastal Area, (GITEWS, 2010)

The model of tsunami disaster level in Cilacap which stated in Figure 1.2 classified into 2 zones of scenario. They are red zone and orange-yellow zone. Red zone represents the area with tsunami wave heights reach between 0.5 m and 3 m. Meanwhile, the orange and yellow zone represents area with the wave height at coast of more than 3 m (GITEWS, 2010).

Providing warehouses for storing logistic material can be new addition in Logistic management problem beside shelters issue. It should be applied in vulnerable area and aims to store logistic material. The process emergency logistic capacity has to be supported by compatible and comprehensive information system. It is proposed to improve the ability of logistic planning at national government, local government, and local population (Oktarina, 2009).

From 2004 Asian Tsunami event, one of aspect admitted acknowledgement was the role of logistics in effective relief aftermath of tsunami; relief goods flooded airports and warehouses in the affected regions, aid agencies struggled to sort through, store and distribute the piles of supplies while disposing of those that were inappropriate. For tsunami Aceh 2004, there were a coordination of tsunami inundation from the military representatives from several countries and large number of foreign aid agencies to handle disaster logistic (Thomas,2005).

As threatening country of natural disasters, emergency logistic management in Indonesia is still needed to be maximized and has to be improved for information, knowledge, role of government and also organization at local and national level. It aims to obtain effective ways for emergency logistic management (Oktarina, 2009). In the aftermath of disaster, logistic is such an essential challenges such as destruction of physical infrastructure; roads, bridges and airports, remoteness of the area and limited transport capacity (Thomas, 2005). Therefore the use of GIS can be effective means to describe the relation between accessibility of public infrastructures combined with the existence of roads and bridge. Geographical Information System (GIS) has been widely used in logistics during the past few years as Olivera (2010) says:

"GIS is a set of tools that obtain, store, and analyze data related to locations. Network analyst is a very important extension in GIS software. Network analyst can dynamically model realistic network conditions [1]. Given the data of roadways and cost attributes, the network analyst can be used to analyze problems such as vehicle routing, closest facility and service area."

Furthermore, he also explains location and selection of warehouse is a major problem faced by any sectors involving; all companies, government agencies, etc since it is a very essential issue faced by any sectoral business. In most of the research, an artificial network lies in their dynamical to the change of real network. That network is used in solving the problem and building optimization models to find the best location. As the network which relating and corresponding to the real world data, many people are using GIS to solve network problem (Olivera, 2010).

Tsunami brought a massive of logistical challenges and required urgent attention, particularly the destruction of transport and public facilities; roads, bridges, energy and telecommunication. It can predict when as tsunami takes place as many coastal areas were totally destroyed and some affected regions hampered the efforts of the relief agencies (Perry, 2007). Therefore, logistic emergency needs should come from local source and even need to design temporary place to store logistic needs around disaster area (Nurjanah, 2011).

According to the previous research named *Humanitarian Aid Warehouse Location Planning;* (Anonim, 2012) stated the pre-positioning warehouse can minimize the expected budget of a humanitarian aid distribution undertaken by local government. By locating warehouse strategiacally, the distance of logistic supplier will be reduced to reach disaster sites because logistic transportation routes have greater cost than operating cost. Therefore this research also considers the optimal number and location of warehouses. Disaster relief of logistic can be effective since warehouses are functioned as buffer stock before reaching shelters with the optimum routes (more than 40 shelters in Cilacap).

1.3 RESEARCH OBJECTIVES

This research tries to identify and decide selection of public buildings and even optimum routes of logistic delivery material to logistic warehouses (in this study impacted by tsunami Cilacap Coastal Area). Some objectives which have to be achieved are:

1. To know logistic management system of disaster handled in Cilacap
2. To determine public building to replace regional and local warehouses impacted by tsunami
   in surrounding area of Cilacap Coastal Area
3. To identify the number of local warehouses belonging to warehouse specification building
   (Indonesian Red Cross and BNPB), tsunami hazard map, public infrastructures (markets), and
   evacuation shelter.
4. To determine the optimum routes of logistic transportation with single centralized warehouse
   Compared local warehouse existence

1.4 RESEARCH QUESTONS

The following research questions combined with research questions can be shown in Table 1.2 below:

Table 1.2 Research Objectives and Research Questions

Research Objectives	Research Questions
1. To know disaster logistic management system handled in Cilacap	a. How the emergency logistic is being handled in Cilacap? b. Who will be suppliers of disaster emergency logistic needs in Cilacap ?
2. To determine public building to replace regional warehouses and local warehouses impacted by tsunami in surrounding area of Cilacap Coastal Area	a. Where is the location of central warehouse, regional warehouses, and local warehouses impacted by tsunami disaster in Cilacap Coastal Area? b. What are parameters considered to select public building as local warehouses in Cilacap? c. Where and how closest facility of market to local warehouses can be accessed in effective time, traffic density, and types of roads?
3.To identify the number of local Warehouses belonging to warehouse Specification building, tsunami hazard map, public infrastructures (market), and evacuation shelter	a. How many are local warehouses can be applied in study area of Cilacap? **b.** What are kinds of logistic material needed by refugees in regional and local warehouses? **c.** How are the capacities of regional and local warehouses to store logistic material?
4. To determine the optimum routes of logistic delivery with single centralized warehouse compared local warehouse existence	a. Where is the optimum route of logistic delivery according to travel time, traffic density, and type of road of central-regional-local warehouse? b. How are the comparisons of logistic optimum route from central warehouse to shelter only with logistic delivery from local warehouse-shelter based on travel time and type of road?

1.5 RESEARCH BENEFIT

The result of this research will be useful for institution involved in disaster management system (donors, logistic provider, military, government, NGO, and aid agencies) and whoever takes interest in disaster logistic management. For more detail, research benefit will be described based on some points below:

1. It can be one of tsunami emergency and disaster mitigation plan in Cilacap
2. It can be key disaster logistic management system in Cilacap
3. It explains how to generate parameters used to identify the selection of emergency logistic warehouses in Cilacap due to tsunami disaster
4. It can identify the optimum routes of transportation in distributing logistic needs in Cilacap from central warehouse to evacuation shelter and from local warehouses to tsunami shelter

1.6 RESEARCH STRUCTURE

Thesis writing of research is grouped in to some chapters:

- Chapter 1 explains general introduction of research and also limitation of research include; background, research problem, research objectives, research benefits, time schedule, and research structure.
- Chapter 2 describes study area of research. It will focus on geographic condition of Cilacap Regency, geomorphologic condition of Cilacap Coastal Area, landuse type, and condition of population.
- Chapter 3 discuss about literature review. It will be separated become several parts; characteristic of coastal area and concept of tsunami, disaster

management system, logistic network and Geographic Information System (GIS), and emergency indicators

- Chapter 4 presents research methodology. It consists of research design, data requirements, tools of research, phases of research, and techniques analysis of research
- Chapter 5 discuss about Logistic Management System in Cilacap
- Chapter 6 analyze about Management of Logistic Warehouse in Cilacap
- Chapetr 7 discuss Transportatioun Routes of Warehouse
- Chapter 8 present Conclusion and Recommendation

1.7 SCOPE AND LIMITATION OF RESEARCH

1.7.1 Scope of Research

This research focus on Site Selection of Logistic warehouse belonging to some approaches; warehouse specification from Indonesian Red Cross and Regional Disaster Agency (BPBD), closest facility of Public infrastructures (market), Service area of logistic warehouse and even warehouse optimum route in a given road network of tsunami post disaster.

1.7.2 Limitation of Research

Some limitations of this research were underlined in this research:

1. The selected road network is derived from the width road network, length of road, travel time, traffic density which can be accessed by truck.
2. Road network are mapped to generate safe area from tsunami inundation and more likely in good condition since Cilacap earthquake caused low magnitude and no impact to road structure
3. The barier of logistic transportation routes are focused on the probable of bridge destruction due to tsunami inundation can cause increase level of river
4. Service are of logistic local warehouses are conducted based on the travel time taken during field measurement
5. Logistic transportation is focused on land transportation where all logistic needs are stocked in central warehouse.

CHAPTER 2. STUDY AREA

Chapter 2 describes about study area of research and mainly focuses on geographic condition of Cilacap Regency, geomorphologic condition of Cilacap Coastal Area, and landuse type in research area.

2.1 GEOGRAPHIC CONDITION OF CILACAP

Cilacap is one of regency located in Central Java Province. Cilacap are laid in three main rivers lies: Donan River, Yasa River, and Sabuk River (see Figure 2.1.) Geographically, Cilacap is located on 108º 4' 30 " - 109º 22' 30 " of longitude east and 3º 20 " – 7º 45' with region area is about 225.361 km2. Administratively, Cilacap regency located among others regencies; Banyumas is in northern side, Hindia Ocean is the southern side, Kebumen is in eastern side, Ciamis is in the western side (see Figure 3). Cilacap also has coastline along ± 105 km from eastern coastal of Jetis Village to western of Ujung Kulon, Nusakambangan island which border to West Java (BPBD Cilacap, 2012). Cilacap consist of 24 sub districts and distributed in to 284 villages. Eleven of these subdistricts have coastal area in the southern parts of Central Java. Number of population in Cilacap reaches 1.872.576 people with the growth of population 8.48% (BPBD Cilacap, 2012)

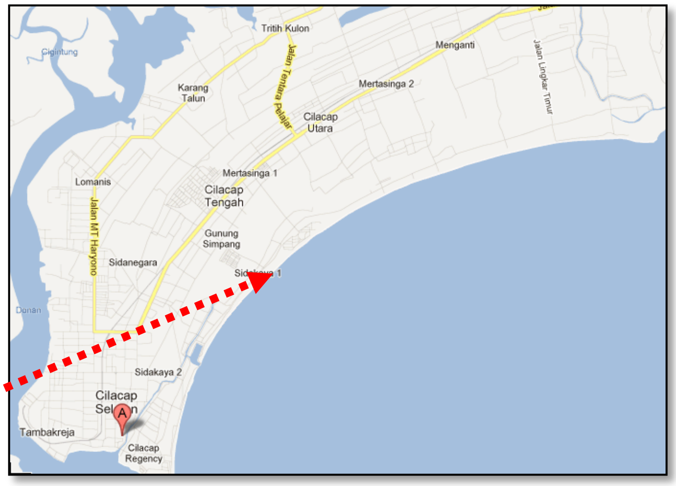


Figure 2.1 Administrative Map of Cilacap Coastal Area (PEMDA, 2012)

2.2 GEOMORPOLOGICAL CONDITION OF CILACAP COASTAL AREA

Cilacap region included coastal area part in the southern side of Java. Coastal lowland contains a variety of landforms which are geologically young due to rapid post glacial sea level rise stabilized only some 6000 years ago. The formation of landforms in Coastal area depend on fluvial process interact with marine processes. This process determines whether or not a depositional body can form the body of river. According to Kurnio (2007) Cilacap coastline can be grouped as depositional and constructional coastlines. It is also combined with adequate sediment supply and accumulation of clastic sediment outweighs erosion by the sea. Clastic material on the coast are resulted by nearby rivers (Donan, Serayu, Bengawan and Ijo) and also transported by along shore currents. Sutikno (1981) declared landforms types of Cilacap coastal area.

1. **Alluvial plains units**
   These landforms unit can be formed by river activity; Serayu and Donan river influence. Both of Serayu and Donan rivers result different materials. Serayu River is dominated by clay texture of material whereas Donan River is dominated by sandy material at the bank of river.
2. **Beach ridge units**
   The existence of beach ridges in Cilacap coastal area commonly is being occupied by settlements. Generally, the materials availability of beach ridges units in Cilacap coastal area is sand with quite fine texture. Beach ridges units lies approximately 0.2 – 1.0 km from coastline.
3. **Lagoon units**
   Lagoon units in Cilacap coastal area form different pattern alternates beach ridges with various ranging 0.2 – 3.9 km.
4. **Sand dunes units**
   Sand dunes units commonly associated with the existence of coast. It has approximately 7 meter above sea level rise. Recently, the presence of sand dune is no longer existed due to the exploitation. Spatial distribution of landforms at Cilacap Coastal Area can be seen in the Figure 2.2 and Figure 2.3 below.

Figure 2.2 Geomorphological pattern of low ridges and shallow depression from SPOT image (Dewi, 2010)

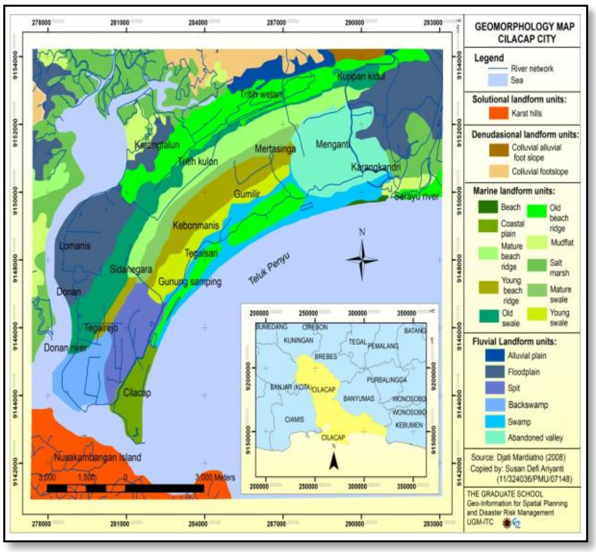


Figure 2.3 Geomorphologic Map (Mardiatno, 2008)

2.3 LAND USE TYPE

Administratively, Cilacap regency are recorded 22.361 hectare (include Nusakambangan island with area 11.511 hectare). Cilacap regency is around 6.94% of total area from Central Java. Its landuse types consist of 63.318 hectare of Rice-field area, Non Rice-Field area and others landuse types (see Figure 2.1). Based on the land utilization, the total area of Rice-Field area is about 29788 hectare, Non rice field area is about 114505 hecatre and other land use type is about 36027 hectare while the land use percentage can be seen in Figure 2 (BPS, 2011)

Table 2.1 Landuse Type in Cilacap Regency

Landuse	Area (ha)	Landuse	Area (ha)
Rice-Field Area		**Non Rice-Field area**	
- Technical irrigation	37256	- Yard	3134
- Half technical irrigation	2629	- Garden	45797
	3867	- Un irrigated rice-field	284
- Simple irrigation	2027	- Grassland	0
- Village irrigation	17499	- Unplowed land	148
- Rain fed rice-field	0	- Public forest	4294
- Tidal rice-field	0	- State forest	42823
- Lowland	40	- Plantation	10153
- Polder and others		- Other	7872
Others	32200		
- Swamp	3069		
- Brackish water	151		
- Fresh water fishery	607		

Source: Cilacap in Figure 2010 (BPS, 2011)

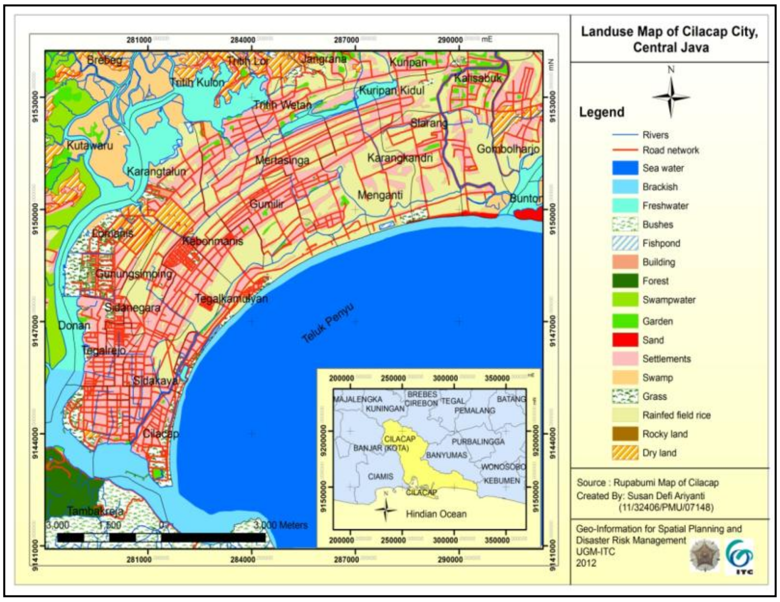


Figure 2.4 Landuse type in Cilacap Coastal Area

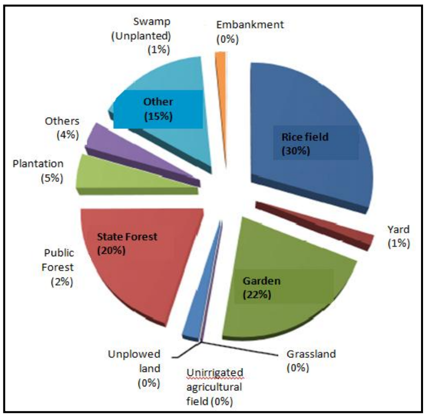


Figure 2.5 Land use percentage 2010 in Cilacap

2.4 CONDITION OF POPULATION

Study area of research covers six districts in Cilacap Regency; South Cilacap, Central Cilacap, North Cilacap. According to Population data in Table 2.2, the most population settled in South Cilacap with the biggest area and the most population compared other study area since south Cilacap district was located in Cilacap City. South Cilacap is the capital city of Cilacap Regency where whole economic and government activities have been taking a place. Number of Population in South Cilacap (see Table 2.2) is also influenced by migration and birth events.

Table 2.2 Population Data of Study area

Districts	Name of Villages	Area (Km^2)	Population	Density
South Cilacap	Sidakaya	9.11	84136	8596
Central Cilacap	Tegal kamulyan	22.15	78310	3798
North Cilacap	Sidanegara Gunung Simping	18.84	68619	3642

Source: Cilacap in Figure 2010 (BPS, 2011)

Generally, main occupation sectors in Cilacap Regency are dominated by any sectors based on Table 2.3. The primary sectors are agriculture, industry, and commerce. Those sectors have been developing well in Cilacap than other sectors. For agriculture sector, it can be supported by numerous factors; land availability (the most land use in Cilacap used for agriculture activities), adequate of agricultural labor, intensification and diversification agriculture program, agriculture fund, and directive counseling for farmers regularly. The second occupation sector dominated in Cilacap was industry sector. Industry sector is being well-developed to support economic welfare of population there. Many private companies existed in Cilacap such as PERTAMINA, Holcim, etc. Most of them were located in capital city of Cilacap too.

Table 2.3 Number of Population based on Occupation Sector

Districts	Occupation Sector		
	Agriculture	Industry	Commerce
South Cilacap	5396	2374	7373
Central Cilacap	3662	3339	6722
North Cilacap	7722	3395	4707

Source: Cilacap in Figure 2010 (BPS, 2011)

According to occupation sector, it can be known the most type occupation which dominated in Cilacap (see Table 2.3) are agricultural labor, fishermen, industry labor, construction worker, government officer, and retired worker. Most agricultural labor concentrated in North Cilacap since North Cilacap had more agricultural land. In addition, the concentrated population in all types occupation in North Cilacap is due to accessibility of region is being done well since North Cilacap is road connection from and to Cilacap. This position can attract population in Cilacap to develop those occupations.

Table 2.4 Number of Population based on Occupation's Type

Districts	Agricultural labor	Fishermen	Industry labor	Construction worker	Government officer	Retired worker
South Cilacap	286	7398	2309	3182	2097	1278
Central Cilacap	1749	1583	3339	4094	6952	1626
North Cilacap	4267	2459	2591	4144	1868	941

Source: Cilacap in Figure 2010 (BPS, 2011)

CHAPTER 3.LITERATURE REVIEW

This chapter presents literature review concerning to research topic which consist of: Characteristic of Coastal area and Concept of Tsunami; Disaster management (Disaster Phase and Disaster Emergency Response); Logistic System; Logistic Network and Geographic Information System.

3.1 CHARACTERISTIC OF COASTAL AREA AND CONCEPT OF TSUNAMI

Coastal area is one of Earth's surfaces which obtain different effect origin of natural phenomenon and anthropogenic phenomenon. In coastal area, meteorological and or geodynamic-genetic events have been resulting severe dynamical change; tsunami disaster. Tsunami can hit any coastal zone in the world with short or no-alarm period (Mastronuzzi, 2010). Related to tsunami characteristic, Mastronuzzi in journal *Tsunami in Mediterranian Sea* mentioned that the morphology of the sea bottom is a major factor of tsunami process since it can cause the convergence or divergence of wave rays due to refraction inducing very different effects on the coast.

The term of tsunami come from Japanese means "wave in harbor". Tsunami parts are not only to reveal sub surface layer but also the entire thickness of water involved in motion (Levin, 2009). Tsunami can arise since interaction between sea floor movement triggered by seismic activity, landslide, and volcanic eruption. But most tsunami generated by a huge earthquake occur in deep water are less than 0.4 meter in vertical height (Ward, 2002). The process of tsunami occurrence and scheme of tsunami can be explained by using the illustration in Figure 3.1 and Table 3.1

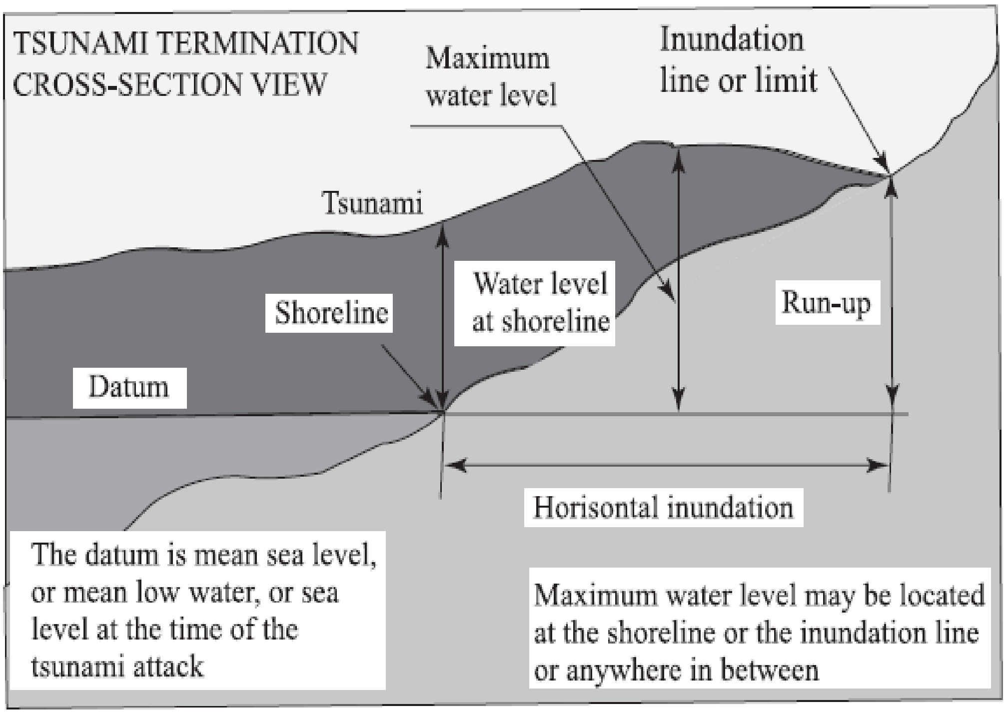
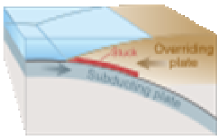
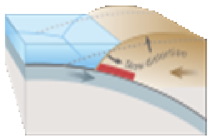
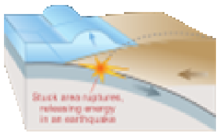


Figure 3.1 Scheme of Tsunami Onshore run up, (Levin 2009)

Table 3.1 Tsunami Process

Process	Description
	Condition of tectonic plate boundary before earthquake. Tectonic earthquakes are a particular kind of earthquake that is associated with the Earth's crustal deformation.
	Dynamic of tectonic movement and collide each other. Overriding plate bulges under strain, causing tectonic uplift
	Plate slips causing subsidence and releasing energy into water. When these earthquakes occur beneath the sea, the water above the deformed area is displaced from its equilibrium position
	A tsunami can be generated if thrust faults associated with convergent or destructive plate boundaries move abruptly, energy released and resulting in water displacement, owing to the vertical component of movement involved.

Source: https://www.eeducation.psu.edu/earth501/content/p2_p3.html

3.2 DISASTER MANAGEMENT

3.2.1 Disaster Phase

Disaster occurrences may lead as the sequence process in continues of disaster mitigation periods. This means each of disaster phases can assist to overcome and analyze disaster information and mitigation. The concept of disaster phases becomes important for preparing disaster management in vulnerable area. According to (Oktarina, 2009) explained disaster phase in to several phases; response phase; rehabilitation and reconstruction phase, prevention and mitigation phase and preparedness phase. Conceptually, disaster phases can be illustrated as presented in Figure 3.2

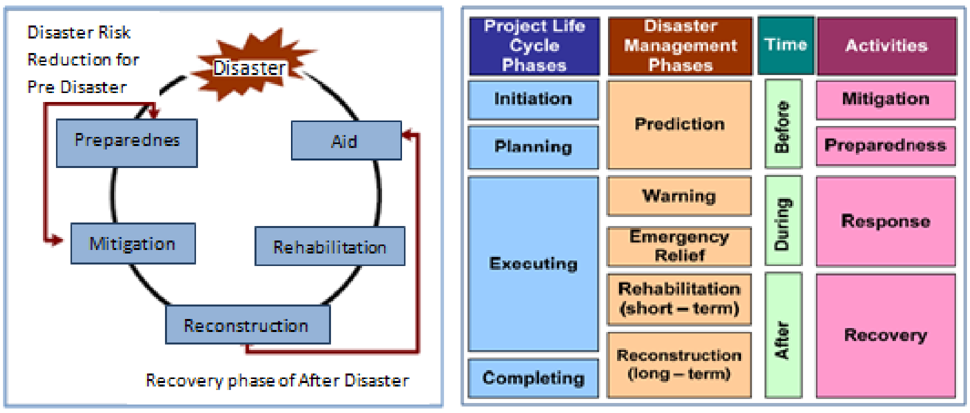


Figure 3.2 Disaster Phases, (Oktarina, 2009)

3.2.2.Disaster Emergency Response

Disaster Emergency response is some actions taken by community, organization, and even the institutional in facing disaster. Disaster emergency response is commonly initialed with or without early warning system. It also involves the implementation of concept of disaster preparedness and its procedures (Oktarina, 2009).

3.3 COMMUNITY BASED DISASTER RISK MANAGEMENT (CBDRM)

Community based Disaster Risk Management is established as a general guidance on the standard of disaster management in Indonesia. This association is characterized by some elements:

- Community (center of attention), actor, and benefit user
- Based on risk reduction
- Correlation to development process
- Multi-sector and multidiscipline approach
- Evolving framework

Community based Disaster risk Management is also organized and planned with the standard procedures and even has its own task and function (UNSCAP, 2008):

- *To internalize that being safe from disaster is human right with Disaster Management Law substance*
- *To take measure on disaster risk alleviation together with the communities in vulnerable area ensuring independence in the vulnerable areas on external parties*
- *To prevent the new vulnerability and community's dependence in the vulnerable areas on external parties*
- *To integrate disaster risk management in development (especially for planning and budgeting) for community sustainable living in vulnerable area*
- *To integrate multi-hazard, multi-sector, multi-culture approach*
- *Participate in all programs*
- *Empowerment, not back to normal approach, should same threat repeat, to ensure no occurrence in similar disaster*
- *Not impairing present system, include local belief/tradition*
- *To establish local partnership (head of villages, local leader, woman, and teacher*
- *To give high priority for role of local community in coping capacity of disaster*
- *To emphasize involvement in community education progress*

3.3.1 Government role in CBDRM

Numerous government department/agency are already attempting to integrate community based disaster risk management in their policies. They are Home-Affair Agency, Social Agency, Energy and Mineral Resources Department, etc (UNESCAP, 2008). Their contributions to cope disaster risk reduction problems as below:

- Home-Affair Agency
  Civil Security (HANSIP) at *Kelurahan* level facilitates security and discipline services. This activity is often referred
- Social Agency
  Social Agency has important role in disaster risk management. One of organization formed is TAGANA (*Taruna Siaga Bencana*). TAGANA is proposed to handle disaster preparedness corps that emphasizes youth

involvement in community disaster risk components organization with an almost nationwide network.

- ❖ Energy and Mineral Resource Agency
  Energy and Mineral Resource Agency had formed a compulsory exercise/simulation of Merapi preparedness in Jogjakarta. This program is conducted in consegment with Forum Merapi, a stakeholder network in Mount Merapi area.
- ❖ Local government of DKI Jakarta
  DKI Jakarta local government develops flood management strengthening at Kelurahan level in order to manage flood and save live
- ❖ Local government of Kota Padang (Sumatera)
  Padang local government is very accommodative in involving community participation in both disaster management policy and local regulation.

The participation of government in disaster risk management in Indonesia is structured at Kelurahan level to Province level (see Figure 3.3).

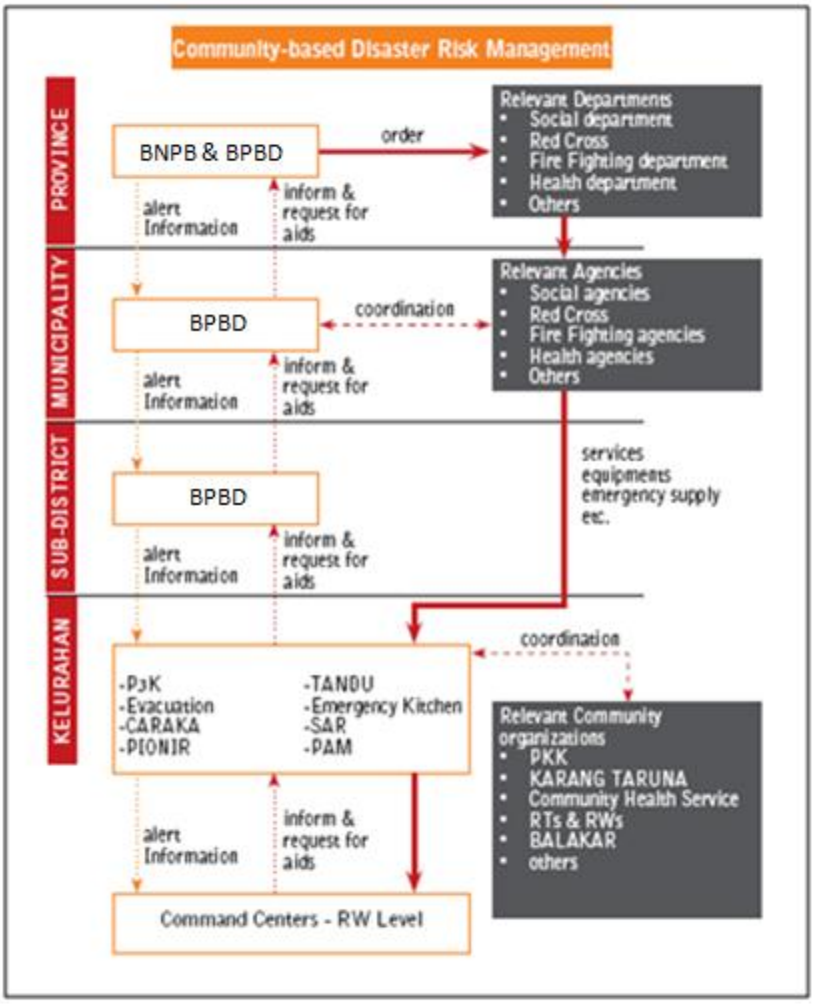


Figure 3.3 Community Based Disaster Risk Management (UNESCAP, 2008)

3.4 DISASTER LOGISTIC SYSTEM

Emergency logistic needs or humanity emergency needs can be defined as the process of procurement, distribution, maintenance, and replacement of material include water and sanitation, radio communication, and distribution process to reach warehouse. In emergency logistic management system is needed the role of several actors involved. According to Tabbara in his journal (2008) stated that the main logistic necessities that must be considered for refugees are:

- Rehabilitation of hospital and clinics
- Water and sanitation
- Distribution of medicine
- Health education
- Primary health centre for refugee centre

Caunhye (2011) stated the socio-economic planning in determining and building the emergency location becomes certain challenges and should consider important key:

- Additional uncertainties (Unusable routes, safety issues, changing facility capacity, and demand uncertainties)
- Complex communication and coordination (damage to communication lines, and civilians, inaccessibility in accurate real time demand of information)
- Harder to achieve efficient and timely delivery
- Limited resources often overwhelmed by the scale of the situation (supply, people, transportation capacity, fuel).

The result of The Council of Supply Chain Management Professionals, logistics management is a part of supply chain management that plans, implements, and controls the efficient and effective way flowing and storaging of goods, service, and relating the information between two points (storage and requirements).

According to Oktarina (2009) mentioned disaster management logistic can be defined as the several activities of procurement, storage, commodity delivery from origin point to destination point. Explanation of emergency logistic system can be described and classified in to three points based on the Figure 3.4 while Strucuture of Logistic System can be seen in Table 3.2:

- Supply points
  Supply points are such source points of logistic emergency commodities; Indonesian Red Cross (*Palang Merah Indonesia*), hospital, and some warehouses
- Transshipment point
  Transshipment points are such points both of demands point and supply points. If there is existence of commodities surplus, those commodities should be transported out to other supply points.
- Destination point
  Destination points are some points such as target points of refugee's necessities. For some disaster cases, destination points are places where disaster takes place.

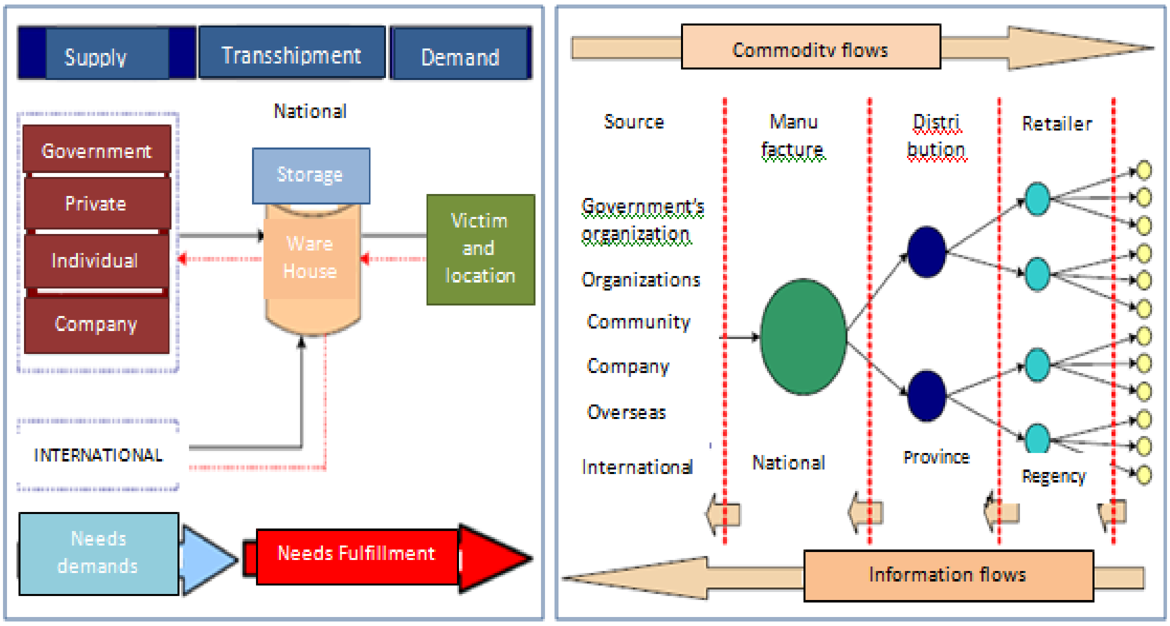


Figure 3.4 Disaster Logistic Management in Indonesia, (Oktarina, 2009)

Table 3.2 Structure of Disaster Logistic

No.	Structure of logistic for supply management	Structure of logistic for disaster management
1.	Soure	Contributor from domestic and overseas
2.	Manufacture	BNPB
3.	Distribution Centre	BPBD
4.	Retailer	Regional and local warehouse
5.	Consumer	Shelters (Refugees)

Source: (Oktarina, 2009)

In Indonesia, Disaster Management Logistic has been handling by governmental organization. Government who is responsible in handling disaster management is National Disaster Agency (BNPB). To do its task, this institutional is assisted by Regional Disaster Agency (BPBD) and others government institution at province and regency level. Management of emergency logistic warehouses system belongs to law regulation No. 13/2008 arranged by BNPB about *Pedoman Manajemen Logistik dan Peralatan Penanggulangan Bencana*. The regulation showed that logistic allocation of each warehouse has to consider the infrastructure support and effectiveness road network. In addition, management of logistic needs and equipment should be integrated in to several warehouses:

- Point input as point entering of logistic
- Central warehouse
- Regional warehouses
- Local warehouses

Journal of Logistic in context of *Disaster Management Training Program* written by Stephenson in 1993 described the transportation and goods flow supported from central-regional-local warehouse (see Figure 3.5). It is stated that the main logistic operation is to establish the operational equivalent of conveyer belts sequence; commodity delivery and using the most appropriate transportation vehicles. In addition, the typical flow of relief commodities is through a port of entry in to primary warehouse at or near the port or airport, transfer to a forward warehouse for holding, transfer to a terminal storage point and the last point deliver to consumer.

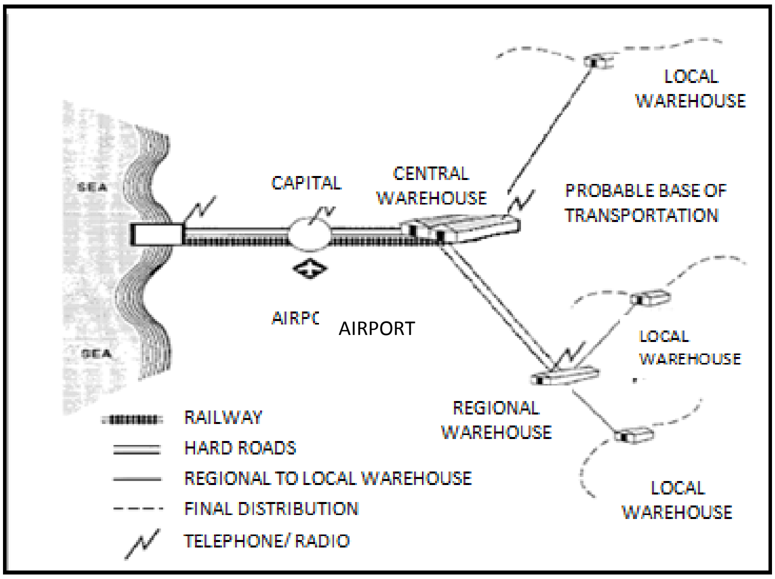


Figure 3.5 Main Components of Logistic System, (Stephenson, 1993)

Warehouse is a connecting link between produces and customer and where logistic system integrated parts. The function of warehouse is proposed to shape a system for all warehousing type shorting as well as freight shipment until the good delivery for goods storage during the production and delivery to customer period (Zidonis, 2002). Some key points are performed as such terminology below.

- Warehouse store all products and distribution centers
- Warehouse include more product maintenance operations
- Activity rate reduction is important in warehousing

As well as warehouse, distribution centre described how all warehouse interconnected each other. Some researcher and authors conclude that distribution center is virtually synonymous with the warehouse because it is also where most goods from different suppliers are collected for delivery to customer's temporary holding areas and or a distribution system. In distribution channels, warehouses are intermediate storage points between suppliers and to customers (refugees). The aspects of distribution centre are ranged into local, regional, national or international. The difference exist not only in names but also in meanings, scope of activity, criteria for evaluation or importance in the context of logistic system:

- Central warehouse (international and national distribution centre)
  A place integrated the operations of procuring goods (through land, sea, air transportation from international and national scale), storage, port, and customs.
- Regional warehouse (regional distribution centre)
  A place where logistic material (goods) transport out from central warehouse in order to fulfill logistic needs of refugees at municipality or regency level
- Local warehouse (local distribution centre)
  A last place of logistic warehouse where logistic material (goods) transport out from regional warehouse in order to fulfill logistic needs of refugees at sub district or villages level.

3.5 GEOGRAPHIC INFORMATION SYSTEM IN LOGISTIC SYSTEM

Accurately, logistic network consist of suppliers, warehouses, distribution centers, retail outlets, as well as raw materials, work in process inventory, and finished goods that flow between the facilities which are part from the network (Sarkar, 2007). Some key strategic decisions of logistic can be pointed as belows:

- ❖ Decision of the optimal number of warehouses
- ❖ Decision the location of each warehouse
- ❖ Decision of size for each warehouse
- ❖ Allocate space for product in each warehouse
- ❖ Determine which products need to transported and in what entities
- ❖ Determine the best routes for vehicle in transportation a network

Geographical Information System (GIS) has been widely used in logistics system during the past few years. One of important extension in GIS software which can obtain, store, and analyze data related to location is network analyst. Network analyst can dynamically model realistic network condition to a given data and cost attributes to analyze problems such as vehicle routing, closest facility and service area. Clearly, GIS can be applied for choosing sites, targeting marketing, planning distribution network, responding to emergencies that include the problem of geographical phenomenon (Sarkar, 2007).

3.6 EMERGENCY INDICATOR

UNHCR (United Nation High Commissioner for Refugees) on its Emergency Book had detailed described about Emergency Management in Disaster. UNHCR defined an emergency is a condition which may start with a sudden of refugees, with several thousand persons crossing a border causing a highly visible life in emergency and need emergency reponse immediately. Table 3.3 shows some indicators are measurable and commonly used as thresholds of an emergency needs.

Table 3.3 Indicator of Emergency Logistic

Indicator	Emergency Level
Mortality Rate	> 2 per 10,000 per day
Nutritional status of children	>10% with less than 80% weight of height
Food	<2100 calories/person/day
Water Quantity	<10 liters/person/day
Water Quality	>25% of people with diarrhea
Site space	<30 square meter per person (this figure does not include any garden space)
Shelter space	<3.5 square meter per person

Source : United Nation High Commissioner for Refugees (UNHCR)

Recently, Literature review about the activities and operational system during emergency period has been improving. Emergency logistic operation can be illustrated based on the Figure 3.6 in such a framework of disaster operations system and associated with facilities and logistic flows (Chaunye, 2012). Emergency logistics contents are able to classify in to two mains categories: facilities location of warehouse and transportation route.

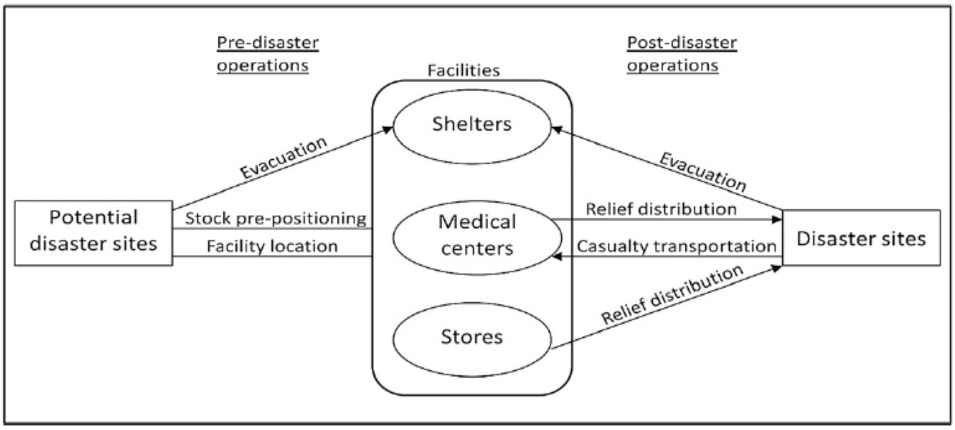


Figure 3.6 Emergency Logistics Contents, (Chaunye, 2012)

Figure 3.6 indicated the framework of emergency logistics activities that associated with facilities supporting and logistic flowing. In this illustration, evacuation deals with the flow of people, relief distribution deals with resources, and casualty transportation deals with wounded people. Non directional arrows do not indicate flows but rather express that a relationship exists between an activity and connected lines. For example, the existing of facility location actually is not a flow process, but it relates to the "placement of facilities" depending on various characteristic (demand size and location). Furthermore, Chaunye determined the emergency logistic operations. For each categories of emergency logistic operation can be described as the follows (Chaunye, 2012):

- **Facility Location**
  The optimization models in emergency disaster operations illustrated to combine the process of location with the stock pre-positioning, evacuation, and relief distribution. This model aims to combine strategic and operational planning in making decisions of emergency warehouse location. Detailed information of facility location can are grouped in a given points below
  a. Location evacuation
  b. Location with the relief distribution and stock pre-positioning
  Facilities are considered either shelters or warehouses. Location models are found to be associated with evacuation operations, stock pre-positioning, and relief distribution. Location models are also purposed to formulate maximal covering location frameworks that are covered by a required amount of stock.
- **Relief distribution and casualty transportation**
  Relief distribution concerns bringing relief of logistic necessities (medical supplies, shelters, manpower, sanitation, and other related resources) to people (shelters) whereas casualty transportation aims to bring wounded people to medical centers.
  a. Resource Allocation
  Resource allocation is such a source of logistic stock. Resource allocation models consider resource without determining flow quantities along arcs. The greater number of demands points, the harder it becomes to perform resource allocation without considering arc flows.

b. **Commodity flows**

Commodity flows deals with the problem of distributing commodities from distribution centers to disaster area. According to (Chaunye, 2012), logistic transported from depots to demands points in such objectives achieved: minimum total cost, minimum travel time, and maximum demand satisfaction. It also moves quantities of logistic stock across a network in the shortest time possible.

c. **Resource allocation and commodity flows**

Both resource allocation and commodity flows have to be considered for constructing logistic relief distribution. For multi-period models, consideration of commodity flow of decisions together with resource transportation is important factors. There were three important reasons to strength those points. First, consideration of activities can be carried out in different time periods on transportation modes and commodities. Second, it considers minimizing the sum of demands overtime to optimize response timeliness. Third reason, the use of split delivery of commodities, requires not only knowledge of commodities being transferred but also knowledge of vehicle capacity.

❖ **Other Operation**

Chaunye mentioned that, there are other emergency logistic operations considered in the literature. For example: schedule short-term lifeline rehabilitation during the critical relief distribution period following disaster; advocate a traffic control model to manage traffic of various types (casualty transportation and relief distribution) following an earthquake.

To analyze the actors who involved in emergency logistic system is important to know since many organizations has different agenda of disaster logistic management. In general, there were six actors' takes a part in management of emergency logistic system; donors, aid agencies, logistic providers, military, government, and other NGO's (Tabbara, 2008). The illustration of relationship among the actors can be presented in Figure 3.7

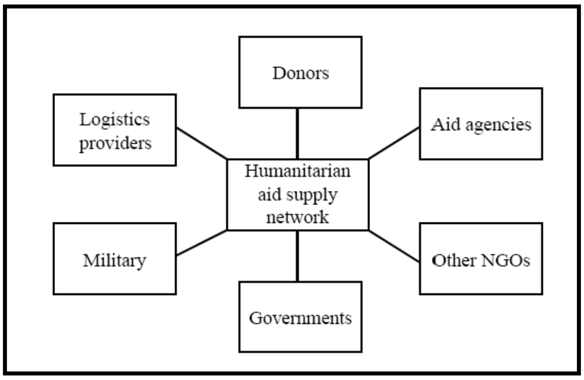
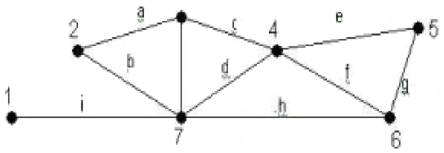


Figure 3.7 Actors in supply network of humanitarian aid, (Tabbara, 2008)

3.7 NETWORK ANALYST IN ARC.GIS

Arc.GIS Network Analyst deals connectivity model that representing real-world in to complex multimodal transportation networks. A real world phenomenon is showed by either one of two spatial models, vectors-based, or raster-based. Network analysis in GIS is often related to finding solutions to transportations problems become a network model. A network model described as a line graph, composed of linear channels links of flow and nodes presenting their connections (Figure 3.8). A network integrates form of edges (or arcs) connecting pairs of nodes (or vertices). Both of nodes and edges are segmented in to a road or a pipeline. A network is functioned as a real-world model, an edge and will be associated with a direction, impedance, resistance, and evan travel cost along the network (ESRI, 2010).



Node
1
2
7

Edge	From	To
a	2	3
b	7	2
i	1	7

Node	From	To	Impedance
7	i	i	1
7	i	h	0
6	g	f	5

Edge	Name	Type	Road Class	Speed Limit	...
a	Elms	Road	A	60	...
b	High	Street	B	30	...
					...
i	North	Avenue	A	40	...

Figure 3.8 Typical network graph and table structure, listing nodes, connectivity of edges, turn impedance and edge attribute data

Network analyst is an available Arc.GIS extension which dynamically modeled in different requirement; turn restriction, speed limits, height restriction, and traffic conditions. Analyst network application functions are commonly used in the case study of logistics warehouse. ESRI (2010), the using of Network Analyst was used to model logistics transportation, closest facility of warehouse, and the service area coverage of each warehouse since it deals with transportation planning and fleet vehicles. These methods should be constructed by creating a geo database network of roads, road length, and travel time. Example of using network analyst in warehouse case studies can be depicted in the Figure 3.9, 3.10, and 3.11.

- **Finding the optimum routes**
  This application can be applied to know the effective and efficient transportation routes to reach a location. Best routes means less cost and less time of transportation to reach destination points.

Figure 3.9 The using of optimum routes from reach one point to other points (ESRI, 2010)

Optimum routes can be generated with various data input for each road segments

- **Finding the closest facility**
  This application commands vehicles to find the closest public and infrastructures facilities. Examples of using this application are finding the closest schools, hospitals, market from residential houses in area, finding the closest hospital in accident place, etc.

Figure 3.10 The using of closest facility
(ESRI, 2010)

Closest facility aims to generate the closest alternative destination of one location

- **Finding service area**
  This application develops the using of service network cover a region in particular impedance. It can be formulated based on term of travel time, distance or other impedance of network.

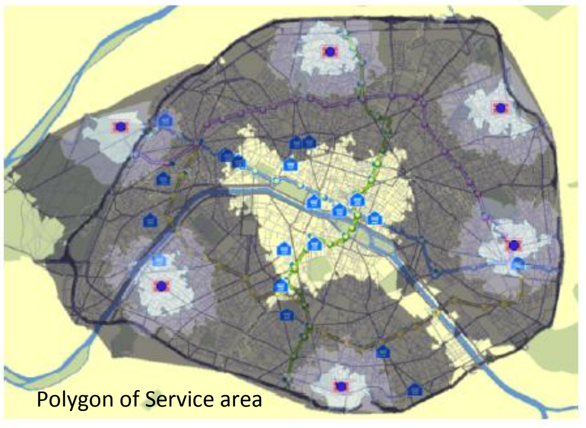


Figure 3.11 The using of service area
(ESRI, 2010)

Service area is conducted to coverage area based on travel time taken, could be inside coverage area and outside coverage area

3.8 LESSON LEARN AND COMPARISON LOGISTIC MANAGEMENT SYSTEM IN TSUNAMI ACEH

The earthquake and tsunami hit Aceh on 26 December 2004 had caused catastrophic destruction of Aceh city and some regencies; northern coastal area in Banda Aceh (Figure 3.12). It was one of the largest ever recorded and damaged many of concrete-framed buildings in Aceh. It approximately had destructed 6 districts (90% collapse buildings) and 60% (low and moderate collapse buildings) (see figure 3.12)

Figure 3.12 Condition of Banda Aceh in post tsunami disaster **(Tsunami Aceh Shelter Project, 2008)**

The impact of tsunami on 26 December 2004 remains visible even after 3 years

On that time, humanitarian emergency phase were handled by central government (*BAKORNAS PBP*) and local government (*Satkorlak* and *Satlak PBP*). Humanitarian emergency responses were also assisted by Indonesian National Army, Police, and severe stakeholders (LSM, International NGOs, BUMN, Private Company, Social organization and volunteer community). It became logistical challenges and foreign aid was limited to access affected disaster area since infrastructures damage and travel restriction resulting from ongoing conflict.

1) Evacuation Shelter

Evacuation Shelter in Aceh was proposed as semi permanent and permanent evacuation shelter. For temporary, it was called *Achinise* shelter (see Figure 3.13). It was composed and made by local timber and had thatched roofs. But recently, temporary shelter had renewed by using a concrete plinth and low brick walls, with a timbered superstructure built on top. For permanent shelter, it was planned approximately six weeks after the tsunami, a community and construction programme had built similar shelter to many families along coastal area in Aceh. Building of permanent evacuation shelter needed over 109.000 buildings to rebuild house and industries.

Figure 3.13 Temporary shelter built by local refugees **(Tsunami Aceh Shelter Project, 2008)**

Many people built their own shelter using reclaimed materials. They picked collapse building up to rebuild temporary shelter

Figure3.14 Settlement area for post tsunami disaster in Banda Aceh **(Tsunami Aceh Shelter Project, 2008)**

In the first weeks after tsunami, people found shelter in large collective tents (left), squatted buildings (right), tents, rented housing or with friend and family. The government built transitional living centres (centre).

Figure 3.15 (left). Permanent Shelter building in Sigli, Aceh (Tsunami Aceh Shelter Project, 2008)

Figure 3.16 (right). Brick material for building material (Tsunami Aceh Shelter Project, 2008)

Obtaining good quality building materials remained problematic. These bricks decayed rapidly in the rain

2) Logistic and Material
   The worst condition aftermath tsunami in Aceh caused disruption of logistic distribution. According to data reporting; roads, bridge, and drainage were severely damaged in some villages as soon as tsunami taken place. Therefore to build housing and to manage logistic program was quicker and more successful in non affected area from tsunami (Medan city). The effectiveness process of logistic delivery received by SATKORLAK and SATLAK PBP in Banda Aceh also had some troubles:
   1) Unavailable information system (number of victims, evacuation place, tsunami shelter and data of logistic material needed by refugees.
   2) Indistinctness of logistic delivery (through air, land, and sea transportation).
   3) Indistinctness of logistic delivery planning system in Aceh Barat, Aceh Jaya, Aceh Besar, and Banda Aceh
   4) Lack of coordination among local governments, organizations, and executor teams in tsunami disaster area
   5) Indistinctness of acceptance and distribution disaster logistic management system since lack of coordination and communication in providing number of logistic material from warehouse in Iskandar Muda and Blang Bintang airport. For this case, there were nothing record-keeping, list registries in accepting logistic material detail.

Figure 3.17 Road's condition after tsunami attacked Aceh (USAID, 2008)

Road shown two years after the tsunami. Access was initially difficult along much of the west coast of Aceh

Humanitarian emergency response was initially activity to provide and to build emergency tents and public kitchen. When emergency public infrastructures were immediately built, towards activity of humanitarian emergency response was belonging to distribute clean water and logistic needs for refugees. In handling humanitarian logistic system in Banda Aceh, there were numerous obstacles: 1) delaying of humanitarian logistic distribution, 2) lacking of humanitarian aids for refugees, 3) destruction of public infrastructures, 4) lacking of humanitarian device (transportation and communication), 5) lacking of natural resource and human resource. To accelerate logistic emergency response, some policies taken by government should do acceleration phases: 1) Cohesiveness operation among sectors to cope with earthquake and tsunami in Banda Aceh and North Sumatera, 2) Distribution food and medicines, 3) Refugees relocation, 4) Seeking for live and death victims, 5) Massive burial of death victims. Then these acceleration phases were integrated in to mechanism coping disaster of tsunami Aceh as explained below.

1) Emergency response phase
   Emergency response phase was used to rescue live victims and relocate them in to evacuation shelter (emergency tents and public buildings). After rescuing and relocating process, further it would be concentrated to provide humanitarian aids (food, clean water, clothes, blanket, and medicine). Government agencies who involved in supplying logistic needs in tsunami Aceh;
   - Social Agency (*Dinas Sosial*) had roles to supply food logistic needs
   - Health Agency (*Dinas Kesehatan*) had roles to supply medicine and health devices
   - Transportation and communication Agency (*Dinas Perhubungan*), Public Works Agency (*Dinas Pekerjaan Umum*), Regional developing and settlement Agency (*Dinas Permukiman dan Pengembangan Wilayah*) had role to supply public infrastructure for refugees likes supplying settlement and emergency hospital.
2) Physical and non Physical rehabilitation
   Physical and non physical rehabilitation aims to generate the coordination both local and central government and to do rehabilitation and reconstruction post tsunami disaster. Generally, coping tsunami disaster in Banda Aceh can be illustrated as the Table 3.4 below.

Table 3.4 Priority Program Post Tsunami Disaster in Aceh and North Sumatera

No.	Phases of Programs	Activities	Time Allocation	Finance Allocation
1.	Emergency response phase	Distribution of logistic needs (food, medicine, and housing)	27 December 2004 – 31 December 2005	1.35 billion rupiahs
2.	Second phase	Rehabilitation public infrastructure	December 2005-Juli 2006	1.35 billion rupiahs
3.	Third phase	Reconstruction	10-12 years	10 billion rupiahs

Source: (Mirza, 2008)

The effectiveness of logistic material distribution in disaster affected area depends on some crucial factors: 1) Logistic and medical equipment are focused in *Banda Aceh, Aceh Besar, and Aceh Barat* since many victims and refugees existed. This factor was important to clean area from collapse building, 2) Information, communication, and coordination factor. These factors were used as basis command to distribute logistic material in evacuation shelter and tents, 3) Volunteer were conducted and assisted in delivering logistic material, 4)Stability and security factors were such a supporting factor of logistic deliver, 5) central government, local government, and organization. The last factor influenced the national and local policies to make decision of logistic management system (see figure 3.18).

Humanitarian Logistic system for tsunami disaster 2004 was minimal preparation as well as many states in Asia. The impact of humanitarian logistic could have been more devastating if it would not be assisted by international sectors. One of international assistance deals with Tsunami Aceh came from USAID. USAID was like governmental aid agencies around the world, stepped into help rebuild disaster affected region. One of disaster framework formed by USAID was **Aceh Technical Assistance Recovery**

Project (A-TARP). Main goals of A-TARP were to establish both rehabilitation and reconstruction in many sectors included logistic distribution. This programme also had obstacles inc transporting logfisti since earthquake and tsunami exacerbated public infrastructure and the damage transport materials (bridge were out; roads were impassable; ports were unusable; and disaster destroyed trucks; barges; and small ships. Therefore the process of procuring, transporting, and storing logistic took long time. A-TRP roles in logistic management system can be described as the follows Table 3.5

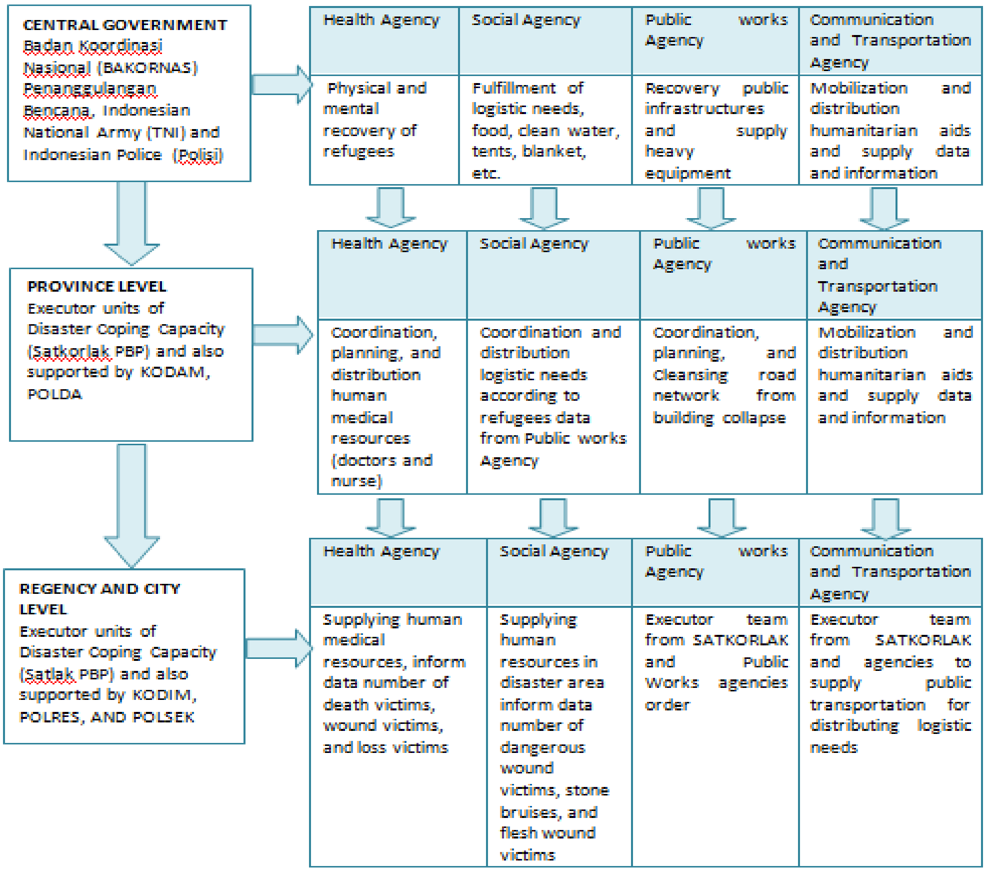


Figure 3.18 Logistic Management System of Tsunami Aceh 2004

Table 3.5 Logistic Management Program in Aceh

No.	A-TARP Framework	Implementation
1.	Provide recovery guidance program	- Ensuring NGOs and others working of the reconstruction program -Identifying where and when building materials needed to rebuild Aceh and Nias
2	Provide technical assistance in five major areas related to logistic	-Repairing ports, roads, and bridges -Transporting reconstruction materials -Logistic planning (procuring and storing building material) -Sourcing legal timber - Establishing priorities for port reconstruction was one of the first tasks at hand -Creating maps showing which roads and bridges were a priority to be accessed

CHAPTER 4. RESEARCH METHODOLOGY

This chapter explains the research design and method of research conducted by research workflow. The explanation starts with the research design and followed by data material (for both data available and data needed), how to develop the model of research, and techniques of analysis.

4.1 RESEARCH DESIGN

To simply this research, it was designed in to 6 phases; Preparation phase, Identification the suppliers of disaster logistic, Identification effective transportation routes of logistic delivery, Identification appropriate local warehouses, analysis, and Conclusion-Recommendation. The detail of research design is presented in Figure 4.1

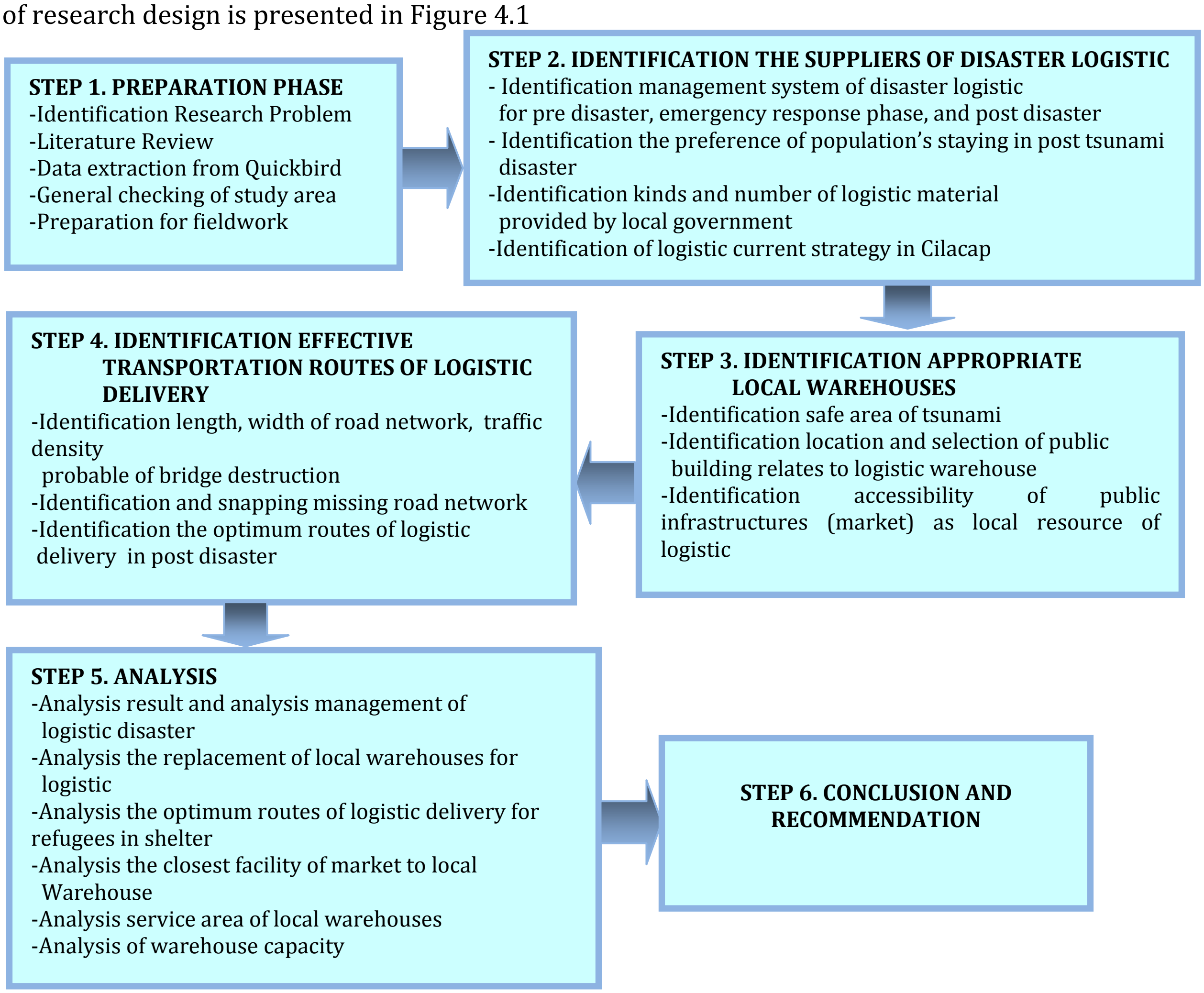


Figure 4.1 Research Design

4.2 DATA REQUIREMENTS

Data requirements of research in Table 4.1 were separated according to data availability and data needed. Classification of data availability and data needed aim to give the explanation about what kinds of data should be prepared before fieldwork and what kinds of data should be collected for fieldwork. The description of data requirement could be showed in Table 4.1

Table 4.1 Data requirements of Research

No.	Data requirements	Data type	Function	Source
Data Availability				
1.	Quickbird Image	Secondary data	To identify and interpret land use, land utilization, point coordinate, and road network	PSBA
2.	Rupabumi map	Secondary data	To get information; administrative boundary, toponimies, and road network	PSBA
3.	Length and width of road network	Secondary data	To know and identify length and width of road network in study area	Dinas Bina Marga Cilacap
4.	Tsunami disaster scenario	Secondary data	To extract tsunami inundation and vulnerability assessment	*Dr. Djati Mardiatno*
5.	Evacuation shelter	Primary data	To identify distribution Evacuation Shelter Building (ESB) in study area	*Ratna Sari Dewi BPBD*
6.	Land use data (shapefile)	Secondary data	To crosscheck change of land use data (combined with Quickbird and Rupabumi Map)	Bakosurtanal
Data Collected				
8.	GPS tracking for routes of transportation	Primary data	To obtaining travel time data (combined with Quickbird and Rupabumi Map)	Field work
9.	Coordinate location Facilities and public infrastructures (market)	Primary data	To identify and replace local warehouses based on the accessibility of facilities and public infrastructures	Field work
10.	Questionnaire (Interviewing Data)	Primary data	To know roles of local government in handling disaster logistic system in Cilacap	Fieldwork
11.	Types kinds and total of logistic material	Primary data	To know logistic material provided for disaster in Cilacap	BPBD
12.	Types vehicles for logistic delivery	Primary data	To know types vehicle used for logistic distribution	BPBD

4.3TOOLS

Tools were used to support process of data captured in field work. The following Table 4.2 would be classified the tools used as means of research;

Table 4.2 Tools of Research

No.	Equipments	Function
1.	Checklist	Notes for collecting data
2.	Global Positioning System	Plotting the coordinates and tracking
3.	Rupabumi Map	Guide for field work
4	Digital Camera	Capturing the picture during filed work
5.	Software a. ENVI and Arc.GIS b. Ms. Office	 GIS application Report writing

4.4 SAMPLING DESIGN

Sampling design of research was proposed to determine amount of samples local warehouses refers to spatial boundary in Cilacap Coastal Area. This research would focus on some district of region: North Cilacap, Central Cilacap, and South Cilacap. For local warehouses sampling, they were determined by using Villages level. The sampling belonged to all public building which had been existed in Cilacap districts which not include as tsunami shelter. While, for interviewing purposes, the number of respondent samplings were distributed in safe area from tsunami disaster (Sidakaya, Tegalkamulyan, Sidanegara, Gunung simping, Mertasinga, Kebonmanis, Tegalrejo, Gumilir, and Tambakreja villages). Each of villages was taken randomly 50 respondents since represent the homogenous data and time constraint (see Appendix 3).

4.5 FRAMEWORK DESIGN

Framework design of research was separated become pre fieldwork, field work, and post field work activities (see Figure 4.2).

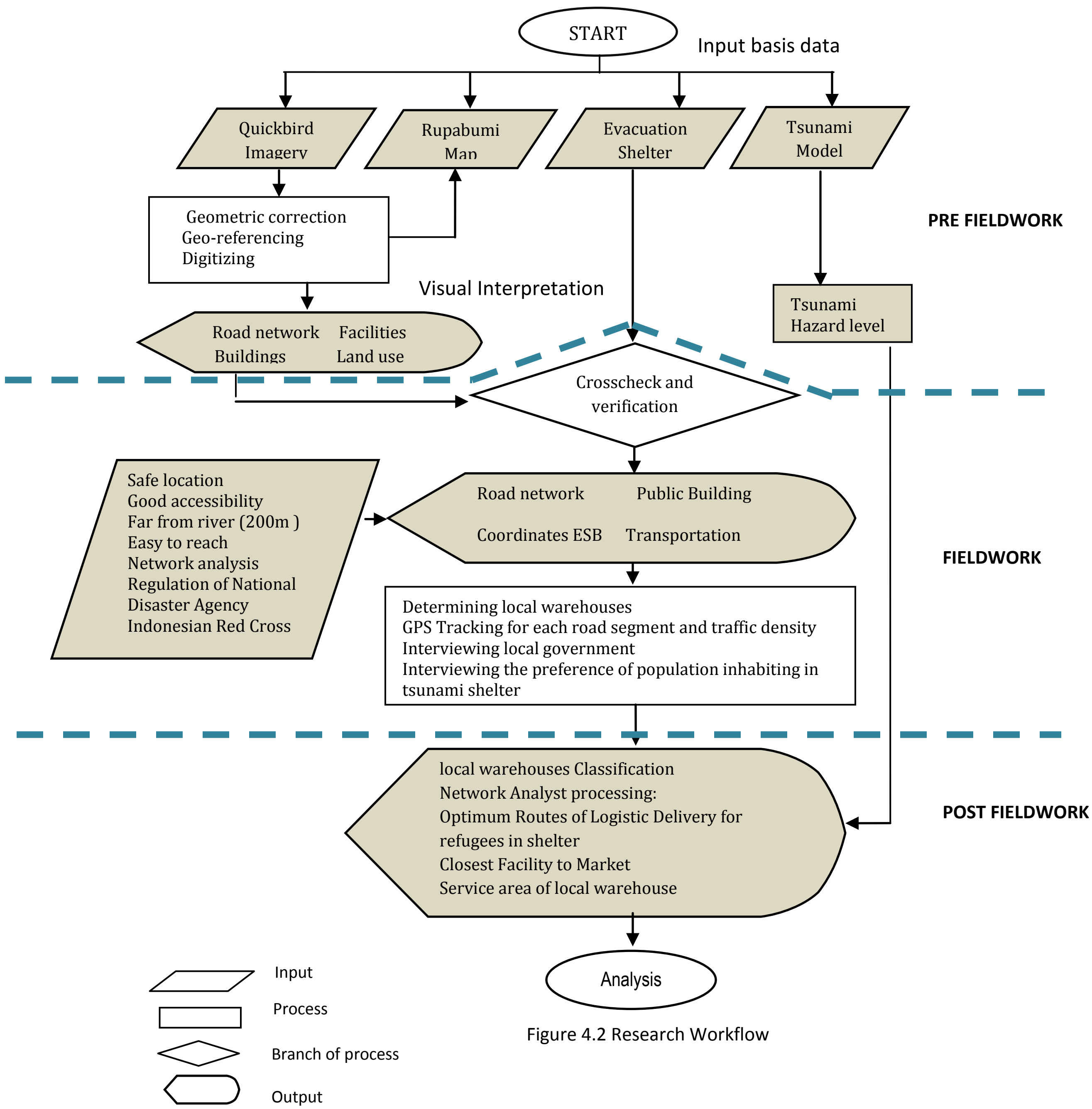


Figure 4.2 Research Workflow

4.6 PHASES OF RESEARCH

4.6.1 Pre Field Work

Pre field work activity was purposed to construct understanding of disaster logistic problem Cilacap. Pre field work also aimed to construct research objectives and research question to construct disaster logistic management system. Pre fieldwork consists of severe steps:

1. Identification of tsunami inundation area and safe area

Tsunami inundation had been developing by previous research by Mardiatno, 2008. This research also had mapped hazard map of tsunami in Cilacap district by using TUNAMI model. TUNAMI model is known since Fumihiko Imamura introduced comprehensive model tsunami in Japan through Disaster Control Research Centre (Tohoku University, Japan) (Mardiatno, 2008). TUNAMI model tried to analyze the tsunami source, tsunami propagation and tsunami inundation. However, information extracted from tsunami model aimed to know coverage safe area to construct logistic warehouse and transportation logistic routes.

2. Identification of public buildings used for local warehouses

As well as shelter, Public buildings were also used as local warehouse in emergency condition (Manual logistic of Indonesian Red Cross, 2007). Building map interpretation could be identified and extracted from Quickbird image (spatial resolution is approximately 0.6 meter). Th existing of public building could be mapped (see Figure 4.3)

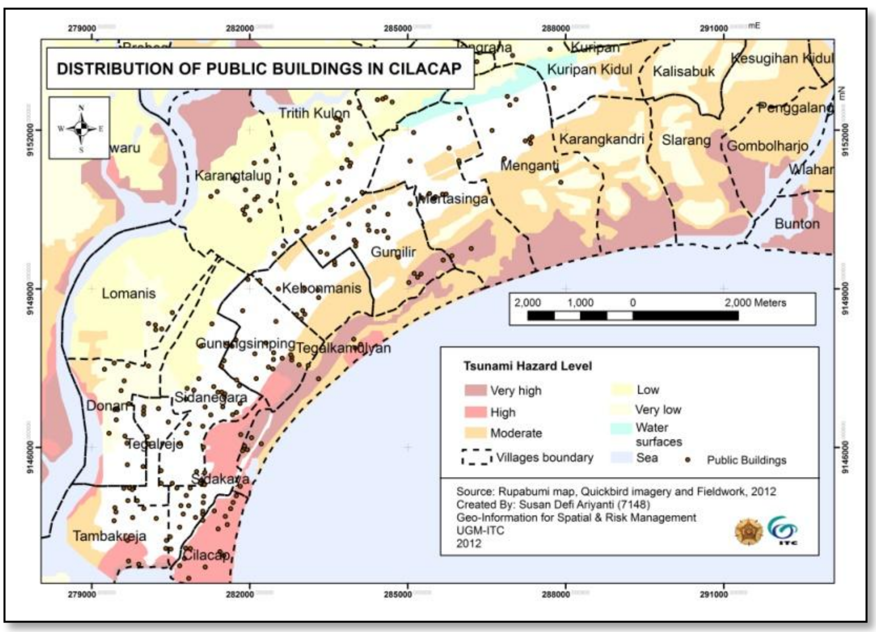


Figure 4.3 Existing of public building

Identification of public buildings could be recognized by doing interpretation of Quick bird image and fieldwork. The result of visual interpretation combined with fieldwork would generate valid and accurate information of public buildings map (school, office, factory, sport building, mosque, etc).

3. Identification road network database

Road network database was precious data needed to identify transportation routes. The existing road network database was derived from *Bakosurtanal* shapefile and *Dinas Bina Marga* JPEG. Road network interpretation obtained uses Quikcbird image and combined with topographic map. General process to adopt road network are:

a. Geometric correction with Ground Control Point (GCP) using Topographic Map of Cilacap
b. Overlaying the rectified image to road network database
c. Digitizing the missing and classifying road network database: travel time, length of road, width of road4.6.2 Field Work

4.6.2. Fieldwork

Principally, fieldwork takes the primary data needed in a research. In general, fieldwork is also used to check and to observe real condition of research area. For specific steps of field work phase can be explained as points below.

1. Interviewing government's agencies to manage of disaster logistic in Cilacap

The result government's institution interview purposed to depict the role of local government in executing the disaster management system. Some of government's institutions involved in disaster management in Cilacap are: BPBD (Disaster Agency), Social Agency, Health Agency, Indonesian Red Cross, which had its own role to coping disaster logistic distribution of disaster.

2. Identification, checking coordinate location, and GPS tracking of road network: Evacuation Shelter Building (ESB), traffic density, Public Infrastructures, Central warehouse, Regional warehouse, and Sample of local warehouses

Identification locations for those data had functioned to obtain distribution location of ESB, Central warehouse (BPBD), regional warehouses, local warehouses, and public infrastructures. Distribution for each location could generate and determine the accessibility to replace local warehouses and information of building specification of public building sample. Traffic density data was taken integrated in to GPS tarcking with all vehicles calculated during GPS tracking.

3. Building Assessment for local warehouses

Building assessment combined with building inventory purposed to identify appropriate place and location for determining local warehouses. Requirements for local warehouses have been mentioned severe criteria previous. From this phase, it could be predicted the existing buildings to replace as local warehouses and how many local warehouses for logistic should be replaced. In building assessment phase, fieldwork activity represented information of buildings location (points coordinates) and documentation. In Indonesia, the existing building could be used to replace regional and local warehouses. It is also stated that replacing regional and local warehouses could use public building (office, school, and mosque) in emergency condition. The using of public building was not only for evacuation shelter but could be also functioned as temporary logistic warehouses as emergency condition (FEMA, 2010). The method of building assessment of local warehouses could be seen in Figure 4.4

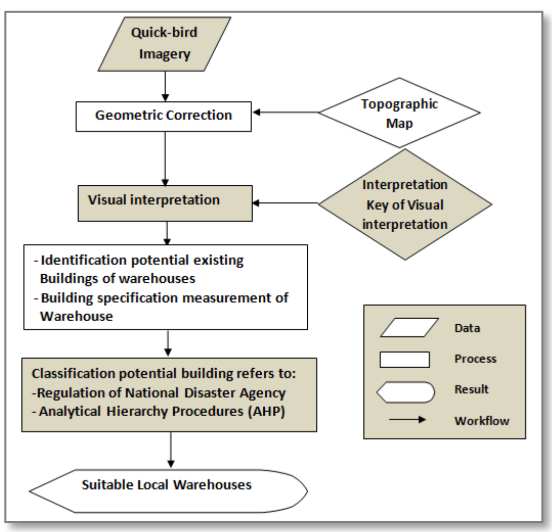


Figure 4.4 Building Assessment Method

These standards operational were issued by Indonesia Red Cross and National Disaster Agency (BNPB). The following list describes standard of logistic warehouses

1. **Indonesian Red Cross**

   Each building can be used as a warehouse of this depends on disaster situational and conditions related to disaster logistic decision. Specification of logistic warehouse according to Indonesian Red Cross in general:

   a. Sturdy building with a flat floor and hard
   b. Dry and enough ventilation and protected from animal,
   c. Equipped with fire fighting facilities
   d. Have easy access for truck and ease of logistic loading and unloading
   e. Safe from theft, door or gate can be locked
   f. Have electric lighting
   g. Easy access to airports and seaports
   h. Have insurance for the warehouse
   i. Have air conditioner (e.g, to save drugs)
   j. Have enough warehouse capacity, security
   k. Building specifications; the height of roof, floors, walls, etc (Manual Logistik Palang Merah Indonesia, 2007)

2. **National Disaster Agency (BNPB)**

   National Disaster Agency had issued the regulation and standard of logistic warehouses; building specification, facilities, and environmental specification of building conducted to *Pedoman Pergudangan Bencana* (see Table 4.3).

Table 4.3 Building Specification of Warehouse

Parameters	Specification
Building Specification	
Height of building	4.5 – 5 meter
Number of floor	1-2 floor
Floor material	Ceramics
Floor color	White
Wall material	Brick
Wall color	White
Height of wall	> 3 meter
Size of ventilation	1.5 X 0.5 meter
Size of door	2 X 5 meter
Facilities Specification	
Electricity	1250 watt
Water supply	PAM and ground water
Communication devices	Existing of telephone and facsimile
Office equipment	Computer and printer
Fire Extinguisher	Existing of Fire Extinguisher
Air conditioner	Existing of air conditioner
Smoke detector	Existing of smoke detector
Environmental Specification	
Condition of Temperature	25 °C - 30°C
Connectivity of rail access	Less than 60 minutes
Connectivity of air access	Less than 60 minutes

Source: Regulation of National Disaster Agency "Pedoman Pergudangan Bencana" (No.06/2009)

All of warehouse specifications above would be executed and integrated to local warehouses samples measurement and finaly using AHP (Analytical Hierarchical Process) method to classify the compatible local warehouse. Method of AHP was introduced by Saaty (2008) for decision making process.

The weighted of AHP could be determined based on the most influence factor which considered for warehouse To make a decision in an organized way to generate priorities decision should considerd some step: 1) Define the problem and kind knowledge sought, 2) Structure decision hierarchy from top up with the goal of decision 3) Construct a set a pairwise comparison metrics. 4) Use priorities obtaining comparison of priorities weight. The weight of warehouse building, weight of facility, weight of environmental condition could be shown in Table 4.4,Table 4.5, Table 4.6

Table 4.4 Weight of Warehouse Building Specification

Parameter and Classification	Weight	Parameter and Classification	Weight
Height of building a. <4.5 – 5 meter b. >4.5 – 5 meter	0.3 0.1 0.9	Wall color a. No white color b. White	0.02 0.4 0.6
Number of floor a. 1 floor b. ≥2 floor	0.2 0.2 0.8	Height of wall a. < 3 meter b. ≥3 meter	0.3 0.2 0.8
Floor material a. Wood b. Ceramics	0.26 0.2 0.8	Size of ventilation a. <1.5 x 0.5 meter b. ≥ 1.5 x 0.5 meter	0.015 0.2 0.8
Floor color a. No white color b. White	0.005 0.4 0.6	Size of door a. < 2 x 5 meter b. ≥ 2x5 meter	0.05 0.2 0.8
Wall material a. Wood b. Brick	0.15 0.2 0.8		

Table 4.5 Weight of Facility Warehouse Specification

Parameter and Classification	Weight	Parameter and Classification	Weights
Electricity a. < 1250 watt b. ≥ 1250 watt	0.3 0.3 0.7	Fire extinguisher a. Unavailability of fire extinguisher b. Availability of fire extinguisher	0.02 0.2 0.8
Water supply a. Unavailable (Water drinking company or groundwater) b. Available	0.1 0.2 0.8	Air conditioner a. Unavailability of air conditioner b. Unavailability of fire extinguisher	0.15 0.2 0.8
Communication devices a. Unavailability of telephone and facsimile b. Availability of computer and facsimile	0.065 0.2 0.8	Smoke detector a. Unavailability of air conditioner b. Availability of air conditioner	0.010 0.2 0.8
Office equipment a. Unavailability of computers and printers b. Availability of computers and printers	0.025 0.2 0.8		

Table 4.6 Weight of Environmetal Warehouse Specification

Parameter and Classification	Weight
Condition of air temperature a. Under or above 25˚C-30˚C b. 25˚C-30˚C	0.4 0.3 0.7
Connectivity of rail access a. >60 minutes b. ≤60 minutes	0.25 0.3 0.7
Connectivity of air access a. >60 minutes b. ≤60 minutes	0.20 0.3 0.7

Table 4.7 Total weight of logistic warehouses

Parameter and Classification	Weight
Building specification	0.65
Facility specification	0.20
Environmental specification	0.15

4. Identification of road network data

The existing data of road network both of Quickbird image and Rupabumi map had been changing due to city development in Cilacap City. This step purposes to add missing network and also to renew of road network change or removing road network that can not pass by truck (see Figure 4.6). Identification area of road network was adjusted with study area and building assessment in previous step (safe from tsunami). Some tools used in fieldwork activity covers; Global Positioning System (GPS), camera digital, printed Quickbird image and Rupabumi map. In general some following steps could be illustrated in Figure 4.5

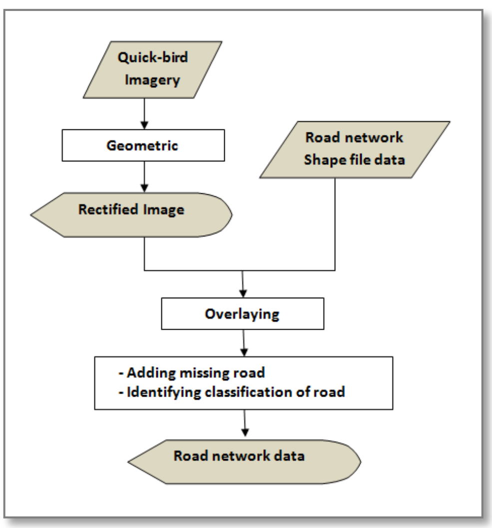


Figure 4.5 Road network assessment method

Figure 4.6 Additional road network data

5. Managing Capacity of Warehouse

Managing capacity warehouse was an essential factor considered to handle warehouse system. As good warehouse design, a warehouse should be able to store some kinds of raw material, port, goods inprocess, finished goods and between start point (point-of-origin) and consumption point (point-of consumption) and also supply information of status, condition, and disposition from stored items (Giri, 2009). The method of warehouses capacity and formulation conducted by Giri belonged to Figure 4.7 and table 4.8

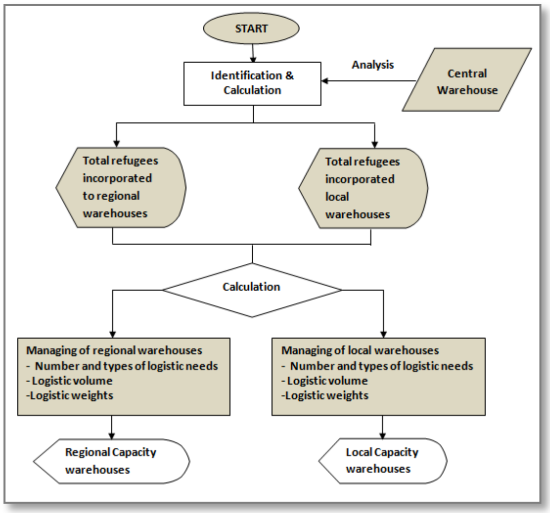


Figure 4.7 Managing Capacity of Warehouse

Table 4.8 Formulation of warehouse's Capacity

Managing Area Capacity of Warehouses	Formulation
FA	LW (ton) * LV (m3) + BS (%)/LV (m3)
US	70% * AB (m2)
SF	LV (m3) / LW (ton)
BF	(SF*100%)-100%
HC	(US*SF)/SF
SOR	LW (ton)*100%/AB (m2)

FA	=	Floor Area	SOR	=	Storage Occupancy Ratio
US	=	Usable Storage	LW	=	Logistic Weight
SF	=	Storage Factor	LV	=	Logistic Volume
BF	=	Broken Factor	BS	=	Broken Factor
HC	=	Holding Capacity	AB	=	Area of Building

6. Calculating Logistic Packaging, Logistic Weight, and Logistic Volume

Calculating Logistic Packaging, Logistic Weight, and Logistic Volume was conducted by Warehouse Information System prepared by BPBD Cilacap. This standardization could also used to calculate logistic warehouse capacity since consider parameter of weight and volume of logistic needs. For those variables, BPBD had decided some calculation according to Table 4.9, Table 4.10, Table 4.11

Table 4.9 Standard Calculation of Logistic Packaging

Type of Logistic Needs	Standard of Logistic Packaging
Food Logistic -Rice -Instant Noodle -Water drinking -Soya	 Total rice/3.64 kilograms/pack Total noodles/40 pieces/pack Total water drinking/19 liter/pack Total soya/ 0.135 liter/20/pack
Basic Needs -Clothes -Bed Cover -Praying uniforms -Socks -Bath Soap -Wash Soap -Tooth brush -Tooth paste	 Total clothes/30 pieces/pack Total bed cover/30 pieces/ pack Total praying unforms/30 pieces/pack Total socks/200 pieces/pack Total bath soap/200 pieces/pack Total wash soap/200 pieces/pack Total brush/200 pieces/pack Total paste/200 pieces/pack
Medical needs and equipment -Medicine boxes -Tent and mattress	 Total mecine boxes (had included packaging) Total tent and mattress (had included packaging)

Source : BPBD, 2012

Table 4.10 Standard Calculation of Logistic Volume

Type of Logistic Volume	Standard Packaging of Logistic Volume
Food Logistic -Rice -Instant Noodle -Water drinking -Soya	 1 packaging * 0.03 m3 1 packaging *0.03 m3 1 packaging *0.03 m3
Basic Needs -Clothes -Bed Cover -Praying uniforms -Socks -Bath Soap -Wash Soap -Tooth brush -Tooth paste	 1 packaging * 0.03 m3 1 packaging *0.03 m3 1 packaging *0.03 m3 1 packaging * 0.03 m3 1 packaging *0.03 m3 1 packaging *0.03 m3
Medical needs and equipment -Medicine boxes -Tent and mattress	 1 packaging * 0.05 m3 1 tent and mattress packaging * 0.14 m3

Source: BPBD, 2012

Table 4.11 Standard Calculation of Logistic Weight

Type of Logistic Needs	Standard Packaging of Logistic Weight
Food Logistic -Rice (had kilogram unit) -Instant Noodle (1 pack = 0.91 gram) -Water drinking (1 galon of waterdrinking 19 liter = 19 kilograms) -Soya (1 bottle of soya 135 ml = 0.62 gram)	 Total rice (packaging)*3.64 Total noodle (packaging)*3.64 Similar water drinking weight Total soya (packaging)*0.626
Basic Needs -Clothes (1 clothes = 0.25 gram) -Bed Cover (1 bed cover = 0.75 gram) -Praying uniforms (1 uniform = 0.25 gram) -Socks (1 pair of socks = 0.027 gram) -Bath Soap (had include gram unit) -Wash Soap (had include gram unit) -Tooth brush (1 item = 0.025 gram) -Tooth paste (1 item = 0.12 gram)	 Total clothes (packaging)*3.64 Total Bed cover (packaging)*3.64 Total Praying uniforms (packaging) *3.64 Total Socks (packaging)*3.64 Total Bath Soap (packaging)*3.64 Total Wash Soap (packaging)*3.64 Total Tooth brush (packaging)*3.64 Total paste (packaging)*3.64
Medical needs and equipment -Medicine boxes (1 medicine boxes = 1.3 kilogram) -Tent and mattress (1 tent and mattress = 1.5 kilogram)	 Total medicine boxes *1.3 Total tent and mattress *1.5

Source: BPBD, 2012

4.6.3 Post Field Work and Model Input Data

4.6.3.1 Post Fieldwork

Post field work was the last phase in a research. It would have focused on the data processing obtained from primary and secondary data. Post fieldwork would have generated the results such as;

1. Analysis result and management of logistic disaster in Cilacap
2. Analysis the replacement of local warehouses and warehouse capacity
3. Analysis result of optimum routes for logistic delivery
4. Conclusion and Recommendation

4.6.3.2 Model Input Data

4.6.3.2.1 Building Inventory

Building the sample inventory of public buildings was done by choosing public buildings scattered in the safe zone of the tsunami hazard and not a public building that had been used as tsunami shelters.

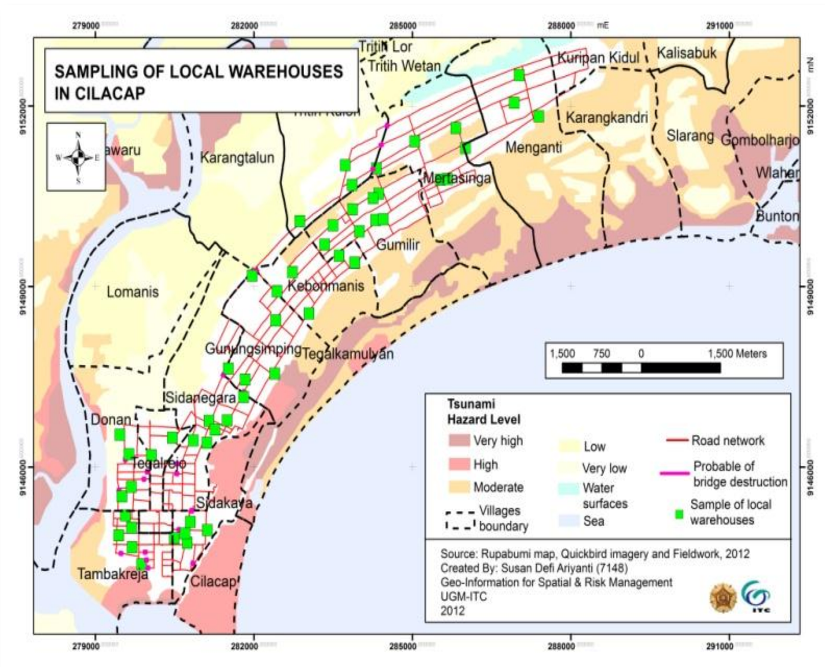


Figure 4.8 Number of public building samples

From all public buildings which totally 284 population, 47 samples were selected thoroughly and spread evenly from3 districts in Cilacap(Tambareja, Tegalrejo, Sidanegara, Gunungsimping, Kebonmanis, Gumilir, Mertasinga villages

4.6.3.2.2 Input road network dataset

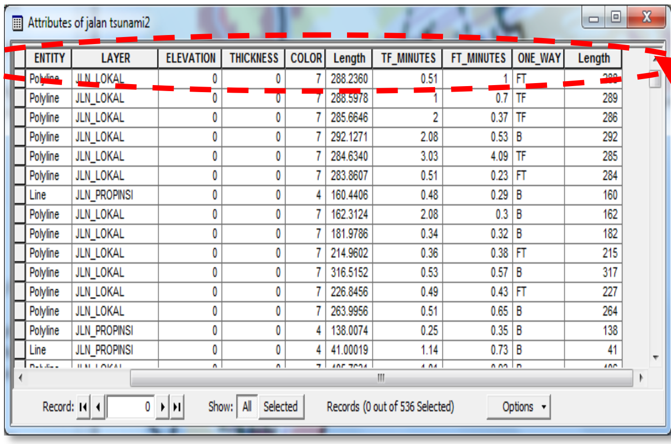
Input data of the road network focused on road transport routes were not inundated from the tsunami inundation and not destrucred by Earthquake since the seismic shaking was in low level. This tsunami inundation course would disrupt distribution logistics. In addition, selected data network was belonging to road network data that passed by trucks carrying logistics (width of the road at least> 2 meters).

Table 4.12 Road Classification

No	Road Width (meter)	Road Classes
1.	≤ 1.5	Pathway
2.	1.5 < x ≤ 4	Other Road
3.	4 < x ≤ 7	Local Road
4.	7 < x ≤ 11	Collector Road
5.	> 11	Arterial Road

Source: Dinas Bina Marga, 2012

Width of the road data were obtained from *Dinas Bina Marga* and fieldwork. From road network database, it informed road that may be passed by transportation vehicles; another way, local roads, provincial roads and national roads (see Table 4.12). In addition, other factor considered to road network database was the probable of bridges destruction since river is main channel of tsunami inundation and included as a barrier in the input data of the Network Analyst. Input each data conducted in building a network dataset (length of road, type of road, road width, TF FT Minutes and minutes) is executed for each road segment measurements.



Attributes of jalan tsunami2

ENTITY	LAYER	ELEVATION	THICKNESS	COLOR	Length	TF_MINUTES	FT_MINUTES	ONE_WAY	Length
Polyline	JLN_LOKAL	0	0	7	288.2360	0.51	1	FT	288
Polyline	JLN_LOKAL	0	0	7	288.5978	1	0.7	TF	289
Polyline	JLN_LOKAL	0	0	7	285.6646	2	0.37	TF	286
Polyline	JLN_LOKAL	0	0	7	292.1271	2.08	0.53	B	292
Polyline	JLN_LOKAL	0	0	7	284.6340	3.03	4.09	TF	285
Polyline	JLN_LOKAL	0	0	7	283.8607	0.51	0.23	FT	284
Line	JLN_PROPINSI	0	0	4	160.4406	0.48	0.29	B	160
Polyline	JLN_LOKAL	0	0	7	162.3124	2.08	0.3	B	162
Polyline	JLN_LOKAL	0	0	7	181.9786	0.34	0.32	B	182
Polyline	JLN_LOKAL	0	0	7	214.9602	0.36	0.38	FT	215
Polyline	JLN_LOKAL	0	0	7	316.5152	0.53	0.57	B	317
Polyline	JLN_LOKAL	0	0	7	226.8456	0.49	0.43	FT	227
Polyline	JLN_LOKAL	0	0	7	263.9956	0.51	0.65	B	264
Polyline	JLN_PROPINSI	0	0	4	138.0074	0.25	0.35	B	138
Line	JLN_PROPINSI	0	0	4	41.00019	1.14	0.73	B	41

Record: 0 Show: All Selected Records (0 out of 536 Selected) Options

Figure 4.9 Road network database of Network Analyst

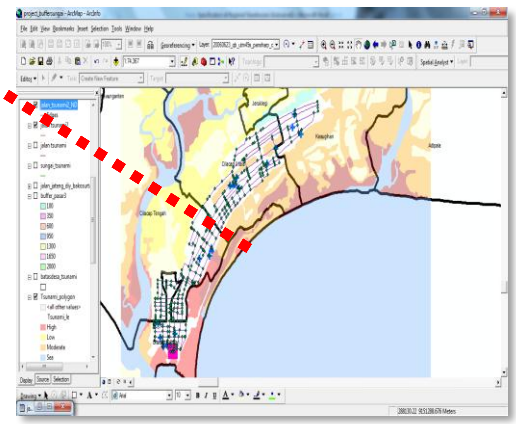


Figure 4.10 Map of road network segment

Both of Figure 4.9 and Figure 4.10 above described the attribute of road network dataset. Each of network variables was entered to road network dataset;

1. ENTITY field were automatically given by software. It described shapes of attribute data consisting: Polyline and line. Polyline informs multi lines of road whereas lines informs the singe road existing.
2. String field named LAYER contain information types of road which can be accessed by truck. They encompasses; other road, local road, province road, and national road.
3. Numeric column named ELEVATION, THICKNESS, and COLOR were automatic attribute information given in software. The elevation data was not included in the road network data. This is because elevation in Cilacap tends to be more flat while it does not describe the elevation difference obviously.
4. Numeric data of FT and TF minutes
   a. FT minutes indicated only one way permitting travel in road network digitizing
   b. TF minutes indicated only one way permitting against in road network digitizing
   c. B value indicates a street that permit travel in either condition

4.6.2.3.3 Closest Facility of Market

Data input of closest facility also used network datasets as well as previous road network dataset cretaed. Closest facility to Market was belonging to the fastest travel time in accessing local warehouse from public infrastructure (market) to closest local warehouse and from local warehouses to closest tsunami evacuation shelter. The attributes data of closest facility consisted of:

1. String field named Shape were automatically given by software. It contained the shape of spatial data used (polyline).
2. Facility ID field described information of ID number for each attribute data
3. Numeric field named Facility Rank contain information of number facility be able to accessed by others spatial data

4. NAME field described the name of routes and direction from facility to incident data
5. Numeric field named Incident described destination spatial data accessed from facility
6. Numeric field named Facility described source point of spatial data executed
7. Numeric field named Travel time describes the travel time data taken to reach incident point

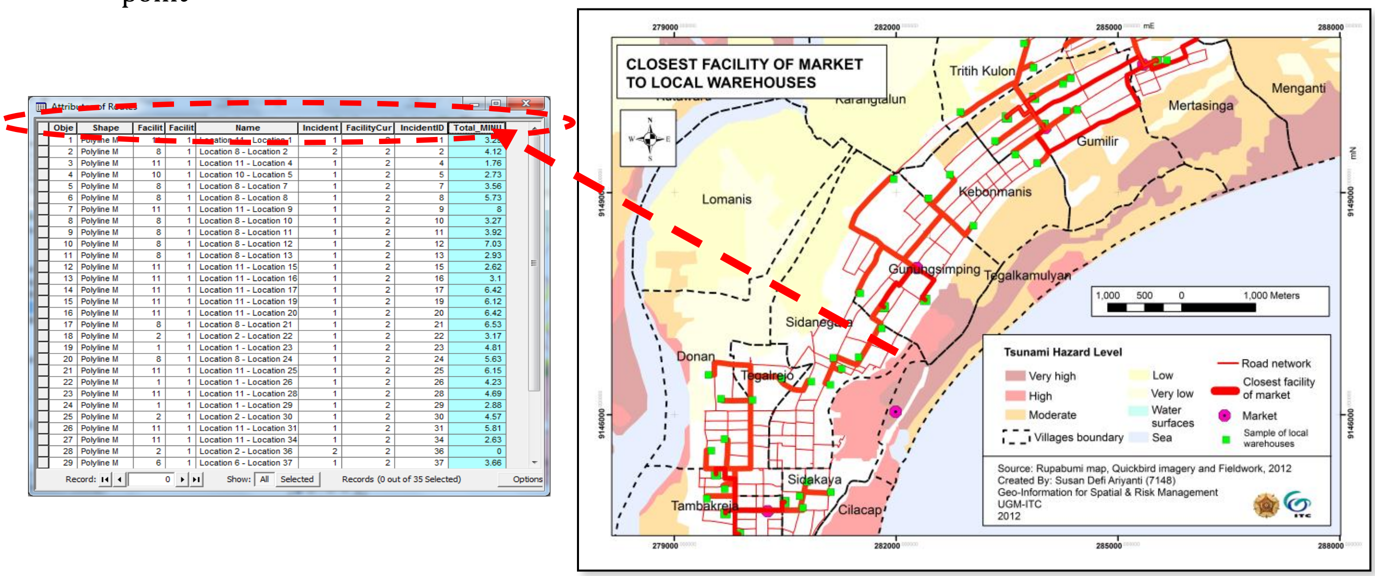


Figure 4.11 Closest facility of market-local warehouses

4.6.2.3.4 Service Area and Routes of local warehouse

Service area and warehouse optimum routes also utilized the attributes of network datasets. Assumptions used optimum routes and service area of local warehouse was also belonging to the fastest travel time, travel time, and length of road (see Figure 4.12).

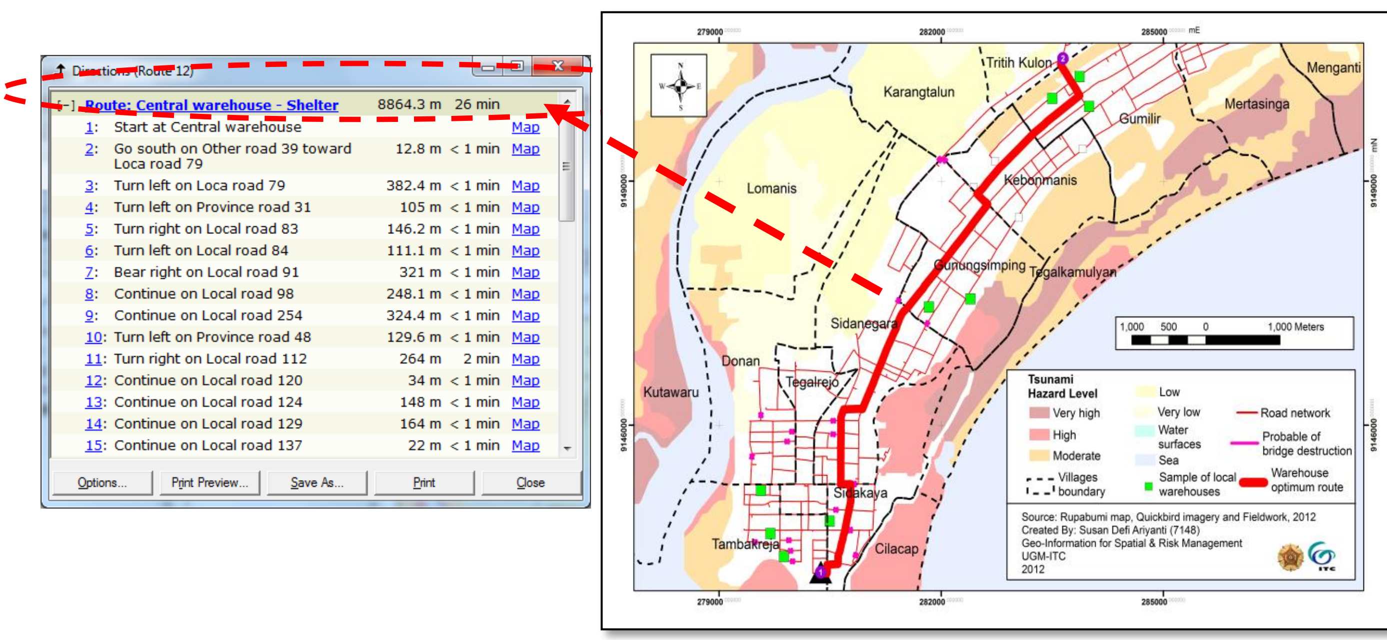


Figure 4.12 Warehouse optimum routes in Cilacap

4.7 Technique of Analysis

Technique analysis of research aimed to process data input. Technique analysis of this research will be described in to each of research objectives (see Table 4.13)

Table 4.13 Tachnuiqe of Analysis

Obj.	Research Question	Techniques Analysis	Expected Output
1	How the emergency logistic is being handled in Cilacap?	Descriptive analysis from interview of local government	Management system of logistic in Cilacap Regency
	Who will be suppliers of disaster emergency logistic needs in Cilacap?	Descriptive analysis from in depth interview of local government	The role of local supplier for logistic needs
2	Where is the location of central, regional, and local warehouses impacted by tsunami disaster in Cilacap Coastal Area?	Checking coordinates Digitizing on screen of Quick bird imagery Spatial sampling for all potential public building	Location of central-regional-local warehouse
	What are parameters considered to select public building as local warehouses and accessibility to public infrastructures (market) impacted by tsunami disaster in Cilacap?	Analytical Hierarchal Process (AHP) of building specification PMI and BNPB	Parameters and Public accessibility of local warehouse
	Where and how closest facility of market can be accessed in effective time, types of roads, length of road and probable of bridge destruction?	Closest facility and Service area of Network Analyst in Arc. GIS	Travel time, type of road, and length of road, probable of bridge destruction to access market
3	How many are local emergency logistic warehouses can be applied impacted by tsunami disaster in study area of Cilacap Coastal Area?	Descriptive analysis and combination of techniques analysis in second objective	Number of local warehouses in Cilacap Coastal Area
	What are kinds of logistic material needed by refugees in regional and local logistic warehouses?	Calculation of logistic needs based on number refugees in district and sub district (villages) level	Kinds and number of logistic needs both of regional and local warehouses
	How the capacity of regional and local warehouses to store logistic needs?	Calculation of Managing warehouse capacity formulation	Warehouse Capacity of regional and local warehouses
4	Where is the optimum route of logistic delivery according to travel time, traffic density, and type of road of central-regional warehouse-local warehouse?	Optimum route Descriptive analysis	Travel time, type of road, length of road, and the probable of bridge destruction of routes (central-regional-local warehouses)
	How are the comparisons of logistic optimum route from central warehouse to shelter only with logistic delivery from local warehouse-shelter based on travel time and type of road?	Optimum route Comparison analysis	Comparison logistic delivery with single central warehouse and local warehouse in effective time

CHAPTER 5. LOGISTIC SYSTEM MANAGEMENT OF LOCAL GOVERNMENT

This chapter explains logistic management system of disaster handled in Cilacap Regency. It will be more discussed in several parts: how logistic systems have been being handled in Cilacap, the suppliers of emergency logistic in Cilacap, management system of emergency logistic.

5.1LOGISTIC SYSTEM OF DISASTER HANDLED IN INDONESIA

Logistic system is one of things considered and prepared to face disaster. Logistic system also becomes one of framework prepared by both national disaster agency (BNPB) at national level and regional disaster agency (BPBD) at regency level. The requirements of logistic management system should fulfill several parts as follows.

- ❖ Supporting logistic and equipment needed in effective time, precise number, precise quality, and suitable for priority scale and standard of service.
- ❖ Transportation system needs improvisation and creativity in the field through land, sea, river, lake, and air.
- ❖ Distribution of logistic delivery and equipment needs specific distribution system (due to lack of transportation device, distribution events, and isolated of disaster location).
- ❖ Inventorizing, supplying, storing, distributing and even giving responsibility of logistic system
- ❖ Noticing dynamic of communitie's movement
- ❖ Coordinating the use of transportation
- ❖ Helpful effort of military, police, government agency, private and social institution, etc.

Disaster logistic system takes some role and parts based on administrative boundary as below.

A. National Level

Disaster logistic management system at national level is handled by *Badan Nasional Penanggulangan Bencana* (BNPB). This agency is coordinated in an organization or institution. All of BNPB institution should take its own roles in logistic management system according to regulation (pre disaster, emergency response, and post disaster). Every phase of disaster was also supported by government at province level, regency level, and other institutions. It means that every information flow of disaster can be informed to community using any media. National Disaster Agency (BNPB) also has responsibilities in coordinating and communicating of logistic material at national level (BNPB Regulation, 2008).

B. Province level

Disaster logistic management system at regional level (province and regency) is accommodated by Regional Disaster Agency (BPBD). This agency has responsibilities in handling and supplying logistic material and disaster equipment. It becomes one of primary points to supply logistic materials including information, verification, and evaluation in disaster area. Correlated with BNPB, Regional Disaster Agency (BPBD) supposed to cooperate and to confirm all component of organization (BNPB Regulation, 2008).

C. Regency Level

Disaster logistic management system and operational system is also managed by regional disaster agency (BPBD) since it handles and coordinates all activities of logistic management in both emergency response and recovery phases (BNPB Regulation, 2008).

5.2 SUPPLIERS OF DISASTER EMERGENCY LOGISTIC IN CILACAP

Cilacap regency is multi-disaster prone area. Multi-disaster probabilities occured in Cilacap comprise: earthquake (94 villages/19 sub district), tsunami (40 villages/9 sub district), landslide (91 villages/13 sub districts), flood (138 villages/22 sub districts), drought (79 villages/12 sub district), whirling wind (59 villages/17 sub district), fire (8 sub district), and technological disaster (3 sub district) (BPBD, 2012). To cope logistic material of disaster in Cilacap, many government agencies are involved in supplying logistic material of disaster as explanation below.

❖ **Regional Disaster Agency (BPBD)**

Regional Disaster Agency is a major government agency who has responsibility in coping disaster problem at regency level. This institution has been preparing and supplying the logistic needs in its own building named central warehouse since stock of logistic need from any agencies and local resources are also stored in central warehouse (Interviewing Result, 2012).

❖ **Social Agency *(Dinas Sosial)***

Social Agency also handled and supplied disaster logistic needs together with BPBD and other agencies. Before 2009, disaster management system had been handled only by Social Agency, but after 2009 it becomes primary task of National Disaster Agency. Referred to Decision letter issued by Social Agency, Social agency had formed a social group called PMK (*Penyandang Masalah Kesejahteraan Sosial*). This organization tries to solve social problem emerged during disaster. In addition, Social Agency has responsibilities to supply rice about 100 ton/year and severe food logistic (Interviewing Result, 2012). In general, the roles of Social Agency of disaster management are:

1. Supplying disaster logistic material is not only for natural disaster but also for social disaster.
2. Types of disaster logistic material supplied by Social Agency are rice, instant noodles, flour chips, bread, tents, clothes, *sarong*, blanket, mattress, boat, and kitchen equipments
3. Supplying financial aid for damaging and collapsing houses. The financial aid is given to disaster victims whose their houses damaged as much 1.500.000., rupiahs or building material
4. In pre disaster phase, Social Agency unionizes an association named as TAGANA (*Taruna Siaga Bencana*) with member about 100.000 persons.

❖ **Health Agency *(Dinas Kesehatan)***

Health Agency is one of government's institutions who deals public health problem. This institution consists of working level with specific task. Concerning with disaster logistic system, Health Agency of Cilacap also supplies medical requirements, death pocketed, professional doctor to assist injured and death victims. Those medical requirements are stocked from some hospitals once in a year (there were 4 main hospitals located in Cilacap to provide medical requirements. To do management disaster logistic, Health Agency is supported by *Unit Pelaksana Teknis* (UPT) so that disaster logistic management system is being easy to done. In addition, Health agency also held socialization of environmental health especially for disaster management in Cilacap. Health agency also formed organization of *"Pemuda Siap Siaga Bencana"* by giving them training every year. However, all program and activities done by "*Pemuda Siap Siaga Bencana" a*re being coordinated and evaluated by Environmental Health sector (Interviewing Result, 2012).

❖ **Indonesian Red Cross (*Palang Merah Indonesia*)**

Indonesian Red Cross, as social organization is function to supply medicine, blood donor activities for disaster victim. Supplying and using both medical requirement and medical treatment for refugees was done by medical team of Indonesian Red Cross in order to prevent more serious illness in post disaster (Interviewing Result, 2012).

5.3MANAGEMENT SYSTEM OF LOGISTIC (PRE DISASTER-EMERGENCY RESPONSE-POST DISASTER)

Recently, developing countries involves much intervention from any agencies in disaster management. As consequences, negotiation mainly roles influence factor dealing with disaster humanitarian aid for disaster. The implementation of humanitarian aid distribution aims to provide quick and extensive response since free distribution of humanitarian aid is important to prevent loss of lives and properties. The presence of logistic warehouse can be modeled using geographic information system (GIS) and remote sensing integrated with decision making process of Logistic Management System (Tong, 2000) (see figure 5.1)

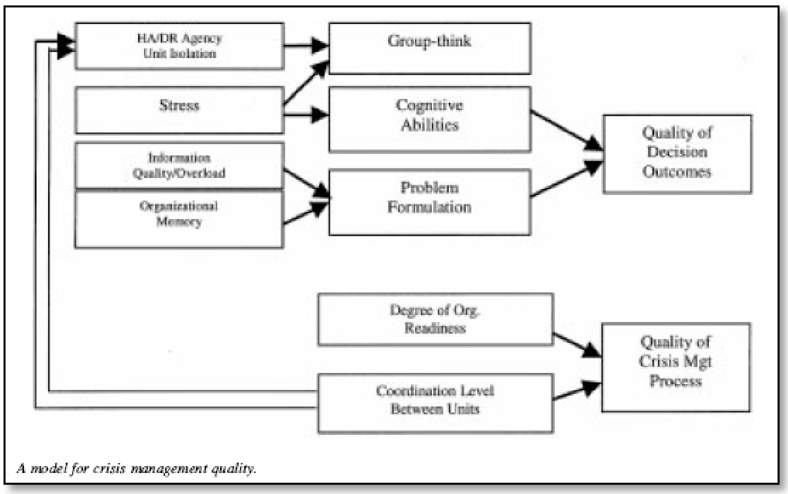


Figure 5.1 Process of Decision Making in Logistic Management System (Tong, 2000)

❖ Disaster Agency (BPBD)

Table 5.1 Logistic Management System of Region Disaster Agency (BPBD)

Pre Disaster	Emergency Response	Post Disaster
A. Designation Plan of logistic material and Equipment To Identify kinds, number, specification, time, and logistic arrangement To plan distribution Logistic material and equipment to regional and local warehouse warehouses **B. Supply of logistic material** To supply logistic material of BPBD can derived from local government, corporate world, and local community	**A. Distribution of logistic material and Equipment** To identify number of refugees, Time delivery,transportation To identify employee who distribute logistic material and employee of warehouse	**A. Monitoring and Evaluation of logistic Material** To Monitor of logistic distribution by external and internal government agency To supervise of logistic material and equipment for quantities and qualities after disaster To evaluate of logistic material and equipment: a. Number of villages receiver of logistic b. Kind and number of logistic c. Value of logistic material d. Utilization of logistic material

Source: Interviewing result, 2012

❖ Social Agency *(Dinas Sosial)*

Table 5.2 Logistic Management System of Social Agency

Pre Disaster	Emergency Response	Post Disaster
A. Identification of logistic requirements To identify kinds of logistic material needed, number of refugees, where and when to distribute logistic material in disaster area **B. Logistic Planning** To identify total number of population/refugees capacity To identify total number of logistic material needed To identify kind of logistic material (basic necessities, food, and housing) To identify step and time of logistic distribution	**A. Distribution of Logistic and Material** To distributing logistic material and equipment to warehouse and shelter To store and ro maintain of logistic material	**A.Monitoring and Reporting** To monitori of logistic material and equipment by internal and external government agencies

Source: Interviewing result, 2012

❖ Health Agency *(Dinas Kesehatan)*

Table 5.3 Logistic Management System of Helath Agency

Pre Disaster	Emergency Response	Post Disaster
To prepare and to supply facilities and medical goods; medicines, transportation, food and beverages To Prepare and to supply doctors and nurse	Rapid Health Assessment Public health service for refugees Mobilization of medical human sources	To evaluate medical logistic distribution To recapitulate medicines using during emergency response

Source: Interviewing result, 2012

❖ *Indonesian Red Cross*

Table 5.4 Logistic Management System of Indonesian Red Cross

Pre Disaster	Emergency Response	Post Disaster
To collect SATGANA member to coordinate disaster logistic delivery To prepare logistic delivery and transportation, personal, and team to accommodate management of logistic To prepare transportation devices and routes to deliver logistic from central warehouse, regional warehouse, and local warehouse	Rapid assessment of logistic delivery To coordinate of Internal sector of Indonesian Red Cross To distribute of logistic needs in disaster area To manage public kitchen in logistic distribution	To evaluate and to monitor disaster logistic system in Cilacap To report result of logistic system in Cilacap

Source: Interviewing result, 2012

Motivated by Tong in his research namely, *A Framework for Designing a Global Information Network for Multinational Humanitarian Assistance/Disaster Relief* depicts the similar strategies as well as the emergency condition in Cilacap; he also explained that the success of overall relief operation depends on the how the activities in these phases are carried out (see Table 5.5)

Table 5.5 Emergency Program in Research conducted by Tong

Pre Crisis Phase	Crisis Phase	Post Crisis Phase
To establish and to maintain close working relationship with other Humanitarian aids organizations To sstablish and to maintain chains of coordination with regional/national networks To foster common understanding of relief coordination policy To organize and manage the collection and to update of basic data on hazards and disaster To monitor disaster related information sources forearly warning purposes To fund raising from government/private sources	To mobilize resources To exchange information To coordinate assistance planning and operational resources via distribution network To disseminate requirements	To finalize reporting and evaluation To disseminate lesson learned To Propose adjustment of existing tools and procedures To facilitate the institutional handover transition activities

Source: Tong, 2000

There are many similarities between disaster management programs conducted by the local government Cilacap and research conducted by Tong. However, there is also a slight difference that can be compared in pre-disaster condition (condition). Cilacap is still less in coordinate with private sectors. All disaster managements are still centralized and controlled local government without involving private sector. Involving of private sector is considerable thing for local government in maximizing disaster managmenet logistic in Cilacap. In addition, Tong (2000) suggested taking into account some important points in decision making process of disaster emergency management as follows:

1. **Information and distortion**
   Information including data and activities are needed both in disaster prevention and response. Emergency situation of both technological and natural disasters should inform accurate time of the event since it is required to release response requirements. Sometime information is likely to be distorted when disaster take a place. The different information among agencies and humanitarian organization will appear a gap of disaster management. In other word, much information and less information will cause a bias for decision maker.
2. **Severity to international**
   Disaster will impact greatly to high dense population area and even settlements. And even many disasters cause injuries, hunger, also interruption of essential public service. The situation might escalate chaotic circumstances since disaster victim behave illogically (caused more destruction and loss of lives).
3. **Coordination complexity**
   During quick and massive responses are required, none single organization has sufficient resources to distribute in disaster effected area. But the involving of many agencies and organization in humanitarian aid operation often affected complex coordination. For example, Haiti's earthquake, there were approximately 400 organizations involved in disaster; supra-nationals, local governments, and military units. Unfortunately, the involving of multi agencies cause difficult coordination to be achieved.
4. **Information standardization needs**
   This information can be counted based on standard operational procedures of relocating affected people to shelter.

5. **Short vs. long term perspectives**
   There might be different coordination between short and long term perspectives among organizations. For example, one organization may be much more concerned about short term of rescue and while another may focus on long term infra structural development. Finally, it causes the loss coordination especially when short term humanitarian aid distribution disrupts with the long term reliance.
6. **Different in organizational cultural bureaucratic constraints**
   Many agencies and others organizations involved competition as human aid distribution. They compete to show their role and their own agenda in supporting logistic needs. It also causes numerous mistrusts, misinterpretation of fact, and incomplete information among disaster actors.
7. **Scarcity of resources**
   Scarcity of resources occurred if a disaster strikes carried out since no single organization or agencies has all the resources to alleviate the human misery and restore economic losses. Therefore resource allocation can lead and bargain among inter and intra agencies involved the existence of public infrastructure.
8. **Military intervention**
   Military service roles at three levels (strategic, operational, and tactical).

Those all information system is needed to construct the solution of disaster crisis, decision making of disaster relief (including logistic distribution).

According to interviewing result with relevant agencies, the points raised above have been considered in disaster logistic system in Cilacap. Information related to the management of logistic can be organized systematically. In BPBD (as central logistic warehouse in Cilacap) had already contained Warehouse Information System. The system contains informations about the amount and types of logistic needs, and timing of supply to be stocked. From that data bases, logistic operational can accumulate and well-documented example about when and what kinds of supply logistics must be distributed, who being responsible for receiving the supply logistics, and etc. By disaster information system, it can also reduce the distortion of information as described by Tong (Interviewing result, 2012).

During emergency phase, logistic needs should be optimized by local capabilities. As strategy of local government, Logistical International aid can be distributed directly to effected area of disaster through air and sea transportation or through central warehouse in order to manage logistic need well. According to *BPBD*, international humanitarian logistics' distribution depends on the conditions of after disaster. If it is impossible to distribute logistic needs by land transportation, both local and international aids are able to be distributed directly by sea or air transportation. To anticipate lack of resource's scarcity, local government orders traditional market as the major supplier of disaster logistic needs. This consideration had been parameter inputted to research (Interviewing result, 2012).

In addition, the preparation of disaster logistics in Cilacap belongs to in the short term of the government agencies. (Social Agency, Health Agency, and Indonesian Red Cross) had prepared program of logistics management for short-term disaster. Logistics management for long term is still under coordinated so that it caused difficult coordination and even overlapping with each other agencies (Tong 2000). Associated with long-term logistic management, the presence of Local logistic warehouse is still not observed to be considered at the village level. Problem finding of disaster logistic management system is how to incorporate disaster warehouse as a buffer stock of the closer place to deliver disaster needs from tsunami shelter. The role of the military in Cilacap is merely as volunteer of logistic operations disaster, but according to Tong, the military can prepare disaster logistics strategy. The involvement of the military activities in disaster logistics distribution in Cilacap is integrated with TAGANA member (recruited by Social Agency) (Interviewing result, 2012).

5.4 CURRENT STRATEGY OF LOGISTIC MANAGEMENT IN CILACAP REGENCY

Table 5.6 describes the general standards operational system in disaster response operations in Cilacap. Standard of disaster reduction was based approach to coping capacity of in Cilacap. Logistics management systems in Cilacap include the category of coping capacity plan. The table 5.6 identified framework of local government in terms of logistics warehouse management and transportation disasters.

Table 5.6 Current Strategy of Logistic Management in Cilacap

Activity	Activity Phase	Government Institution	Operational Institution
Coping disaster plan	Arrangement of Coping disaster plan (RPB), Disaster Reduction Action (PRB), disaster contingency, emergency operational Arrangement of vulnerability map, coastal management system, evacuation	BPBD	All institution
	Analysis of communication means, public work, settlement, culture and tourism related to disaster risk reduction	Bureau of Economic and Natural Resource	BAPPEDA, BPBD, PU, ESDM, Agricultural, BLH
	Analysis of industry, commerce, cooperation, agriculture, forestry, fishery, environmental, and invest financial capital to disaster risk reduction program	Bureau of maritime and fishery	BAPPEDA, BPBD, PU, ESDM, and related institution
	a. Supplying and preparing of basic needs minimal for three days after disaster (in emergency response phase) 1. Logistic: rice, clothing, kitchen, family kit, ship, tend, refugees camp etc. 2. Emergency disaster unit b. Arrangement warehouse both of permanent and temporary warehouses as buffer stock of logistic (involved village government), stock of logistic material c. Designing the probable public buildings as replacement of regional (district level and priority replace in district office) and local warehouse (villages level) d. Designing transportation routes during emergency condition (three days) 1. Central warehouse – Regional warehouse – Local warehouse (first scenario of logistic transportation route) 2. Regional warehouse – Local warehouse (second scenario of logistic transportation route) 3. Local warehouse – Shelters (third scenario of logistic transportation) e. Mapping disaster potency area	BPBD	BPBD, Social Agency, Health Agency, Public Works Agency
	Arrangement forestry and plantation framework, plantation zone, and action plan	Forestry agency	BAPPEDA
Disaster Risk Reduction	Arranging Disaster Risk Map, Disaster Information System, and Response disaster	BPBD	Social & Health agency
	Designing evacuation route		All institution
	Handling building and developing of building construction Socialization disaster risk reduction in school, hospital	PU, ESDM	PU, ESDM, local government
	Socialize disaster risk reduction in school	Education agency	BPBD, local government
	Socialize disaster risk reduction in hospital	Health agency	BPBD, local government
	Observing, warning, and safety in disaster area	Police	BPBD, PU
	Rehabilitation coastal plantation	BPBD	BPBD

Source: BPBD, 2012

CHAPTER 6. MANAGEMENT OF LOGISTIC WAREHOUSE

This chapter explains site selection of logistic warehouses (parameters considered to determine logistic warehouse, facility location of public infrastructures), Managing capacity of warehouse, Service area of local warehouse, and optimum routes of logistic warehouse in Cilacap Regency

6.1 SITE SELECTION OF REGIONAL AND LOCAL LOGISTIC WAREHOUSE

The model of disaster relief should consider uncertainty of warehouse location and relief distribution of supplier might be partially destroyed by disaster. However, the important point of logistic transportation attempts to minimize the total expected value; the variance of the total cost of the relief chain. Therefore, it is important to develop the logistical strategies to accelerate logistic distribution (Yi and Kumar 2007 after Amri 2011).

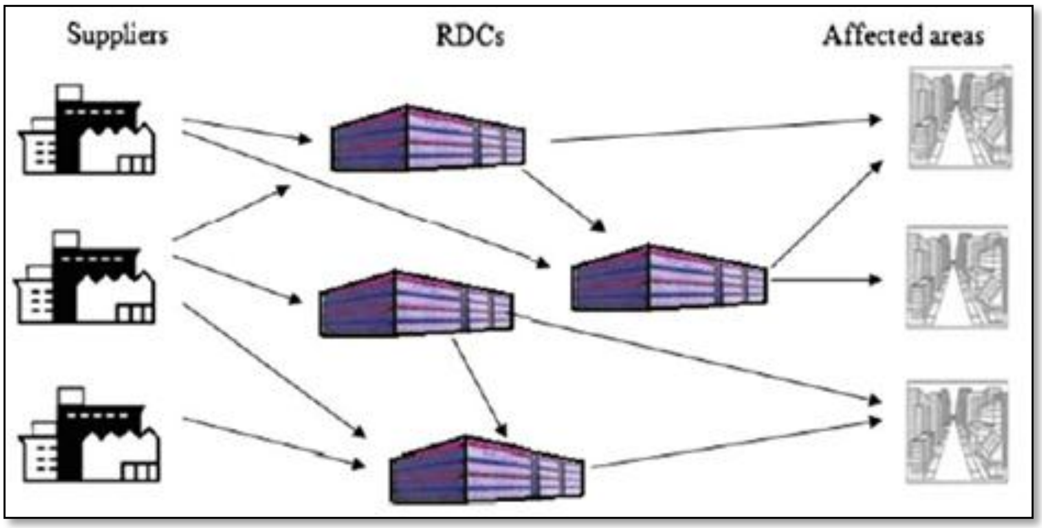


Figure 6.1 Distribution Disaster Logistic Needs (Amri, 2011)

According to general schema of disaster relief (see Figure 6.1), (Amri, 2011) constructed Relief Disaster Center (RDC) with the consideration below:

1. The logistical capability of Relief Disaster Center may be partially disrupted of disaster and effected to destruction road, and public infrastructures
2. Both demand and cost parameter level greatly depend on various factors; disaster scenario and impact of disaster
3. More than one of logistic's commodity must be delivered and with different volume and cost of procurement, storage, and transportation used
4. Logistic distribution should focus on obtaining the customer satisfaction (victims' demands) as much as possible.

Compared with the research of the tsunami warehouse in Cilacap, the availability of warehouse logistics is needed since many tsunami shelters are located in Cilacap. Amri (2011) stated that the placement of disaster relief may be on the affected area or safe area. It totally depends on the process of decision making of local government. However, in this study the placement of disaster logistics warehouse located in safe area from the tsunami in order to facilitate and to accelerate distribution of disaster logistics. From the schematic of distribution of disaster needs (see Figure 6.1), it can be seen that there was a distribution logistic disaster scenario designed in this study (only consisted of one buffer stock of logistic needs) named as Relief Disaster Center.

In this study Relief Disaster Center placement are strongly differentiated becomes district level (regional warehouses) and village levels (local warehouse). Figure 6.1 also indicates the model of disaster relief take suppliers in to account to his research. This research also consider the main supply of disaster logistic needs both from government agencies and public infrastructure; traditional markets. Disaster relief in Cilacap can be designed into a central warehouse, regional warehouses and local warehouses. Supported by interviewing with relevant government agencies; BPBD, Secretary of BPBD Cilacap says:

> *"Yes of course, we need saving place for logistic needs, we are as the local government has not fully focused in addressing disaster logistics warehousing. However, the placement of logistics warehouse and distribution both at the district and village level should be existed refer to disaster operational standard in Cilacap. We only had one logistic warehouse in BPBD and need to be adding in district and village level.*

Fredrich (2010) also has developed SYNTRADE model to evaluate warehouse location. This model used bounded-rationality logistics-network model. It mapped and optimized emergency logistic network for food retailing; the first one was the optimization of the warehouse structure (logistic network structure), including stratification (existence of central warehouse level), number of regional warehouses, location and allocation of scale point. The second one was the choice of alternatives, commodity flow, including delivery frequencies. Figure 6.2 showed all of warehouses in food retailing in Germany in real data and model results. The map showed the number of real logistic warehouse data was commonly different with the number of model logistic warehouse since the model considered algortim function.

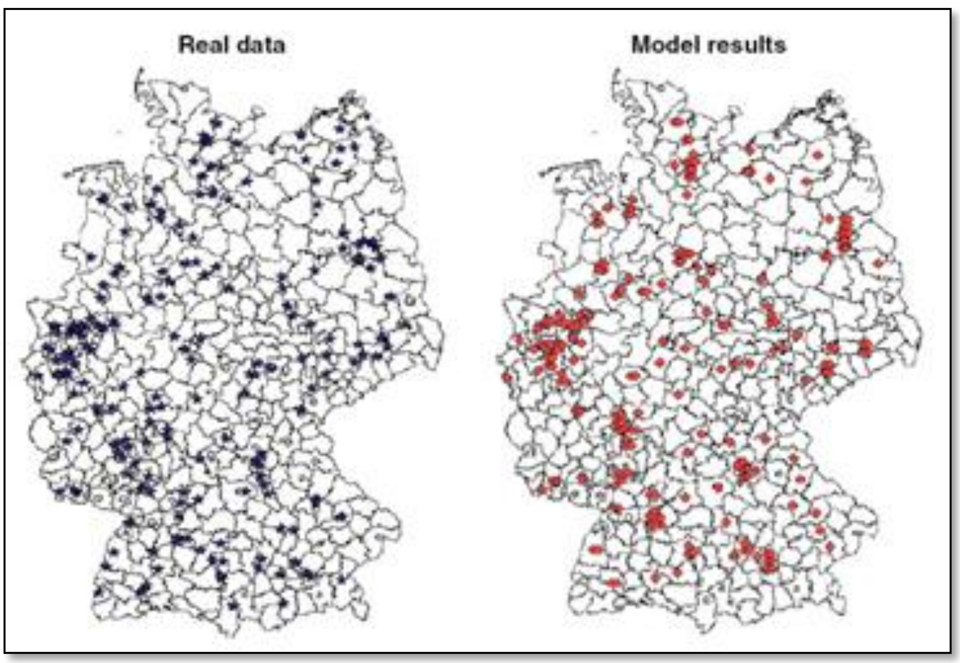


Figure 6.2 Warehouse Location: real location vs model result of SYNTRADE (Fredrich, 2010)

The model developed by Fredrich (2010), was conducted with the algoritm formulation and integrated them in to economic scale. Meanwhile, designing logistic warehouse in Cilacap was still organized by central coordination of local government. Meanwhile, there were similarities with the application of logistic warehouses conducted by Fredrich (2010) with the research conducted by researcher since the presence of logistic warehouse consisted of central warehouse, regional warehouse, and local warehouses. In addition, the logistic network in this research is derived in to micro, meso, and macro of tsunami logistic warehouse network. Briefly, logistic warehouses in Cilacap can be explained clearly as below.

1. Central warehouse

BPBD Cilacap as local governments which handle disaster has also provided a major warehouse as a supplier of disaster logistics needs. Warehouse has been being supplying with a wide range of both basic needs and equipment of disasters. Processes and working system management of logistic disaster needs in central warehouse include:

a. Acceptance of goods; includes types, quantity, quality of disaster logistic needs, and documents who is being responsible to receive and deliver logistic needs.
b. Storage of goods; logistic items stored in warehouse should be compatible to warehouse's capacity, supporting facilities, and adequate security system to protect them from damaging, lossing, and decreasing of quality standards.
c. Distribution system; goods should be distributed by using FEFO and FIFO principles. FEFO (First Expire First Out) is belonging to logistic distribution system since the aid that should be distributed out are those that almost expired while FIFO (First In First Out) is belonging to logistic distribution system since are the aid that should be distributed out are those that coming first out to warehouse. On the other words, FEFO stressed for food while the FIFO logistic emphsize on non-food logistic (Figure 6.3 and Figure 6.4)

Figure 6.3 FEFO logistic distribution

Figure 6.4 FIFO logistic distribution

2.Regional Logistic warehouse

Regional logistics warehouse is a warehouse that serves and fullfill the logistical needs of disaster at the district level. The source of logistic needs in regional warehouse came from central warehouse.

Placement regional logistics warehouses in the district are belonging to district office (north, central, and south) as quote from staff BPBD:

> "*I have also coordinated Cilacap district head to handle the logistics of disaster emergency. I asked them provide logistical storage in each district office as a regional warehouse. Warehouse at the regional level is expected to supply the logistical needs of refugees in the district level ".Replacement of logistics warehouse district office will make it easier to manage, distribute, and distribution, evaluate logistics of district government actors. I also thinking to supply of logistics warehouse in Cilacap because shelters have quite a lot in Cilacap mainly in densely populated South Cilacap where they need immediately logistic after tsunami disaster.''*

3. Local logistic warehouse

Selected public building of logistic warehouse considers the requirements of warehouse; safe from the tsunami hazard zoning, quite far from the river, selected roadnetwork passed by truck, close to public infrastructure. In this study, the selection of appropriate building to be used as warehouse logistics concentrated to be closer (shorter travel time) to public building market. This consideration are purposed to provide much more logistic needs with optimal result of logistic distribution.From measurement of building samples and proximity to closest facility (market), there are13 local warehouse tend to be used as temporary disaster warehouse. These buildings are decided as local warehouse by observing the requirements of warehouse:

1. **Factor of tsunami hazard zoning**

Central logistic warehouse, regional warehouse and local warehouses should be located in safe area from tsunami hazard area (very low of tsunami hazard) (see Figure 6.5). However tsunami hazard areas will hampeer the distribution of logistic because of destruction of road network, bridge, collapsing building. Of the total samples of buildings, the selcted buildings are located in safe area from tsunami hazard area

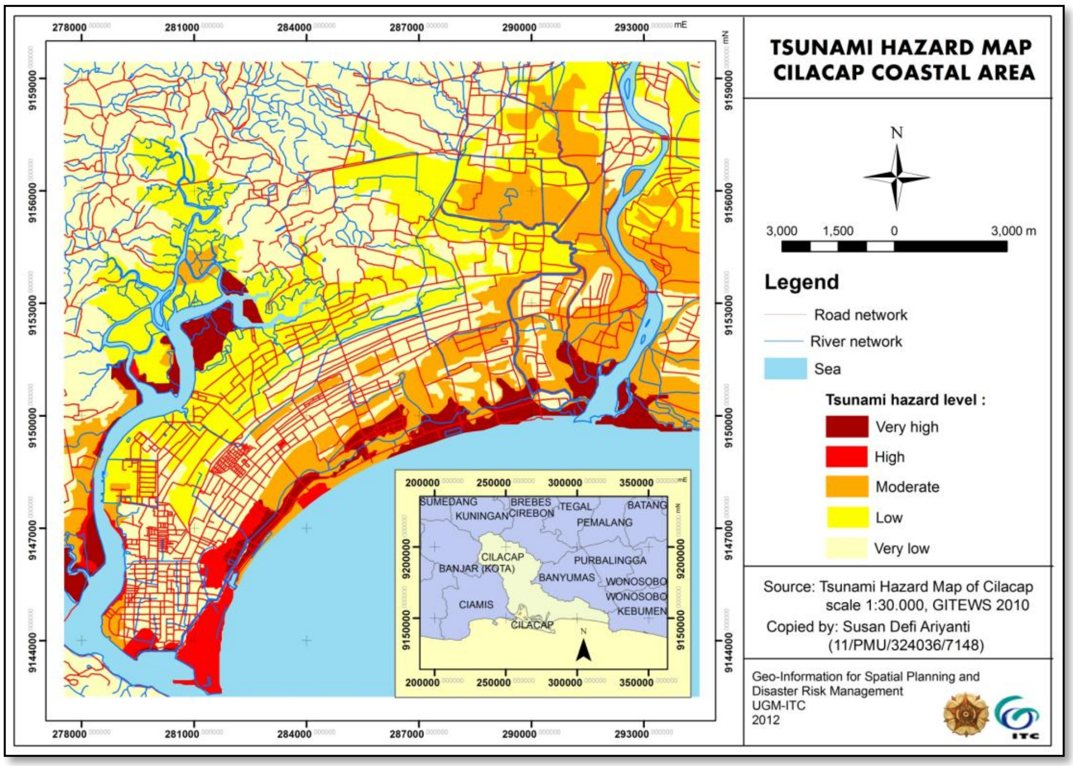


Figure 6.5 Tsunami Hazard Map in Cilacap Coastal Area

2. **The distance from a river bank**

The presence of Cilacap's river becomes a constraint fo disaster logistic distribution since it can overflow to surrounding area when tsunami occurred. It can also destruct bridge and road and even disturb logistic distribution flow. The map of river overflow shows the probability of river to inundate using mutiple buffer method in Arc.GIS as well as sows in Figure 6.6

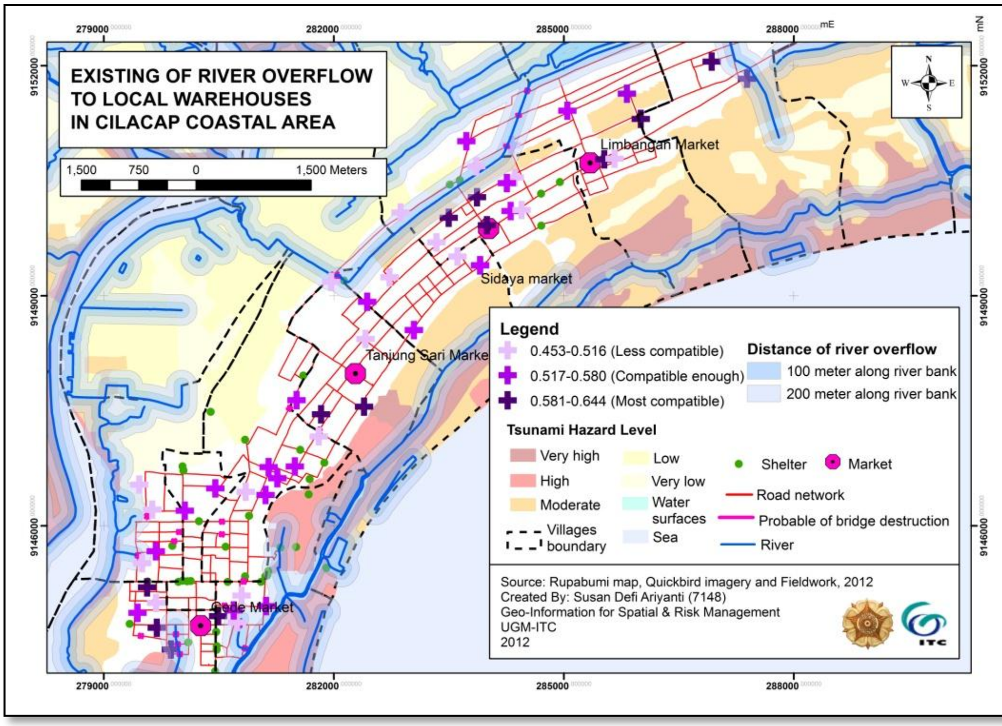


Figure 6.6 Existing of River overlandflow in Cilacap Coastal Area (Data Processing, 2012)

These maps in Figure 6.6 are informed that the position of local warehouses belonging to the overflowing river zone. Among warehouse samples, there are 6 local warehouses within 200 meters of the river and those warehouses are belonging to the less suitable category for local warehouse. In addition local warehouse at Tambakreja office in South cilacap is not reccomendated well as local logistic warehouse since it located close to river.

3. Building Specification

a. Height of building and wall

The height of buildings is an important factor in determining the capacity of the goods' storage. The higher the building or wall, the greater the storage capacity of warehouse logistics since it provide more space to store logistic needs. From warehouse's sample, generally, they have sufficient height to store logistic needs

b. Number and material of floor

As well as building height, number of floors also determines the capacity of the building to store logistic aid. The more the number of floors, the greater the power tamping logistic.In addition, the floor of the warehouse as a horizontal basis material that should have a solid structure to ensure the stability of the logistic stuff on it

c. Wall material and wall color

Wall material highly recommended for storage is a material made of brick. That building materials are highly recommended and aim to keep logistic goods from the weather, moisture, and bacteria. Meanwhile, the wall color of warehouse should be bright white and will enhance the lighting in the warehouse logistics.

d. Size ventilation and door

Factor of warehouse's ventilation is functioned to keep the air circulation inside warehouse. In ventilation standard, good ventilation of warehouse is made of wood and fitted with iron bars and safe from the criminal action. Meanwhile, doors of logistic warehouse have to ensure that logistic materials can be stored safely. Warehouse door should have a balanced force between the length and height so that the logistic loading process in warehouse becomes easier and faster.

4. **Specifications of building facilities**
   The building which used as a warehouse should be equipped with facilities such as electricity, water, communications and office facilities, fire extinguishers, air conditioning, and a smoke detector. All of those equipments are intended to maximize the storage and maintenance of logistics needs since food logistic and medicine need specific maintenance.
5. **Specification of environmental factors around the warehouse**
   Environmental factors are an important factor determining the selection and location of disaster logistic warehouse. The environmental condition around the disaster logistic warehouse has to be supported by supporting factors, such as:
   a. **Temperature and air pollution factor**
   In general, the environmental condition of logistics warehouse is supported by free influence of air and water pollution and has a temperature that is not too cold and not too hot. Effect of temperature and environmental pollution will obviously reduce the quality of goods.
   b. **Accessibility to public facilities (markets, stations, airports), transportation (truck)**
   The position of asset and public infrastructure can be supporting factor as well as barrier factor for logistic supplier, it really depends on an additional investment and also disaster preparedness before the event occurs. Accessibility of rail and air transportion is absolutely necessary at the time of disaster emergency. Both of that accessibility is allowed to supply logistic transportation relief from domestic and international aid. In general, warehouse building that those are compatible for logistic warehouse in Cilacap can access public facilities less than 60 minutes. This condition will support to distribute logistic aids in a shorter time and lower cost of distribution.

Linked to Ozdamar (2011), he tried to describe the accessibility of hospital to his research's variables in to disaster relief distribution. Logistic supplies were stocked at various airports, sea ports, and at warehouses near two central train stations. It had 8 warehouses (see Figure 6.8). Replacement of hospitals as the variables to relief disaster was considered since most of those hospitals were located in safer location from earthquake's epicentrum while hospitals were not replaced as the shelters. Ozdamar (2011) also included ten major state hospitals in the relief network and represented the hospitals cluster, bed capacities of earthquake's victims.

From the list of Hospitals and list of disaster warehouses in Turkey (see Figure 6.8), the accessibility to hospitals were essential factor to distinguish the location of warehouses. In that case, all of those hospitals should suplly logistic need for all warehouses. If compared to this research, the accessibility to public infrastructure is strongly focused on the existence of market since markets are located in safe area from tsunami hazard. In addition, market can also be local supplier of logistic warehouses in Cilacap. Researcher did not consider the existence of hospital as well as Ozdamar did because most of medical need in Cilacap also prepared by BPBD and health agency (health agency in Cilacap had stored medical tools on its warehouse). In addition, the medical logistic is not only prepared by local hospitals but also supplied by Indonesian Red Cross and national humanitarian aid.

Figure 6.7 Logistic transportation type 1

Figure 6.8 Logistic transportation type 2

Figure 6.9 Logistic transportationtype 3

c. Roads quality and the posiibility of damaging bridge

Roads and bridges quality are the most important factor in distributing humanitarian aids. The better quality roads and bridge the faster travel time to deliver logistic needs. In this study, the selected route should be safe from tsunami hazard and should avoid possible damaging bridge. In general, the condition of roads in Cilacap were very good for every types of road (see Figure 6.12, 6.13, 6.14, 6.15)

Figure 6.10 Province road type

Figure 6.11 Local road type

Figure 6.12 Other road type

Figure 6.13 National road type

d. Accessibility logistic warehouse to Market

Accessibility warehouse to the market was also a supporting factor of warehouse building selection. Market as local suppliers are much used as a logistic's backup (all of logistic needs) when suddenly warehouse is lack of logistic supply. Market presence in Cilacap can be illustrated in Figure 6.17, 6.18, 6.19, and 6.20.

Figure 6.14 Limbangan market (North Cilacap)

Figure 6.15 Gede market (South Cilacap)

Figure 6.16 Tanjung Sari Market (Central Cilacap)

Figure 6.17 Sidaya Market (North Cilacap)

6. **Relation of warehouse specification and accessibility to markets.**

Based on the calculation and comparison charts of all building samples measured (see Figure 6.23, 6.24, 6.25, 6.26), there were approximately 13 buildings that can serve as a local logistics warehouse in Cilacap. Distribution of local warehouses scattered in some districts; 4 warehouses located in the District of South Cilacap, 5 local warehouses located in the District Central Cilacap, and 4 local warehouses located in the District of North Cilacap. Those buildings are considered as logistics warehouse (buffer stock of logistic needs for tsunami shelters) in an emergency situation since those buildings have facilities, supproting condition of environment, and warehouse building specification (see Figure 6.21). However from 13 warehouses (see Table 6.1,6.2,6.3), the two local warehouses located in North Cilacap and one local warehouse in South Cilacap is not used since it is quite far (take long travel time accessed) from warehouse eventhough, they are such kind of local warehouse (based on classification's class of warehouse's criteria and market's accessibility).

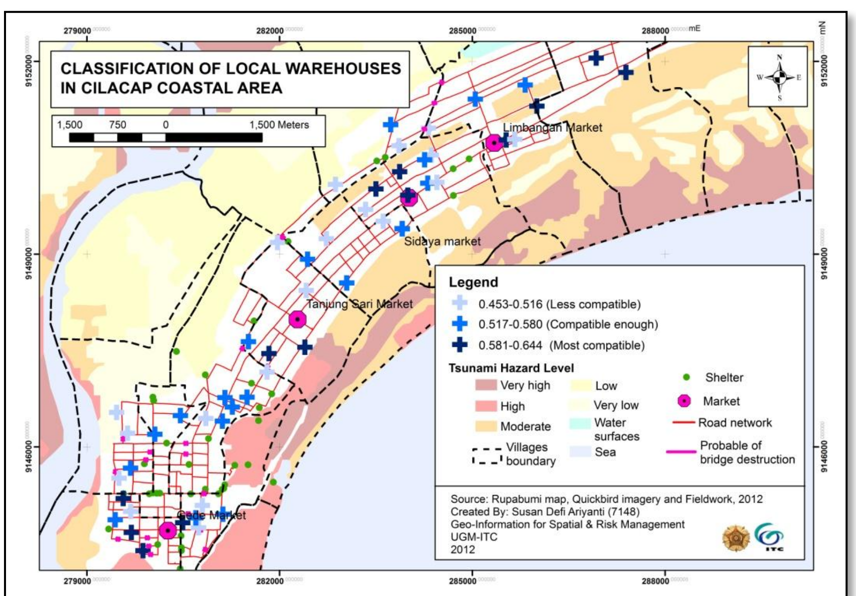


Figure 6.18 Classification of local warehouses samples

Table 6.1 Interpretation Public Buildings of Quickbird Imagery in South Cilacap

No.	*Public Buildings*	*Quickbird Imagery*	*Warehouse Information*		
			Building Specification	*Facility Specification*	*Environmental Specification*
1.	*SMP Cilacap Selatan*		*Height of Building: > 4 meter* *Number of Floor: 1 floor* *Floor Material: Ceramics* *Floor Color: White* *Wall Material: Brick* *Wall Color: White* *Height of Wall: > 3meter* *Size of ventilation: 1.5 mX0.5 m* *Size of door: 2X5 meter*	*Electricity: >1250 watt* *Water supply: Available* *Communication: Available* *Office Equipment: Available* *Fire Extinguisher: Available* *Air Conditioner: Available* *Smoke Detector: Available*	*Condition of air temperature: Normal* *Connectivity of rail access: < 60 minutes* *Connectivity of air access: < 60 minutes*
2.	*Tambakreja Office*		*Height of Building: > 4 meter* *Number of Floor: 1 floor* *Floor Material: Ceramics* *Floor Color: White* *Wall Material: Brick* *Wall Color:Green* *Height of Wall: > 3 meter* *Size of ventilation:1.5mX0.5 m* *Size of door: 2X5 meter*	*Electricity: > 1250 watt* *Water supply: Available* *Communication: Available* *Office Equipment: Available* *Fire Extinguisher: Available* *Air Conditioner: Available* *Smoke Detector: Unavailable*	*Condition of air temperature: Normal* *Connectivity of rail access: < 60 minutes* *Connectivity of air access: < 60 minutes*
3.	*Tambakreja Building Hall*		*Height of Building: > 4 meter* *Number of Floor: 2 floor* *Floor Material: Ceramics* *Floor Color: White* *Wall Material: Brick* *Wall Color: Green* *Height of Wall: > 3 meter* *Size of ventilation: > 1,5mX0.5 meter* *Size of door:2X5 meter*	*Electricity: >1250 watt* *Water supply: Available* *Communication:Available* *Office Equipment: Available* *Fire Extinguisher: Available* *Air Conditioner:Available* *Smoke Detector:Available*	*Condition of air temperature: Normal* *Connectivity of rail access: < 60 minutes* *Connectivity of air access: < 60 minutes*
4.	*Sidakaya Office*		*Height of Building:> 4 meter* *Number of Floor: 1 floor* *Floor Material: Ceramics* *Floor Color:White* *Wall Material: Brick* *Wall Color: Cream* *Height of Wall: > 3 meter* *Size of ventilation:1.5X0.5 meter* *Size of door:2X5 meter*	*Electricity:>1250 watt* *Water supply:Available* *Communication:Available* *Office Equipment:Available* *Fire Extinguisher:Available* *Air Conditioner:Available* *Smoke Detector:Available*	*Condition of air temperature: Normal* *Connectivity of rail access: < 60 minutes* *Connectivity of air access: < 60 minutes*

Table 6.2 Interpretation Public Buildings of Quickbird Imagery in Central Cilacap

No.	*Public Buildings*	*Quickbird Imagery*	*Warehouse Information*		
			Building Specification	*Facility Specification*	*Environmental Specification*
1.	*SMK Mukti 1*	 	*Height of Building:> 4 meter* *Number of Floor: >2 Floor* *Floor Material:Ceramics* *Floor Color: White* *Wall Material: Brick* *Wall Color: White* *Height of Wall: >3meter* *Size of ventilation:1.5X0.5 meter* *Size of door:2X5 meter*	*Electricity:>1250 watt* *Water supply:Available* *Communication: Available* *Office Equipment:Available* *Fire Extinguisher:Unavailable* *Air Conditioner:Available* *Smoke Detector:Unavailable*	*Condition of air temperature: Normal* *Connectivity of rail access: <60 minutes* *Connectivity of air access: <60 minutes*
2.	*Gunungsimping office*	 	*Height of Building:>4 meter* *Number of Floor:2 Floor* *Floor Material:Ceramics* *Floor Color:White* *Wall Material:Brick* *Wall Color:Green and Yellow* *Height of Wall:> 3meter* *Size of ventilation:1.5X0.5 meter* *Size of door:2X5 meter*	*Electricity: 1365 watt* *Water supply: Available* *Communication: Available* *Office Equipment: Available* *Fire Extinguisher: Unavailable* *Air Conditioner: Available* *Smoke Detector: Unavailable*	*Condition of air temperature Normal* *Connectivity of rail access <60 minutes* *Connectivity of air access <60 minutes*

Table 6.3 Interpretation Public Buildings of Quickbird Imagery in North Cilacap

No	*Public Buildings*	*Quickbird Imagery*	*Warehouse Information*		
			Building Specification	*Facility Specification*	*Environmental Specification*
1.	*SMP 5 Cilacap*	 	*Height of Building:> 4 meter* *Number of Floor:2 Floors* *Floor Material:Ceramics* *Floor Color:White* *Wall Material:Brick* *Wall Color:White* *Height of Wall:>3.5 meter* *Size of ventilation:1.5X0.5 meter* *Size of door:2X5meter*	*Electricity:>1250 watt* *Water supply:Available* *Communication: Available* *Office Equipment: Available* *Fire Extinguisher:* *Air Conditioner: Unavailable* *Smoke Detector: Unavailable*	*Condition of air temperature Normal* *Connectivity of rail access <60 minutes* *Connectivity of air access <60 minutes*
2.	*Gumilir Office*		*Height of Building:>4meter* *Number of Floor:1Floor* *Floor Material:Ceramics* *Floor Color:White* *Wall Material:Brick* *Wall Color:White* *Height of Wall:>4.5 meter* *Size of ventilation:1.5X0.5 meter*	*Electricity:>1250 watt* *Water supply: Available* *Communication: Available* *Office Equipment: Available* *Fire Extinguisher: Available*	*Condition of air temperature Normal* *Connectivity of rail access <60 minutes* *Connectivity of air access <60 minutes*

			*Size of door:2X5 meter*	*Air Conditioner:* *Available* *Smoke Detector:* *Unavailable*	
3.	*SMK Makmur*	 	*Height of Building:>4meter* *Number of Floor:2 Floor* *Floor Material:Ceramics* *Floor Color:White* *Wall Material:Brick* *Wall Color:White* *Height of Wall:>3.5 meter* *Size of ventilation:1.5X0.5 meter* *Size of door:2X5 meter*	*Electricity:>1250 watt* *Water supply:* *Available* *Communication:* *Available* *Office Equipment:* *Available* *Fire Extinguisher:* *Air Conditioner:* *Available* *Smoke Detector:* *Unavailable*	*Condition of air temperature Normal* *Connectivity of rail access <60 minutes* *Connectivity of air access <60 minutes*
4.	*Mertasinga Office*	 	*Height of Building:>4 meter* *Number of Floor:2 Floor* *Floor Material:Ceramics* *Floor Color:White and Pink* *Wall Material:Brick* *Wall Color:White* *Height of Wall:>3.5 meter* *Size of ventilation:1.5X0.5 meter* *Size of door:>2X5 meter*	*Electricity>1250 watt* *Water supply* *Available* *Communication* *Available* *Office Equipment:* *Available* *Fire Extinguisher* *Available* *Air Conditioner* *Available* *Smoke Detector* *Unavailable*	*Condition of air temperature Normal* *Connectivity of rail access <60 minutes* *Connectivity of air access <60 minutes*
5.	*SMP 7*	 	*Height of Building:>4.5 meter* *Number of Floor:1 Floor* *Floor Material:Ceramics* *Floor Color:Cream* *Wall Material:Brick* *Wall Color:Cream* *Height of Wall:>3,5 meter* *Size of ventilation:1.5X0.5 meter* *Size of door:>2X5 meter*	*Electricity:>1250 watt* *Water supply* *Available* *Communication* *Available* *Office Equipment* *Available* *Fire Extinguisher* *Available* *Air Conditioner* *Available* *Smoke Detector* *Unavailable*	*Condition of air temperature Normal* *Connectivity of rail access <60 minutes* *Connectivity of air access <60 minutes*
6.	*SMP Pemda 2*		*Height of Building:>3.5 meter* *Number of Floor:2Floor* *Floor Material:Ceramics* *Floor Color:White* *Wall Material:Brick* *Wall Color:White* *Height of Wall:>3.5 meter* *Size of ventilation:1.5X0.5 meter*	*Electricity:1250 watt* *Water supply* *Available* *Communication* *Available* *Office Equipment* *Available* *Fire Extinguisher* *Available*	*Condition of air temperature Normal* *Connectivity of rail access <60 minutes* *Connectivity of air access <60 minutes*

			*Size of door:>2X5 meter*	*Air Conditioner Available* *Smoke Detector Unavailable*	
7.	*SD Menganti 3*	 	*Height of Building:>3 meter* *Number of Floor:2 Floors* *Floor Material:Ceramics* *Floor Color:Cream* *Wall Material:Brick* *Wall Color:White* *Height of Wall:>3 meter* *Size of ventilation:1.5X0.5 meter* *Size of door:>2X5 meter*	*Electricity:1250 watt* *Water supply Available* *Communication Available* *Office Equipment Available* *Fire Extinguisher Available* *Air Conditioner Available* *Smoke Detector Unavailable*	*Condition of air temperature Normal* *Connectivity of rail access <60 minutes* *Connectivity of air access <60 minutes*

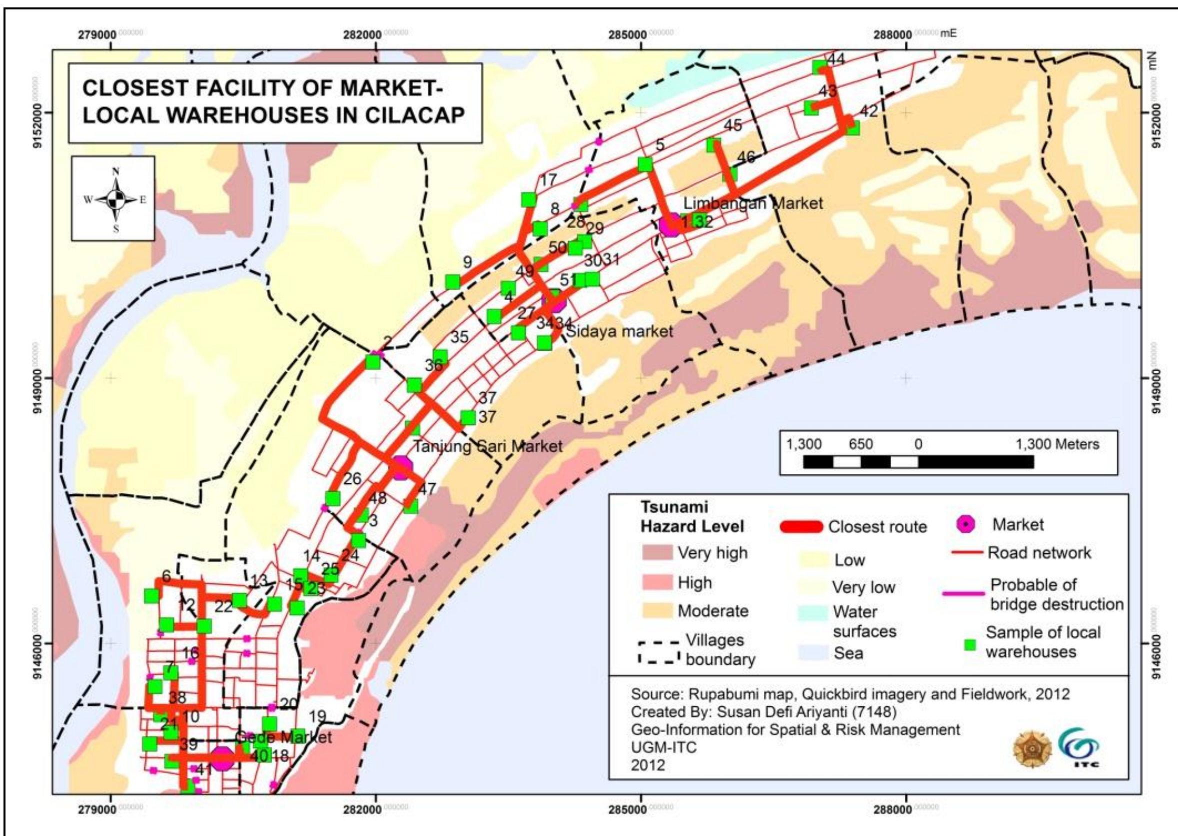


Figure 6.19 Closest facility Market to local warehouses samples

Chart comparison weighting (see Figure 6.23, 6.24, 6.25, and 6.26 above) revealed that among the total weighted of travel time and specification warehouse, local warehouses pointed (38,39,40, 47, 48, 31, 39, 50, 5, 46) has a similiar pattern line to total sample weighting line compared to other local warehouses. Many public buildings used as logistics local warehouse located in South Cilacap

District (see Figure 6.23) than other districts since number of public building densely concetrated in South Cilacap District.

The most compatible building of local warehouse in Central and North Cilacap (see Figure 6.24, 6.25, 6.26) also showed the same pattern of lines since it belonging to total weighting's patterline. Of all samples measured, 13 samples inferred to be less suitable for logistic warehouse while in South Cilacap, logistic warehouses in 10 samples and 13 samples Central Cilacap logistic warehouses in North cilacap. This is proved from the chart pattern and time weighting warehouses present a less equal to the total weighting pattern of lines. The combination between the warehouse and the accessibility specifications are then grouped into three classifications to be used as appropriate warehouse. Weighting for warehouse construction specifications and accessibility to the market can be classified into the following.

a. Weight of warehouse (building, facility, environmental specification)

Table 6.4 Weight of Warehouse

Total weight of logistic warehouses	Explanation
0.561800-0.60905	Low
0.609051-0.672350	Moderate
0.672351-0.711350	High

b. Weight of travel time to Market

Table 6.5 Weight of Travel time

Class of travel time	Weight of travel time	Explanation
1.25-3.59	0.5	Low
4.0-6.33	0.3	Moderate
6.34-8.67	0.2	High

c. Formulation of total weight :
(0.7*weight of logistic warehouse + 0.3*weight of travel time)

Table 6.6 Total Weight of Warehouse Selection

Class of total weight	Explanation
0.453-0.516	Less compatible
0.517-0.580	Compatible enough
0.581-0.644	Most compatible

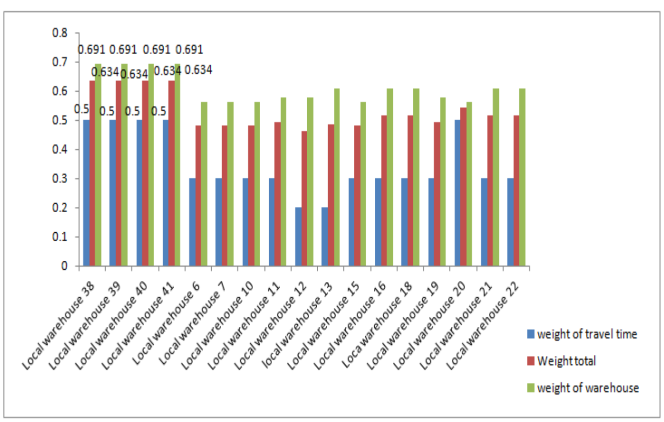


Figure 6.20 Graph of selecting local warehouse samples to Accessibility of Gede Market and Warehouse specification in South Cilacap

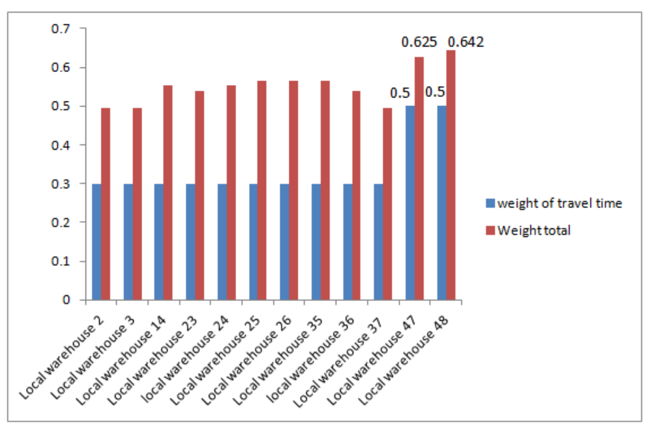


Figure 6.21 Graph of selecting local warehouse samples to Accessibility of Tanjungsari Market and Warehouse specification in Central Cilacap

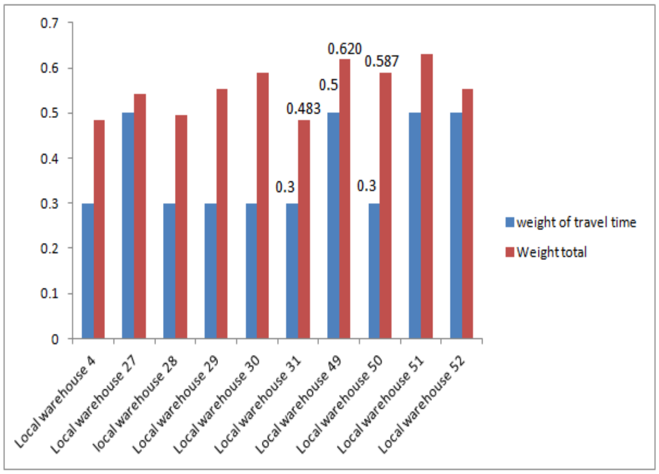


Figure 6.22 Graph of selecting local warehouses samples to Accessibility of sidaya Market and Warehouses specification in North Cilacap

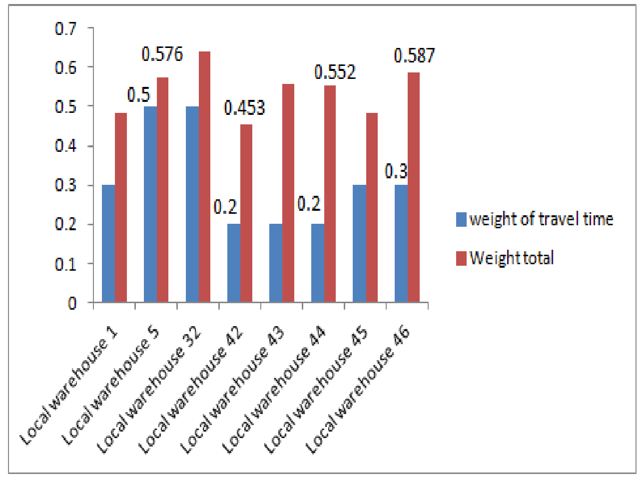


Figure 6.23 Graph of selecting local warehouse samples to Accessibility of Limbangan Market and Warehouse specification in North Cilacap

6.2 CLOSEST FACILITY OF LOCAL WAREHOUSES-PUBLIC INFRASTRUCTURES (MARKET)

6.2.1 Closest Facility of Local warehouse-Market in South Cilacap District

The presence of Gede market in South Cilacap is modeled to supply four local warehouses. The figure 6.27 below shows the alternative routes and closest facilities in a short time reached by market local warehouse. The direction and type of road used shown in Figure 6.27.

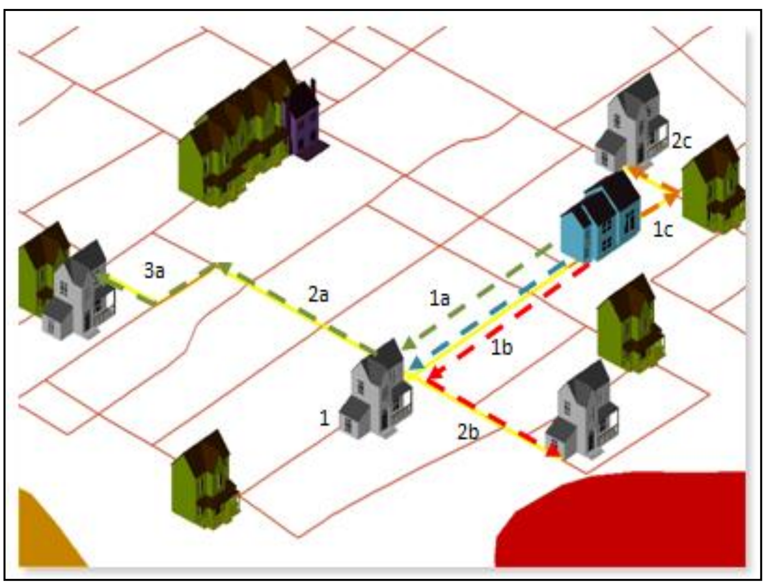


Figure 6.24 Closest facility of Market local warehouse in South Cilacap

Route of Gede Market-local warehouses at SMP Cilacap Selatan (354.46meter)

1. *Routes: Other road, local road*

Route of Gede Market-local warehouses at Tambakreja Building hall (1343.57 meter)

1a. Routes: Other road, local road
2a. Routes: Province road
3a. Routes: local road

Route of Gede Market-local warehouses at Tambakreja office (831.19 meter)

1b. Routes: Other road, local road, province road
2b. Routes: Province road, other road

Route of Gede Market-local warehouses Sidakaya office (608.45 meter)

1c. Routes: Other road, local road, province road,
2c. Routes: local road

In addition, measurements of the closest market also consider; traffic density and length of road. Combination of these factors integrated with tools of Network Analyst, result closest local warehouse facilities to public infrastructure (markets). Comparison of all those factors can be seen in the graph (see Figure 6.28 and Figure 6.29).

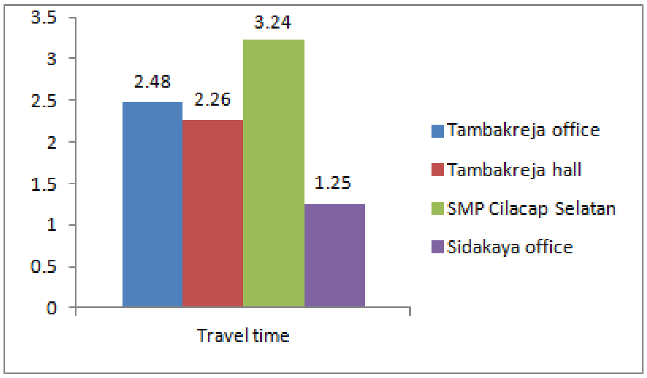


Figure 6.25 Travel time of local warehouse to Market in South Cilacap

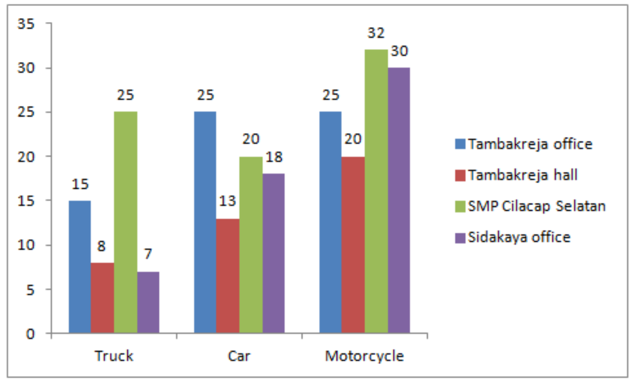


Figure 6.26 Traffic density of local warehouse to Market in South Cilacap

Both graphs above shows the fastest travel time can be accessed is local warehouse at Sidakaya office. Travel time of market to local warehouse at Sidakaya office only takes in 1 minute 25 seconds. The fastest travel time was caused by road distance factor and traffic density since he distance between Gede markets to local warehouse at Sidakaya office is about 608.45 meters and has low number of truck among other local warehouses. This small number of trucks still did not tend traffic jam so travel time taken be faster. It can be helpful for reducing transportation logistic cost. But number of car and motorcycles tend to be quite a lot since these vehicles are dominated used by local people. Meanwhile, the longest travel time is belonging to local warehouse at SMP Cilacap Selatan, which takes 3 minutes 24 seconds, even though the distance between two locations is the shortest distance between other warehouses (354. 46 meters). This is due to the density of traffic on this route is filled by all types of vehicles (trucks, cars and motorcycles). Finally, It becomes the most congested vehicles among those local warehouses routes.

6.2.2 Closest Facility Of Local warehouse-Market in Central Cilacap District

Local resource of logistic needs in Central Cilacap is able to be accommodated by Tanjungsari Market. Tanjung Sari market can supply logistic material for two local warehouses; local warehouses at Gunungsimping office and SMK Mukti (see Figure 6.30).

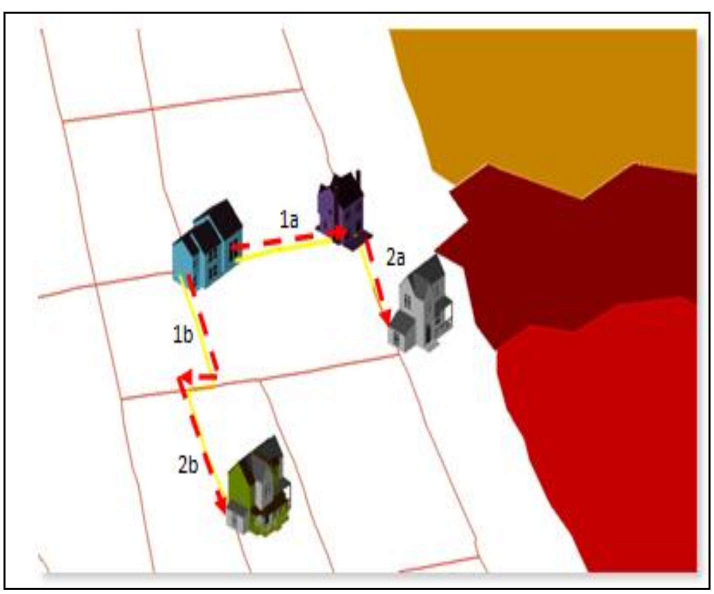


Figure. 6.27 Route Closest facility of Market to local warehouse in Central Cilacap

Route of Tanjungsari-local warehouses at Gunungsimping office (617.86 meter)
1a. Other road, local road
2a. Province road, other road
Route of Tanjungsari-local warehouses SMK Mukti 1 (793.79)
1b. Other road, local road
2b. Local road

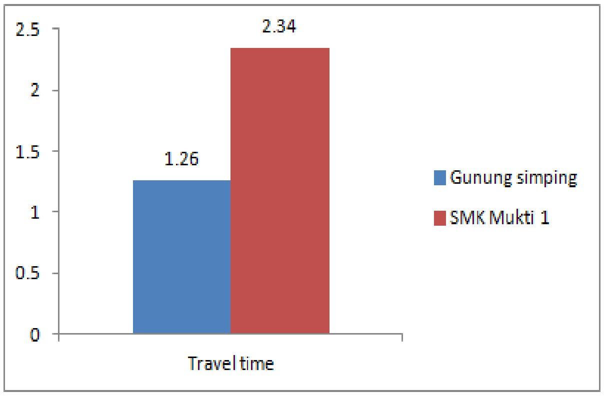


Figure 6.28 Travel time of local warehouse to Market in Central Cilacap

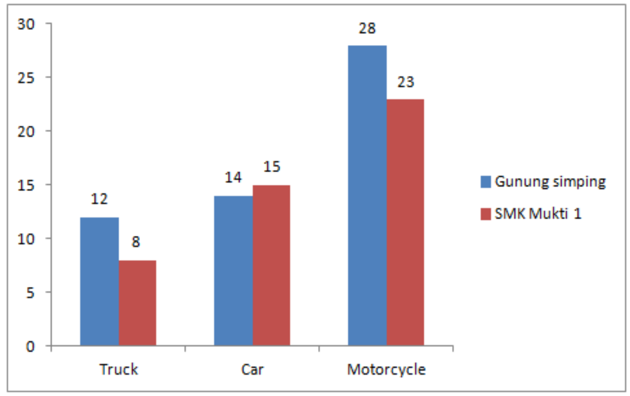


Figure 6.29 Traffic density of local warehouse to Market in Central Cilacap

Local warehouse at SMK Mukti 1 is belonging to the longest travel time since distance between SMK Mukti local warehouse to Tanjungsari market is the farthest distance (793.79 meters) and the most number of cars and motorcycles. Local warehouse at Gunungsimping office had most number of vehicles. This condition may cause traffic congestion in transportation logistic route. And increase transportation cost of disaster relief.

Transportion routes of Tanjungsari market local warehouse at gunungsimping office is the most effective routes since it requires a relatively rapid time. This will accelerate the supply of logistics to the local warehouse.

6.2.3 Closest facility of Local warehouse- Market in North of Cilacap

Sidaya and Limbangan market are able to be alternative of logistic needs. Both of markets are able to supply disaster logistics needs for five local warehouses; Sidaya market supplies three local warehouses while Limbangan market accomodates two local warehouses.

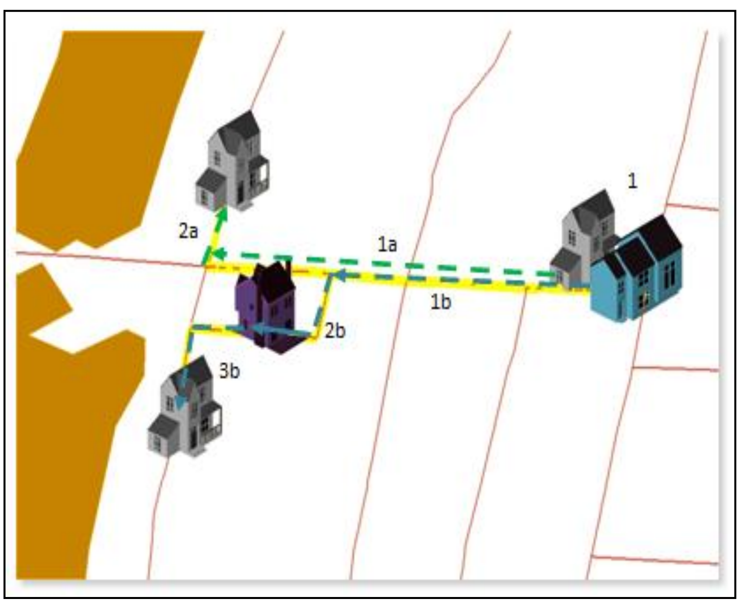


Figure 6.30 Closest facility of Maket to local warehouse in North Cilacap

Route of Sidaya Market-local warehouse at SMK makmur (673.625 meter)

1a. Routes: Other road, national road

2a. Routes: Local road, other road

Route of Sidaya Market-local warehouse at SMP 5 Cilacap (351.72 meter)

1b. Routes: Other road, National road

2b. Routes: Other road

3b. Routes: Local road, other road

Route of Sidaya Market-local warehouse at Gumilir office (106.1 meter)

1.Other road, national road

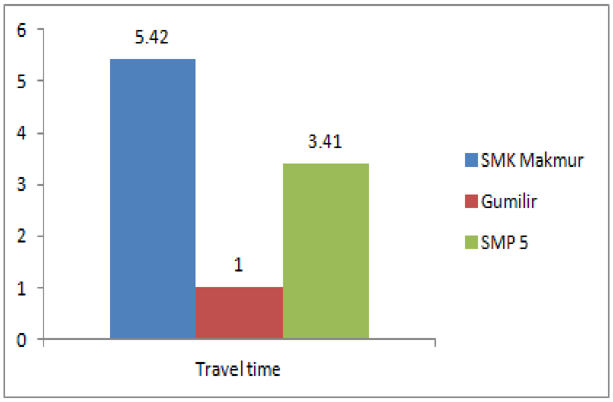


Figure 6.31 Travel time of local warehouse to Market in North Cilacap

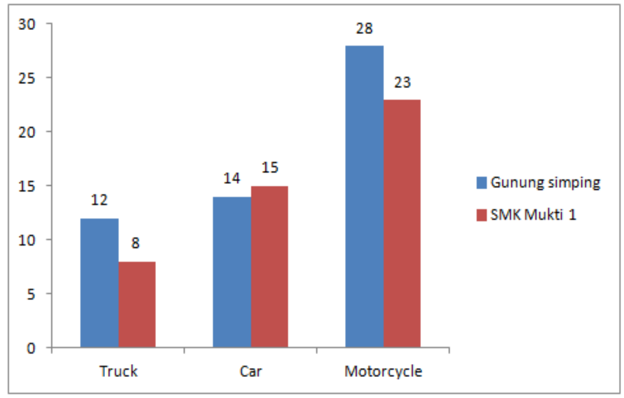


Figure 6.32 Traffic density of local warehouse to Market in North Cilacap

The shortest time to access local warehouse from Sidaya market achieved by local warehouse at gumilir local warehouse since this route only takes 3 minutes (see figure 6.34). This statement is supported by traffic density data (see figure 6.35). Traffic density graph in Figure 6.35 shows local warehouse at gumilir has the fewest of vehicles numer, and the shortest road distance.

Compared to others local warehouses, the longest travel time is belonging to the routes of Sidaya Market to local warehouse at SMK Makmur. This route takes approximately 5 minutes 42 seconds to distribute humanitarian aid. This is because of distance traveled and number of vehicles (trucks, cars and motorcycles), and the number of roads are much more among other local warehouses.

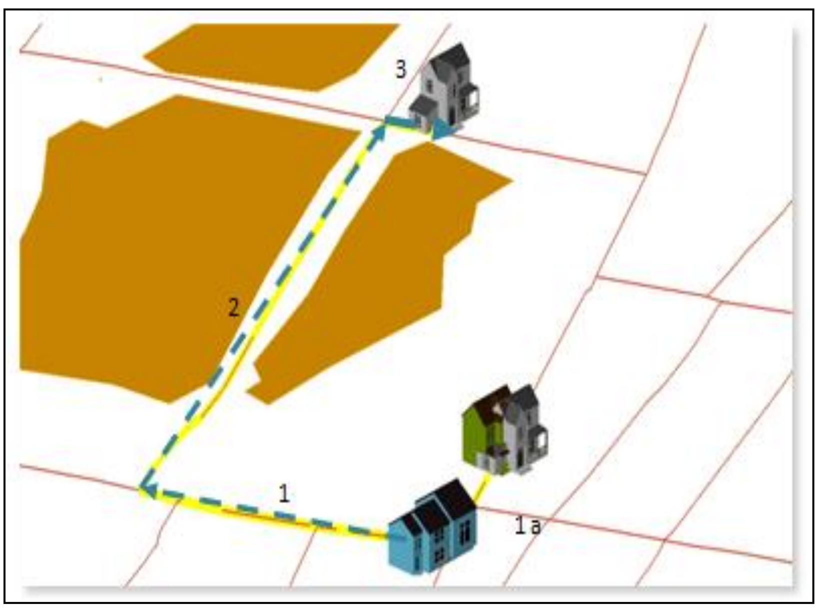


Figure 6.33 Closest facility of Market to local warehouse in North Cilacap

Route of Limbangan-local warehouse at SMP 7 (1349.36 meter)
1.Other road, local road
2.Local road
3.Local road
Route of Limbangan-local warehouse at Mertasinga office (61.99 meter)
1a. Local road

Besides Sidaya Markets, other resource that can be used to supply disaster logistic needs in North Cilacap is Limbangan market. Comparisons of travel time and traffic volume graph for each warehouse are shown in Figure 6.37 and Figure 6.38.

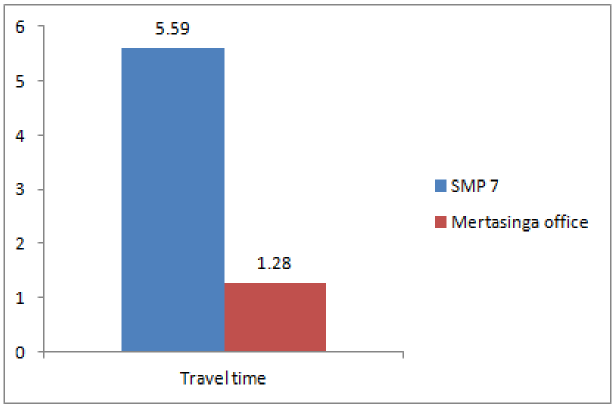


Figure 6.34 Travel time of local warehouse to Market in North Cilacap

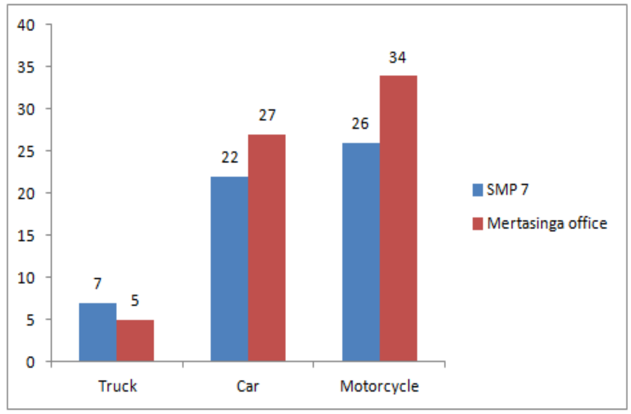


Figure 6.35 Traffic density of local warehouse to Market in North Cilacap

From the graph, it can be indicated that local warehouse at SMP 7 had the longest travel time to reach Limbangan Market since distance route is longer than logistic routes of Limbangan market-Mertasinga office. But traffic density (all type of vehicles) of local warehouse at SMP 7 is much more than the first one. This is because surrounding this route are existed traffic jam when date measurement taken. However, different travel time in both of local warehouses is about 4 minutes and 31 second.

6.3 DENSITY OF REFUGEES IN EVACUATION SHELTER BUILDINGS (DAY AND NIGHT TIME)

Density of refugees in evacuation shelter buildings are depicted in two scenario of time; day time and night time. In general, number of refugee who settles at day is much more than at night. The highest refugee's density in ESB is concentrated in South Cilacap (Sidakaya, Sidanegara, Tambakreja, Donan, Tegalreja villages) since South Cilacap is located in central city of Cilacap which has dense population and has more ESB. Meanwhile, the lowest density of refugees (both day and night time) is located at Mertasinga, Gumilir, Tritih Kulon, and Kebonmanis villages in North of Cilacap.

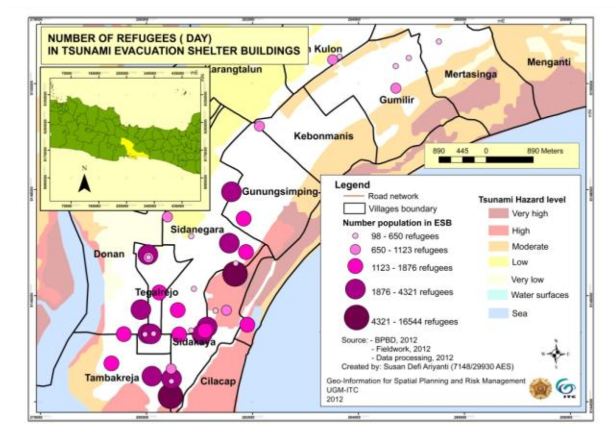


Figure 6.36 Refugee's density in ESB (day time)

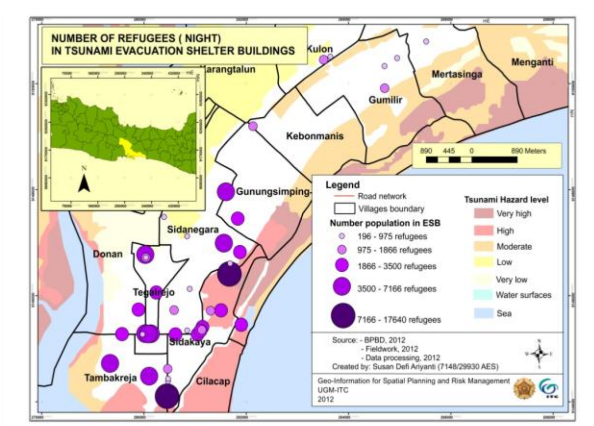


Figure 6.37 Refugee's density in ESB (night time)

Different density refugees day and night time (see Appendix 6-11) were significantly different since some people might come back to their houses (if it is not collapse) to check their own houses but mostly they come back and stay in ESB at day to obtain logistic needs during disaster emergency phase. According to interviewing result, it was known that the percentage of population stay in shelters (see Figure 6.41-Figure 6.58).

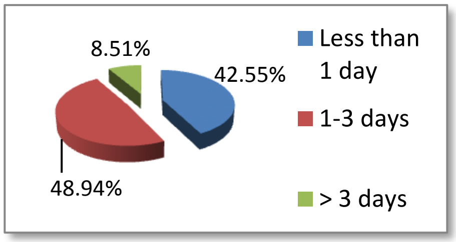


Figure 6.38 Long time of respondent inhabiting at shelter, Sidakaya

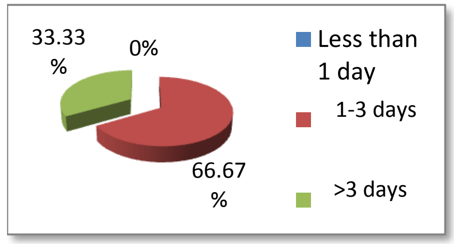


Figure 6.39 Long time of respondent inhabiting at other places, Sidakaya

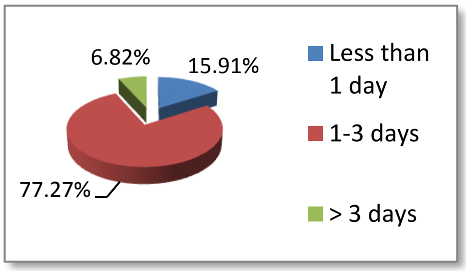


Figure 6.40 Long time of respondent inhabiting at shelter, Tegalkamulyan

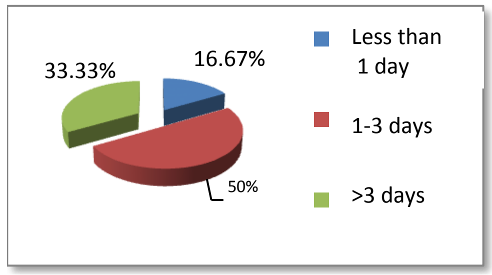


Figure 6.41 Long time of respondent inhabiting at other places, Tegalkamulyan

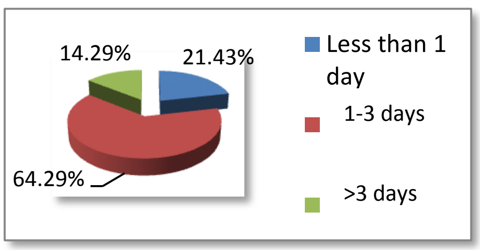


Figure 6.42 Long time of respondent inhabiting at shelter, Sidanegara

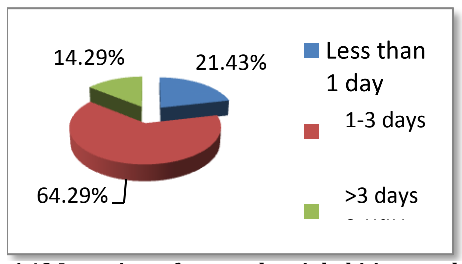


Figure 6.43 Long time of respondent inhabiting at other places, Sidanegara

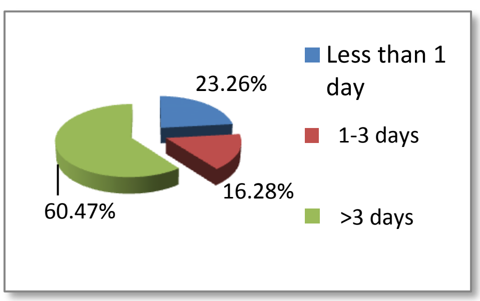


Figure 6.44 Long time of respondent inhabiting at shelter, Gunungsimping

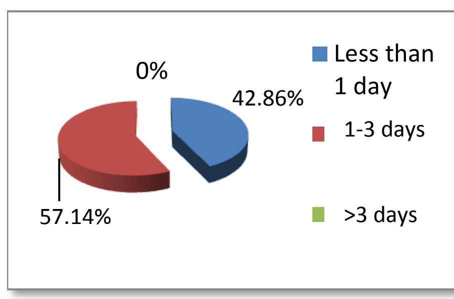


Figure 6.45 Long time of respondent inhabiting at other places, Gunungsimping

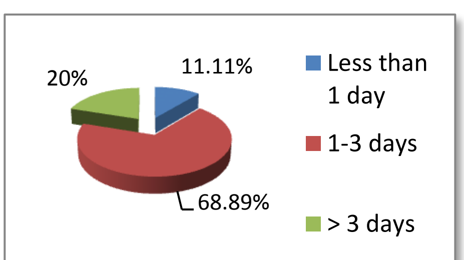


Figure 6.46 Long time of respondent inhabiting at shelter, Mertasinga

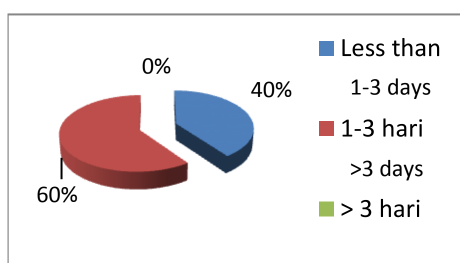


Figure 6.47 Long time of respondent inhabiting at other places, Mertasinga

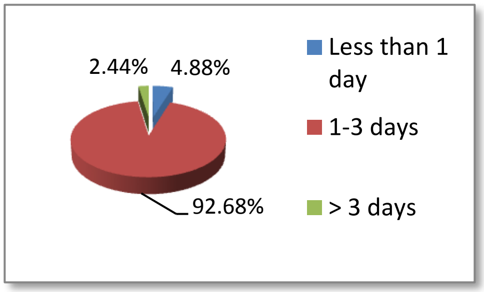


Figure 6.48 Long time of respondent inhabiting at shelter, Kebonmanis

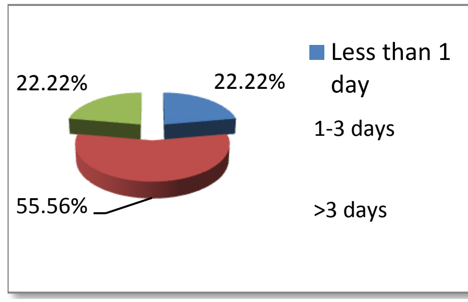


Figure 6.49 Long time of respondent inhabiting at other places, Kebonmanis

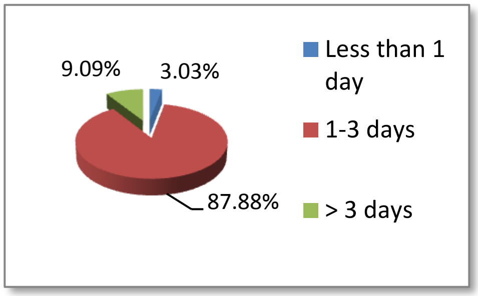


Figure. 6.50 Long time of respondent inhabiting at shelter, Tegalrejo

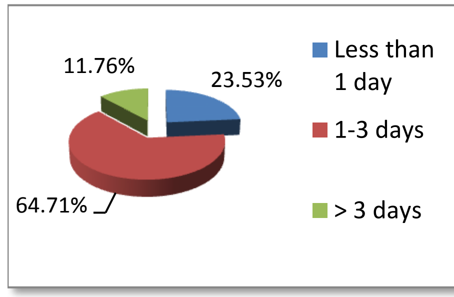


Figure 6.51 Long time of respondent inhabiting at other places, Tegalrejo

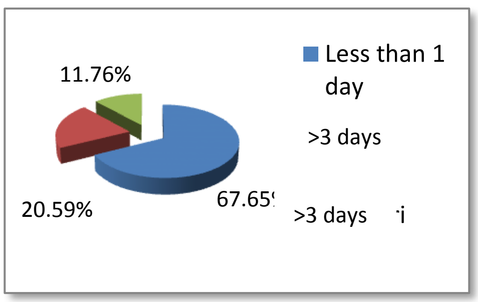


Figure 6.52 Long time of respondent inhabiting at shelter, Gumilir

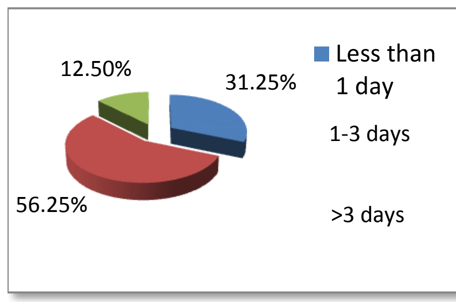


Figure 6.53 Long time of respondent inhabiting at other places, Gumilir

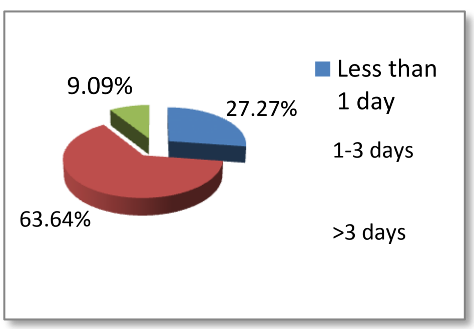


Figure 6.54 Long time of respondent inhabiting at shelter, Tambakreja

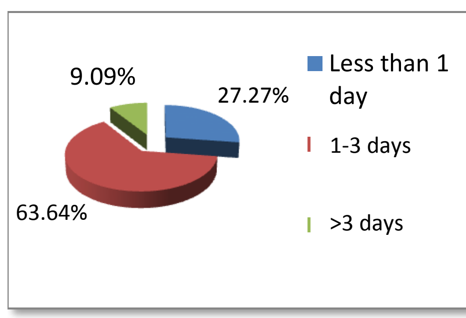


Figure 6.55 Long time of respondent inhabiting at other places, Tambakreja

In general, most respondent from each village prefer to stay in tsunami shelters, when tsunami occurred in Cilacap. They choose tsunami shelter as temporary place to stay since logistics needs can be fulfilled continuesly by local government. Respondent who prefer stay in tsunami shelter during 1-3 days mostly come from the village Tegalkamulyan, Mertasinga, and Kebonmanis. According to them time of 1-3 days is a relatively precise time in disaster emergency response since that time is set by BPBD as disaster relief time also effective time for refugees to clean up and clear the debris of their damaged homes of the disaster caused by the tsunami. This reason is used as the basis calculation of logistic needs (food, clothing, and medicine to refugees) both at the district and village level (Interviewing result, 2012).

Responden who prefer to stay less than 1 day or more than 3 days is belonging to population living in villages far from the beach and or relatively safe area of the tsunami hazard (see Figure 6.47 and Figure 6.55). This is because those villages are rural and population density is relatively small compared to villages in South Cilacap. In addition, Gumilir's respondents mostly prefer stay less than 1 day since horizontal distance between Gumilir to coastal are is relatively far enough. Population who stays in 3 days in other places (safe area from tsunami of relative's house) is the most than population stay less than 1 day or > 3 days. This is because 3 days is moderate time to evacuate since they hope to come back as soon as possible to their houses. In addition, they choose other places (relative's house) to stay since logistic needs can be supplied by themselves (Interviewing result, 2012).

6.4COMPARISON EVACUATION SHELTER BUILDING (ESB) AND LOGISTIC WAREHOUSES

Public buildings can be used as well as shelter and logistic warehouse since it has larger building. But shleters logistic warehouse should be separated to monitor and mainte process of emergency response phase. This is stated by interviewing officer of BPBD:

"I think a good place both tsunami evacuation shelter and temporary warehouse logistics can utilize public buildings. Public buildings tend to be more spacious and can supply more logistical but I emphasize public buildings that tsunami evacuation should be separated from the building used as temporary warehouse logistics ".It aims to facilitate logistics distribution in disaster. In addition, I think the separation between the buildings with warehouse logistics tsunami shelter is to make it more secure and reduce the risk of logistical items stolen in such a panic condition of refugees".

It is also caused that ESB have been functioned to accommodate refugees maximally (all rooms fully filled to evacuate refugees. In other hand, logistic warehouse also needs any building requirements as logistic warehouse. Compared t o previous research conducted by Dewi (2010), public building which has the most facilities is belonging to SMA Al-Irsyad (Sidanegara village) shelter. This can be supported by refugees as emergency logistic needs.

Figure 6.56 Existing of water of emergency logistic need (Dewi, 2010)

6.5 NUMBER AND KINDS OF LOGISTIC MATERIAL NEEDED FOR REFUGEES

Timoleon (2012) stated that, there was a correlation of disaster type with the victim's health impact (occurrence of injuries). Earthquake disaster type will bring many traumas and require more medical treatment while flood disaster relatively causes few injuries. In addition, it is also possible occurred infectious disease as soon as disaster takes place. It brings medical problem to refugees' health. Whatever type of disaster, need for food, clothing, and medicine are clearly necessary to be fullfiiled to prevent the growing number of victims injured. Sometimes the availability of logistics needs may be difficult due logistic resources can be difficult to be accessed. This becomes major logistic problems. In addition, Timoleon (2012) also stated:

> *"The various effects of disasters on the population and its surroundings generate different kinds of needs and require different approaches to meet those needs. It is therefore important to have a general sense of what these effects are, and which systems are most commonly affected. We have the short-term effects of major disasters, as death or severe injuries, requiring extensive treatment and some effects, which change the way of life of the disaster victims for a long time".*

According to a statement conducted by Timoleon, calculations logistic needs addressed to refugees who inhabited in tsunami shelter. This is correlated with Cilacap case, since most people generally prefer to live in refugee shelters within 1-3 days. Therefore, the calculation of logistic needs is focused on refugees who inhabit tsunami shelter.

6.5.1 NUMBER AND KINDS OF LOGISTIC MATERIAL NEEDED IN REGIONAL WAREHOUSES

Regional Warehouses are functioned to accommodate disaster logistic needs at district level. In this research, district which triggered by tsunami disaster are belonging to North of Cilacap, Central of Cilacap, and South of Cilacap districts. The proportion of logistic needs at district level is concentrated for refugees staying evacuation shelter building which based on administrative ESB location. Shortly, the distribution of ESB according to regional (districts) level and standard of Logistic needs can be depicted in Figure 6.7 and Figure 6.8.

Table 6.7 Tsunami Evacuation Shelter Buildings in Cilacap

No.	District	Evacuation Shelter Building	
1.	South of Cilacap	SMP Negeri 1 Cilacap	SMK YPE Cilacap
		SMP Negeri 3 Cilacap	SMA Yos Sudarso
		Gedung Dakwah Muh	Rusunawa Cilacap
		Hotel Tiga Intan	SD Al-Irsyad 01
		Politeknik Cilacap	DPRD Cilacap
		SMP Pius Cilacap	SMA Negeri 1 Cilacap
		Hotel Cilacap Indah	SMP Muh. 1 Cilacap
		SMP Purnama 1 Cilacap Cilacap	SD N Tegalrejo 01
		RSU Santa Maria Cilacap	SD N Tegalrejo 02
		SMP Negeri 8 Cilacap	
2.	Central of Cilacap	RSUD Cilacap	SMP Negeri 6 Cilacap
		AKBID Graha Mandiri	Masjid Darussalam
		Asrama Puri STIKES	Hotel Mutiara Cilacap
		Badan Diklat, Arsip	SMP Purnama 2 Cilacap
		Asuransi Bumi putera	SMA Al-Irsyad
		SD Negeri 08 Sidanegara	SMP Negeri 2 Cilacap
		RS Aprillia	SMA Sri Mukti
		Gedung Golkar	SMP Negeri 4 Cilacap
3.	North of Cilacap	BPC Gapensi	RSI Fatimah
		Masjid Al-Jihad	Kelurahan Mertasinga
		SMP PGRI 1 Cilacap	SMP Muhammadiyah 2
		PMI Cilacap	

Source: BPBD, 2012

Table 6.8 Standard of Logistic Needs

Logistic Need	Number
- Food logistic	
a. Rice	0.4 kilograms/person/day
b. Instant noodle	3 pack/person/day
c. Soya	150 ml/person/day
d. Water drinking	4 liter/person/day
- Basic Needs	
a. Clothes	1 sheet/person/day
b. Bed cover	1 sheet/person/day
c. Praying uniform	1 sheet/day
d. Sock	1 pair of sock/person
e. Soap	250 gram/person
f. Wash Soap	200 gram/person
g. Tooth brush	1 item/person
h. Tooth paste	1 item/person
- Medical Needs	
a. Medicine boxes	1 medicine box = 4 person
b. Tents and mattress	1 tent and mattress = 4 person

Source: BPBD, 2012

Logistic needs problem in shortages of aftermath disaster are generally due to two causes. First is destruction of disaster logistic stocks in the affected area, and lack of local resources (scarcity) to supply availability or affordability of logistic needs. Second is a disorganized distribution system of logistic needs with many logistic actors. Logistic distribution is needed to design both short and long term scale. One crucial consideration taken, after disaster, many cases appear since mass displacements of people and chaotic of disaster relief. Therefore, the presence of logistical warehouse will help the logistic need delivery in time (Timoleon, 2012). The previous research of *Humanitarian Aid Warehouse Location Planning* had highlighted in different number and types of logistic need based on Figure 6.60. In that case, logistic needs are mainly focused in general emergency needs and equipment; food and water, shelter, lighting/communication, first aid, rescue equipment, and sanitation. Compared with standard logistic need issued by National Disater Agency regulation, food logistic needs are specified in to many kinds of local preffered food (noodle, rice, soya, and water drinking). These foods are explained detail number for aech person while the previous research is explained in general number.

Food and Water	Shelter	Lighting/Communication	First Aid	Search/Rescue	Sanitation
5 emergency food bars (72-hour food supply per bar) 15 water boxes with straws 50 water purification tablets	5 emergency blankets 1 emergency tent	1 hand-crank powered light 1 shake light 3 green light sticks 1 yellow light stick 5 emergency candles 50 waterproof matches	160-piece first aid kit	Safety whistle 5 dust masks Pair of vinyl gloves Survival guide	Snap-on toilet seat Sanitation/toilet bags Package of toilet chemicals Tissue 5 gallon bucket

Figure 6.57 Logistic Needs of research *Humanitarian Aid Warehouse Location Planning* (Source: Anonim, 2012)

In addition, the other logistic and equipment needs; lighting/communication, search/rescue, and sanitation are prepared as warehouse facilities in Cilacap case. In general, the previous research are particulary similar with this study since both of them determining total number of disaster logistic needs and calculation based on the number of refugees which prefer to inhabit in shelters.

Table 6.9 Stock of Food Logistic in Regional Warehouses

District	Stock of Food logistic			
	Rice (kg)	Instant Noodle (pack)	Soya (liter)	Water drinking
South of Cilacap	81408	610560	30528	818784 (liter)
Central of Cilacap	47286	354645	17732.25	447677
North of Cilacap	9181.2	68859	3442.95	91812

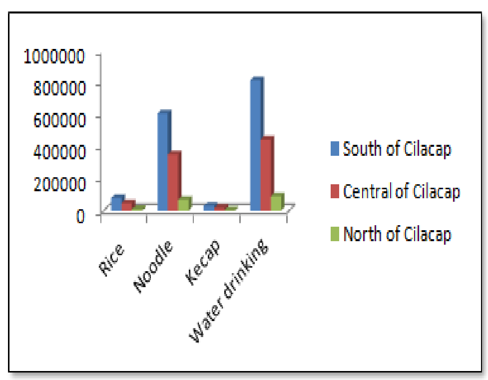


Figure 6.58 Total of Food Logistic at district level in Cilacap

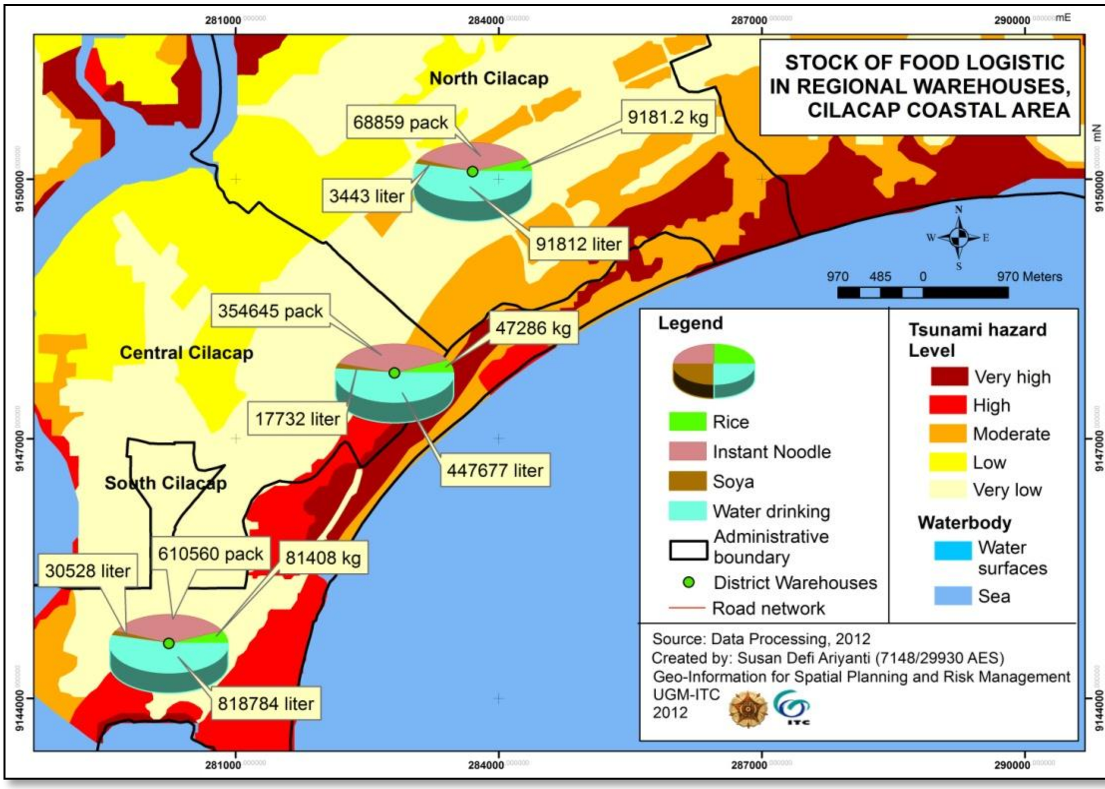


Figure 6.59 Map of Food Logistic in Regional warehouse

Logistic foods in emergency response of disaster are proposed to fulfill immediately since food is major needs of refugees. At district level, every district should supply logistic needs from central warehouse to regional warehouse. Figure 6.61 shows generally demands all kinds of food logistic (rice, instant noodle, soya, and water drinking) in South Cilacap are the highest than other districts. It is caused that, number of refugees (in evacuation shelter) are the biggest among others districts.

Table 6.10 Stock of Basic needs in Regional Warehouses

District	Stock of Basic Needs							
	Clothes (sheets)	Bed cover (sheets)	Socks (pair of socks)	Praying uniforms (sheets)	Bath soap (items)	Wash soap (items)	Tooth brush (items)	Tooth paste (items)
South of Cilacap	203520	67840	67840	67840	15942.5	13568	67840	67840
Central of Cilacap	125415	39405	39405	39405	9851.25	7881	39405	39405
North of Cilacap	22953	7651	6345	7651	1912.75	1536.2	7651	7651

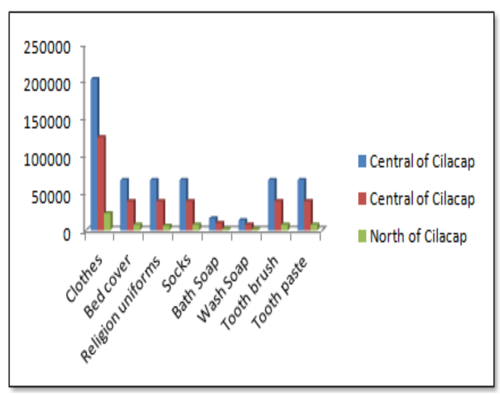


Figure 6.60 Basic needs of logistic at district level in Cilacap

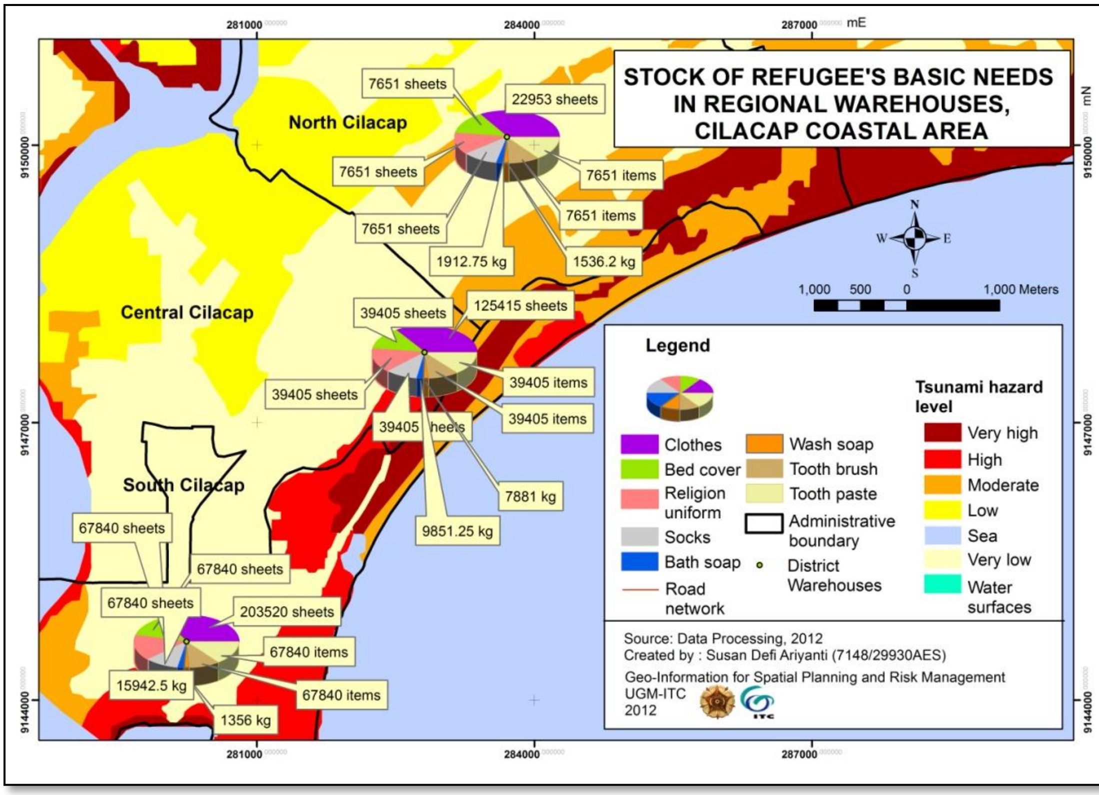


Figure 6.61 Map of Basic Needs in Regional warehouse

Basic needs can be defined as the priorities needs of people used in a whole day. Basic needs are calculated based 3 days since most population prefer to stay along 3 days in disaster emergency response. Therefore the calculation of basic needs should be multiplied 3 except; bed cover, praying uniforms, socks, bath soap, wash soap, tooth brush, and tooth paste. If compared, total of basic needs in Central of Cilacap are much more than other districts since South of Cilacap has more evacuation shelter building and also number of refugees settle during disaster emergency response (see Figure 6.65).

Table 6.11 Stock of Medical and Equipment needs in Regional Warehouses

District	Stock of Medical and Equipment Needs	
	Medicine (boxes)	Tent and mattress (pack)
South of Cilacap	16557	16557
Central of Cilacap	9856	9856
North of Cilacap	3415	3415

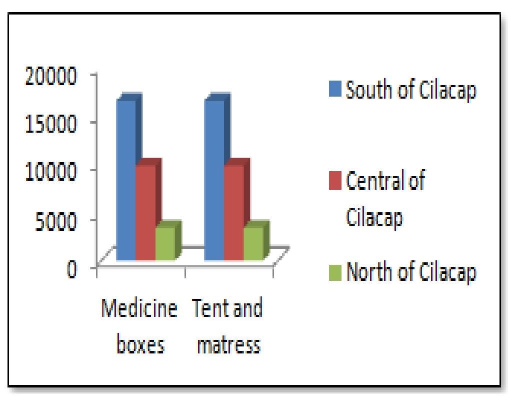


Figure 6.62 Medical and equipment needs at district level in Cilacap

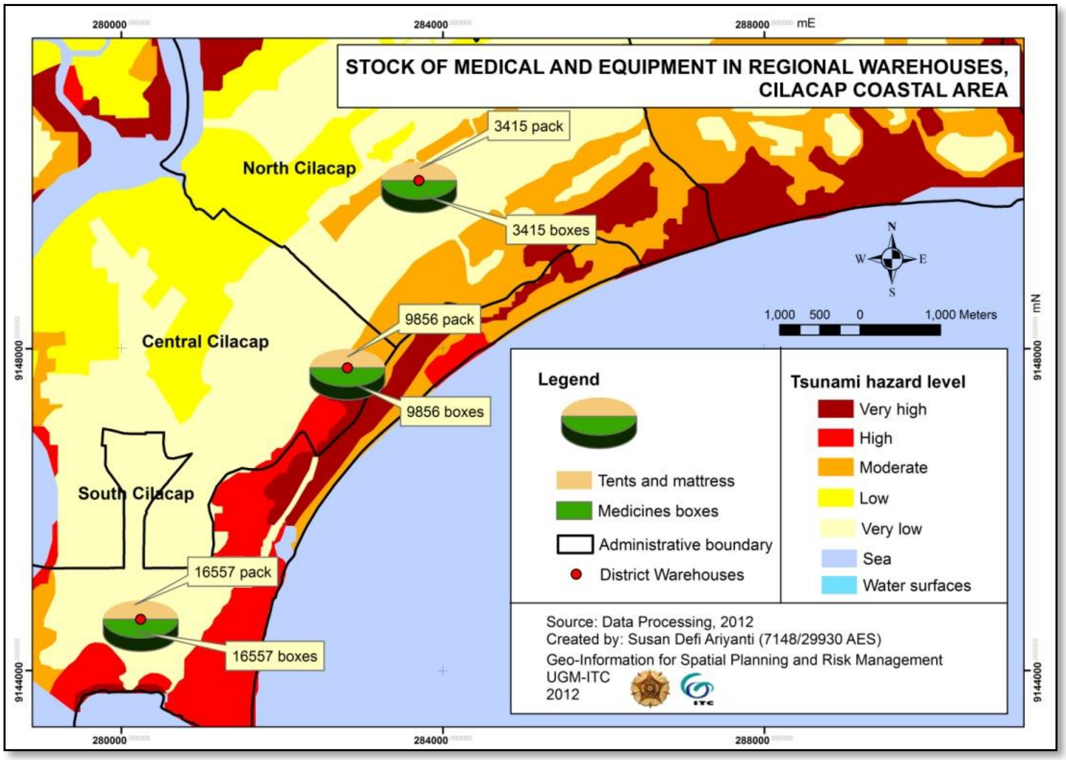


Figure 6.63 Map of Medical and Equipment needs in Regional Warehouse

Medical and equipment are belonging to tent & mattress needs. These needs are also essential and should be supplied in logistic warehouses since after disaster take place, it is depicted such injured people and loss their houses at the moment. Medicine boxes are functioned to treat injured people and to prevent appearing possible illness in evacuation shelter whereas tent and mattress are used to additional humanitarian aid for refugees to stay in tsunami shelter. Both of medicine boxes and tent & mattress are proposed for 4 person needs. The calculation of medical and equipment are based on the total number of refugees divided for 4 persons. From those calculations, it can be resulted 16557 of medicine boxes and tent & mattress in South of Cilacap. Meanwhile, each Central of Cilacap and North of Cilacap has 9856 and 3415 of medicine boxes and tent & mattress. The result of medical and equipment needs can be illustrated in Figure 6.65

6.5.2 NUMBER AND KINDS OF LOGISTIC MATERIAL NEEDED IN LOCAL WAREHOUSES

Local warehouses are used to accommodate disaster logistic needs in village level. According to data processing, it can be known the total number of each logistic needs in every local warehouse as depicted in tables and figures below (see Table 6.12; 6.13; 6.14 and Figure 6.67; 6.68; 6.69)

Table 6.12 Stock of Food Logistic in Local Warehouses

Local Warehouses	Stock of Food Logistic			
	Rice (kg)	Noodle (pack)	Water drinking (liter)	Soya (liter)
SMP Cilacap Selatan	7200	54000	2700	72000
Building hall of tambakreja	39519.6	296397	14819.85	363936
Sidakaya Office	24900	186750	9337.5	249000
Gunungsimping office	37494	281205	14060.25	367739
SMK Mukti	7335.6	55017	2750.85	73356
SMP 7 Cilacap	4550.4	34128	1706.4	45504
Mertasinga Office	1872	14040	702	18720

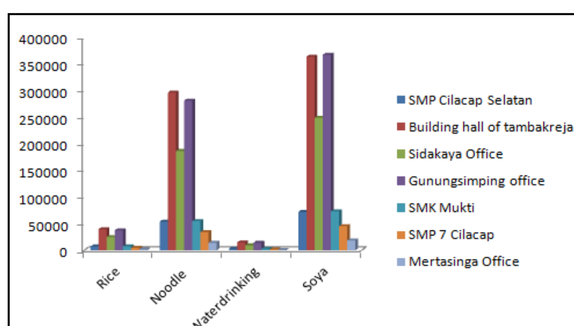


Figure 6.64 Total of Food logistic at villages level in Cilacap

Table 6.13 Stock of Basic needs in Local Warehouses

Local Warehouses	Stock of Basic Needs							
	Clothes (sheets)	Bed Cover (sheets)	Praying uniforms (sheets)	Socks (pair of socks)	Bath Soap (items)	Wash Soap (items)	Tooth brush (items)	Tooth paste (items)
SMP Cilacap Selatan	18000	6000	6000	6000	1500	1200	6000	6000
Building hall of tambakreja	105999	32933	32933	32933	17390.75	6586.6	32933	32933
Sidakaya Office	62250	20750	20750	20750	5187.5	4150	20750	20750
Gunungsimping office	93735	31245	31245	31245	7811.25	6429	31245	31245
SMK Mukti	18339	6113	6113	6113	1528.25	1228.6	6113	6113
SMP 7 Cilacap	11376	3792	3792	3792	948	758.4	3792	3792
Mertasinga Office	4680	1560	1560	1560	390	312	1560	1560

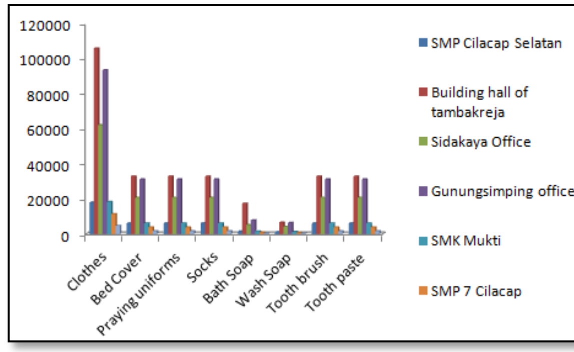


Figure 6.65 Basic logistic needs at villages level in Cilacap

Table 6.14 Stock of Medical and Equipment in Local Warehouses

Local Warehouses	Stock of Medical and Equipment Needs	
	Medicine (boxes)	Tent and mattress (packs)
SMP Cilacap Selatan	1500	1500
Building hall of tambakreja	8237	8237
Sidakaya Office	5191	5191
Gunungsimping office	7814	7814
SMK Mukti	1529	1529
SMP 7 Cilacap	2449	2449
Mertasinga Office	390	390

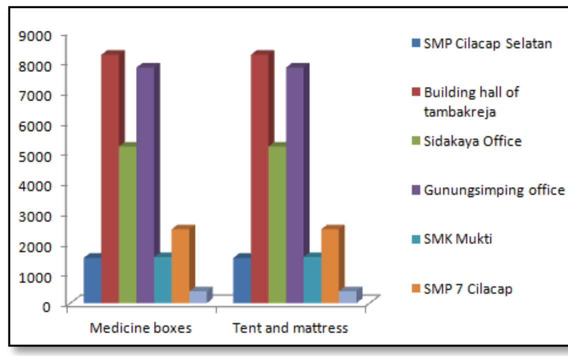


Figure 6.66 Medical and equipment needs at villages level in Cilacap

According to distribution of public infrastructures (market) and evacuation shelter building, it can be known; there are seven appropriate local warehouses. For all types of food logistic, basic needs, and medical needs of local warehouse at building hall of tambakreja and Sidakaya office require more stock of logistic needs since the number of refugees and evacuation shelter buildings are much more than other local warehouses. The important logistic food should be prepared before tsunami disaster occurs are rice, noodle, water drinking and soya since rice is primary food of Indonesian and instant noodle is as an alternatives food beside rice. The most basic need and medical needs supply are also belonging to local warehouse at Building hall of Tambakreja. The calculation of bed cover, praying uniforms, socks, bath soap, wash soap, tooth paste, and tooth brush are done with the assumption that one refugee only needs one kind of those needs during 3 days in evacuation shelter building. Therefore quantity of bed cover, praying uniforms, socks, tooth paste, and tooth brush needs are same as the total number of refugees for each village.As well as medical needs, it was calculated since both of them can accommodate one pieces for 4 refugees and the results shows that local warehouse at building hall of tambakreja.

6.6MANAGING CAPACITY WAREHOUSES BUILDING

6.6.1 MANAGING CAPACITY AREA BUILDING OF REGIONAL WAREHOUSES

Managing capacity area building of warehouses is proposed to know how to store and keep logistic material efficiently. The much more managing capacity done, the much better capability and effectiveness of warehouses management system.

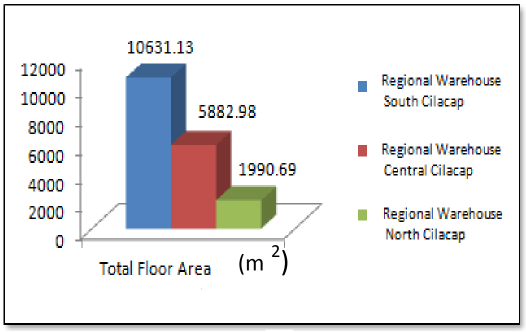


Figure 6.67 Total floor area of regional warehouses

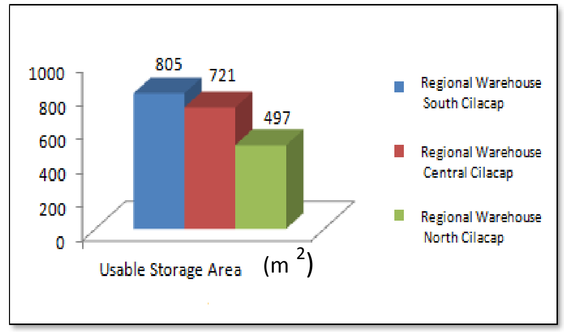


Figure 6.68 Usable storage area of regional warehouses

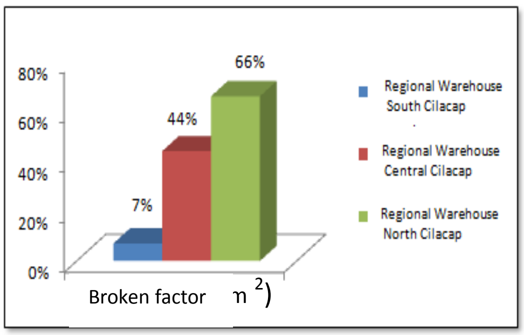


Figure 6.69 Broken factor of regional warehouses

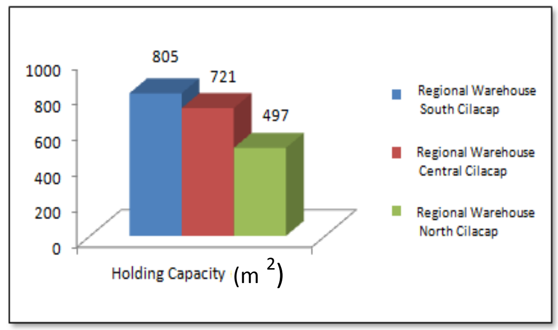


Figure 6.70 Holding capacity of regional warehouse

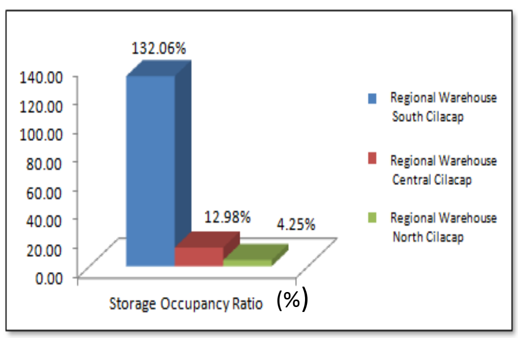


Figure 6.71 Storage occupancy ratio of regional warehouse

Total floor area of warehouses aims to identify the number of area floors (mater aquare) needed to store logistic material. Bigger number of logistic material will need bigger total floor area. But, it also depends on logistic weight, logistic volume, and broken storage factor. From the calculation and histogram, it can be known that, total floor area needed to store logistic needs in South of Cilacap district office is 10631.13 meter square, Central of Cilacap district is 5882.98 meter square, and North of Cilacap district office is 1990.69 meter square (see Figure 6.70)

Usable storage area is the effectiveness of building space to store logistic material. Approximately, it has to reach 70% of available area building to store material whereas 30% of area buildings are used for office (to store logistic document). From definition, it can be identified that, area building is not only primary factor influenced of usable storage area but also consider total number of logistic prepared to be stored. South of Cilacap district office also has the highest value of usable storage area since it also has higher area building and total number of logistic value. Broken factor can be defined as space which can not be used to store logistic material. The result of usable storage area can be depicted in Figure 6.71.

The opposite of broken factor called as stowage factor. Among the managing capacity area of logistic warehouse, the highest value of broken factor is embedded at North of Cilacap district office (66%). Holding capacity of warehouse is the capability of warehouse to store logistic needs. In general, holding capacity value is as the same value as usable storage area since holding capacity considers stowage factor. As the usable storage area mentioned, South of Cilacap district office has the highest holding capacity. It approximately store 805 meter square of total logistic material (see Figure 6.73). Storage occupancy is the formulation used to determine whether a warehouse activity can retain logistic material in period of time. If storage occupancy ratio has more than 70% indicates a warehouse activity can not retain supply of logistic material. It also means that, logistic material within warehouse should be transported out of other warehouses (local warehouses). From the calculation and histogram, even tough that holding capacity, usable storage area, and stowage factor value of South Cilacap district office are high enough than other district but for storage occupancy ratio value, it becomes increase until 132.06% (see Figure 6.74). Warehouse capacity of South Cilacap district office can not retain logistic load in along time (more than 3 days), it should be transported out when it is overload. Meanwhile, Central Cilacap and North Cilacap district office are adequate to store logistic load more than 3 days since less number of refugees and logistic material supply.

6.6.2 MANAGING CAPACITY AREA BUILDING OF LOCAL WAREHOUSES

Total floor area described the number of logistic are stocked horizontally at warehouse's floor. As much number of logistic needs as much the total floor area needed in a warehouse.

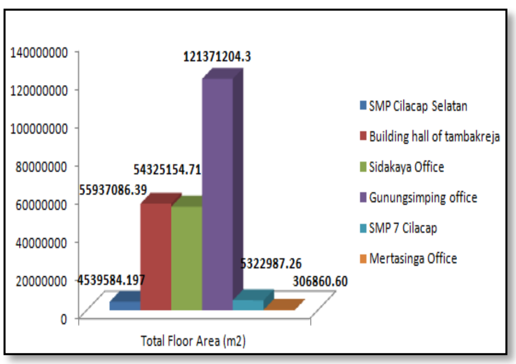


Figure 6.72 Total floor area of local warehouses in Cilacap

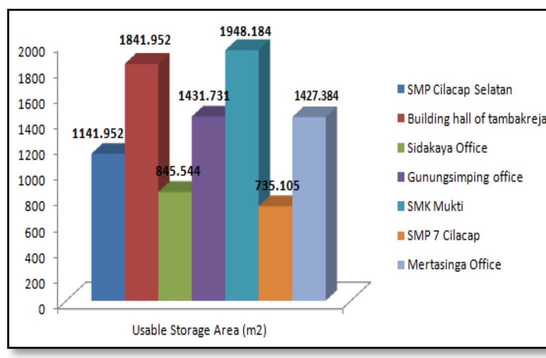


Figure 6.73 Usable storage area of local warehouses in Cilacap

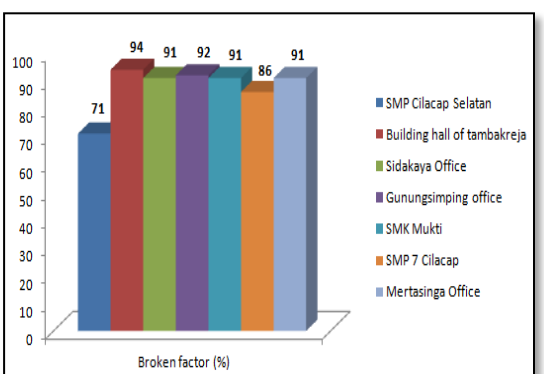


Figure 6.74 Broken factor of local warehouses in Cilacap

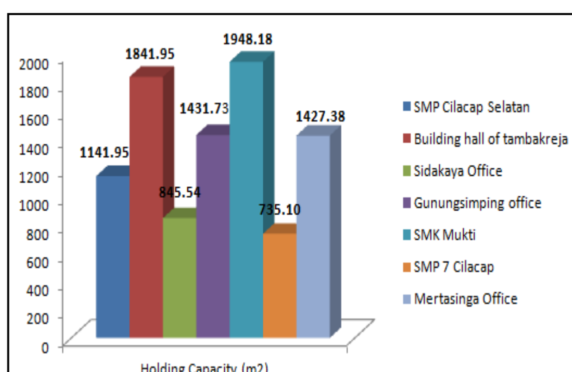


Figure 6.75 Holding Capacity of Local warehouses in Cilacap

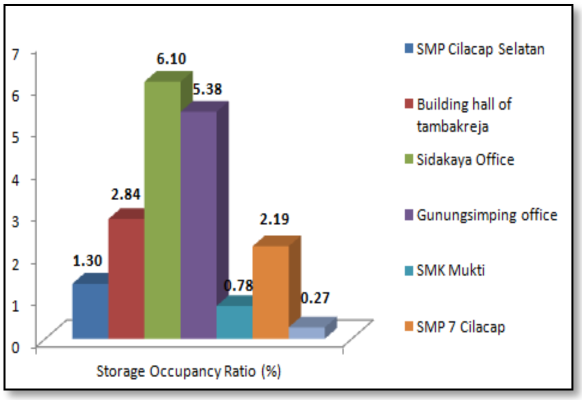


Figure 6.76 Storage occupancy ratio of local warehouses in Cilacap

Among those toal floor area in Figure 6.75, it can be known that, local warehouse at gunung simping office has the highest total floor area value since it has more refugees number after refugees in building hall tambakreja local warehouse. Usable storage areas are used to identify the capability of building to storage logistic needs based on area building of warehouse. The minimal standard of usable storage area of a warehouse is about 70% of area building. It can be stated that 30% of area building of warehouse is used to space for office and space of warehouse layouts (Giri, 2007). Figure 6.76 showed the highest value of usable storage area belonging to local warehouse at *SMK Mukti*. It reaches 1948.184 meter square of usable storage area and the lowest value of usable storage area is belonging to local warehouses at Sidakaya office which take 845.544 meter square. It means area building of local warehouse at *SMK Mukti* is higher enough than other local warehouses.

The highest broken factor value is belonging to local warehouse at building hall tambakreja (94%) and the lowest value is to local warehouse at *SMP Cilacap Selatan* (see Figure 6.77). This lowest broken factor value at local warehouse at Gumilir office is caused by this local warehouse used to maximize logistic disaster storage. The interesting thing of broken storage value is belonging to local warehouse at Sidakaya and *SMK Mukti 1* which had same values (91%); but they have different value of usable storage factor. Local warehouse at *SMK Mukti 1* had higher usable storage than local warehouse among local warehouses, but has the highest broken factor value. This is because local warehouse at *Sidakaya office* had less area building than area building of *SMK Mukti 1* local warehouse; and even number logistic needs of refugees in Sidakaya local warehouse is much more than *SMK Mukti* local warehouse.

Holding capacity value is depicted as the capacity of logistic warehouse to store logistic needs. In general, value of usable storage is similar with holding capacity. But holding capacity considers storage factor while usable storage area considers warehouse's area building. From the histogram (see figure 6.78), it can be known that the highest holding capacity of warehouse is belonging to local warehouse at *SMK Mukti* (1948.18 meter square) and the lowest holding capacity of warehouse is belonging to local warehouse at *SMP Cilacap Selatan* (735.10 meter square) (see Figure 6.78) since local warehouse *SMK Mukti* also had the largest of area building while local warehouse at *SMP Cilacap Selatan* had the smallest of area building.

Storage occupancy ratio is used to calculate the capability of a warehouse to store logistic in period of time (emergency response phase). It can be indicated that all local warehouses in each village has lower value (less than 70%) of storage occupancy ratio (see Figure 6.79). This means all local warehouses can accommodate logistic need at least 3 days in emergency response phase. But, if there is much of logistic accumulation (in case more than 3 days), those storage of logistic needs in local warehouse should be distributed to evacuation shelter building. This space of local warehouse is proposed to input other logistic disaster needs (from regional warehouse).

Holding capacity value did not always depict the storage occupancy value. All of those are depending to various factors; area building and number of logistic needs. If the former is larger enough and the lattest is less enough, it tends to have the high value of storage occupancy ratio since logistic needs can be replaced long time in warehouse. From the calculation, it has been indicated that, the highest value of storage occupancy ratio is belonging to local warehouse at Sidakaya office while the lowest is belonging to local warehouse at *SMP Cilacap Selatan*. Since holding capacity, logistic weight, and logistic volume of local warehouse (*Sidakaya office*) has higher value and need to transport out immediately than local warehouse at *SMP Cilacap Selatan.*

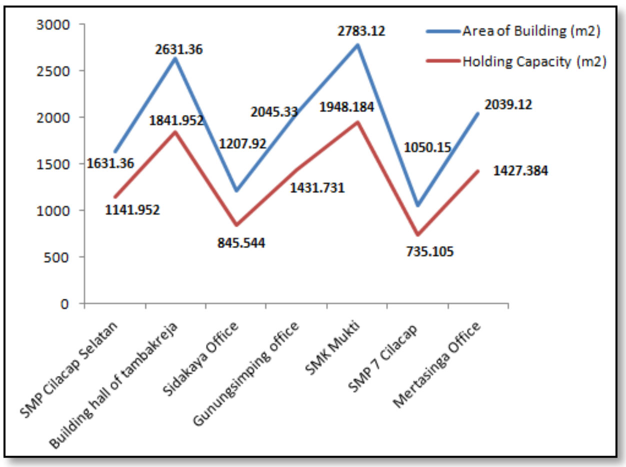


Figure 6.77 The correlation of Warehouse's Area Building and Warehouse's Holding Capacity

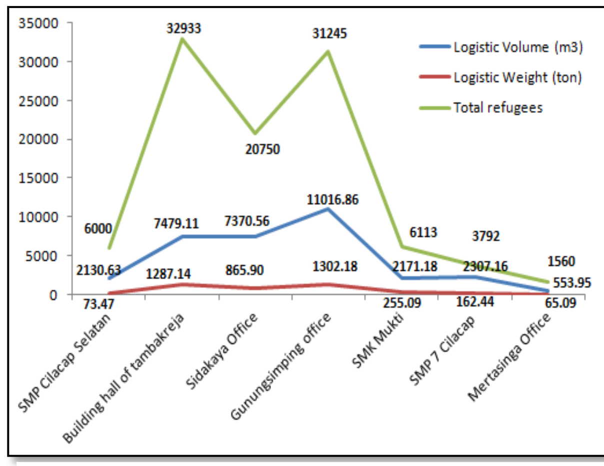


Figure 6.78 The correlation of Logistic Voulme, Logistic Weight, and Total refugees

Figure 6.80 shows the correlation between area building and warehouse holding capacity. Area building of warehouse has liniear correlation to warehouse holding capacity since both variables has same pattern line. The more area building of warehouse, the bigger logistic warehouse capacity to accommodate logistic needs. But it totally depends on the result value of Logistic Weight and Logistic Volume

Both logistic weight and logistic volume, in this resrach was calculated by knowing number of refugee's capacity accommodated of tsunami shelter. As consequence each of local warehouses has different number of shelter to be accommodated logistically. The more number shelter accommodated by local warehouse, the more value of logistic weight and logistic volume. The most logistic weight and logistic value are belonging to local warehouse at Building hall tambakreja and local warehouse at *Gunungsimping office* (see Figure 6.81).

CHAPTER 7. TRANSPORTATION ROUTES OF WAREHOUSE

This chapter tries to analyze the effectiveness of transportation routes in Network Analyst processing. This chapter will be divided in to several sub chapters: service area and closest facility os shelters to local warehouses and warehouse optimum routes.

7.1 SERVICE AREA AND CLOSEST FACILITY OF SHELTERS TO LOCAL WAREHOUSE

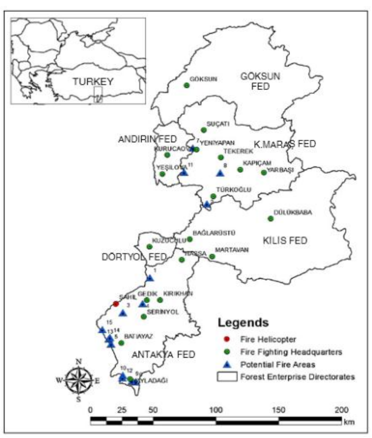
According to Liedtke (2012), the concept of logistic network comes from different transportation network. Transportation modeling and challenge could occurr since micro and macro gap of road network as his explain:

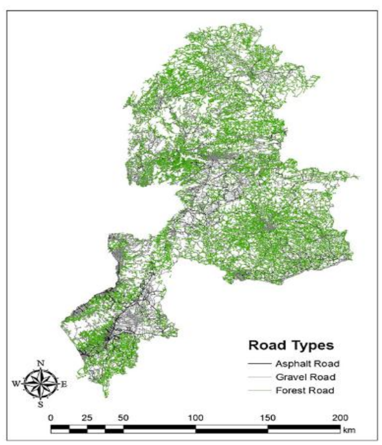
> *"The modeling method of logistic network could be based on two main characteristics; the changeability of network within models (fixed, partially variable and variable networks) and form of cost functions mapped (economies of scale, constant average cost, and methodologies and models that map variable networks)".*

Different flows of goods and road condition are routed over a multimodal transport (Sheffi 1985 after Liedtke, 2012). Meanwhile, the incorporating process of logistic operating program carried out such as warehousing and transportation network (Tavasszy et al 1998). In addition, the researchers and practitioners have been developing and incorporating more logistical details in to transport models in microscophic level (Wisetjindawat et al 2007 after Liedtke, 2012).

7.1.1 Service area and Closest Facility of Shelters to Local Warehouse in South of Cilacap

Service area and closest facility method are applied in to transportation routes both warehouse route and accessibility routes of local supplier to warehouses. According to Akay (2011) to his research mentioned that, the using of closest facility can be aimed to design the minimum travel time for each potential forest fire cases. He also stressed on integrating the multicomplex attribute data input; road material, land use, length of road, and travel time to his transportation model (see Figure 7.1).





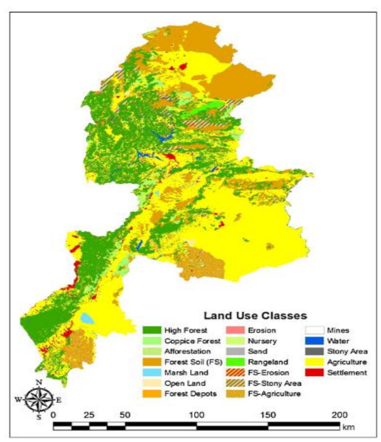


Figure 7.1 Point Forest Fire (Akay, 2011) **Figure 7.2 Road Material type** (Akay, 2011) **Figure 7.3 Landuse type** (Akay, 2011)

The transportation routes model conducted by Akay tried to determine and incorporate land use to road network attribute data. It aimed to obtain fire point of forest fire case. In addition, the routes were created by taking input data of length of road, material road type, and travel time. As the result, some road section might be closed or impacted by forest fire area. This becomes an important consideration for selecting routes that safe from forest fire disaster. Compared to Cilacap case, either optimum routes or closest facility route consider some similar factors to data input such as; length of road and travel time. But researcher did not consider the road material since

Cilacap city is dominated by asphalt material and also has good condition. Therefore, transportation routes in this research focus on considering the type of road and vehicle volumes. Local warehouse in South Cilacap can accommodate the logistical needs about twenty-five of tsunami shelters. The number of shelters that can be served by a local warehouse is not similar with other local warehouses. This really depends on the travel time required by the closest local warehouse to reach the shelter (see Figure 7.4 in South Cilacap case).

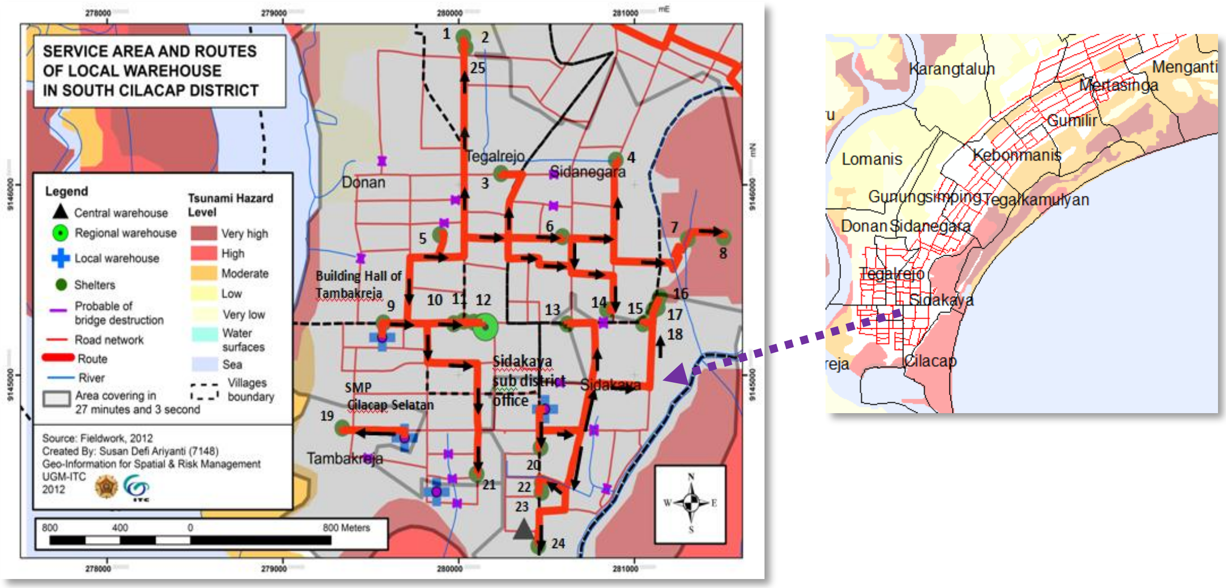


Figure 7.4 Service area of local warehouses to shelters in South Cilacap District: ***(1)SMA 1, (2)SDN Tegalrejo 02, (3)SMP Muh.2 (4)Gedung Asuransi (5)SMP2 (6)Gedung Golkar (7)SMP Purnama 1 (8) SMP Purnama 2 (9)SMP 3 (10)SD Al Irsyad 01 (11) SMA Al Irsyad (12)DPRD Cilacap (13) SMP N 8 (14)Masjid Darussalam (15)Hotel Cilacap Indah (16)SMK YKPE (17)AKBID Graha (18) Badan Diklat (19)Hotel Tiga Intan (20)SMA YOs Sudarso (21)Gedung Olahrga (22)RSU Santa Maria (23)SMP Pius Cilacap (24)SMP 1 (25)SDN Tegalrejo 01***

The fastest transportation routes of logistic delivery aims to reduce transportation cost and to obtain satisfaction of refugees' needs at the time of disaster. In this study, the distribution of disaster relief logistics attempted to avoid the presence of the bridge. The presence of the bridge may bother tranportation routes since it could be the bridge collapsed due to the earthquake or river flow inundation triggered by tsunami.

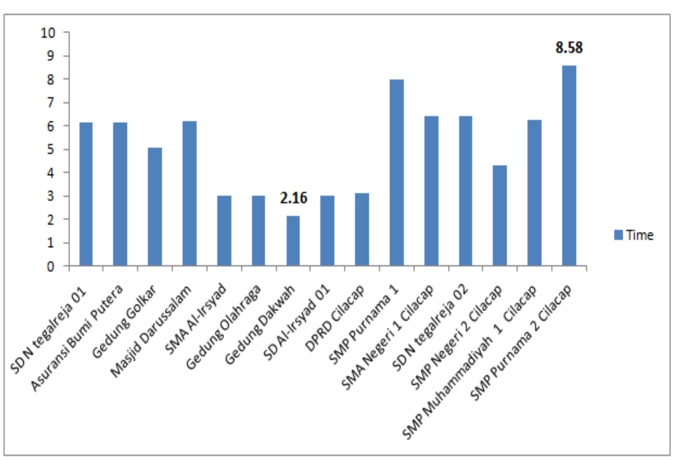


Figure 7.5 Travel time of Tambakreja hall local warehouse to shelters

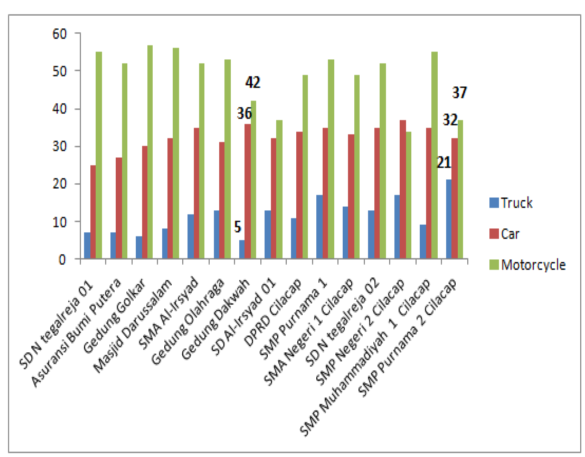


Figure 7.6 Traffic density of Tambakreja hall local warehouse to shelters

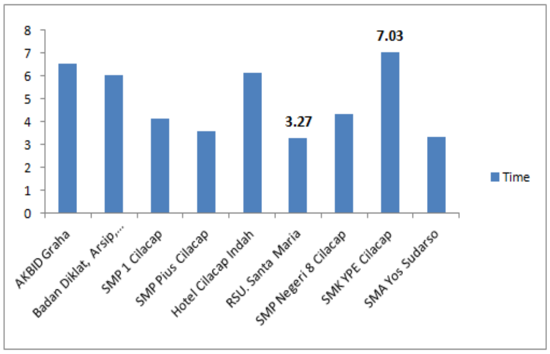


Figure 7.7 Travel time of Sidakaya local warehouses to shelters

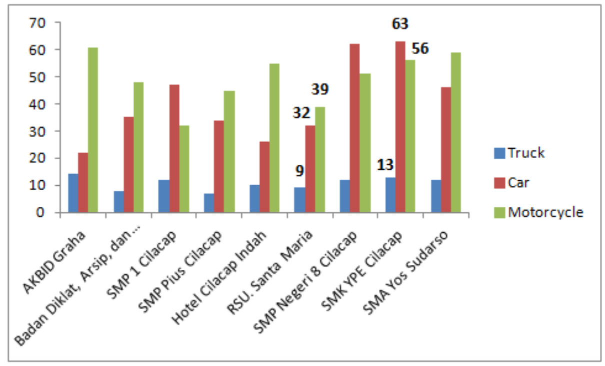


Figure 7.8 Traffic density of Sidakaya local warehouse to shelters

Based on the comparison of travel time and traffic density charts (see Figure 7.5 and Figure 7.6), The longest travel time of logistic needs is belonging to transportation routes from Tambakreja warehouse at *Building hall of Tambakreja* to tsunami shelter at *SMP Purnama2*. This is because of different of traffic density (especially number of trucks) is much more than other shelters. This route can take longer time, since tsunami shelter at *SMP Purnama 2* is located in high tsunami hazard zone. This route will impact to the distribution of disaster relief logistic since many buildings destroyed and collapsed of tsunami. Meanwhile, the fastest time of transportation routes from local warehouse at *Sidakaya office* to shelter is belonging to tsunami shelter at *RSU Santa Maria*, while the longest travel time from is belonging *SMK YPE* shelter. It mainly due to traffic density factor (most of traffic density toward to local warehouse at *SMK YPE* are densely of traffic congestion). Local warehouse at tambakreja office is completely suitable for tsunami warehouse (from classification and market accessibility), but this warehouse is located adjacent to the river where consist of bridges. This position will influence and bother disaster relief.

7.1.2 Service area and Closest Facility of Shelters to Local Warehouse in Central of Cilacap

Local logistic warehouses in Central Cilacap can supply logistics needs for nine tsunami shelters. These tsunami shelters scattered in Sidanegara and gunungsimping villages (see Figure 7.9).

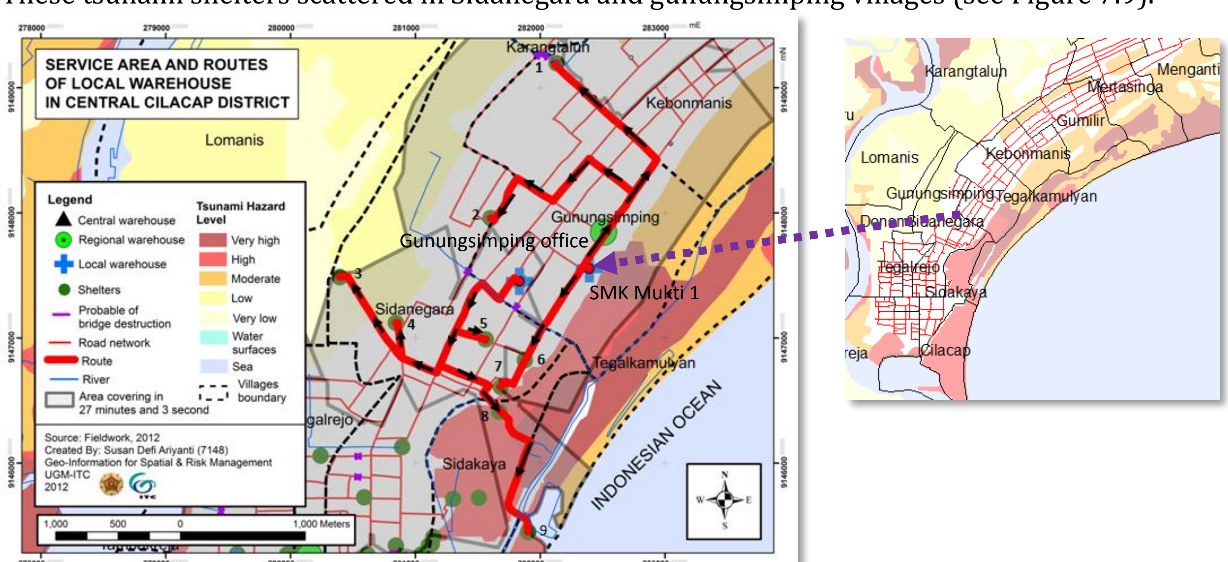


Figure 7.9 Service area of local warehouses to shelters in Central Cilacap District: *(1)RSI Fatimah, (2)AMN Cilacap, (3)Hotel Mutiara, (4)SMPN 6 (5)Asrama STIKES (6)SMP 4 Cilacap (7)SD Negeri 08 Sidanegara (8)Politeknik Cilacap (9)Rusunawa*

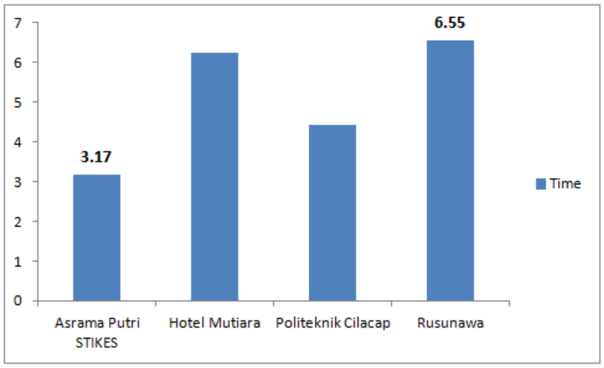


Figure 7.10 Travel time of SMK Mukti 1 local warehouse to shelters

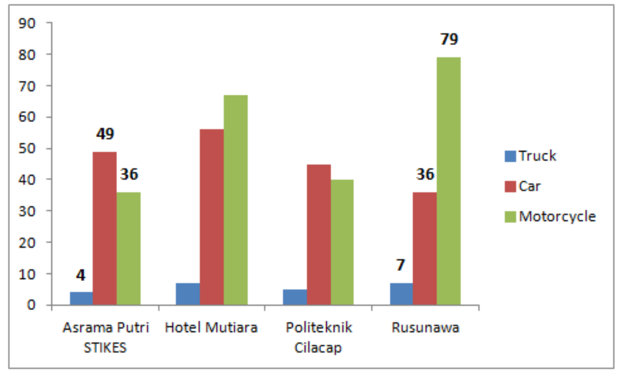


Figure 7.11 Traffic density of SMK Mukti 1 local warehouse to shelters

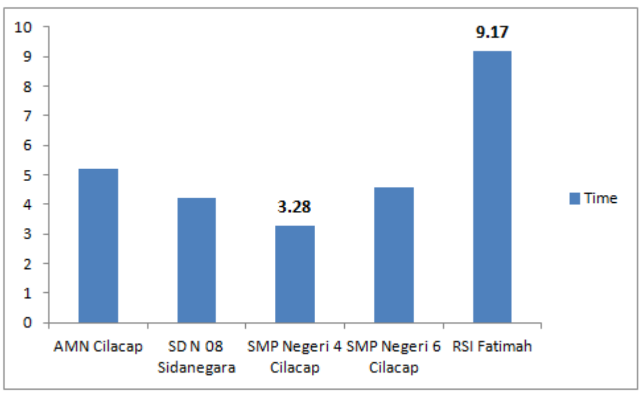


Figure 7.12 Travel time of Gunung simping local warehouse to shelters

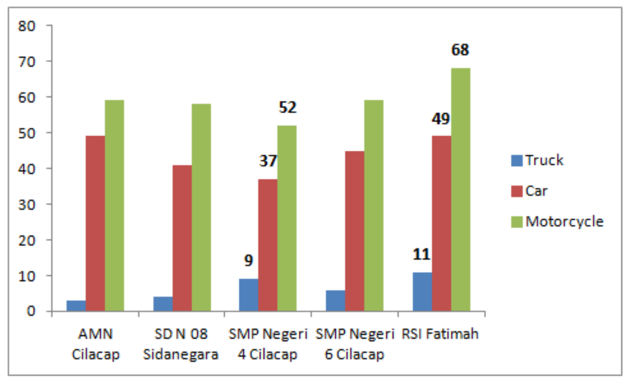


Figure 7.13 Traffic density of Gunungsimping local warehouse to shelters

Local warehouse at *SMK Mukti 1* can access *Asrama Putri STIKES* tsunami shelter in shortest time (3 minutes 17 seconds), while the longest time of logistic delivery is belonging to *Rusunawa* shelter (6 minutes 55 second). As well as other trsnportation routes, differences of the travel time due to both of length road and amount of traffic volume since number vehicles of *Rusunawa shelter* routes is completely more than *Asrama Putri STIKES* shelter.

In addition, local warehouse at *Gunungsimping office* can accommodate 5 shelters according to closest facility method of Network Analyst. The shortest time of that route is belonging to shelter at *SMP Negeri 4* (take 3 minutes and 28 second) (see Figure 7.12) while the longest travel time towards to shelter at *RSI Fatimah*. The longest of logistic travel time toward to *RSI Fatimah* shelter due to the volume of vehicles of that route is numerous and complex; trucks (11), car (49), and motorcycles (68) (see Figure 7.13). The number of vehicles that may lead to more congestion and traffic flow becomes slower. In addition, warehouse logistics service from gunungsimping warehouse towards to *Politeknik* and *Rusunawa* shelter has barrier because of tsunami inundation (see Figure 7.9). This condition will impact to logistic delivery as well as logistic transportation routes in *SMP Purnama 2* shelter.

7.1.3 Service area and Closest Facility of Shelters to Local Warehouse in North of Cilacap

Disaster logistic needs in North Cilacap district can be accommodated by two local warehouses (see Figure 7.14); since number of tsunami shelters located in North Cilacap district are (there are only four tsunami shelter in Gumilir nad Mertasinga villages). The presence of fewest number of tsunami shelter because it was quite far from coast and the population is not so dense compared to Central and North Cilacap district.

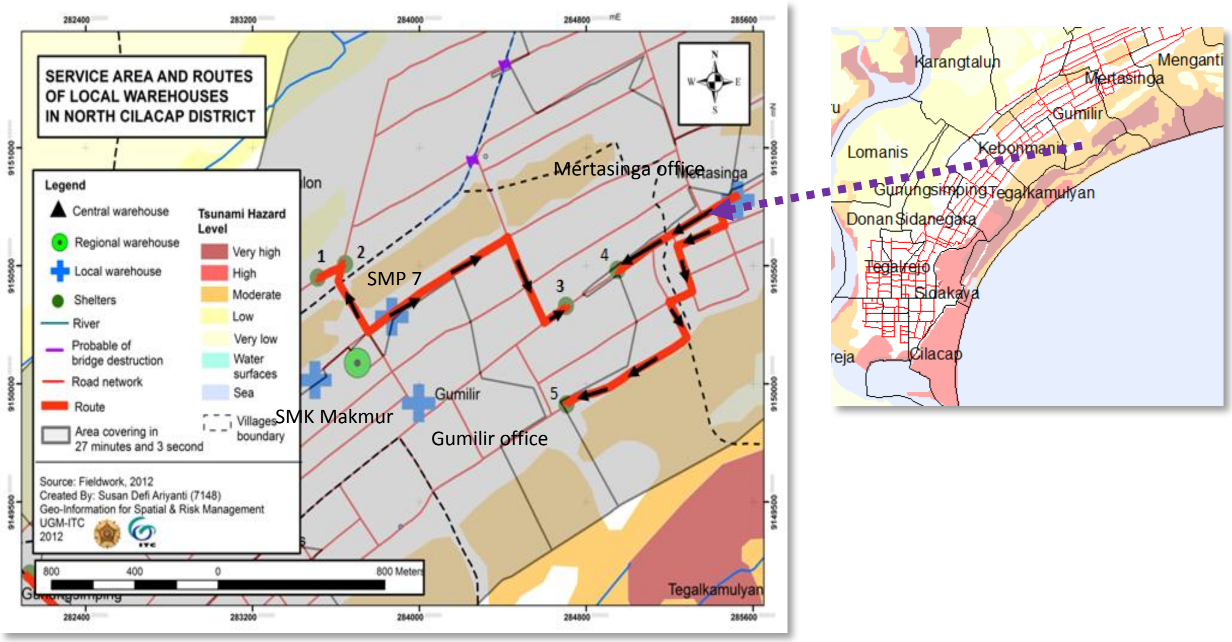


Figure 7.14 Service area of local warehouses to shelters in Central Cilacap District: *(1)SMP Muhammadiyah1, (2)BPC Gapensi (3)SMP PGRI 1 (4)Masjid Al-Jihad (5)PMI Cilacap*

Among four local warehouses, it appeared that the most effective local warehouse logistics in distributing disaster logistic is *SMK Makmur* warehouse and *Mertasinga* local warehouse. Both local warehouses are possible to distribute in a relatively since it has short time compared local warehouse at *SMP 7* and local warehouse at *Gumilir office*. Local warehouse at SMK Makmur can accommodate three tsunami shelters (*SMP Muhammadiyah1 BPC Gapensi, and SMP PGRI1*), while local warehouse at *Mertasinga office* can accommodate logistic needs for two shelters (*Masjid Al-Jihad and PMI*) (see Figure 7.14).

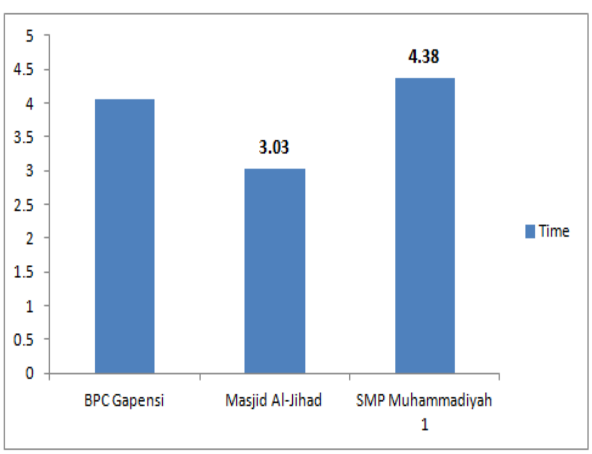


Figure 7.15 Travel time of SMK Makmur local warehouse to shelters

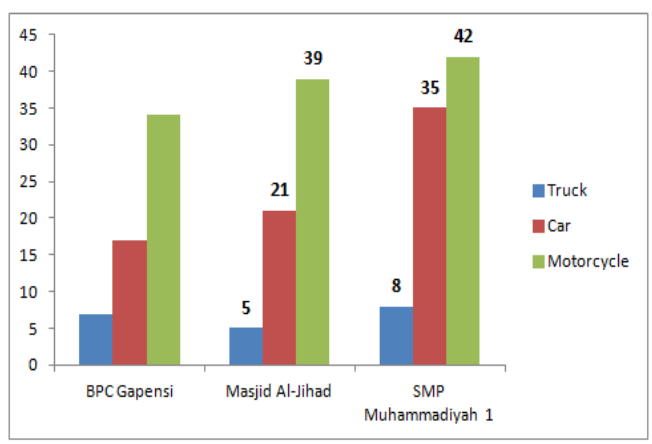


Figure 7.16 Traffic density of SMK Makmur local warehouse to shelters

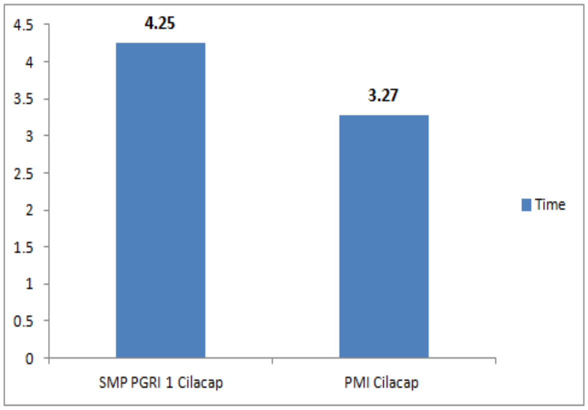


Figure 7.17 Travel time of Mertasinga local warehouse to shelters

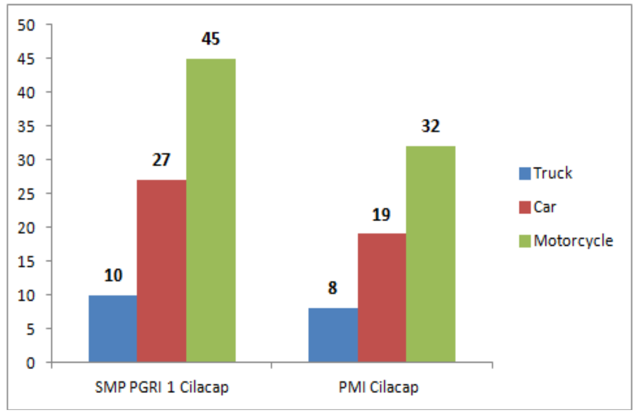


Figure 7.18 Traffic density of Mertasinga local warehouse to shelters

The shortest time taken of logistic delivery from local warehouse at SMK Makmur to tsunami *ih* shelter (3 minutes 3 seconds) while the longest route of logistic routes toward shelter SMP Muhammadiyah 1 (takes 4 minutes 38 seconds) (see Figure 7.15) since the number of vehicles to *Masjid Al-Jihad* shelter relatively less compared to the number of vehicles on the route towards shelter of *SMP Muhammadiyah 1*.

The similar thing can be illustrated in chart of travel time and traffic volume for local warehouse at *mertasinga office*. Local Warehouse at *mertasinga office* take a longer time to reach *SMP PGRI 1* shelter compared with *PMI Cilacap* shelter (a gap of travel time of 1 minute 38 seconds) (see Figure 7.17) . This difference is caused by some factors; length and volume of vehicles passing through the two routes are significantly different. For example, the length of road towards shelter at *SMP PGRI 1* (1599.45 meters) is longest distance while the length of road towards local shelter at *PMI* is 674.16 meters. And even traffic density from local warehouse to shelter at SMP PGRI 1 is also more than shelter at PMI Cilacap.

7.2 WAREHOUSE OPTIMUM ROUTES

(Ichoua et al. 2000; Gendreau et al 2001 after Liedtke, 2012) stated that recently, vehicles problem become important factor of road network as his statement below.

"Vehicle problem especially transportation in real time should be updated dynamically as vehicle travel across a network since the real time solutions allow for vehicle movement within a n etwork, changing network pathways."

Liedtke suggested to solve vehicles problem can be used GIS approach; Network Analyst approach. In his research Network analyst tools is used to find and determine the optimal routing for selecting of a new route reaches forest fire in Turkey since this shortest routes is utilized for fire engine. According to this research, this research also considers different road types and critical time in for vehicles to arrive in destination point. As well logistic distribution as forest fire cases, both commonly use truck vehicles to reach destination place and in fastest time. But this research does not consider road materials since Cilacap's road are generally good condition.

Liedtke also explained, transportation rotes models should determine between short and long term reaction. The short term reaction belongs to the change of traffic flows that are routed in to transportation network whereas long term reactions are based on the change of the structure

(topology) of network. Usually, the long term scenario of warehouse can decline the cost of transportation (Gudehus, 2005 after Liedtke, 2012).
In this research, the using of Network Analyst tool is strongly functioned to determine the coverage area of a local warehouse in distributing logistics to the closest shelters. The considerations emphasized the travel time taken between the local warehouses to closest shelter. Network analyst executed service area polygons of local warehouse that do not overlap with the other coverage polygons. It aimed to distribute logistic needs of a local warehouse which do not overlap with other local warehouses. Warehouse optimum routes on this study are done to obtain alternatives way to reach transportation routes form central-regional-local warehouse in the shortest possible time and can be accessed by truck logistically.

Result of roadnetwork's attributes execution (Network Analyst) describes that, the shortest road network does not reflect the shortest time taken, and also the longest road network does not mean the longest time taken. It totally depends on numerous factor carried out; condition of road network, bridge factor (barrier factor), traffic density, urban and rural factor, etc. If road network belongs to good condition, it will cause traffic-lane more fluently and take shortest time to reach destination place while destructive road and bridge will impact long time to be accessed. Third; urban and rural factor since urban area has more type of road and densely populated than rural area.

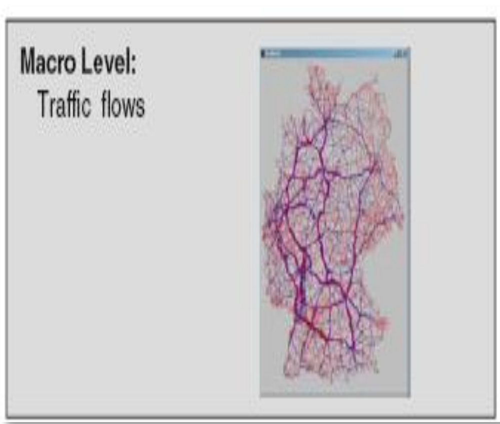


Figure 7.19 Macro level of routes (Liedtke, 2012)

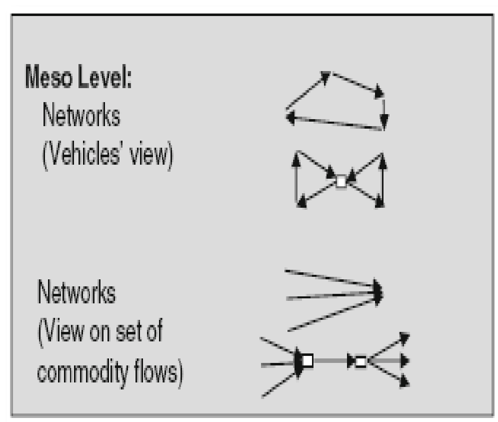


Figure 7.20 Meso level of routes (Liedtke, 2012)

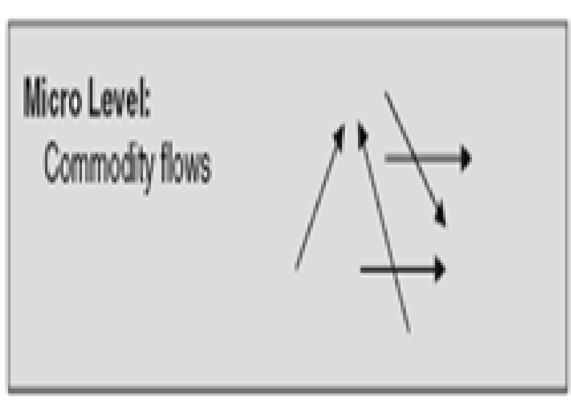


Figure 7.21 Micro level of routes (Liedtke, 2012)

Still motivated by research done Liedtke (2012), He distinguished the freight transportation in to different level as; macro level, meso level, and micro level (see Figure 7.19, Figure 7.20, and Figure

7.21). Division of freight transportation effected to complex logistic network phenomenon and represented gap between macro and micro level. Furthemore, Liedtke stated that macro level of freight transportation was belonging and influencing to the perspective of transportation planners and policy makers. Macro level also considered to vehicle flows in infrastructure network and even involved many distribution points. Meanwhile, the micro level of freight transportation only depicted the two points; sender and recipient. Meso level of freight transportation was described as when the combination of some microscopic commodity flows between sender (logistic warehouse) and recipient (tsunami shelter).

George (2007) had defined transportation network:
"The kernel framework in spatio-temporal aspect and require road network data support of their large and multidimensional data."

He took the example of *Advanced Traveler Information System and Intelligent Vehicle Highway System* method as his model. That model tried to find a suitable a spending travel time of road network by inputing different time measurement of traffic congestion (see Figure 7.22).

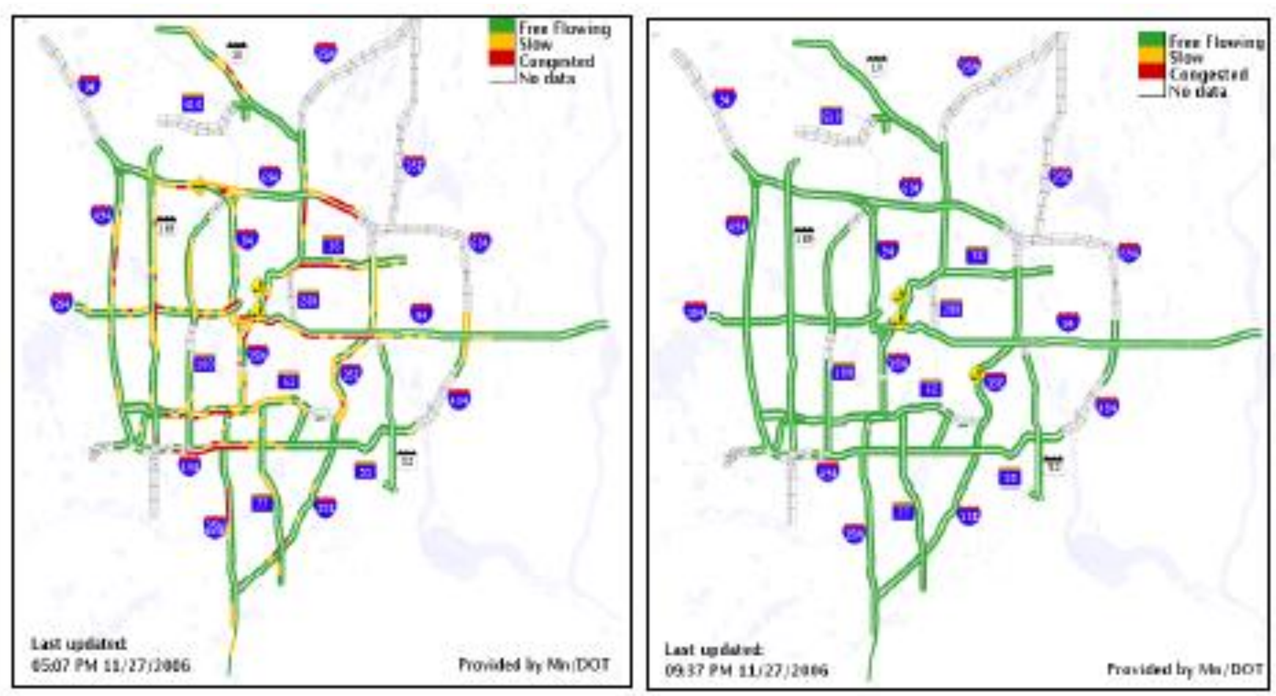


Figure 7.22 Sensor network report periodically report time-variant and traffic volume (George, 2007)

Figure 7.22 above depicted transportion road in time varying (5: 07 pm and 9:37 pm). The result of research shows that, different traffic congestion in 5:07 pm and 9:37 pm. In 5:07 pm, the condition of traffic congestion was likely more varying value since each parameter of free flowing, slow, and congested condition. Meanwhile the measurement in (9:37 pm) showed the road network mostly free flowing of traffic congestion. Compared to this research, researcher did not consider varying time of measurement since logistic delivery was enough difficult to predict in tsunami post disaster in Cilacap. However, both of this research and George's research had similar variables since they considered traffic congestion which means the number and type of transportation used is calculated.

7.2.1Warehouses optimum routes in South of Cilacap

The optimum route is such an important query on spatio-temporal of computation's road network data. In computerizing calculation, it was developed by efficient algorithms with various times. This computation was being done either for a given time and length of road.

Disaster relief of logistics in South Cilacap could be distributed within 35 route directions (see Figure 7.24). This route can be accessed in 15 minutes with road length is about 5459.9 meters. This route covers all road types except the national road type. The longer road segments which can be accessed are belonging to local road 15 and other road 37 (see Figure 7.24). Both road segments (local road 15 and other road 37) can be reached within a period of 1 minute (the route marked on the map magnifier) since length of road and traffic density is relatively dense.

However, the optimum route of logistic distribution in South Cilacap is the fastest route than logistics route in Central and North Cilacap. This is because central warehouse located in South Cilacap so distance logistic route becomes shorter. In addition, road segments in South Cilacap tend to be more complex and many alternative routes disaster logistics distribution.

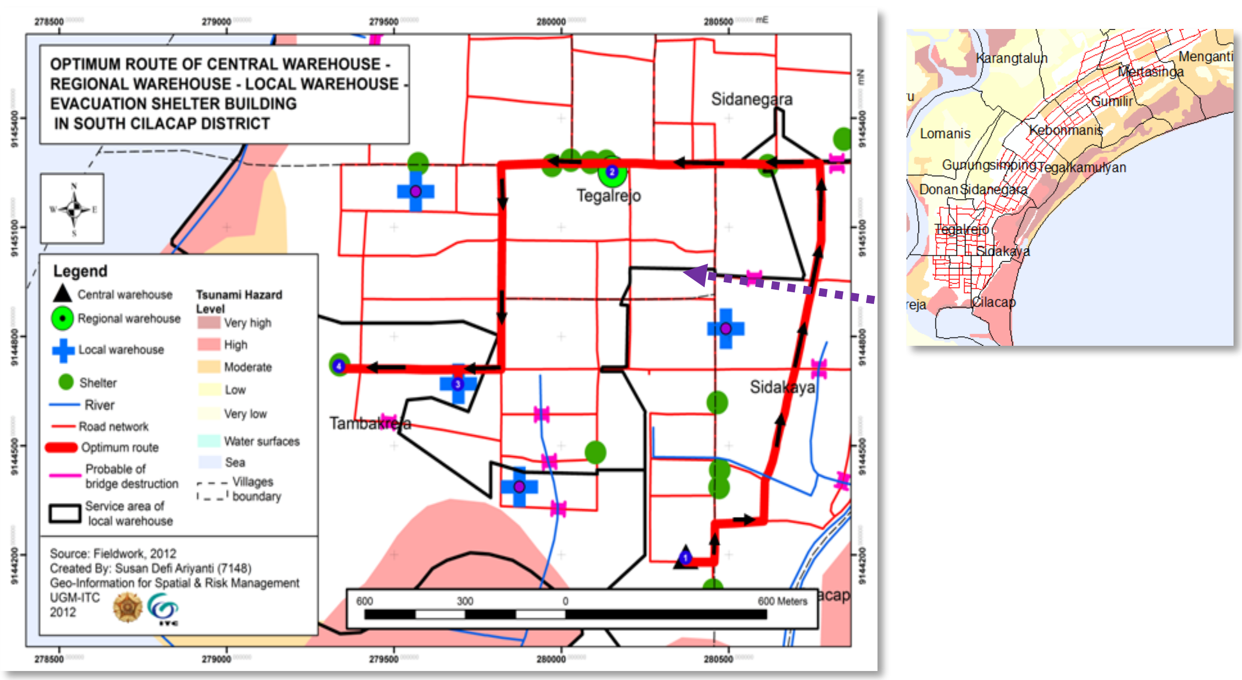


Figure 7.23 Optimum Routes of Central-Regional-Local warehouse-Shelter in South Cilacap

According to freight transportation level, optimum routes of logistic distribution relief (central – regional – local warehouses- tsunami shelter) is categorized at meso level transportation routes since it involves approximately more than one transition logistic points (regional and local warehouses) and ended in tsunami shelter (final point). In context of transportation term, this route includes as the short term route since it was generated by flow transportation which only distinguished by structure of transportation data attributes without changing topology's network.

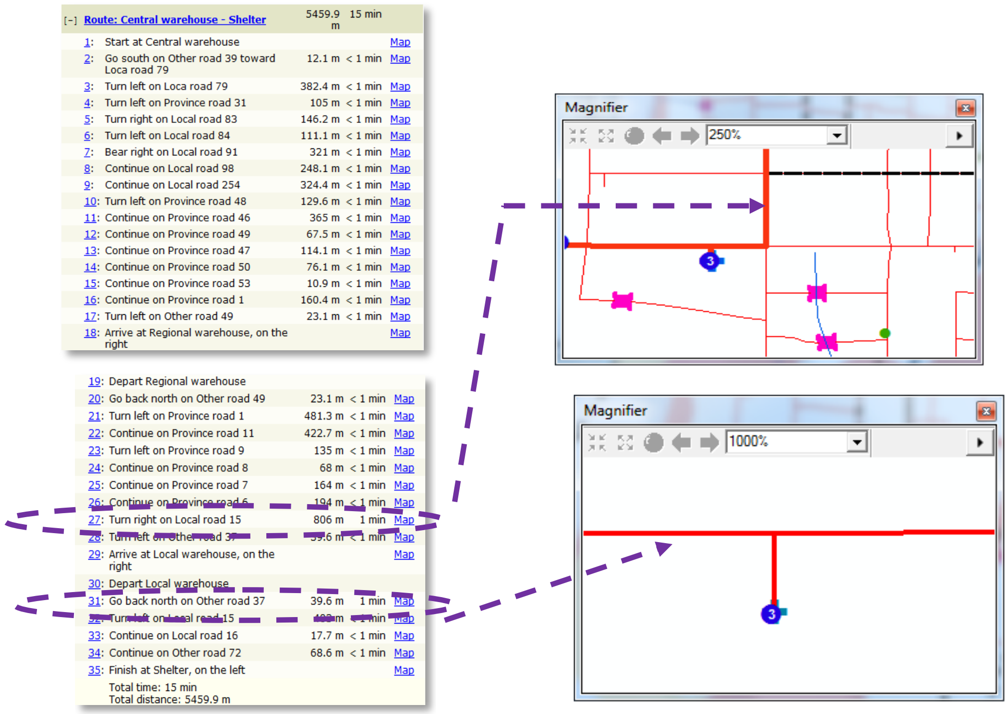


Figure 7.24 Directional routes of Central-Regional-Local warehouses-Shelter in South Cilacap

7.2.2Warehouses optimum routes in Central of Cilacap

The model of logistic transportion routes in central Cilcap can be travelled within 27 minutes (see Figure 7.26). Travel time of this route can be travelled maximally by 9113.8 meters with through 51 road segments. According to Figure 7.26, road segments which have longer of travel time are belonging to local roads 112 and local roads 146. The former road segments can be accessed within 2 minutes and the lattest can be travelled within 4 minutes.

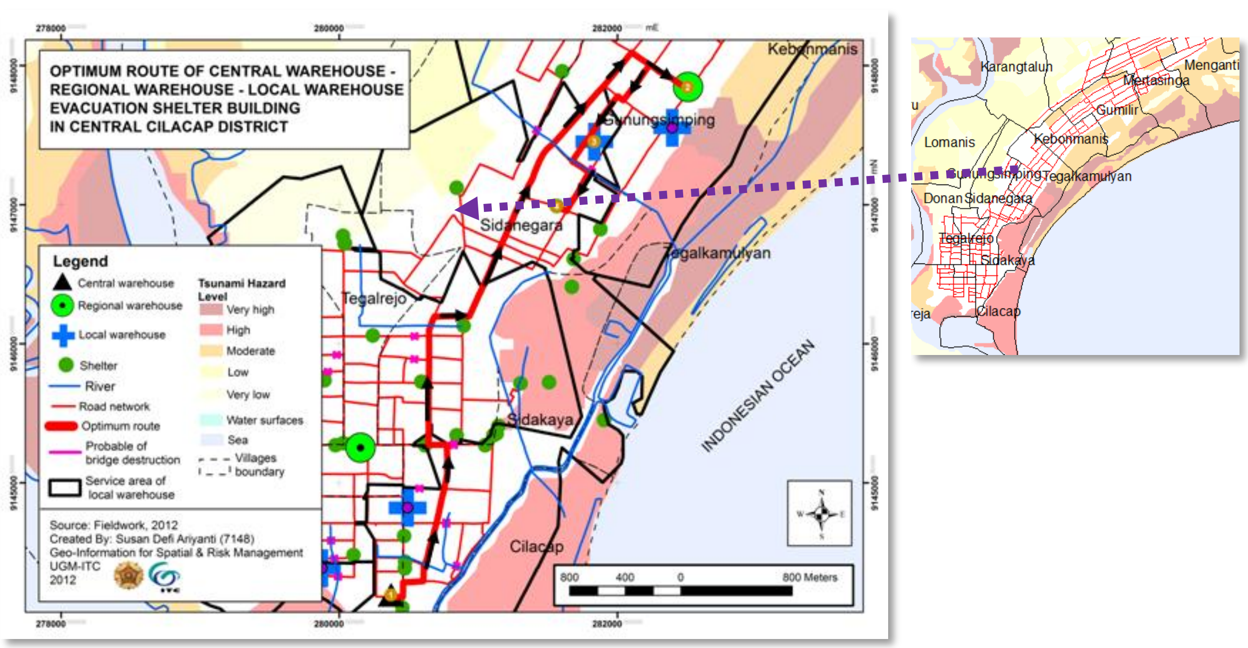


Figure 7.25 Optimum Routes of Central-Regional-Local warehouse-Shelter in Central Cilacap

This optimum routes is relatively take longer of travel time than logistic optimum routes in South of Cilacap since it has longer distance since it has a combination of all of road types (other roads, local roads, provincial and national roads). The presence of national road likely will extend travel time since the national road and the road are the main road link between the province and other provinces. National road will be compacted by type of vehicles and even traffic jam.

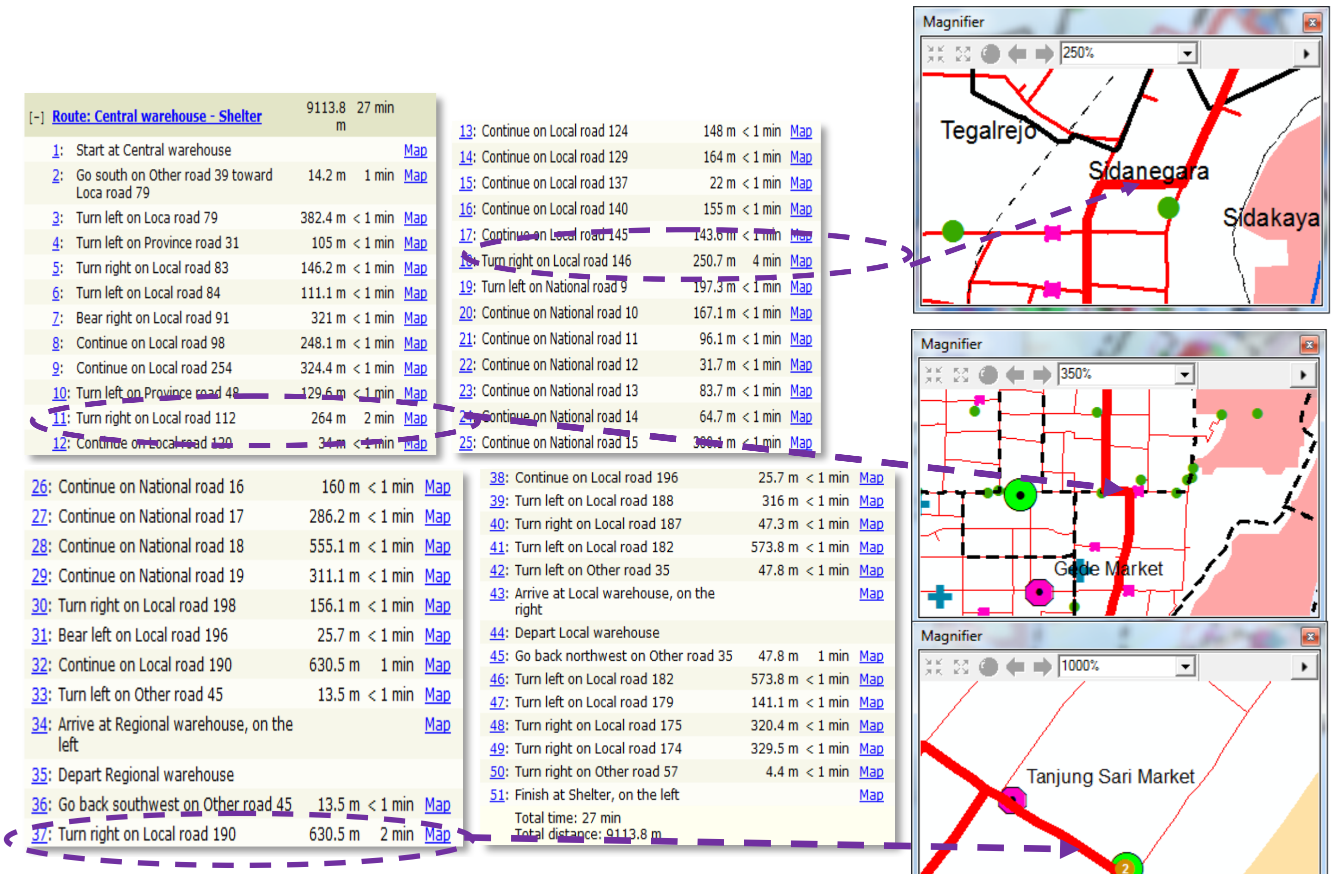


Figure 7.26 Directional routes of Central-Regional-Local warehouses-Shelter in Central Cilacap

7.2.3 Warehouses optimum routes in North of Cilacap

A warehouse optimum route in North Cilacap is the farthest distance than warehouse optimum routes in South and Central warehouse. This logistic route can be travelled within 30 minutes in 9940.9 length of road (see Figure 7.27). The longest of travel time due to many road segments should be travelled and this route is also dominated by national road. As mentioned before that, the presence of national road commonly indicated traffic congestion. Based on Figure 7.28, this optimum route of central-regional-local warehouse-tsunami shelter has 58 road directions. Both local road 146 and another road 31 are the longest travel time since they can be accessed within 4 minutes and 2 minutes.

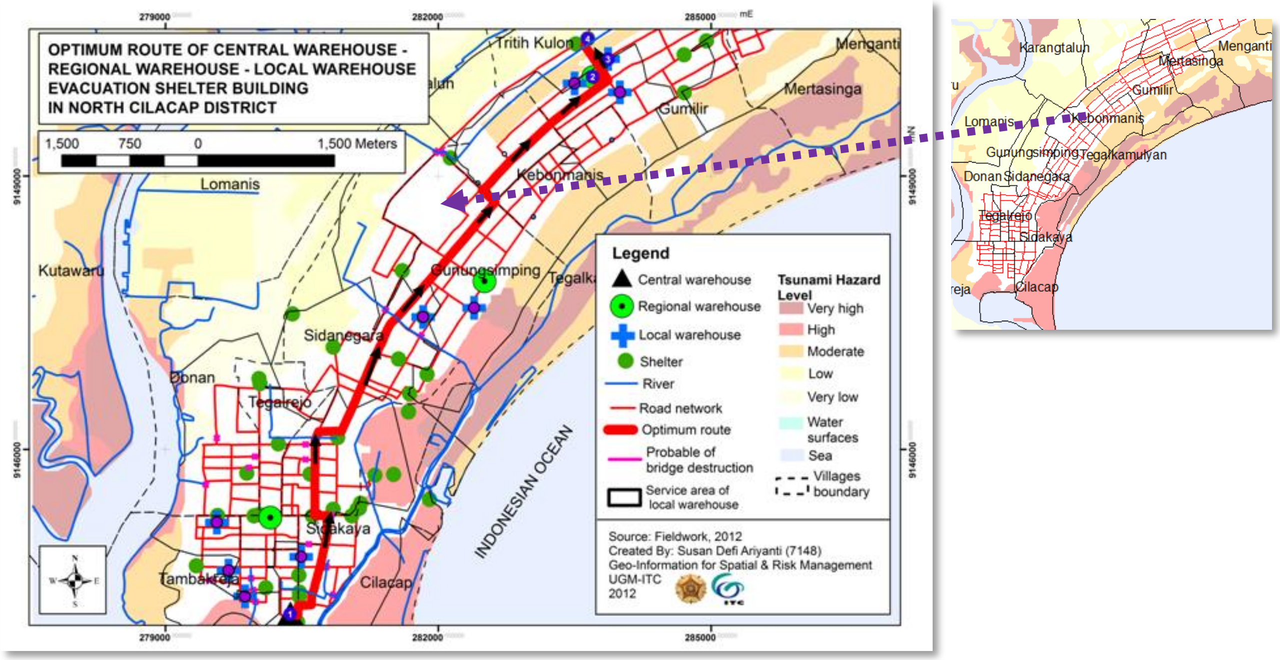


Figure 7.27 Optimum Routes of Central-Regional-Local warehouse-Shelter in North Cilacap

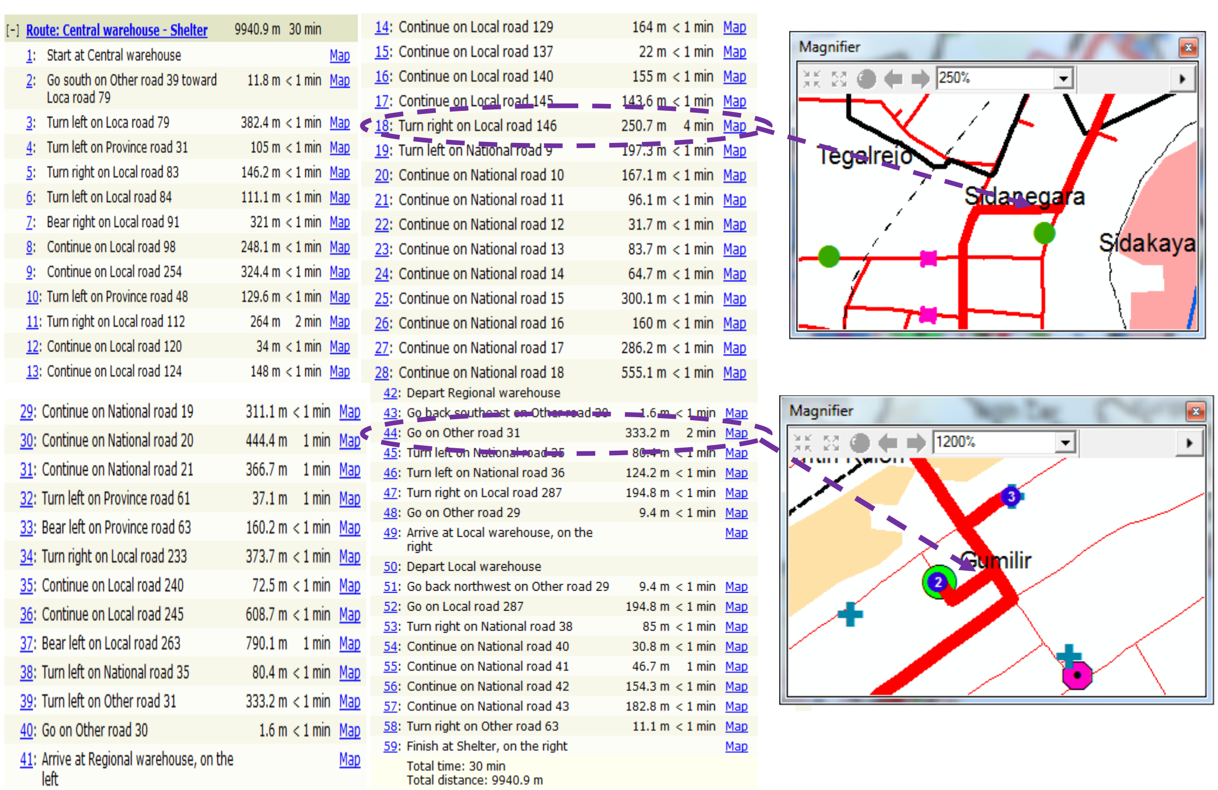


Figure 7.28 Directional routes of Central-Regional-Local warehouses-Shelter in North

7.3 COMPARISON TRAVEL TIME OF SINGLE LOGISTIC WAREHOUSE AND LOCAL WAREHOUSE

Wandelin (2012) in his research entitled *The Impact of rising Oil Price on Logistics networks and Transportation Greenhouse gas emission*, stated that network of logistic distribution can produce variety configuration of relief distribution. The point catched of research findings conducted by wandelin (2012):

"The total numbers of transshipment facilities or warehouses with their relief distribution define the degree of centralization".

That statement means the presence of warehouses linked to the lower transportation cost than centralized logistic network since the role of warehouses can also provide the shorter time to destination place. As the consequences, transitions logistic (warehouses) will influence low cost of oil prices. The fuel consumption is major issues since it becomes criteria factor of growth economic value. Relation between fuels cost and existence of logistic warehouses can be depicted as Figure 7.29 belows. This illustration depicted the much more optimal warehouses, the lower logistic cost (oil cost and losing cost)

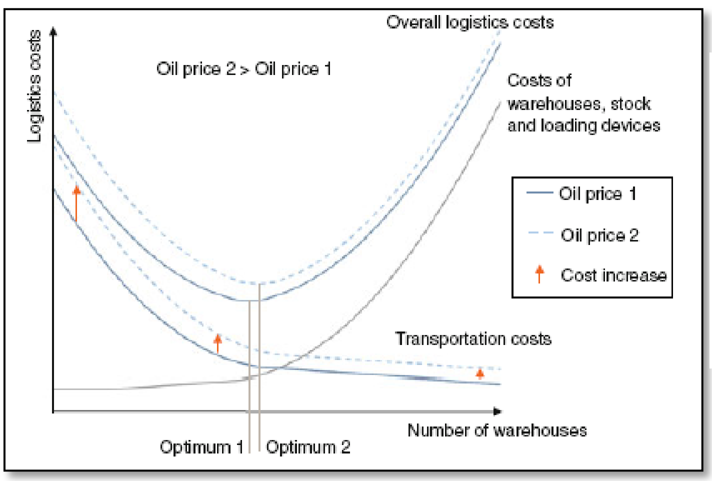
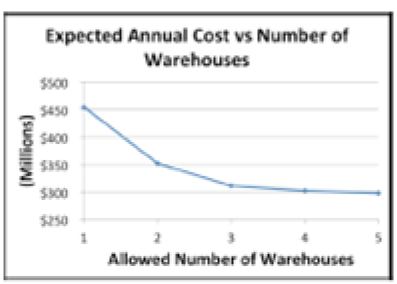


Figure 7.29 Theoretical dependency of optimal number of warehouses, logistics cost and oil price (Wandelin, 2012)

Ilustrated different scenario of oil price 1 and oil price 2. Overall logistic cost depend on stock and loading device, the higher logistic stock the higher cost, but strongly depend on the number of warehouses.



Maximum Number of Warehouse Locations				
1	2	3	4	5
Miami	Miami India	Miami India Singapore	Miami India Singapore Honduras	Miami India Singapore Honduras Kenya

Figure 7.30 the Relation between number of warehouses location and expected annual cost (Anonim, 2012)

According to Anonim(2012) also mentioned similar things as Wandelin (2012)disaster warehouses can be functioned to reduce transportation route.

According to the explanation related in Figure 7.30, the model of warehouse location was designed in macro scale since it involved a large scale of network since it depicted many potential warehouse location and potential disaster sites. Road network of logistic distribution needs will the exchange of topology' network (this changing due to physical and direction changing of road network).

From the Figure 7.31, it could be known that as more warehouses increases as much operating cost decreases. This is because logistic routes becomes shorter (logistic routes from local warehouse – tsunami shelter is commonly shorter than logistic routes from local warehouse –shelter). As previous research (see Figure 7.31) was illustrated that single warehouse in Miami had expected annual operating cost of $455 million. Meanwhile, by adding the additional warehouse can decrease the annual operating cost become $100 million. This finding had supported the result of research and also proved logistic distribution in Cilacap might be lower since the presence of logistic warehouses

Distribution of logistic needs in this research can be designed in to 3 scenario which each of scenario is travelled during 1 day. Those scenarios are derived: 1) Logistic routes from local warehouse –tsunami shelters, 2) logistic routes from regional warehouse – local warehouses, 3) logistic routes from central-regional-local warehouse-tsunami shelter. Those routes area able to apply in Cilacap depend on commands of local government. In this research is proposed to compare travel time of logistic distribution from central warehouse- tsunami shelter and from local warehouse-shelter. It aims to show different travel time taken. Furthermore, it will be explained in the next sub chapter.

7.3.1.Comparison travel time of single logistic warehouse and local warehouses in South Cilacap

The existence of a local warehouse in South Cilacap tends to reduce the distribution logistics' time. It is proved that total time required for transporting logistics with or without warehouse have a range of long time (a gap is about 7 minutes and 43 second) (see Figure 7.34).

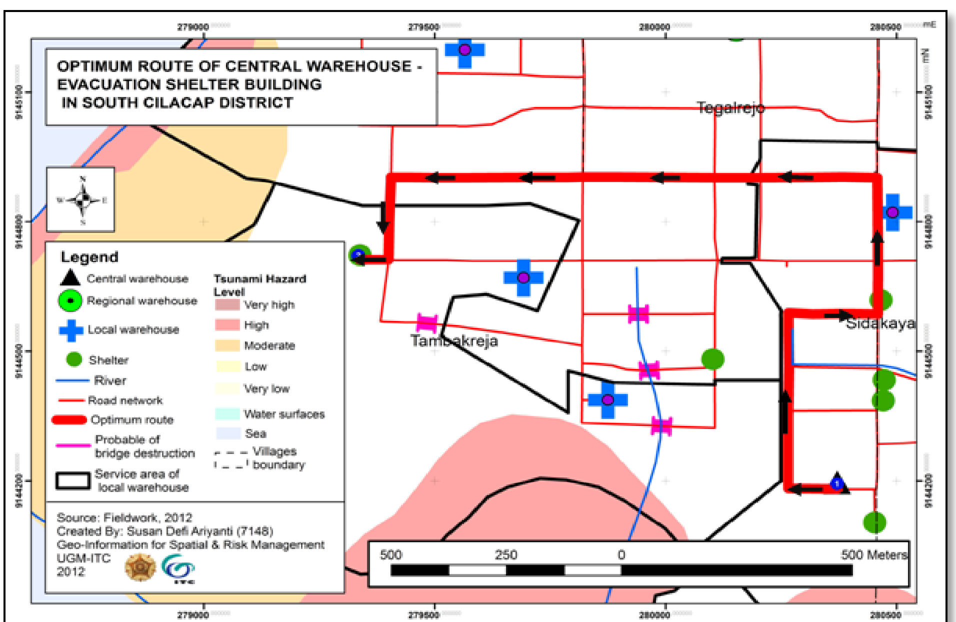


Figure 7.31 Optimum route of central wraehouse-Shelter in South Cilacap (2752.7 meter) (local road, province road, and other road)

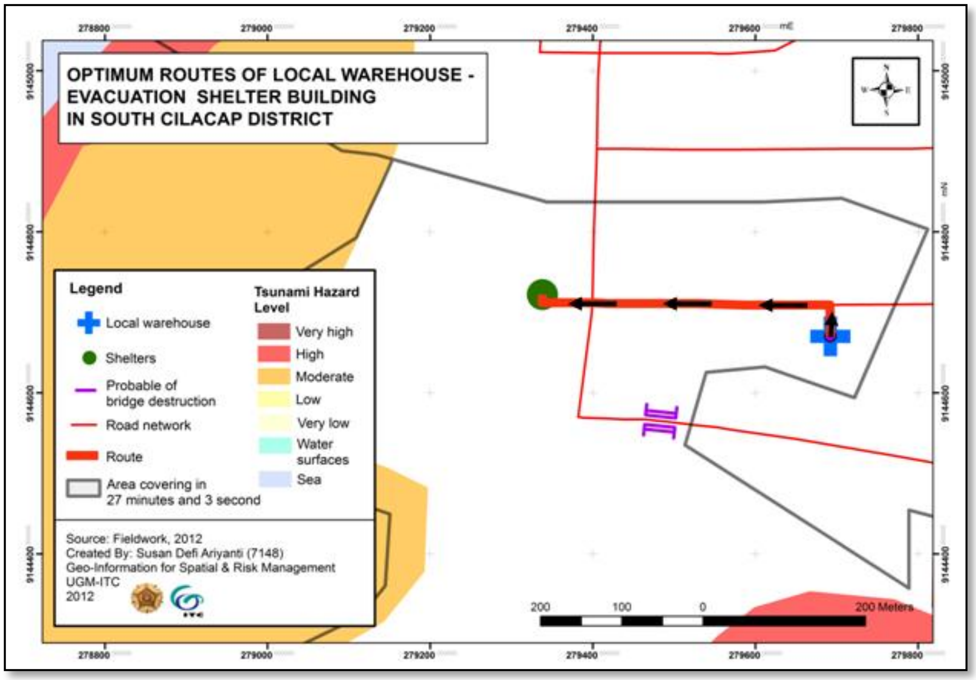


Figure 7.32 Optimum route local warehouse-shelter in South Cilacap (402.98 meter) (other road and local road)

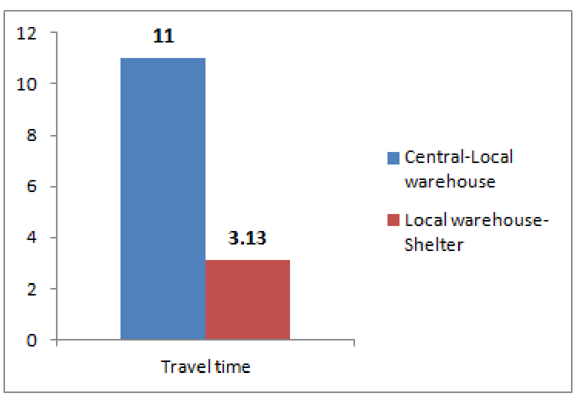


Figure 7.33 Travel time of logistic distribution in South Cilacap

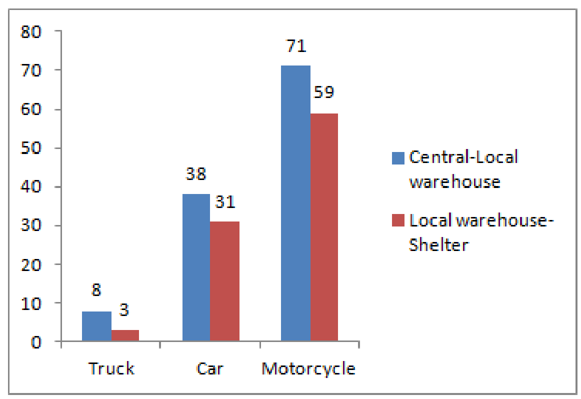


Figure 7.34 Traffic density measurement in South Cilacap

For example, the existence of local logistics warehouse in South Cilacap can be distributed logistic needs which only 3 minutes and 13 second while logistic routes which only organized single central warehouse take 11 minutes of travel time. This is because routes from local warehouse – shelter is shorter than from central – shelter (see Figure 7.32 and Figure 7.33). Different both of travel time is completely caused different traffic density (see Figure 7.35)

7.3.2. Comparison travel time of single logistic warehouse and local warehouses in Central Cilacap

Logistics transport route from central warehouse to tsunami shelter in Central Cilacap District is far enough compared to the same route in the District of South Cilacap (Figure 7.38). The route takes at least 15 minutes with the length of road of 4236.3 meters. However, the route can be completed in a relatively short time in the presence of local warehouses which only need 3 minutes and 17 second (Figure 7.36). Transport route from the local warehouse to tsunami shelter tend to be shorter since it takes different segment routes compared central warehouse-shelter (each of road segment represent different travel time, length of road, and traffic density). In addition, logistic routes from local warehouse-tsunami shelter are generally dominated by other roads. This type of road is not a major transportation road traveled for inter-city so traffic congestion tends to be less (Figure 7.39). Compared to the optimum route from the central warehouse to the shelter, the type of road used a type of national roads and provincial roads type (see Figure 7.38). Both road types are used as a major of transportation routes so that travel time becomes longer.

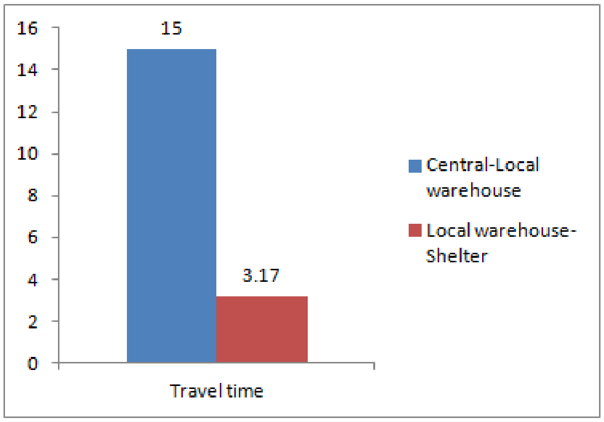


Figure 7.35 Travel time of logistic distribution in Central Cilacap

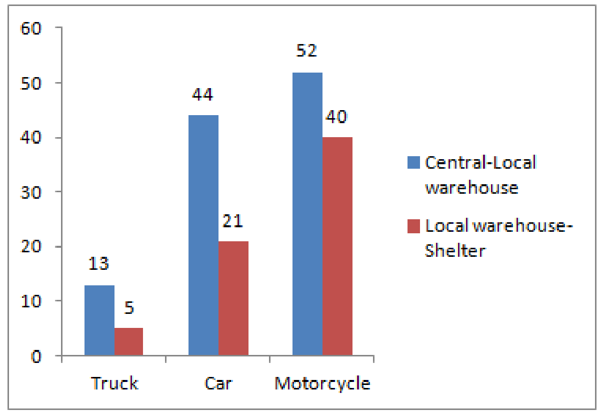


Figure 7.36 Traffic density measurement in Central Cilacap

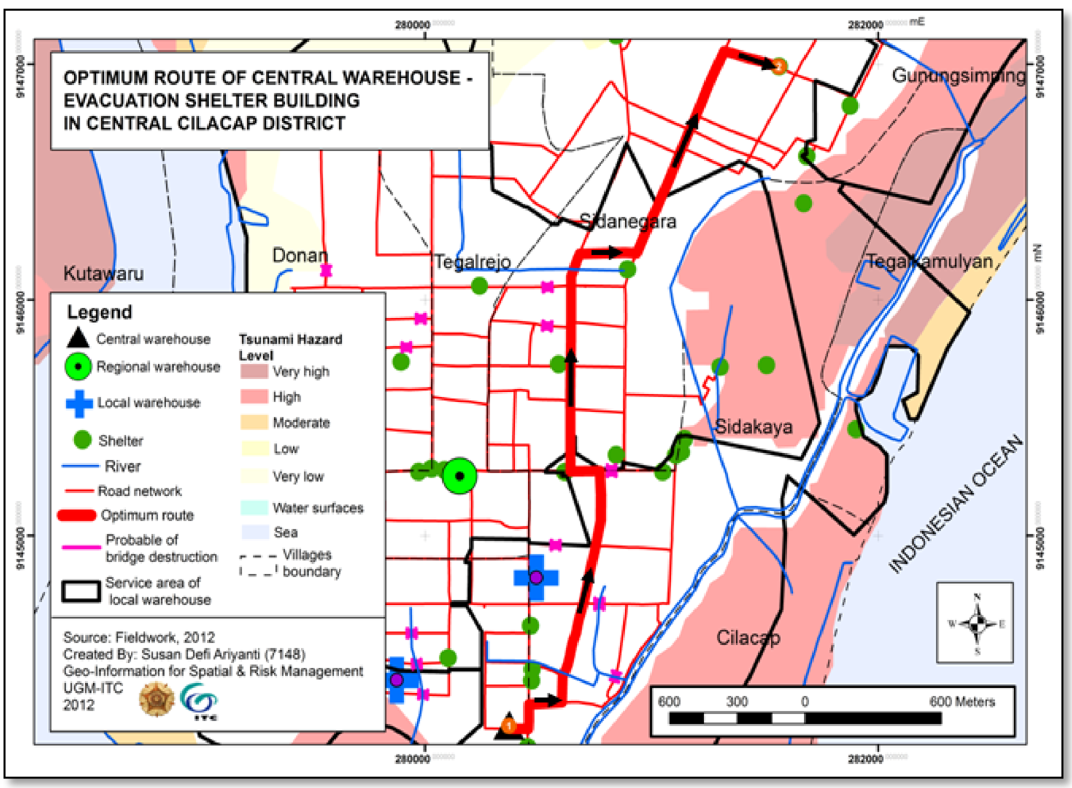


Figure 7.37 Optimum route of central Warehouse-Shelter (426.3 meter) in Central Cilacap (local road, province road, other road, and national road)

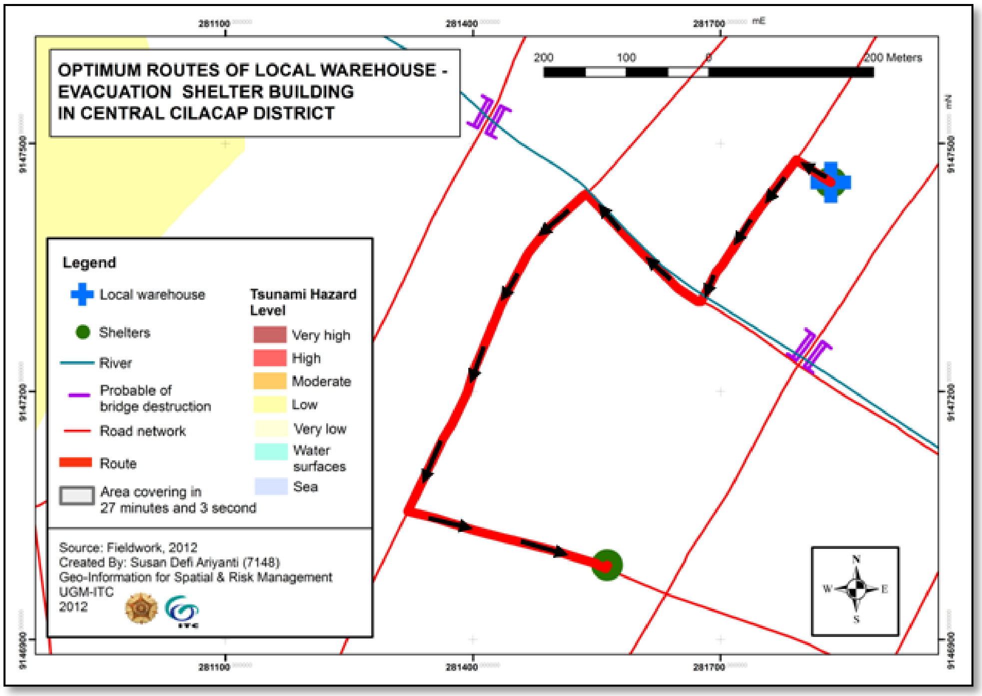


Figure 7.38 Optimum route local warehouse-shelter (1150.26 meter) in Central Cilacap (other road)

7.3.3 Comparison travel time of single logistic warehouse and local warehouses in North Cilacap

Optimum routes of logistic distribution goes from the central warehouse to the tsunami shelter is shown in Figure 7.39. This route takes approximately for 26 minutes to deliver logistic needs. Travel time can be shortened to 4 minutes and 6 second if logistic needs are supplied from local warehouse (Figure 7.43). This is surely can avoid traffic congestion during disaster relief.

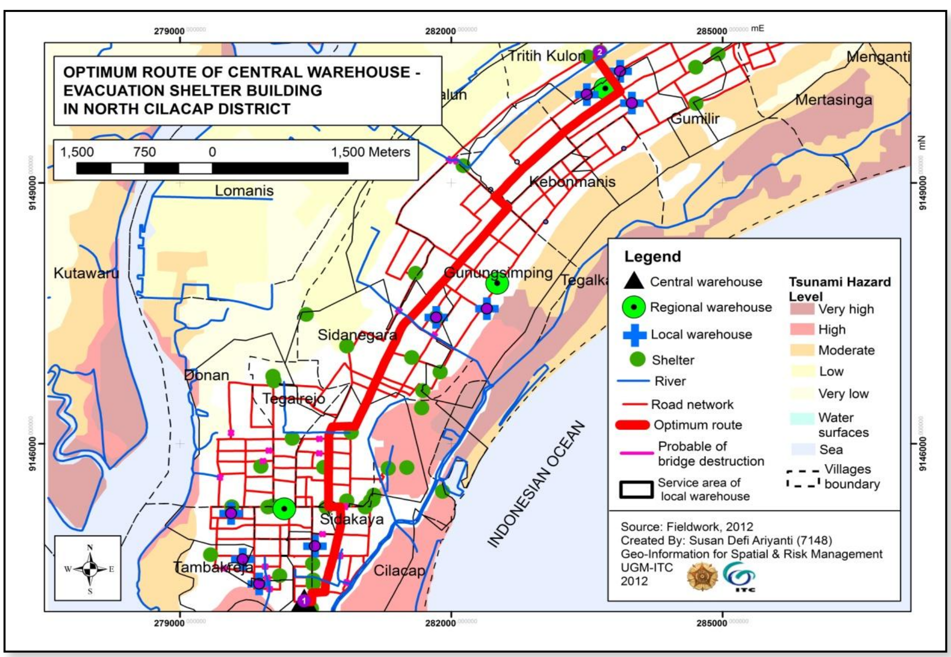


Figure 7.39 Optimum route of central warehouse -Shelter (8864.3 meter) in North Cilacap (local road, province road, other road, and national road)

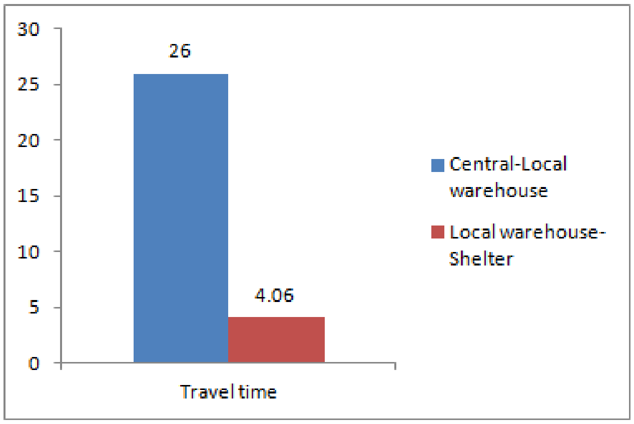


Figure 7.40 Travel time of logistic distribution in North Cilacap

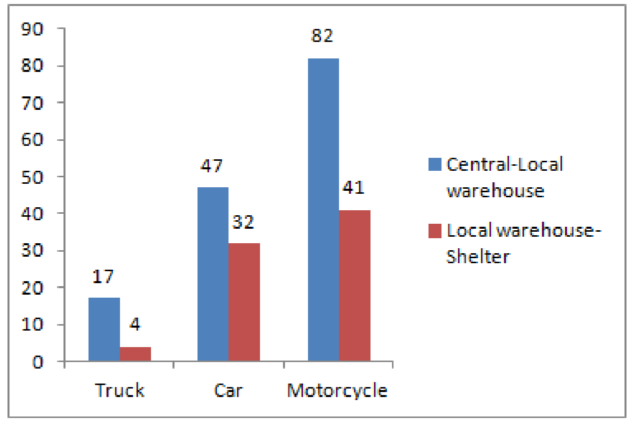


Figure 7.41 Traffic density measurement in North Cilacap

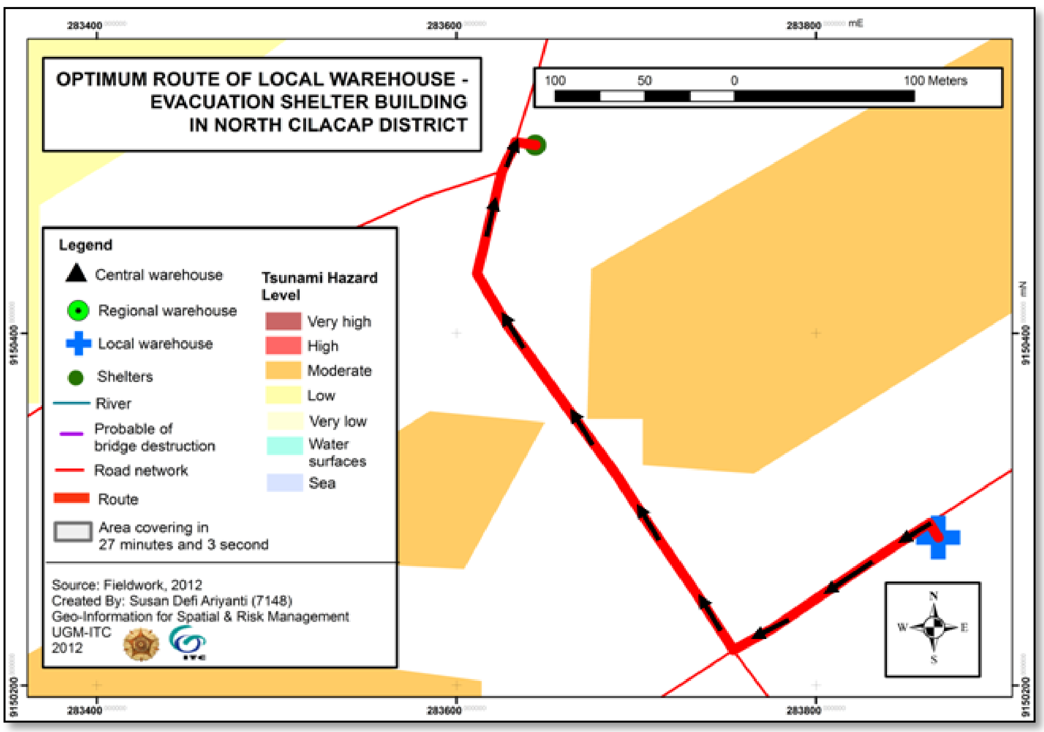


Figure 7.42 Optimum route of local warehouse-shelter (487.2 meter) in North Cilac ap (other road, local road, and national road)

The longest travel time from central warehouse-tsunami shelter are often caused by traffic density (see Figure 7.42). Numbers of traffic density on that route are higher for all types of vehicles. In addition this route is dominated by vaiying types of routes (other, local, province, and national routes). This complex route will impact the traffic congestion and traffic jam in distrubting disaster logistic needs.

CHAPTER 8. CONCLUSION AND RECOMENDATION

This chapter explains about the conclusion and recommendation carried out of the research.

8.1 CONCLUSION

The conclusion generated is based on the research objectives and research question. The main of this research is focused on the selection of warehouse and effective transportation routes.

1. This conclusion based on the first objective is to know logistic management system handled in Cilacap
   - Logistic management disaster in Cilacap is controlled by Regional Disaster Agency (BPBD). This agency has been preparing the logistic needs in its own warehouse as central warehouse. The main government agencies are also involved in logistics management is a disaster in Cilacap; Social Agency, Health Agency, and the Indonesian Red Cross. Each of agency roles and responsibilities both in providing and managing logistic needs at every stage of disaster, before the disaster, during disaster response, as well as post disaster. The third government agencies were also active in recruiting volunteers to assist in the distribution logistics.
2. This conclusion based on the second objective is to determine public building to replace regional and local warehouses impacted by tsunami hazard
   - Placement of local warehouses to utilize public building as well as tsunami shelters but must comply with the requirements specified warehouse. It also must consider the nearest access to public facilities (market) as a local supplier in the local Cilacap.
3. This conclusion based on the third objective is to identify the number of local warehouses regarding to support factors
   - Regional warehouse logistics in Cilacap accommodated at the district office aims to facilitate monitoring, security, and distribution logistics support to the disaster area. Because in every phase of logistics management as an evaluation must be evaluated and take the responsibility when disaster rehabilitation and reconstruction phase. For local logistics warehouse, there are approximately thirteen alternatives of local warehouses but only 7 local warehouses can be functioned belonging to service area and closest facility method in Network Analyst. Placement of local warehouses also utilizes public building as well as tsunami shelters but must comply with the requirements specified warehouse. It also must consider the nearest access to public facilities (market) as a local supplier in the local Cilacap. The function of local warehouse can be used as a buffer stock of logistics for refugees.
4. This conclusion based on the fourth objective is to determine optimum routes of logistic transportation. Optimum route of logistic distribution divided in to different delivery:
   - Optimum routes Central-Regional-Local warehouse
     This route is generally conducted as the initial phase of logistic distribution after tsunami takes place. The shortest optimum routes among Cilacap district are belonging to South Cilacap district since has the shortest length of road and few road segments.
   - Comparison optimum routes; central warehouse-shelter with local warehouse-shelter
     The result of network analyst shows that the existence of local warehouses is to speed up logistic delivery to shelter compared logistic delivery without using local warehouse.

8.2 RECOMMENDATION

1. The existence of a tsunami warehouse needed to be considered by local authorities in Cilacap given the amount shelter tsunami in Cilacap very much and unevenly distributed.
2. Optimum route from the research can be adopted by local governments as an alternative route for the distribution of disaster considered the shortest of travel time.
3. The logisitic transportation routes should avoid the probable bridge destruction since it can be collapse by earthquake.
4. Local warehouse can be effectively to be buffer stock of logistic since it can supllay logistic needs in village level
5. Management of disaster logistic system should be organized well among local agencies to support the disaster risk reduction
6. This research can also be developed to consider and comparison the cost needed with single logistic warehouse and local warehouses
7. The Model of logistic warehouse design can used be used as AHP method of public buildings and accessibility of closest market (Network Analyst tool)

REFERENCES

Amri, Ali Bozorgi. 2011. *A Multi-Objective Robust Stochastic Programming Model for Disaster Relief Logistic under Uncertainty*. Retrivied 28 February 2013, from http://www.springerlink.com/content/g1mk7705lu1q0343/fulltext.pdf

Anonim, 2012. *Humanitarian Aid Warehouse Planning*.

Akay. 2011. *A GIS-Based Decision Support System for determining the shortest and safest route to forest Fires.* Retrivied 28 February 2013, from http://www.springerlink.com/content/t372vg2723786267/fulltext.pdf

BNPB. 2008. *Peraturan Nomor 13 tahun 2008 tentang Pedoman Manajemen Logistik dan Peralatan Penanggulangan Bencana*. Jakarta

BPBD Cilacap. 2012. *Diklat Penanggulangan Bencana: Pengurangan Resiko Bencana*. Cilacap

Badan Pusat Statistik Cilacap. 2010. *Cilacap in Figures*. BPPS Cilacap; 459 pages

Chaunye., Aakil M. 2012. *Optimization models in emergency logistics: Literature review*. Department of Mechanical and Industrial Engineering. Qatar

Consortium of Non-Traditional Security Studies in Asia. 2007. *Workshop on Humanitarian Emergencies and Human Security: Lesson from Aceh*. S. Rajaratman School of International Studies and Centre for Strategies and International Studies, Indonesia.

Dewi,. Ratna Sari. 2010. *A GIS based to The Selection Evacuation Shelter Buildings and Routes for Tsunami Risk Reduction*. Gadjah Mada University; Faculty of Geo-information and Earth Observation; University of Twente. Yogyakarta, Indonesia and Enschede, Netherlands

Esri, 2010. *Network Analyst Tutorial*. Published by ESRI.

FEMA. 2010. *Guidance on Planning for Integration of Functional Needs Support Service in General Population Shelters.* BCFS Health and Human Service, San Antonio, Texas. USA

Diposaptono, S.; Budiman. 2008. *Hidup Akrab dengan Gempa dan Tsunami*. Buku Ilmiah Populer, Bogor, 384hlm.

George, Betsy. 2007. *Spatio-Temporal Network Databases and Routing Algorthms: A summary of Results*. Retrieved 27 February 2013, from http://www.springerlink.com/content/j8v33286r6u7j4w8/fulltext.pdf

Giri, I Wayan Kemara. 2009. *Optimalisasi Utilitas Gudang Unilever PT Pos Indonesia di Kawasan Pulo Gadung Melalui Penataan Lay Out Gudang dan Aplikasi Sistem Informasi Manajemen*

Inventory Pergudangan berupa System Radio Frequency Identification; Volume 9, No.7, Desember 2009. Politeknik Pos Indonesia. Bandung.

GITEWES. 2010. *Technical Documentation: Tsunami Hazard Map for Kabupaten Cilacap*. Cilacap Working Group for Tsunami Hazard Mapping.

ISDR, 2004. *Living with Risk: A global review of disaster reduction initiatives.* UNISDR,Geneva.

Kurnio, Hananto. 2007. *Review of Coastal Characteristic of Iron Sand Deposit in Cilacap Central Java*. Bulletin of Marine Geology, Volume 22 No. 1.

Levin and Mikhail Nosov. 2009. *Physics of Tsunamis*. Faculty of Physics. Institute of Marine Geology and Geophysics

Lidtke, Giernot. 2012. *Generation of Logistics in Freight Transportion Models*, Retrivied 28 February 2013,from http://www.springerlink.com/content/757920617r657276/fulltext.pdf

Mardiatno, 2008. *Tsunami Risk Assessment Using Scenario Based Approach, Geomorphological Analysis and Geographic Information System- A Case Study of in South Coastal Area of Java Island*. Faculty of Geo and Atmospheric Science. Innsbruck. University of Innsbruck. Dissertation: 249 pages

Mastronuzzi, Giuseppe. 2010*. Tsunami in Mediterranian Sea*. Dipartimento di Geologia e Geofisica, Università degli Studi "Aldo Moro", Bari, Italy. Volume 2 Number 1.

Mirza, Teuku. 2008. *Efektivitas Penyaluran Bantuan kemanusiaan Bagi Korban Bencana Pasca Tsunami di Banda Aceh.* Jurnal Kebijakan dan Administrasi Publik. Magister Administrasi Publik. Universitas Gadjah Mada

NGDC, 2009. *Tsunami Events*. Retrieved 21 May 2009 from uk/tsunami-risks/.

Nurjannah, Sugiharto.R. 2011. Manajemen Bencana. Alfabet. Bandung

Oktarina, Rienna. 2009. *Konseptual Perancangan Sistem Informasi Manajemen Logistik Penanggulangan Bencana*. Jurusan Teknik Industri, Universitas Widyatama. Bandung, Indonesia.

Oktarina, Rienna. 2010. *Pemetaan Sistem Konfigurasi Jaringan Komunikasi dan Informasi Tanggap Darurat Bencana di Indonesia*. Jurusan Teknik Industri, Universitas Widyatama. Bandung, Indonesia.

Olivera, Fransisco. 2007. *Using GIS Network to Solve a Distribution Center Location Problem in Texas*. Zachry Department of Civil Engineering. Texas A and M University. USA

Ozamar, Linet. 2011. *Planning Helicopter Logistics In Disaster Relief*, Retrievied 28 Febriary 2013, from http://www.springerlink.com/content/wgk7123w21156640/fulltext.pdf

Palang Merah Indonesia. 2007. *Manual Logistik Palang Merah Indonesia*. Jakarta: Penerbit Palang

Merah Indonesia

Perry, Marcia. 2007. *Natural Disaster Management planning; A Study of logistics Managers responding to the Tsunami*. Department of Management, Monash University. Australia

Sarkar, Avijit. 2007. *GIS Application in Logistics: A Literature Review*. University of Redlands.USA

Saaty, Thomas., L. 2008. *Decision Making with the Analytic Hierarchy Process*. Pittsburgh: University of Pittsburgh. USA.

Shelter Project. 2008. Emergency Non-Food item Distribution Land Right Advocacy Housing

Stephenson, R.S. 1993. Logistic 1st Edition. UNDP. Disaster Training Management Programme.

Sutikno, 1981. *Pattern of Water Resources Utilization for Domestic Purposes in the Serayu River Basin. Faculty of Geography*. Gadjah Mada University. Yogyakarta. Doctoral dissertation: 277 pages

Tabbara, Line N. 2008. *Emergency Relief Logistics: Evaluation of Disaster Response Models, Based On Asian Tsunami Logistics Response*. Oxfoord Brooks University.

Thywissen, K., 2006. *Components of Risk; a Comparative Glossary, SOURCE No. 2/2006*, United Nations University-Institute for Environmental and Human Security (UNU-EHS), Bonn.

Thomas., S. Anisya. 2005. *From Logistics to Supply Chain Management: The Path Forward in the Humanitarian Sector*. Frtiz Indsitute

Tong, Bui. 2000. *A Framework for Designing A Global Information Network for Multinational Humanitarian Assistance/Disaster Relief*, Retrieved 28 March 2013, from http://www.springerlink.com/content/m3x0715803204362/fulltext.pdf

UNHCR. *Handbook for Emergency Second Edition*. United Nations

UNESCAP., ADPC. 2008. *Monitoring and Reporting Progress on Community based Disaster Risk Management in Indonesia*. Partnership for Disaster Reduction South East Asia.

USAID Indonesia. 2008. *Building Back Better: Aceh Technical Assistance Recovery Project Final Report*. United States Agency for International Development.

Wendelin F. Gross., Cristina Hayden. 2012. *About the Impact of Rising Oil Price on Logistics Network and Transportation Greenhouse Gas Emission*. Retrieved 27 February 2013, from http://www.springerlink.com/content/2161330767q03474/fulltext.pdf

Židonis, Ž. 2002. *Verslo logistika*. Vilnius: Vilniaus vadybos kolegija, 2002. 146 p.

Appendix 1

Questionnaire 1 of Research (Agencies Purposes)

Lokasi : ***(BPBD), Social Agency, Health Agency, Indonesian Red Cross***
Tema : **Site Selection and Transportation Routes of Tsunami Emergency Logistic Warehouse using GIS in Cilacap Regency**

Peneliti : **Susan Defi Ariyanti**
Jurusan : **(S2) Geo-Information for Spatial Planning and Disaster Risk Management, Universitas Gadjah Mada, Yogyakarta**

Day : ....
Date : ....
Location : ....
District : ....
Coordinates : ....

A. Personal Information of Interviewer and Respondent

Name of Interviewer	
Name of Respondent	
Sex	
Address	
Education (year)	
Job	

1. **How is disaster logistic management is being handled in Cilacap (Pre Disaster-Emergency condition-and Post Disaster?**

Pre Disaster	Emergency Condition	Post Disaster

1. **What are kinds and type of logistic needs supplied by local government?**
   …….
   …….
   …….
   …….
   …….
2. **Where the most logistic supplier come from?**
   …….
   …….
   …….
   …….
   ……
3. **What kind of transportation are used for logistic distribution in Cilacap?**
   …….
   …….
   …….
   …….
   ……
4. **What kinds of Public Infrastructure should be considered for disaster losgitic distribution in Cilacap ?**
   …….
   …….
   …….
   …….
   ……
5. **Is there any existing of logistic warehouse in cilacap? If yes, where each of logitstic warehouse should be replaced ?**

Logistic Chain	**Location**
Entry point	
Central warehouse	
Regional warehouse	
Local warehouse	

6. **What are the requirements is needed for each logistic warehouse mainly regional and local warehouses?**

……
……
……
……
……

7. **What are kind and logistic needs standard for refugees?**

……
……
……
……
……

8. **Is there any NGO (Non Government Organization) involved for logistic system in Cilacap? If yes, what are the role and activities held by them?**

……….

……….

……….

……….

……….

9. **What and explain the activities of logistic management system should existed in BPBD?**

Manajemen logistik	**Kegiatan**
Stocking	
Warehousing	
Distributing	
Pengangkutan	
Transporting	
Removing	
Evaluating	

10. **What are the obstacles faced by local government in handling disaster logistic system?**

………
………
………
………
………

11. **What kind of data and information needed to replace logistic warehouse?**

………
………

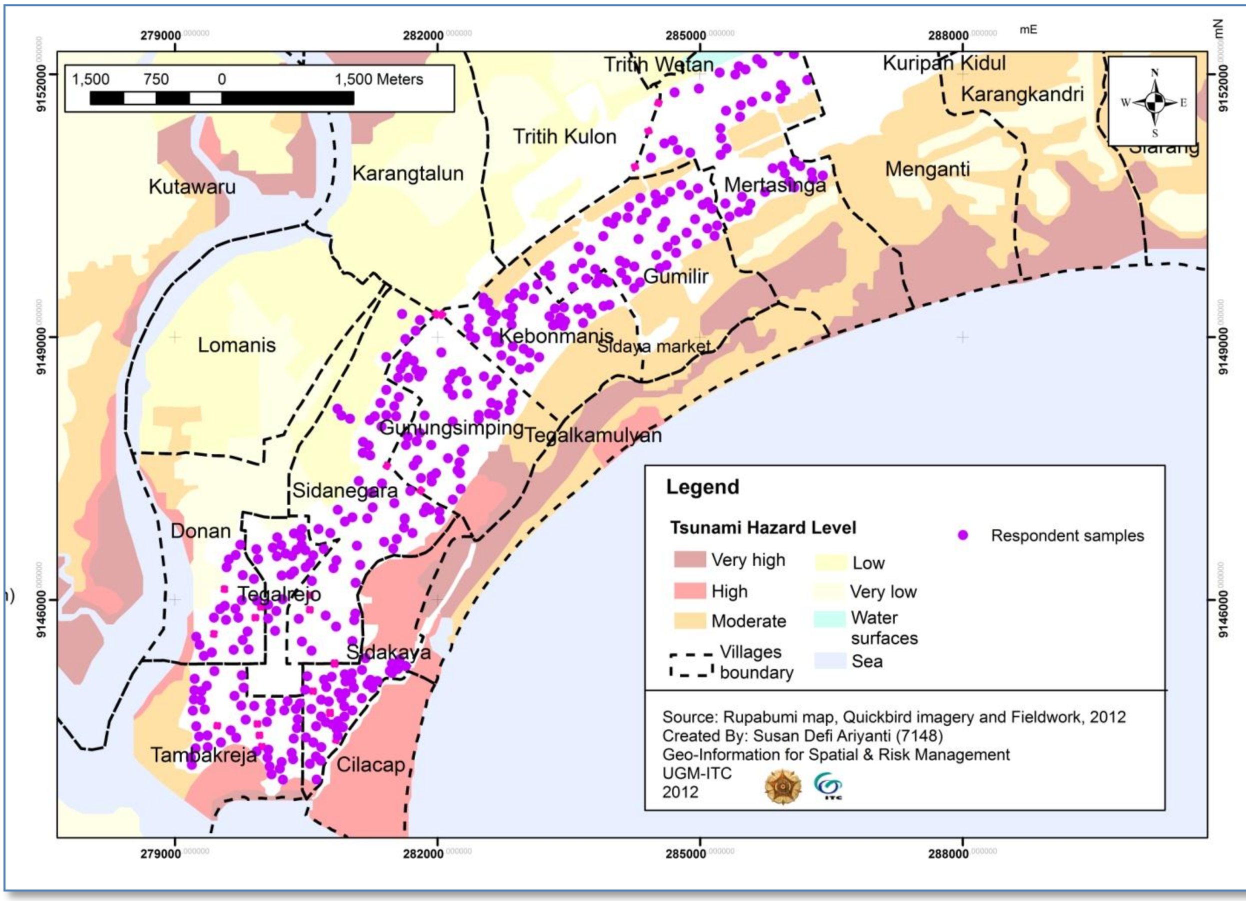
Appendix 2

<u>Questionnaire 2 of Research (Population Purposes)</u>

1. Do you know that your settlement area located in tsunami hazard?
    a. Yes
    b. No
2. If yes, is there any socialization or mitigation activities of disaster held in your settlement area ?
    a. Yes, If yes, What any socialization and mitigation of disaster in your settlement area?Ji
    b. No
3. Is that mitigation program related to disaster logistic? If yes, what its relationship to disaster logistic?
    a. Socialization of types of disaster logistic needs prior to Cilacap's community needs
    b. Socialization of replacement of diasaster warehouse
4. From your house, how long is the distance to tsunami shelter?
    a. <5meter
    b. >5 meter
5. From your house, how long is the distance to closest local warehouse?
    a. < 5 meter
    b. > 5 meter
6. If, tsunami occurr in Cilacap, where will you evacuate?
    a. Tsunami shelter
    b. Relative's house
    c. Other place far from tsunami
7. If you settle in tsunami shelter, how long will you be in tsunami shelter?
    a. Less than 1 day
    b. 1-3 days
    c. > 3 days
8. If you settle in other places, how long will you be in that place?
    a. Less than 1 day
    b. 1-3 days
    c. > 3 days
9. What is your reason to choose shelter as place of to stay temporarily?
    a. Safer and can gather with other refugees in post disaster
    b. Easier to organize and well fulfill disaster logistic needs
10. What is you reason to choose other places to stay temporarily?
    a. Safer and can gather will other refugees in post disaster
    b. Free to handle of own disaster logistic needs

Appendix 3

Sample of respondent



Appendix 4. Central warehouse and Tsunami Shelters

No.	Name of Building	X and Y	Area of Building (meter square)	Refugees (day)	Refugees (night)	Picture
1	BPBD Cilacap	280102 9144481	138	460	472	
2	SMP Negeri 1 Cilacap	280453 9144103	1491	4970	1654	
3	SMP Negeri 3 Cilacap	279572 9145274	700	2333	1567	
4	Gedung Dakwah Muh. Cilacap	279972 9145270	80	260	122	
5	Hotel Tiga Intan Cilacap	279338 9144722	2000	6000	1432	

No.	Name of Building	X and Y	Area of Building (meter square)	Refugees (day)	Refugees (night)	Picture
1	Politeknik Cilacap	281672 9146409	2646	17640	12340	
2	SMP Plus Cilacap	280471 9144385	256	853	555	
3	Hotel Cilacap Indah	281049 9145270	1000	3333	2123	
4	SMP Purnama 1 Cilacap	281303 9145715	350	1166	530	
5	RSU Santa Maria	280473 9144433	180	600	2300	

No	Name of Building	X and Y	Area of Building (meter square)	Refugees (day)	Refugees (night)	Picture
1	Rusunawa	281903 9145451	886	2953	1396	
2	SD Al Irsyad 01	280087 9145278	429	4070	2315	
3	DPRD Cilacap	280134 9145281	2150	7166	567	
4	SMA Negeri 1 Cilacap	280027 9146775	1371	4570	2314	
6	SMP Negeri 8 Cilacap	280617 9145269	702	2340	1654	
7	SMK YPE Cilacap	281145 9145409	1008	3360	2124	
8	SMA Yos Sudarso	280466 9144618	850	1700	927	

No	Name of Building	X and Y	Area of Building (meter square)	Refugees (day)	Refugees (night)	Picture
1	AKBID	281132 9145354	560	1866	1790	
2	Asrama Putri STIKES	281563 9146990	800	5333	2354	
3	AMN	281603 9147959	1344	4480	3125	
4	Badan Diklat, Arsip, dan Perpusda	281107 9145341	736	2453	1280	
5	SMP Muhamadiyah I	280241 9146059	960	3200	1240	
6	SD N Tegalreja 01 Cilacap	280038 9146719	339	1130	987	
7	SD N Tegalreja 02 Cilacap	280040 9146721	59	196	98	

No	Name of Building	X and Y	Area of Building (meter square)	Refugees (day)	Refugees (night)	Picture
1	BPC. Gapensi,	283644 9150507	200	666	259	
2	Masdjid Al-Jihad,	284703 9150330	144	480	321	
3	SMP PGRI I Cilacap	284706 9149913	546	1820	876	
4	PMI Kab. Cilacap	284950 9150483	324	900	456	

No	Name of Building	X and Y	Area of Building (meter square)	Refugees (day)	Refugees (night)	Picture
1	Kelurahan Mertasinga	285518 9150794	200	666	437	
2	SMP Muhamadiyah 2	283513 9150450	392	1306	987	

Appendix 5. Regional warehouses

No.	Name of Building	District, Villages	Coordinate	Picture	Specification
1.	District Office of Cilacap Tengah	Cilacap Tengah, Gunung Simping	X: 282811 Y: 9147761	  	

Building Specification	Facility Specification	Environmental Specification
Number floor Oneand two floors	**Electricity** 5500 watt	**Temperature** Suitable temperature
Floor Material Floor plaster (Ceramics)	**Water Supply** PDAM and groundwater	**Connectivity of rail access** 10 minutes (3 kilometer)
Wall Material Brick	**Communication** Telephone and Facsimile	**Connectivity of air access** 25 minutes (20 km)
Wall color Bright color	**Office Equipment** 11 units Computer 7 units Printer 2 units Cupboard	**Safe location of chemical and physical condition** Area surrounding building is safe from chemical and physical pollution
Floor color White		
Size of door >2 X 5 meter	**Fire Extinguisher** –	
Size of ventilation > 1.5 X 0.5 meter	**Air conditioner** Two units of air conditioner	
Height of Building >3 meter		
	Smoke Detector -	

<table>
<tr><td>2.</td><td>District Office of Cilacap Utara</td><td>Cilacap Utara, Mertasinga</td><td>X: 285823
Y: 9151634</td><td>


</td><td>(see specification table below)</td></tr>
</table>

Building Specification	Facility Specification	Environmental Specification
Number floor One floor	**Electricity** 1300 watt	**Temperature** Suitable temperature
Floor Material Floor plaster (Ceramics)	**Water Supply** PDAM and groundwater	**Connectivity of rail access** 10 minutes (3 kilometer)
Wall Material Brick	**Communication** Telephone and Facsimile	**Connectivity of air access** 15 minutes (8-10 km)
Wall color Bright color	**Office Equipment** 5 units Computer 3 units Printer 3 units Cupboard	**Safe location of chemical and physical condition** Area surrounding building is safe from chemical and physical pollution
Floor color White		
Size of door 2 X 5 meter	**Fire Extinguisher** –	
Size of ventilation > 1.5 X 0.5 meter	**Air conditioner** Two units of air conditioner	
Height of Building >3 meter		
	Smoke Detector -	

3.	District Office of Cilacap Selatan	Cilacap Selatan	X: 287391 Y: 9151829	  	See specification table below

Building Specification	Facility Specification	Environmental Specification
Number floor One floor	**Electricity** 1500 watt	**Temperature** Suitable temperature
Floor Material Floor plaster (Ceramics)	**Water Supply** PDAM and groundwater	**Connectivity of rail access** 10 minutes (10kilometer)
Wall Material Brick	**Communication** Telephone and Facsimile	**Connectivity of air access** 15 minutes (25 km)
Wall color Bright color	**Office Equipment** 10 units Computer 5 units Printer 5 units Cupboard	**Safe location of chemical and physical condition** Area surrounding building is safe from chemical and physical pollution
Floor color White		
Size of door 2 X 5 meter	**Fire Extinguisher** –	
Size of ventilation < 2 X 2.1 meter	**Air conditioner** Two units of air conditioner	
Height of Building >3 meter		
	Smoke Detector -	

Appendix 6. Calculation of Logistic Needs

1	**AKBID Graha Mandiri**	560	**1866**	Lt. 2	-Rice = 2239.2 kilograms -Noodle = 16794 pack -Kecap = 839.7 liter -Water = 22392 liter Drinking	-Clothes = 5598 sheets -Bed cover = 1866 sheets -religion = 1866 sheets Uniform -Socks = 1866 pair of socks -Bath Soap = 466.5 kilograms -Wash Soap = 373.2 kilograms -Tooth brush = 1866 items -Tooth paste = 1866 items	-Medicine boxes = 467 boxes -Tent, mattress = 467 pack
2.	**Asrama Putri STIKES Al Irsyad Cilacap**	800 + 800	**5333**	Lt. 2 + 3	-Rice = 6399.6 kilograms -Noodle = 47997 pack -Kecap = 2399.85 liter -Water = 63996 liter drinking	-Clothes = 15999 sheets -Bed cover = 5333 sheets -religion = 5333 sheets uniform -Socks = 5333 pair of socks -Bath Soap = 1333.250 kilograms -Wash Soap = 1066.6 kilograms -Tooth brush = 5333 items -Tooth paste = 5333 items	-Medicine boxes = 1334 boxes -Tent, mattress = 1334 pack
3.	**SD Al Irsyad 01**	729 + 492	**4070**	Lt. 2 + 3	-Rice = 4884 kilograms -Noodle = 36630 pack -Kecap = 1831.5 liter -Water = 48840 liter drinking	-Clothes = 12210 sheets -Bed cover = 4070 sheets -religion = 4070 sheets Uniform -Socks = 4070 pair of socks -Bath Soap = 1017,5 kilograms -Wash Soap = 814 kilograms -Tooth brush = 4070 items -Tooth paste = 4070 items	-Medicine boxes = 1018 boxes -Tent, mattress = 1018 pack

Appendix 6. Number of refugee’s capacity of tsunami shelters in Tambakreja

No.	Buildings	X	Y	Refugees (day)	Refugees (night)
1	BPBD Kab. Cilacap, Lantai 2	280102	9144481	4970	4321
2	SMP Negeri 1 Cilacap, Lantai 2	280453	9144103	17640	16544
3	SMP Negeri 3 Cilacap, Lantai 2	279572	9145274	2333	1567
4	Gedung Dakwah Muh Clp, Lantai 2	279972	9145270	260	122
5	Hotel Tiga Intan Cilacap, Lantai 2	279338	9144722	6000	1432
6	Politeknik Cilacap, Lantai 2	281672	9146409	17640	12340
7	SMP Pius Cilacap, Lantai 2	280471	9144385	853	555
8	Hotel Cilacap Indah, Lantai 2	281049	9145270	3333	2123
9	SMP Purnama 1 Cilacap, lantai 2	281303	9145715	1166	530
10	RSU Santa Maria, Lantai 2	280473	9144433	600	2300
11	SMP Negeri 8 Cilacap, Lantai 2	280617	9145269	2340	1654
12	SMK YPE Cilacap, Lantai 2	281145	9145409	3360	2124
13	SMA Yos Sudarso, Lantai 2	280466	9144618	1700	927
14	Rusunawa, Lantai 3	281903	9145451	2953	1396
15	SD Al Irsyad 01, lantai 2	280087	9145278	4070	2315
16	DPRD Kab. Cilacap, Lantai 2	280134	9145281	7166	567
17	SMA Negeri 1 Cilacap, Lantai 2	280027	9146775	4570	2314
18	SMP Muhamadiyah I, Lantai 2	280241	9146059	3200	1240
19	SD N Tegalreja 01 Cilacap, Lantai 2	280038	9146719	1130	987
20	SD N Tegalreja 02 Cilacap, Lantai 2	280040	9146721	196	98

Appendix 7. Number of refugee’s capacity of tsunami shelters in Tambakreja

No.	Buildings	X	Y	Refugees (day)	Refugees (night)
1	Politeknik Cilacap, Lantai 2	281672	9146409	17640	12340
2	SMP Pius Cilacap, Lantai 2	280471	9144385	853	555
3	Hotel Cilacap Indah, Lantai 2	281049	9145270	3333	2123
4	SMP Purnama 1 Cilacap, lantai 2	281303	9145715	1166	530
5	RSU Santa Maria, Lantai 2	280473	9144433	600	2300
6	SMP Negeri 8 Cilacap, Lantai 2	280617	9145269	2340	1654
7	SMK YPE Cilacap, Lantai 2	281145	9145409	3360	2124
8	SMA Yos Sudarso, Lantai 2	280466	9144618	1700	927

Appendix 8. Number of refugee's capacity of tsunami shelters in Tegalreja

No.	Buildings	X	Y	Refugees (day)	Refugees (night)
1	Rusunawa, Lantai 3	281903	9145451	2953	1396
2	SD Al Irsyad 01, lantai 2	280087	9145278	4070	2315
3	DPRD Kab. Cilacap, Lantai 2	280134	9145281	7166	567
4	SMA Negeri 1 Cilacap, Lantai 2	280027	9146775	4570	2314
5	SMP Muhamadiyah I, Lantai 2	280241	9146059	3200	1240
6	SD N Tegalreja 01 Cilacap, Lantai 2	280038	9146719	1130	987
7	SD N Tegalreja 02 Cilacap, Lantai 2	280040	9146721	196	98

Appendix 9. Number of refugee's capacity of tsunami shelters in Sidanegara

No.	Buildings	X	Y	Refugees (day)	Refugees (night)
1	AKBID	281132	9145354	1866	1790
2	Asrama Putri STIKES	281563	9146990	5333	2354
3	AMN	281603	9147959	4480	3125
4	Badan Diklat, Arsip, dan Perpusda	281107	9145341	2453	1280
5	Asuransi Bumi Putera	280894	9146129	446	231
6	SDN 8 Sidanegara	281685	9146609	833	650
7	RS Aprillia	281260	914693	3500	2314
8	Gedung Golkar	280590	9145727	1500	1245
9	SMP Negeri 4 Cilacap	281877	9146823	2856	1876
10	SMP Negeri 6 Cilacap	280844	9147121	730	578
11	Masjid Darussalam	280844	9145342	975	452
12	Hotel Mutiara	280395	9147486	900	876

Appendix 10. Number of refugee's capacity of tsunami shelters in Donan and Gunungsimping

No.	Buildings	X	Y	Refugees (day)	Refugees (night)
1	SMP Purnama 2 Cilacap, Lantai 2	281508	9145723	2300	1123
2	SMA Al Irsyad, Lantai 2	280028	9145284	4130	3500
3	SMP Negeri 2 Cilacap, Lantai 2	279894	9145737	3383	2136
4	SMA Sri Mukti Cilacap, Lantai 2	281834	9147453	2520	1379

Appendix 11. Number of refugee's capacity of tsunami shelters in Gumilir

No.	Buildings	X	Y	Refugees (day)	Refugees (night)
1	BPC. Gapensi, Lantai 2	283644	9150507	666	259
2	Masdjid Al-Jihad, Lantai 2	284703	9150330	480	321
3	SMP PGRI I Cilacap, Lantai 2	284706	9149913	1820	876
4	PMI Kab. Cilacap, Lantai 2	284950	9150483	900	456

Appendix 12. Number of refugee's capacity of tsunami shelters in Mertasinga and Tritih Kulon

No.	Buildings	X	Y	Refugees (day)	Refugees (night)
1	Kelurahan Mertasinga, Lantai 2	285518	9150794	666	437
2	SMP Muhamadiyah 2, Lantai 2	283513	9150450	1306	987