MSc Thesis

Developing Inland Logistics Hub in North Sulawesi Province to Reduce Transport Cost to/from Bitung Port

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Developing Inland Logistics Hub in North Sulawesi Province to Reduce Transport Cost to/from Bitung Port

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Acknowledgement

"And that there is not for man except that [good] for which he strives.
Then he will be recompensed for it with the fullest recompense"
Quran Surah An-Najm: 39-40

Patriotic family in Indonesia has been raising me. To contribute my work for Indonesia has been a principle for me. The field of transportation, infrastructure, and logistics has always been my passion since I acknowledged it in my bachelor thesis in 2013. Nevertheless, there is no proper education in this field given since then. Therefore, I have envisioned to pursuing the master degree in this area. Note to myself, by this level, I will be the first integrated transportation, infrastructure, and logistics engineer from Indonesia.

This report is the product of my relentless works in the past six months inside the constant steep of 2-years master study. I dedicated those times to learn new things, interact with international people, capture the most relevant issue in Indonesia, collect the data directly in North Sulawesi Province, calibrate the subpar quality of data, research the most suitable method, and keep myself on track to derive the optimum solution. Honestly, six months cannot suffice to obtain the best result of this study. Nevertheless, I put strict schedule to keep working on it and provide the best work I can accomplish.

I would first like to thank the almighty, Allah SWT. He strengthened me whenever I ran into trouble spot or stuck in the progress of my thesis.

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Thirdly, I would like to thank the experts and stakeholders in North Sulawesi Province: Audy Pangemanan (Regional Development Agency of Bitung), Sardi (Pelindo IV Bitung), Syam Panai (Associations of Freight Forwarder of Bitung), and Anita (PT. SMS Tuna), who were involved in providing their opinions and data of Bitung Port and North Sulawesi Province.

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Family and close relatives are always become my supporters in this steep 2-years study. I always being thankful to have you in my life. Thank for your patience and loyalty in supporting me these entire life: Dies Fatmawati, Imam Anshori Saleh, Taufika Rahardini, Rahmia Hasniasari, Holy Bilowo, Riski Raisa Putra, Mohammad Fatah Azizi, Mohammad Fatih Alfadly, and Dalaila Gisdara (PS: you always cheer me up☺) .

Summary

Introduction

Indonesia is turning their infrastructure development concept towards maritime related infrastructure. As the result, the State Ministry of National Development Planning (BAPPENAS) in 2015 has planned to develop 24 main ports to support inter-island maritime highway concept. It has envisioned to balancing the trade activity between the eastern and western part of Indonesia. Indonesia have planned to make these main ports as the core stops for backbone container traffic.

Problem of trade activity in Indonesia does not depend only by its maritime network and infrastructure. Hinterland connection from port to the interior region also has burdened the economic activity with traffic jam and the inefficiency of failing to reach economies scale. Moreover, in developing country like Indonesia, the hinterland connection mostly has depended with single mode transport in unorganized shipments.

Hinterland costs is often the largest part of total door-to-door cost. Efficient hinterland access has been a key determinant of port competitiveness (Fleming & Baird, 1999). Logistics hub such as inland ports is truly the gateways for their respective hinterlands, vital for a region's industrial and economic development, and thus helping to achieve a more balanced development for the entire country. One of the idea to create the more efficient hinterland is developing logistics hub.

The area to be focus in this research is Bitung. Bitung has been included in several national plans such as Special Economic Zone, Sulawesi Economic Corridor, and National Economic Development Planning Zone. Indonesia has planned to set Bitung Port to be the international hub for eastern Indonesia. International wise, Bitung has been one of the network node in ASEAN Ro-Ro shipping network. Nevertheless, there is a lack in the arrangement of their freight transport to hinterland. Nowadays, there is a mixed of vans and various types of truck as the means of freight delivery between Bitung port and the hinterland. These mixed transport flow to hinterland is not efficient and brings more empty return trips.

The focus in this research is develop the inland logistics hub in the sense of reducing generalized transport cost to create more efficient hinterland connection. Develop the logistics hub comprises steps: determining the location of logistics hub, design the logistics hub, and estimate the feasibility of this project by Social Cost Benefit Analysis (SCBA). Hence, the following research question for this study is:

"To what extent can the development of inland hubs in the North Sulawesi reduce the overall generalized transport cost to/from the port of Bitung?"

The scope of hinterland is North Sulawesi Province. Amurang, Airmadidi, Bitung, Bolang Uki, Boroko, Lolak, Kotamobagu, Manado, Melonguane, Ondong Siau, Ratahan, Tahuna, Tomohon, Tondano, and Tutuyan are the considered regional nodes. Reflected to the present condition, the only possible mode is single road transport. Nevertheless, reduction of generalized transportation cost expects more arranged consolidation of shipment.

Business Model of Logistics Hub

A business model of logistics hub is able to realize to realize the logistics hub concept. The logic of the business case was that the new scheme of logistics hub should reduce the existing condition of hinterland transport. Beforehand, the location of logistics hub was required to be determined. Solving the location problem used discrete cost simulation method. It included a set of calculation of generalized transport

cost, OD matrix construction, and the final generalized cost comparison between the new scheme and existing scheme.

The existing scheme involved mixed capacity of vans (1-ton capacity), light truck (4-ton capacity), medium (8-ton capacity), and heavy trucks (20-ton capacity). These delivered freight directly from Bitung Port to regional nodes and vice versa. Direct shipment cost between Bitung Port and regional node (vice versa) modelled the generalized transport cost. The second scheme, ideal scheme with applied logistics hub, included three kinds of generalized transport cost: first leg transport, logistics hub, and second leg transport. Using only heavy truck was the first leg transportation. The second leg used medium truck and heavy truck. The first leg transport connected Bitung Port to logistics hub. In the meantime, the second leg connected the logistics hub and loading points in regional node. Parameters of value of time, transport cost, loading and unloading time in port, loading points, and regional node, and handling cost modelled generalized transportation cost.

Airmadidi Dry Port

Derived volume of shipment from constructed OD matrix results the unit cost and annual cost in both schemes. The result shows which location that saves the highest generalised transport cost and is preferred with most regions. Determination of the optimum location of logistics hub used assumption. This assumption was that a certain regional node could save the annual generalised transport cost from other node at the minimum benefit of 20%. The most profitable and attractive location, thus, was Airmadidi. It saved € 2.39 million of annual cost and attracted six regional nodes to be participating. The participants of this logistics hub were Lolak, Tahuna, Melonguane, Boroko, Ondong Siau, Tutuyan, and Kotamobagu. The attracted volume there was 122,728 tons. On average, Airmadidi saved € 20/ton.

The selected logistics hub defined the possible activities. Subsequently, activities determined the design of logistics hub, cost and benefit. Airmadidi was as dry port with close range, since it was located 28 km from port. The activities were customs and clearance, stacking yard, freight consolidation, and office and restaurant rental.

Design of dry port was planned for 20-years' time span. Annual growth of 4% and the gradual change of cargo share contributed handled volume of 964,897 tons in 2039. It required 19-hectare area, which consisted container yard, CFS, warehouse, offices, gatehouse, parking area, and vehicle holding area.

Feasibility of Project

The economic feasibility of this project was analysed by Social Cost Benefit Analysis. Benefit components were consumer's surplus, socio cost of carbon saving, and traffic accident cost reduction. On the other hand, cost included infrastructure investment, equipment investment, and operation and maintenance cost. Thorough SCBA revealed that this project resulted IRR of 9% (higher than real interest rate of 6.5%), BCR of 2.3, and NPV of € 38,230,669. Thus, this project was an economically feasible project. Several indicators that were sensitive to change the result of SCBA are real interest rate, change of willingness of participation from regions, change of value of time.

Recommendations for future improvements are capturing other factors such as specific commodity data, railway mode for future phase, project feasibility analysis, generalized transport cost model, and synchronization with current plan of special economic zone.

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1. INTRODUCTION

The first chapter presents the background information, reasons to consider Bitung as a focus, and problem definition of research. These formulated subsequently the research objective and research question. This chapter presents the scope of the study, thesis structure, and research methods in section 4, 5, and 6.

1.1 Problem Introduction

1.1.1 Background

Indonesia currently is moving forward to turn its form into a maritime nation. It has started in October 2014, when new elected President, Jokowi, declared his vision to making Indonesia to be "global maritime axis". The maritime doctrine includes a specific key element to realize Indonesia's long-dormant potential to arise as a maritime power: developing marine infrastructure through an inter-island maritime highway (The Jakarta Post, 2015).

Related with that element, this research focuses in hinterland and maritime transport of Indonesia. Indonesia has challenge of their wide-ranging archipelago form. This country has 17,508 islands. It has the status of "the world' longest coastline": 54,716 km (CIA, 2014). To comply with this challenge, State Ministry of National Development Planning (BAPPENAS) has started to set 24 main ports to support inter-island maritime highway concept (BAPPENAS, 2015). Although, this number is far less than the extensive coastal line there.

From Figure 1-1, twenty-four main ports are drawn to delegating Indonesia' big islands. The red dots describe several hub ports to be the core stops of inter-island maritime highway. The planned hub ports are Belawan (North Sumatera), Tanjung Priok (DKI Jakarta), Tanjung Perak (East Java), and Bitung (North Sulawesi). Meanwhile, the yellow dots are the feeder ports for this concept.

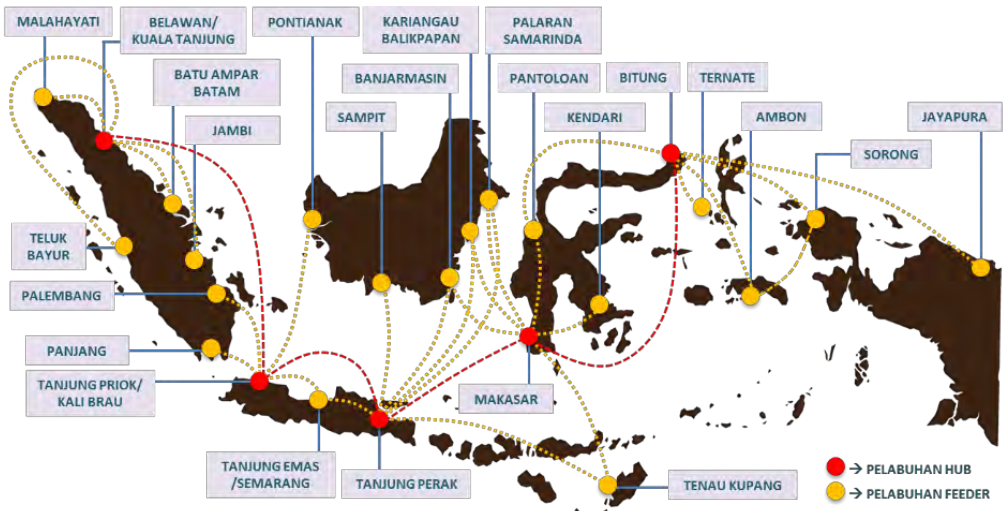

Figure 1-1: Indonesia 24 main ports map
Source: (BAPPENAS, 2015)

1.1.2 Problem Introduction

One of main issues in the concept of inter-island maritime connection of Indonesia is the small trade volume from the eastern of Indonesia. Less quantity of trade has resulted high logistics cost, thus, the economies of scale of the sea highway cannot be achieved (BAPPENAS, 2015). In terms of policy, Special Economic Zone (SEZ) has been a useful tool as part of an overall economic growth strategy to enhance industry competitiveness and attract foreign direct investment (FIAS, 2008).

Figure 1-2: Map of Indonesia Special Economic Zones in Sulawesi Island.
Source: own and Google Maps, 2016

In line with that, government has planned SEZ in the eastern part of Indonesia through National Board of SEZ. There are two kinds of SEZ in Sulawesi Island (see Figure 1-2): Palu and Bitung (Presidential Decree, 2014). Each SEZ accommodates the industries within certain provinces and its captives. In Sulawesi Island, Palu SEZ covers Central Sulawesi province while Bitung covers North Sulawesi province. Palu SEZ has the size of 500 hectares. The main activities are logistics service, agriculture, mine processing, and manufacturing industries. Bitung SEZ has total area of 534 hectares. It functions to gather four main industries of fisheries processing, coconut-based products and medicinal plants, pharmacies, and logistics industries.

Bitung as Focus

Several government master plans have stated Bitung to be a strategic location of economy trade increase in the eastern part of Indonesia. Indonesia has projected Bitung Port to be international hub port in the east of Indonesia (BAPPENAS, 2015). It also has became the part of Sulawesi Economic Corridor (Coordinating Ministry for Economic Affairs, 2011). In addition, Bitung has been a vital entry gate to support national strength in the border with other countries, such as Malaysia and Philippines (Committee of Acceleration and Expansion of Economic Development, 2011).

Nevertheless, the existence of port depends from the hinterland connection. As hinterland costs are often the largest part of total door-to-door cost, efficient hinterland access has been a key determinant of port competitiveness (Fleming & Baird, 1999). Logistics hub such as inland ports is truly the gateways for their respective hinterlands, vital for a region's industrial and economic development, and thus helping to achieve a more balanced development for the entire country (Lam & Iskounen, 2010).

Hinterland transportation in Bitung Port

Mixed volume of truck and vans dominated present condition in the hinterland connection to/from Bitung Port (see Figure 1-3). There are few warehouses in Manado and Minahasa districts, which are not able to consolidate for whole goods in efficient way. Irregular volumes of mixed freight vehicles (range from 1 to 20-ton capacity) lead to severe congestion in districts whose activities is high such as Manado and Minahasa. To ease the bottleneck in hinterland connections, there are several ideas, such as consolidation of freight shipment in larger capacity mode (truck or railway) in logistics hub to allow consolidation in larger scale.

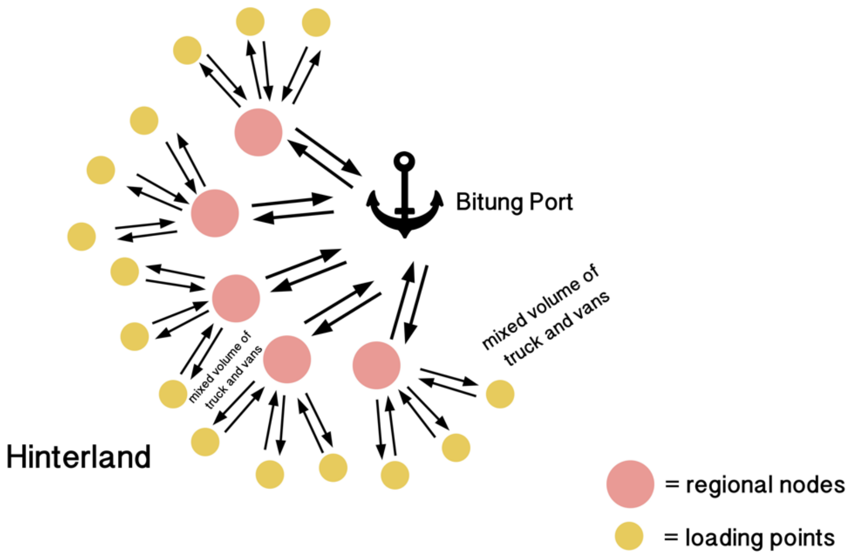

Figure 1-3: Existing condition of hinterland connection from/to Bitung Port

The idea in this research is develop inland logistics hub to increase the efficiency of hinterland freight transportation of Bitung Port. It allows bigger shipment from Bitung Port to hinterland and vice versa by using only medium and heavy truck (see Figure 1-4). The logistics hub has role to de-consolidate the volume into smaller scale and deliver those to/from each regional nodes in smaller volume by medium and heavy truck. Expected benefits of logistics hub are better consolidation of capacity in main route, efficient use of large truck instead many small vans, less land side congestion in the port, reduction of empty return trips, and multiplier effect to the surrounding areas by job openings and business activities.

More transport volume will increase the scale of economies of logistics hub operation. Consequently, it will lower generalized transport cost. It is in line with the network effects, which showing that when increasing number of demands uses service, services will become more valuable to users because quality increases (Katz & Shapiro, 1985). Even, railway mode is also potential to result more efficient freight transport in future. Thus, investigating the idea of logistics hub location will be sensible in light of increasing competitiveness of Bitung by decreasing hinterland costs of hinterland transport.

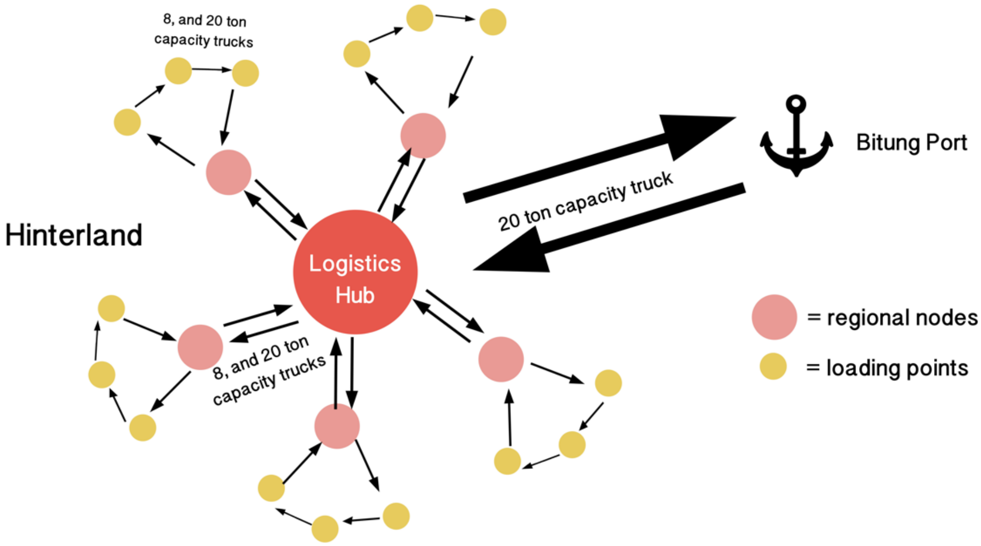

Figure 1-4: Proposed idea of inland logistics hub for hinterland connection

This study is one of the main idea for final problem owner, North Sulawesi Province government. Currently there is no integrated logistics hub facility in Bitung. Therefore, it is potential to conduct detail analysis regarding to development of logistics hub for Bitung Port. The preferred form of logistics hub is inland hub rather than a feeder port. It is because Bitung Port has the significant market share (21%) in the eastern part of Indonesia (Pelindo IV, 2012). Plagued by delays, bureaucratic red tape, and viewed by users as unavoidable parameters are the other reasons to not use feeder port in developing countries (Lam & Iskounen, 2010). It was the main reason why Author prefer to analyse inland logistics hub. Feeder ports also adds more traffic in the port interior in other areas, which is not as flexible as if delivered via land transport (in the case of Sulawesi Island).

1.1.3 Problem Definition

Eastern Indonesia still has the lowest share of trade of Indonesia (Fahmiasari, 2015). In line with maritime vision of Indonesia, this region should be change towards a more competitive region, especially Bitung Port. Bitung Port has significant potency in the eastern Indonesia (Prasetyadi & Widianto, 2004). In other hand, the hinterland connection still depends with mixed volume of vans and truck from regional nodes to Bitung Port and vice versa. Several number of warehouses in regional nodes are not fully capable to consolidate the large shipment to Bitung Port.

The strategy to change Bitung Port (North Sulawesi Province generally) to be more competitive is by increasing domestic cargo that leads to economies of scale. In the end, it potentially will result a better hinterland connection. Thus, Author focuses in hinterland transport to/from Bitung Port. There has been a research that stated “portion of inland costs in the total costs of container shipping would range from 40% to 80%” (Notteboom & Rodrigue, 2005). Therefore, Author believes that inland logistics will be the most vital area still left to cut costs.

One of the solution to create the more efficient hinterland is developing logistics hub. Therefore, the main problem in this research is how to develop the inland logistics hub to/from Bitung Port in the sense of reducing generalized transport cost to create more efficient hinterland connection.

1.2 Research Objective

The research objective, therefore, is to analyse whether developing inland logistics hub in North Sulawesi Province is able to reducing generalised transport cost to/from Bitung Port.

1.3 Research Question

Research objective and the problem analysis formulates research question. The main research question, thus, is:
"To what extent can the development of inland hubs in the North Sulawesi reduce the overall generalized transport cost to/from the port of Bitung?"
There are several sub-research questions in order to answer the main research questions:

a. "Where are the possible inland logistics (hub) s for Bitung Port to be located?"
b. "How can the cost reduction be modelled (for the proposed inland hub(s))?"
c. "What are the expected generalized cost reduction of the proposed inland hubs on the overall transport cost to/from the hinterland of Bitung Port?"
d. "Is the expected business model of inland hub logistics development economically feasible?"

1.4 Scope

A clear scope explains the boundary of study. Limited time and scarcity of data in Indonesia in both quantity and quality wise restricted several parameters.

1.4.1 Geographical Scope

The geographical scope indicates the boundary of study. The study focuses on the North Sulawesi province, the captive hinterland of Bitung Port. There are 15 districts, which are included by 12 municipalities and 3 cities, see Figure 1-5. To keep it manageable, range of regional nodes only covering capital city of regions and assumed loading points.

1.4.2 Single transport mode

Due to the non-existent of railway infrastructure in Sulawesi Island, the usage of railway infrastructure is not possible for quick solution. Therefore, the intermodal concept that is used to be the characteristics of logistics hub will be replaced by "consolidation" concept from mixed kind of small and large volume of vehicle into uniform 1 TEU truck, which is more common than 1 FEU for freight companies North Sulawesi Province. Nevertheless, the construction of logistics hub allows further development of railway infrastructure for next phase.

1.4.3 Generalized transport cost

Generalized transport cost structure in this study has the scope between loading point in each regional and Bitung Port. Consideration of handling cost in logistics hub scheme only applies for handling cost in logistics hub.

1.4.4 Time horizon

The time horizon is set for 20 years. The operation of logistics hub will start in 2039. This 20 years' time span is an appropriate period to see significant changes in North Sulawesi Province and generally in Indonesia.

1.4.5 Empty return trips

There is no further discussion of difference number of empty return trips after logistics hub application is since it will be the recommendations of future study. The empty return trip only considers the data between regional nodes and Bitung Port.

1.4.6 Economic feasibility

Social Cost Economic Benefit Analysis (SCBA) analyses the economic feasibility of project. Section of financing source only discuss the basic concept of financing the infrastructure. It does not integrate the figures of SCBA with application of financing scheme.

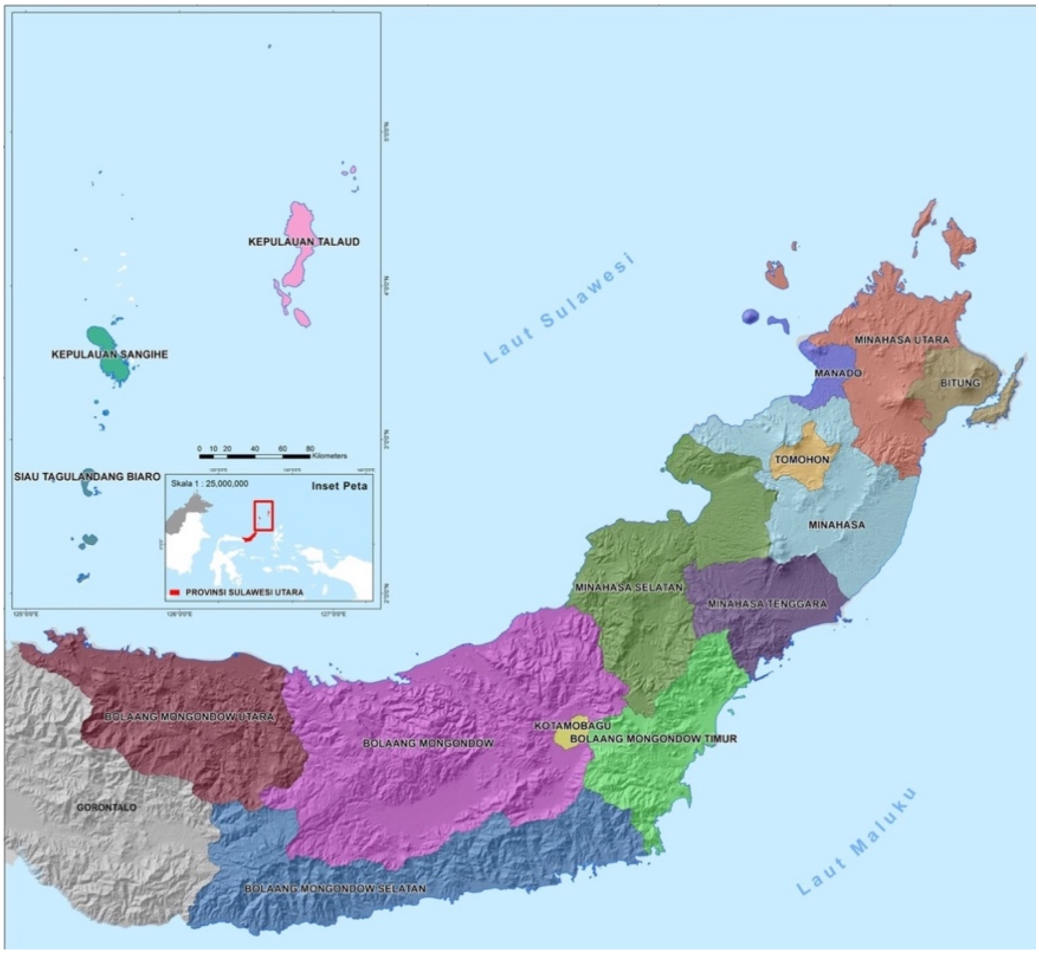

Figure 1-5: North Sulawesi Province map

Source: (Statistics of North Sulawesi Province, 2015)

1.5 Thesis Structure

This section presents the structure of thesis. A framework should be set up to explore the development of inland logistics hub to/from Bitung Port. As shown in Figure 1-6, this research follows these steps. The structure of the report consists of seven chapters.

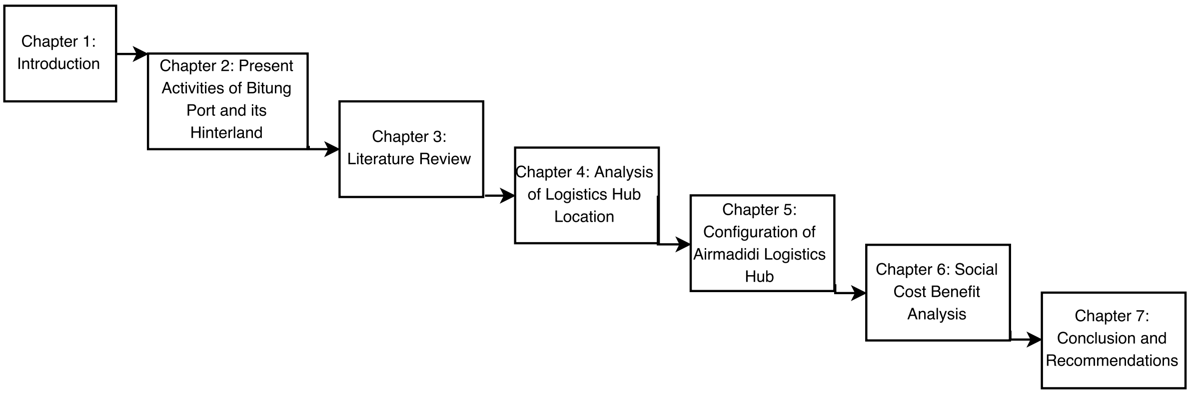

Figure 1-6: Thesis Structure

Chapter 1 introduces and elaborates problem. In addition, it formulates research objective and research question, which will be the basis of this thesis. This chapter also describes structure and scope of report.

To describe the present situation, chapter 2 firstly describes Bitung Port and its hinterland in recent situation. It explains trade activity, transportation infrastructure of Bitung Port and its hinterland specifically. In addition, this chapter explains priority of government and service of shipping in Bitung Port.

Chapter 3 elaborates literature review in order to answer research question. It explains certain eligible literature in each analysis from broader view.

In chapter 4 the logistics hub location is analysed. Since it reflects to decision making of developing logistics hub. A discrete cost simulation results the optimal location to be logistics hub. It also provides the cost saving for each regional node.

In chapter 5 explains the configuration of chosen logistics hub. The configuration describes the type of logistics hub, layout and related stakeholders in logistics hub. It is the basis of following chapter, chapter 6.

From previous configuration, chapter 6 analyses the feasibility of this project by applying Social Cost Benefit Analysis. The constructed layout in chapter 5 help to estimate possible cost and benefit. Sensitivity analysis and possible financing source of logistics hub complete this chapter.

Finally, chapter 7 summarize the report with sections of conclusion, recommendations, and reflection.

1.6 Research Methods

Applying several different research methods aims to answer the research question systematically. This study has a research question of **"To what extent can the development of inland hubs in the North Sulawesi reduce the overall generalized transport cost to/from the port of Bitung?"** To answer this main question, Author elaborates four sub-research question. Figure 1-7 displays the flow of chapter in answering these four questions.

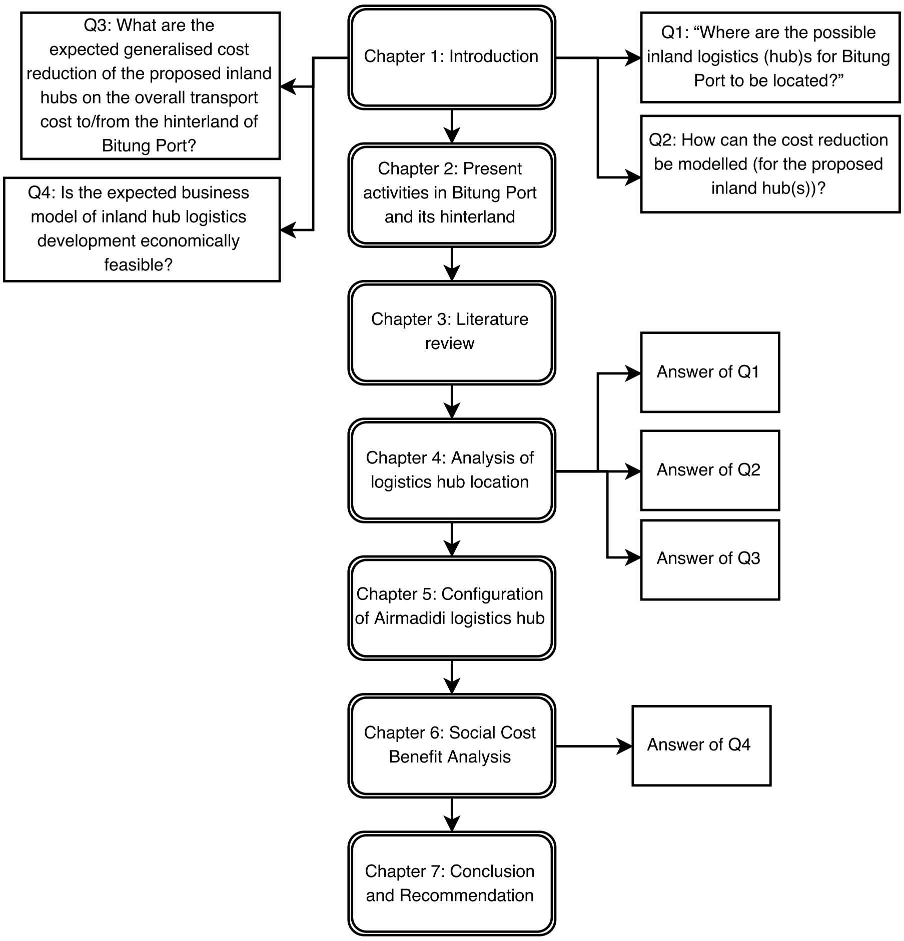

Figure 1-7: Methodology to answer question of research

Chapter 1 has presented four sub-research questions. Chapter 1, 2, and 3 were the basis of chapter 4 to answer the first, second, and third sub-research questions. Chapter 5 was the basis of chapter 6 in answering the last sub-research question. Chapter 7 concluded all answers and recommendation of this study. In addition, it explained future recommendations. Each chapter explained more detail research methodology to obtain the answer of sub-research questions.

This study performed different research method. Below paragraph explains each method generally. To see the specific method, each chapter provided methodology section.

- Literature review
  Literature reviews aims to gain information in the development of logistics hub and its implications for Bitung Port. Author used scientific literatures, newspaper, government and consultants report to review recent trend and the possible development of logistics hub in North Sulawesi Province. Chapter 3 explicitly clarified certain important formula and literatures. Nevertheless, it provided foundation to all analysis along the research.

- Modelling approach
  In order to gain the optimum location of logistics hub, a modelling approach was applied using discrete simulation cost. Author used Socio Cost Benefit Analysis method to analysing economic feasibility of project. Chapter 3 explained both model and formulas, after which chapter 4 and 6 presented the applications and results. The model presented a better understanding of each candidate ability in reducing generalised transport cost generally in a system and individually (with other candidate location). It reflected the effect of location decision with feasibility of project.

- Interviews
  To collect insight from different perspectives on the result of this research, several parties were in the data collection phase. The interviewees were port operator (Pelindo IV), regional government agency (BAPPEDA Bitung), freight forwarder association, local tuna industry, and domestic shipping lines. These interviews provided author insights and real problems in the field. These interviews were "reality check" to reveal certain facts that have not been known in the earlier time.

Research methods were critically looked from different angles. The literature review delivered a solid basis for a construction of problem and questions. The modelling approach assisted for quantification of defining the optimum location and the feasibility of project. Finally, the interviews provided feedback on making decision and assumptions for this study.

2. PRESENT ACTIVITIES OF BITUNG PORT AND ITS HINTERLAND

Chapter 2 aims to analyse the present activities of Bitung Port and its hinterland. It discusses thorough analysis of existing infrastructure, market share, and transportation infrastructure of Bitung Port. The hinterland analysis describes captive hinterland, recent government plan of Bitung, main commodities, and supporting transportation infrastructure of Bitung Port to hinterland. This report uses this chapter as basic perspective.

2.1 Present Situation of Bitung Port

2.1.1 Inclusion in Government Planning

Bitung City and its port hold a high priority for both national and regional government plans. Four national government plans and one international (ASEAN) plan stated the urgency of this region. Table 2-1 summarizes these plans.

No	Name of regulation	Type of level
1	Special Economic Zones (KEK)	National
2	Sulawesi Economic Corridor	National
3	National Economic Development Planning Zone (KAPET)	National
4	International hub port in Maritime Highway	National
5	ASEAN Ro-Ro shipping network	International

Table 2-1: Bitung City and port inclusion in various government planning

2.1.2 Infrastructure of Bitung Port

Figure 2-1: Illustration of Bitung Port existing situation
Source: (Pelindo IV Bitung, 2016)

The high potency of Bitung does not align with a sufficient efficiency from the port in term container traffic. Container productivity and time efficiency in Table 2-3 describes it. The container productivity in Bitung Port is only 20 boxes/crane/hour whereas container productivity of Makassar Port (the biggest port in Sulawesi Island) is 25 boxes/crane/hour. Container throughput in Makassar is more than twice higher than Bitung. For general cargo, Makassar handle five times higher than volume in Bitung. By the indicators of yard, berth, and shed occupancy ration Makassar shows higher utilization than Bitung in container wise. Table 2-3 and Table 2-4 shows detail term of time efficiency parameter. With 82% of time efficiency, container operation in Makassar is only idle for 4 hours. Unfortunately, for general cargo, the exact utilization data are not available.

Figure 2-2: Bitung Port

Table 2-2 shows that facility of Makassar Port outperforms Bitung Port. Reflect to the lower facilities numbers and lower traffic volume, Bitung Port only has share of 16% in Eastern Indonesia market (Pelindo IV Bitung, 2016). As can be seen in Figure 2-2, Bitung Port currently has two terminals: multipurpose and container terminals.

No	Facility	Unit	Value	Compared to Makassar
1	Quay length	m	1,542	2,685
2	Warehouse	m^2	14,600	23,800
3	Yard	m^2	98,300	187,000
4	Tug Boat	unit	2	4
5	Pilotage Boat	unit	1	3
6	Container Crane	unit	2	5
7	Container Throughput	TEU	207,061	569,121
8	General Cargo Throughput	Ton	961,019	352,653
9	Terminal Tractor/Reach Stacker/Side Loader	unit	6/2/0	10/3/1
10	Passenger Terminal	m^2	2,400	3,620
11	Depth	M LWS	-9-10	-12

Table 2-2: Facilities in Bitung Port
Source: (Pelindo IV, 2012)

No	Operation	Value	Compared to Makassar
1	Operational hours in 1 day	24 hours	24 hours
2	Turn Around Time (Average)	56 hours	33 hours
3	Waiting Time	72 hours	72 hours
4	Time Efficiency of container operation (%)	61	82
5	Berth Occupancy Ratio (%)	67	67
6	Shed Occupancy Ratio (%)	14	17
7	Yard Occupancy Ratio (%)	78	75

Table 2-3: Bitung Port operational indicators
Source: (Pelindo IV, 2012)

No	Port	Utilization of container operation	Handling Speed		Unproductive hours of container service
			Container	General cargo	
1	Bitung	61%	20 box/crane/hour	60 ton/ship/hour	9.4
2	Makassar	82%	25 box/crane/hour	88 ton/ship/hour	4.3

Table 2-4: Time Efficiency indicator in both ports
Source: modified from (Pelindo IV, 2012), (Idrus, Samang, Adisasmita, Sitepu, & Ramli, 2012)

2.1.3 Market Share of Bitung Port

The eastern part of Indonesia currently contributes 22% share to total Indonesia trade flow (Pelindo IV, 2012). As indicated in Figure 1-1, BAPPENAS determines the eastern zone for Bitung Port operation. It includes provinces of North Sulawesi, Gorontalo, Central Sulawesi (Pantoloan and Toli-Toli Ports), Maluku (Ambon Port), North Maluku Islands (Ternate Port), Papua (Jayapura Port), and West Papua (Sorong Port).

Bitung contributes 16% share to Eastern Indonesia trade flow (see Figure 2-3). Makassar (South Sulawesi), the existing hub, contributes the highest share (41%). If we compare to the nearest port such as Pantoloan and Kendari, Bitung takes quite a significant share in this area and becomes the only challenger to Makassar.

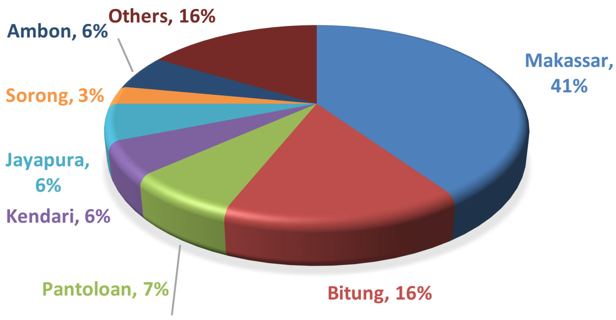

Figure 2-3: Market share of Eastern Indonesia ports in 2014
Source: (Pelindo IV, 2016)

Table 2-5 shows the national trade flow between main ports in Indonesia. Bitung Port has the least share of container flow if compared to other leading ports. About 7% of all container trade to/from main ports crosses this port. Bitung covers 1% of total national container traffic.

To read this table, take the example of the sixth row to see the outgoing flows from Bitung. It presents Bitung container flow to different five port destination. The container flows from Bitung to Tj. Priok is 45,324 TEU in the year, which is representing 1.9% of total flow between these five analysed ports. The sixth column shows incoming flows to Bitung Port. The movement to Bitung Port from Tj. Priok is 68,004 TEU, which is representing 2.9% of total flow inside all flows in five main ports.

OD Goods Flow (TEU/year)	Kuala Tanjung (North Sumatera)	Tj. Priok (DKI Jakarta)	Tj. Perak (East Java)	Makassar (South Sulawesi)	Bitung North Sulawesi)	Total
Kuala Tanjung (North Sumatera)		157,272 6.6%	40,440 1.7%	0 0.0%	0 0.0%	197,712
Tj. Priok (DKI Jakarta)	235,956 9.9%		139,140 5.9%	54,456 2.3%	68,004 2.9%	497,556
Tj. Perak (East Java)	60,660 2.6%	42,288 1.8%		168,492 7.1%	31,356 1.3%	302,796
Makassar (South Sulawesi)	0 0.0%	36,276 1.5%	80,988 3.4%		7,512 0.3%	124,776
Bitung (North Sulawesi)	0 0.0%	45,324 1.9%	20,904 0.9%	0 0.0%		66,228
Total	296,616	281,160	281,472	222,948	106,872	2,378,136 100.0%
% of national container traffic covered	10%	15%	13%	4%	1%	

Table 2-5: Container flow between main ports in Indonesia
Source: own analysis, (Pelindo IV, 2012)

2.1.4 Service of Shipping Lines in Bitung Port

Container liner shipping service in Bitung Port is categorised into domestic and international service. In the domestic side, there are six shipping line companies. Figure 2-4 reflects the composition of shipping lines share. Tanto and SPIL Lines share the same share of 24%. Meanwhile, Maersk Line, the international liner only has 2% of share. The domestic service in Bitung Port covers the national hub ports such as Jakarta, Surabaya, and Makassar. The smaller ports in eastern Indonesia that become the destinations from Bitung Port are Palembang (South Sumatera), Pantoloan (Central Sulawesi), Ambon (Maluku), and Gorontalo.

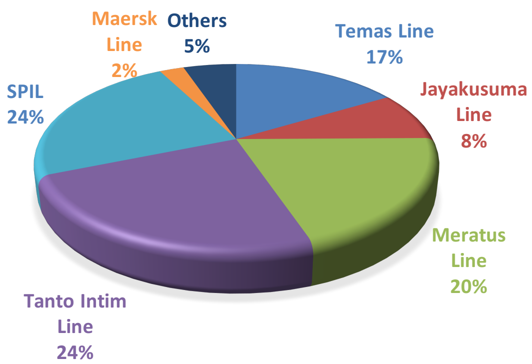

Figure 2-4: Market share of shipping lines in Bitung Port
Source: (Pelindo IV Bitung, 2016)

Table 2-6 depicts the domestic liner shipping to and from Bitung Port. The most frequent service is to/from Jakarta. Nevertheless, the largest total capacity is shown by Bitung—Surabaya and vice versa. In the case of service to/from Jakarta and Surabaya, the westbound cargo side is lower than eastbound. Less industry in Bitung than Jakarta and Surabaya causes it. Most of the received goods in Bitung Port from those areas are daily-consumed goods such as rice, noodles, soap, shampoo, etc.

Bitung Port already has had one international liner shipping, Maersk Line, since 2014. It has operated from Tanjung Pelepas (Malaysia). The strategic location of Bitung Port is potential to be a transhipment hub for containers imported to Indonesia (primarily to Java island via Tanjung Priok and Tanjung Perak) from Hongkong (representing China), Busan (representing South Korea), Philippines, and Tokyo (representing Japan) and vice versa.

There are four reasons on why Maersk Line introduced international call from Bitung. The first one is Bitung' strategic location that fits their network. Secondly, there is untapped potential from eastern Indonesia. Next, growing the export market for fishery industry in Bitung. The last is the inefficient, high-cost, and unreliable domestic service in Bitung region (Maersk Line, 2014).

No	Origin	Destination	Frequency/month	TEUS/month
1	Bitung	Jakarta	8	229
2	Bitung	Surabaya	4	487
3	Bitung	Palembang	2	313
4	Bitung	Pantoloan	2	313
5	Bitung	Ambon	2	313
6	Jakarta	Bitung	8	343
7	Surabaya	Bitung	4	731
8	Gorontalo	Bitung	3	662
9	Pantoloan	Bitung	2	313
10	Palembang	Bitung	2	313
11	Makassar	Bitung	2	313
12	Ambon	Bitung	2	313

Table 2-6: Domestic liner service from and to Bitung

Source: own analysis, (The World Bank, 2014)

Figure 2-5: Maersk Line connection through Bitung

Source: (Maersk Line, 2014)

Figure 2-5 shows the service of Maersk Line from Tanjung Pelepas-Bitung-Papua New Guinea. They used two vessels with 700 TEU nominal capacity. Therefore, there was no major deviation by calling Bitung. Maersk Line becomes the only and the first shipping line that offers direct international service from Bitung to transhipment port in Tanjung Pelepas, Malaysia. It resulted in better transit time from 12 days (using local feeder Bitung-Jakarta-Tanjung Pelepas) into seven days (from Bitung to transhipment port, Tanjung Pelepas).

The other benefits for exporters were direct access to global market, equipment that was always available at the time of booking, local logistics cost reduction by optimum domestic transhipment, the risk of damage reduction due to re-stuffing process in Jakarta/Surabaya, and direct process of custom in Bitung. Captured by the advantages, the existence of this service was able to increase the market range of Bitung shortly to national and international trade.

Unfortunately, this service stopped in September 2015. The reason was an insignificant load on this connection. The primary cause of the small load was the recent fishing moratorium from the minister of marine affairs and fisheries of Indonesia. The production capacity of fisheries processing industry declined 80% after the minister enacted the foreign vessel license moratorium and forbade transhipment in the middle ocean by anglers (TEMPO, 2016). On the other hand, the minister vigorously reinforced this regulation to avoid the income loss of county by illegal fishing practice, which is accounted up to 2 billion Euro per year (TEMPO, 2016).

2.1.5 Trade Activities in Bitung Port

There are two perspectives to an overview trade activities of Bitung Port. The first perspective is overview of container flows via Bitung Port to/from the other ports in Sulawesi Island. Bitung Port mostly conduct import/export than transhipment activity (related to national trade) in ratio 6:1 (see Figure 2-6.). The second perspective includes container flows via Bitung Port to/from other islands in Eastern Indonesia. Figure 2-7 captures container flows inside these two models. The first market outranked the second market three times larger.

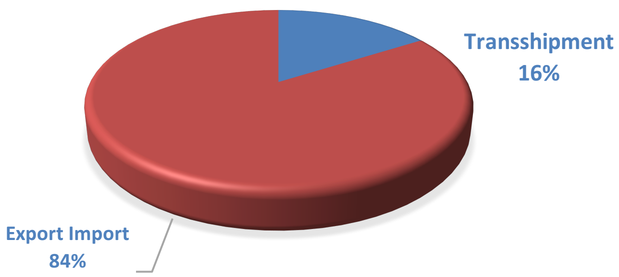

Figure 2-6: Type of trade activity in Bitung Port
Source: (Pelindo IV, 2016)

Table 2-7 depicts how many goods imported and exported via Bitung Port to/from the Sulawesi Island. Bitung dominates other ports in Sulawesi Island. Makassar, with largest market share in the Eastern Indonesia, has more traffic from the western side. It only has a share of 10%. The Eastern Indonesia has significant share due to combined traffic from three big ports there: Ambon, Manokwari, and Ternate.

Bitung Port	Value (TEU/year)	Percentage
Direct import/export to/from Sulawesi Island	161,508	78%
Transhipment to Sulawesi Island	31,059	15%
Transhipment to/from Eastern regions	14,494	7%
Total	207,061	100%

Table 2-7: Two perspectives of liner container traffic of Bitung Port
Source: (Pelindo IV, 2016)

Figure 2-6 shows that (un)loading cargo is the dominant activity in Bitung Port. Only 16% represents transhipment activities. Regarding that figure, therefore this research will focus more on the local market, which comprises Sulawesi Island as the focus.

Sulawesi Island's	Import/Export (TEU/year)	Percentage
Bitung	44,976	27%
Pantoloan	15,024	9%
Gorontalo	22,440	13%
Makassar	16,368	10%
Kendari	14,796	9%
Other Sulawesi Ports	56052	33%
Total	169,656	100%

Table 2-8: Import/Export Container traffic of Sulawesi Island' ports
Source: **(Pelindo IV, 2016)**

Container contributes the highest share of total commodities (by tonnage) in Bitung Port (as shown in Figure 2-7). The second biggest volume of cargo is liquid bulk. It represents a massive production of coconut and cooking oil along with other derivatives. Many industries located along the way to Bitung Port reflects it. Table 2-9 provides data of each cargo type volume in ton in the year 2015. Dry bulk, general cargo, and bag cargo share the rest percentage.

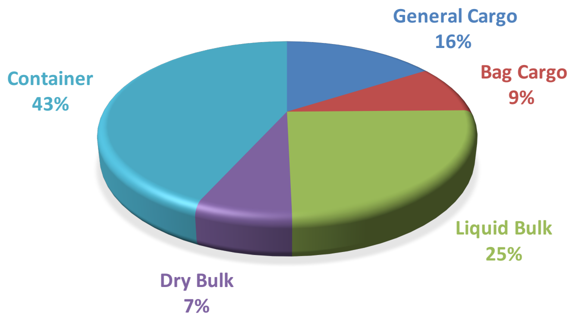

Figure 2-7: Share of cargo by packaging
Source: (Pelindo IV, 2016)

No	Cargo type	Volume in 2015 (ton)
1	General cargo	961,019
2	Bag cargo	530,241
3	Dry bulk	1,502,427
4	Liquid bulk	428,384
5	Container	2,608,969

Table 2-9: Volume of cargo per type in 2015
Source: (Pelindo IV, 2016)

Figure 2-8 hows trade activity in North Sulawesi Province. The darkest red presents the highest trade activity by measuring theirs incoming and outgoing commodities. Lighter red node shows the lower trade activity. Most of the activities take place near the Bitung Port, such as Tondano (Minahasa), Airmadidi (North Minahasa), and Manado (Manado City). The node of Ondong Siau, one of the island in the northward of this province depicts the little activity.

Figure 2-9 portrays the interaction of trade between Bitung Port and its hinterland. North part districts of this province, such as Manado, Minahasa, and North Minahasa, contributes significantly to Bitung Port activity. Figure 2-10 shows projection in container traffic. It starts from the recent number of the container in 2015 and projected for the next 20 years. The projection uses annual growth 4% from the previous analysis of Transportation Ministry of Indonesia.

Figure 2-8: Trade activity in North Sulawesi Province
Source: own analysis, (Ministry of Transportation Indonesia, 2011)

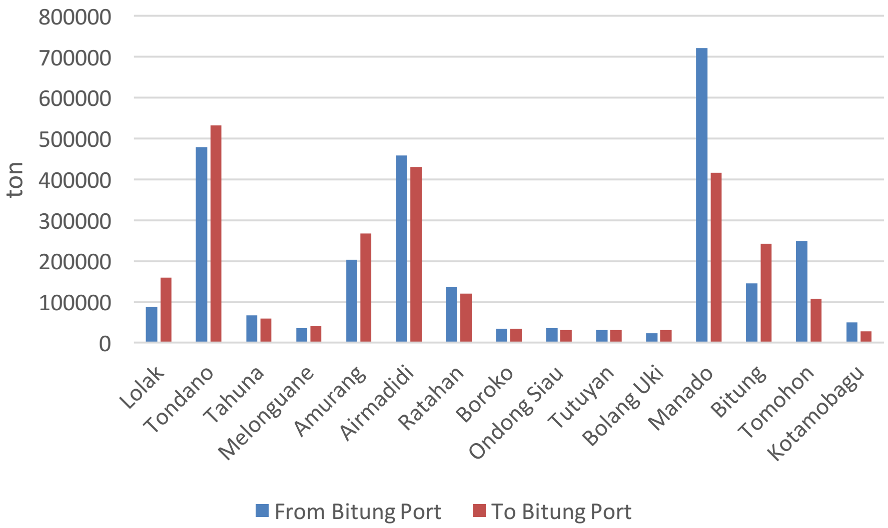

Figure 2-9: Trade activity between each regional node and Bitung Port
Source: (Ministry of Transportation Indonesia, 2011)

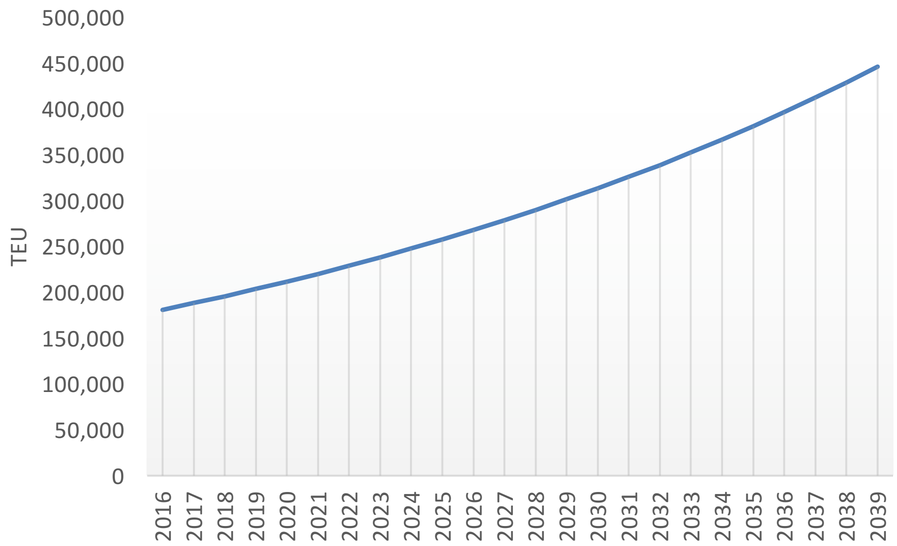

Figure 2-10: Projection of container demand of Bitung Port
Source: (Pelindo IV, 2016) (Ministry of Transportation, 2014)

2.2 Hinterland of Bitung Port

The captive of the Bitung Port in this study is North Sulawesi Province. Therefore, the next section will mainly explain North Sulawesi Province and its potency.

2.2.1 North Sulawesi Province

The capital city of North Sulawesi Province is Manado. The area of this province is 15,273 km2. It has almost open ocean borders in all direction. In the north side, there are Sulawesi Sea, Philippines Republic, and the Pacific Ocean as the frontier. Maluku Sea marks the eastern side border. Tomini Bay becomes the boundary on the south shore. Gorontalo Province becomes the non-sea border on the west side.

From the top level, Sulawesi Island contributes only 5% of national GDP. The domination of Java exceeds 60% than other islands (see Figure 2-11). Figure 2-12 shows GDRP per capita of Sulawesi Island with its six provinces. The lowest GDRP per capita inside Sulawesi Island is Gorontalo Province, the newest province in this Island. South Sulawesi Province, where the biggest port in Sulawesi Island (Makassar Port) located, results in the highest GDRP per capita among all provinces. North Sulawesi Province becomes the second best.

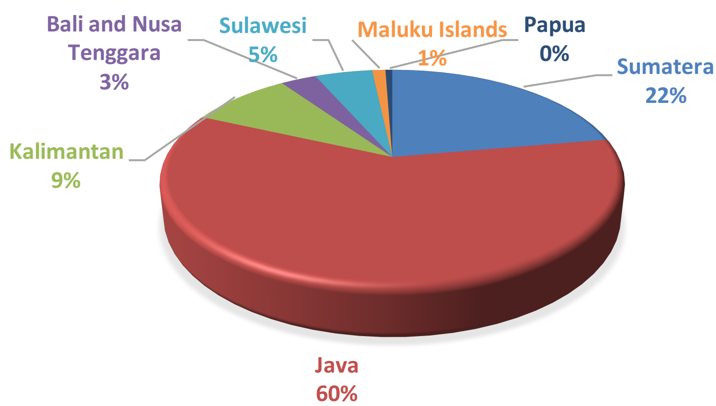

Figure 2-11: Contribution of GDP from big islands in Indonesia

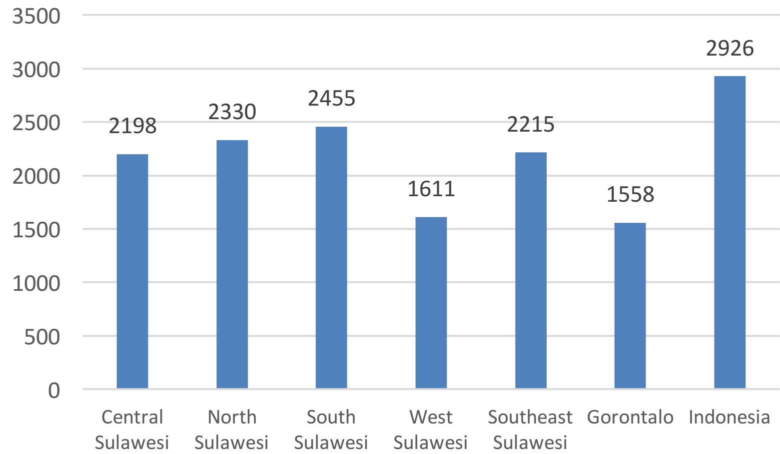

Figure 2-12: GDP per capita of Sulawesi and Indonesia
Source: (BPS-Statistics Indonesia, 2015)

Bitung City is the second largest city of North Sulawesi with an area of 332.79 km2 and a population of 193,956 people (BPS-Statistics of Bitung City, 2014). As the main port of North Sulawesi, Bitung has a tremendous growth potential by its region's natural resources and to its direct links with ports of Ambon, Ternate, and East Kalimantan (Balikpapan, Samarinda, Tarakan, and Nunukan) (The World Bank, 2014).

Figure 2-13 portrays trading activity inside this province, the share of the export commodity by export volume. Animal fat and animal/vegetables oils still a dominant product with having a share of 54%. By the volume share, the combination of meat and processed fish and fisheries and shrimp commodities only has 3% of share. Therefore, the most dominant product is animal fat and animal/vegetable oils. Fisheries commodity is the superior products in the hinterland of Bitung. It has high priority in this area (Pangemanan, 2016). Tuna from Bitung has become one of the high-ranking exports to some countries. It has also helped economic growth at the regional and national level.

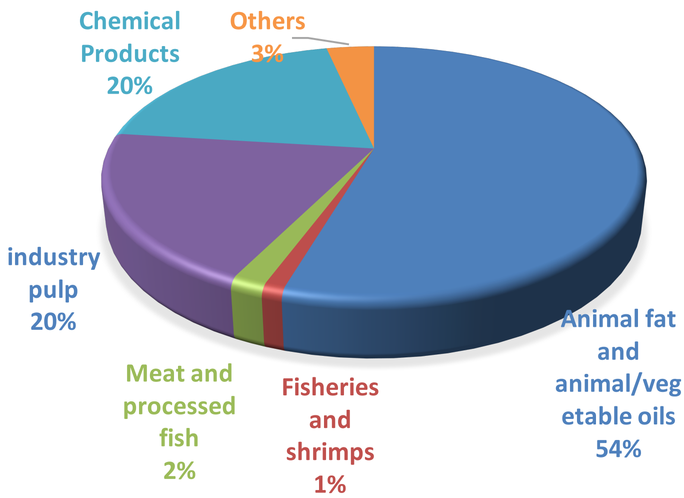

Figure 2-13: Share of export commodities by ton volume
Source: (Statistics of North Sulawesi Province, 2015)

2.2.2 Transport to Hinterland

Hinterland costs are often the largest part of the total door-to-door cost. Efficient hinterland access is a key determinant of port competitiveness (Fleming & Baird, 1999). A suitable hinterland connection allows a port to have a well-connected link to local industries (Notteboom, 2008). It is possible to improve the hinterland connection by developing logistics hub (Notteboom & Rodrigue, 2005). Logistics hub such as inland ports is truly the gateways for their respective hinterlands, vital for a region's industrial and economic development, and thus helping to achieve a more balanced development of the entire country (Lam & Iskounen, 2010). Several similar terms by academics and researchers discuss the definition of inland logistics hub. Next chapter (see Table 3-1) presents summary of those terms definitions.

In the case of Bitung Port, the hinterland connection connects Bitung Port to North Sulawesi Province. Currently, there is only road connection to connect Bitung Port to North Sulawesi Province. Appendix A previews the existing road link from Bitung Port to other North Sulawesi Province. The arterial road (drawn in red lines) connects Bitung City, which is categorised as national activities centre, to the capital city of the province, Manado. This road network continues toward neighbour province, Gorontalo. Collector road network (drawn in orange lines) connects the rest of North Sulawesi Province to Manado and Bitung.

In the other part of the province, Tondano, Tomohon, and Kotamobagu are the Center of Regional Activities. Collector roads and arterial roads connect these selected areas. Table 2-10 shows the more detail data of road network infrastructure in North Sulawesi Province toward Bitung Port.

Point A	Point B	Total road network (km)	Arterial road (km)	Collector road (km)
Bitung	Manado	45	45	-
Bitung	Tomohon	64.2	64.2	-
Bitung	Tondano	42.1	21.1	21
Bitung	Kotamobagu	237.8	204.5	33.3

Table 2-10: Road networks toward Bitung
***Source:* (Statistics of North Sulawesi Province, 2015)**

Three main routes are determined to observe traffic flow in the hinterland. These three ways (see Figure 2-14) are the primary connection from North Sulawesi to Gorontalo Province, the neighbouring province (Ministry of Transportation, 2014). North route (drawn by the red line) connects Manado-Tumpuan-Gorontalo. Figure 2-15 shows that this line has the highest flow amongst other routes. It connects Manado to Gorontalo via Tanawangko and Tumpaan. The following purple line and blue lines symbolize middle and south routes.

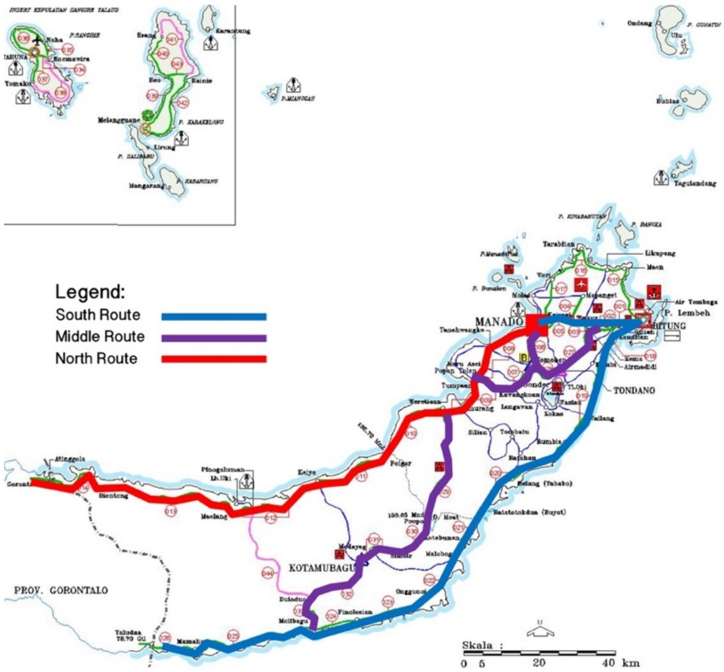

Figure 2-14: Main route in North Sulawesi Province
Source: (Ministry of Transportation, 2014)

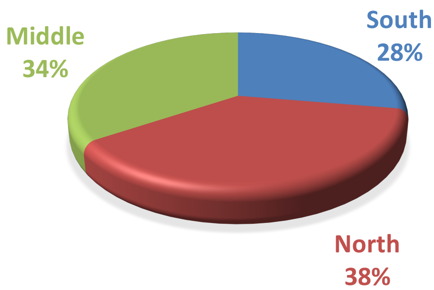

Figure 2-15: Traffic volume in three main routes
Source: (Ministry of Transportation, 2014)

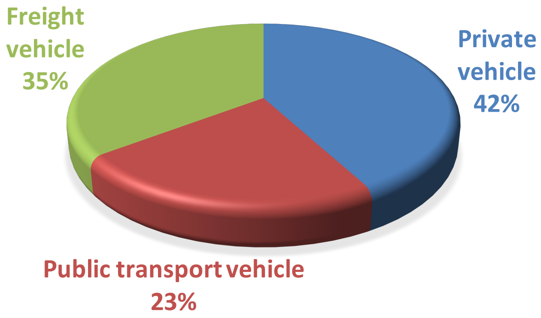

Figure 2-16: Road traffic composition in North Sulawesi Province
Source: own analysis, (Ministry of Transportation, 2014).

Freight vehicle contributes to 35% share of road traffic in North Sulawesi Province (see Figure 2-16). There are three type of freight vehicles in the road network (Ministry of Transportation, 2014): van, light truck, medium truck, heavy truck, and a semi-trailer (see Figure 2-17).

Present situation lacks shipment arrangement thus increase the generalized transportation cost by using inefficient capacity per vehicle (see Table 2-12). Table 2-11 hows the shipment volume analysis based on Bitung Port trade activity to the hinterland in 2015. Currently, the average empty return in hinterland transport of Bitung Port is 10%, although each trip to/from each district has a different fraction.

Figure 2-17: Freight vehicles type in North Sulawesi Province
Van, light truck, medium truck, heavy truck, and semi traler (left to right and above to bottom)
Source: (Mitsubishi Motors, 2016), (Shandong Shanglong, 2015), (Kingstar, 2015), (Shandong Jixin, 2016), (Des Au, 2016)

Bitung Port to hinterland			Hinterland to Bitung Port
No	**Commodity type**	**Volume (ton)**	**Volume (ton)**
1	General cargo	59,798	23,641
2	Bag cargo	202,954	80,238
3	Dry bulk	557,156	220,271
4	Liquid bulk	303,107	119,833
5	Container	445,793	450,050
6	Others	2,732	1,080
TOTAL		1,765,278	1,748,580

Table 2-11: Commodity volume and type of Bitung Port and the hinterland trade activity in 2015
Source: own analysis, (Pelindo IV, 2016)

Type of freight vehicle	Van	Light truck	Medium truck	Heavy truck	Semi-trailer
Truck type	-	2 axle rigid trucks	2 axle rigid trucks	3 axle rigid truck	3 axle trailer
Average payload capacity (ton)	1	4	8	20	25-40
Share in hinterland traffic by number of vehicles (%)	25%	25%	26%	13%	11%

Table 2-12: Hinterland traffic of freight vehicle
Source: **(Ministry of Transportation, 2014)**

2.3 Summary of present situation in Bitung Port and its hinterland

National and international plans include Bitung City and its port as a high priority. Abundant resources of fisheries and agriculture are one of the main motors of local economic development. Nevertheless, there is still less frequency of domestic shipping lines and absence of international shipping lines to optimize the potential into the more advantage to this port. Not only the shipping line service but has it also lacked efficiency in the term of container traffic if compared to Makassar Port.

In 2015, Bitung Port has throughput of 173,931 TEUs (container), 961,019 tons (general cargo), 530,241 tons (bag cargo), 1,502,427 tons (liquid bulk), and 428,384 tons (dry bulk). It contributes to 16% share of Eastern ports in Indonesia and 1% share in national coverage. The main trade activity is export and import.

Road infrastructure is the only way to connect Bitung Port to its hinterland, North Sulawesi Province. Currently, there is no fixed arrangement of shipment. Mixed use of vans, light truck, medium truck, heavy truck, and semi-trailer with the share of 25%, 25%, 26%, 13%, and 11% respectively occurs there. The analysis in OD matrix reveals that there is 10% empty trip in average, but it has a different value on each trip of the district to/from Bitung Port.

3. LITERATURE REVIEW OF DEVELOPING LOGISTICS HUB

Chapter 3 aims to discuss the literature reviews in developing logistics hub. It functions to define essential formula and method in developing logistics hub for Bitung Port. Chapter 3 discusses the logistics hub definition, four-step model of transportation, optimum location for logistics hub, and social cost-benefit analysis of a logistics hub. These significant works of literature are necessary to define further input and calculation method.

3.1 Logistics Hub Definition

There are ample of names in mentioning the term of logistics hub. Several terms have a very close definition, such as intermodal freight centre, inland port, dry port, inland clearance depot, and hinterland terminal. Table 3-1 lists the complete definition.

No	Term	Definition	Source
1	Intermodal Freight Centre	A concentration of economically independent companies working in freight transport and supplementing services on a designated area where a change of transport units between traffic modes can take place	(Cardebring & Warnecke, 1995)
2	Inland Port	It is located inland, generally far from seaport terminals; they supply regions with an intermodal terminal offering value-added services or a merging point for different traffic modes involved in distributing merchandise that comes from ports	(Harrison, McCray, Henk, & Prozzi, 2002)
3	Dry Port	An inland intermodal terminal directly connected to seaport(s) with high capacity transport mean(s), where customers can leave/pick up their standardised units as if directly to a seaport;	(Leveque & Roso, 2002), (Roso, Woxenius, & Lumsden, 2008)
4	Inland Clearance Depot	A common-user inland facility, other than a port or an airport, with public authority status, equipped with fixed installation and offering services for handling and temporary storage on any kind of goods (including container) carried under Custom transit by any applicable mode of inland surface transport, placed under Customs control and with Customs and other agencies competent to clear goods for home use, warehousing, temporary admission, re-export, temporary storage for onward transit and outright export	(UN ECE, 1998)
5	Hinterland Terminal	Small continental cargo shipments are brought to the hinterland terminal and consolidated into bigger freight flows. These bigger freight flows are further transported by larger transport means such as trains or barges. The corresponding bundling model is the trunk line with a collection and distribution network	(Wiegmans, Masurel, & Nijkamp, 1999)
6	Green Port	A port that sees green growth as an economic driver and as key to its commercial and operational activities	(Vellinga, 2011)

Table 3-1: Logistics hub definition

The logistics hubs are developed to create a modal shift from road transport to rail or barge transport and to prevent the overcrowding of seaport areas (Notteboom & Rodrigue, 2005). These infrastructures have the logistics capabilities to facilitating modal transitions; thus, contributing to the reduction of highway congestion and increasing the efficiency of freight movement (Oberstart & DeFazio, 2008). Additional user benefit is the reduction of VMT (Vehicle Miles Trip) and the respective emissions when multiple modes of transportation are supported (Rahimi, Asef-Vaziri, & Harrison, 2008).

However, investing and developing the capability of logistics hubs are resource intensive, and their benefit is very hard to be quantitatively measured (Long & Grasman, 2012). Therefore, the affecting factors in determining the location of logistics hub are necessary to be analyzed. Infrastructure, proximity to market, land availability, government and industry support, labour supply, origin/destination distances, and congestion are list of criteria that affecting the decision of logistics hub location (Long & Grasman, 2012) (Lipscomb, 2010) (Sirikijpanichkul, Van Dam, Ferreira, & Lukszo, 2007).

For further analysis in this study, the intended logistics hub in this study will provide the activities listed in definition number 1, 2, 3, and 5. The future logistics hub will be located in the land providing the service of (i) freight consolidation, (ii) customs and clearance, (iii) warehouse, and (iv) container storage. "Dry port" term defines it.

A dry port is one of the measures to reduce the congestion around the seaport. Normally, dry port business related with the container and multimodal service. All logistics services and facilities aim to ease the business of shipping and freight forwarding agents. The classification of dry port (see Figure 3-1) can be determined by kind of service to respective port (FDT, 2009): (i) a single dry port servicing single port, (ii) a single dry port servicing multiple ports, (iii) multiple dry ports servicing single port. The left figure shows the single dry port servicing one port; the middle figure shows a dry port servicing multiple ports, and the right figure shows a single port served by a single port. For further study, the first type of single dry port for the single port will be the type of dry port in the hinterland of Bitung Port.

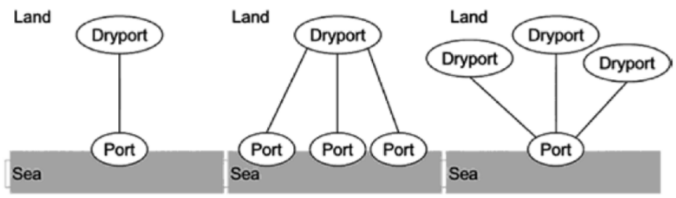

Figure 3-1: Dry Port categorization based on service to nearby port
Source: (Bergqvist & Wilmsmeier, 2013)

Three types of dry port classification are close, mid-range, and distant dry ports (Woxenius, Roso, & Lumsden, 2004). The first type, close dry port, can reduce the local traffic surrounds the port by introducing consolidation of freight to and from shippers outside the city area (see Figure 3-2). It is also crucial option when port lacks space and experiencing the congestion. This type of dry port offers possibilities for buffering containers and even loading them on the rail shuttle or bigger freight vehicle in sequence to synchronize with loading of a ship in port (Woxenius, Roso, & Lumsden, 2004). A typical distance of close dry port is between 25-50 km from the port (Bergqvist & Wilmsmeier, 2013).

The second type, the mid-range dry port is consequently situated within a distance the port covered by road transport as shown in Figure 3-3. The distance has a range of 50-150 km from the seaport. It has the relatively equal characteristic with close dry port regarding the distance, which is relatively small. Thus road transport alone can handle inbound and outbound flows in this kind of dry ports. The last type (see Figure 3-4), the distant dry port has a range of distance beyond 150 km. The far distance of this kind results in the economies scale benefit of using rail transport to deliver freight to the seaport. The competitive advantage for seaport by using distant dry port is an expansion of its hinterland. Table 3-2 mentions detail disadvantage and advantage of each dry port type.

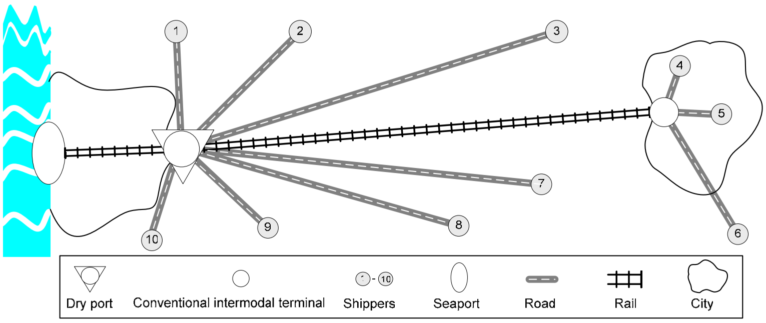

Figure 3-2: Close dry port
Source: (Woxenius, Roso, & Lumsden, 2004)

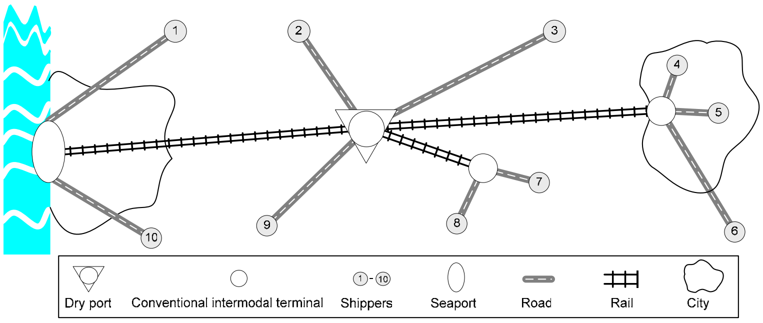

Figure 3-3: Mid-range dry port
Source: (Woxenius, Roso, & Lumsden, 2004)

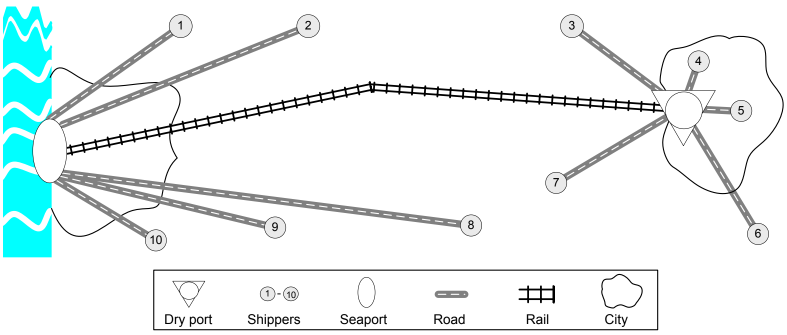

Figure 3-4: Distant dry port
Source: (Woxenius, Roso, & Lumsden, 2004)

Indicator	Close dry port	Mid-range dry port	Distant dry port
Conditions	Transit activity dominant in seaport; There is a need due to the lack of space in seaport	High volume customers; Rail link between seaport and market	Rail link between seaport and market
Location level	Decongestion of the city access; Reduction of pollution; Increased intermodal transportation	Region attracts industries; Reduction of pollution; Increased intermodal transportation	Acquiring new hinterland of the seaport in consideration; Reduction of pollution; Increased intermodal transportation
Infrastructure level	Reduction of road maintenance cost; Increase of rail maintenance cost; Reduction of cost for road infrastructure development; Increase of cost for rail infrastructure development	Reduction of road maintenance cost (in case of pay roads, reduction of profit); Increase of rail maintenance cost	Reduction of road maintenance cost (in case of pay roads, reduction of profit); Increase of rail maintenance cost
Transport level	Light reduction activity for road carriers from/to seaports; Reduction of congestion and waiting time for transport operators; Increase of transit time; Increase of handlings	Reduction activity for road carriers from/to seaports; Reduction of congestion and waiting time for units; Decrease of transport costs; Coordination with rail passenger traffic	Light reduction activity for road carriers from/to seaports; Reduction of congestion and waiting time for units; Decrease of transport costs; Coordination with rail passenger traffic
Logistical level	Increased inland access and city distribution; Invitation for the use of intermodal solutions	Increased inland access; Decrease of costs	Increased inland access; Possibility to choose between ports; Decrease of costs
Customer viewpoint	Raise of costs at the beginning; Decrease of costs in the long run; Reception of units closer to their own geographical location	Easy access to seaport; Decrease of costs; Slight increase of transit time	Easy access to seaport; Decrease of costs; Increase of transit time (or decrease depending on the country of interest, on its road infrastructure quality level, and on distance to cover)

Table 3-2: Advantages and disadvantages of different kind of dry port

Source: own analysis, (FDT, 2009) (Roso, Woxenius, & Lumsden, 2008)

The concept of dry port has integrated basic logistics services, value-added logistics services, and commercial financial services. It adds logistics value at a facility that acts as an intermediary in the supply chain (Villiers, 2015). Basic logistics services relate to intermodal transfer, loading and unloading, handling and transhipment, warehousing, and distribution centres. The value-added logistics services include groupage, quality control, packaging, inspection, consolidation, stuffing, vehicle maintenance, freight clearing, and information and communication. The higher level of service is contained in commercial and financial services. It includes financial institutions, security and services, accommodation, retail, restaurants, and health and medical services. Figure 3-5 depicts those services.

The future dry port in North Sulawesi Province provides the basic logistics services of container freight station, warehouse, and consolidation. It provides other features of value-added logistics service such as customs and clearance.

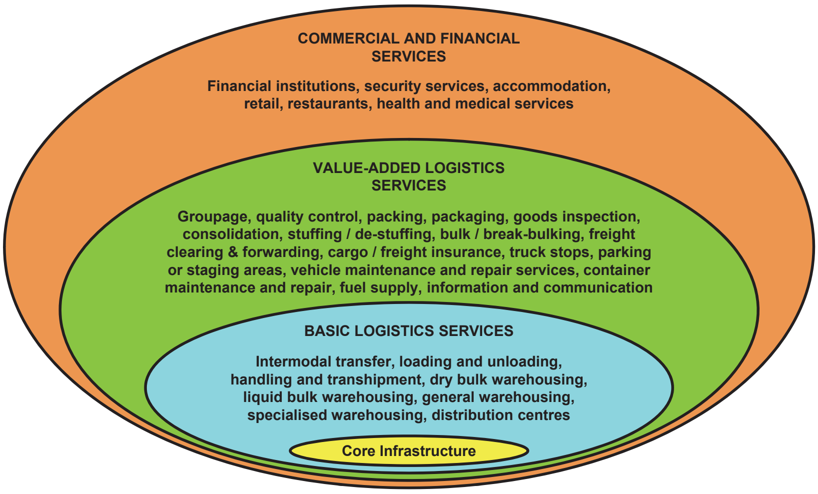

Figure 3-5: Value-adding logistics services around the core infrastructures
Source: (Villiers, 2015)

3.2 The Four Step Model of Transportation

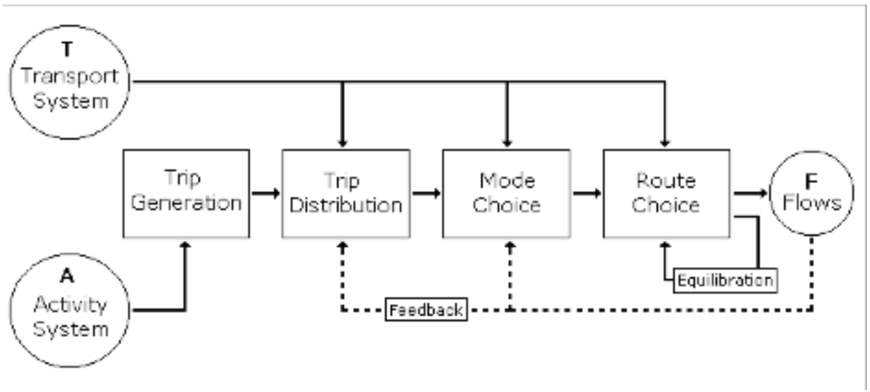

Figure 3-6: Four step model
Source: (McNally, 2007)

This section explains the four-step model. Since the further analysis to construct OD matrix uses it. The four-step model of transportation provides a mechanism to estimate direct demand functions together with link performance functions (McNally, 2007). There are four steps in this model, which are the trip generation, trip distribution, mode choice, and route choice (see Figure 3-6).

Trip generation provides the total number of trips generated by (O_i) and attracted to (D_j) each zone of the study area (Ortuzar & Willumsen, 2011). It classifies two kind of trips: trip production and trip attraction. Regarding to logistics theme, term of "flow" replaces "trip. Thus," terms of "outbound flow" and "inbound flow" replace "trip production" and "trip generation".

For calculation of outbound flow and inbound flow, equation (1) and (2) are given. O_i represents the sum of outbound flow from zone i to zone j. T_{ij} is the total goods flow (in tons) from district i to district j. D_j represents the total inbound flow from municipality j to i. O_i represents the outbound flow from zone i to j.

$$O_i = \sum_j T_{ij} \quad (1)$$

$$D_j = \sum_i T_{ij} \quad (2)$$

$$T_{ij} = \rho O_i D_j e^{\beta c_{ij}} \quad (3)$$

Trip distribution is a model of the number of trips that occur between each origin zone and each destination zone (Levine, 2010). It predicts the number of freight trips between each origin and destination zone. Balancing outbound and inbound flow apply doubly constrained formula. Equation (3) shows formula of trip distribution. It indicates that balancing factor (ρ) balances outbound flow and inbound flow which related to impedance function ($e^{-\beta c_{ij}}$).

Impedance function ($e^{-\beta c_{ij}}$) represents the function of parameter (β) and travel distance (c_{ij}) between district i and j. The parameter of β indicates the sensitivity the accessibility value is to the change of transport cost (Alam, 2013). This function uses the scheme of negative exponential function. The negative exponential function provides the best estimation of the regional freight matrices in Indonesia (Sonny, Hadiwardoyo, Susantono, & Benabdelhafid, 2015). It provides the relationship that when the transport distance between municipalities increased; the value of attractiveness of particular district will decrease.

The gravity method to construct OD matrix provides a very close approach to the real world since it captures possible activities derived from each district freight attraction and generation (McNally, 2007). Therefore, one should have robust data of these freight activities to provide a vigorous result of OD matrix.

3.3 Analysis of Logistics Hub Location

The location is a key factor for all the transport operators whose main activity is moving freight from one place to one another using different modes of transport (EUROPLATRFORMS, 2004). One should carefully consider a location of logistics hub. Since it implies to direct and indirect benefit of several stakeholders including investors, policy makers, infrastructure providers, hub operators, hub users and the community.

3.3.1 Discrete Cost Simulation Method

Finding the best location for logistics hub observes three methods. These observed methods are accessibility measure, single location, and discrete cost simulation. Currently, the first two approaches provide approach from distribution cost minimization without considering the existing port. These methods do not link the concept of logistics hub location from existing port perspective. From these three observed methods, discrete cost simulation provides the best approach.

Discrete cost simulation perceives both minimised total generalized transport cost and each district perception to the selected logistics hub. It also combines the parameter of freight volume in calculating the annual trip cost. General steps of this method are (i) construct the generalized transport cost in both schemes (existing and with logistics hub scheme), (ii) OD matrix construction from particular port to the hinterland, (iii) analyse the possible cost reduction between both schemes.

Section 3.3.2 will explain trip generation step further. Secondly, constructing OD matrix intends to estimate the volume of each shipment. The second step of discrete cost simulation is constructing the Origin-Destination (OD) matrices. OD matrix describes trips that take place in certain location. The activities between possible locations (O_i and D_j) is derived from trip generation and trip distribution steps, which is the first and second step of the four-step model (FSM) (see Figure 3-6).

Subsequently, the third step is calculating generalized transport cost in both schemes (existing and with logistics hub). Generalized transport cost in existing scheme estimates direct cost from seaport to each district. Scheme of logistics hub inclusion calculates generalized transport cost from Bitung Port to the destined district via logistics hub. Discrete step simulates generalized transportation cost by applying each district to be logistics hub, one by one. The best location is the district that can save the highest total generalized transport cost annually.

Also, this method can capture the willingness of each district to participate in the selected logistics hub. It is derived from the percentage saving that is derived in each simulation of logistics hub cost calculation. The advantages of this method are (i) calculates the total saving generalised transport cost, (ii) calculate the saving generalised transport cost individually, (iii) estimate each preference of logistics hub from different district, and (iv) allocate how much freight to be allocated in logistics hub to design the size of logistics hub in further step. Therefore, analysis of logistics hub location in this study uses this method.

3.3.2 Determining Generalized Transport Cost

To model both situations (direct and logistics hub scheme shipment), the generalized transport cost component should be defined first in both settings.

$$Total\ c_{ijm} = \sum_{i=0}^{m} c_{im}^{1st} + c_{lh} + c_{jm}^{2nd} \tag{4}$$

Where,

Total c_{ijm} = total generalized transport code from origin *i* to destination *j* by mode *m*,

c_{im}^{1st} = generalized transport cost in first leg of trip

c_{lh} = generalized transport cost in logistics hub

c_{jm}^{2nd} = generalized transport cost in second leg

Generalized costs include amongst others: transport costs, value of time, value of reliability, costs of damage, storage costs, and costs related to administrative and logistic processes at the sending and receiving companies (Van Dorsser, 2015). The capacity of possible means and transport cost can assess relative competitiveness of unimodal transport. Conversely, multimodal transport also considers handling cost, pre and end haulage trip cost. Using generalized transport cost maintain uniformity. Therefore it can be applied in all modes of transport (Tavasszy L. A., 1996)

Unimodal vs intermodal transport cost

Analysis of logistics hub concept requires the comparison between the existing scheme of unimodal transport and the intermodal transport cost. Unimodal transport is the transfer between the vehicles of the same mode (Geogios, 2015). Unimodal transport arrangement is easily to handle and accomplish since it uses one vehicle and operated in the same medium (Mahoney, 1985). In the other hand, intermodal transportation is defined as the movement of goods in one and the same load unit using several successive modes of transportation without handling of the goods themselves in changing modes (European Conference of Ministers of Transport, 2003) (Tsamboulas & Kapros, 2000) (van Duin & van Ham, 1998).

In order to make an intermodal transport chain attractive, the cumulative costs of all individual chains should be less than the costs of unimodal road transport (Van Dorsser, 2015). As example, Figure 3-7 shows both concepts. Figure 3-8 presents these different concepts of costs.

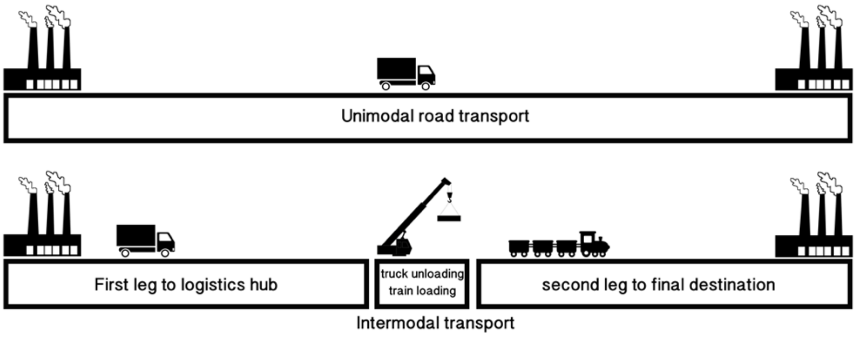

Figure 3-7: The competitive position of intermodal railway transportation
Source: own creation, adopted from (Van Dorsser, 2015)

The additional handling in combined transport (CT) mode result in the lower cost for unimodal transport in a certain short distance. Figure 3-8 presents the additional transhipment cost in the transition of transport mode. Thus, the standby cost of investing multimodal infrastructure has already higher than unimodal road transport. Despite recent sustainability higher environment advantages, and green logistics considerations, total cost remains the central selection criterion for transport carrier choice (Bendul, 2012).

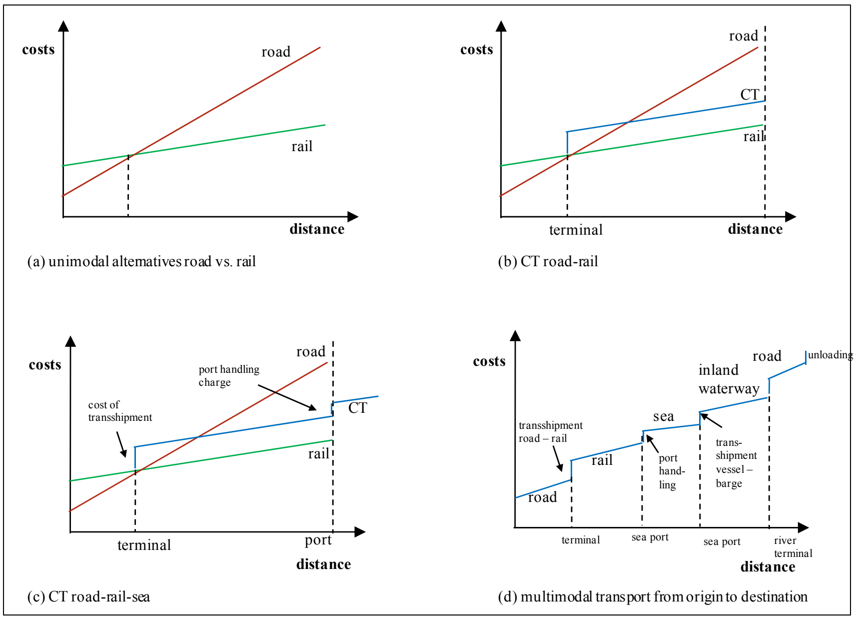

Figure 3-8: Schematic costs for unimodal, combined, and multimodal concept
Source: (Bendul, 2012)

In this study, the intermodal concept itself does not represent the usage of another mode such as railway or inland waterway since the consolidation will use only road mode vehicle with different capacities. The assumed condition of using logistics hub shipment is first leg trip from Bitung Port uses the high capacity of a heavy truck (20 ton) and second leg trip from logistics hub to a destination use medium trucks (8 ton) and heavy trucks (20 ton). Nevertheless, the existence of logistics hub to consolidation and de-consolidation freight allows the logic that the "intermodal" concept (using logistics hub) cost should be lower than the unimodal (direct shipment).

Generalized transport cost model

Generalized transport cost can be modeled based on unit cost and total flow (Sjafruddin, Lubis, Frazila, & Dharmowijoyo, 2010) (Tavasszy L. A., 1996). Equation (5) shows the generalized transport cost formula (c_{ijm}). The generalized transport includes all location and mode specific costs, such as loading and unloading, distance and time, packing and unpacking, sorting, as well as transportation and transhipment to and from the nearest regional network connection (Tavasszy L. A., 1996).

$$c_{ijm} = c_{im}^{1st} + c_{lh} + c_{jm}^{2nd} \tag{5}$$

where:
c_{im}^{1st}= the costs of first leg from origin *i* by mode *m,*
c_{lh}= the cost in logistics hub,
c_{jm}^{2nd}= the cost of second leg to destination j by mode *m*

Reflect on the case in this study, the volume of freight will multiply the modeling of generalized transport cost. It can provide realistic information of total annual cost. Mostly, one should be aware of the existence of empty return trip. The fraction of return empty trip can only be calculated when the volume of freight is considered.

3.4 Social Cost Benefit and Analysis

Throughout this study, Social Cost Benefit Analysis (SCBA) assess the feasibility of dry port economically. SCBA is a systematic and cohesive method to survey all the impacts caused by an urban development project (Decisio, 2015). The reason to choose SCBA is that SCBA does not only consider financial effects but also measure the social consequences, like pollution and safety. It appraises the contribution of the project to the economic welfare of the region. The activities and design of dry port formulate main components of SCBA: cost and benefit. Analysed layout and operations in dry port define the required equipment and personnel (Meidute, 2007).

3.4.1 Cost

The establishment of logistics centre (LC) involves cost and revenue components (Nasirian & Zadeh, 2013). The cost of constructing logistics hub are capital and operational expenditure (CAPEX and OPEX). CAPEX in logistics centre includes land acquisition, equipment procurement, construction of logistics centre (such as a warehouse, yard, office, and CFS), and road access construction (Nasirian & Zadeh, 2013) (Huang & Chu, 2004).

Capital Cost

The first component of capital cost, land acquisition cost, depends on the location of the area, economy activity, land use, and spatial pattern of the area (Hansen, 1959) (Handy & Niemeier, 1997). The denser the population results in, the more economy activities in the certain area. More economic activities will attract more trip. Thus, it adds more value to the land. In the end, the denser the trip activity results in the high price of land (Levine, 2010).

Secondly, the number of cargo handling equipment determines the cost of equipment procurement. A great variety of handling equipment has different efficiency and cost. Therefore, one should put high attention to the factors relating to equipment number decision. Primary determinants related to the equipment procurement cost is the area of logistics centre, efficiency of equipment, operational, and maintenance cost of equipment (Huang & Chu, 2004). Table 2-3 mentions different advantages and disadvantages of each equipment.

No	Type of Equipment	Suitable Cargo	Advantage	Disadvantage
1	Straddle Carrier (SC)	Container	Low purchase cost, economic and flexible operation, stable and safe	Less space efficient than RTG and RMG, lower operational capacity, less suitable for higher automation, greater downtime and higher maintenance
2	Rubber Tired Gantry Crane (RTG)	Container	Space-efficient, fast in operation, more suitable for automation, more flexible than RMG	Higher development cost than SC, more expensive to operate than RMG,
3	Rail Mounted Gantry Crane (RMG)	Container	Space-efficient, fast in operation, more suitable for automation, cheaper to install,	Higher development cost than SC, limited flexibility, not suitable for small terminal
4	Reach Stacker (RS)	Container	Greater stacking density, flexible to pass through a narrow aisle, better visibility and stability	Low capacity than RTG and RMG, big workspace
5	Forklift 3 and 8 ton	Bag Cargo, Palletized Cargo, container	Simple in operation and maintenance, easy acceptance among users, small investment needed	Least efficient in utilizing available land area, high wheel load of front axle often cause great damage in the yard

Table 2-3: Type of cargo handling equipment and its characteristics

Source: (Huang & Chu, 2004) (Lam, Selecting Container Handling Equipment for Growth, 1988) (Carvalho, 2012)

The cost of construction of the logistics hub itself depends on with the design or layout of the logistics hub. Each logistics hub has different function compared to another logistics hub (UNCTAD, 1991). Therefore, one should classify what kind of activities in certain logistics hub to determine the layout, which finally leads to a final cost of construction.

Operational Cost

Operational cost includes the annual expenditure for operational and maintenance of logistics centre. It includes staff salary, the operational cost of facilities and equipment, and maintenance cost of facilities and equipment (Nasirian & Zadeh, 2013). Provided data of kind of activities in logistics hub defines it. Overall, the cost of operation and maintenance of the logistics hub and equipment forms the operational cost. Operational cost depends on with the number and level of salary staff, cost of equipment, and cost of maintenance for infrastructure and equipment (Meidute, 2007) (Litvinenko & Palšaitis, 2005).

3.4.2 Benefit

The components of benefit in SCBA of transportation and logistics project (European Comission, 2008) can be measured in terms below:

- time savings for the existing passengers traffic;
- consumer's surplus for the existing freight traffic (due to fares reduction on account of the reduced marginal costs made possible by transport infrastructure upgrading);
- time and operating cost savings for passenger traffic;
- CO_2 emission reduction as a result of the shift of freight and passenger traffic from old transport infrastructure to upgraded one;
- Accident reduction owing to the shift of freight and passenger traffic from old transport infrastructure to upgraded one.

SCBA in this logistics hub project uses the benefit components: consumer's surplus, CO2 emission reduction, and accident reduction. The benefit that will be discussed in literature review concerns to the most significant parameter, which is consumer's surplus.

Consumer's surplus

From the economic point, application of the rule of half method estimates consumer's surplus. The rule of half based on the quantification of the consumer's surplus (Victoria Transport Policy Institute, 2015). Consumer's surplus has the definition of the excess of consumer's willingness-to-pay over the current generalised cost of a specific trip (European Comission, 2008). Willingness-to-pay is the maximum amount of money that customer willing to pay to make a trip. Figure 3-9 represents the relationship of the trip with generalised cost.

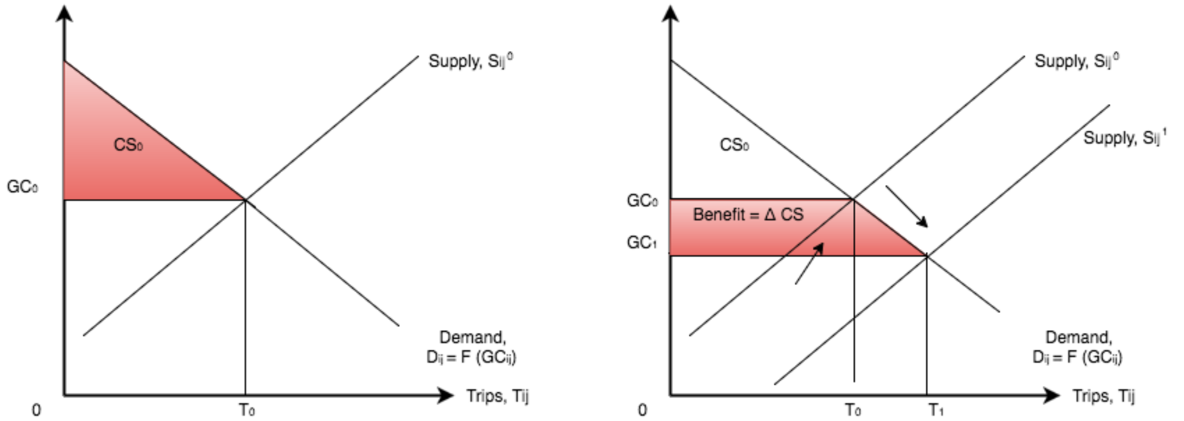

Figure 3-9: Rule of Half diagram

Source: (European Comission, 2008)

In the left graph, the present condition of the traffic situation. GC_0 shows the generalized transport cost in existing scheme. T_0 is the total trip conducted. Total trip is the result of the present supply (S_{ij}^0) and function of demand (D_{ij}). The red area is the customer surplus. The additional infrastructure (S_{ij}^1) results in more trips thus it lowers the generalized transport cost into GC_1. The right graph shows it. The area of shifting GC_0 and GC_1, which is limited by demand, generates the benefit. The benefit is the difference between the existing and new customer surplus (Δ CS). This area is called as the area for quantifying Rule of Half method. It is shown by the equation (6).

$$\Delta\, CS = \frac{1}{2}(GC_0 - GC_1)(T_0 + T_1) \qquad (6)$$

When the effect of a project can capture the reduction of generalized transport costs between determined origin and destination, the rule of half is a useful approximation of quantifying true customer benefit. The input of this method is the reduced generalized transport cost when selected logistics hub is applied.

To avoid complexity in using this rule, one should not be trying to track individual changes in needless information such as consumer travel time, convenience, and vehicle operating costs. The necessary information is the difference in price, which changes consumption. In the end, it will incorporate all of the complex trade-offs that consumers make between money, time, convenience and the value off mobility (Victoria Transport Policy Institute, 2015).

3.4.3 Decision Criteria

Decision criteria decide whether the logistics hub project is economically feasible or not. This study uses three criterions of Internal Rate of Return (EIRR), Net Present Value (ENPV), and Benefit Cost Ratio (BCR). All three criterions consider the discounted cash flow as their main component inside the calculation.

The net present value is the most popular traditional investment appraisal method (Kalyebara & Islam, 2014). It uses net present value to measure the performance of capital projects (see equation (7)). From the calculation of NPV, the value of BCR and IRR can be estimated. Benefit Cost Ratio includes the discounting of future net cash flows. The sum of all present values in term of benefit is divided by the sum of present values of cost (see equation (8)). The project is feasible when benefit cost ratio is larger or equal to one. If the values of BCR is less than one, thus, the project is not feasible. IRR is calculated from NPV equation on condition that there is such an interest rate for which the NPV is equal to zero (see equation (9)).

$$NPV = \sum_{t=0}^{T} NCF_t \times q^{-t} \tag{7}$$

$$BCR = \frac{PV\ Benefit}{PV\ Cost} \tag{8}$$

$$\sum_{t=1}^{T} \frac{CF_t}{(1 + IRR)^t} = 0 \tag{9}$$

Where,

PV = present value;

FV = future value;

t = cash flow period;

q^{-t} = discounting factor, $q^{-t} = (1+(i/100))^{-t}$;

CF_t = cash flow in year t;

4. ANALYSIS OF LOGISTICS HUB LOCATION

Chapter 4 aims to analyse of the possible logistics hub locations and its cost saving. First, it presents the methodology section. Next, it introduces a business model for a logistics hub. Referred to the proposed idea, the best location of logistics hub is determined afterward. Before performing the calculation, the third section explained the used assumptions in constructing generalized transport cost for both situations: direct shipment and application of logistics hub. Section 4 describes the calculation of both schemes. Section 5 lastly concludes this chapter.

4.1 Methodology

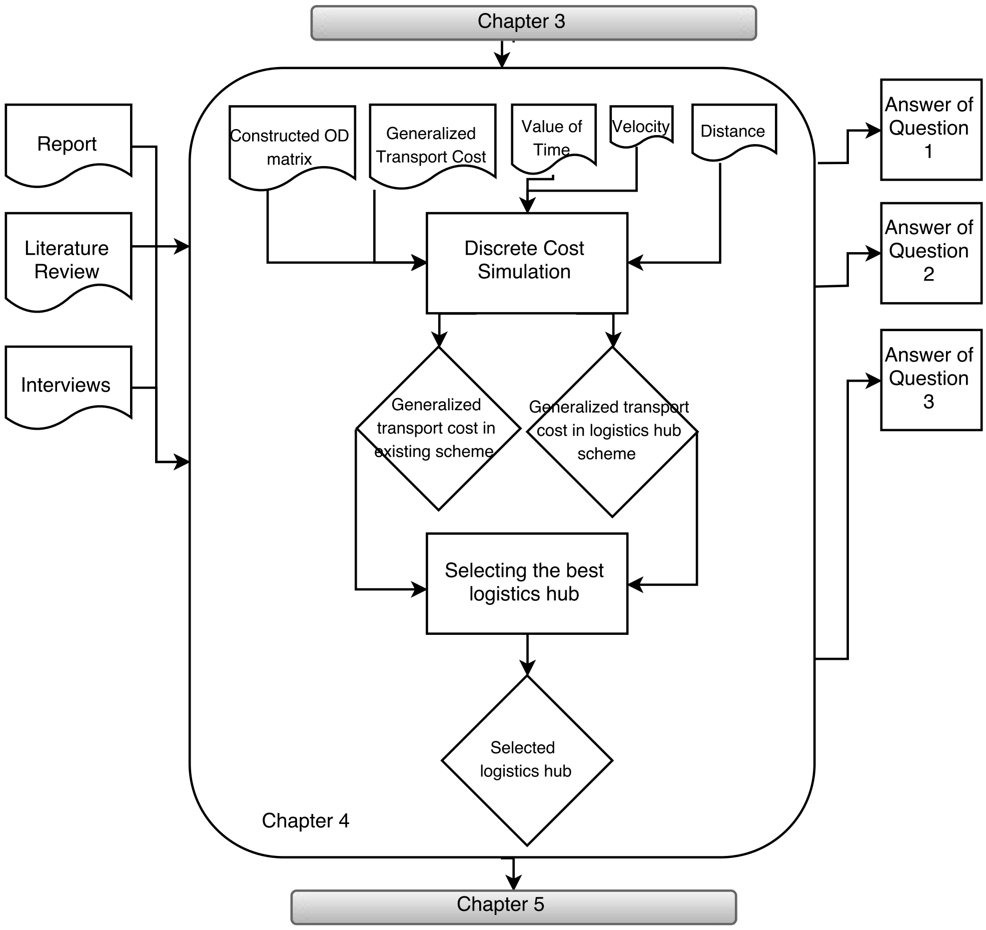

Figure 4-1: Methodology of chapter 4

The input of this chapter was the previous results from chapter 1, 2, and 3. The report, literature review, and interviews were elaborated to derive necessary method and components of generalized transport cost. The result of OD matrix was constructed and modified from OD matrix of Transportation Ministry report in 2011 using four-step model of transportation. The value of time, velocity, and distance were derived from regional government reports and interviews with the port operator and freight forwarders.

These above components constructed generalized transport cost. It was used further in discrete cost simulation. Discrete cost simulation was applied for both schemes of existing and 'with-hub' scheme. The result of discrete cost simulation, which was the final generalized cost in both schemes, decided the optimum logistics hub location and how many districts that interest to participate in logistics hub. Thus, it answered the first sub-research question and subsequently sub-research question 2 and 3 (see Figure 4-1). Selected logistics hub was the primary reference for analysis in chapter 5.

4.2 Introduction of Business Model for Logistics Hub

A business model for logistics hub describes how rationale this facility allows the movement of freight to generate the benefits compared to existing condition in such arrangement of cost and network design. Recall from chapter 1, the existing situation (see Figure 4-2) shows the status of the mixed volume of vans and truck comes and leave Bitung Port to regional nodes and finally to last mile, loading points. Regional nodes are the centre of activities in regional. Loading points represent the loading and unloading of freights, which are located within regional distances from each regional node. Below figure, nevertheless, does not describe the real number of regional nodes and loading points.

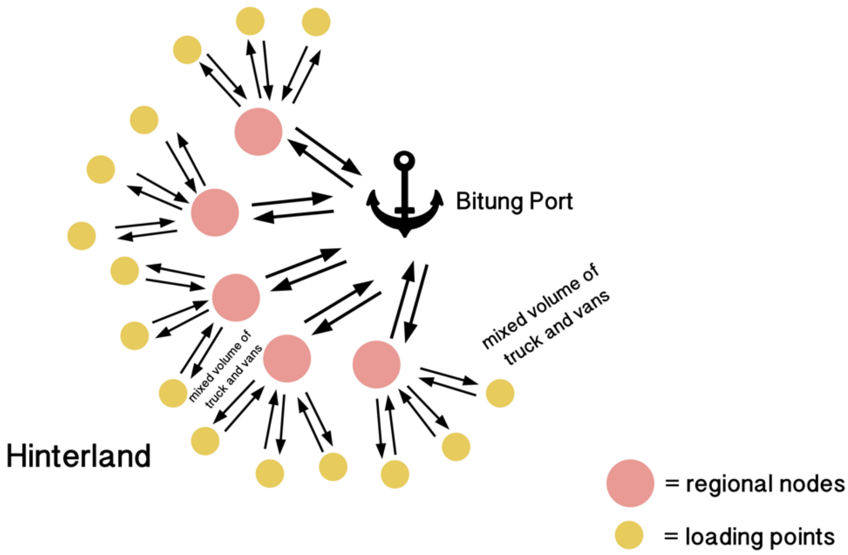

Figure 4-2: Present situation of hinterland connection

The role of logistics hub aims to consolidate smaller volume of goods from van and light truck to be transported in larger quantities using heavy trucks (20 ton). Heavy truck covers first leg distance while medium (8 ton) and heavy (20 ton) truck serve second and last mile distance into regional areas (see Figure 4-3). The milk run trips, which present the collecting trips of mixed loads from different suppliers, inside the regional, is operated with the same medium and heavy truck. For example, one medium truck can replace four vans and one light truck per shipment. Consolidation leads to economies scale of commodities. Therefore, generalized transport cost can be reduced.

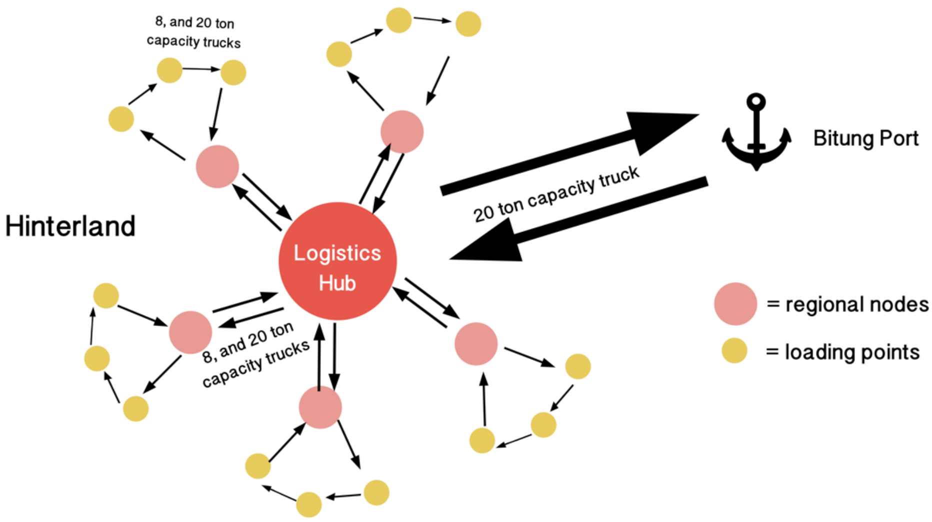

Figure 4-3: Hinterland connection with logistics hub

Comparison of generalized transport cost in both schemes is analysed to overview how this concept can generate an advantage. The expected condition should have the precise location of logistics hub. It is determined by estimation of generalized transportation cost in both settings.

4.3 Generalized Transport Cost

This section explains how generalized transport cost is derived by taking into account various cost components. The formula of generalized transport cost (c_{ijm}) is recalled from section 3.3.2

$$c_{ijm} = c_{im}^{1st} + c_{lh} + c_{jm}^{2nd}$$

where:

c_{im}^{1st}= the costs of first leg from origin *i* by mode *m,*

c_{lh}= the cost in logistics hub,

c_{jm}^{2nd}= the cost of second leg to destination j by mode *m*

c_{ijm} component	Direct shipment	With logistics hub shipment
c_{im}^{1st}	VOT * (administrative work time + loading time in origin *i* + travel time from *i* to *j*+ unloading time in destination *j* + travel time from *j* to loading point + loading time in loading point + unloading time in port) + transport cost * (distance between *i* and *j* + relocation distance) + road charge	VOT * (administrative work time + loading time in origin *i* + travel time from *i* to *j* + unloading time in logistics hub) + transport cost * distance between *i* and *j*
c_{lh}	0	VoT * (waiting time in logistics hub + loading time in logistics hub) + handling cost
c_{jm}^{2nd}	0	VoT * (unloading time in destination *j* + travel time between *i* and *j* + travel time from *j* to loading point + loading/unloading time in loading point + unloading time in port) + transport cost * (distance between *i* and *j* + relocation distance) + road charge

Table 4-1: Scheme of generalized transport cost in two situations

Table 3-1 displays the scheme of generalized transportation cost in two situations of direct and using logistics hub shipment. Both schemes present the generalised transport cost only from loading point (loading and unloading freight point in each district) to port. Take the example of shipment from Bitung Port to Tondano district. Direct shipment only considers the first component of generalized transportation cost (c_{ijm}^{1st}).

For direct shipment setting, c_{ijm} is the sum of VOT * (administrative work time + loading time in origin i + travel time from i to j+ unloading time in destination j + travel time from j to loading point + loading time in loading point + unloading time in port) + transport cost * (distance between i and j + relocation distance) + road charge. On the other hand, the logistics hub setting uses additional cost component in logistics hub, second leg trip, and relocation cost in loading points (see Table 4-1).

From the previous definition, the component of generalized transport cost that need to be described in further details are listed below. Several components such as paperwork, the cost of damage, and logistics cost are assumed neglected since it is hard to be predicted precisely. It is hard to obtain the real generalized cost structure in the Bitung case since there is no uniform standard of price structure taken from the interview with freight forwarder associations (see appendix M). Nevertheless, the generalized transport cost in further analysis contains the components below.

- Value of time;
- Unimodal road transport cost by various freight vehicles;
- Handling cost in logistics hub

4.3.1 Value of Time (VOT)

The VOT relates to the resources (capital, employment, storage) tied up during the transport process and opportunities missed (small market) due to longer transport time (Verhaeghe, Yusuf, Indriastiwi, Halim, & Tavasszy, 2016). Components of the value of time in this study are using factor cost method, in which the monetary value of time saving is equal to the sum of wage rate of the driver, the opportunity cost of the truck (interest rate times the value of vehicle) and the cargo (Zamparini & Reggiani, 2007).

VOT analysis uses multi-commodity stream. It aggregates the commodity with the respective percentage. Table 4-2 shows the result of multiplication of share of commodities by tonnage and their respective VoT. The VoT is taken from the average value of VoT in the world (van Diepen, 2011). Not all commodity types are included in the calculation. Dominant commodity comes from agricultural products and live animals, which is represented by the high production of fisheries. The aggregate VoT is € 40.8. For next analysis, the VoT values are converted into 0.11 €/ton/hour.

ID	Commodity	VoT ($/TEU/day)	Share by ton	Aggregate value ($/TEU/day)
0	Agricultural products and live animals	38.1	57%	21.72
2	Solid mineral fuels	10.7	1%	0.11
4	Ores and mineral waste	26.6	19%	5.05
5	Metal products	69	2%	1.38
8	Chemicals	70	20%	14
9	Machinery, transport equipment, manufactured articles and miscellaneous articles	411	1%	4.11
Aggregated VoT (€/TEU/day)				46.37 (€ 40.8) or 0.11 €/ton/hour

Table 4-2: Aggregation of VoT
Source: adopted from (van Diepen, 2011)

4.3.2 The transport costs of unimodal road transport by trucks

Data of Road User Costs Knowledge System (RUCKS) of World Bank in 2007 obtains the transport cost of unimodal road transport. It helps quantify how road user costs in developing country, which is common, used in Indonesia. The data is affected by vehicle fleet and road characteristics, including geometric standards, which reflect the amount of capital investment in the road, and surface standards, which reflect both initial capital and subsequent maintenance expenditures. The details data of operating cost and investment are shown in appendix C. Table 2-12 of chapter 2 shows the domination in the road are coming from the van, light truck, medium truck, and heavy truck types. These modes are considered mode for later calculations of generalized transport cost in the present situation.

Average distance travelled by truck in Indonesia is quite low, which is 21,800 kilometres per year, less than half of the Asian annual average of 57,000 kilometres. It is caused by poor road infrastructure, delays, and problematic bureaucracy (The Asia Foundation, 2008). Annual correction of 6% due to inflation is applied to implement the data into the year 2016. The data of transport cost of RUCKS is converted from US dollar into Euro. Table 4-3 shows transport cost of a truck. For detail, appendix B shows the calculation. This transport cost figure has close annualized value with the cost of transport in the India's road transport study of World Bank in 2005 (World Bank, 2005).

Unit	Van	Light truck	Medium truck	Heavy truck
€/ton/km	0.25	0.1	0.06	0.03

Table 4-3: Transport cost of various freight vehicles
Source: (The World Bank, 2007)

The transport costs of a road trip are calculated by multiplying above figures to the respective distance of the trip. The additional charge in the local road is derived from a combination of local retribution, weight stations, and police charges. These detail additional charges are presented in appendix D. Each route has different charge since not all route has similar weigh stations locations.

Assumption of time and distance setting

The assumption of trip and distance setting is partially adopted from the thesis of Van Dorsser in 2015. Two contexts are described here: direct shipment trip and 'logistics hub scheme' trip.

Direct shipment context

Component of trip time in direct shipment contexts are loading time in port, travel time from port to regional nodes, unloading time at the regional node, travel time from unloading points to loading points, travel time of return trip to regional then to port, loading time spent in loading point in return trip, and unloading time in port. Un/loading time in port includes administrative and waiting time, which spends 4 hours. Travel time is linear with the function of distance. Unloading time in regional node takes 1 hour. It goes the same with loading time in loading point.

Thus, the total time of the trip is: 2 x travel time between Bitung Port and regional nodes + 2 x travel time between regional nodes and loading points + 2 x loading/unloading time in ports + unloading time in regional node + loading time in loading points.

Two-ways trip has distance setting as followed: the outward and inward distance are equal, but there is additional distance from unloading point to the re-loading point (called as regional distance). Appendix E shows that each district has different regional distance. Therefore, the total distance of two-ways trip is 2 x distance between Bitung Port and regional node + 2 x intra regional distance. The truck trip has its own velocity between districts. It is shown in appendix G.

Logistics hub context

Additional time setting in logistics hub context are time spent in logistics hub and loading time in loading points. The assumption for time spent in logistics hub for the heavy truck (20-ton capacity) coming from the port is 2 hours. The time consists documents checking and unloading the freights. Outgoing heavy truck to port has additional 2 hours waiting time for adjusting mismatch of time from freight consolidations of medium trucks from regional, besides consolidation and loading time (total time spent is 4 hours). Time spent for the incoming distributing truck from regional in logistics hub is 3 hours, which includes documents checking, waiting time and unloading time. Outgoing distributing truck to regional spends 2 hours of waiting, deconsolidation, and loading times.

Relocation cost in regional node and loading points neglect handling cost since it assumes the final customer who picks up and deliver their goods to loading point within the district. The main reason to use this assumption is a lack of final customer data setting in Bitung hinterland. Therefore, total time spent in return trip is 2 x travel time between Bitung Port to logistics hub + 2 x travel time between logistics hub and regional node + 2 x travel time between regional node and loading point + 2 x loading/unloading time in port + 2 x time spent by heavy truck in logistics hub + 2 x time spent by distributing truck in logistics hub + unloading time in regional + loading time in loading points.

Total distance traveled in this context is 2 x distance between Bitung Port and logistics hub + 2 x regional node distance to loading points + distance between loading points. Equal distance is assumed for each loading points within one distance. The distance and time setting are assumed to be reduced by half for the one-way trip setting.

Effect of demurrage and detention time

The container has the portion of 43% of all flow to and from Bitung Port. Container commodity need to consider term of term demurrage[1] and detention[2]. Demurrage tariff for import container is counted after five days of being stored in the terminal, while for export container is seven days. The below demurrage cost data is based on the application in the Cikarang Dry Port, Jakarta.

- Import container: free stacking on period of day 1-5; charge of 200% of normal stacking cost from day 6-10; charge of 300% of normal stacking cost from day 11-more;
- Export container: free stacking on period of day 1-7; charge of 200% of normal stacking cost from day 8-10; charge of 300% of normal stacking cost from day 11-more.

4.3.3 Handling cost in logistics hub

The cost of transfer in terminal depends on the size and activities belong to logistics hub. In this study, the first assumption of handling cost in logistics hub uses the figures provided by Cikarang Dry Port, Ipoh Dry Port in Malaysia, and Abu Dhabi Ports in 2016 (see Table 4-4). The average handling cost of cargo (dry bulk, general cargo, and bag cargo) is the sum of administration cost, deconsolidation and consolidation cost, and Lift off/Lift On from the receiver truck to the delivery truck. The simplification of using only one

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[1] Demurrage: This charge will be levied when the Customer holds containers inside the terminal for longer than the agreed free days and is applicable to all containers that remain at the terminal longer than the agreed free time (CMA-CGM, 2016)

[2] Detention: This charge will be levied when the Customer holds containers outside the terminal longer than the agreed free time (CMA-CGM, 2016)

type of handling cost for general cargo, dry bulk, and bag cargo is to offset the possible miscalculation in freight handling volume. The cost is assumed per ton, except for container handling.

Type of cargo	Handling cost (€)
General cargo (per ton)	7
Container (per TEU)	225

Table 4-4: Average of handling cost of cargo

Source: (Cikarang Dry Port, 2016) (Terminal, 2016) (Abu Dhabi Ports, 2016)

4.3.4 Assumptions on the empty return trip

The empty return trip in total freight flow between Bitung Port and hinterland has a percentage of 10%. OD matrix is the source of empty return data. Discrete cost simulation considers empty return trip as 1-way shipment. Therefore, it has different cost from the 2-ways shipment. The trip from Bitung Port to the regional node and vice versa applies empty return trip. Following equation calculates the final total cost of the trip.

Annual c_{imj} *= (% of 1-way trip * annual volume of 1-way trip * cost per ton of 1-way trip) + (% of 2-ways trip * annual volume of 2-ways trip * cost per ton of 2-ways trip)*

The calculation of the annual cost is neglecting the factors of trip imbalance over time, an imbalance due to different owners, an imbalance due to various companies since an imbalance in practice is higher than assumed. No such reliable data to capture these factors in reality. Thus, the calculation of empty return trip in determining generalized transport cost assuming the average condition. In fact, empty trips are possible to exist in the highest volume direction.

The consolidation from 8-ton capacity into the 20-ton capacity truck in logistics hub experiences a mismatch of time in reality. Additional waiting time of 2 hours is added to logistics hub time for the heavy truck to shipping the freight to/from Bitung Port to tackle this problem.

4.4 Selection of Logistics Hub Location

The selection of logistics hub is performed by applying discrete cost simulation that is described before in section 3.3.2. This method describes both generalized transport cost settings in present and with logistics hub.

4.4.1 Generalized transportation cost in existing situation

The primary data should be defined further to calculate the generalized transportation cost for both settings. Those data are regional nodes, distance matrix, OD matrix, and velocity matrix.

Transportation Regional Node

There are 15 districts in the North Sulawesi Province (see Figure 2-8). Regional transportation nodes are defined from the capital of each district (BAPPENAS, 2012) (Statistics of North Sulawesi Province, 2015), as can be seen in Table 4-5. These nodes have accessible road networks to other districts via both arterial and collector roads. Each trade activity in the regional node is described in OD-matrix. The loading points within regional in real context are hard to be defined. The assumption is made by capturing four most critical nodes in each region derived from North Sulawesi Province profile (Statistics of North Sulawesi Province, 2015).

No	District	Regional transportation node
1	Bolaang Mongondow	Lolak
2	Minahasa	Tondano
3	Sangihe Islands	Tahuna
4	Talaud Islands	Melonguane
5	South Minahasa	Amurang
6	North Minahasa	Airmadidi
7	Southeast Minahasa	Ratahan
8	North Bolaang Mongondow	Boroko
9	Sitaro Islands	Ondong Siau
10	East Bolaang Mongondow	Tutuyan
11	South Bolaang Mongondow	Bolang Uki
12	Manado City	Manado
13	Bitung City	Bitung
14	Tomohon City	Tomohon
15	Kotamobagu City	Kotamobagu

Table 4-5: Regional transportation nodes in North Sulawesi Province

Source: own analysis, (BAPPENAS, 2012) (Statistics of North Sulawesi Province, 2015)

Transportation infrastructure

Appendix A presents the road network map. Sulawesi Island has only road infrastructure for freight transport. The direct shipment, which represents the current situation, delivers freight directly from Bitung Port to the final destination of the regional node and vice versa. Logistics hub scheme considers the trip from Bitung Port to the selected logistics hub as the first leg. The second leg delivers the freight from selected logistics hub to the final destination of regional node. All used infrastructure is the existing road connection.

Distance matrix

Distance matrix becomes the indicator for construction OD matrix. The connection cannot be derived only from the map coordinates distances since not all connections are directly linked. The distance between each district is taken from the trip along the artery, collector, and local road networks (Statistics of North Sulawesi Province, 2015).

There are three types of distance for analysis: first leg distance, second leg distance, and last mile distance. Direct shipment can disregard these types of distance since it only figures the total distance of all three types. In the ideal situation with logistics hub, the first leg distance shows the trucking distance from Bitung Port to the selected logistics hub. The second leg distance uses the distance from selected logistics hub to the regional node. The last mile distance in each regional node has a different value related to the industries there. The matrix of distance is presented in Appendix D.

Origin-Destination (OD) Matrix

The trade activities between regional nodes are described by OD-matrix. The construction of OD-matrix is based on freight attraction and freight generation in each regional node and Bitung Port itself (see section 2.1.5). The construction of OD matrix first uses the distance between each node as c_{ij} indicator in impedance function ($e^{-\beta c_{ij}}$). The beta value (β) is derived from iteratively solving freight attraction, freight generation, and trip probabilities. The beta value results in the value of 0.0034 (see appendix F). Balancing the matrix applies doubly constrained method by trip distribution step of 4-step transport model. Appendix F explains detail construction of OD matrix.

The result of OD matrix construction shows that the highest production activity is originated from Manado and the lowest one is Ondong Siau. The node with the highest trip attraction is again Manado. On the contrary, Bolang Uki is the lowest attractive node. These findings are logical since Manado is the capital city with the highest economic contribution to North Sulawesi province (Statistics of North Sulawesi Province, 2015).

Velocity matrix

Velocity matrix consists the velocity of the truck between each district. The truck velocity is derived from truck route survey in North Sulawesi Province (Ministry of Transportation, 2014). The impact of road congestion is already calculation in the result of survey. The assumption is used in defining the value of velocity to and from three islands districts. The velocity to and from Ondong Siau, Tahuna, and Melonguane use the total distance from the island to the destination divided by the total trip time (which comprises ferry connection). The matrix of velocity is presented in appendix F.

Calculation of existing generalized transport cost

Calculation the existing generalized transport cost regards several factors.

Share of freight vehicles

As mentioned in Chapter 2 (section 2.2.2, Table 2-12), the percentage of freight vehicles need to be considered since each type has different distance and time-related cost (see Table 4-3). Each trip to and from each district is assumed to have same share setting of freight vehicle. In the end, aggregating this freight vehicle share with respective particular cost generates the total cost per district.

Freight volume

The calculation in both contexts of direct shipment and logistics hub inclusion only analyse 25% of freight volume in the hinterland of Bitung Port. The first reason to use this assumption is that most people are not interested in shifting their initial way to ship the freight via logistics hub in the first year. The second reason, there is still the share of freight that requires quick delivery, which avoids the more time spent in logistics hub, Thirdly, there is share of people who eager to pick up their goods directly to logistics hub with their own vehicle. The share of the commodity to be calculated in both context (existing and with logistics hub) is assumed to remain the same.

2-ways trip or 1-way trip

There are two types of cost: 1-way trip and 2-ways trip, to consider the return empty trip factor. In total outward and the backward trip from Bitung Port to regional distance, there are 10% return empty trip. Nevertheless, it has different fraction when it comes to a single trip to each district (see Table 4-6). Detail calculation of empty and return trips is provided in appendix E. The volume of each trip is derived from the result of OD matrix.

To	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan
% of 2-ways trip	71%	95%	94%	94%	86%	97%	93%
% of 1-way trip	29%	5%	6%	6%	14%	3%	7%
Freight volume of 2-ways trip (ton)	32,640	179,343	22,075	13,612	76,013	161,429	44,910
Freight volume of 1-ways trip (ton)	13,466	10,216	1,426	875	12,026	5,309	3,185

Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung	Tomohon	Kotamobagu
99.7%	85%	99%	87%	80%	75%	80%	70%
0.3%	15%	1%	13%	20%	25%	20%	30%
12,688	11,508	11,497	8,720	215,167	54,802	74,666	13,072
37	1,019	15	1,359	27,642	17,997	9,249	2,758

Table 4-6: Fraction of return and empty trips

Optimal load of truck

The optimal load in each vehicle is assumed by 80% of the maximal capacity of the truck. It is caused by different shapes of bulk, inefficient of loading process especially in developing countries, and a safety factor of hazardous goods that cannot be placed altogether with other goods (World Bank, 2005). Although in developing countries, more trucks bring over capacity load (World Bank Institute, 2000).

The calculation only considers the first leg transport cost with a total distance of Bitung Port to the destined regional node. Table 4-7 recalls the formula.

c_{ijm} component	Direct shipment
c_{im}^{1st}	VOT * (administrative work time + loading time in origin i + travel time from i to j+ unloading time in destination j + travel time from j to loading point + loading time in loading point + unloading time in port) + transport cost * (distance between i and j + relocation distance) + road charge
c_{lh}	0
c_{jm}^{2nd}	0

Table 4-7: Direct shipment formula

By considering this factor, thus the cost will be the result of share of freight vehicles aggregate and combined with aggregate cost of 1-way and 2-way trips. Appendix A provides the detail calculation . To give the clearer explanation, the example of calculation for generalized transport cost calculation from and to Lolak is shown below:

***Known**:*
% of 2-ways trip = 71%; Volume of freight of 2-ways trip = 32,640 ton;
% of 1-way trip = 29%; Volume of freight of 1-way trip = 13,466 ton;
***Thus**,*
unit generalized transport cost of 2-ways trip = 63 €/ton;
unit generalized transport cost of 1-way trip = 32 €/ton;
*Annual cost = 32,460 ton * 63 €/ton + 13,466 tons * 32 €/ton = € 2,473,800;*

The result of the direct cost calculation is provided in Table 4-8. Detail calculations are shown in appendix G. The lowest annual and unit cost is shown by Bitung district (€ 332,723 and € 5/ton). The reason is its close location from Bitung Port. The highest unit cost is shown by Melonguane (€ 91/ton), the island district with relatively low annual volume. Other districts that have relative low unit cost are located in north part of this province including Tondano, Tomohon, Airmadidi, and Manado. These regional nodes are located near Bitung Port. Most industries take places in these regions. Thus, high volume of goods originates from these four regions.

To and from	Annual generalized transport cost (€)	Annual volume (ton)	Combined unit cost (€/ton)
Lolak	2,478,911	46,106	54
Tondano	3,029,505	189,559	16
Tahuna	1,629,543	23,501	69
Melonguane	1,317,965	14,487	91
Amurang	2,711,466	88,039	31
Airmadidi	2,110,740	166,738	13
Ratahan	1,193,835	48,095	25
Boroko	1,051,327	12,725	83
Ondong Siau	588,929	12,527	47
Tutuyan	450,505	11,513	39
Bolang Uki	773,248	10,079	77
Manado	3,322,634	242,810	14
Bitung	332,723	72,799	5
Tomohon	1,300,224	83,914	15
Kotamobagu	843,432	15,830	53
TOTAL	**23,134,986**		

Table 4-8: Generalized transport cost in existing situation

4.4.2 Generalized transportation cost in ideal situation (with hub)

Calculation in the ideal situation considers the component of second leg transport c_{jm}^{2nd} cost and cost in logistics hub (c_{lh}) in setting of total generalized transport cost (c_{ijm}). Calculation in the context of logistics hub uses several assumptions.

Assumptions in calculation

Below assumptions to derive the generalised transport cost in ideal setting are:

Setting in vehicle usage

The first leg transport uses only heavy truck (20-ton capacity). Vans (1-ton) and light truck (4-ton) are replaced by medium truck (8-ton) in the second leg and last mile distance. Heavy truck and medium truck operates in the second leg.

Loading points in regional

Last mile transport presents the transhipment from and to loading points to its regional centre and vice versa. Lack of data in real application results in the assumptions that each medium truck covers the milk-run distance to six loading points. The reason is to cover six original loading points that are served by four vans and one light truck in the initial setting. Therefore, two-way trips of medium truck form circular distance from the regional center to five different loading points. Assumption and the data of North Sulawesi Province Statistics underlie the establishment of six loading points. The distance between loading points is assumed to equal. Distance matrix in appendix D presents these assumptions.

Freight consolidation

The consolidation in logistics hub applies to other commodities than container, such as general cargo. Logistics hub (de)consolidates heavy truck into medium truck in shipping the goods from port to regional and vice versa.

Calculation of generalized transport cost

Table 4-9 shows the formula calculate generalized transport cost in ideal setting. Appendix A explains the complete calculation.

c_{ijm} component	With logistics hub shipment
c_{im}^{1st}	VOT * (administrative work time + loading time in origin i + travel time from i to j + unloading time in logistics hub) + transport cost * distance between i and j
c_{lh}	VoT * (waiting time in logistics hub + loading time in logistics hub) + handling cost
c_{jm}^{2nd}	VoT * (unloading time in destination j + travel time between i and j + travel time from j to loading point + loading/unloading time in loading point + unloading time in port) + transport cost * (distance between i and j + relocation distance) + road charge

Table 4-9: Generalized transport cost setting in logistics hub inclusion context

Appendix H presents detail calculation per district when performing the role as a logistics hub. It simulates each regional node to be a logistics hub. It also provides the result of annual generalised transport cost per district and the whole system. Calculation of annual cost saving aims to derive the most beneficial regional node from being the logistics hub. Annual cost saving is the difference between the total annual cost of the direct shipment and the ideal condition. The sum of annual cost saving is derived from the total saving of the region which benefits at least 20% cost reduction from the present situation. Table 4-10 shows the result of calculation.

Logistics hub	Annual cost saving (€)	Number of regions who are willing to participate	Number of volume attracted (ton)	Unit cost saving (€/ton)
Lolak	1,700,134	4	84,740	20
Tondano	2,121,294	6	122,728	17
Tahuna	1,125,897	2	37,988	30
Melonguane	616,969	1	14,487	43
Amurang	1,701,602	5	99,228	17
Airmadidi	2,395,497	6	122,728	20
Ratahan	1,393,363	4	84,740	16
Boroko	463,783	1	12,725	36
Ondong Siau	1,193,234	3	50,514	24
Tutuyan	1,490,218	5	96,253	15
Bolang Uki	538,376	2	12,725	42
Manado	1,897,218	5	112,649	17
Bitung	2,087,331	6	122,728	17
Tomohon	2,166,294	6	122,728	18
Kotamobagu	289,492	1	15,830	18

Table 4-10: Result of generalized transport cost calculation when each regions perform as logistics hub

The highest annual cost saving is derived when Airmadidi performs as a logistics hub. Airmadidi saves € 2,395,497 from six regions who benefit with this scheme. It saves in average 20 €/ton from all attracted volumes. Other regions who gain the high benefits (higher than 2 million euros) when they become logistics hub are consecutive: Tomohon, Manado, Bitung, and Tondano (see detail result in appendix I). The unattractive regions to be logistics hub are Melonguane, Boroko, Bolang Uki, and Kotamobagu. Each of them saves annual cost for less than a million euro. Airmadidi, Bitung, Tomohon and Bitung attract the significant number of regions and volume to participate: six with 122,728 tons. Kotamobagu and

Melonguane only attract one region for each. Far distance and low freight demand cause that. The result positions Airmadidi to be the optimum logistics hub. It obtains the highest annual generalized transport cost saving and the highest number of attracted regions.

Region	Annual cost in present setting (€)	Annual cost through Airmadidi (€)	Annual cost saving (€)	Saving (%)	Annual volume (ton)
Lolak	2,478,911	1,916,021	562,890	23%	46,106
Tondano	3,029,505	4,315,828	-	-	189,559
Tahuna	1,629,543	1,220,641	408,901	25%	23,501
Melonguane	1,317,965	901,031	416,934	32%	14,487
Amurang	2,711,466	2,626,896	84,570	3%	88,039
Airmadidi	2,110,740	3,536,992	-	-	166,738
Ratahan	1,193,835	1,296,153	-	-	48,095
Boroko	1,051,327	727,873	323,454	31%	12,725
Ondong Siau	588,929	516,118	72,811	12%	12,527
Tutuyan	450,505	418,651	31,854	7%	11,513
Bolang Uki	773,248	539,991	233,257	30%	10,079
Manado	3,322,634	4,893,030	-	-	242,810
Bitung	332,723	1,348,639	-	-	72,799
Tomohon	1,300,224	1,746,223	-	-	83,914
Kotamobagu	843,432	393,371	450,061	53%	15,830

Table 4-11: Comparison of existing and new situation unit cost for Airmadidi logistics hub

Table 4-11 shows the calculation of saving when Airmadidi becomes the logistics hub. The most benefit regional node from this scheme is Lolak, with the annual saving of € 562,890. Tondano, Airmadidi, Ratahan, Manado, Bitung and Tomohon does not generate 20% advantage when Airmadidi becomes logistics hub. Therefore, the other regions who benefit up to 20% cost reduction for this situation are Lolak, Tahuna, Melonguane, Boroko, Ondong Siau, Tutuyan, and Kotamobagu.

4.5 Conclusion

Reflected in the ideal setting of business model, the location of logistics hub should be analysed in detail. The decision of selecting the best logistics hub location are derived after conducting the steps of constructing OD matrix to estimate freight trip between regional nodes, calculating generalized transport cost, and discrete cost simulation for both settings.

Generalized transport cost considers the component of first leg cost, logistics hub costs, and second leg costs. Bitung results the lowest direct generalized transport cost in present setting (€ 5/ton). Near distance to Bitung Port causes that low cost. In ideal setting generalized transport cost calculation, each regional node performs to be the logistics hub. The regional node which can save the highest annual cost and is preferred by other regions will be the best logistics hub. The result positions Airmadidi to be the logistics hub. It saves the highest annual cost (€ 2,395,497) and is preferred from six regions: Lolak, Tahuna, Melonguane, Boroko, Ondong Siau, Tutuyan, and Kotamobagu.

Districts in the north part of this province save significant generalized transport cost: Tomohon, Manado, Bitung, Amurang, and Tondano. The remote area and more isolated such as Bolang Uki, Melonguane, Boroko, and Kotamobagu perform worst to be a logistics hub. Significant annual saving and the high number of participating regions, choose Airmadidi to be logistics hub in North Sulawesi Province

5. CONFIGURATION OF AIRMADIDI LOGISTICS HUB

This chapter explains the configuration of logistics hub. It aims to analyse the optimum design and stakeholders in logistics hub. Before starting the analysis, methodology section described the flow of this chapter. The second section explains the setting of logistics hub. Section 3 presents optimum layout afterward. The fourth section presents the analysis of stakeholder. Finally, section five concludes this chapter.

5.1 Methodology

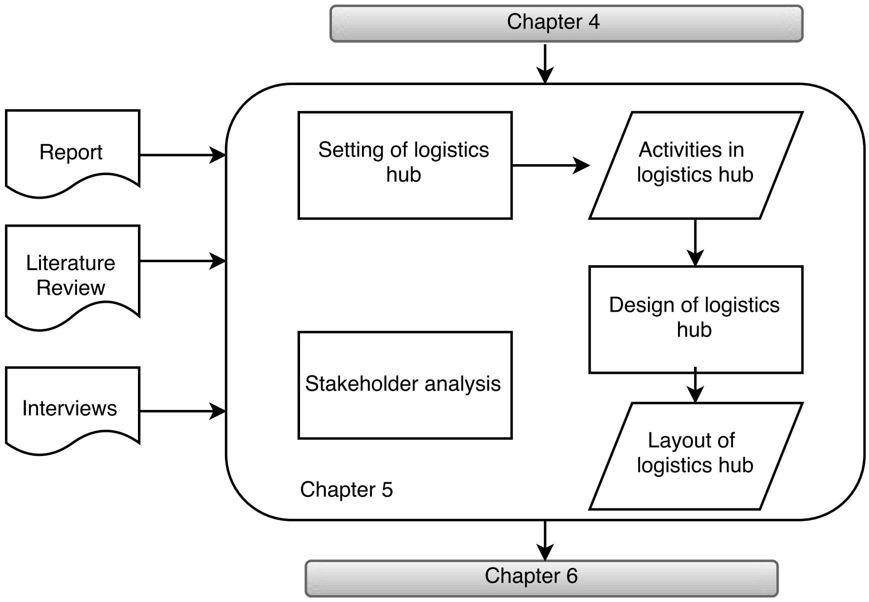

Figure 5-1: Methodology of chapter 5

Figure 5-1 explains the process in this chapter. The selected logistics hub location from chapter 4 was a foundation of logistics hub in this chapter. Inputs from UNCTAD report, port, and terminal guideline books, and interviews with the port operator are elaborated in determining the possible activities and their volumes in logistics hub. The volume of selected activities of logistics hub will analysed the optimum layout of logistics hub. Guideline of UNCTAD and Port and Terminal book from Ligteringen was the primary reference in designing layout of dry port. Parameters of layout consisted of container yard, CFS, delivery side, security, office and building, and parking. Container yard and CFS were designed from the. Other parameters were defined simply by calculating the needed space with assumptions from handbook of UNCTAD. AutoCAD was used for layout drawing.

A stakeholder analysis was elaborated to complete the configuration. Interviews with related stakeholders were carried out as the source of the analysis. It aims to consider the power and interest of involved parties in decision-making. The output of this chapter was used for analysis in the subsequent chapter, chapter 6.

5.2 Setting of Airmadidi Logistics Hub

Figure 5-2: Location of Airmadidi from Bitung Port and Manado
Source: maps.google.com

Airmadidi logistics hub (see Figure 5-2) s chosen to be the logistics hub by six districts even with the condition that direct trip will give quicker travel time to Bitung Port. The inclusion of only 25% of freight share in the first year, when logistics hub concept applies, justify the other needs from other shippers who want the direct shipment to Bitung Port. Furthermore, the idea of logistics hub needs to consider the inclusiveness, which is highlighted by more than 20% reduction of generalized transport cost from participating districts.

Airmadidi logistics hub operates a dry port role referred from section 3.1. It is located in the centre of North Minahasa district. Relative short distance from the port, which is 28 km, categorized Airmadidi as a close dry port type. It is a single port servicing only seaport, based on the type of port number in service. This kind of dry port alleviates the congestion in surrounds port area. Dry port aims to handle the container and non-container-oriented activities. Provided services in Airmadidi dry port are (i) freight consolidation, (ii) customs and clearance, (iii) warehouse, and (iv) container storage.

5.2.1 Attracted freight demand

Lolak (Bolaang Mongondow district), Tahuna (Sangihe Islands district), Melonguane (Talaud Islands district), Boroko (North Bolaang Mongondow), Ondong Siau (Sitaro Islands), Tutuyan (East Bolaang Mongondow), and Kotamobagu (Kotamobagu) are the six regional nodes to participate in Airmadidi dry port. Total attracted freight to Airmadidi dry port, which assumes that all freights are served via the port, is 122,728 tons in 2016.

The result of OD matrix shows the incoming and outcoming flows to/from Bitung Port. Outbound flow shows freight flow from Bitung Port to all participants. Meanwhile, inbound flow or import flow is taken from all flows from Bitung Port to regional nodes (see appendix E).

Type of cargo	Container (TEU)	General cargo (ton)	Dry Bulk (ton)	Bag Cargo (ton)
Volume	4,664	25,773	11,046	15,955
Share	57%	21%	9%	13%

Table 5-1: Type and volume of freight in Airmadidi Dry Port in 2016

Currently, the share per type of packaging is not known for each origin and destination trip. The assumption that is used for cargo share is that proportion of packaging is based on the known cargo share in Bitung Port (see section 2.1.5). The types of packaging are a container, general cargo, and dry bulk. Handled cargo in dry port excludes liquid bulk because there is already well-maintained liquid bulk storage in Bitung Port. Table 5-1 shows the share of freight in this dry port.

5.2.2 Operation scheme

The basic operation for Airmadidi Dry Port is required to be determined to obtain the optimum design. The operational hour of Airmadidi Dry Port is 24 hours. The operations are captured in two types of flows: import and export flows. Figure 5-5 and Figure 5-6 shows the export and import container flow operation in Airmadidi Dry Port.

For non-containerized cargo, the cargo has been cleaned in Bitung Port. The import flow starts from the incoming cargo from a truck. After it enters the dry port, it is stored in the storage area (yard or warehouse). The general cargo, afterward, is (de)consolidated to be transported into distributing truck to regional and vice versa. Figure 5-3 and Figure 5-4 present the flows of export and import in Airmadidi dry port. The different between handling each cargo in these operation schemes are the handling equipment, which will be described in the analysis of equipment in section 6.2.2.

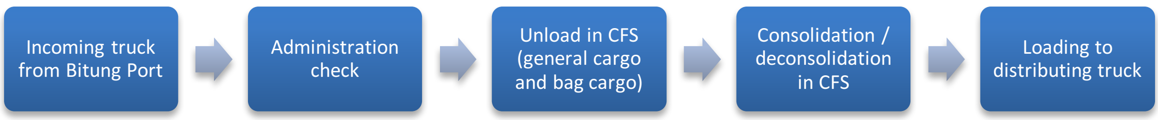

Figure 5-3: Import flow in Airmadidi dry port for general cargo and bag cargo
Source: modified from (UNCTAD, 1991)

Figure 5-4: Export flow in Airmadidi dry port for general cargo and bag cargo
Source: modified from (UNCTAD, 1991)

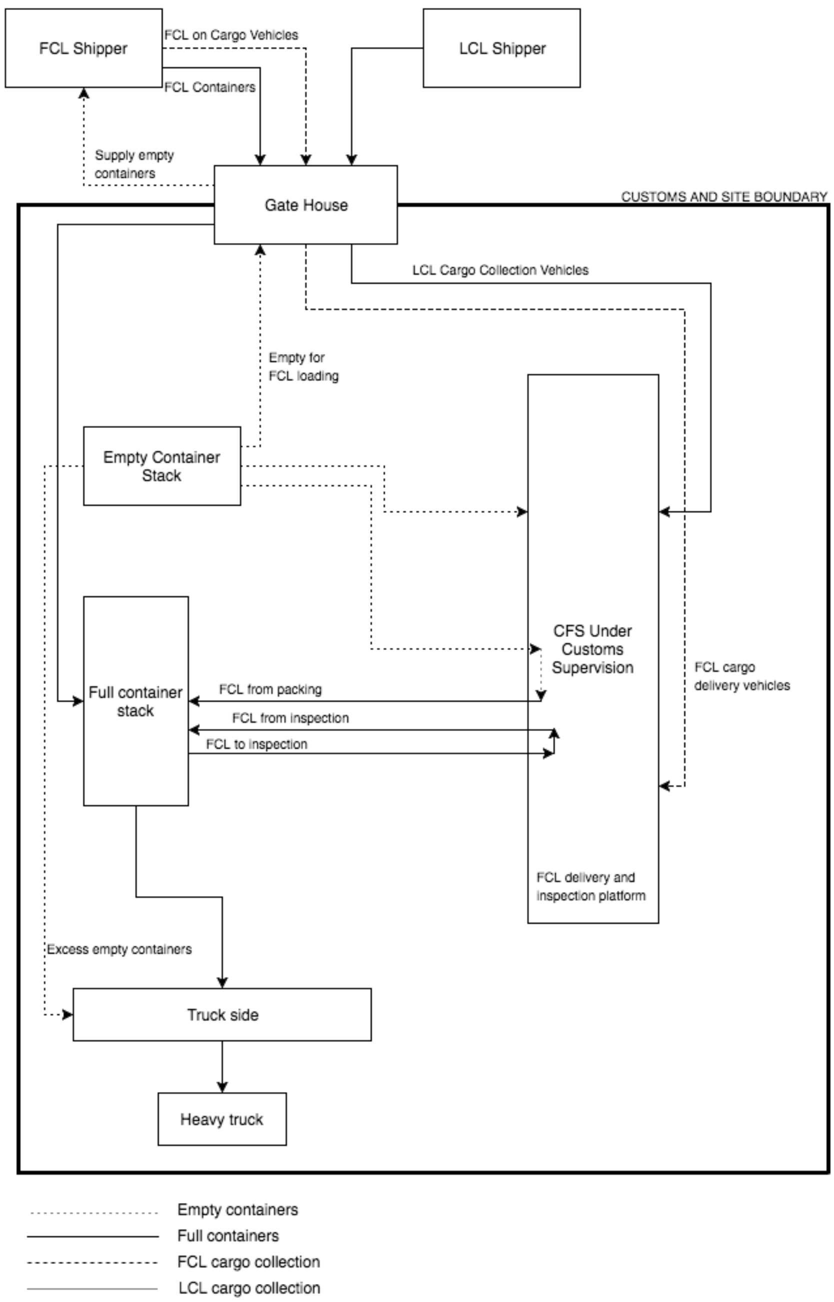

Figure 5-5: Export flow for cargo operation in Airmadidi Dry Port
Source: modified from (UNCTAD, 1991)

The inbound cargo from regional nodes to Airmadidi Dry Port is divided into two types of size load: (i) Full Container Load (FCL), which is included by container cargo, and (ii) Less Container Load (LCL), which is included by bag cargo, general cargo, and dry bulk. All inbound pass gate house to be the first security check of a document of the incoming vehicle. All cargo that is clear to go, proceed to enter the customs and primary site of Airmadidi Dry Port.

Next, The FCLs are brought to the stack of a full container, although afterward it will be checked in the FCL delivery and inspection platform that is located in Container Freight Station (CFS), adjacent to the stack. LCL cargo collection vehicles deliver their goods to be inspected and later on to be packed into full container load in CFS. All FCL from CFS afterward is transported into full container stack. From full container stack, FCL then is delivered by heavy truck to Bitung Port on the truck side. On the other hand, there is empty container stack. It brings back the empty container to be loaded to FCL shipper or shipped the excess empty containers to Bitung Port via heavy truck.

For import flow operation, the operation and flow occur oppositely from the export flow. Flow starts from the arrival of cargoes from Bitung Port. It follows the operations inside the customs and site boundary until finally is delivered to respective regional nodes.

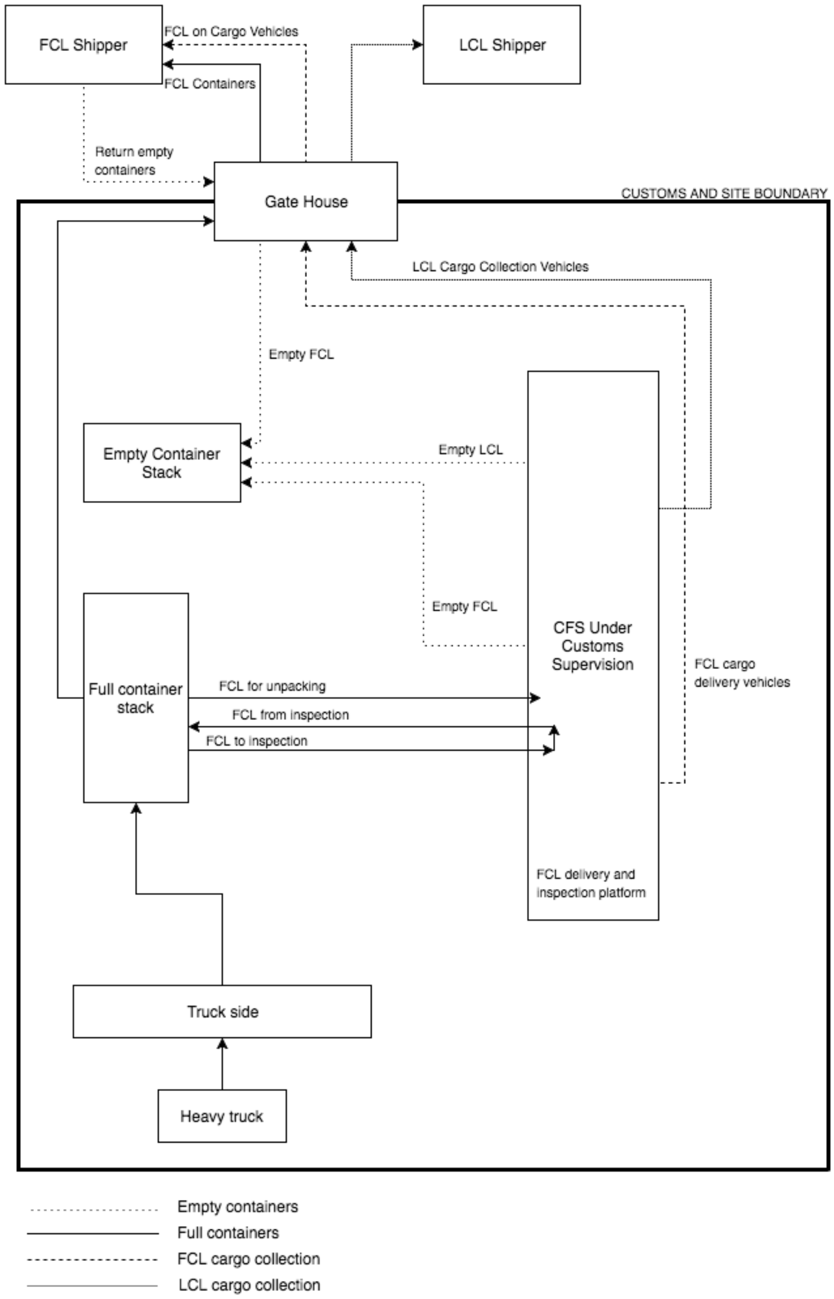

Figure 5-6: Import flow operation in Airmadidi Dry Port
Source: modified from (UNCTAD, 1991)

5.3 Layout of Airmadidi Dry Port

he layout of the dry port is unique to each location depending on traffic volume, traffic pattern, and special trade conditions. Thus, no universal design can be applied to the number of dry ports. Nevertheless, UNCTAD dry port handbook in 1991 requires the dry port layout should include parameters of (i) the initial freights to be handled; (ii) an estimated volume of cargo to be handled by the facility within a 20-year time horizon, and (iii) the type of facilities and equipment's that customers will require. Furthermore, the layout of dry port defines the cost and benefit of dry port.

5.3.1 Services in logistics hub

Logistics hub can be configured to provide various functions such as storage, transport, distribution, assembly, direct shipment, shipment with milk runs, cargo consolidation, sorting, break-bulk, distribution network management/vehicle routing, delivery, package-tracking, e-commerce services, etc. (Hamzeh, Tommelein, Ballard, & Kaminsky, 2007). Several functions of these functions will be employed in Airmadidi hub. The functions refer to hinterland potential are (i) freight consolidation, (ii) temporary storage, (iii) customs and clearance, (iv) container maintenance, and (v) container washing.

These types of service determine required equipment and further cost in dry port. A brief description of these functions is mentioned in Table 5-2. These features define the necessary infrastructure that should be provided in Airmadidi Dry Port: container yard, warehouse, CFS, container maintenance depot, office and restaurant rental, and administration building.

No	Function of logistics hub	Description
1	Container yard	For stacking the full and empty containers
2	Warehouse	To store general cargo
3	Freight Consolidation	Commodities coming from different regional nodes are consolidated in Airmadidi Dry Port and then shipped to Bitung Port from regional node and vice versa
4	Customs and clearance	Airmadidi dry port confirms whether the export/import declaration and the actual goods are consistent with the provided data
5	Office and restaurant rental	Space to be rented for related transport companies, catering, and others.

Table 5-2: Functions description in Airmadidi dry port

5.3.2 Estimated volume of cargo to be handled within a 20-year time horizon

The estimation of growth of handled volume in Airmadidi dry port is predicted based on the (i) freight generation in North Sulawesi Province from Ministry of Transportation database and (ii) changing share of logistics hub in North Sulawesi Province. The assumption of dry port operation starts in 2019. Years of 2017 and 2018 are assumed as the period of construction.

Freight generation growth

The prediction of growth using multiple regression from the parameters of GDP per capita and number of inhabitants. In average, the growth per year is 4%. The volume to be handled in Airmadidi Dry Port is based on 2039 volume: 964,898 tons. The annual growth of North Sulawesi Province is relatively lower than the growth of South Sulawesi Province. South Sulawesi Province grows faster in term of inhabitants and GDP per capita. Therefore, this prediction is eligible to be used.

Changes in market share of using logistics hub

As mentioned earlier in section 4.3.1, he first year of Airmadidi Dry Port only considers 25% of total freight volume in North Sulawesi Province. The change of market uses the assumption that it will increase to 50% market share in the fifth year (2024) and reach the maximum share of 75% in the 10th year (2029). The highest percentage of 75% is caused by the 25% share that prefers for direct delivery.

The forecasted volume determines the design of Airmadidi Dry Port and activities inside up to 2039 is shown in Figure 5-7. Volume to be handled in the first year (2019) is 139,162 tons, meanwhile, in 2039 is 964,898 tons.

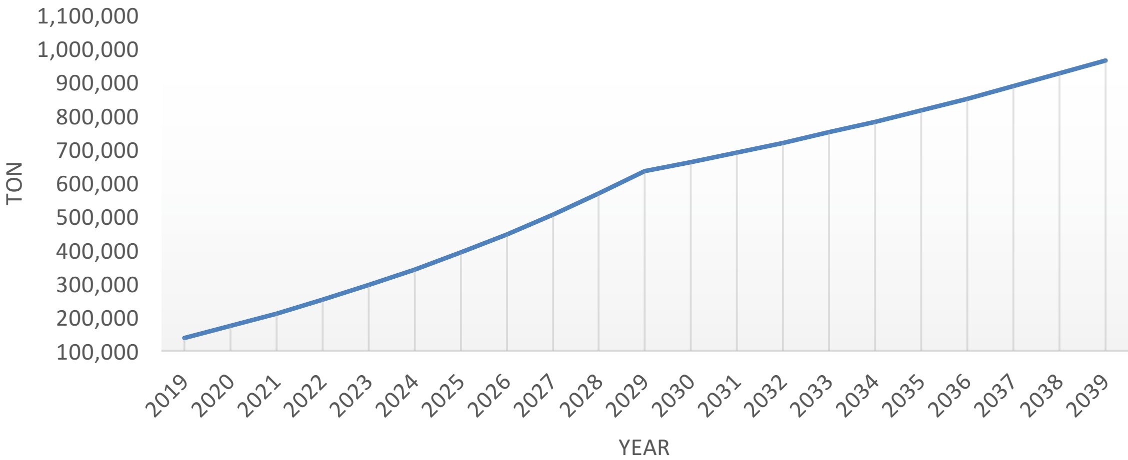

Figure 5-7: Forecasted demand in Airmadidi dry port
Source: own analysis

Ministry of Transport has shown a study of the forecasted share up to 2040 in Bitung Port (Ministry of Transportation, 2014). The proportion of the container is expected to grow up to 59% in 2026 afterward reach 62% in 2036. Decreasing share of bag cargo follows in 2026 with a share of 10%. As shown in Figure 5-8, dry bulk share remains the same, and general cargo share slightly increase in 2036. These shares are used to analyze future demand of Airmadidi dry port. Following the forecasted volume in 2026, therefore the new volume of freight in 2016 and 2036 by packaging is shown in Table 5-3.

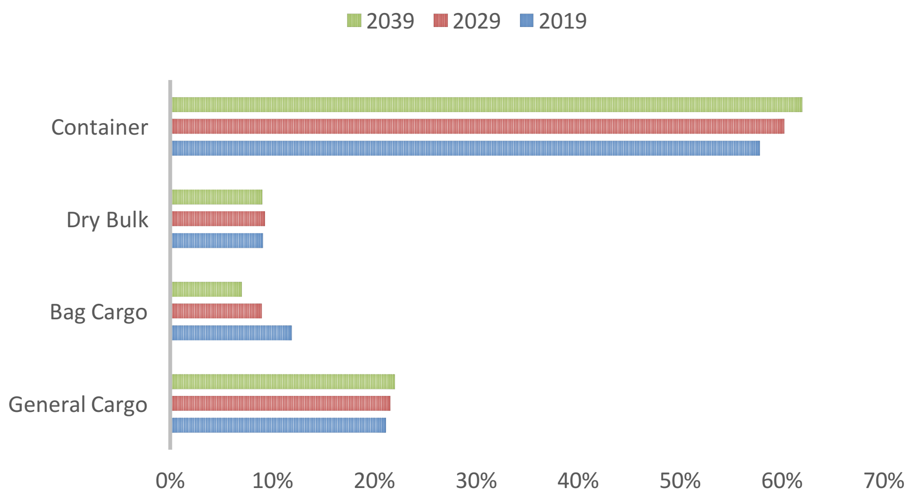

Figure 5-8: The share of cargo of Bitung Port flow in 2019, 2029, and 2039
Source: (Ministry of Transportation, 2014)

Type of packaging	General Cargo	Bag Cargo	Dry Bulk	Container (TEU)	Total
Volume in 2019 (ton)	29,224	18,091	12,525	5,288	139,162
Share in 2019	22%	13%	9%	57%	100%
Volume in 2039 (ton)	202,628	67,543	86,841	39,882	964,897
Share in 2039	21%	7%	9%	62%	100%

Table 5-3: The freight type by packaging in Airmadidi

5.3.3 Layout of Container Yard

It is required to define the quantity of containers in the 20 years' time span to calculate the layout of the container yard. The volume of the container in 2039 is 39,882 TEU. There are different types of stacks in a container terminal. The overall storage area yard is divided into separate stacks for export, import, reefers, and empties (see Table 5-4). The share of import, export, and empties are derived from ingoing and outgoing flow between Airmadidi dry port, Bitung Port, and regional nodes.

Type of container flow	Volume (TEU)	Share
Import	18,346	46%
Export	17,548	44%
Empties	3,988	10%
Total	39,882	100%

Table 5-4: Share of annual container throughput

The required area of container yard depends on with the needs of container and CFS. The formula to calculate the required area of the container is mentioned in equation (10) (Ligteringen & Velsink, 2012). The formula has the parameter of dwelling time ($\bar{t_d}$) which becomes the function of the size of the container yard. The number of dwelling time differs for a different type of container. Normally, six days is for the import containers. Three days is for the export containers. Empties has the 15 days of dwelling time. These numbers are derived from the average observed days in Cikarang Dry Port Terminal in 2016.

$$A = \frac{N_c \times \bar{t_d} \times A_{TEU}}{r_{st} \times 365 \times m_c} \quad (10)$$

in which,

A = area required (m^2),
N_c = number of container visits per year per type of stack in TEUs,
$\bar{t_d}$ = average dwell time (days),
A_{TEU} = required area per TEU inclusive of equipment traveling lanes (m^2),
r_{st} = ratio average stacking height over nominal stacking height (0.6 to 0.9),
m_c = acceptable occupancy rate (0.65 to 0.70)

Rubber tired gantry crane (RTG) is used as equipment in a container terminal. It is used for nominal stacking height of 4. Therefore, A_{TEU} is estimated as 8 m^2. RTG is chosen because it has the advantages of high stacking density, low maintenance cost compared to straddle carrier, and more flexibility as compared to the rail mounted gantry as the RTG is able to cross travel and access all containers stacked within a yard (Lam, Selecting Container Handling Equipment for Growth, 1988).

The factor r_{st} reflects the fact that the sequence in which the containers will leave the stack, is partly unknown (mostly so for the import stack) and that extensive intermediate re-positioning of containers is expensive (Ligteringen & Velsink, 2012). Increasing stack height will increase the need for re-positioning. Consequently, r_{st} value requires decreasing. r_{st} uses 0.8 value to resulting more efficient area for import and export containers. The empty container uses 0.9.

The factor m_c (optimum occupancy rate) adjusts the stochastic characteristics of arrival and departures of the containers in terminal. The optimum value of m_c depends on the frequency distribution of these arrivals and departures, and of the acceptable frequency of occurrence of full saturated stack (Ligteringen & Velsink, 2012). m_c is assumed using the value of 0.65 for the reason that the occupancy will not be as maximum as 70%. Table 5-5 shows the required area for different stacking types by following equation (10). The surface alongside inside container yard should be paved to sustain the allowed loads from equipment's and containers. The required area of container stack is 9,840 m^2.

Component	N_c (TEU)	t_d (days)	A_{TEU} (m^2)	r_{st}	m_c	Storage Area (m^2)
Import	18,346	6	8	0.8	0.65	4,640
Export	17,548	4	8	0.8	0.65	2,959
Empty	3,988	15	8	0.9	0.65	2,241
Total						9,840

Table 5-5: Required area for each container stack

5.3.4 Layout of Container Freight Station (CFS), Shed, and Storage Area

A CFS has the function to be the consolidation or segregation of less than container load (LCL). It is the location where containers holding more than one consignment are packed or unpacked (UNCTAD, 1991). CFS comprises a covered shed for a truck that needs to access stacked containers inside a shed. Customs staff must be present in the shed to check and examine the containers and cargo as they are packed and unpacked. Equation (11) is given to calculate CFS area.

$$A_{CFS} = \frac{N_c \times V \times \bar{t_d} \times f_{bulk} \times f_{area}}{h \times 365 \times m_c} \quad (11)$$

in which,

A_{CFS} = CFS area required (m^2),
N_c = number of container visits per year per type of stack in TEUs,
$\bar{t_d}$ = average dwell time (days),
m_c = acceptable occupancy rate (0.65 to 0.70),
V = contents of 1 TEU container (=29 m^3),
f_{bulk} = bulking factor,
f_{area} = ratio gross area over net area (accounting for internal travel lanes and containers),
h = average height of cargo in the CFS (m)

The volume to be handled in CFS for the container is complete LCL, 24,444 TEU. Dwelling time (t_d) f CFS is estimated as ten days. farea is assumed to be 1.4. f_{area} is assumed to be 1.4. f_{bulk} is assumed to be 0.65. Table 5-6 shows the required area for the container in CFS. The operations of container handling will be described in section 5.2.2.

Component	N_c (TEU)	V (m^3)	t_d (days)	f_{area}	f_{bulk}	h_s (m)	m_c	Storage Area (m^2)
CFS for container	24,444	29	10	1.4	1.1	4	0.65	11,503

Table 5-6: Calculation of CFS area for container

Handled volume in transit shed is 202,628 tons (general cargo) and 67,543 tons (bag cargo). Transit shed requires floor area, A_{gr}. It is calculated by equation (12) (Ligteringen & Velsink, 2012). Parameters of t_d, ρ_{cargo}, h_s, f_{area}, f_{bulk}, and m_c use the average value of transit shed design in dry port for developing countries (UNCTAD, 1991). The result is shown in Table 5-7.

$$A_{gr} = \frac{f_{area} \times f_{bulk} \times N_c \times \bar{t_d}}{m_c \times h_s \times \rho_{cargo} \times 365} \quad (12)$$

In which:

N_c = total annual throughput which passes the transit shed,
$\bar{t_d}$ = average dwell time of the cargo in days,
ρ_{cargo} = average relative density of the cargo (e.g. 0.6),
h_s = average stacking height in the storage (e.g. 2 m),
f_{area} = ratio gross over net surface, accounting for traffic lanes for FLTs etc. (e.g. 1.5),
f_{bulk} = bulking factor due to stripping and separately stacking of special consignment, damaged goods, etc.,
m_c = average rate of occupancy of the transit shed or storage

Component	N_c (ton)	t_d (days)	f_{area}	f_{bulk}	ρ_{cargo} (t/m³)	h_s (m)	m_c	Storage Area (m²)
Transit shed	270,171	10	1.5	1.2	0.6	2	0.65	17,081

Table 5-7: Calculation of transit shed area

Calculation of dry bulk storage uses the rule of thumb. The main reason to use the rule of thumb lacks commodity data in dry bulk. Suggested rules of thumb for the storage factor are for coal between 15 and 25 tons per square meter per year [ton/m2/y] and iron ore between 30 and 40 [ton/m2/year] (Ligteringen & Velsink, 2012). Since there is no clear type of commodity, iron ore is used. Therefore, it will result in the larger area. The warehouse of dry bulk is $\frac{86{,}841\ ton/year}{40\frac{ton}{m^2}/year}$ = 2171 m².

5.3.5 Layout of delivery side

The delivery side is intended to be the side of the incoming and outcoming of three axles rigid truck from and to Bitung Port. There is also the percentage of using the medium truck to the certain regional node that requires less capacity vehicle. Still, the design of the delivery side uses the largest dimension of the vehicle. The size of three axles rigid truck (see Figure 5-9) is provided in Table 5-8. An assumption of the width of the truck side is using ten times of the width of vehicles. It is intended for the track of reach stacker accessibility and for the truck to turn around.

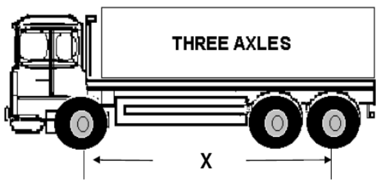

Figure 5-9: Three axle rigid truck
Source: (Road Safety Authority, 2015)

Dimension	Three axle rigid truck
Length (m)	10
Width (m)	2.5
Height (m)	3.3

Table 5-8: Dimension of heavy truck
Source: (NSW Government, 2008)

The annual number of trucks that passing this side is calculated by dividing the incoming flows divided by the capacity of heavy truck (15 tons). Daily flow is dividing annual flow from Bitung Port to logistics hub and vice versa, with the number of operational days in a year. Therefore, the regular oncoming trucks to this side is $\frac{64{,}326\ trucks}{365\ days}$= 155 trucks daily. With 24 hours' operation, it results in 7 vehicles passing in an hour. The design of truck area considers the parameter of peak hour and dwell time. The parameter of peak hour increases the usage up to 1.5 times than normal capacity. As mentioned before, the dwelling time (waiting and loading time) for the heavy truck is 4 hours. Therefore, the design of delivery side is intended for following a number of trucks: 7 x 4 x 1.5 = 42 trucks. The configuration is designed for 3 x 14 trucks line up with additional free space in between trucks (see Table 35). Minimum width of truck side design is 2 x 2 + 2.5 x 3 + 2 x 2 = 17.5. Minimum length of truck design is 2 x 2 + 14 x 10 + 13 x 2 = 174. The minimum required area of the truck side is 17.5 x 174 m = 3,045 m^2 (see Table 5-9).

Component	Width (m)	Length (m)	Quantity	Total (m^2)
Truck side	17.5	174	1	3,045

Table 5-9: Calculation of minimum size of delivery truck side

For the next development phase of logistics hub, the area of the delivery side is suitable for the placement of railway infrastructure. It is assumed that the railway track has the width of 4 m per lane (track, and free area).

5.3.6 Administration Building and Communications

The administration building is the most important part of production and processing of all documents related to the cargo handling in Airmadidi Dry Port. It functions to increase efficiency by conducting a swift communication between involved parties in the operation of the dry port. It contains office for the dry port management team, customs, freight forwarding agents, transport operators agents, and banks. Sanitary facilities and restaurant are the fixed facilities to facilitate the occupant's needs.

The assumption for each occupant requires office with size mentioned in Table 5-10. The construction of the building is preferred to be located outside of the central area of the dry port. Nevertheless, there is a restricted-access for the dry port management team and customs personnel to the operational area. The functional area is restricted for staff in offices other than the dry port management team and customs personnel.

Component	Width (m)	Length (m)	Quantity	Area (m^2)
Dry Port management office	20	20	1	400
Customs	10	10	1	100
Freight forwarding agents	4	4	5	80
Transport operator agent	4	4	3	48
Banks	5	5	2	50
Sanitary facilities	4	4	2	32
Restaurant	7	7	1	49
Free space	7	3	1	21
TOTAL				780

Table 5-10: Calculation of admin building size

5.3.7 The gatehouse and security features

The gatehouse is the vital point of site security. It functions as the security checkpoint for vehicles that enter and leave the central area of the dry port. The security has tasks to check CFS area, allowing the vehicles to enter and exit the dry port after documents checking. The personnel of this facility should also be in this post. The security posts are placed beside the gates for trucks and staff.

Perimeter fencing and lighting must meet the standards required by customs authorities to secure the area (UNCTAD, 1991). Security staffs are responsible for securing the whole area even when it is not in use and keep an eye on the site of the perimeter. The dimension of gatehouse and security is assumed as 10 x 10 m size. Thus, it requires 100 m^2 per one security post.

5.3.8 Vehicle holding area and traffic flows

Vehicle holding area functions as the area that allows the truck driver park and finishes the paperwork in an office building before entering the central area. It prevents the bottleneck in the main operation area and ensures the security staff that these vehicles are clear to proceed in the security zone. The traffic flow should be a one-directional to eases congestion and maintain the safety. White marks and signs can be the road surface markings.

The required area of vehicle holding is assumed to use the biggest trucks uses the same number with the truck number in the truck delivery side from Table 5-9. Time of paper work and waiting time is assumed as 2 hours. The area required is derived from hourly flow from distributing trucks. There are two types of distributing trucks: medium and heavy truck. Dwelling time is 3 hours. Assuming 1.5 coefficient to be multiplied in anticipating peak hours. The hourly flow of medium truck is derived from dividing all operated medium trucks with the number of operating hours. The number of the hourly medium truck is 82. The hourly heavy truck is seven trucks. The capacity then is intended to serve medium trucks: 82 * 3 * 1.5 = 369. Following the same rule, it also serves additional seven heavy trucks. The dimension of truck uses the same dimension of the heavy truck. Truck positions follow the 19 x 20 trucks formation, which is set as mentioned in Table 5-11.

Component	Width (m)	Length (m)	Quantity	Total (m^2)
Vehicle holding area	87.5	242	1	21,175

Table 5-11: Calculation of vehicle holding area

5.3.9 Specialized container area

Specialized container area is referred to reefer container. It is equipped with a cooling and electric socket to maintain the quality of cargo. The area of reefer container is assumed by 20% of container flow. The daily handled container is of 22 containers. Referred to five days dwelling time, thus total daily handled container is 110 containers. The size is calculated in the Table 5-12. The required size is 5,688 m^2.

Specialized are	Length (m)	Width (m)	Quantity	Total
Container area	6.1	2.44	110	1,638
Maneuver area	9	5	90	4,050
Total				5,688

Table 5-12: Calculation of specialized container size

5.3.10 Parking area

The parking area is designated to the office tenants and customer of dry port. The area is designed with size of 150 x 75 m. Asphalt paves it.

5.3.11 Final design

Following all of the facility size requirements above, the layout of Airmadidi Dry Port is presented in Figure 5-10. The total area of the dry port is 190,000 m^2 (19 Ha).

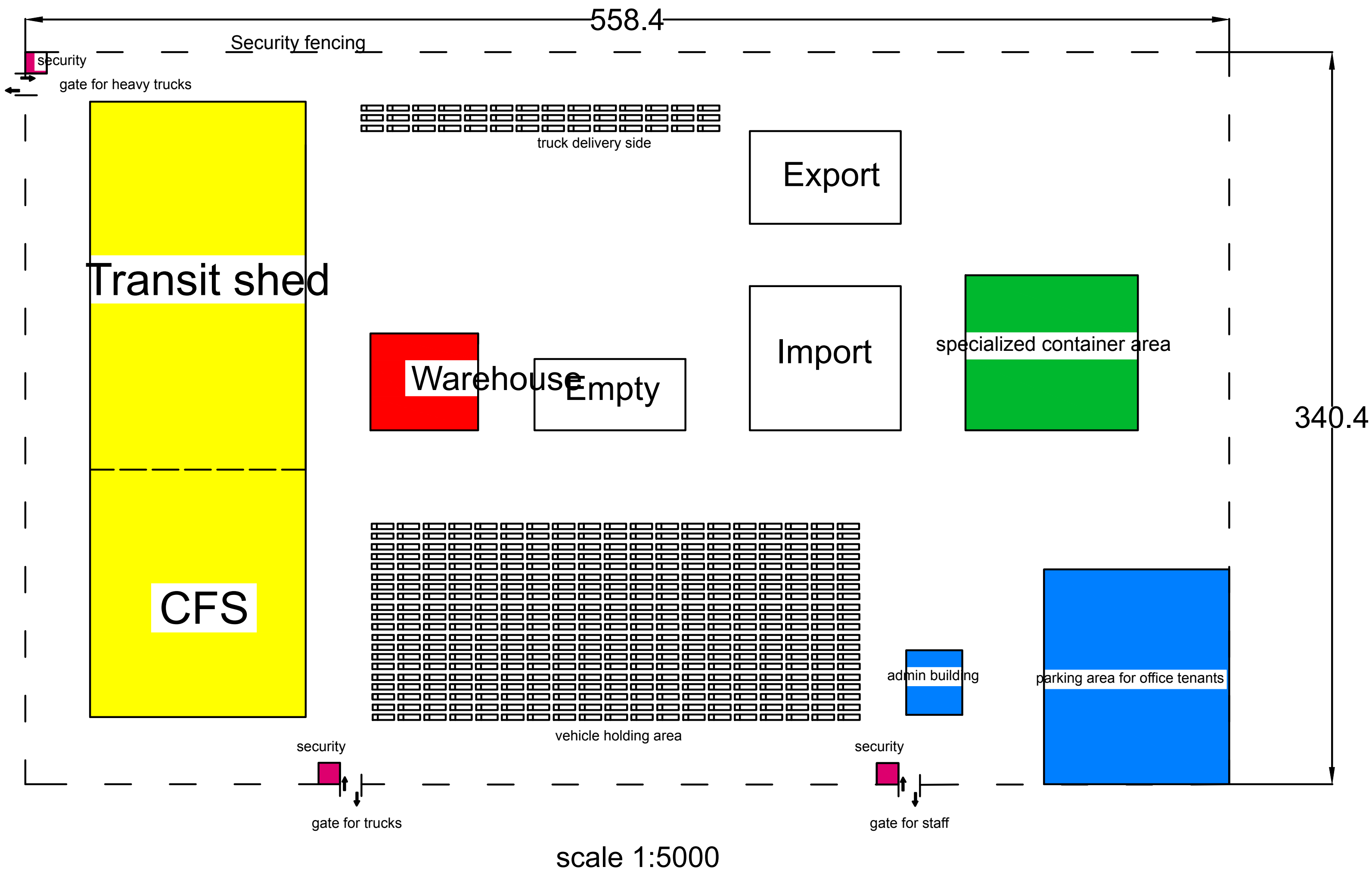

Figure 5-10: Layout of Airmadidi Dry Port

5.4 Stakeholder Analysis in Logistics Hub

Port planning and port management are increasingly influenced by a complex environment, driven by a variety of social, political, economic and technological developments, as well as a variety of external stakeholders, each pursuing specific strategic objectives concerning port activities and port development (Dooms, Macharis, & Verbeke, 2004). In the establishment of logistics hub investment, each stakeholder has their interest and capacity to oppose the planning.

Stakeholder Analysis is one of measure to facilitate institutionally and policy reform processes by accounting for and often incorporating the needs of those who have a 'stake' or an interest in the changes under consideration (The World Bank, 2001). They interact with each other to accommodate their best interest and capacity. Stakeholder itself means any group or individual who can affect or is affected by the achievement of the organization's objectives' (Freeman, 2010).

According to the previous definition, Bitung Port has groups who can affect decision-making process, especially in developing more accessible hinterland with both improved connection and logistics hub establishment. The involved groups are the regulator, operator, user and population, and third parties. The regulator group involves the regional government of Bitung (GoB) and Port Authority (PA, under Ministry of Transportation of Indonesia (MoT)). Figure 5-11 identifies the stakeholders by top down approach. Top down approach helps the analysis to look from the central actors who are seen as most relevant in producing desire effect (Liedl, 2011).

The operator' group comprises Pelindo IV (Eastern Indonesia Port Corporation) and/or private company. Users and population group include terminal operators/stevedoring, domestic shipping lines, international shipping lines, terminal operators, warehousing companies, stevedoring, transport companies. Third parties group comprises the association of logistics and freight forwarders (ALFI/ILFA), Indonesia shipping owner associations (INSA), fisheries products and vegetable oils industries, and environmentalists.

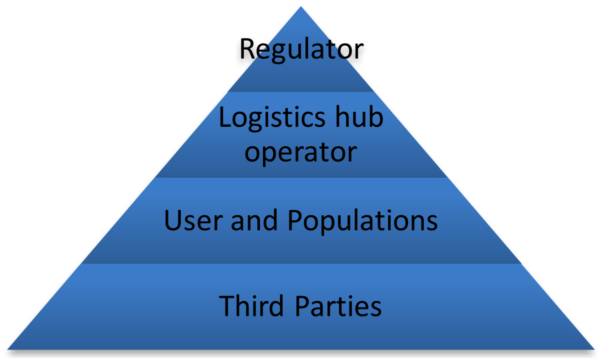

Figure 5-11: Top-down approach of stakeholder identification in Bitung Port

Source: (Fraser, Dougill, Mabee, Reed, & McAlpine, 2006)

The power and interest matrix is one of the real methods to analyse each stakeholder intervention. It helps to determine which player's interest and power must be taken into account to address the problem or issue at hand (Bryson, 2004). Evaluation of each stakeholder interest and influence are derived from interviews with the interested parties mentioned above. The interview provides an insight into the present situation of Bitung Port from different perspectives of stakeholders. The interviews are presented in appendix K. Each stakeholder has characteristics as described below regarding their power and interest of making any decision in dry port.

Regulators

PA has a high interest and a medium power. Indeed, they are likely to be very interested in suggestions to improve Bitung Port connection to the hinterland, and they do have power but are not as close to the field as the GoB, which manages the city on behalf of the government. In national planning level, the GoB holds the significant role in proposing Bitung to be one of the SEZ to Coordinating Ministry of Economy of Indonesia. SEZ includes a plan to connect Bitung Port by additional toll road and railway connection.

Consequently, the GoB is deemed to have a high interest in a well-developed hinterland connection to/from Bitung Port and a high power since it is the regulation, which is initiated by them.

Logistics hub operator

Pelindo IV has a high interest in the suggestions of improving hinterland connection—their business depends on it—but medium power since they do not outperform the level of power of the GoB. It has medium power and high interest on this hub. The private company is also the option to be the logistics hub operator. It also has the higher capacity in optimizing the potential of logistics hub in term of financial benefit. It has the medium power and interest.

User and population

Improved hinterland access will increase the economic activity and thus significantly impact trade activity in the hinterland of Bitung Port. Different perspective exists between users of Bitung Port. The first type of user, user A is likely to support the improvement of hinterland connection and logistics hub development. User A has the mid power and high interest. The second type of user, user B has hesitation since they have enjoyed the monopoly of trucking mode and direct connection to port from the regional node and vice versa. They might be reluctant to shift to more organized freight transport. User B has mid power and high interest in negative view against the logistics hub concept.

Populations in this context are the people in North Sulawesi Province. There is three populations type: (a) individuals who support the project, (b) individuals who dislike the project, and (c) individuals who don't mind about the project. Population A grants benefit from the more organized hinterland and trade distribution, since disorganization deteriorates their living environment with unsafe conditions, noise, crowdedness, and pollution. It has a low power and high interest. Nevertheless, there are population B. People who don't like the improvement since it increases the hazard and noise by the more traffic and construction in logistics hub surrounds their living area. They have low power but high interest in negative perspective against this project. Population C doesn't put attention and think that the business is not in their backyard. They have both low power and interest.

Third parties

Environmentalists can be expected to support the plan of developing logistics hub since heavy traffic, congestion, and the use of high-percentage lead-containing fuels are usual in this province, deteriorating the quality of air if no policy intervention occurs. Environmentalists have low power and medium interest in this project.

Local and national media are concerned with actions taken by the government on a general basis, and especially when it concerns a large project that can affect daily lives of people, e.g. when it comes to transport infrastructure. There are two kinds of media: the objective one and the negative one. They have a medium interest and high power in deciding the thoughts of the inhabitants about the project.

Related industries and NGOs such as ALFI/ILFA and INSA have a medium-to-low level of power and a medium level of interest. Indeed, although they are quite active with some initiatives taken in favor of improved hinterland connectivity, their area of direct influence is limited. They are also divided into negative and positive side toward the idea of logistics hub.

Figure 48 shows the power-interest matrix based on the previous analysis. The green colour denotes positive attitude by related party toward the logistics hub idea. The red colour indicates contra character toward the notion. Yellow shows neutrality to keep objective to this idea.

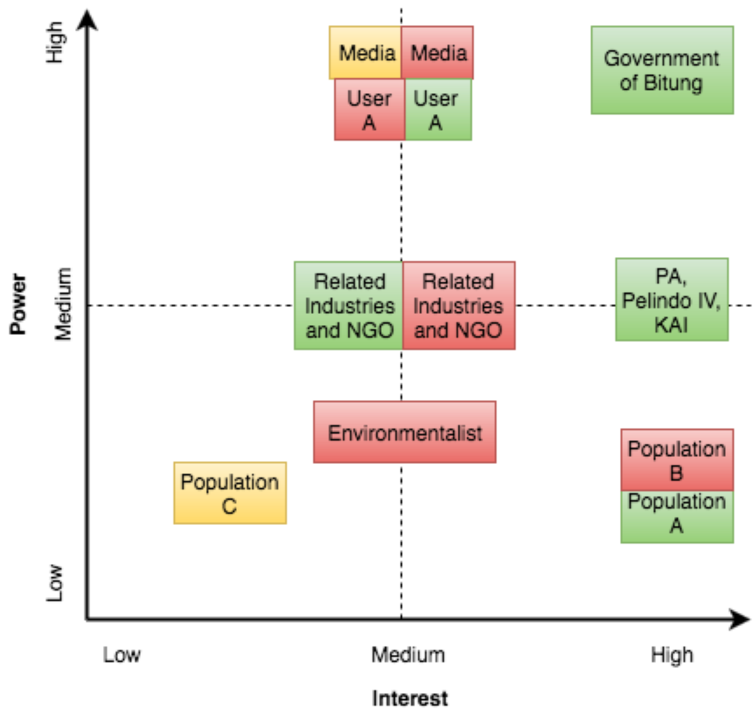

Figure 5-12: Power-interest matrix

5.5 Conclusion

Airmadidi logistics hub is chosen as the logistics hub location. The close distance of 28 km classifies Airmadidi as a dry port. It provides services of (i) freight consolidation, (ii) customs and clearance, (iii) warehouse, and (iv) container storage. The activities handle container and non-container goods. Six regional nodes participate to be this dry port user including Lolak, Tahuna, Melonguane, Boroko, Ondong Siau, Tutuyan, and Kotamobagu (Kotamobagu). Total attracted freight to Airmadidi dry port, which assumes that all freights are served via the port, is 122,728 tons in 2016.

The time span of the design of Airmadidi dry port is 2019. It will start in 2019 in which 2017 and 2018 will be the construction period. With annual growth of 4%, the handled volume in Airmadidi dry port will be 139,162 tons in 2019 and 964,897 tons in 2039. This figure also follows the change of share in freight type and increasing the share of dry port usage along the year. The share of freight by type in the first year operation is 57% of the container, 21% of general cargo, 13% of bag cargo, and 9% of dry bulk. The share of dry port usage is 25% in the first year and will increase gradually up to 75% in 2039.

The layout of the dry port depends on with kind of activities and their volume. Central infrastructures in Airmadidi dry port are CFS, container yard, warehouse, specialized container area, and administration building and office. These are completed with gatehouse and security building, parking area, truck area, and vehicle holding area. The final layout of Airmadidi dry port consumes the area of 19 hectares (560 m x 340 m).

Stakeholders are involved in the decision-making process of Airmadidi dry port. These comprise regulators, logistics hub operator, user and population, and third parties. The regulator has the highest power and interest in a positive way towards this logistics hub scheme. Logistics hub operator side shows positive attitude with high interest but a medium power. User comprises two different perspectives of positive and negative interest. Nevertheless, they have same medium interest and high power. The population includes neutral, negative and positive respondent. The neutral one has low interest and low power. For the last two groups, they have medium interest and low power. Third parties range their power and interest from the medium into high. They also have a variation of positive and negative response.

6. SOCIAL COST BENEFIT ANALYSIS

This chapter analyses a social cost-benefit analysis for Airmadidi dry port. Methodology section, firstly, explains the flow of this chapter. Two main components of Socio Cost Benefit Analysis (SCBA), which are cost and benefit, are elaborated in the second and third section. The fourth section performs the SCBA to analyse this project feasibility. Sensitivity analysis tests the result of SCBA by applying several indicators to SCBA in the fifth section. Possible financing source of the dry port is explained in section 6. Lastly, conclusion section summarizes the result of this chapter.

6.1 Methodology

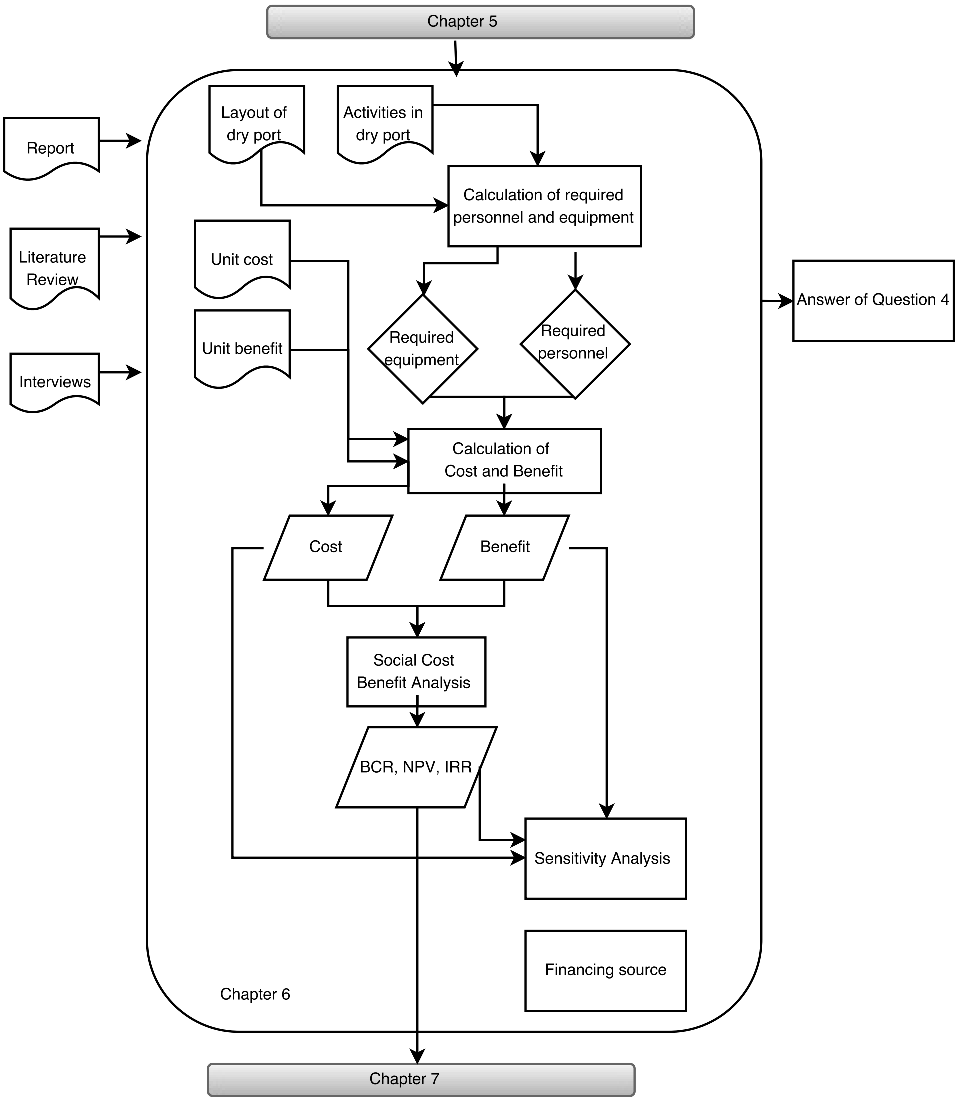

Figure 6-1: Methodology of chapter 6

Figure 6-1 explains the process in this chapter. The configuration of logistics hub in chapter 5 has given input (layout and activities in dry port) for chapter 6 to analyze the required equipment and personnel. Reports (from other Asia dry ports, CE Delft, local government, ADB, UNCTAD, World Bank) and interview with the local contractor were used to derive estimated unit cost and social benefit of operation in dry port.

The layout of selected logistics hub further defined the required equipment and personnel. Selection of equipment was based on the dimension of logistics hub, specifications of equipment, and the specification of each activity. Afterward, equipment information was analysed from the literature review and technical report (Kalmar reach stacker, Toyota, and Hyundai Forklift) for each selected equipment. The number of personnel was based on literature review and guideline from UNCTAD. Thus, the expenditure and benefit were derived.

The result of cost and benefit was the main components in performing SCBA. The components of BCR, NPV, and IRR decided the feasibility of this project. Sensitivity analysis was conducted to test the robustness of the result of SCBA. Several developing bank reports (ADB, World Bank, Islamic Development Bank) were the guidance in performing SCBA and sensitivity analysis. A brief explanation, based on literature reviews, of financing source, was explained. This chapter answered the last sub-research question in the end.

6.2 Cost

The cost of dry port establishment referred to two components of capital expenditure (infrastructure and equipment investment) and operational expenditure (staff salary and dry port operational and maintenance expenditure). Expenditure from local price (IDR) is converted into Euro with conversion rate in 2016, in which 1 Euro equals to 14,500 Indonesian Rupiah (IDR).

6.2.1 Infrastructure investment

Infrastructure investment captures the cost of land acquisition, road access, and dry port facilities construction. Each investment depends on with the size of demand in the dry port (see section 5.3). Data of investment cost, especially in term of civil works are derived from the interviews with local contractor staffs, Doni Febriyanto and Hanriyanto Pakpahan, from PP (*Pembangunan Perumahan*) company in 2016[3].

Land acquisition

The expenditure of land acquisition depends on the planned area of container yard, restaurant, and offices space. The assumption of land price per square meter in North Minahasa is € 21. It is higher from the average of North Sulawesi Province. Nevertheless, it is relevant since Minahasa district is one of the main activity centre in this province. The total area of land acquisition is derived from the total area of logistics hub that has been described in section 5.3. Road access is assumed by the provision of 1,200 m x 5 m area. Respective cost is shown in Table 6-1.

Type of land acquisition	Unit	Unit Cost (€)	Volume	Cost (€)
Dry Port Area	m2	21	190000	3,933,000
Road access	m2	21	6000	126,000
TOTAL				4,059,000

Table 6-1: Land acquisition cost
Source: (Febriyanto & Pakpahan, 2016)

Road access construction

In this component, road access is assumed to have the length of 1,200 m and 5 m width. Local construction unit cost is used. This construction includes the drainage, soil works, structure works, and other detail technical works. The construction cost in Sulawesi Island compared to Java Island has a

[3] The cost from the interview reflects the middle rate of construction price in North Sulawesi Province. In the real construction, some figures can be adjusted depend with the owner's request of construction specification.

relative higher price since the primary construction material such as cement and steels are shipped from Java. Cost of road access construction is shown in Table 6-2.

Type of construction	Unit	Unit Cost (€)	Volume	Cost (€)
Road access	m2	138	6000	827,586

Table 6-2: Construction cost of road access
Source: (Febriyanto & Pakpahan, 2016)

Dry Port construction

Dry port construction includes construction of CFS, container yard, admin building, transit shed, warehouse, specialized container, vehicle holding, and parking area pavement. Each required area is calculated in section 5.3. Pavement is applied in the CFS, transit shed, specialized container, warehouse, and specialized container area, and container workshop area. These areas must provide the same quality of asphalt pavement for heavy equipment load such as reach stacker (RS) forklift. For container yard, the concrete plate is used. Thus, it results in a higher cost than asphalt one.

The cost of admin building includes the structure, finishing, and landscape setting. All costs are taken from local contractor interview referred to medium warehouse quality in the recent year of 2016. Container workshop area, CFS, transit shed, warehouse, and specialized container area are designed to have the building and pavement. Thus, they have the high unit cost. The calculation is shown in Table 6-3.

Type of logistics hub construction	Unit	Unit Cost (€)	Volume	Cost (€)
CFS construction	m^2	345	11,503	3,966,686
Transit shed construction	m^2	345	17,081	5,890,146
Warehouse	m^2	345	11,500	3,965,517
Container yard pavement	m^2	69	9,840	678,595
Admin Building	m^2	345	780	268,966
Specialized Container area	m^2	345	5,687	1,961,117
Vehicle holding area	m^2	69	21,175	1,332,759
Parking area	m^2	69	11250	775,862
TOTAL				18,063,786

Table 6-3: Construction of logistics hub
Source: (Febriyanto & Pakpahan, 2016)

Sum of these tree components of infrastructure investment results € 18,063,786 million. Infrastructure cost is spent equally throughout the first and second year of construction.

6.2.2 Equipment investment

The investment of equipment is determined by each facility needs mentioned in section 5.3. Different equipment is dedicated to the various annual handled cargo of dry port. Procurement of equipment follows the demand growth in dry port.

Calculation of required equipment

To calculate how much equipment is needed, the parameters to be determined are movements between each facility, hourly volume, cycle time, and productivity of each equipment. Detail movements figure is presented in Table 6-11. The following explanation is mentioning the requirement to be used in 2039 and 2019. Required of equipment in complete years is shown in Table 5-7.

Assumptions in calculating the needs of equipment

Several rules are applied in determine each parameter:

- Hourly volume

In some cases, the average weight per cycle cannot cope with certain cargo's weight. The coefficient of 0.6 is used for capacity per equipment per cycle time calculation. The factor of 1.5 is multiplied by hourly handled volume to anticipate peak hour traffic.

- Cycle time

Cycle time is total time of unloading, loading, and travel time over the CFS/yard. The calculation requires given maximum distance traveled and average speed per mobile equipment. Productivity per hour is derived from 3600 seconds/ (cycle time * capacity per forklift). Details calculation are provided in the appendix. Traveling speed per equipment as part of the calculation of cycle time is shown in Table 6-4.

No	Name of equipment	Average traveling speed (km/hour)
1	Forklift 3 tons	12
2	Forklift 8 tons	15
3	Reach Stacker (RS)	10

Table 6-4: Data of average traveling speed per handling equipment
Source: (Kalmar Global, 2016), (Hyundai Heavy Industries, 2015)

Movements of containers from heavy truck to container yard (vice versa)

Full containers (FCL) are unloaded and loaded in stacking yard. Direct movement is conducted by heavy truck. The FCL share is derived from heavy truck share. Therefore, the annual FCL movement in 2039 is 15,438 movement[4] and 2,227 in 2019. Less container load (LCL) is derived from the rest number of container share, 24,444[5] TEU. Average movement per hour is 4 movements[6]. Peak volume of the is 6 movements/hour[7]. RS is used to move container in this scheme. Given average productivity of RS is 5 movements per hour (see appendix for detail calculation), 2 RS is used in this type of movement in 2039 and only one RS for 2019' scheme.

Movements of containers from truck to CFS (vice versa)

LCL containers are unloaded and loaded in CFS to be consolidated. Annual movement of this type in 2039 is 24,444 TEUs and 3,525 TEUs in 2019. It results in the average hourly movement of 4 and 6 in peak hour. The productivity of RS in this movement setting is 5 movements per hour. Thus, 2 RS are sufficient to handle the needs in 2039 but only one RS for 2019' scheme.

Movements of containers from container yard to CFS (vice versa)

The annual movement in 2039 is 24,444 movements and 3,525 movements in 2019. It results in the average hourly movement of 4 and 6 in peak hour. The productivity of one RS in this movement setting is six movements per hour. Thus, one RS is required in both 2019 and 2039.

Movements of containers from container yard to specialized container area

Twenty-percent of the annual container is handled in this setting, which results in 7,976 movements in 2039 and 1,058 movements in 2019. Average movement per hour is 1 movement. Peak volume of this setting is one movement. One scheme of movement handles movement from the container yards to specialized container area since its low needs than other handling scheme. Productivity of RS is 6 movements per hour. Thus, only 1 RS is required in both years.

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[4] 0.24 x (850,953 tons/15) = 13,615 TEU or movements

[5] 62% x (850,953 tons/15) – 13,615 = 21,557 TEU or movements

[6] 13,615 / (365 x 24) = 2

[7] 1,5 x 2 = 3

Movements of dry bulk from truck to warehouse and vice versa

The annual volume of dry bulk in 2039 is 86,841 tons and 12,525 tons in 2019. The average hourly volume of this cargo is 10 tons and 15 tons in peak hour. The used equipment is forklift 3 tons. The productivity of forklift 3-ton in transporting dry bulk is 15 movements per hour or total is 27[8] tons/hour, derived after applied the factor of 0.6 to obtain optimum capacity per movement. Thus, one forklift of 3-ton is required in 2019 and 2039.

Movements of general cargo and bag cargo from truck to CFS and vice versa

The annual volume of general cargo and bag cargo is 270,171 tons. The average hourly volume of this cargo is 31 tons and 47 tons in peak condition. Forklift 3-ton and 8-ton types are used. The 8-ton type is used to anticipating overload in certain cargo that exceeds the capacity of the forklift 3 ton. The productivity of forklift 3-ton in this scheme is 27 tons/hour. The 8-tons type provides the productivity of 48 tons/hour. Thus, one forklift 3-ton and one forklift 8-ton are required in 2019 and 2039 scheme. The share of using forklift 3-ton and forklift 8-ton is assumed as 60:40 of all handled volumes.

Contingencies matter

Additional equipment is added to avoid the lack of equipment when one breaks down. Two additional RS, two forklift 3-tons, and two forklift 8-tons are picked for 2039' operation. Total required equipment in 2039 are six RS, five forklift 30-ton, and two forklift 8-ton. Scheme of 2019 requires six RS, four forklift 30-ton, and two forklift 8-ton (see Table 6-5 and Table 6-6).

No	Type of movement	Annual volume	Average hourly volume	Hourly peak volume	Required Equipment
1	Containers loaded / unloaded from/to container yard directly by heavy truck	2,227 TEUs (2,227 moves)	0.3 TEU (1 move)	0.4 TEU (1 move)	1 RS
2	Containers loaded/unloaded from heavy truck to CFS	3,525 TEUs (3,525 moves)	0.6 TEU (1 move)	0.8 TEU (1 move)	1 RS
3	Containers loaded/unloaded from stack yard to CFS	3,525 TEUs (3,525 moves)	0.6 TEU (1 move)	0.8 TEU (1 move)	1 RS
4	Dry bulk unloaded/loaded to warehouse from CFS	12,618 tons (7,010 moves of forklift 3-ton)	1 ton (1 move)	2 (1 move)	1 forklift 3-ton
5	General cargo and bag cargo loaded/unloaded from truck to/from CFS	46,031 tons (15,344 forklift 3-ton and 3,836 forklift 8-ton)	5 tons (2 moves of forklift 3-ton)	8 tons (3 moves of forklift 3-ton and 1 move of forklift 8-ton)	1 forklift 3-ton and 1 forklift 8-ton
6	Containers loaded / unloaded from/to workshop and specialized container area	1,586 TEUs (1,586 moves)	0.1 TEU (1 move)	0.2 TEU (1 move)	1 RS
Total required equipment with contingencies				6 RS, 4 forklift 3-ton, and 2 forklift 8-ton	

Table 6-5: Type of movements and the required equipment in 2019

[8] 15 x 3 x 0.6 = 27 tons

No	Type of movement	Annual volume	Average hourly volume	Hourly peak volume	Required Equipment
1	Containers loaded / unloaded from/to container yard directly by heavy truck	15,438 TEU (15,438 moves)	2 TEU (2 moves)	4 TEU (4 moves)	1 RS
2	Containers loaded/unloaded from heavy truck to CFS	24,444 TEU (24,222 moves)	4 TEU (4 moves)	6 TEU (6 moves)	1 RS
3	Containers loaded/unloaded from stack yard to CFS	24,444 TEU (24,444 moves)	4 TEU (4 moves)	6 TEU (6 moves)	1 RS
4	Dry bulk unloaded/loaded to warehouse from CFS	86,841 tons (48,245 moves)	10 (6 moves)	15 (8 moves)	1 forklift 3-ton
5	General cargo and bag cargo loaded/unloaded from truck to/from CFS	270,171 ton (90,057 moves with forklift 3-ton and 22,514 moves with forklift 8-ton)	31 tons (20 moves of forklift 3-ton and 3 moves of forklift 8-ton)	47 tons (30 moves of forklift 3-ton and 4 moves of forklift 8-ton)	2 forklift 3-ton and 1 forklift 8-ton
6	Containers loaded / unloaded from/to workshop and specialized container area	11,965 TEU (11,965 moves)	1 TEU (1 move)	1 TEU (1 moves)	1 RS
Total required equipment with contingencies				6 RS, 5 forklift 3-ton, and 2 forklift 8-ton	

Table 6-6: Type of movements and the required equipment in 2039

Gradual equipment investment

Gradual equipment investment depends on with the different demand each year and the lifetime of the equipment. A lifetime of forklifts 3-ton (internal combustion type) is assumed to be three years. On the other hand, five years is intended for forklift 8-ton due to the light operation (Hyundai Heavy Industries, 2015). Reach stacker is assumed to have the lifespan of 20 years (Patra, Nayak, & Mishra, 2014). The required equipment per year referred to previous data of lifetime and calculation per movement in each year is listed in Table 6-7. The bold font indicates that the equipment should be replaced in a respective year. In the end of the dry port operation, each equipment has a residual value of 10% from its initial investment (Porter & Norton, 2015).

Procurement cost of equipment follows afterward in Table 6-8. Equipment for contingencies uses the second-hand equipment. Each price is derived from the recent cost of equipment from the brand of Kalmar (Reach stacker) and Hyundai (Forklift) in 2016. Trucks fleet in the delivery side is not part of the investment in this study since it will be owned and managed by freight forwarders.

Year	Reach stacker	Forklift 3-ton	Forklift 8-ton
2019	**6**	**4**	**2**
2020	6	4	2
2021	6	4	2
2022	6	**4**	2
2023	6	4	2
2024	6	4	**2**
2025	6	**4**	2
2026	6	4	2
2027	6	4	2
2028	6	**5**	2
2029	6	5	**2**
2030	6	5	2
2031	6	**5**	2
2032	6	5	2
2033	6	5	2
2034	6	**5**	**2**
2035	6	5	2
2036	6	5	2
2037	6	**5**	2
2038	6	5	2
2039	6	5	**2**

Table 6-7: Required handling equipment of Airmadidi Dry Port

Type of equipment	Unit	Unit Cost (€)
Reach Stacker (new)	unit	450,000
Reach Stacker (old)	unit	200,000
Forklift 3 ton (new)	unit	20,000
Forklift 3 ton (old)	unit	10,000
Forklift 8 ton (new)	unit	90,000
Forklift 8 ton (old)	unit	45,000

Table 6-8: Price of handling equipment

6.2.3 Operation and Maintenance (O&M) cost

The cost of operation and maintenance depends on to required personnel, facilities, and equipment in dry port. Calculation of O&M cost is composed of two types of expenditure: fixed expenditure and variable expenditure. Annual staff salary and general O&M are classified as the fixed cost. Equipment operations and maintenance expenditure are classified as a variable cost.

Annual staff salary

To determine how many personnel that is needed in dry port operation, Figure 6-2 shows the typical organization of dry port. General manager, as the chief of the facility, leads the department of security, operations, engineering, accounts, and marketing. The activities are divided into the main area of dry port operations: CFS, yard, and truck side.

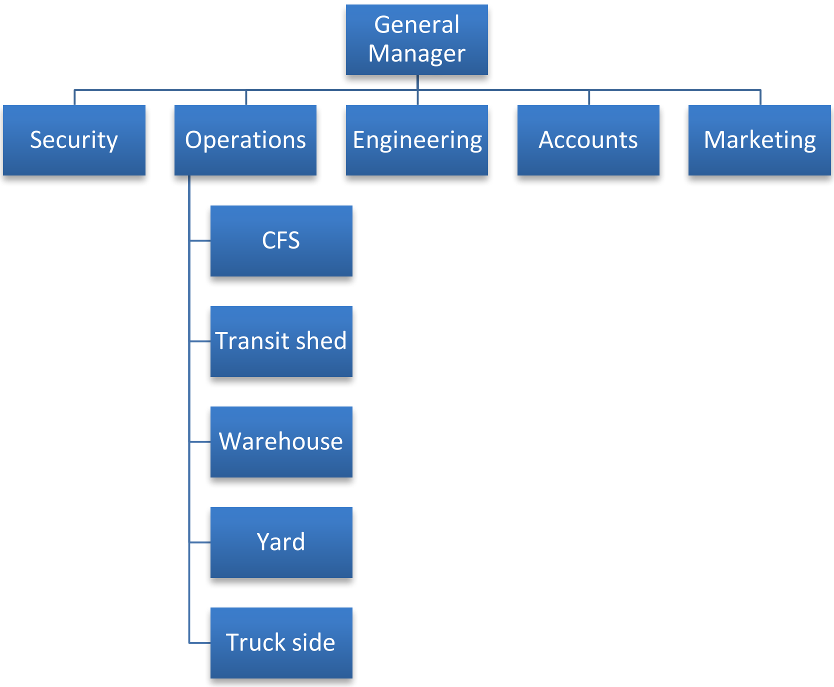

Figure 6-2: Typical organization of dry port

Source: modified from (UNCTAD, 1991)

General Manager

This post holds the greatest power and importance in managing the dry port. The position should be the first to be considered. Thus, the selected general manager can give input to the design process and the construction. The appointee requires combination skills of management, communication, and technical experience in the logistics field. The necessary number of a general manager is 1.

Security Officer

The security officer can be appointed from local police, customs personnel, or private agency. The roles are ensuring the cargo moving inside dry port holds the right permits and will not cause any damage to dry port itself, patrolling the cargo areas, and keeping safe the revenues of dry port. The required security officers are eight personnel (inclusive one personnel to be head of security): 6 for guard the entrance gate, 3 for patrolling in container yard and CFS, and the last four people guarding the two gates on the truck side. It includes two shift operations.

Head of Operations

This post is one of the crucial posts after General Manager since it is the core position to manage daily operations of the dry port. The person in charge of this task should have high level of experience in port and terminal operations. He/she will be assisted by other personnel in CFS, yard, and truck side activities. The head of operations requires two persons that working in different two shifts.

Referred to section 6.2.2, the required personnel in operating handling equipment is 14 persons (including two shifts). In container yard, there is four staff who check the ground situation of containers and on the delivery side. CFS and transit shed requires eight persons for additional manual stuffing/stripping and 4 for customs inspection. In specialized containers and workshop, there are eight persons for handling, to inspect and repair the containers. In total, there is 38 personnel.

Head of Accounts

The position of head of accounts doesn't necessarily require the person to be very expert in logistics. At least, this person can cope up with the accounting of dry port operation. The main tasks are preparing invoices, producing account statements, paying wages, and provide all information of accounting and costs to create the report and data statistics to other managers. Therefore, the precise tariffs can be determined regards to the correct data from the accounting department. The required personnel of head of the account is one person. Nevertheless, he/she will be assisted by other two accountant staffs.

Head of Engineering

The primary responsibilities of the head of engineering are control the maintenance and operation of equipment and infrastructure. Thus mechanical, electrical and civil engineering skills are needed in this department. The required number of head of the engineering department is 1. Nevertheless, he/she will be assisted by other three engineers: 1 civil engineers, one mechanical engineer, and one electrical engineer.

Marketing

Marketing of dry port acts as the integrator between the business parties, customers, government, and the dry port itself. This task can be done directly by General Manager. Appointing a senior marketing person to assist General Manager will be fruitful to broaden dry port exposure into a larger market share and influence government to increase their support. Therefore, the required person for marketing is 1.

Staff Salary

The salaries of staff in dry port are categorized into four categories: A, B, C, and D (Meidute, 2007). Category A is high salary (managerial). Category B is high-middle salary (scientific-technological support), Category C stands for low-middle salary (technical), and category D is low salary (handling). In the application of Airmadidi Dry Port, category A stands for General Manager. Category B belongs to each head of division: Engineering, Operations, Accounting, and Marketing. Category C belongs to the head of security, accounting staffs, and engineers. Category D stands for the 38 operators/person in charge for CY, CFS, delivery side, specialized container, and workshop area.

The source of salary data for category A, B, and C is based on the national standard for General Manager, head of the department, accountants, and engineers in a warehouse in 2016. The wage of category D (low salary) is determined by the standard of Association of Load/Unloading Workers (ATKBM) in 2016. Table 6-9 provides the annual operational expense in term of staff salary.

Type of salary	Unit	Monthly salary (€)	Volume	Annual salary (€)
High salary	person	4,200	1	50,400
High-middle salary	person	1034	5	62,069
Low-middle salary	person	690	6	49,655
Low salary	person	524	38	239,164
TOTAL				401,288

Table 6-9: Annual salary of staff expenditure

Source: own analysis, (Manado Line, 2016), and (Kelly Services, 2016)

Facilities Operational and Maintenance Cost

The electricity usage is based on kilowatt-hour (kWh) consumption. Water usage is based on m3 use. Telecommunication comprises office telephone and the internet. All expenses are calculated based on month expenses (see Table 6-12) with following the reference case of a medium warehouse in Indonesia in 2010 (Zulaihah, 2010). It represents the small level of the warehouse with an area of 19 Ha. The cost from referred case is annualized into the year 2016. The reefer container plugs electricity cost is added in total electricity operational expense. There are 60 container plugs located in specialized container area.

The assumption of operational cost per equipment depends on the annual activity per equipment accomplishes and the consumption of fuel and oil. The movement of each equipment depends on the annual cargo/container handled/ Fuel cost depends on the usage of handling equipment. Each equipment has different consumption of fuel per hour. Fuel consumption per hour is taken from the EU report (EU Comission, 2012). The data (see Table 6-10) are relevant to several facts from equipment sheet facts in 2016 (Kalmar Global, 2016).

Port Kaohsiung (Taiwan) in 2000 revealed the data of annual operational cost between handling equipment based on the movement of handled cargo (Port of Kaohsiung, 2000). The number of movement per equipment is based on the activities inside the dry port (see Table 6-6). The data to calculate the operational and maintenance cost per equipment is provided in Table 6-10. Movement data in 20 years is listed in Table 6-11.

Type of equipment	Fuel consumption (L/hour)	Operational cost (€/movement)	Maintenance cost (% of capital cost)
RS	17	0.75	5.5%
Forklift 3 ton	2.5	0.11	3%
Forklift 8 ton	3.5	0.16	3%

Table 6-10: Operational and maintenance data per equipment

Year	RS movements	Forklift 3-ton movements	Forklift 8-ton movements
2019	10,335	22,354	3,836
2020	12,959	28,094	4,755
2021	15,766	34,275	5,785
2022	18,799	40,510	6,829
2023	22,065	46,991	7,934
2024	25,578	53,729	9,103
2025	29,355	60,734	10,338
2026	33,393	68,485	11,761
2027	37,744	76,108	13,151
2028	42,408	84,035	14,617
2029	47,406	92,277	16,162
2030	49,461	96,399	16,678
2031	51,576	101,315	17,391
2032	53,812	105,571	17,940
2033	56,144	109,888	18,503
2034	58,577	114,267	19,083
2035	61,116	118,708	19,677
2036	63,730	124,137	20,519
2037	66,493	128,728	21,152
2038	69,376	133,385	21,800
2039	72,303	138,302	22,514

Table 6-11: Data of movements per equipment in 20 years operation

UNCTAD determines the maintenance cost for surfaces in the terminal in 1985. The determination is based on a percentage of capital cost in paving. The maintenance cost differs per type of pavement: concrete plate and asphalt. Airmadidi Dry Port uses the concrete plate in the container yard. It has a maintenance cost of 1% from the capital cost of paving. Asphalt surface' maintenance cost is defined as 0.75% of capital cost of paving. Another building is assumed to have a maintenance cost of 0.5% of their capital investment. All operational and maintenance cost are provided in Table 6-12.

Type of general O&M in dry port	Unit	Monthly Cost (€)
Electricity	month	4,138
Water	month	1,655
Telecommunication and Internet	month	459
Concrete yard maintenance cost	month	24,894
Asphalt surface maintenance cost	month	18,139
Other building maintenance cost	month	67
TOTAL		12,126

Table 6-12: General operation and maintenance cost
Source: own analysis and modified from (Zulaihah, 2010)

6.3 Benefit

From the perspective of investor and government, the investment of dry port should be beneficial for the economic point of view. The benefit of dry port comes from consumer's surplus, the social cost of carbon saving, and traffic accident saving.

6.3.1 Consumer's surplus

Freight's consumer surplus has been calculated according to "rule of half" method (see section 3.4.2). This approach suggests that when consumers change their travel in response to a financial incentive, the net consumer surplus averages half of their price change. It is applied to the freight trip in the intermodal trip and for trips remaining on the road trip that benefits from congestion reduction (Victoria Transport Policy Institute, 2015).

The benefit for the consumer is derived from annual cost saving presented in Table 6-13. Airmadidi Dry Port saves 20 euro/ton of total attracted volume from 6 districts. This unit cost saving is assumed to be equal to 20 years along with demand growth. Referred to the following growth as was described in Figure 5-7, the benefit for consumers in 2019 is € 1.392 million. On the other hand, a benefit for the consumer in 2039 is € 9.649 million.

Year	Unit cost saving (€/ton)	Volume (ton)	Annual cost saving (€)	"Rule of Half" Benefit (€)
2019	20	139,162	2,783,234	1,391,617
2020	20	174,138	3,482,755	1,741,377
2021	20	211,852	4,237,032	2,118,516
2022	20	252,473	5,049,468	2,524,734
2023	20	296,183	5,923,661	2,961,830
2024	20	343,170	6,863,406	3,431,703
2025	20	393,636	7,872,712	3,936,356
2026	20	447,791	8,955,811	4,477,906
2027	20	505,859	10,117,170	5,058,585
2028	20	568,075	11,361,502	5,680,751
2029	20	634,689	12,693,780	6,346,890
2030	20	661,840	13,236,799	6,618,399
2031	20	690,152	13,803,047	6,901,524
2032	20	719,676	14,393,519	7,196,759
2033	20	750,462	15,009,250	7,504,625
2034	20	782,566	15,651,321	7,825,660
2035	20	816,043	16,320,858	8,160,429
2036	20	850,952	17,019,037	8,509,519
2037	20	887,354	17,747,084	8,873,542
2038	20	925,314	18,506,275	9,253,137
2039	20	964,897	19,297,942	9,648,971

Table 6-13: Consumer's surplus of Airmadidi Dry Port

6.3.2 Socio cost of carbon saving

A dry port will help to decrease the carbon footprint from converting a substantial number of mixed vans and light trucks into less number of medium trucks and heavy trucks. Characteristics of freight vehicles to approximate the social cost of carbon, are shown in Table 6-14.

Vehicle type	Payload (ton)	Liters/km	CO_2 (g/km)
van	1	0.01	234
LT	4	0.131	311
MT	8	0.157	374
HT	20	0.244	764

Table 6-14: Typical freight vehicle characteristics

Source: own analysis and modified from (GHG Protocol, 2005)

Analysis of socio cost of carbon saving is carried out by comparing the existing scheme (without dry port) and the dry port scheme. In the scheme of dry port, total socio cost of carbon is the sum of carbon from the truck trip and handling equipment in dry port (Charuka, 2014). Distance data and volume are based on previous OD matrix analysis. Valuation of CO_2 takes the value of €30 per ton CO_2 (CE, 2002). Example of calculation of CO_2 emission is described as (take van for example):

The CO_2 emission = $\frac{Fuel\ consumption \times g\ CO_2 per\ ton\ km}{Payload}$

The CO_2 emission of van = 0.01 * 234 g CO_2 / 1 ton = 2.288 g CO_2 / ton-km

The annual CO2 emission = 2.288 g CO_2 / ton-km * 34,790 tons * (3,712 km + 1,856 km)

= 443,000,000 g or 443 ton

Valuation to monetary value = 443 ton * € 30 per ton CO_2 = € 13,298

The same calculation applies to all type of vehicles (Table 6-15). It shows that the annual socio cost of carbon in existing scheme is € 36,620. The effect of having dry port is shown in Table 6-16 and Table 6-17. Data of fuel consumption is taken from Kalmar and Hyundai equipment fact sheet in 2016. Distance is based from movement per equipment. Emission unit per liter is considered using diesel (Veidenheimer, 2014). Formula to calculate the annual CO_2 cost of handling equipment in dry port is (take RS for example):

The CO_2 emission of RS = 0.6 L/km * 42,048 km * 2.672 kg CO_2/L = 64 ton

Valuation to monetary value = 64 ton * €30 per ton = €1,910

Vehicle type	Total distance of 2 ways	Total distance of 1 way	CO^2 emission (g /ton km)	volume (ton)	Annual CO^2 emission (ton)	Annual social cost of carbon (€)
van	3,712	1856	2.288	34,790	443	13,298
LT	3,712	1856	2.546	36,182	513	15,390
MT	3,712	1856	0.917	34,790	178	5,332
HT	3,712	1856	0.466	33,399	87	2,600
					TOTAL	36,620

Table 6-15: Annual CO_2 cost in existing scheme

Vehicle type	total distance of 2 ways	total distance of 1 way	CO^2 emission (g /ton km)	volume (ton)	Annual CO^2 emission (ton)	Annual social cost of carbon (€)
MT	3,786	1856	0.917	60,854	315	9,450
HT	3,786	1856	0.466	99,289	261	7,832
					TOTAL	17,282

Table 6-16: Annual CO_2 cost in truck trip of dry port setting

Equipment type	Fuel consumption L/km	Annual distance (km)	kg CO^2/L	ton CO2	Annual social cost carbon (€)
RS	0.6	42,048	2.672	64	1910
Forklift 3ton	0.2	21024	2.672	12	351
Forklift 8ton	0.23	8760	2.672	5	164
				TOTAL	2425

Table 6-17: Annual CO_2 cost of handling equipment in dry port

Total socio cost of carbon in dry port is: € 17,282 + € 2,425 = € 19,702. Social cost saving in 2019 is the difference between ideal setting and present setting: € 36,620 - € 19,702 = € 16,912. The unit saving cost is used to simplify the calculation of total socio cost of carbon saving. Unit saving cost is the result of dividing total saving with freight volume in 2019: € 16,912 / 139,162 ton = € 0.12/ton. Annual socio cost of carbon, thus, can be derived from multiplying the unit saving cost with the volume of freight in each year (see Table 6-18).

Year	Socio cost of carbon saving (€)
2019	16,912
2020	21,163
2021	25,746
2022	30,683
2023	35,995
2024	41,706
2025	47,839
2026	54,420
2027	61,477
2028	69,038
2029	77,134
2030	80,433
2031	83,874
2032	87,462
2033	91,204
2034	95,105
2035	99,174
2036	103,416
2037	107,840
2038	112,454
2039	117,264

Table 6-18: Socio cost of carbon saving in Airmadidi dry port

6.3.3 Traffic accident cost saving

Consolidation of freight in dry port will reduce the number of vehicles on the road. This situation is considered as a social benefit of a dry port in term of fewer accidents on the highway. Fewer trucks on highway have led to a fewer case of accidents (UNESCAP, 2015). The number of road accidents and the level of accident severity has been extensively applied as the indicators of life loss valuation in each country. Casualties of accidents are classified into three categories in Indonesia: dead, severely injured, and lightly injured (Ministry of Transportation, 2013). North Sulawesi Province experienced 1,535 accidents in 2011. This figure has 2,491 as casualties, which is included by 328 deaths, 822 severely injured, and 1,341 with light injury (Ministry of Transportation, 2013).

	Death	Severely Injured	Lightly Injured
Number	328	822	1341
Share	13%	33%	54%
Cost per casualty (€)	26,843	2,853	602

Table 6-19: Parameters of traffic safety in Indonesia

Source: (Ministry of Transportation, 2013) and (Ministry of Public Works, 2013)

The analysis is carried out by comparing two schemes of existing and dry port. Both analyses use parameters that are reflected in Table 6-19. The cost of casualty in developing countries, such as Indonesia, are relatively low if compared to another country in Asia (Litman & Fitzroy, 2016). Accidents rate per km is derived from the report of Victoria Transport Institute (Litman & Fitzroy, 2016). Calculation of traffic accident cost is described as (take death by vans trip for example):

Accidents occurrence = Accidents per km * distance = 0.009 * 5,568 = 50
Death = Share of death * accidents = 13% * 50 = 6 dead
Cost of dead by van = Cost per death * dead number = € 26,843/dead * 6 dead
= € 161,058

Table 6-20 shows the calculation of total cost in existing scheme. Total traffic accident cost saving in current situation results in €653,643 in a year. For ideal situation, it reduces into € 186,553 (see Table 6-21). Thus, the traffic accident cost saving in 2019 is: € 653,643 - € 186,553 = € 467,090. Simplification of calculation is done by using unit traffic accident saving. It is conducted to calculate further saving in coming years: € 467,090 / 139,162 ton = € 3,4/ton. Complete traffic accident cost is shown in Table 6-22.

Vehicle type	Accidents / km	Distance (km)	Accidents	Death	Severely injured	Lightly injured
van	0.009	5,568	50	6	17	27
LT	0.01	5,568	55	7	21	34
MT	0.002	5,568	13	2	5	8
HT	0.002	5,568	12	2	4	6
Cost (€)				476,738	131,859	45,046
Total (€)				653,643		

Table 6-20: Traffic accident cost calculation in existing scheme

Vehicle type	Accidents / km	Distance (km)	Accidents	Dead	Severely injured	Lightly injured
MT	0.002	7,869	19	2	6	10
HT	0.002	7,498	16	3	5	8
Cost (€)				476,738	131,859	45,046
Total (€)				186,553		

Table 6-21: Traffic accident cost calculation in dry port scheme

Year	Traffic accident cost saving (€)
2019	467,090
2020	584,486
2021	711,070
2022	847,416
2023	994,125
2024	1,151,836
2025	1,321,220
2026	1,502,989
2027	1,697,891
2028	1,906,718
2029	2,130,305
2030	2,221,436
2031	2,316,465
2032	2,415,560
2033	2,518,894
2034	2,626,648
2035	2,739,011
2036	2,856,182
2037	2,978,364
2038	3,105,774
2039	3,238,634

Table 6-22: Traffic accident cost saving in Airmadidi dry port

6.4 Result of SCBA

This section performs the SCBA of Airmadidi dry port with taking into accounts the components of cost and benefit in two previous sections. Table 6-23 reflects the cost component in Airmadidi dry port. Part of the cost is an investment in infrastructure, equipment, general operation and maintenance (O&M), annual salary, and O&M cost of handling equipment.

Construction of dry port spends two years in 2017 and 2018. The expenditure of infrastructure construction is divided equally in these years. All required equipment are bought at the end of 2018 to start the operation in 2019, a routine cost of general operation and maintenance and annual salary are spent equally from 2019-2039. The cost of operation and maintenance of handling equipment follows the demand in each year altogether with the replacement that occurs periodically in column "new equipment" (see section 6.2.2 and 6.2.3). Total cost is the sum of all cost columns in each year. Present Value of Cost (PV Cost) conversion uses the real interest rate of 6.5%, the recent real interest rate for Indonesia (Bank Indonesia, 2016). Total present value of cost is € 29,795,066.

COST									
Year	Year ID	Investment of infrastructure	New equipment	General O&M	Annual salary	Handling equipment operations	Handling equipment maintenance	Total Cost	PV of Costs
2017	0	11,475,186						11,475,186	11,475,186
2018	1	11,475,186	2,395,000					13,870,186	13,023,649
2019	2			12,126	401,288	11,248	7,460	432,122	380,985
2020	3			12,126	401,288	14,112	7,460	434,986	360,103
2021	4			12,126	401,288	17,179	7460	438,053	340,509
2022	5		60,000	12,126	401,288	20,437	7460	501,311	365,897
2023	6			12,126	401,288	23,917	7460	444,791	304,830
2024	7		135,000	12,126	401,288	27,633	7460	583,507	375,490
2025	8		60,000	12,126	401,288	31,598	7460	512,472	309,652
2026	9			12,126	401,288	35,878	7460	456,752	259,140
2027	10			12,126	401,288	40,393	7460	461,267	245,729
2028	11		80,000	12,126	401,288	46,537	7460	547,411	273,822
2029	12		135,000	12,126	401,288	50,329	7460	606,203	284,723
2030	13			12,126	401,288	52,504	7460	473,378	208,768
2031	14		80,000	12,126	401,288	54,837	7460	555,711	230,120
2032	15			12,126	401,288	57,177	7460	478,051	185,879
2033	16			12,126	401,288	59,604	7460	480,478	175,420
2034	17		215,000	12,126	401,288	62,121	7460	697,995	239,281
2035	18			12,126	401,288	64,731	7460	485,605	156,311
2036	19			12,126	401,288	67,539	7460	488,413	147,620
2037	20		80,000	12,126	401,288	70,352	7460	571,226	162,112
2038	21			12,126	401,288	73,271	7460	494,145	131,678
2039	22		135,000	12,126	401,288	76,238	7460	632,112	158,162
PV Cost									29,795,066

Table 6-23: Calculation of cost of Airmadidi dry port from 2019-2039

Table 6-24 reflects the benefit components in Airmadidi dry port. The benefit of dry port starts in the first year of operation (2019). Consumer's surplus, socio cost of carbon and traffic accident saving are the components of benefit in Airmadidi dry port. An additional benefit is taken from the residual value of equipment in the end of the dry port operation (2039). Total present value of the benefit is € 68,025,735.

BENEFIT							
Year	Year ID	Consumer's surplus	Socio cost of carbon saving	Traffic accident saving	Residual value of equipment	Total Benefit	PV Benefit
2017	0	0	0	0	0	0	0
2018	1	0	0	0	0	0	0
2019	2	1,391,617	16,649	464,999	0	1873265.077	1,651,582
2020	3	1,741,377	20,833	581,869	0	2344080.311	1,940,545
2021	4	2,118,516	25,345	707,888	0	2851748.889	2,216,730
2022	5	2,524,734	30,205	843,623	0	3398562.275	2,480,545
2023	6	2,961,830	35,434	989,676	0	3986940.543	2,732,386
2024	7	3,431,703	41,056	1,146,680	0	4619439.186	2,972,638
2025	8	3,936,356	47,093	1,315,307	0	5298756.271	3,201,674
2026	9	4,477,906	53,572	1,496,262	0	6027739.966	3,419,858
2027	10	5,058,585	60,519	1,690,292	0	6809396.441	3,627,543
2028	11	5,680,751	67,963	1,898,184	0	7646898.173	3,825,072
2029	12	6,346,890	75,932	2,120,770	0	8543592.678	4,012,779
2030	13	6,618,399	82,568	2,306,097	0	9007064.693	3,972,267
2031	14	6,901,524	82,568	2,306,097	0	9290188.876	3,847,070
2032	15	7,196,759	89,783	2,507,620	0	9794162.171	3,808,230
2033	16	7,504,625	89,783	2,507,620	0	10102027.64	3,688,203
2034	17	7,825,660	93,624	2,614,891	0	10534175.67	3,611,247
2035	18	8,160,429	97,629	2,726,752	0	10984810.29	3,535,897
2036	19	8,509,519	101,805	2,843,398	0	11454722.31	3,462,119
2037	20	8,873,542	106,161	2,965,034	0	11944736.39	3,389,881
2038	21	9,253,137	110,702	3,091,873	0	12455712.46	3,319,149
2039	22	9,648,971	115,438	3,224,138	241500	13230047.25	3,310,320
PV Benefit							68,025,735

Table 6-24: Calculation of benefit of Airmadidi dry port from 2019-2039

Benefit Cost Ratio (BCR) of Airmadidi dry port is 2.3 with IRR of 9%. Net Present Value of this project is € 38,230,669. Since BCR is larger than 1 and IRR is higher than real interest rate (6.5%), thus this project is viable economically. In average, unit cost of using Airmadidi dry port is: PV Cost/PV Volume = € 29,795,066 / 964,897 ton = € 30/ton.

6.5 Sensitivity Analysis

The result of the economic analysis of Airmadidi dry port is subject to uncertainty given the preliminary definition of parameters, the variability of expected demand forecast, limited information of unit costs and public interest of using the dry port. Primarily, lack of data in North Sulawesi Province and Indonesia forces Author to create several assumptions along the analysis. Therefore, this section aims to draw how sensitive is the result of SCBA by testing critical indicators to the economic analysis. The most crucial indicators are demand growth, the share of dry port usage, infrastructure investment cost, benefit, real interest rate, the willingness of participation from districts, and value of time. These indicators affect the decision of design and SCBA of dry port substantially. Comparison of base scenario and the pessimistic scenario is presented afterward.

6.5.1 Indicator

Annual growth

In a previous analysis, the increase of demand in Airmadidi dry port follows the annual grow of North Sulawesi Province, which is 4% annually. Due to moratorium regulation of foreign vessel in Indonesia, especially in Bitung Port (see 2.1.4), the growth of demand is possible to change to lower or higher scenario. The low scenario decreases growth into only 1% growth per year.

Share of dry port usage

The existence of dry port competes with the direct delivery. The previous assumption in this report reveals that the share of the dry port in the first year is 25% of total demand. The following years increase the share gradually up to 75% in the 10th year, as the maximum share of dry port usage. Low scenario sets 15% of share in the first year of operation and stops in the maximum value of 65% in the 10th year of operation.

Infrastructure investment cost

Infrastructure investment cost of Airmadidi dry port is the largest numerically component in determining cost in SCBA. Investment cost increases 10% in the scheme of low scenario. The source of change is possible comes from the increasing land acquisition cost and unstable material price for civil works.

Benefit

The low scenario in sensitivity analysis determines a 10% of reduced benefit. The reduction is possible to occur regard to the overestimated carbon cost, accident cost, dynamic demand, and reducing consumer's surplus.

Real Interest Rate

Indonesia has a changing real interest rate in recent ten years. The low economic scenario set the average interest rate in last ten years' period of 8% to anticipate the unstable interest rate.

Willingness of participation from associated districts

Author uses assumption for participating districts in dry port. It is said that district which benefits at least 20% of cost saving by dry port will be involved. This assumption is still rough prediction in North Sulawesi Province application. Therefore, low scenario targets at least 30% of cost saving to make each district want to participate in the dry port scheme.

Value of Time (VoT)

The existence of dry port includes the cost of waiting time in dry port. Change of VoT aims to see the sensitivity of analysis regarding the change in transport cost. Low scenario sets VoT to be three times higher than the previous assumption.

6.5.2 Result of Sensitivity Analysis

A result of sensitivity analysis is presented in Table 6-25. The indicator A to E shows the direct impact in changing value of SCBA result. Indicator F and G are the critical value switchers in deciding how many districts who has interest in participating in dry port. The main parameter column shows a comparison of changing parameter from base to low scenario.

Indicator A reflects that low growth of 1% results in the smaller demand, cost, and benefit. It produces the lower IRR, NPV, and BCR than before. Lower share of dry port usage in indicator B leads to a reduced cost. Nevertheless, the constant growth of 4% per year in indicator B still allows the value of BCR and IRR remain the same. Indicator C, 10% increase of infrastructure investment cost, results in lower IRR, BCR, and NPV than base scenario. Reduction of the benefit of 10% in indicator D previews the lower IRR, BCR, and NPV than base scenario. Change of real interest rate to 8% shows the lower BCR, IRR, and NPV. It turns the project to be infeasible economically by the lower result of IRR than the real interest rate.

The last two indicators, F and G, switch the decision making in the first analysis of logistics hub location. Indicator F, shift the minimum benefit of each district from 20% to 30%. Airmadidi is still the winner to be the logistics hub, but only four districts who are willing to participate. It lowers the demand into almost half of the existing. Lower demand leads to a reduced cost and benefit, thus lower NPV, BCR, and IRR. Indicator G switches the value of time into three times than initial. It results in the reduction of participation in Airmadidi dry port into only four regions. Consequently, it produces in the same BCR, NPV, and IRR with the indicator F scenario. Settings in indicators A to D show that Airmadidi dry port project is viable economically. The sensitivity analysis of indicator E, F and G results that the project is fragile with very limited IRR. Therefore, these last three indicators are the most sensitive indicators in sensitivity analysis.

ID	Indicator	Main parameter		BCR		IRR		NPV	
		Base	Low	Base	Low	Base	Low	Base	Low
A	Annual growth of demand	4%	1%	2.3	1.9	9%	7%	38,230,669	21,085,442
B	Share of dry port usage	25%	15%	2.3	2.3	9%	9%	38,230,669	37,573,873
C	Infrastructure investment cost	100%	110%	2.3	2.1	9%	8%	38,230,669	36,005,668
D	Benefit	100%	90%	2.3	2.1	9%	7%	38,230,669	31,428,096
E	Real interest rate	6.5%	8%	2.3	1.9	9%	7%	38,230,669	27,225,228
F	Willingness of dry port participation	20%	30%	2.3	1.7	9%	6.5%	38,230,669	17,288,221
G	Value of Time	100%	300%	2.4	1.7	9%	6.5 %	38,230,669	17,288,221

Table 6-25: Sensitivity analysis by critical indicators

6.6 Source of Financing

Capital investment of dry port is quite an amount of money. It requires not only from private fund but also government to be able to realize this dry port. Thus, dry port should be the part of national plan through the coordination of combination of ministries such as Coordinator of Economics Affair, Transportation, Public Works, and Industrial Ministries. As such, the development of dry port have to fit with national schemes and budgets.

To financing dry port, several options of funding source can opt. The options can be selected from total public sector funding, total private sector financing, and the combination of public and private funding (PPP). The application and advantages/disadvantages for each option are analysed below.

6.6.1 Total public sector funding

The provision of total funding from public sector such as national government and regional government ensures the equality in treatment to all users (freight forwarders, shipping lines, and other foreign agencies) and more equitable distribution of cargo among various modes (road and railway) within a centrally planned transport policy (UNCTAD, 1991). Investment in more expensive infrastructure, such as railway line, will be entirely funded by the national budget.

The first disadvantage of this concept is a relative subpar quality of dry port management since the government never has experience in functioning themselves into a private-sector business practices. Secondly, it requires high priority in the national budget to allocate such quite fund in developing dry port.

As far it is concerned, there is no kind of port-related infrastructure in Indonesia that are entirely funded by public sector except for isolated islands facilities. Nevertheless, it is entirely feasible for Indonesia since in 2015 their infrastructure budget is allocated from 8% of national budget spending plan (RAPBN-P), which results € 21.6 billion (Ministry of Finance, 2015). urthermore, central government places logistics and transportation infrastructure in their top priority to realize the National Logistics System blueprint. Therefore, total public sector funding is quite too optimistic for Airmadidi Dry Port but is not an impossible option.

6.6.2 Total private sector funding

The advantages of total private sector funding are allocation of private resources into national transport infrastructure, flexible reaction to trade environment, and efficient management. The first advantage implies that the resources of private investment generate benefits that directly contributes to the sake of national transport infrastructure. Private investment is very responsive with situation of trade, thus the quick changes relate to tariff structure and operational based policy are in line with recent trend. Private sector is well-known with high efficiency in managing investment of project since they intend to achieve the most cost-efficient operation.

The first disadvantage of this concept is the high tariff if there is no subsidy from government for user. Second disadvantage is inflexibility for regional government since they have limited influence. Another drawback is the risk. Extra attention is needed since there is no guarantee that private sector could make better cost benefit analysis better than public sector. The only dry port in Indonesia, Cikarang Dry Port, uses this type of concept. It is owned and operated by private company: PT. Cikarang Inland Port. For Airmadidi, this concept is still not feasible due to the lack experience of regional government of North Sulawesi Province in understanding private finance initiative based on Author's analysis in the field. With quite massive capital investment, the risk should be taken care precisely.

6.6.3 Public Private Partnership (PPP)

PPP arranges the cooperation between public and private sector. The minimum characteristics of PPP are (Katz D. , 2006):

- A public agency enters into a contract with a private company or consortium to provide finance and arrange design, construction, and ongoing operation of a facility;
- The contract is typically for 20-30 years, or a substantial part of the life of facility;
- At the end of contract, control of facility is usually returned to the government or a local authority

The first advantage of PPP is the reduction of risk for the private sector by government involvement. The second advantage is a better whole-of-life project evaluation. By this benefit, the private sector has higher incentive than public sector to be realistic about the feasibility of the project. In conventional procurement, public sector tends to have optimism bias in the project. It leads to the second advantage of having most optimum design and operation to minimize whole-of-life costs. The incentive to do so is higher than conventional procurement. The third advantage is provisional of additional capital. A government with poor credit rating really prefer to have PPP. Thus, the concept of PPP is suitable with Airmadidi Dry Port. It is also assured that PPP brings the proper maintenance of dry port since there are no other priorities as if compared to public sector fund.

The form of PPP in Airmadidi Dry Port can be conceptualized as follows in Figure 6-3. Public agency specifies the output of the required dry port and services. Afterward, the consortium is chosen by competitive tender. This consortium handles the design and planning, construction, operation, and maintenance of dry port. Consortium is organized by a lead contractor who coordinates engineering firms, construction companies, and facilities management services.

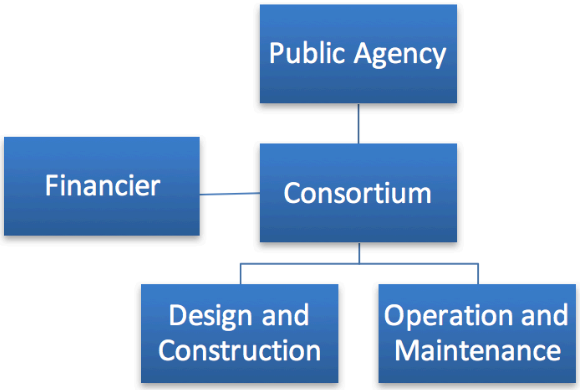

Figure 6-3: PPP scheme in Tondano Dry Port
Source: modified from (Katz D. , 2006)

There is another possibility that public and private provide different investment to share the risk. For example, public agency fund land acquisition and dry port construction. On the other hand, private sector funds the equipment purchase.

6.7 Conclusion

Social Cost Benefit Analysis of Airmadidi dry port consists of benefit and cost component. The benefits are consumer's surplus, socio cost saving of carbon, and traffic accident cost saving. Component of costs is infrastructure investment, equipment investment, and operation and maintenance cost. Infrastructure investment comprises of land acquisition, access road construction, and dry port facilities construction. Reach stackers, forklift 3-tons and forklift 8-tons compose the whole equipment investment. Operation and maintenance cost includes staff salary and operation and maintenance cost of facilities and equipment.

Using the real interest rate of 6.5%, Airmadidi dry port present value of costs € 29,795,066. Meanwhile, it can generate present value benefit of € 68,025,735. Net present value of this project is € 38,230,669. IRR of this project is 9%. Therefore, this project is considered as economically feasible.

Sensitivity analysis is performed to test the SCBA decision making in this project. There are five indicators to test the SCBA result: (A) decreasing annual growth from 4% to 1%, (B) decreasing share of dry port usage from 25% to 15% in the first year, (C) 10% increase in infrastructure investment cost, (D) 10% reduction of benefit, and (E) increasing real interest rate into 8%. Other two indicators are the value switcher in the first place of logistics hub location and participants: (F) change the willingness in using the dry port, and (G) modify the Value of Time. The result is that changes of indicator A to D remain to make the project economically feasible. Nevertheless, indicator E shows the lower IRR than the real interest rate. Indicator F and G turns the participant of the dry port to be four regions. Thus it turns Airmadidi dry port to be economically infeasible. These indicators lower IRR value compared to the real interest rate.

The financing concept of PPP is potential to be applied for Airmadidi dry port. Public agency specifies the output of the required dry port and services. Afterward, the consortium is chosen by competitive tender. This consortium handles the design and planning, construction, operation, and maintenance of dry port. Consortium is organized by a lead contractor who coordinates engineering firms, construction companies, and facilities management services.

7. CONCLUSION AND RECOMMENDATION

This chapter concludes the study performed in this report. The first section provides an answer to the research question posed at the start of the report is given in section 7.1. The second section shows the recommendation for Government of North Sulawesi Province. The third section reflects the limitation and suggestions for further study. The last section explains the reflection from Author.

7.1 Conclusion

Based on the analysis performed in the first chapter, the main research question can be answered. The research question as defined in the Chapter 1 was:
"To what extent is developing inland hubs in the North Sulawesi able to reduce overall generalized transport cost to/from the port of Bitung?"
To answer the main questions, answering the related four sub-research questions were performed. There were four sub-research questions to be answered in this study:

- *"Where are the possible inland logistics (hub)s for Bitung Port to be located?"*
- *"How can the cost reduction be modeled (for the proposed inland hub(s))?"*
- *"What are the expected overall generalized transport cost reduction of the proposed inland hubs on the overall generalized transport cost to/from the hinterland of Bitung Port?"*
- *"Is the expected business model of inland hub logistics development economically feasible?"*

To answer the first, second and third sub-research questions, findings of chapter 3 revealed the characteristics of discrete cost simulation method. Discrete cost simulation method was preferred to another method since it provided not only the generalized cost reduction in a whole system but also cost reduction individually between Bitung Port and each candidate. Findings in chapter 4 showed detail modeling of discrete cost simulation. The parameters were defined in this method: list of candidates, generalized transport cost, distance, and velocity. The candidates of logistics hub are 15 regional nodes in North Sulawesi Province: Lolak, Tondano, Tahuna, Melonguane, Amurang, Airmadidi, Ratahan, Boroko, Ondong Siau, Tutuyan, Bolang Uki, Manado, Bitung, Tomohon, and Kotamobagu.

Discrete cost method simulation was performed in two schemes: existing situation and logistics hub scheme. Existing situation scheme simulated generalized transport cost for direct delivery from Bitung Port to the regional node. Logistics hub scheme includes a logistics hub as the center of consolidation between Bitung Port and regional node. The direct shipment generalized transport cost only used the first leg cost. The parameters of direct shipment cost were transport cost, un/loading time in port, logistics hub, the value of time. The applied logistics hub cost has another logistics hub and second leg cost. The logistics hub cost associated with parameters of handling the cost and waiting time in port. The second leg cost provides cost between selected logistics hub to the regional node.

The regional node who profits the highest benefit, when it performs a role as a logistics hub, was chosen to be the logistics hub. Twenty-percent was to be set to be the benchmark for one regional node who wanted to participate in logistics hub. Airmadidi was chosen because it saved the highest annual generalized transport cost and was preferred by the highest number of interested regional nodes. It saved € 2,395,497from six interested regional nodes. In the unit of generalized transport cost, it saved € 20/ton on average.

To answer the fourth sub-research question, Social Cost Benefit Analysis (SCBA) was used. Thus, the configuration of logistics hub, cost, and benefits were defined. Chapter 5 was functioned to analyze the optimum logistics hub configuration. Airmadidi held the role of dry port, which provided service of consolidation, customs and clearance, warehouse, and container storage. It needed the area of 19 hectares. Infrastructure investment, equipment investment, and operation & maintenance cost composed the cost component as a whole. Benefit comprised customer's surplus, socio cost carbon saving, and traffic accident cost saving. The result was Airmadidi dry port is economically feasible with IRR of 9% (higher than the real interest rate, 6.5%), BCR of 2.3, and NPV of € 38,230,669.

7.2 Recommendations for Government of North Sulawesi Province

his section elaborates recommendations for the government of North Sulawesi Province that can be executed for the development of logistics hub to reduce transport cost to/from Bitung Port. It has been shown that developing inland logistics hub requires several adjustments regarding the analysis made in this study.

The government of North Sulawesi Province should reflect the decision of developing logistics hub of this study with the real application in the field. A few notes should be made on how to implement such decision. The most social approach such as the land availability, readiness of a region, and budget within a province. Also, the participation into the micro scale of logistics chain in regional nodes should be aware of the decision that will be made. Furthermore, the Government of North Sulawesi Province should introduce this concept into the larger scale, such as investors and industries. They have significant roles as the possible financier and participants of dry port.

Findings of generalized transport cost modeling in this study have shown the close estimation to the real case. Although, it needed more parameters and accuracy on data. At least, this study has demonstrated the possible evaluation to assess future impacts on any other transport, logistics, and infrastructure related field in Eastern Indonesia generally and North Sulawesi Province, specifically. For this reason, the model of transportation cost can be used as a strategic tool for policy development and a mean to assist North Sulawesi Province.

7.3 Limitations and Suggestions for Future Studies

Due to the limitation of data and time in this research, not all of the contents related to logistics hub can be captured. On the other way around, to successfully developing the logistics hub, attention needs to be paid to several details, for which further studies may be necessary.

7.3.1 Commodity Data

In this study, exact commodity data was hard to be defined. It only uses the assumption from statistics of regional and Bitung port limited data. Nevertheless, a successful logistics hub should be able to capture precisely the potencies in particular regional. The precise commodity sources, supplier, and retailers can provide more detailed generalized transportation cost. It also reflects the better forecasted for each product. Thus, the more detailed activities in logistics hub can be derived.

7.3.2 Railway Mode

Railway infrastructure is not described in this study since the infrastructure doesn't exist. Thus, it seems to be unrealistic to input the calculation since the infrastructure takes the time to exist and is not the best solution in this province in a quick period. Nevertheless, in later time after 2020, the infrastructure should be ready for the national planning. Thus, the more comprehensive study is required to combine this mode in the logistics hub. Logically, railway mode will further increase the cost reduction by maximise the capacity of the wagon. For example, one wagon contains 40 tons, which can replace two trucks of 15-ton capacity. Although, one should notice the share between road and railway mode in transporting freight via logistics hub. Study to overview the adverse effects related with existing freight forwarder also necessary to be discussed.

7.3.3 Generalized Transport Cost Modelling

There were numbers of the assumption that was made in modeling the generalized transport cost includes simple decisions on a number of loading points in regions, aggregated value of time, and empty return trip between regional node and loading points. Therefore, the future studies should be able to capture these three assumptions into the real cases based on the field estimation. I believe it needs more time and difficulties since there was no actual reliable data on the Eastern side of Indonesia. Nevertheless, the result will be worth the efforts.

7.3.4 Project Feasibility

SCBA was the only tool to analyze the feasibility of the project in this study. The reason is the lack of data and time to perform other analysis such as financial analysis. Further discussion of financial analysis in this dry port is also important to assess the feasibility. On the other hand, quite massive investment for dry port needs an additional source of income. A study that relates with additional profit and possible participation of industries in detail should be considered. Therefore, the more realistic feasibility can be derived.

7.3.5 Synchronization with Current Plan of Special Economic Zone (SEZ)

Nowadays, central and regional government deal with planning Bitung to be SEZ. Thus, many industries will be located in Bitung. Further stakeholder analysis and technical analysis should be conducted. The stakeholder analysis itself is intended to solve the conflicted interests between two districts. The technical analysis will lead to the possible connection to integrate this districts because it seems possible to connect these areas, which only has 46 km distance.

7.4 Reflection

Writing thesis based on TU Delft standard for me is a new challenge. Just for your information, I will be the first integrated Transport, Infrastructure, and Logistics engineer from Indonesia. It captures how this unified field is very new for Indonesia. That is why, it required a struggle to cope up from writing the proposal, fulfilling each deadline, communicating with the lecturer, and writing the report itself. The idea of this study itself comes from my thought. Therefore, it is quite a challenge to realize it into a well-structured proposal and report.

In the first step before kickoff meeting, I had another obligatory course of Interdisciplinary Design Project. There is no predecessor course of "Master Thesis Writing" of "Research Writing" in my track. Instead of preparing the proposal, I still needed to finish my green light and final presentation of Interdisciplinary Design Project. Luckily, I could organize my limited time then started kick off meeting on time in the mid-February.

The second step was data collection. I needed to face several stakeholders related to logistics case in North Sulawesi Province of Indonesia. With my Bahasa Indonesia skills, it was not so hard to communicate with them. As a developing country, the real struggle is in data collection and calibrate these data. Only a few data available there and thus needed many assumptions to cope up with analysis needs. In this phase, experiences and communication skills with local government were very necessary.

Logistics hub implementation is kind of new thing in Indonesia. Therefore, next struggle is how to design it based on Indonesia condition. For example, I cannot force to consider railway since the infrastructure itself was not there. Therefore, fixing the present situation is the best option for this study.

I modified several times the method to capture the cost modeling. This study is an iterative process. The optimum design iteratively affects cost and demand. Thus, deciding which kind of method to model the cost reduction took longer time than predicted. Reflect this; I should put more attention in cost modeling and details.

Overall, a very limited time of my study has been a significant driver for my outcome. I only had less than six months to produce a high standard of TU Delft master thesis. Communication and guidance from supervisors helped me even it was quite a lifetime challenge for me. However, I believe that all of my work up to now will contribute to the development of my country a step further. Thus, master thesis phase makes me feel the content of the opportunity that I have experienced.

Bibliography

Abu Dhabi Ports. (2016). *Tariff of General Cargo Charges in 2016.* Abu Dhabi Ports. Abu Dhabi: Abu Dhabi Ports.

Alam, S. A. (2013). *Location of the potential locations for the logistics hubs: A case study for a logistics company.* KTH Royal Institute of Technology, Transport Science. Stockholm: KTH Royal Institute of Technology.

Bank Indonesia. (2016, July 21). *BI Rate*. (B. Indonesia, Producer) Retrieved August 2, 2016, from Bank Indonesia: http://www.bi.go.id/en/moneter/bi-rate/data/Default.aspx

BAPPENAS. (2012). *Sulawesi Island Development Planning.* Ministry of National Development Planning. Jakarta: BAPPENAS.

BAPPENAS. (2015, March 20). Inter-island Maritime Highway Development for Long Term Planning 2015-2019 and Its Implementation in 2014. Jakarta, DKI Jakarta, Indonesia.

Bendul, J. C. (2012). *Performance-oriented Integration of Combined Transport into Supply Chain Concepts.* University of St. Gallen, Management, Economics, Law, Social Sciences, and International Affairs. St. Gallen: University of St. Gallen.

Bergqvist, R., & Wilmsmeier, G. (2013). *Dry Ports - A Global Perspective: Challenges and Developments in Serving Hinterlands.* New York: Routledge.

BPS-Statistics Indonesia. (2015). *Gross Regional Domestic Product in Indonesia.* Jakarta: Statistics Indonesia.

BPS-Statistics of Bitung City. (2014). *Bitung City in Figures.* BPS-Statistics of Bitung City. Bitung: BPS-Statistics of Bitung City.

Bryson, J. M. (2004). What to do when stakeholders matter. *Public Management Review, 6*(1), 22-53.

Cardebring, P. W., & Warnecke, C. (1995). *Combi-terminal and Intermodal Freight Centre Development.* Stockholm: KFB-Swedish Transport and Communication Research Board.

Carvalho, H. D. (2012). *Information Technology Applied to Container Terminals Automation.* Politechnico di Milano, Dipartimento di Ignegneria Gestionale. Milan: Politechnico di Milano.

CE. (2002). *External costs for aviation.* CE. Delft: CE.

Charuka, B. (2014). *Unlocking the landlocked: appraising the economic viability of dry ports for Zimbabwe.* World Maritime University. Malmo: World Maritime University.

CIA. (2014, January 20). *The World Factbook*. Retrieved January 12, 2016, from CIA Website: https://www.cia.gov/library/publications/the-world-factbook/fields/2060.html

Cikarang Dry Port. (2016, January 1). *Tariff Guidelines Cikarang Dry Port.* Retrieved June 22, 2016, from Cikarang Dry Port:

http://www.cikarangdryport.com/upload/download/CDP_Pedoman_Tarif_Terminal_Jan_Jun_2016.pdf

CMA-CGM. (2016, February 4). *Demurrage and Detention Tariffs*. Retrieved from CMA CGM Website: https://www.cma-cgm.com/ebusiness/tariffs/demurrage-detention

Committee of Acceleration and Expansion of Economic Development. (2011, March 12). *Bitung Global Hub*. Retrieved January 14, 2016, from Committee of Acceleration and Expansion of Economic Development: http://kp3ei.go.id/in/main_ind/content2/130/132

Coordinating Ministry for Economic Affairs. (2011). *Masterplan Acceleration and Expansion of Indonesia Economic Development 2011-2025.* Jakarta: Coordinating Ministry for Economic Affairs.

Des Au. (2016, July 1). *Des*. Retrieved August 6, 2016, from Des: http://desdrivingschool.com.au/

Dooms, M., Macharis, C., & Verbeke, A. (2004). *Proactive Stakeholder Management in the Port Planning Process: Empirical Evidence From The Port of Brussels.* Vrije Universiteit Brussel. Brussels: Vrije Universiteit Brussel.

European Comission. (2008). *Guide to Cost-Benefit Analysis of investment projects.* European Comission, Directorate General Regional Policy. Brussels: European Comission.

European Conference of Ministers of Transport. (2003). *Glossary for transport statistics* (3rd Edition ed.). Luxembourg City, Luxembourg: United Nations.

EUROPLATRFORMS. (2004). *Logistics centres: Directions for Use.* EU. Brussels: EUROPLATFORMS EEIG.

Fahmiasari, H. (2015, March 27). Pendulum Nusantara Network Efficiency. *State of Logistics Indonesia 2015*, pp. 20-33.

FDT. (2009). *The Dry Port-Concept and Perspectives.* FDT. Aalborg: FDT.

Febriyanto, D., & Pakpahan, H. (2016, June 21). Construction price in Sulawesi Island. (H. Fahmiasari, Interviewer) Makassar, South Sulawesi, Indonesia.

FIAS. (2008). *Special Economic Zones: Performance, Lessons Learned, and Implications for Zone Development.* World Bank Group, The Multi-Donor Investment Climate Advisory Service. Washington: The World Bank.

Fleming, D. K., & Baird, A. J. (1999). Some reflections on port competition in the United States and Western Europe. *Maritime Policy and Management, 26*(4), 383-394.

Fraser, E. D., Dougill, A. J., Mabee, E. W., Reed, M., & McAlpine, M. (2006, January). Bottom up and top down: Analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *Environmental Management, 78*, 114-127.

Freeman, R. E. (2010). *Strategic Management.* Virginia, USA: Cambridge.

Gan, Y., Duan, Q., Gong, W., Tong, C., Sun, Y., Chu, W., . . . Di, Z. (2014, January). A comprehensive evaluation of various sensitivity analysis methods: A case study with a hydrological model. *Environmental Modelling & Software, 51*, 269-285.

Geogios, C. (2015). *Differences between unimodal and intermodal transportation networks.* Aarhus University, Business and Social Science. Aarhus: Aarhus University.

GHG Protocol. (2005). *Calculating CO2 Emissions From Mobile Sources.* Washington: GHG Protocol.

Handy, S. L., & Niemeier, D. A. (1997). Measuring accessibility: an exploration of issues and alternatives. *Environment and Planning A, 29*, 1175-1194.

Hansen, W. G. (1959). *Accessibility and Residential Growth.* Massachusetts Institute of Technology, Department of City and Regional Planning. Cambridge: Massachusetts Institute of Technology.

Harrison, R., McCray, J. P., Henk, R., & Prozzi, J. (2002). *Inland Port Transportation- - Evaluation Guide.* The University of Texas, Center for Transportation Research. Austin: The University of Texas.

Huang, W. C., & Chu, C. Y. (2004). A selection model for in-terminal container handling systems. *Journal of Marine Science and Technology, 12*(3), 159-170.

Hyundai Heavy Industries. (2015). *Forklift 22/25/30/32/35B-9.* Ulsan: Hyundai Heavy Industries.

Idrus, M., Samang, L., Adisasmita, R., Sitepu, G., & Ramli, M. I. (2012). A Study on the Container Yard Utilization of the Major Ports in Indonesia Eastern Region. *International Journal of Engineering and Technology, 12*(03), 96-100.

Kalmar Global. (2016, February 24). *Reach stacker for intermodal handling*. Retrieved May 10, 2016, from Intermodal handling: https://www.kalmarglobal.com/equipment/reachstackers/intermodal-handling/

Kalyebara, B., & Islam, S. M. (2014). *Corporate Governance, Capital Markets, and Capital Budgeting.* London: Springer.

Katz, D. (2006). *Financing Infrastructure Projects: Public Private Partnership (PPPs).* New Zealand Treasury. Wellington: New Zealand Treasury.

Katz, M. L., & Shapiro, C. (1985, June). Network Externalities, Competition, and Compatibility. *The American Economic Review, 75*(3), 424-440.

Kelly Services. (2016). *2016 Salary Guide.* Kelly Services. Jakarta: Kelly Services.

Kingstar. (2015, September 18). *Zhanjiang Kingstar Vehicle Co., Ltd. HomeAbout UsProductsNewsCertificatesContact Us* . Retrieved August 6, 2016, from Zhanjiang Kingstar Vehicle Co., Ltd. HomeAbout UsProductsNewsCertificatesContact Us :

http://kingstar2004.en.tradevv.com/pid15747348/KINGSTAR+PLUTO+BL1+8Ton+Diesel+Medium+duty+truck.htm

Lam, L. (1988, June). Selecting Container Handling Equipment for Growth. *Terminals Operators Conference* , 1-25.

Lam, L., & Iskounen, A. (2010, March 20). Feeder ports, Inland ports, and Corridors: Time for a closer look. *HTG Yearbook 2010*, pp. 19-23.

Leveque, P., & Roso, V. (2002). *Dry Port Concept for Seaport Inland Access with Intermodal Solutions.* Chalmers University of Technology, Department of Logistics and Transportation. Gothenburg: Chalmers University of Technology.

Levine, N. (2010). *Spatial Statistics Program.* Washington: The National Institute of Justice. Retrieved from Michigan University Education: https://www.icpsr.umich.edu/CrimeStat/files/CrimeStatChapter.14.pdf

Liedl, C. (2011). *Top-down vs Bottom-up.* Universiteit Twente. Twente: Universiteit Twente.

Ligteringen, H., & Velsink, H. (2012). *Ports and Terminals* (1st Edition ed.). Delft, Zuid-Holland, Netherlands: VSSD.

Lipscomb, R. T. (2010). *Strategic criteria for evaluating inland freight hub locations.* Missouri University of Science and Technology, Operations Research, System Engineering, and Industrial Engineering Commons. Missouri: Curtis Laws Wilson Library.

Litman, T., & Fitzroy, S. (2016). *Safe Travels: Evaluating Mobility Management Traffic Safety Impacts.* Victoria Transport Policy Institute. Victoria: Victoria Transport Policy Institute.

Litvinenko, M., & Palšaitis, R. (2005). The Evaluation of Transit Transport Probable Effects on the Development of Country's Economy. *20*(2), 135-140.

Long, S., & Grasman, S. E. (2012, December 7). A strategic decision model for evaluating inland freight hub locations. *Research in Transportation Business & Management*.

Maersk Line. (2014). *The First International Call in Bitung.* Jakarta: Maersk Line.

Mahoney, J. M. (1985). *Intermodal Freight Transportation.* Eno Foundation for Transportation. Connecticut: Westport.

Manado Line. (2016, January 31). *Tertinggi di Sulawesi, UMP Sulut 2016 Rp2,4 Juta*. Retrieved May 10, 2016, from Manado News: http://manadoline.com/tertinggi-di-sulawesi-ump-sulut-2016-rp24-juta/

McNally, M. G. (2007). The Four Step Model. In D. A. Hensher, & K. J. Button, *Handbook of Transport Modeling* (pp. 35-53). Irvine, California, USA: Pergamon.

Meidute, I. (2007, February 1). Economical evaluation of logistics centres establishment. *Transport, XXII*(2), 111-117.

Minister of Transportation. (2011). *Ministry Decree Number 43.* Jakarta: Ministry of Transportation.

Ministry of Finance. (2015). *Informasi APBN 2016.* Direktorat Jenderal Anggaran. Jakarta: Ministry of Finance.

Ministry of Public Works. (2013). *Pengkajian Besaran Biaya Kecelakaan Lalu Lintas Atas Dasar Perhitungan Biaya Korban Kecelakaan .* Ministry of Public Works, Department of Highway and Bridge. Jakarta: Ministry of Public Works.

Ministry of Transportation Indonesia. (2011). *Commodity Flow Survey in Indonesia.* Transportation Ministry of Indonesia, Research and Development Division. Jakarta: Transportation Ministry of Indonesia.

Ministry of Transportation Indonesia. (2011). *National Transportation Origin-Destination Survey of Indonesia.* Jakarta: Transportation Ministry of Indonesia.

Ministry of Transportation. (2013). *Profil dan Kinerja Perhubungan Darat.* Ministry of Transportation, Land Authority Department. Jakarta: Ministry of Transportation.

Ministry of Transportation. (2014). *Executive Summary of Development Study of Bitung Port.* Jakarta: Ministry of Transportation.

Ministry of Transportation. (2014). *Feasibility Study of Gorontalo-Manado Railway Planning.* Railway Department. Jakarta: Ministry of Transportation.

Mitsubishi Motors. (2016, April 28). *Kredit Mitsubishi Colt T120SS*. Retrieved August 6, 2016, from Mitsubishi Bandung: http://www.mitsubishi-bandung.com/kredit-mitsubishi-colt-t120ss.html

Nasirian, A., & Zadeh, F. H. (2013). *Evaluation of Logistics Centers Establishment: Financial and Non-Financial Factors.* Chalmesr University of Technology, Construction Management. Gothenburg: Chalmers University of Technology.

National Board of Special Economic Zones. (2014, October 12). *Bitung Special Economic Zone*. Retrieved January 10, 2016, from National Board of Special Economic Zones: http://kek.ekon.go.id/kek-di-indonesia/bitung/

Notteboom, T. E., & Rodrigue, J. P. (2005). Port regionalization: towards a new phase in port development. *Maritime Policy and Management, 32*(3), 297-313.

Notteboom. (2008). *The relationship between seaports and the inter-modal hinterland in light of global supply chains.* University of Antwerp, ITMMA. Paris: OECD/ITF.

NSW Government. (2008). *Vehicle standards information.* Haymarket: NSW Government Australia.

Oberstart, J. L., & DeFazio, P. A. (2008). *Approaches to mitigate freight congestion.* Washington D.C.: United States Government Accountability Office.

Ortuzar, J. d., & Willumsen, L. G. (2011). *Modelling Transport* (4th Edition ed.). Chichester, West Sussex, United Kingdom: John Wiley and Sons.

Panai, S. (2016, March 14). Trucking cost in Bitung. (H. Fahmiasari, Interviewer) Bitung, North Sulawesi, Indonesia.

Pangemanan, A. (2016, March 13). Potency of North Sulawesi Island. (H. Fahmiasari, Interviewer) Bitung, North Sulawesi, Indonesia.

Patra, S. S., Nayak, N. C., & Mishra, A. (2014, Janury). An Empirical Research on Supply Chain Performance Evaluation of Material Handling Systems in Port Operation. *International Journal of Engineering Research and Technology, 3*(1).

Pelindo IV Bitung. (2016). *Market share of shipping lines.* Bitung: Pelindo IV-Bitung.

Pelindo IV. (2012). *Annual Report Pelindo IV 2012.* Makassar: Pelindo IV.

Pelindo IV. (2012). *Rencana Pengembangan Pelabuhan Makassar, Bitung, Balikpapan, dan Sorong.* PT. Pelabuhan Indonesia IV. Makassar: PT. Pelabuhan Indonesia IV.

Pelindo IV. (2015). *Rencana Peningkatan Kapasitas dan Produktivitas PT Pelabuhan Indonesia IV.* Bitung: Pelindo IV.

Pelindo IV. (2016). *Information and Development Planning of Bitung Port.* Bitung: Pelindo IV.

Pelindo IV. (2016). *Trade Activity in Pelindo IV.* Makassar: Pelindo IV.

Port of Kaohsiung. (2000). *Handling Capacity Comparison of Container Operation Systems.* Taipei: Port of Kaohsiung.

Porter, G. A., & Norton, C. L. (2015). *Financial Accounting: The Impact on Decision Makers* (10th ed.). Boston, USA: Cengage Learning.

Prasetyadi, & Widianto, R. H. (2004, September 7). Bitung as a Future Hub Port in The Eastern Part of Indonesia. *Journees Nationales Genie Civil, VIII*, 839-848.

Presidential Decree. (2014, Agustus 25). Presidential Decree Number 34 Year 2014. Jakarta, DKI Jakarta, Indonesia.

Public Works and Housing Ministry of Indonesia. (2015). *Ministerial Decree Number 248/KPTS/M/2015.* Jakarta: Public Works and Housing Ministry of Indonesia.

Rahimi, M., Asef-Vaziri, A., & Harrison, R. (2008). An Inland Port Location-Allocation Model for a Regional Intermodal Goods Movement System. *Maritime Economics and Logistics, 10*, 362-379.

Road Safety Authority. (2015). *Guidelines on Maximum Weights and Dimensions of Propelled Vehicles and Trailers, Including Manoeuvrability Criteria.* Ballina: RSA.

Rodrigue, J. P., Comtois, C., & Slack, B. (2013). *The Geography of Transport Systems.* London: Routledge.

Rodrigue, J.-P. (2013). *The Geography of Transport Systems.* New York, USA: Routledge.

Roso, V., Woxenius, J., & Lumsden, K. (2008). The dry port concept: connecting container seaports with the hinterland. *Journal of Transport Geography, 17*, 338-345.

Sardi. (2016, March 13). Pelindo IV Container Terminal Bitung. (H. Fahmiasari, Interviewer) Bitung, North Sulawesi, Indonesia.

Shandong Jixin. (2016, April 26). *20 Ton SHACMAN heavy sealed box truck*. Retrieved August 6, 2016, from 20 Ton SHACMAN heavy sealed box truck: http://sdtc.en.alibaba.com/product/478370382-0/20_Ton_SHACMAN_heavy_sealed_box_truck.html

Shandong Shanglong. (2015, June 2). *Shandong Shanglong Economic and Trade Corporation Ltd.* Retrieved August 6, 2016, from Shandong Shanglong Economic and Trade Corporation Ltd.: http://jnshanglong.en.made-in-china.com/product/PeBEywUOkCrL/China-Light-Flatbed-Truck-4-Ton-4X4-Cargo-Truck.html

Sirikijpanichkul, A., Van Dam, K. H., Ferreira, L., & Lukszo, Z. (2007). Optimizing the Location of Intermodal Freight Hubs: An Overview of the Agent Based Modelling Approach. *Journal of Transportation System Engineering and Information Technology, 7*(4), 71-81.

Sjafruddin, A., Lubis, H. A., Frazila, R. B., & Dharmowijoyo, D. (2010). Policy Evaluation of Multimodal Transportation Network: The Case of Inter-island Freight Transportation in Indonesia. *Asian Transport Studies, 1*(1), 18-32.

Sonny, I., Hadiwardoyo, S. P., Susantono, B., & Benabdelhafid, A. (2015, October). The Development of a Freight Distribution Model for Connecting Inter-Island Freight Transport. *International Journal of Technology, 5*, 743-750.

Statistics of North Sulawesi Province. (2015). *North Sulawesi in Figures.* Manado: Statistics of North Sulawesi Province.

Tavasszy, L. A. (1996). *Modelling European Freight Transport Flows.* Delft University of Technology, Transportation Planning and Traffic Engineering. Delft: Delft University of Technology.

Tavasszy, L., Minderhoud, M., Perrin, J. F., & Notteboom, T. (2011). A strategic network choice model for global container flows: specification, estimation, and application. *Journal of Transport Geography, 19*, 1163-1172.

TEMPO. (2016, March 20). *Menteri Susi Larang 'Transhipment', Bos Kapal Curhat ke JK* . Retrieved March 29, 2016, from TEMPO Bisnis: https://m.tempo.co/read/news/2016/03/19/090755106/menteri-susi-larang-transhipment-bos-kapal-curhat-ke-jk

Terminal, I. C. (2016, February 1). *Rates of Service*. Retrieved June 28, 2016, from Ipoh Cargo Terminal Rate: http://www.ictipoh.com.my/index.php?option=com_content&view=article&id=34&Itemid=186

The Asia Foundation. (2008). *The Cost of Moving Goods: Road Transportation, Regulations, and Charges in Indonesia.* The Asia Foundation. Jakarta: The Asia Foundation.

The Jakarta Post. (2015, March 22). *Rethinking Indonesia's global maritime axis*. Retrieved February 13, 2016, from The Jakarta Post: http://www.thejakartapost.com/news/2015/03/22/rethinking-indonesia-s-global-maritime-axis.html

The World Bank. (2001, April 11). *Stakeholder Analysis*. Retrieved May 18, 2016, from Governance and Political Economy: http://www1.worldbank.org/publicsector/anticorrupt/PoliticalEconomy/stakeholderanalysis.htm

The World Bank. (2007, March 3). *Developing Countries Average Unit Road User Costs*. Retrieved May 3, 2016, from The World Bank-Road and Highways: http://go.worldbank.org/VX8U4PQDX0

The World Bank. (2014). *Connectivity for Eastern Indonesia, Opening Up Bitung Port.* The World Bank. Jakarta: The World Bank.

Tsamboulas, D. A., & Kapros, S. (2000). Decision-making process in intermodal transportation. *Transportation Research Record, 1707*, 86-93.

UN ECE. (1998). *UN/LOCODE - Code for Ports and other Locations.* Geneva: Economic Comission for Europe.

UNCTAD. (1991). *Handbook on the Management and Operation of Dry Ports.* Geneva, Switzerland: UNCTAD.

UNESCAP. (2004). *Guidelines for Developing Logistics Centres in Ports.* UNESCAP. Bangkok: UNESCAP.

UNESCAP. (2015, September 8). *Importance of Dry Ports in Integrating Infrastructure Networks.* Retrieved from UNESCAP Files: http://www.unescap.org/sites/default/files/Session%203b%20Importance%20and%20benefits%20of%20Dry%20Ports.pdf

United Nations. (2003). *Cost Benefit Analysis of Transport Infrastructure Projects.* United Nations, Economic Commission for Europe. New York and Geneve: United Nations.

van Diepen, A. P. (2011). *Effects of global long term scenarios on container throughput in the port of Rotterdam: A worldwide modelling approach.* Delft University of Technology, Transport and infrastructure. Delft: Delft University of Technology.

Van Dorsser, C. (2015). *Very Long Term Development of the Dutch Inland Waterway Transport System.* Delft University of Technology, Civil and Geosciences. Delft: TRAIL Research School.

van Duin, R., & van Ham, H. (1998). Three-stage modeling approach for the design and organization of intermodal of transportation services. *International Conference on Systems, Man, and Cybernetics. 4*, pp. 4051-4056. San Diego: IEEE.

Van Nes, R. (2014). *Transportation and spatial planning: Trip distribution.* Delft University Technology, Transportation and Planning. Delft: Delft University of Technology.

Veidenheimer, K. (2014). *Carbon Dioxide Emission in Maritime Container Transport and Comparison of Europeran Deepwater Ports.* Hamburg, Germany: Anchor Academic Publishing.

Vellinga, T. (2011). *Green Ports: Fiction, condition, or foregone conclusion?* Delft University of Technology, Ports and Waterways. Delft: Delft University of Technology.

Verhaeghe, R., Yusuf, A. A., Indriastiwi, F., Halim, R. A., & Tavasszy, L. (2016). *Optimization of the inter-island container transport service : comprehensive design and economic evaluation.* Manila: ADB.

Victoria Transport Policy Institute. (2015). *Transportation Cost and Benefit Analysis II-Evaluating Transportation Benefits.* Victoria Transport Policy Institute. Victoria: Victoria Transport Policy Institute.

Villiers, G. (2015). Inland Intermodal Terminals and Freight Logistics Hubs. *WIT transactions on State of the Art in Science and Engineering, 86*, 123-150.

Wiegmans, B. W., Masurel, E., & Nijkamp, P. (1999). Intermodal Freight Terminals: An Analysis of the Terminal Market . *Transportation Planning and Technology, 23*(2), 229-252.

World Bank Institute. (2000). *Privatization and Regulation of Transport Infrastructure: Guidelines for Policymakers and Regulators.* (A. Estache, & G. de Rus, Eds.) Washington, D.C., USA: The World Bank.

World Bank. (2005). *Road Transport Service Efficiency Study.* World Bank, Energy and Infrastructure Operations Division. Washington: World Bank.

World Bank. (2007, December 30). *Developing Countries Average Unit Road User Costs*. Retrieved August 6, 2016, from The World Bank Data: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTTRANSPORT/EXTROADS HIGHWAYS/0,,contentMDK:20964930~menuPK:1097394~pagePK:148956~piPK:2166 18~theSitePK:338661~isCURL:Y,00.html

Woxenius, J., Roso, V., & Lumsden, K. (2004). *The Dry Port Concept-Connecting Seaports with their Hinterland by Rail.* Chalmers: ICLSP.

Zamparini, L., & Reggiani, A. (2007). Freight Transport and the Value of Travel Time Savings: A Meta Analysis of Empirical Studies. *Transport Reviews, 27*, 621-636.

Zulaihah, L. (2010, December). Analisa Kelayakan Investasi Gudang Material Di PT. IP. *Bina Teknika, 6*(1), 19-40.

APPENDIX

A. Transportation to Hinterland

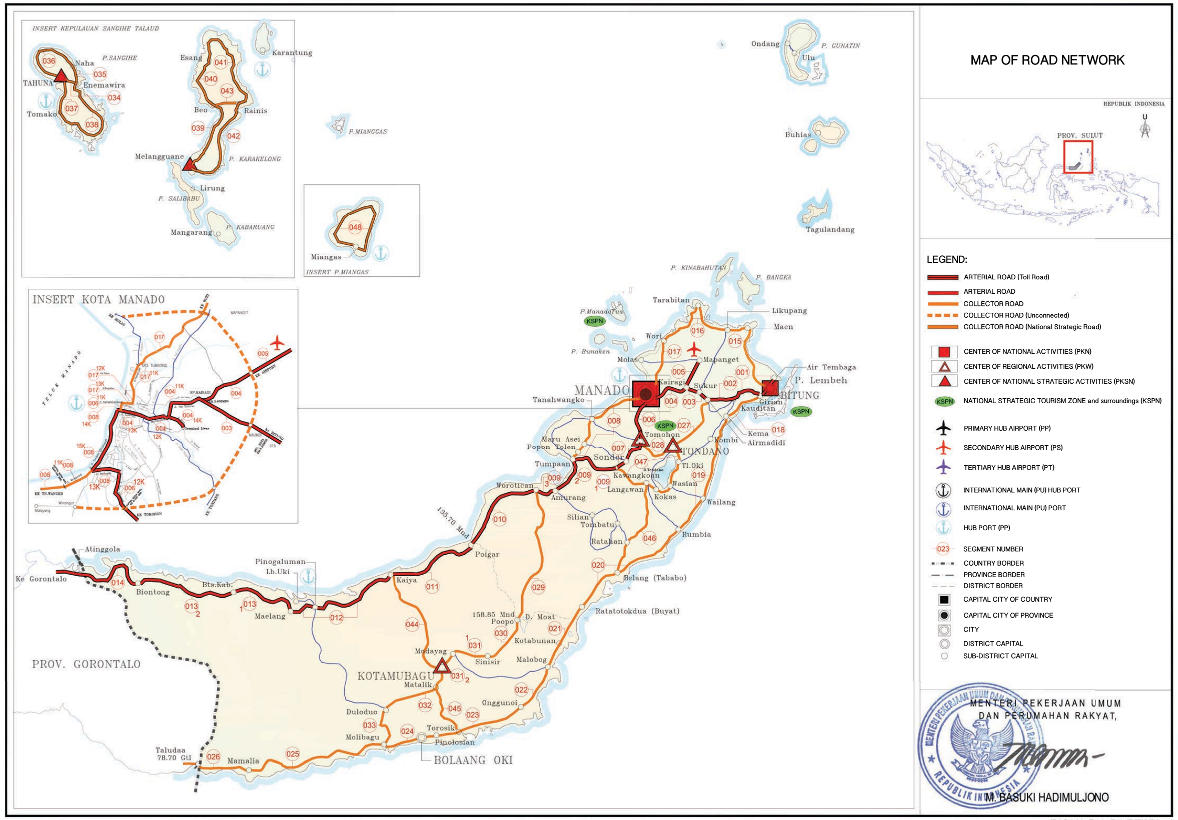

Figure 0-1: Transportation infrastructure in North Sulawesi Province. *Source:* (Public Works and Housing Ministry of Indonesia, 2015)

B. Investment and Operation Cost Data of Truck

Breakdown of vehicle operating costs		Medium Truck	Van	Light Truck	Heavy Truck
Fuel (% of total)	28%	0.06	0.07	0.04	0.09
Lubricants (% of total)	2%	0.00	0.01	0.00	0.01
Tire (% of total)	1%	0.00	0.00	0.00	0.00
Maintenance parts (% of total)	18%	0.04	0.05	0.03	0.06
Maintenance labor (% of total)	1%	0.00	0.00	0.00	0.00
Crew Time (% of total)	10%	0.02	0.03	0.01	0.03
Depreciation (% of total)	27%	0.05	0.07	0.04	0.09
Interest (% of total)	10%	0.02	0.03	0.01	0.03
Overhead (% of total)	2%	0.00	0.01	0.00	0.01
Total vehicle operating costs (€/km)		**0.2**	**0.25**	**0.14**	**0.32**
Total vehicle operating costs (€/ton.km)		**0.06**	**0.25**	**0.09**	**0.03**

Table 0-1: Typical Economic Unit Road User Costs Composition. *Source:* (World Bank, 2007)

- Example of calculation of total vehicle operating cost (medium truck) = 0.2/(8 ton*0.8 ton) = € 0.06/ton.km
  Note: 0.8 is the efficiency coefficient of vehicle usage

C. Data of Road Charges

One way (return empty)

Road Charge (	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung	Tomohon	Kotamobagu
Bitung Port	13.53	3.12	13.53	13.53	3.87	3.87	3.87	13.53	13.53	13.53	13.53	3.12	3.12	3.87	13.53

Two-ways

Road charge	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung	Tomohon	Kotamobagu
Bitung Port	27.06	6.24	27.06	27.06	7.74	7.74	7.74	27.06	27.06	27.06	27.06	6.24	6.24	7.74	27.06068966

Source: (The Asia Foundation, 2008)

D. Distance Matrix

D_{ij} (km)	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung Port	Bitung	Tomohon	Kotamobagu
Lolak	0	159	444	545	109	178	140	122	346	108	126	200	216	209	154	55
Tondano	159	0	275	376	69	21	41	279	177	94	229	31	46	39	11	144
Tahuna	444	275	0	165	309	271	359	474	96	380	634	244	281	274	275	428
Melonguane	545	376	165	0	410	372	460	575	241	481	735	345	382	375	376	529
Amurang	109	69	309	410	0	88	32	228	211	80	188	65	115	108	64	103
Airmadidi	178	21	271	372	88	0	62	296	173	114	285	27	28	21	32	200
Ratahan	140	41	359	460	32	62	0	260	261	57	193	115	88	81	42	108
Boroko	122	279	474	575	228	296	260	0	376	228	194	230	325	318	274	175
Ondong Siau	346	177	96	241	211	173	261	376	0	282	536	146	183	176	177	330
Tutuyan	108	94	380	481	80	114	57	228	282	0	140	136	140	133	95	55
Bolang Uki	126	229	634	735	188	285	193	194	536	140	0	390	314	307	231	85
Manado	200	31	244	345	65	27	115	230	146	136	390	0	49	42	31	184
Bitung	199	39	288	389	108	21	81	311	190	133	307	42	7	7	51	220
Bitung Port	216	46	281	382	115	28	88	325	183	140	314	49	0	0	58	227
Tomohon	154	11	275	376	64	32	42	274	177	95	231	31	58	51	0	146
Kotamobagu	55	144	428	529	103	200	108	175	330	55	85	184	227	220	146	0

Figure 0-2: Data of distance between regional nodes and Bitung Port. ***Source:*** **(Statistics of North Sulawesi Province, 2015)**

intra regional	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung	Tomohon	Kotamobagu
Lolak	37														
Tondano		17													
Tahuna			10												
Melonguane				11											
Amurang					23										
Airmadidi						17									
Ratahan							16								
Boroko								20							
Ondong Siau									5						
Tutuyan										4					
Bolang Uki											28				
Manado												5			
Bitung													4		
Tomohon														3	
Kotamobagu															5

Table 0-2: Data of distance between regional nodes and loading points

Distance between the loading points are assumed equal and based on average distance of six local activities center in each district (Statistics of North Sulawesi Province, 2015).

intra regional	Distance between loading points (km)
Lolak	20
Tondano	12
Tahuna	11
Melonguane	11
Amurang	15
Airmadidi	12
Ratahan	12
Boroko	14
Ondong Siau	11
Tutuyan	11
Bolang Uki	15
Manado	4
Bitung	4
Tomohon	4
Kotamobagu	4

E. Construction of OD matrix

The steps of constructing OD matrix from/to Bitung Port from regional nodes are:

(a) Determine beta value from given OD matrix of North Sulawesi Province by Ministry of Transportation in 2011;

(b) Balancing OD matrix with freight generation and attraction input from Transportation Ministry in 2015 by calculating several sub step:

   a. Define impedance function

   b. Conducting trip distribution process

Determination of Beta Value

Calibrating beta value is required to conduct the gravity model. OD matrix in Table 66 only show the parameterParameter of transport cost can be replaced by distance since the given distance has pictured the real route to be passed by certain trip. All destinations are assumed to have the fixed transport cost per km. Thus, using distance has represented the parameter of transport cost.

If beta value results 0, then the distance parameter (C_{ij}) has no effect. The increase of beta value is proportional with the increase of distance. Therefore, determining beta value as accurate as possible is required. Beta value is the result of solving five equations related to the gravity model below.

$$Outbound\ flow, O_i = \sum_j Tij \tag{13}$$

$$Inbound\ flow, D_j = \sum_i Tij \tag{14}$$

$$\sum_i \sum_j T_{ij} C_{ij} = \sum_i O_i \sum_j C_{ij} \times P_{ij} \tag{15}$$

$$P_{ij} = \frac{D_j e^{-\beta C_{ij}}}{\sum_k D_k e^{-\beta C_{ik}}} \tag{16}$$

Total number of freight trip (T_{ij}) based on directions determine the outbound flow (O_i) and inbound flow (D_j) of certain district. Equation (13) and (14) show the relationship between outbound and inbound flow. Equation (13) shows two parts: the summation of goods flow with their respective transport cost (left side) and the total outgoing flow with total cost parameter multiplied by probability to choose destination (right side). Probability equation is included by parameter of inbound flow (D_j), k is the number of possible destinations to be reached, and impedance function ($e^{-\beta C_{ij}}$) with inclusion of beta value and distance parameters. Probability of trip (P_{ij}) is derived from dividing the utility of certain destination ($D_j e^{-\beta C_{ij}}$) by total utilities for all destinations $\sum_k D_k e^{-\beta C_{ik}}$.

Actual data of OD matrix between regionals inside the North Sulawesi Province from the Ministry of Transportation provides the value of T_{ij}. From that point, deriving the beta values can be solved by iteratively input value of beta:

(i) Input beta value to equation 14,

(ii) Get the result of probability of trip,

(iii) Input the probability trip value to equation 13, whose value of, C_{ij}, and O_i are derived from existing OD and distance matrix,

(iv) Get the result of T_{ij}, if it results the same value of T_{ij} then stop,

(v) Else, back to step (i)

Following above steps, the beta value thus results 0.0034. The beta value is used to determine the impedance function.

Freight generation and attraction

The data of freight and generation are derived from Transportation Ministry in 2015. These figures are used to balancing OD matrix between Bitung Port and regional nodes.

Regional nodes	Freight generation (ton)	Freight attraction (ton)
Lolak	2,991,357	1,740,327
Tondano	8,223,066	7,457,844
Tahuna	1,013,225	1,134,199
Melonguane	735,943	654,090
Amurang	4,694,484	3,649,986
Airmadidi	6,165,549	6,626,610
Ratahan	1,901,576	2,227,891
Boroko	696,979	721,662
Ondong Siau	489,985	573,349
Tutuyan	518,386	534,811
Bolang Uki	575,597	469,168
Manado	8,803,171	11,081,019
Bitung	3,081,110	1,839,115
Bitung Port	3,001,190	3,029,850
Tomohon	3,169,013	3,987,306
Kotamobagu	690,834	1,024,237

Table 0-3: Freight generation and attraction in each regional node in 2015. Source (Minister of Transportation, 2011)

Impedance function

$$F(C_{ij}) = e^{-\beta C_{ij}}$$

Fcij	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung Port	Bitung	Tomohon	Kotamobagu
Lolak	1.00	0.58	0.22	0.16	0.69	0.55	0.62	0.66	0.31	0.69	0.65	0.51	0.48	0.49	0.59	0.83
Tondano	0.58	1.00	0.39	0.28	0.79	0.93	0.87	0.39	0.55	0.73	0.46	0.90	0.86	0.88	0.96	0.61
Tahuna	0.22	0.39	1.00	0.57	0.35	0.40	0.30	0.20	0.72	0.27	0.12	0.44	0.38	0.39	0.39	0.23
Melonguane	0.16	0.28	0.57	1.00	0.25	0.28	0.21	0.14	0.44	0.19	0.08	0.31	0.27	0.28	0.28	0.17
Amurang	0.69	0.79	0.35	0.25	1.00	0.74	0.90	0.46	0.49	0.76	0.53	0.80	0.68	0.69	0.80	0.70
Airmadidi	0.55	0.93	0.40	0.28	0.74	1.00	0.81	0.37	0.56	0.68	0.38	0.91	0.91	0.93	0.90	0.51
Ratahan	0.62	0.87	0.30	0.21	0.90	0.81	1.00	0.41	0.41	0.82	0.52	0.68	0.74	0.76	0.87	0.69
Boroko	0.66	0.39	0.20	0.14	0.46	0.37	0.41	1.00	0.28	0.46	0.52	0.46	0.33	0.34	0.39	0.55
Ondong Siau	0.31	0.55	0.72	0.44	0.49	0.56	0.41	0.28	1.00	0.38	0.16	0.61	0.54	0.55	0.55	0.33
Tutuyan	0.69	0.73	0.27	0.19	0.76	0.68	0.82	0.46	0.38	1.00	0.62	0.63	0.62	0.64	0.72	0.83
Bolang Uki	0.65	0.46	0.12	0.08	0.53	0.38	0.52	0.52	0.16	0.62	1.00	0.27	0.34	0.35	0.46	0.75
Manado	0.51	0.90	0.44	0.31	0.80	0.91	0.68	0.46	0.61	0.63	0.27	1.00	0.85	0.87	0.90	0.53
Bitung	0.51	0.88	0.38	0.27	0.69	0.93	0.76	0.35	0.52	0.64	0.35	0.87	0.98	0.98	0.84	0.47
Bitung Port	0.48	0.86	0.38	0.27	0.68	0.91	0.74	0.33	0.54	0.62	0.34	0.85	1.00	1.00	0.82	0.46
Tomohon	0.59	0.96	0.39	0.28	0.80	0.90	0.87	0.39	0.55	0.72	0.46	0.90	0.82	0.84	1.00	0.61
Kotamobagu	0.83	0.61	0.23	0.17	0.70	0.51	0.69	0.55	0.33	0.83	0.75	0.53	0.46	0.47	0.61	1.00

Trip Distribution: iteration 1

$$T_{ij} = \rho O_i D_j e^{\beta c_{ij}}$$

Iteration 1																	
	Bolaang Mongondow	Minahasa	Kepulauan Sangihe	Kepulauan Talaud	Minahasa Selatan	Minahasa Utara	Minahasa Tenggara	Bolmong Utara	Kep. Sitaro	Bolmong Timur	Bolmong Selatan	Kota Manado	Bitung Port	Kota Bitung	Kota Tomohon	Kota Kotamobagu	Total Production
Bolaang Mongondow	216850	379808	45077	24805	243146	320585	134436	80728	24307	40407	53014	501999	137012	83491	209171	106009	2991357
Minahasa	280595	1448914	177910	97899	618915	1214697	418214	105171	95935	94152	82985	1981285	542600	330643	755708	174030	8223066
Kepulauan Sangihe	22978	122757	97799	43292	59063	112043	30613	11696	27268	7684	4519	207252	52668	32094	66466	14300	1013225
Kepulauan Talaud	15380	82165	52659	71586	39533	74994	20490	7828	15715	5143	3025	138721	35253	21482	44488	9571	735943
Minahasa Selatan	199474	687281	95054	52306	469346	580113	258622	75021	51257	59222	57216	1058571	257378	156838	378505	119989	4694484
Minahasa Utara	203215	1042233	139328	76668	448236	1007877	300830	76688	75130	67956	52996	1551617	445646	271562	543596	111138	6165549
Minahasa Tenggara	72915	307031	32572	17924	170980	257400	117117	27330	17564	26010	22847	362738	114589	69827	165676	47914	1901576
Bolmong Utara	43312	76377	12310	6774	49062	64908	27034	36963	6638	8126	12723	137087	28602	17429	42063	21318	696979
Kep. Sitaro	12576	67185	27676	13113	32325	61322	16755	6401	14823	4206	2473	113430	28825	17565	36377	7826	489985
Bolmong Timur	23368	73702	8718	4797	41747	61999	27734	8759	4701	9075	7864	97083	27601	16819	39770	16492	518386
Bolmong Utara Selatan	34094	72238	5701	3137	44852	53766	27091	15250	3074	8745	19634	63491	23693	14438	38848	23100	575597
Kota Manado	274072	1464179	221973	122146	704471	1336393	365137	139501	119696	91651	53900	2471996	603082	367499	792771	170563	8803171
Kota Bitung	98560	510669	68500	37694	218136	488824	146899	37960	36937	33184	25616	768049	249317	148353	265445	54086	3081110
Bitung Port	91676	491428	69132	38042	209917	470406	141364	35671	37279	31934	24651	739111	251620	149723	255443	52048	3001190
Kota Tomohon	110842	542052	69094	38021	244487	454430	161869	41545	37258	36441	32010	769464	202303	123277	304676	67129	3169013
Kota Kotamobagu	40422	89822	10697	5886	55770	66854	33685	15151	5768	10874	13696	119124	29661	18075	48304	28723	690834
Total Attraction	1740327	7457844	1134199	654090	3649986	6626610	2227891	721662	573349	534811	469168	11081019	3029850	1839115	3987306	1024237	
Recent sum	1740327	7457844	1134199	654090	3649986	6626610	2227891	721662	573349	534811	469168	11081019	3029850	1839115	3987306	1024237	

Iteration 2																	
	Bolaang Mongondow	Minahasa	Kepulauan Sangihe	Kepulauan Talaud	Minahasa Selatan	Minahasa Utara	Minahasa Tenggara	Bolmong Utara	Kep. Sitaro	Bolmong Timur	Bolmong Selatan	Kota Manado	Bitung Port	Kota Bitung	Kota Tomohon	Kota Kotamobagu	Total Production
Bolaang Mongondow	249410	436836	51845	28529	279654	368720	154622	92849	27957	46474	60974	577373	157584	96027	240577	121926	2991357
Minahasa	274043	1415084	173756	95613	604464	1186335	408449	102716	93695	91954	81047	1935025	529931	322923	738063	169966	8223066
Kepulauan Sangihe	25515	136308	108595	48071	65583	124412	33993	12987	30278	8532	5018	230131	58482	35637	73803	15879	1013225
Kepulauan Talaud	17740	94774	60740	82571	45599	86502	23635	9030	18127	5932	3489	160008	40662	24778	51315	11040	735943
Minahasa Selatan	205529	708142	97940	53894	483592	597721	266472	77298	52812	61019	58952	1090701	265190	161599	389993	123631	4694484
Minahasa Utara	195321	1001750	133916	73690	430825	968728	289145	73709	72212	65317	50937	1491348	428336	261014	522481	106822	6165549
Minahasa Tenggara	75749	318964	33838	18620	177625	267404	121669	28392	18247	27021	23735	376836	119043	72541	172115	49776	1901576
Bolmong Utara	51102	90115	14524	7992	57887	76583	31897	43611	7832	9587	15011	161745	33747	20564	49629	25152	696979
Kep. Sitaro	13313	71120	29297	13881	34218	64913	17736	6776	15691	4452	2618	120072	30513	18594	38507	8285	489985
Bolmong Timur	25761	81250	9610	5288	46023	68348	30574	9656	5182	10005	8670	107025	30427	18541	43843	18181	518386
Bolmong Utara Selatan	43498	92164	7274	4003	57224	68597	34563	19457	3922	11158	25050	81004	30228	18420	49564	29472	575597
Kota Manado	259457	1386103	210137	115633	666906	1265132	345667	132062	113313	86764	51026	2340180	570923	347902	750498	161468	8803171
Kota Bitung	95248	493512	66198	36427	210807	472400	141964	36685	35696	32069	24755	742244	240940	143368	256526	52269	3081110
Bitung Port	89057	477390	67157	36955	203921	456968	137326	34652	36214	31021	23946	717997	244432	145446	248146	50561	3001190
Kota Tomohon	108584	531013	67687	37246	239507	445174	158572	40699	36499	35699	31358	753793	198183	120766	298470	65762	3169013
Kota Kotamobagu	47130	104727	12472	6863	65024	77948	39275	17665	6725	12678	15969	138892	34583	21074	56320	33489	690834
Total Attraction	1740327	7457844	1134199	654090	3649986	6626610	2227891	721662	573349	534811	469168	11081019	3029850	1839115	3987306	1024237	

Final OD matrix after five iterations

	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung Port	Bitung	Tomohon	Kotamobagu	Total Production
Lolak	244543	439022	51479	28113	278873	371377	154462	90949	27974	46161	59400	581812	158860	96794	241628	119910	2991357
Tondano	267947	1418209	172048	93956	601097	1191557	406892	100334	93493	91079	78736	1944473	532733	324597	739224	166690	8223066
Tahuna	24979	136782	107664	47298	65300	125117	33906	12702	30251	8462	4881	231547	58866	35867	74013	15592	1013225
Melonguane	17383	95189	60273	81316	45443	87071	23596	8839	18127	5889	3397	161137	40966	24961	51507	10851	735943
Amurang	201144	710365	97067	53009	481345	600910	265702	75575	52747	60495	57324	1097044	266840	162587	390969	121361	4694484
Airmadidi	190922	1003676	132562	72392	428303	972714	287960	71979	72036	64677	49470	1498201	430478	262292	523154	104733	6165549
Ratahan	74118	319902	33530	18311	176765	268777	121293	27754	18221	26784	23075	378953	119760	72970	172512	48852	1901576
Boroko	50124	90601	14427	7879	57747	77164	31876	42735	7840	9526	14629	163051	34033	20737	49865	24746	696979
Ondong Siau	13022	71306	29021	13646	34042	65226	17676	6622	15663	4411	2544	120709	30688	18698	38584	8128	489985
Tutuyan	25224	81545	9529	5204	45831	68746	30501	9445	5178	9924	8434	107700	30631	18664	43974	17856	518386
Bolang Uki	42692	92718	7230	3948	57121	69160	34562	19078	3929	11093	24427	81708	30503	18586	49830	29013	575597
Manado	253615	1388772	208013	113597	663004	1270342	344251	128963	113037	85915	49557	2350942	573780	349607	751466	158311	8803171
Bitung	93095	494417	65523	35782	209555	474302	141369	35821	35606	31752	24040	745589	242124	144058	256834	51242	3081110
Bitung Port	87040	478248	66470	36300	202702	458791	136746	33835	36121	30714	23254	721206	245623	146140	248435	49567	3001190
Tomohon	108278	531859	66981	36578	238027	446860	157871	39731	36398	35338	30445	757009	199108	121318	298757	64455	3169013
Kotamobagu	46203	105235	12382	6762	64832	78497	39228	17301	6728	12591	15554	139937	34857	21239	56557	32930	690834
Total Attraction	1740327	7457844	1134199	654090	3649986	6626610	2227891	721662	573349	534811	469168	11081019	3029850	1839115	3987306	1024237	

For the analysis, only trips from and to Bitung Port, that will be considered. These numbers are highlighted in red.

Empty return trip calculation

From final OD matrix, empty trip can be defined by calculating the difference between outbound and inbound flow of Bitung Port.

Example of calculation or empty return trip between Lolak and Bitung Port

To	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung	Tomohon	Kotamobagu
% of 2-ways trip	71%	95%	94%	94%	86%	97%	93%	99.7%	85%	99%	87%	80%	75%	80%	70%
% of 1-way trip	29%	5%	6%	6%	14%	3%	7%	0.3%	15%	1%	13%	20%	25%	20%	30%
Freight volume of 2-ways trip (ton)	32,640	179,343	22,075	13,612	76,013	161,429	44,910	12,688	11,508	11,497	8,720	215,167	54,802	74,666	13,072
Freight volume of 1-ways trip (ton)	13,466	10,216	1,426	875	12,026	5,309	3,185	37	1,019	15	1,359	27,642	17,997	9,249	2,758

Return empty trips (ton) = Freight trips Lolak to Bitung Port – freight trip Bitung Port to Lolak
= 158,860 – 87,040
= 71,819

Twoways trip (ton) = Total freight trips between Bitung Port and Lolak – return empty trips
= 158,860 + 87,040 – 71,819
= 174,080

% 1-way trip = Return empty trips / total freight trips
= 71,819 / 245,900
= 29%

% 2-ways trip = 1 - % 1-way trip
= 1 – 29%
= 71%

Total % of return empty trips = total return empty trips / total all trips
= 10%

Volume of 2-ways trip = % without liquid * % of share of dry port in 1st year * 2-ways trip
= 0.75 * 0.25 * 174,080
= 32,640

Volume of 1-way trip = % without liquid * % of share of dry port in 1st year * 1-way trip
= 0.75 * -.25 * 71,819
= 13,466

F. Velocity Matrix

Velocity (km/hours)	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung	Tomohon	Kotamobagu
Lolak	1.0	58.0	41.0	41.0	58.0	53.7	56.5	58.0	41.0	56.5	56.5	58.5	50.3	53.0	56.5
Tondano	58.0	1.0	41.0	41.0	55.0	48.0	54.5	56.5	41.0	54.0	54.0	49.5	46.0	55.0	55.0
Tahuna	41.0	41.0	1.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0
Melonguane	41.0	41.0	41.0	1.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0
Amurang	58.0	55.0	41.0	41.0	1.0	51.5	55.0	58.0	41.0	55.0	55.0	59.0	51.5	55.0	55.0
Airmadidi	54.0	48.0	41.0	41.0	51.5	1.0	54.0	53.7	41.0	54.0	54.0	44.0	44.0	48.0	52.7
Ratahan	56.5	54.5	41.0	41.0	55.0	54.0	1.0	55.7	41.0	54.0	54.0	51.5	54.0	55.0	54.5
Boroko	58.0	56.5	41.0	41.0	58.0	53.7	55.7	1.0	41.0	56.5	56.5	58.5	58.5	56.5	56.5
Ondong Siau	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	1.0	41.0	41.0	41.0	41.0	41.0	41.0
Tutuyan	56.5	54.0	41.0	41.0	55.0	54.0	54.0	56.5	41.0	1.0	54.0	51.0	54.0	54.5	54.5
Bolang Uki	56.5	54.0	41.0	41.0	55.0	54.0	54.0	56.5	41.0	54.0	1.0	52.3	54.0	54.5	55.0
Manado	58.5	49.5	41.0	41.0	59.0	44.0	51.5	58.5	41.0	51.0	52.3	1.0	44.0	48.0	51.5
Bitung	50.3	46.0	41.0	41.0	51.5	44.0	54.0	58.5	41.0	54.0	54.0	44.0	1.0	49.5	54.0
Tomohon	53.0	55.0	41.0	41.0	55.0	48.0	55.0	56.5	41.0	54.4	54.5	48.0	49.5	1.0	56.0
Kotamobagu	56.5	55.0	41.0	41.0	55.0	52.7	54.5	56.5	41.0	54.5	55.0	51.5	54.0	56.0	1.0

G. Calculation of Direct Shipment Cost

The calculation is performed by doing several tables to capture the most precise situation. Table I provides the calculation for 2-ways trip. Table Ia overviews the data. To grasp the real condition, the start point in calculation uses the daily flow from Bitung Port to regional node and vice versa. It eases the simulation of calculation for author. Each type of freight vehicle thus will have its frequency and volume daily.

Table Ib provides frequency and volume of each type of freight vehicle. Table Ic provides daily and unit generalized transport cost per freight vehicle. The formula that is used in this table are:

- Daily unit generalized transport cost (GTC) per type of vehicle = VoT * (loading time in port + 2 * travel time Bitung Port-regional + Unloading time in regional node + 2 * travel time regional node to loading point + loading time in loading point + unloading in port) + Transport cost * (2 * distance Bitung Port-regional node + 2 * distance regional node-loading point + 2 * road charge)
- Annual GTC per type of vehicle = daily unit generalized transport cost * annual volume per type of vehicle
- Annual cost 2-ways = annual GTC 2-ways van + annual GTC 2-ways LT + annual GTC MT 2-ways + annual GTC 2-ways HT
- Annual cost 1-way = annual GTC 1-way van + annual GTC 1-way LT + annual GTC 1-way MT + annual GTC 1-way HT

For 1-way trip, there is also table II (a, b, and c) to explain the procedures into final result. It follows the formula and step as mentioned earlier in 2-ways trip.

Both calculation of 2-ways and 1-way are multiplied by each percentage to derive the combined annual GTC. It also results the unit GTC. The result GTC is presented in table III. Examples of calculation are provided afterward.

Table Ia (2-ways trip)

Bitung Port	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung	Tomohon	Kotamobagu
loading time+waiting in Bitung Port (hour)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
2 x distance Bitung Port-regional	432	92	562	764	230	56	176	650	366	280	628	98	14	116	454
2 x distance regional-loading point	74	34	20	22	46	34	32	40	10	8	56	10	8	6	10
2 x travel time Bitung Port-regional (hr)	7.45	2.00	13.71	18.63	3.90	1.22	3.26	11.21	8.93	5.19	11.63	2.23	0.32	2.52	8.25
2 x travel time regional-loading points (hr)	1.28	0.74	0.49	0.54	0.78	0.74	0.59	0.69	0.24	0.15	1.04	0.23	0.18	0.13	0.18
average velocity (km/h)	58	46	41	41	59	46	54	58	41	54	54	44	44	46	55
Road charges (eur/ton)	3.38	0.78	3.38	3.38	0.97	0.97	0.97	3.38	3.38	3.38	3.38	0.78	0.78	0.97	3.38
unloading time in regional node (hr)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
loading cargo in loading point in regional	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
unloading (hour)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
VoT (Eur/Ton/hour)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Table Ib (2 ways trip)

Volume of commodities (ton)	32,640	179,343	22,075	13,612	76,013	161,429	44,910	12,688	11,508	11,497	8,720	215,167	54,802	74,666	13,072
Vans per year (1 ton)	8,160	44,836	5,519	3,403	19,003	40,357	11,227	3,172	2,877	2,874	2,180	53,792	13,701	18,666	3,268
daily volume of commodities by van (ton)	23	128	16	10	54	115	32	9	8	8	6	154	39	53	9
Van frequency per day	29	160	20	12	68	144	40	11	10	10	8	192	49	67	12
Light truck per year (4 ton)	8,486	46,629	5,739	3,539	19,763	41,972	11,677	3,299	2,992	2,989	2,267	55,944	14,249	19,413	3,399
daily volume of commodities by LT (ton)	24	133	16	10	56	120	33	9	9	9	6	160	41	55	10
LT frequency per day	8	42	5	3	18	37	10	3	3	3	2	50	13	17	3
Medium truck per year (8 ton)	8,160	44,836	5,519	3,403	19,003	40,357	11,227	3,172	2,877	2,874	2,180	53,792	13,701	18,666	3,268
daily volume of commodities by MT (ton)	23	128	16	10	54	115	32	9	8	8	6	154	39	53	9
MT frequency per day	4	20	2	2	8	18	5	1	1	1	1	24	6	8	1
Medium truck per year (8 ton)	7,834	43,042	5,298	3,267	18,243	38,743	10,778	3,045	2,762	2,759	2,093	51,640	13,153	17,920	3,137
daily volume of commodities by HT (ton)	22	123	15	9	52	111	31	9	8	8	6	148	38	51	9
HT frequency per day	1	8	1	1	3	7	2	1	1	1	0	10	3	3	1

*LT: light truck; MT: medium truck; HT: heavy truck

Table Ic (2-ways trip)

daily unit GTC per van (eur/ton)	135	34	155	206	73	26	55	182	103	80	180	30	8	34	125
GTC annual all van (euro)	1,103,675	1,544,278	854,537	702,278	1,377,956	1,038,723	622,340	575,961	295,812	231,128	392,765	1,609,143	112,500	631,116	407,598
daily unit GTC per LT (eur/ton)	53	14	61	79	28	11	22	70	42	34	69	12	5	14	50
GTC annual all LT (euro)	452,864	655,200	348,122	280,159	550,290	468,934	254,171	230,618	125,575	101,043	157,494	695,692	66,268	273,061	168,689
daily unit GTC per MT (eur/ton)	37	10	42	54	19	8	15	48	30	25	47	9	4	10	35
GTC annual all MT (euro)	302,188	447,675	231,073	183,056	359,851	333,674	169,025	151,111	85,833	70,441	103,311	481,439	53,992	189,062	113,264
daily unit GTC per HT (eur/ton)	24	7	27	34	12	6	10	30	20	17	30	6	3	7	23
GTC annual all HT (euro)	190,134	292,993	144,068	110,974	218,473	232,390	105,724	92,077	56,210	47,581	63,077	321,528	44,534	126,364	72,022
annual cost 2 - ways	2,048,861	2,940,145	1,577,800	1,276,467	2,506,571	2,073,722	1,151,259	1,049,766	563,430	450,194	716,648	3,107,802	277,294	1,219,603	761,573

Example of calculation

Bitung Port—Lolak—Bitung Port (the first column, example: van)

- Daily unit cost = Daily unit generalized transport cost per type of vehicle = VoT * (loading time in port + 2 * travel time Bitung Port-regional + Unloading time in regional node + 2 * travel time regional node to loading point + loading time in loading point + unloading in port) + Transport cost * (2 * distance Bitung Port-regional node + 2 * distance regional node-loading point + 2 * road charge)
  = 0.11 * (4 + 7.45 + 1 + 1.28 + 1 + 4) + 0.25 * (432 + 74) + 2 * 3.38
  = € 135/ton
- Annual generalized transport cost = daily unit generalized transport cost * annual volume per type of vehicle
  = € 135/ton * 32,640 ton
  = € 1,103,675

Annual GTC 2-ways = annual GTC van + annual GTC LT + annual GTC MT + annual GTC HT
= € 1,103,675 + € 452,864 + € 302,188 + € 190,134
= € 2,048,861

Table IIa (1-way trip)

Bitung Port	Lolak	Tondano	Tahuna	Melonguane	Amurang	Airmadidi	Ratahan	Boroko	Ondong Siau	Tutuyan	Bolang Uki	Manado	Bitung	Tomohon	Kotamobagu
loading time in Bitung Port (hour)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
O-D distance Bitung Port-regional	216	46	281	382	115	28	88	325	183	140	314	49	7	58	227
distance regional-loading point	37	17	10	11	23	17	16	20	5	4	28	5	4	3	5
travel time Bitung Port-regional (hr)	3.72	1.00	6.85	9.32	1.95	0.61	1.63	5.60	4.46	2.59	5.81	1.11	0.16	1.26	4.13
travel time regional-loading points (hr)	0.64	0.37	0.24	0.27	0.39	0.37	0.30	0.34	0.12	0.07	0.52	0.11	0.09	0.07	0.09
average velocity (km/h)	58	46	41	41	59	46	54	58	41	54	54	44	44	46	55
Road charges (eur/ton)	3.38	0.78	3.38	3.38	0.97	0.97	0.97	3.38	3.38	3.38	3.38	0.78	0.78	0.97	3.38
unloading time in regional node (hr)	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
loading time in loading point in regional	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
unloading in port (hour)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
VoT (Eur/Ton/hour)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11

Table IIb (1-way trip)

Volume of commodities (ton)	13466	10216	1426	875	12026	5309	3185	37	1019	15	1359	27642	17997	9249	2758
Vans per year (1 ton)	3367	2554	356	219	3006	1327	796	9	255	4	340	6911	4499	2312	689
daily volume of commodities by van (ton)	10	7	1	1	9	4	2	0	1	0	1	20	13	7	2
Van frequency per day	12	9	1	1	11	5	3	0	1	0	1	25	16	8	2
Light truck per year (4 ton)	3501	2656	371	227	3127	1380	828	10	265	4	353	7187	4679	2405	717
daily volume of commodities by LT (ton)	10	8	1	1	9	4	2	0	1	0	1	21	13	7	2
LT frequency per day	3	2	0	0	3	1	1	0	0	0	0	6	4	2	1
Medium truck per year (8 ton)	3367	2554	356	219	3006	1327	796	9	255	4	340	6911	4499	2312	689
daily volume of commodities by MT (ton)	10	7	1	1	9	4	2	0	1	0	1	20	13	7	2
MT frequency per day	2	1	0	0	1	1	0	0	0	0	0	3	2	1	0
Heavy truck per year (8 ton)	3232	2452	342	210	2886	1274	764	9	244	4	326	6634	4319	2220	662
daily volume of commodities by HT (ton)	9	7	1	1	8	4	2	0	1	0	1	19	12	6	2
HT frequency per day	1	0	0	0	1	0	0	0	0	0	0	1	1	0	0

Table IIc (1-way trip)

daily GTC per van (eur/ton)	68	18	78	104	37	13	28	91	52	41	91	16	5	17	63
GTC annual all van (euro)	229520	45389	27795	22687	110656	17810	22506	850	13234	158	30797	107164	20947	40359	43379
daily GTC per LT (eur/ton)	27	8	31	40	14	6	11	36	22	17	35	7	3	8	25
GTC annual all LT (euro)	95343	20122	11447	9128	45250	8470	9468	344	5704	70	12469	48640	13455	18234	18190
daily GTC per MT (eur/ton)	19	6	21	27	10	5	8	24	15	13	24	5	3	6	18
GTC annual all MT (euro)	64188	14155	7659	6002	30119	6217	6432	227	3939	49	8239	34726	11340	12981	12328
daily GTC per HT (eur/ton)	13	4	14	18	7	4	5	16	11	9	16	4	2	4	12
GTC annual all HT (euro)	40999	9694	4841	3681	18870	4522	4169	140	2622	34	5095	24302	9688	9047	7962
annual cost 1-way	430,050	89,360	51,743	41,498	204,895	37,018	42,575	1,561	25,499	311	56,600	214,832	55,430	80,621	81,859

Example of calculation of van (Bitung Port to Lolak)

- Daily unit cost = Daily unit generalized transport cost per type of vehicle = VoT * (loading time in port + travel time Bitung Port-regional + Unloading time in regional node + travel time regional node to loading point + loading time in loading point + unloading in port) + Transport cost * (distance Bitung Port-regional node + distance regional node-loading point + road charge)
  = 0.11 * (4 + 3.72 + 1 + 1.28 + 1 + 4) + 0.25 * (216 + 37) + 3.38
  = € 68/ton
- Annual generalized transport cost = daily unit generalized transport cost * annual volume per type of vehicle
  = € 68/ton * 13,466 ton
  = € 229,520

Annual GTC 1-way = annual GTC van + annual GTC LT + annual GTC MT + annual GTC HT
= € 229,520 + € 95,343 + € 64,188 + € 40,999
= € 430,050

Table III

Example of calculation of Lolak

- Annual GTC of Lolak = annual GTC 2-ways + annual GTC 1-way
  = € 2,048,861 + € 430,050
  = € 2,478,911
- Combined unit GTC = Annual GTC of Lolak / (volume of 2-ways trip + volume of 1-way trip)
  = (€ 2,048,861 + € 430,050) / (€ 32,640 + € 13,466)
  = € 54/ton

H. Calculation of applying logistics hub

With applying logistics hub, the generalized transport cost model is added by other two costs of logistics hub and the second leg cost. Table IV shows the calculation of 2-ways trip for each regional node. It is split into first and second leg transport. Cost of handling is applied in logistics hub. The handling cost is the same for all district that will be the logistics hub since they use the same volume to be handled. In the second leg, medium truck has additional distance to several loading points. Heavy truck operates as it was in the first place.

The first leg transport uses the heavy truck to transport the goods (20-ton capacity). The second leg transport uses 8-ton capacity to consolidate original van and light truck. The portion of heavy truck operates as existing condition along the first and second leg. In the second leg, the un-consolidation occurs from 20-tons truck into 8-ton.

Table V shows the cost of freight trip portion with 1-way trip. The executed step is the same with table IV. The only difference is the number of trip and only considering the regional nodes who have return empty trip. Example of calculation and formula are explained only for one scheme of logistics node. Other regions follow the calculation and formula.

Table IV (2-ways trip)

To derive into the result per node, volume per vehicle type are calculated in the first place.

Via Lolak

				First leg										
Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	Loading time n Port (hours)	HT unloading time + document checking	MT waiting time+loading in logistics hub (hr)	MT unload + docs checking	HT waiting+load	unit GTC HT (euro/ton)	annual GTC HT (eur)
Bitung Port	Lolak	216	50.3	8.6	93	6	15	4	2	2	1	4	15.2	497188
	Tondano	216	50.3	8.6	512	34	15	4	2	2	1	4	15.2	2731830
	Tahuna	216	50.3	8.6	63	4	15	4	2	2	1	4	15.2	336250
	Melonguane	216	50.3	8.6	39	3	15	4	2	2	1	4	15.2	207350
	Amurang	216	50.3	8.6	217	14	15	4	2	2	1	4	15.2	1157865
	Airmadidi	216	50.3	8.6	461	31	15	4	2	2	1	4	15.2	2458959
	Ratahan	216	50.3	8.6	128	9	15	4	2	2	1	4	15.2	684086
	Boroko	216	50.3	8.6	36	2	15	4	2	2	1	4	15.2	193269
	Ondong Siau	216	50.3	8.6	33	2	15	4	2	2	1	4	15.2	175292
	Tutuyan	216	50.3	8.6	33	2	15	4	2	2	1	4	15.2	175132
	Bolang Uki	216	50.3	8.6	25	2	15	4	2	2	1	4	15.2	132830
	Manado	216	50.3	8.6	615	41	15	4	2	2	1	4	15.2	3277526
	Bitung	216	50.3	8.6	157	10	15	4	2	2	1	4	15.2	834776
	Tomohon	216	50.3	8.6	213	14	15	4	2	2	1	4	15.2	1137341
	Kotamobagu	216	50.3	8.6	37	2	15	4	2	2	1	4	15.2	199112

Example of calculation of Bitung Port to Lolak via Lolak logistics hub:

First leg, Bitung Port—Lolak logistics hub

- Unit GTC HT = VoT * (2 * un/loading time in Bitung Port + 2 * travel time Bitung Port to logistics hub + HT unloading time in logistics hub) + HT transport cost * 2 * distance Bitung Port to logistics hub
  = € 0.11/ton.hour * (2 * 4 hour + 8.6 hour + 2 hour) + € 0.03/ton.km * 2 * 216 km
  = € 15.2/ton
- Annual GTC HT (1st leg) = Unit GTC HT * daily volume HT * 350
  = € 15.2/ton * 93 ton * 350
  = € 497,188

Loading time n Port (hours)	HT unloading time + document checking	MT waiting time+loading in logistics hub (hr)	MT unload + docs checking	HT waiting+load	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
4	2	2	1	4	7	119.626	16	266.343
4	2	2	1	4	7	657.291	16	1.463.437
4	2	2	1	4	7	80.903	16	180.129
4	2	2	1	4	7	49.890	16	111.077
4	2	2	1	4	7	278.588	16	620.267
4	2	2	1	4	7	591.637	16	1.317.261
4	2	2	1	4	7	164.594	16	366.464
4	2	2	1	4	7	46.501	16	103.534
4	2	2	1	4	7	42.176	16	93.904
4	2	2	1	4	7	42.138	16	93.818
4	2	2	1	4	7	31.960	16	71.157
4	2	2	1	4	7	788.589	16	1.755.766
4	2	2	1	4	7	200.851	16	447.188
4	2	2	1	4	7	273.650	16	609.272
4	2	2	1	4	7	47.907	16	106.664

<u>Second leg, Lolak logistics hub to Lolak final destination</u>

- Unit GTC MT (handling) = VoT * (MT waiting and loading time in logistics hub + MT docs checking and unloading time) + unit handling cost
  = € 0.11/ton.hour * (2 hr + 1 hr) + € 7/ton
  = € 7.3/ton
- Annual GTC MT (handling) = unit GTC MT * daily volume of handled freight of MT * 350
  = € 7.3/ton * 46.5 ton * 350
  = € 119,626
- Unit GTC HT (handling) = VoT * 2 * (HT waiting and loading time in logistics hub + HT docs checking and unloading time) + unit handling cost
  = € 0.11/ton.hour * 2 * (4 hr + 2 hr) + € 15/ton
  = € 16/ton
- Annual GTC HT (handling) = unit GTC HT * daily volume of handled freight of HT * 350
  = € 16/ton * 46.5 ton * 350
  = € 266,343

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Lolak	Lolak	0	37	20	0,0	1,3	1	58	1	3,38	1	17	422.660	9	73.515	882.143	1.379.332
	Tondano end	159	17	12	5,5	0,6	1	58	1	0,78	1	26	3.477.634	13	567.836	6.166.198	8.898.027
	Tahuna end	444	10	11	21,7	0,5	1	41	1	3,38	1	64	1.052.056	37	196.764	1.509.852	1.846.102
	Melonguane end	545	11	11	26,6	0,5	1	41	1	3,38	1	75	770.447	44	143.469	1.074.882	1.282.233
	Amurang end	109	23	15	3,8	0,8	1	58	1	0,97	1	22	1.253.899	11	195.483	2.348.237	3.506.103
	Airmadidi end	178	17	12	6,6	0,6	1	54	1	0,97	1	28	3.448.248	15	575.741	5.932.888	8.391.847
	Ratahan end	140	16	12	5,0	0,6	1	56,5	1	0,97	1	24	806.384	12	132.439	1.469.881	2.153.967
	Boroko end	122	20	14	4,2	0,7	1	58	1	3,38	1	28	263.575	16	49.311	462.921	656.190
	Ondong Siau end	346	5	11	16,9	0,2	1	41	1	3,38	1	52	444.566	30	83.681	664.327	839.619
	Tutuyan end	108	4	11	3,8	0,1	1	56,5	1	3,38	1	23	201.903	14	39.346	377.205	552.337
	Bolang Uki end	126	28	15	4,5	1,0	1	56,5	1	3,38	1	29	192.123	17	35.552	330.791	463.622
	Manado end	200	5	4	6,8	0,2	1	58,5	1	0,78	1	27	4.350.918	15	778.033	7.673.306	10.950.831
	Bitung end	209	4	4	8,3	0,2	1	50	1	0,78	1	28	1.151.404	16	206.692	2.006.136	2.840.911
	Tomohon end	154	3	4	5,8	0,1	1	53	1	0,97	1	22	1.224.519	12	222.076	2.329.517	3.466.857
	Kotamobagu end	55	5	4	1,9	0,2	1	57	1	3,38	1	15	151.598	11	34.139	340.308	539.419

- Unit GTC MT (second leg) = VoT * (2 * travel time from logistics hub to regional node + 2 * travel time from regional node to loading point + unloading time in regional node + 5 * loading time in each loading point) + transport cost * (2 * distance between logistics hub and regional node + 2 * additional intra regional distance + 5 * distance between loading points) + 2 * road charges
  = € 0.11/ton.hour * (0 hr + 1.3 hr + 0 hr + 5 * 1 hr) + € 0.06/ton.km * (2 * 0 + 2 * 37 km + 5 * 20 km) + 2 * € 3.38/ton
  = € 17/ton
- Annual GTC MT (second leg) = unit GTC MT * daily volume of MT in second leg * 350
  = € 17/ton * 69.75 ton * 350
  = € 422,660
- Unit GTC HT (second leg)= VoT * (2 * travel time from logistcics hub to regional node + 2 * travel time from regional node to loading point + unloading time in regional node + loading time in each loading point) + transport cost * (2 * distance between logistics hub and regional node + 2 * additional intra regional distance) + 2 * road charges
  = € 0.11/ton.hour * (0 hr + 1.3 hr + 0 hr + 1 hr) + € 0.03/ton.km * (2 * 0 + 2 * 37 km) + 2 * € 3.38/ton
  = € 9/ton
- Annual GTC HT (second leg) = unit GTC HT * daily volume of handled freight of HT * 350
  = € 9/ton * 22.32 ton * 350 = € 73,515

Total annual 2-ways trip Bitung Port to Lolak via Lolak logistics hub

= Annual GTC HT (1st leg) + Annual GTC MT (handling) + Annual GTC HT (handling) + Annual GTC MT (second leg) + Annual GTC HT (second leg)
= € 497,188 + € 119,626 + € 266,343+ € 422,660 + € 73,515
= € 1,379,332

Subsequent regional node performs logistics hub role with only provided with table of calculation.

Via Tondano

First leg

Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Lolak	46	46	2	93	6	15	4,1	134754	7	119.626	16	266.343
Tondano	46	46	2	512	34	15	4,1	740416	7	657.291	16	1.463.437
Tahuna	46	46	2	63	4	15	4,1	91135	7	80.903	16	180.129
Melonguane	46	46	2	39	3	15	4,1	56199	7	49.890	16	111.077
Amurang	46	46	2	217	14	15	4,1	313820	7	278.588	16	620.267
Airmadidi	46	46	2	461	31	15	4,1	666459	7	591.637	16	1.317.261
Ratahan	46	46	2	128	9	15	4,1	185410	7	164.594	16	366.464
Boroko	46	46	2	36	2	15	4,1	52382	7	46.501	16	103.534
Ondong Siau	46	46	2	33	2	15	4,1	47510	7	42.176	16	93.904
Tutuyan	46	46	2	33	2	15	4,1	47466	7	42.138	16	93.818
Bolang Uki	46	46	2	25	2	15	4,1	36001	7	31.960	16	71.157
Manado	46	46	2	615	41	15	4,1	888317	7	788.589	16	1.755.766
Bitung	46	46	2	157	10	15	4,1	226252	7	200.851	16	447.188
Tomohon	46	46	2	213	14	15	4,1	308257	7	273.650	16	609.272
Kotamobagu	46	46	2	37	2	15	4,1	53966	7	47.907	16	106.664

Second leg

Destination	distance of logistics hub to regional	additional distance (milk run)	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Lolak	159	37	20	6,2	3,0	1,0	51,5	1	3,38	1	36	877.873	20	156.359	1.420.201	1.554.956
Tondano end	0	17	12	0,0	1,4	1,0	59	1	0,78	1	8	1.023.930	3	127.843	3.272.502	4.012.918
Tahuna end	285	10	11	13,9	1,6	1,0	41	1	3,38	1	45	746.390	27	141.439	1.148.861	1.239.996
Melonguane end	387	11	11	18,9	1,6	1,0	41	1	3,38	1	57	583.150	34	109.569	853.686	909.885
Amurang end	92	23	15	3,1	1,8	1,0	59	1	0,97	1	20	1.148.123	10	177.278	2.224.256	2.538.075
Airmadidi end	38	17	12	1,6	1,7	1,0	48	1	0,97	1	12	1.505.482	6	227.640	3.642.021	4.308.480
Ratahan end	57	16	12	2,1	1,5	1,0	55	1	0,97	1	14	487.297	7	75.454	1.093.810	1.279.220
Boroko end	299	20	14	10,1	1,6	1,0	59	1	3,38	1	48	458.554	28	84.518	693.107	745.489
Ondong Siau end	182	5	11	8,9	1,3	1,0	41	1	3,38	1	32	280.175	20	53.922	470.177	517.687
Tutuyan end	98	4	11	3,6	1,0	1,0	54	1	3,38	1	22	192.885	14	37.852	366.693	414.159
Bolang Uki end	257	28	15	9,5	2,1	1,0	54	1	3,38	1	45	292.118	26	53.721	448.956	484.957
Manado end	36	5	4	1,5	0,5	1,0	49	1	0,78	1	8	1.311.266	5	232.515	4.088.135	4.976.453
Bitung end	43	4	4	1,7	0,5	1,0	51	1	0,78	1	9	362.180	5	64.266	1.074.485	1.300.737
Tomohon end	14	3	4	0,5	0,4	1,0	55	1	0,97	1	6	319.527	3	59.019	1.261.467	1.569.724
Kotamobagu end	149	5	4	5,4	0,5	1,0	55	1	3,38	1	26	258.406	17	53.443	466.421	520.387

Via Tahuna

First leg

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	281	41	13,7	93	6	15	19,8	645100	7	119.626	16	266.343
	Tondano	281	41	13,7	512	34	15	19,8	3544539	7	657.291	16	1.463.437
	Tahuna	281	41	13,7	63	4	15	19,8	436284	7	80.903	16	180.129
	Melonguane	281	41	13,7	39	3	15	19,8	269036	7	49.890	16	111.077
	Amurang	281	41	13,7	217	14	15	19,8	1502326	7	278.588	16	620.267
	Airmadidi	281	41	13,7	461	31	15	19,8	3190491	7	591.637	16	1.317.261
	Ratahan	281	41	13,7	128	9	15	19,8	887600	7	164.594	16	366.464
	Boroko	281	41	13,7	36	2	15	19,8	250765	7	46.501	16	103.534
	Ondong Siau	281	41	13,7	33	2	15	19,8	227441	7	42.176	16	93.904
	Tutuyan	281	41	13,7	33	2	15	19,8	227233	7	42.138	16	93.818
	Bolang Uki	281	41	13,7	25	2	15	19,8	172347	7	31.960	16	71.157
	Manado	281	41	13,7	615	41	15	19,8	4252578	7	788.589	16	1.755.766
	Bitung	281	41	13,7	157	10	15	19,8	1083118	7	200.851	16	447.188
	Tomohon	281	41	13,7	213	14	15	19,8	1475695	7	273.650	16	609.272
	Kotamobagu	281	41	13,7	37	2	15	19,8	258347	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Tahuna	Lolak	444	37	20	21,7	1,8	1	41	1	3,38	1	69	1.694.247	39	304.988	2.385.204	3.030.304
	Tondano end	275	17	12	13,4	0,8	1	41	1	0,78	1	40	5.338.203	21	911.379	8.370.311	11.914.850
	Tahuna end	0	10	11	0,0	0,5	1	41	1	3,38	1	12	193.040	8	40.526	494.598	930.881
	Melonguane end	165	11	11	8,0	0,5	1	41	1	3,38	1	31	317.086	19	61.011	539.064	808.101
	Amurang end	309	23	15	15,1	1,1	1	41	1	0,97	1	46	2.598.162	24	441.613	3.938.630	5.440.956
	Airmadidi end	271	17	12	13,2	0,8	1	41	1	0,97	1	40	4.793.948	21	824.627	7.527.474	10.717.964
	Ratahan end	359	16	12	17,5	0,8	1	41	1	0,97	1	50	1.676.125	27	291.696	2.498.879	3.386.479
	Boroko end	474	20	14	23,1	1,0	1	41	1	3,38	1	69	657.135	40	121.185	928.355	1.179.121
	Ondong Siau end	96	5	11	4,7	0,2	1	41	1	3,38	1	22	192.417	14	37.820	366.317	593.758
	Tutuyan end	380	4	11	18,5	0,2	1	41	1	3,38	1	55	477.412	32	89.652	703.020	930.253
	Bolang Uki end	634	28	15	30,9	1,4	1	41	1	3,38	1	89	581.860	51	106.642	791.619	963.966
	Manado end	244	5	4	11,9	0,2	1	41	1	0,78	1	32	5.233.783	18	945.944	8.724.082	12.976.660
	Bitung end	274	4	4	13,4	0,2	1	41	1	0,78	1	36	1.472.319	20	266.263	2.386.622	3.469.740
	Tomohon end	275	3	4	13,4	0,1	1	41	1	0,97	1	36	2.027.030	21	369.512	3.279.463	4.755.158
	Kotamobagu end	428	5	4	20,9	0,2	1	41	1	3,38	1	59	579.791	36	112.138	846.501	1.104.848

Via Melonguane

First leg

Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Lolak	382	41	18,6	93	6	15	26,5	864064	7	119.626	16	266.343
Tondano	382	41	18,6	512	34	15	26,5	4747647	7	657.291	16	1.463.437
Tahuna	382	41	18,6	63	4	15	26,5	584370	7	80.903	16	180.129
Melonguane	382	41	18,6	39	3	15	26,5	360354	7	49.890	16	111.077
Amurang	382	41	18,6	217	14	15	26,5	2012255	7	278.588	16	620.267
Airmadidi	382	41	18,6	461	31	15	26,5	4273426	7	591.637	16	1.317.261
Ratahan	382	41	18,6	128	9	15	26,5	1188874	7	164.594	16	366.464
Boroko	382	41	18,6	36	2	15	26,5	335882	7	46.501	16	103.534
Ondong Siau	382	41	18,6	33	2	15	26,5	304640	7	42.176	16	93.904
Tutuyan	382	41	18,6	33	2	15	26,5	304361	7	42.138	16	93.818
Bolang Uki	382	41	18,6	25	2	15	26,5	230846	7	31.960	16	71.157
Manado	382	41	18,6	615	41	15	26,5	5696013	7	788.589	16	1.755.766
Bitung	382	41	18,6	157	10	15	26,5	1450757	7	200.851	16	447.188
Tomohon	382	41	18,6	213	14	15	26,5	1976584	7	273.650	16	609.272
Kotamobagu	382	41	18,6	37	2	15	26,5	346036	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
	Lolak	545	37	20	26,6	1,8	1	41	1	3,38	1	81	1.983.180	46	357.539	2.726.689	3.590.752
	Tondano end	376	17	12	18,3	0,8	1	41	1	0,78	1	51	6.925.764	28	1.200.125	10.246.618	14.994.265
	Tahuna end	165	10	11	8,0	0,5	1	41	1	3,38	1	31	512.269	19	98.587	871.888	1.456.258
	Melonguane end	0	11	11	0,0	0,5	1	41	1	3,38	1	12	120.232	8	25.207	306.406	666.761
	Amurang end	410	23	15	20,0	1,1	1	41	1	0,97	1	57	3.271.038	31	563.996	4.733.888	6.746.143
	Airmadidi end	372	17	12	18,1	0,8	1	41	1	0,97	1	51	6.222.934	28	1.084.532	9.216.365	13.489.790
	Ratahan end	460	16	12	22,4	0,8	1	41	1	0,97	1	62	2.073.671	34	364.002	2.968.731	4.157.605
Melonguane	Boroko end	575	20	14	28,0	1,0	1	41	1	3,38	1	81	769.450	47	141.613	1.061.098	1.396.980
	Ondong Siau end	241	5	11	11,8	0,2	1	41	1	3,38	1	39	338.663	23	64.419	539.163	843.803
	Tutuyan end	481	4	11	23,5	0,2	1	41	1	3,38	1	67	579.187	39	108.163	823.306	1.127.667
	Bolang Uki end	735	28	15	35,9	1,4	1	41	1	3,38	1	101	659.053	58	120.682	882.851	1.113.697
	Manado end	345	5	4	16,8	0,2	1	41	1	0,78	1	44	7.138.467	25	1.292.368	10.975.190	16.671.203
	Bitung end	375	4	4	18,3	0,2	1	41	1	0,78	1	48	1.957.436	27	354.496	2.959.972	4.410.729
	Tomohon end	376	3	4	18,3	0,1	1	41	1	0,97	1	48	2.687.978	27	489.725	4.060.624	6.037.209
	Kotamobagu end	529	5	4	25,8	0,2	1	41	1	3,38	1	71	695.502	42	133.184	983.257	1.329.293

Via Amurang

First leg

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	115	51,5	4,5	93	6	15	8,6	281113	7	119.626	16	266.343
	Tondano	115	51,5	4,5	512	34	15	8,6	1544590	7	657.291	16	1.463.437
	Tahuna	115	51,5	4,5	63	4	15	8,6	190118	7	80.903	16	180.129
	Melonguane	115	51,5	4,5	39	3	15	8,6	117237	7	49.890	16	111.077
	Amurang	115	51,5	4,5	217	14	15	8,6	654663	7	278.588	16	620.267
	Airmadidi	115	51,5	4,5	461	31	15	8,6	1390307	7	591.637	16	1.317.261
	Ratahan	115	51,5	4,5	128	9	15	8,6	386786	7	164.594	16	366.464
	Boroko	115	51,5	4,5	36	2	15	8,6	109275	7	46.501	16	103.534
	Ondong Siau	115	51,5	4,5	33	2	15	8,6	99111	7	42.176	16	93.904
	Tutuyan	115	51,5	4,5	33	2	15	8,6	99020	7	42.138	16	93.818
	Bolang Uki	115	51,5	4,5	25	2	15	8,6	75103	7	31.960	16	71.157
	Manado	115	51,5	4,5	615	41	15	8,6	1853129	7	788.589	16	1.755.766
	Bitung	115	51,5	4,5	157	10	15	8,6	471986	7	200.851	16	447.188
	Tomohon	115	51,5	4,5	213	14	15	8,6	643058	7	273.650	16	609.272
	Kotamobagu	115	51,5	4,5	37	2	15	8,6	112579	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Amurang	Lolak	109	37	20	3,8	1,3	1	58	1	3,38	1	30	730.282	16	128.886	1.245.137	1.526.249
	Tondano end	69	17	12	2,5	0,6	1	55	1	0,78	1	15	2.084.408	7	317.396	4.522.532	6.067.122
	Tahuna end	309	10	11	15,1	0,5	1	41	1	3,38	1	48	790.868	28	149.259	1.201.160	1.391.277
	Melonguane end	410	11	11	20,0	0,5	1	41	1	3,38	1	60	609.385	35	114.175	884.526	1.001.763
	Amurang end	0	23	15	0,0	0,8	1	55	1	0,97	1	9	537.771	4	66.621	1.503.247	2.157.909
	Airmadidi end	88	17	12	3,4	0,7	1	51,5	1	0,97	1	18	2.190.886	9	349.261	4.449.046	5.839.353
	Ratahan end	32	16	12	1,2	0,6	1	55	1	0,97	1	11	386.811	5	56.890	974.760	1.361.546
	Boroko end	228	20	14	7,9	0,7	1	58	1	3,38	1	40	379.864	23	70.243	600.141	709.416
	Ondong Siau end	211	5	11	10,3	0,2	1	41	1	3,38	1	36	308.406	21	58.916	503.401	602.512
	Tutuyan end	80	4	11	2,9	0,1	1	55	1	3,38	1	20	174.121	12	34.353	344.429	443.449
	Bolang Uki end	188	28	15	6,8	1,0	1	55	1	3,38	1	37	239.062	21	44.027	386.205	461.308
	Manado end	65	5	4	2,2	0,2	1	59	1	0,78	1	11	1.839.663	6	326.066	4.710.083	6.563.212
	Bitung end	108	4	4	4,2	0,2	1	51,5	1	0,78	1	16	669.962	9	119.635	1.437.636	1.909.622
	Tomohon end	64	3	4	2,3	0,1	1	55	1	0,97	1	11	641.113	7	116.733	1.640.767	2.283.825
	Kotamobagu end	103	5	4	3,7	0,2	1	55	1	3,38	1	21	206.009	14	43.955	404.535	517.113

Via Airmadidi

First leg

Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Lolak	28	46	1,2	93	6	15	2,9	96074	7	119.626	16	266.343
Tondano	28	46	1,2	512	34	15	2,9	527883	7	657.291	16	1.463.437
Tahuna	28	46	1,2	63	4	15	2,9	64975	7	80.903	16	180.129
Melonguane	28	46	1,2	39	3	15	2,9	40067	7	49.890	16	111.077
Amurang	28	46	1,2	217	14	15	2,9	223739	7	278.588	16	620.267
Airmadidi	28	46	1,2	461	31	15	2,9	475155	7	591.637	16	1.317.261
Ratahan	28	46	1,2	128	9	15	2,9	132189	7	164.594	16	366.464
Boroko	28	46	1,2	36	2	15	2,9	37346	7	46.501	16	103.534
Ondong Siau	28	46	1,2	33	2	15	2,9	33872	7	42.176	16	93.904
Tutuyan	28	46	1,2	33	2	15	2,9	33841	7	42.138	16	93.818
Bolang Uki	28	46	1,2	25	2	15	2,9	25667	7	31.960	16	71.157
Manado	28	46	1,2	615	41	15	2,9	633331	7	788.589	16	1.755.766
Bitung	28	46	1,2	157	10	15	2,9	161307	7	200.851	16	447.188
Tomohon	28	46	1,2	213	14	15	2,9	219773	7	273.650	16	609.272
Kotamobagu	28	46	1,2	37	2	15	2,9	38475	7	47.907	16	106.664

Second leg

Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Lolak	178	37	20	6,6	1,4	1,0	54	1	3,38	1	38	926.495	21	164.410	1.476.874	1.572.947
Tondano end	21	17	12	0,9	0,7	1,0	48	1	0,78	1	10	1.341.723	4	183.946	3.646.398	4.174.281
Tahuna end	271	10	11	13,2	0,5	1,0	41	1	3,38	1	43	717.349	26	135.887	1.114.269	1.179.244
Melonguane end	372	11	11	18,1	0,5	1,0	41	1	3,38	1	55	564.048	32	105.929	830.944	871.011
Amurang end	88	23	15	3,4	0,9	1,0	51,5	1	0,97	1	20	1.118.907	9	171.609	2.189.371	2.413.110
Airmadidi end	0	17	12	0,0	0,7	1,0	51	1	0,97	1	8	957.571	3	126.567	2.993.037	3.468.192
Ratahan end	62	16	12	2,3	0,6	1,0	54	1	0,97	1	15	503.709	7	77.988	1.112.755	1.244.944
Boroko end	296	20	14	11,0	0,7	1,0	54	1	3,38	1	48	455.385	28	83.965	689.385	726.731
Ondong Siau end	173	5	11	8,4	0,2	1,0	41	1	3,38	1	31	270.079	19	51.945	458.104	491.976
Tutuyan end	114	4	11	4,2	0,1	1,0	54	1	3,38	1	24	208.057	15	40.480	384.492	418.334
Bolang Uki end	285	28	15	10,6	1,0	1,0	54	1	3,38	1	48	312.482	27	57.282	472.881	498.548
Manado end	27	5	4	1,2	0,2	1,0	44	1	0,78	1	7	1.139.652	4	201.041	3.885.048	4.518.378
Bitung end	21	4	4	1,0	0,2	1,0	44	1	0,78	1	6	256.749	3	45.123	949.911	1.111.219
Tomohon end	32	3	4	1,3	0,1	1,0	48	1	0,97	1	8	435.294	4	79.795	1.398.010	1.617.784
Kotamobagu end	32	5	4	1,2	0,2	1,0	53	1	3,38	1	13	125.682	9	29.485	309.739	348.214

Via Ratahan

First leg

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	88	54	3,3	93	6	15	6,8	222974	7	119.626	16	266.343
	Tondano	88	54	3,3	512	34	15	6,8	1225143	7	657.291	16	1.463.437
	Tahuna	88	54	3,3	63	4	15	6,8	150798	7	80.903	16	180.129
	Melonguane	88	54	3,3	39	3	15	6,8	92990	7	49.890	16	111.077
	Amurang	88	54	3,3	217	14	15	6,8	519268	7	278.588	16	620.267
	Airmadidi	88	54	3,3	461	31	15	6,8	1102769	7	591.637	16	1.317.261
	Ratahan	88	54	3,3	128	9	15	6,8	306792	7	164.594	16	366.464
	Boroko	88	54	3,3	36	2	15	6,8	86675	7	46.501	16	103.534
	Ondong Siau	88	54	3,3	33	2	15	6,8	78613	7	42.176	16	93.904
	Tutuyan	88	54	3,3	33	2	15	6,8	78541	7	42.138	16	93.818
	Bolang Uki	88	54	3,3	25	2	15	6,8	59570	7	31.960	16	71.157
	Manado	88	54	3,3	615	41	15	6,8	1469871	7	788.589	16	1.755.766
	Bitung	88	54	3,3	157	10	15	6,8	374372	7	200.851	16	447.188
	Tomohon	88	54	3,3	213	14	15	6,8	510063	7	273.650	16	609.272
	Kotamobagu	88	54	3,3	37	2	15	6,8	89296	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Ratahan	Lolak	140	37	20	5,0	1,3	1	56,5	1	3,38	1	33	818.207	18	144.773	1.348.949	1.571.923
	Tondano end	41	17	12	1,5	0,6	1	54,5	1	0,78	1	12	1.649.722	6	239.085	4.009.536	5.234.679
	Tahuna end	359	10	11	17,5	0,5	1	41	1	3,38	1	54	887.604	31	166.853	1.315.490	1.466.288
	Melonguane end	460	11	11	22,4	0,5	1	41	1	3,38	1	66	669.037	38	125.024	955.028	1.048.019
	Amurang end	32	23	15	1,2	0,8	1	55	1	0,97	1	13	748.467	6	104.598	1.751.921	2.271.188
	Airmadidi end	62	17	12	2,3	0,6	1	54	1	0,97	1	15	1.824.581	7	282.852	4.016.331	5.119.099
	Ratahan end	0	16	12	0,0	0,6	1	54	1	0,97	1	8	262.368	3	34.465	827.892	1.134.684
	Boroko end	260	20	14	9,3	0,7	1	56	1	3,38	1	44	415.393	25	76.697	642.126	728.801
	Ondong Siau end	261	5	11	12,7	0,2	1	41	1	3,38	1	42	358.835	25	68.088	563.004	641.617
	Tutuyan end	57	4	11	2,1	0,1	1	54	1	3,38	1	18	151.254	11	30.237	317.446	395.988
	Bolang Uki end	193	28	15	7,1	1,0	1	54	1	3,38	1	37	242.945	21	44.742	390.804	450.375
	Manado end	115	5	4	4,5	0,2	1	52	1	0,78	1	17	2.779.882	10	496.701	5.820.938	7.290.810
	Bitung end	81	4	4	3,0	0,1	1	54	1	0,78	1	13	540.800	7	96.215	1.285.054	1.659.426
	Tomohon end	42	3	4	1,5	0,1	1	55	1	0,97	1	9	498.826	5	91.087	1.472.834	1.982.897
	Kotamobagu end	108	5	4	4,0	0,2	1	55	1	3,38	1	22	211.710	14	44.988	411.270	500.566

Via Boroko

First leg

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	325	58,5	11,1	93	6	15	22,2	723462	7	119.626	16	266.343
	Tondano	325	58,5	11,1	512	34	15	22,2	3975106	7	657.291	16	1.463.437
	Tahuna	325	58,5	11,1	63	4	15	22,2	489280	7	80.903	16	180.129
	Melonguane	325	58,5	11,1	39	3	15	22,2	301717	7	49.890	16	111.077
	Amurang	325	58,5	11,1	217	14	15	22,2	1684819	7	278.588	16	620.267
	Airmadidi	325	58,5	11,1	461	31	15	22,2	3578050	7	591.637	16	1.317.261
	Ratahan	325	58,5	11,1	128	9	15	22,2	995419	7	164.594	16	366.464
	Boroko	325	58,5	11,1	36	2	15	22,2	281227	7	46.501	16	103.534
	Ondong Siau	325	58,5	11,1	33	2	15	22,2	255069	7	42.176	16	93.904
	Tutuyan	325	58,5	11,1	33	2	15	22,2	254835	7	42.138	16	93.818
	Bolang Uki	325	58,5	11,1	25	2	15	22,2	193283	7	31.960	16	71.157
	Manado	325	58,5	11,1	615	41	15	22,2	4769153	7	788.589	16	1.755.766
	Bitung	325	58,5	11,1	157	10	15	22,2	1214688	7	200.851	16	447.188
	Tomohon	325	58,5	11,1	213	14	15	22,2	1654953	7	273.650	16	609.272
	Kotamobagu	325	58,5	11,1	37	2	15	22,2	289729	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Boroko	Lolak	122	37	20	4,2	1,3	1	58	1	3,38	1	31	766.971	17	135.489	1.288.430	2.011.892
	Tondano end	279	17	12	9,9	0,6	1	56,5	1	0,78	1	40	5.342.469	21	904.060	8.367.257	12.342.363
	Tahuna end	474	10	11	23,1	0,5	1	41	1	3,38	1	67	1.110.097	39	207.320	1.578.450	2.067.730
	Melonguane end	575	11	11	28,0	0,5	1	41	1	3,38	1	79	806.239	46	149.978	1.117.184	1.418.901
	Amurang end	228	23	15	7,9	0,8	1	58	1	0,97	1	36	2.036.024	18	336.263	3.271.141	4.955.960
	Airmadidi end	296	17	12	11,0	0,6	1	53,7	1	0,97	1	42	5.099.567	23	873.571	7.882.037	11.460.087
	Ratahan end	260	16	12	9,3	0,6	1	55,7	1	0,97	1	38	1.273.286	20	216.609	2.020.954	3.016.373
	Boroko end	0	20	14	0,0	0,7	1	58	1	3,38	1	14	129.733	8	25.220	304.988	586.215
	Ondong Siau end	376	5	11	18,3	0,2	1	41	1	3,38	1	55	474.824	32	89.184	700.088	955.157
	Tutuyan end	228	4	11	8,1	0,1	1	57	1	3,38	1	37	321.301	22	60.852	518.108	772.944
	Bolang Uki end	194	28	15	6,9	1,0	1	57	1	3,38	1	37	243.439	21	44.795	391.351	584.633
	Manado end	230	5	4	7,9	0,2	1	59	1	0,78	1	30	4.908.894	17	878.445	8.331.694	13.100.847
	Bitung end	318	4	4	10,9	0,1	1	59	1	0,78	1	40	1.662.413	23	297.903	2.608.356	3.823.044
	Tomohon end	274	3	4	9,7	0,1	1	57	1	0,97	1	36	1.997.651	20	361.015	3.241.588	4.896.541
	Kotamobagu end	175	5	4	6,2	0,2	1	57	1	3,38	1	29	287.344	19	58.589	500.504	790.233

Via Ondong Siau

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	183	41	8,9	93	6	15	13,3	432640	7	119.626	16	266.343
	Tondano	183	41	8,9	512	34	15	13,3	2377167	7	657.291	16	1.463.437
	Tahuna	183	41	8,9	63	4	15	13,3	292596	7	80.903	16	180.129
	Melonguane	183	41	8,9	39	3	15	13,3	180431	7	49.890	16	111.077
	Amurang	183	41	8,9	217	14	15	13,3	1007544	7	278.588	16	620.267
	Airmadidi	183	41	8,9	461	31	15	13,3	2139722	7	591.637	16	1.317.261
	Ratahan	183	41	8,9	128	9	15	13,3	595274	7	164.594	16	366.464
	Boroko	183	41	8,9	36	2	15	13,3	168177	7	46.501	16	103.534
	Ondong Siau	183	41	8,9	33	2	15	13,3	152535	7	42.176	16	93.904
	Tutuyan	183	41	8,9	33	2	15	13,3	152395	7	42.138	16	93.818
	Bolang Uki	183	41	8,9	25	2	15	13,3	115586	7	31.960	16	71.157
	Manado	183	41	8,9	615	41	15	13,3	2852017	7	788.589	16	1.755.766
	Bitung	183	41	8,9	157	10	15	13,3	726400	7	200.851	16	447.188
	Tomohon	183	41	8,9	213	14	15	13,3	989684	7	273.650	16	609.272
	Kotamobagu	183	41	8,9	37	2	15	13,3	173262	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Ondong Siau	Lolak	346	37	20	16,9	1,8	1	41	1	3,38	1	58	1.413.896	32	253.998	2.053.862	2.486.503
	Tondano end	177	17	12	8,6	0,8	1	41	1	0,78	1	28	3.797.797	15	631.210	6.549.736	8.926.902
	Tahuna end	96	10	11	4,7	0,5	1	41	1	3,38	1	23	378.773	14	74.307	714.112	1.006.708
	Melonguane end	241	11	11	11,8	0,5	1	41	1	3,38	1	40	407.758	24	77.503	646.228	826.659
	Amurang end	211	23	15	10,3	1,1	1	41	1	0,97	1	34	1.945.273	18	322.865	3.166.993	4.174.537
	Airmadidi end	173	17	12	8,4	0,8	1	41	1	0,97	1	28	3.407.407	15	572.443	5.888.748	8.028.470
	Ratahan end	261	16	12	12,7	0,8	1	41	1	0,97	1	38	1.290.387	21	221.538	2.042.983	2.638.257
	Boroko end	376	20	14	18,3	1,0	1	41	1	3,38	1	58	548.156	33	101.364	799.555	967.733
	Ondong Siau end	0	5	11	0,0	0,2	1	41	1	3,38	1	11	95.591	7	20.209	251.881	404.415
	Tutuyan end	282	4	11	13,8	0,2	1	41	1	3,38	1	44	378.660	26	71.691	586.307	738.702
	Bolang Uki end	536	28	15	26,1	1,4	1	41	1	3,38	1	78	506.961	44	93.019	703.097	818.682
	Manado end	146	5	4	7,1	0,2	1	41	1	0,78	1	21	3.385.674	12	609.809	6.539.838	9.391.855
	Bitung end	176	4	4	8,6	0,2	1	41	1	0,78	1	24	1.001.612	14	180.651	1.830.302	2.556.701
	Tomohon end	177	3	4	8,6	0,1	1	41	1	0,97	1	25	1.385.714	14	252.869	2.521.504	3.511.188
	Kotamobagu end	330	5	4	16,1	0,2	1	41	1	3,38	1	48	467.517	29	91.718	713.807	887.068

Via Tutuyan

First leg

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	140	54	5,2	93	6	15	10,2	333515	7	119.626	16	266.343
	Tondano	140	54	5,2	512	34	15	10,2	1832518	7	657.291	16	1.463.437
	Tahuna	140	54	5,2	63	4	15	10,2	225558	7	80.903	16	180.129
	Melonguane	140	54	5,2	39	3	15	10,2	139091	7	49.890	16	111.077
	Amurang	140	54	5,2	217	14	15	10,2	776699	7	278.588	16	620.267
	Airmadidi	140	54	5,2	461	31	15	10,2	1649476	7	591.637	16	1.317.261
	Ratahan	140	54	5,2	128	9	15	10,2	458887	7	164.594	16	366.464
	Boroko	140	54	5,2	36	2	15	10,2	129645	7	46.501	16	103.534
	Ondong Siau	140	54	5,2	33	2	15	10,2	117586	7	42.176	16	93.904
	Tutuyan	140	54	5,2	33	2	15	10,2	117479	7	42.138	16	93.818
	Bolang Uki	140	54	5,2	25	2	15	10,2	89103	7	31.960	16	71.157
	Manado	140	54	5,2	615	41	15	10,2	2198573	7	788.589	16	1.755.766
	Bitung	140	54	5,2	157	10	15	10,2	559970	7	200.851	16	447.188
	Tomohon	140	54	5,2	213	14	15	10,2	762931	7	273.650	16	609.272
	Kotamobagu	140	54	5,2	37	2	15	10,2	133565	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Tutuyan	Lolak	108	37	20	3,8	1,3	1	56,5	1	3,38	1	30	727.817	16	128.492	1.242.278	1.575.794
	Tondano end	94	17	12	3,5	0,6	1	54	1	0,78	1	18	2.473.881	9	387.752	4.982.362	6.814.880
	Tahuna end	380	10	11	18,5	0,5	1	41	1	3,38	1	56	928.234	33	174.243	1.363.509	1.589.066
	Melonguane end	481	11	11	23,5	0,5	1	41	1	3,38	1	68	694.091	40	129.581	984.639	1.123.731
	Amurang end	80	23	15	2,9	0,8	1	55	1	0,97	1	19	1.064.512	9	161.564	2.124.932	2.901.631
	Airmadidi end	114	17	12	4,2	0,6	1	54	1	0,97	1	21	2.552.164	11	414.061	4.875.124	6.524.600
	Ratahan end	57	16	12	2,1	0,6	1	54	1	0,97	1	14	484.246	7	74.478	1.089.782	1.548.669
	Boroko end	228	20	14	8,1	0,7	1	57	1	3,38	1	40	380.101	23	70.319	600.455	730.100
	Ondong Siau end	282	5	11	13,8	0,2	1	41	1	3,38	1	44	380.016	26	71.941	588.036	705.623
	Tutuyan end	0	4	11	0,0	0,1	1	57	1	3,38	1	11	94.445	7	19.991	250.392	367.871
	Bolang Uki end	140	28	15	5,2	1,0	1	54	1	3,38	1	31	202.886	18	37.518	343.521	432.624
	Manado end	136	5	4	5,3	0,2	1	51	1	0,78	1	20	3.173.151	11	567.849	6.285.355	8.483.927
	Bitung end	133	4	4	4,9	0,1	1	54	1	0,78	1	19	787.803	11	140.758	1.576.600	2.136.570
	Tomohon end	95	3	4	3,5	0,1	1	55	1	0,97	1	15	841.808	9	152.936	1.877.666	2.640.596
	Kotamobagu end	55	5	4	2,0	0,2	1	55	1	3,38	1	15	151.682	11	34.166	340.419	473.983

Via Bolang Uki

First leg

Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Lolak	314	54	11,6	93	6	15	21,6	703403	7	119.626	16	266.343
Tondano	314	54	11,6	512	34	15	21,6	3864889	7	657.291	16	1.463.437
Tahuna	314	54	11,6	63	4	15	21,6	475714	7	80.903	16	180.129
Melonguane	314	54	11,6	39	3	15	21,6	293352	7	49.890	16	111.077
Amurang	314	54	11,6	217	14	15	21,6	1638104	7	278.588	16	620.267
Airmadidi	314	54	11,6	461	31	15	21,6	3478842	7	591.637	16	1.317.261
Ratahan	314	54	11,6	128	9	15	21,6	967819	7	164.594	16	366.464
Boroko	314	54	11,6	36	2	15	21,6	273429	7	46.501	16	103.534
Ondong Siau	314	54	11,6	33	2	15	21,6	247997	7	42.176	16	93.904
Tutuyan	314	54	11,6	33	2	15	21,6	247770	7	42.138	16	93.818
Bolang Uki	314	54	11,6	25	2	15	21,6	187923	7	31.960	16	71.157
Manado	314	54	11,6	615	41	15	21,6	4636919	7	788.589	16	1.755.766
Bitung	314	54	11,6	157	10	15	21,6	1181009	7	200.851	16	447.188
Tomohon	314	54	11,6	213	14	15	21,6	1609066	7	273.650	16	609.272
Kotamobagu	314	54	11,6	37	2	15	21,6	281696	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Bolang Uki	Lolak	126	37	20	4,5	1,3	1	56,5	1	3,38	1	32	778.662	18	137.650	1.302.281	2.005.684
	Tondano end	229	17	12	8,5	0,6	1	54	1	0,78	1	34	4.572.412	18	766.193	7.459.334	11.324.223
	Tahuna end	634	10	11	30,9	0,5	1	41	1	3,38	1	86	1.419.653	50	263.622	1.944.307	2.420.022
	Melonguane end	735	11	11	35,9	0,5	1	41	1	3,38	1	98	997.127	57	184.697	1.342.792	1.636.143
	Amurang end	188	23	15	6,8	0,8	1	55	1	0,97	1	31	1.775.613	16	289.738	2.964.207	4.602.311
	Airmadidi end	285	17	12	10,6	0,6	1	54	1	0,97	1	41	4.944.793	22	845.540	7.699.231	11.178.073
	Ratahan end	193	16	12	7,1	0,6	1	54	1	0,97	1	30	1.013.638	16	169.947	1.714.643	2.682.463
	Boroko end	194	20	14	6,9	0,7	1	57	1	3,38	1	36	342.769	21	63.594	556.398	829.827
	Ondong Siau end	536	5	11	26,1	0,2	1	41	1	3,38	1	74	636.200	43	118.535	890.815	1.138.812
	Tutuyan end	140	4	11	5,2	0,1	1	54	1	3,38	1	27	233.967	16	45.153	415.075	662.844
	Bolang Uki end	0	28	15	0,0	1,0	1	57	1	3,38	1	15	97.037	9	18.425	218.578	406.502
	Manado end	390	5	4	14,9	0,2	1	52	1	0,78	1	49	7.913.017	28	1.423.013	11.880.384	16.517.304
	Bitung end	307	4	4	11,4	0,1	1	54	1	0,78	1	39	1.614.311	22	289.808	2.552.158	3.733.167
	Tomohon end	231	3	4	8,5	0,1	1	55	1	0,97	1	31	1.721.675	17	311.568	2.916.165	4.525.231
	Kotamobagu end	85	5	4	3,1	0,2	1	55	1	3,38	1	19	185.628	13	40.281	380.480	662.176

Via Manado

First leg

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	49	44	2,2	93	6	15	4,3	141549	7	119.626	16	266.343
	Tondano	49	44	2,2	512	34	15	4,3	777748	7	657.291	16	1.463.437
	Tahuna	49	44	2,2	63	4	15	4,3	95730	7	80.903	16	180.129
	Melonguane	49	44	2,2	39	3	15	4,3	59032	7	49.890	16	111.077
	Amurang	49	44	2,2	217	14	15	4,3	329643	7	278.588	16	620.267
	Airmadidi	49	44	2,2	461	31	15	4,3	700062	7	591.637	16	1.317.261
	Ratahan	49	44	2,2	128	9	15	4,3	194758	7	164.594	16	366.464
	Boroko	49	44	2,2	36	2	15	4,3	55023	7	46.501	16	103.534
	Ondong Siau	49	44	2,2	33	2	15	4,3	49905	7	42.176	16	93.904
	Tutuyan	49	44	2,2	33	2	15	4,3	49860	7	42.138	16	93.818
	Bolang Uki	49	44	2,2	25	2	15	4,3	37817	7	31.960	16	71.157
	Manado	49	44	2,2	615	41	15	4,3	933107	7	788.589	16	1.755.766
	Bitung	49	44	2,2	157	10	15	4,3	237660	7	200.851	16	447.188
	Tomohon	49	44	2,2	213	14	15	4,3	323799	7	273.650	16	609.272
	Kotamobagu	49	44	2,2	37	2	15	4,3	56687	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Manado	Lolak	200	37	20	6,8	1,3	1	58,5	1	3,38	1	40	986.917	22	175.052	1.547.938	1.689.487
	Tondano end	31	17	12	1,3	0,7	1	49,5	1	0,78	1	11	1.496.958	5	211.911	3.829.598	4.607.346
	Tahuna end	244	10	11	11,9	0,5	1	41	1	3,38	1	40	665.112	24	126.386	1.052.530	1.148.260
	Melonguane end	345	11	11	16,8	0,5	1	41	1	3,38	1	52	531.836	31	100.070	792.873	851.905
	Amurang end	65	23	15	2,2	0,8	1	59	1	0,97	1	17	964.388	8	143.327	2.006.570	2.336.213
	Airmadidi end	27	17	12	1,2	0,8	1	44	1	0,97	1	11	1.339.794	5	196.116	3.444.808	4.144.871
	Ratahan end	115	16	12	4,5	0,6	1	51,5	1	0,97	1	21	710.889	11	115.472	1.357.419	1.552.178
	Boroko end	230	20	14	7,9	0,7	1	58,5	1	3,38	1	40	381.981	23	70.613	602.629	657.652
	Ondong Siau end	146	5	11	7,1	0,2	1	41	1	3,38	1	28	242.847	17	46.992	425.919	475.824
	Tutuyan end	136	4	11	5,3	0,2	1	51	1	3,38	1	27	230.270	16	44.527	410.752	460.611
	Bolang Uki end	390	28	15	14,9	1,1	1	52,3	1	3,38	1	60	392.206	34	71.710	567.033	604.850
	Manado end	0	5	4	0,0	0,2	1	46	1	0,78	1	4	631.898	2	108.887	3.285.139	4.218.246
	Bitung end	42	4	4	1,9	0,2	1	44	1	0,78	1	9	357.299	5	63.368	1.068.706	1.306.365
	Tomohon end	31	3	4	1,3	0,1	1	48	1	0,97	1	8	428.794	4	78.619	1.390.334	1.714.133
	Kotamobagu end	184	5	4	7,1	0,2	1	51,5	1	3,38	1	30	298.225	19	60.647	513.444	570.131

Via Bitung

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	7	44	0,3	93	6	15	1,6	50996	7	119.626	16	266.343
	Tondano	7	44	0,3	512	34	15	1,6	280202	7	657.291	16	1.463.437
	Tahuna	7	44	0,3	63	4	15	1,6	34489	7	80.903	16	180.129
	Melonguane	7	44	0,3	39	3	15	1,6	21268	7	49.890	16	111.077
	Amurang	7	44	0,3	217	14	15	1,6	118761	7	278.588	16	620.267
	Airmadidi	7	44	0,3	461	31	15	1,6	252213	7	591.637	16	1.317.261
	Ratahan	7	44	0,3	128	9	15	1,6	70166	7	164.594	16	366.464
	Boroko	7	44	0,3	36	2	15	1,6	19823	7	46.501	16	103.534
	Ondong Siau	7	44	0,3	33	2	15	1,6	17980	7	42.176	16	93.904
	Tutuyan	7	44	0,3	33	2	15	1,6	17963	7	42.138	16	93.818
	Bolang Uki	7	44	0,3	25	2	15	1,6	13624	7	31.960	16	71.157
	Manado	7	44	0,3	615	41	15	1,6	336173	7	788.589	16	1.755.766
	Bitung	7	44	0,3	157	10	15	1,6	85622	7	200.851	16	447.188
	Tomohon	7	44	0,3	213	14	15	1,6	116656	7	273.650	16	609.272
	Kotamobagu	7	44	0,3	37	2	15	1,6	20423	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Bitung	Lolak	199	37	20	6,9	1,3	1,0	58	1	3,38	1	40	984.282	22	174.605	1.544.856	1.595.852
	Tondano end	39	17	12	1,7	0,7	1,0	46	1	0,78	1	12	1.624.261	5	235.279	3.980.269	4.260.471
	Tahuna end	288	10	11	14,0	0,5	1,0	41	1	3,38	1	45	750.239	27	141.869	1.153.141	1.187.630
	Melonguane end	389	11	11	19,0	0,5	1,0	41	1	3,38	1	57	584.330	34	109.618	854.915	876.183
	Amurang end	108	23	15	3,7	0,8	1,0	59	1	0,97	1	22	1.246.847	11	194.147	2.339.848	2.458.609
	Airmadidi end	21	17	12	0,9	0,7	1,0	46	1	0,97	1	10	1.254.169	5	180.441	3.343.509	3.595.722
	Ratahan end	81	16	12	3,0	0,6	1,0	54	1	0,97	1	17	577.668	8	91.325	1.200.052	1.270.218
	Boroko end	311	20	14	10,7	0,7	1,0	58	1	3,38	1	49	470.920	28	86.632	707.587	727.411
	Ondong Siau end	190	5	11	9,3	0,2	1,0	41	1	3,38	1	33	287.225	20	55.064	478.369	496.348
	Tutuyan end	133	4	11	4,9	0,1	1,0	54	1	3,38	1	26	226.991	16	43.895	406.841	424.804
	Bolang Uki end	307	28	15	11,4	1,0	1,0	54	1	3,38	1	50	329.110	29	60.281	492.508	506.132
	Manado end	42	5	4	1,9	0,2	1,0	44	1	0,78	1	9	1.421.640	5	252.207	4.218.202	4.554.375
	Bitung end	7	4	4	0,3	0,2	1,0	44	1	0,78	1	5	189.716	3	32.960	870.715	956.337
	Tomohon end	51	3	4	2,2	0,1	1,0	46	1	0,97	1	10	559.401	6	102.336	1.544.658	1.661.314
	Kotamobagu end	220	5	4	8,0	0,2	1,0	55	1	3,38	1	35	338.483	22	67.833	560.887	581.310

Via Tomohon

First leg

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	58	46	2,5	93	6	15	4,9	160541	7	119.626	16	266.343
	Tondano	58	46	2,5	512	34	15	4,9	882104	7	657.291	16	1.463.437
	Tahuna	58	46	2,5	63	4	15	4,9	108575	7	80.903	16	180.129
	Melonguane	58	46	2,5	39	3	15	4,9	66953	7	49.890	16	111.077
	Amurang	58	46	2,5	217	14	15	4,9	373873	7	278.588	16	620.267
	Airmadidi	58	46	2,5	461	31	15	4,9	793995	7	591.637	16	1.317.261
	Ratahan	58	46	2,5	128	9	15	4,9	220891	7	164.594	16	366.464
	Boroko	58	46	2,5	36	2	15	4,9	62406	7	46.501	16	103.534
	Ondong Siau	58	46	2,5	33	2	15	4,9	56602	7	42.176	16	93.904
	Tutuyan	58	46	2,5	33	2	15	4,9	56550	7	42.138	16	93.818
	Bolang Uki	58	46	2,5	25	2	15	4,9	42891	7	31.960	16	71.157
	Manado	58	46	2,5	615	41	15	4,9	1058309	7	788.589	16	1.755.766
	Bitung	58	46	2,5	157	10	15	4,9	269548	7	200.851	16	447.188
	Tomohon	58	46	2,5	213	14	15	4,9	367246	7	273.650	16	609.272
	Kotamobagu	58	46	2,5	37	2	15	4,9	64293	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)
Tomohon	Lolak	154	37	20	6,0	1,4	1,0	51,5	1	3,38	1	35	859.521	19	152.461	1.397.951	1.558.493
	Tondano end	11	17	12	0,4	0,6	1,0	55	1	0,78	1	9	1.183.395	4	154.991	3.459.114	4.341.218
	Tahuna end	275	10	11	13,4	0,5	1,0	41	1	3,38	1	44	725.088	26	137.295	1.123.415	1.231.990
	Melonguane end	376	11	11	18,3	0,5	1,0	41	1	3,38	1	56	568.821	33	106.797	836.584	903.538
	Amurang end	64	23	15	2,3	0,8	1,0	55	1	0,97	1	17	959.164	8	142.576	2.000.595	2.374.468
	Airmadidi end	32	17	12	1,2	0,7	1,0	51,5	1	0,97	1	12	1.405.995	5	207.529	3.522.422	4.316.417
	Ratahan end	42	16	12	1,5	0,6	1,0	55	1	0,97	1	13	425.712	6	63.902	1.020.673	1.241.563
	Boroko end	274	20	14	9,3	0,7	1,0	59	1	3,38	1	45	430.149	26	79.268	659.452	721.859
	Ondong Siau end	177	5	11	8,6	0,2	1,0	41	1	3,38	1	32	274.113	19	52.679	462.872	519.474
	Tutuyan end	95	4	11	3,5	0,1	1,0	54	1	3,38	1	22	189.122	13	37.066	362.144	418.693
	Bolang Uki end	231	28	15	8,6	1,0	1,0	54	1	3,38	1	42	271.667	24	49.922	424.705	467.596
	Manado end	31	5	4	1,3	0,2	1,0	49	1	0,78	1	8	1.211.885	4	213.737	3.969.976	5.028.285
	Bitung end	51	4	4	2,2	0,2	1,0	46	1	0,78	1	10	399.901	5	71.029	1.118.969	1.388.517
	Tomohon end	0	3	4	0,0	0,1	1,0	55	1	0,97	1	4	227.189	2	42.125	1.152.235	1.519.481
	Kotamobagu end	146	5	4	5,3	0,2	1,0	55	1	3,38	1	26	254.696	17	52.731	461.998	526.291

Via Kotamobagu

First leg

Origin	Final destination	distance (km)	velocity (km/h)	2 x travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	227	54	8.4	93	6	15	15.9	518459	7	119.626	16	266.343
	Tondano	227	54	8.4	512	34	15	15.9	2848704	7	657.291	16	1.463.437
	Tahuna	227	54	8.4	63	4	15	15.9	350636	7	80.903	16	180.129
	Melonguane	227	54	8.4	39	3	15	15.9	216221	7	49.890	16	111.077
	Amurang	227	54	8.4	217	14	15	15.9	1207402	7	278.588	16	620.267
	Airmadidi	227	54	8.4	461	31	15	15.9	2564159	7	591.637	16	1.317.261
	Ratahan	227	54	8.4	128	9	15	15.9	713353	7	164.594	16	366.464
	Boroko	227	54	8.4	36	2	15	15.9	201537	7	46.501	16	103.534
	Ondong Siau	227	54	8.4	33	2	15	15.9	182792	7	42.176	16	93.904
	Tutuyan	227	54	8.4	33	2	15	15.9	182624	7	42.138	16	93.818
	Bolang Uki	227	54	8.4	25	2	15	15.9	138513	7	31.960	16	71.157
	Manado	227	54	8.4	615	41	15	15.9	3417746	7	788.589	16	1.755.766
	Bitung	227	54	8.4	157	10	15	15.9	870489	7	200.851	16	447.188
	Tomohon	227	54	8.4	213	14	15	15.9	1185999	7	273.650	16	609.272
	Kotamobagu	227	54	8.4	37	2	15	15.9	207630	7	47.907	16	106.664

Second leg

Origin	Destination	distance	additional distance	distance between loading points (km)	2 x Travel time from hub to regional (hr)	2 x Travel time from regional to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Kotamobagu	Lolak	55	37	20	1.9	1.3	1	56.5	1	3.38	1	24	578,109	13	101,527
	Tondano end	144	17	12	5.2	0.6	1	55	1	0.78	1	24	3,249,511	12	527,402
	Tahuna end	428	10	11	20.9	0.5	1	41	1	3.38	1	62	1,021,100	36	191,134
	Melonguane end	529	11	11	25.8	0.5	1	41	1	3.38	1	74	751,358	43	139,997
	Amurang end	103	23	15	3.7	0.8	1	55	1	0.97	1	21	1,215,951	10	188,861
	Airmadidi end	200	17	12	7.6	0.6	1	52.7	1	0.97	1	31	3,758,115	16	631,907
	Ratahan end	108	16	12	4.0	0.6	1	54.5	1	0.97	1	20	682,612	10	110,229
	Boroko end	175	20	14	6.2	0.7	1	57	1	3.38	1	34	321,906	20	59,837
	Ondong Siau end	330	5	11	16.1	0.2	1	41	1	3.38	1	50	428,429	29	80,746
	Tutuyan end	55	4	11	2.0	0.1	1	55	1	3.38	1	17	149,242	11	29,871
	Bolang Uki end	85	28	15	3.1	1.0	1	55	1	3.38	1	25	161,261	14	30,004
	Manado end	184	5	4	7.1	0.2	1	52	1	0.78	1	25	4,068,921	14	729,470
	Bitung end	220	4	4	8.1	0.1	1	54	1	0.78	1	29	1,201,057	16	215,283
	Tomohon end	146	3	4	5.2	0.1	1	56	1	0.97	1	21	1,170,856	12	212,135
	Kotamobagu end	0	5	4	0.0	0.2	1	54	1	3.38	1	9	89,389	7	22,935

Table Va (1-way trip and total)

Via Lolak

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)
Bitung Port	Lolak	216	50.3	4.3	38	3	15	7.5	101080
	Tondano	216	50.3	4.3	29	2	15	7.5	76684
	Tahuna	216	50.3	4.3	4	0	15	7.5	10703
	Melonguane	216	50.3	4.3	2	0	15	7.5	6567
	Amurang	216	50.3	4.3	34	2	15	7.5	90269
	Airmadidi	216	50.3	4.3	15	1	15	7.5	39849
	Ratahan	216	50.3	4.3	9	1	15	7.5	23907
	Boroko	216	50.3	4.3	0	0	15	7.5	280
	Ondong Siau	216	50.3	4.3	3	0	15	7.5	7647
	Tutuyan	216	50.3	4.3	0	0	15	7.5	116
	Bolang Uki	216	50.3	4.3	4	0	15	7.5	10203
	Manado	216	50.3	4.3	79	5	15	7.5	207490
	Bitung	216	50.3	4.3	51	3	15	7.5	135089
	Tomohon	216	50.3	4.3	26	2	15	7.5	69422
	Kotamobagu	216	50.3	4.3	8	1	15	7.5	20702

Example of calculation of Bitung Port to Lolak via Lolak logistics hub:

<u>First leg, Bitung Port to Lolak logistics hub</u>

- Unit GTC HT = VoT * (loading time in Bitung Port + travel time Bitung Port to logistics hub) + HT transport cost * distance Bitung Port to logistics hub
  = € 0.11/ton.hour * (4 hour + 4.3 hour) + € 0.03/ton.km * 216 km
  = € 7.5/ton
- Annual GTC HT (1st leg) = Unit GTC HT * daily volume HT * 350
  = € 7.5/ton * 38 ton * 350
  = € 101,080

Second leg, Lolak logistics hub to Lolak final destination

- Unit GTC MT (handling) = VoT * (MT waiting and loading time in logistics hub) + unit handling cost
  = € 0.11/ton.hour * (2 hr) + € 7/ton
  = € 7.3/ton
- Annual GTC MT (handling) = unit GTC MT * daily volume of handled freight of MT * 350
  = € 7.3/ton *67 ton * 350
  = € 24,306
- Unit GTC HT (handling) = VoT * (HTT waiting and loading time in logistics hub + HT docs checking and unloading time) + unit handling cost
  = € 0.11/ton.hour * (4 hr + 2 hr) + € 15/ton
  = € 16/ton
- Annual GTC HT (handling) = unit GTC HT * daily volume of handled freight of HT * 350
  = € 105,769

HT unloading time + document checking	MT waiting time+loading in logistics hub (hr)	MT unload + docs checking	HT waiting+load	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
2	2	1	4	7	24.306	16	105.769
2	2	1	4	7	18.440	16	80.241
2	2	1	4	7	2.574	16	11.200
2	2	1	4	7	1.579	16	6.871
2	2	1	4	7	21.707	16	94.457
2	2	1	4	7	9.582	16	41.697
2	2	1	4	7	5.749	16	25.016
2	2	1	4	7	67	16	292
2	2	1	4	7	1.839	16	8.002
2	2	1	4	7	28	16	121
2	2	1	4	7	2.453	16	10.676
2	2	1	4	7	49.895	16	217.115
2	2	1	4	7	32.485	16	141.356
2	2	1	4	7	16.694	16	72.643
2	2	1	4	7	4.978	16	21.662

Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Lolak	0	37	20	0,0	0,6	1	58	1	3,38	1	6	56.814	5	15.165	202.054	303.134	1.682.466
Tondano end	159	17	12	2,7	0,3	1	58	1	0,78	1	11	84.550	7	16.173	199.404	276.088	9.174.116
Tahuna end	444	10	11	10,8	0,2	1	41	1	3,38	1	30	32.104	19	6.355	52.232	62.935	1.909.038
Melonguane end	545	11	11	13,3	0,3	1	41	1	3,38	1	36	23.607	22	4.610	36.667	43.234	1.325.467
Amurang end	109	23	15	1,9	0,4	1	58	1	0,97	1	9	78.349	5	15.464	209.977	300.246	3.806.349
Airmadidi end	178	17	12	3,3	0,3	1	54	1	0,97	1	12	49.165	7	9.467	109.912	149.760	8.541.607
Ratahan end	140	16	12	2,5	0,3	1	56,5	1	0,97	1	10	24.074	6	4.696	59.535	83.442	2.237.410
Boroko end	122	20	14	2,1	0,3	1	58	1	3,38	1	12	326	8	72	758	1.038	657.227
Ondong Siau end	346	5	11	8,4	0,1	1	41	1	3,38	1	24	18.338	15	3.704	31.883	39.530	879.149
Tutuyan end	108	4	11	1,9	0,1	1	56,5	1	3,38	1	10	115	7	26	291	407	552.744
Bolang Uki end	126	28	15	2,2	0,5	1	56,5	1	3,38	1	12	12.618	8	2.771	28.518	38.721	502.343
Manado end	200	5	4	3,4	0,1	1	58,5	1	0,78	1	13	263.362	8	49.977	580.348	787.839	11.738.670
Bitung end	209	4	4	4,2	0,1	1	50	1	0,78	1	13	178.565	8	33.939	386.344	521.433	3.362.345
Tomohon end	154	3	4	2,9	0,1	1	53	1	0,97	1	10	70.446	6	13.754	173.537	242.959	3.709.816
Kotamobagu end	55	5	4	1,0	0,1	1	57	1	3,38	1	7	14.385	5	3.601	44.626	65.328	604.747

- Unit GTC MT (second leg) = VoT * (travel time from logistics hub to regional node + travel time from regional node to loading point + unloading time in regional node) + transport cost * (distance between logistics hub and regional node + additional intra regional distance) + Road charges
  = € 0.11/ton.hour * (0 hr + 0.6 hr) + € 0.06/ton.km * (0 + 37 km) + € 3.38/ton
  = € 6/ton
- Annual GTC MT (second leg) = unit GTC MT * daily volume of MT in second leg * 350
  = € 56,814
- Unit GTC HT (second leg)= VoT * (travel time from logistcics hub to regional node + travel time from regional node to loading point + unloading time in regional node) + transport cost * (distance between logistics hub and regional node + additional intra regional distance) + road charges
  = € 0.11/ton.hour * (0 hr + 0.6 hr + 0 hr + 1 hr) + € 0.03/ton.km * (0 + 37 km) + € 3.38/ton
  = € 5/ton
- Annual GTC HT (second leg) = unit GTC HT * daily volume of handled freight of HT * 350
  = € 15,165

Total annual GTC 1-way trip Bitung Port to Lolak via Lolak logistics hub

= Annual GTC HT (1st leg) + Annual GTC MT (handling) + Annual GTC HT (handling) + Annual GTC MT (second leg) + Annual GTC HT (second leg)
= € 101,080 + € 24,306 + € 105,769+ € 56,814 + € 15,165
= € 303,134

Total annual GTC Bitung Port to Lolak via Lolak logistics hub

= Total annual 1-ways trip Bitung Port to Lolak via Lolak logistics hub + Total annual 2-ways trip Bitung Port to Lolak via Lolak logistics hub
= € 1,372,151 + € 303,134 = € 1,682,466

Via Tondano

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	46	46	1	38	3	15	2.0	26316	7	24.306	16	105.769
	Tondano	46	46	1	29	2	15	2.0	19965	7	18.440	16	80.241
	Tahuna	46	46	1	4	0	15	2.0	2787	7	2.574	16	11.200
	Melonguane	46	46	1	2	0	15	2.0	1710	7	1.579	16	6.871
	Amurang	46	46	1	34	2	15	2.0	23502	7	21.707	16	94.457
	Airmadidi	46	46	1	15	1	15	2.0	10375	7	9.582	16	41.697
	Ratahan	46	46	1	9	1	15	2.0	6224	7	5.749	16	25.016
	Boroko	46	46	1	0	0	15	2.0	73	7	67	16	292
	Ondong Siau	46	46	1	3	0	15	2.0	1991	7	1.839	16	8.002
	Tutuyan	46	46	1	0	0	15	2.0	30	7	28	16	121
	Bolang Uki	46	46	1	4	0	15	2.0	2656	7	2.453	16	10.676
	Manado	46	46	1	79	5	15	2.0	54020	7	49.895	16	217.115
	Bitung	46	46	1	51	3	15	2.0	35171	7	32.485	16	141.356
	Tomohon	46	46	1	26	2	15	2.0	18074	7	16.694	16	72.643
	Kotamobagu	46	46	1	8	1	15	2.0	5390	7	4.978	16	21.662

Second leg

Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Lolak	159	37	20	3,1	0,7	1,0	51,5	1	3,38	1	15	149.854	10	31.978	311.907	338.223	1.893.179
Tondano end	0	17	12	0,0	0,3	1,0	59	1	0,78	1	2	14.321	1	3.532	116.534	136.498	4.149.416
Tahuna end	285	10	11	7,0	0,2	1,0	41	1	3,38	1	21	22.169	13	4.548	40.490	43.276	1.283.272
Melonguane end	387	11	11	9,4	0,3	1,0	41	1	3,38	1	27	17.550	17	3.508	29.508	31.218	941.102
Amurang end	92	23	15	1,6	0,4	1,0	59	1	0,97	1	8	69.478	5	13.862	199.503	223.005	2.761.080
Airmadidi end	38	17	12	0,8	0,4	1,0	48	1	0,97	1	4	17.001	3	3.673	71.954	82.328	4.390.808
Ratahan end	57	16	12	1,0	0,3	1,0	55	1	0,97	1	5	12.644	3	2.639	46.048	52.273	1.331.493
Boroko end	299	20	14	5,1	0,3	1,0	59	1	3,38	1	22	611	14	124	1.094	1.167	746.656
Ondong Siau end	182	5	11	4,4	0,1	1,0	41	1	3,38	1	14	11.017	10	2.372	23.230	25.220	542.908
Tutuyan end	98	4	11	1,8	0,1	1,0	54	1	3,38	1	9	109	7	25	283	314	414.473
Bolang Uki end	257	28	15	4,8	0,5	1,0	54	1	3,38	1	20	20.349	13	4.167	37.645	40.301	525.259
Manado end	36	5	4	0,7	0,1	1,0	49	1	0,78	1	3	67.738	2	14.816	349.565	403.585	5.380.037
Bitung end	43	4	4	0,8	0,1	1,0	51	1	0,78	1	4	48.743	2	10.478	233.061	268.231	1.568.968
Tomohon end	14	3	4	0,3	0,1	1,0	55	1	0,97	1	2	14.286	2	3.620	107.242	125.316	1.695.040
Kotamobagu end	149	5	4	2,7	0,1	1,0	55	1	3,38	1	12	25.619	9	5.627	57.887	63.277	583.663

Via Tahuna

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	281	41	6.9	38	3	15	19.0	255993	7	24.306	16	105.769
	Tondano	281	41	6.9	29	2	15	19.0	194209	7	18.440	16	80.241
	Tahuna	281	41	6.9	4	0	15	19.0	27107	7	2.574	16	11.200
	Melonguane	281	41	6.9	2	0	15	19.0	16631	7	1.579	16	6.871
	Amurang	281	41	6.9	34	2	15	19.0	228615	7	21.707	16	94.457
	Airmadidi	281	41	6.9	15	1	15	19.0	100920	7	9.582	16	41.697
	Ratahan	281	41	6.9	9	1	15	19.0	60547	7	5.749	16	25.016
	Boroko	281	41	6.9	0	0	15	19.0	708	7	67	16	292
	Ondong Siau	281	41	6.9	3	0	15	19.0	19366	7	1.839	16	8.002
	Tutuyan	281	41	6.9	0	0	15	19.0	294	7	28	16	121
	Bolang Uki	281	41	6.9	4	0	15	19.0	25839	7	2.453	16	10.676
	Manado	281	41	6.9	79	5	15	19.0	525486	7	49.895	16	217.115
	Bitung	281	41	6.9	51	3	15	19.0	342125	7	32.485	16	141.356
	Tomohon	281	41	6.9	26	2	15	19.0	175818	7	16.694	16	72.643
	Kotamobagu	281	41	6.9	8	1	15	19.0	52429	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Tahuna	Lolak	444	37	20	10,8	0,9	1	41	1	3,38	1	32	319.120	19	62.914	512.109	768.102	3.798.406
	Tondano end	275	17	12	6,7	0,4	1	41	1	0,78	1	18	137.543	11	25.958	262.181	456.390	12.371.240
	Tahuna end	0	10	11	0,0	0,2	1	41	1	3,38	1	4	4.360	4	1.309	19.442	46.549	977.430
	Melonguane end	165	11	11	4,0	0,3	1	41	1	3,38	1	14	9.039	9	1.960	19.450	36.080	844.181
	Amurang end	309	23	15	7,5	0,6	1	41	1	0,97	1	20	184.686	12	34.933	335.784	564.398	6.005.354
	Airmadidi end	271	17	12	6,6	0,4	1	41	1	0,97	1	18	71.292	11	13.559	136.131	237.052	10.955.016
	Ratahan end	359	16	12	8,8	0,4	1	41	1	0,97	1	23	54.915	14	10.343	96.023	156.570	3.543.049
	Boroko end	474	20	14	11,6	0,5	1	41	1	3,38	1	32	904	20	178	1.441	2.149	1.181.270
	Ondong Siau end	96	5	11	2,3	0,1	1	41	1	3,38	1	9	7.178	7	1.674	18.692	38.058	631.816
	Tutuyan end	380	4	11	9,3	0,1	1	41	1	3,38	1	26	301	16	60	510	804	931.057
	Bolang Uki end	634	28	15	15,5	0,7	1	41	1	3,38	1	42	42.992	25	8.311	64.433	90.272	1.054.238
	Manado end	244	5	4	6,0	0,1	1	41	1	0,78	1	15	320.072	9	60.762	647.845	1.173.331	14.149.991
	Bitung end	274	4	4	6,7	0,1	1	41	1	0,78	1	17	231.259	10	43.720	448.819	790.944	4.260.685
	Tomohon end	275	3	4	6,7	0,1	1	41	1	0,97	1	17	120.148	10	22.885	232.370	408.188	5.163.346
	Kotamobagu end	428	5	4	10,4	0,1	1	41	1	3,38	1	29	59.557	18	11.830	98.027	150.456	1.255.304

Via Melonguane

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	382	41	9.3	38	3	15	25.4	342681	7	24.306	16	105.769
	Tondano	382	41	9.3	29	2	15	25.4	259974	7	18.440	16	80.241
	Tahuna	382	41	9.3	4	0	15	25.4	36286	7	2.574	16	11.200
	Melonguane	382	41	9.3	2	0	15	25.4	22262	7	1.579	16	6.871
	Amurang	382	41	9.3	34	2	15	25.4	306031	7	21.707	16	94.457
	Airmadidi	382	41	9.3	15	1	15	25.4	135095	7	9.582	16	41.697
	Ratahan	*382*	*41*	*9.3*	9	1	*15*	25.4	81050	7	5.749	16	25.016
	Boroko	382	41	9.3	0	0	15	25.4	948	7	67	16	292
	Ondong Siau	382	41	9.3	3	0	15	25.4	25924	7	1.839	16	8.002
	Tutuyan	382	41	9.3	0	0	15	25.4	393	7	28	16	121
	Bolang Uki	382	41	9.3	4	0	15	25.4	34589	7	2.453	16	10.676
	Manado	382	41	9.3	79	5	15	25.4	703433	7	49.895	16	217.115
	Bitung	382	41	9.3	51	3	15	25.4	457980	7	32.485	16	141.356
	Tomohon	382	41	9.3	26	2	15	25.4	235356	7	16.694	16	72.643
	Kotamobagu	382	41	9.3	8	1	15	25.4	70183	7	4.978	16	21.662

Second leg

Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Lolak	545	37	20	13,3	0,9	1	41	1	3,38	1	37	378.722	23	73.754	582.551	925.232	451598
Tondano end	376	17	12	9,2	0,4	1	41	1	0,78	1	24	182.759	14	34.182	315.622	575.596	1556986
Tahuna end	165	10	11	4,0	0,2	1	41	1	3,38	1	14	14.670	9	3.184	31.628	67.914	152417
Melonguane end	0	11	11	0,0	0,3	1	41	1	3,38	1	4	2.713	4	810	11.974	34.236	70099
Amurang end	410	23	15	10,0	0,6	1	41	1	0,97	1	26	237.914	15	44.615	398.692	704.723	745086
Airmadidi end	372	17	12	9,1	0,4	1	41	1	0,97	1	24	94.789	14	17.833	163.902	298.997	1378878
Ratahan end	460	16	12	11,2	0,4	1	41	1	0,97	1	29	69.011	17	12.907	112.684	193.734	435133
Boroko end	575	20	14	14,0	0,5	1	41	1	3,38	1	38	1.069	23	208	1.636	2.584	139956
Ondong Siau end	241	5	11	5,9	0,1	1	41	1	3,38	1	18	13.651	12	2.851	26.343	52.267	89607
Tutuyan end	481	4	11	11,7	0,1	1	41	1	3,38	1	32	369	20	73	591	984	112865
Bolang Uki end	735	28	15	17,9	0,7	1	41	1	3,38	1	48	49.008	29	9.405	71.543	106.132	121982
Manado end	345	5	4	8,4	0,1	1	41	1	0,78	1	21	442.419	13	83.015	792.444	1.495.877	1816708
Bitung end	375	4	4	9,1	0,1	1	41	1	0,78	1	23	310.914	13	58.208	542.963	1.000.943	541167
Tomohon end	376	3	4	9,2	0,1	1	41	1	0,97	1	23	161.083	14	30.330	280.750	516.106	655331
Kotamobagu end	529	5	4	12,9	0,1	1	41	1	3,38	1	35	71.764	21	14.050	112.454	182.637	151193

Via Amurang

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	115	51.5	2.2	38	3	15	8.4	112669	7	24.306	16	105.769
	Tondano	115	51.5	2.2	29	2	15	8.4	85476	7	18.440	16	80.241
	Tahuna	115	51.5	2.2	4	0	15	8.4	11930	7	2.574	16	11.200
	Melonguane	115	51.5	2.2	2	0	15	8.4	7320	7	1.579	16	6.871
	Amurang	115	51.5	2.2	34	2	15	8.4	100619	7	21.707	16	94.457
	Airmadidi	115	51.5	2.2	15	1	15	8.4	44418	7	9.582	16	41.697
	Ratahan	115	51.5	2.2	9	1	15	8.4	26648	7	5.749	16	25.016
	Boroko	115	51.5	2.2	0	0	15	8.4	312	7	67	16	292
	Ondong Siau	115	51.5	2.2	3	0	15	8.4	8524	7	1.839	16	8.002
	Tutuyan	115	51.5	2.2	0	0	15	8.4	129	7	28	16	121
	Bolang Uki	115	51.5	2.2	4	0	15	8.4	11373	7	2.453	16	10.676
	Manado	115	51.5	2.2	79	5	15	8.4	231281	7	49.895	16	217.115
	Bitung	115	51.5	2.2	51	3	15	8.4	150578	7	32.485	16	141.356
	Tomohon	115	51.5	2.2	26	2	15	8.4	77382	7	16.694	16	72.643
	Kotamobagu	115	51.5	2.2	8	1	15	8.4	23075	7	4.978	16	21.662

Second leg

Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Lolak	109	37	20	1,9	0,6	1	58	1	3,38	1	12	120.271	8	26.587	276.933	389.603	191585
Tondano end	69	17	12	1,3	0,3	1	55	1	0,78	1	6	44.868	4	9.040	152.589	238.066	630518
Tahuna end	309	10	11	7,5	0,2	1	41	1	3,38	1	22	23.668	14	4.821	42.262	54.193	144547
Melonguane end	410	11	11	10,0	0,3	1	41	1	3,38	1	28	18.431	17	3.669	30.550	37.870	103963
Amurang end	0	23	15	0,0	0,4	1	55	1	0,97	1	2	21.701	2	5.270	143.134	243.754	240166
Airmadidi end	88	17	12	1,7	0,3	1	51,5	1	0,97	1	7	28.490	5	5.743	85.513	129.930	596928
Ratahan end	32	16	12	0,6	0,3	1	55	1	0,97	1	4	9.196	3	2.017	41.978	68.627	143017
Boroko end	228	20	14	3,9	0,3	1	58	1	3,38	1	18	497	12	103	960	1.271	71068
Ondong Siau end	211	5	11	5,1	0,1	1	41	1	3,38	1	16	12.311	11	2.608	24.760	33.283	63579
Tutuyan end	80	4	11	1,5	0,1	1	55	1	3,38	1	8	97	6	23	269	398	44384
Bolang Uki end	188	28	15	3,4	0,5	1	55	1	3,38	1	16	16.276	11	3.431	32.837	44.209	50551
Manado end	65	5	4	1,1	0,1	1	59	1	0,78	1	5	102.052	3	20.945	390.007	621.287	718449
Bitung end	108	4	4	2,1	0,1	1	51,5	1	0,78	1	7	99.513	5	19.644	292.997	443.576	235319
Tomohon end	64	3	4	1,2	0,1	1	55	1	0,97	1	5	34.314	3	7.230	130.880	208.262	249208
Kotamobagu end	103	5	4	1,9	0,1	1	55	1	3,38	1	10	20.125	7	4.637	51.402	74.477	59159

Via Airmadidi

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	28	46	0.6	38	3	15	1.4	18337	7	24.306	16	105.769
	Tondano	28	46	0.6	29	2	15	1.4	13911	7	18.440	16	80.241
	Tahuna	28	46	0.6	4	0	15	1.4	1942	7	2.574	16	11.200
	Melonguane	28	46	0.6	2	0	15	1.4	1191	7	1.579	16	6.871
	Amurang	28	46	0.6	34	2	15	1.4	16376	7	21.707	16	94.457
	Airmadidi	28	46	0.6	15	1	15	1.4	7229	7	9.582	16	41.697
	Ratahan	28	46	0.6	9	1	15	1.4	4337	7	5.749	16	25.016
	Boroko	28	46	0.6	0	0	15	1.4	51	7	67	16	292
	Ondong Siau	28	46	0.6	3	0	15	1.4	1387	7	1.839	16	8.002
	Tutuyan	28	46	0.6	0	0	15	1.4	21	7	28	16	121
	Bolang Uki	28	46	0.6	4	0	15	1.4	1851	7	2.453	16	10.676
	Manado	28	46	0.6	79	5	15	1.4	37641	7	49.895	16	217.115
	Bitung	28	46	0.6	51	3	15	1.4	24507	7	32.485	16	141.356
	Tomohon	28	46	0.6	26	2	15	1.4	12594	7	16.694	16	72.643
	Kotamobagu	28	46	0.6	8	1	15	1.4	3756	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Airmadidi	Lolak	178	37	20	3,3	0,7	1,0	54	1	3,38	1	16	160.746	10	33.915	324.736	343.074	1.916.021
	Tondano end	21	17	12	0,4	0,4	1,0	48	1	0,78	1	3	23.715	2	5.239	127.635	141.547	4.315.828
	Tahuna end	271	10	11	6,6	0,2	1,0	41	1	3,38	1	20	21.294	13	4.389	39.456	41.398	1.220.641
	Melonguane end	372	11	11	9,1	0,3	1,0	41	1	3,38	1	26	16.975	16	3.404	28.829	30.020	901.031
	Amurang end	88	23	15	1,7	0,4	1,0	51,5	1	0,97	1	8	67.671	5	13.575	197.410	213.785	2.626.896
	Airmadidi end	0	17	12	0,0	0,3	1,0	51	1	0,97	1	2	8.211	2	2.081	61.571	68.800	3.536.992
	Ratahan end	62	16	12	1,1	0,3	1,0	54	1	0,97	1	6	13.341	4	2.765	46.871	51.209	1.296.153
	Boroko end	296	20	14	5,5	0,4	1,0	54	1	3,38	1	22	608	14	123	1.091	1.141	727.873
	Ondong Siau end	173	5	11	4,2	0,1	1,0	41	1	3,38	1	14	10.615	9	2.299	22.755	24.142	516.118
	Tutuyan end	114	4	11	2,1	0,1	1,0	54	1	3,38	1	10	120	7	27	296	317	418.651
	Bolang Uki end	285	28	15	5,3	0,5	1,0	54	1	3,38	1	22	21.998	14	4.464	39.592	41.443	539.991
	Manado end	27	5	4	0,6	0,1	1,0	44	1	0,78	1	3	57.087	2	12.914	337.011	374.652	4.893.030
	Bitung end	21	4	4	0,5	0,1	1,0	44	1	0,78	1	2	31.664	2	7.409	212.913	237.420	1.348.639
	Tomohon end	32	3	4	0,7	0,1	1,0	48	1	0,97	1	3	21.566	2	4.942	115.845	128.439	1.746.223
	Kotamobagu end	32	5	4	0,6	0,1	1,0	53	1	3,38	1	6	11.651	5	3.111	41.401	45.157	393.371

Via Ratahan

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	88	54	1.6	38	3	15	6.7	89577	7	24.306	16	105.769
	Tondano	88	54	1.6	29	2	15	6.7	67957	7	18.440	16	80.241
	Tahuna	88	54	1.6	4	0	15	6.7	9485	7	2.574	16	11.200
	Melonguane	88	54	1.6	2	0	15	6.7	5819	7	1.579	16	6.871
	Amurang	*88*	*54*	*1.6*	*34*	*2*	15	6.7	79997	7	21.707	16	94.457
	Airmadidi	88	54	1.6	15	1	15	6.7	35314	7	9.582	16	41.697
	Ratahan	88	54	1.6	9	1	15	6.7	21187	7	5.749	16	25.016
	Boroko	88	54	1.6	0	0	15	6.7	248	7	67	16	292
	Ondong Siau	88	54	1.6	3	0	15	6.7	6777	7	1.839	16	8.002
	Tutuyan	88	54	1.6	0	0	15	6.7	103	7	28	16	121
	Bolang Uki	88	54	1.6	4	0	15	6.7	9042	7	2.453	16	10.676
	Manado	88	54	1.6	79	5	15	6.7	183878	7	49.895	16	217.115
	Bitung	88	54	1.6	51	3	15	6.7	119716	7	32.485	16	141.356
	Tomohon	88	54	1.6	26	2	15	6.7	61522	7	16.694	16	72.643
	Kotamobagu	88	54	1.6	8	1	15	6.7	18346	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Ratahan	Lolak	140	37	20	2,5	0,7	1	56,5	1	3,38	1	14	138.409	9	29.864	298.348	387.925	1959848
	Tondano end	41	17	12	0,8	0,3	1	54,5	1	0,78	1	4	32.488	3	6.810	137.978	205.936	5440614
	Tahuna end	359	10	11	8,8	0,2	1	41	1	3,38	1	25	26.793	16	5.389	45.955	55.440	1521728
	Melonguane end	460	11	11	11,2	0,3	1	41	1	3,38	1	31	20.348	19	4.017	32.816	38.635	1086654
	Amurang end	32	23	15	0,6	0,4	1	55	1	0,97	1	4	38.368	3	8.274	162.805	242.802	2513990
	Airmadidi end	62	17	12	1,1	0,3	1	54	1	0,97	1	6	22.467	4	4.651	78.398	113.712	5232811
	Ratahan end	0	16	12	0,0	0,3	1	54	1	0,97	1	2	4.783	2	1.222	36.770	57.957	1192641
	Boroko end	260	20	14	4,7	0,4	1	56	1	3,38	1	20	549	13	113	1.021	1.269	730070
	Ondong Siau end	261	5	11	6,4	0,1	1	41	1	3,38	1	19	14.544	12	3.014	27.398	34.175	675791
	Tutuyan end	57	4	11	1,1	0,1	1	54	1	3,38	1	7	81	5	20	251	354	396341
	Bolang Uki end	193	28	15	3,6	0,5	1	54	1	3,38	1	16	16.579	11	3.487	33.195	42.237	492611
	Manado end	115	5	4	2,2	0,1	1	52	1	0,78	1	8	162.447	5	31.905	461.362	645.240	7936050
	Bitung end	81	4	4	1,5	0,1	1	54	1	0,78	1	6	78.305	4	15.798	267.944	387.660	2047086
	Tomohon end	42	3	4	0,8	0,1	1	55	1	0,97	1	4	25.501	3	5.641	120.479	182.001	2164898
	Kotamobagu end	108	5	4	2,0	0,1	1	55	1	3,38	1	10	20.726	7	4.746	52.112	70.458	571024

Via Boroko

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	325	58.5	5.6	38	3	15	21.6	290246	7	24.306	16	105.769
	Tondano	325	58.5	5.6	29	2	15	21.6	220194	7	18.440	16	80.241
	Tahuna	325	58.5	5.6	4	0	15	21.6	30734	7	2.574	16	11.200
	Melonguane	325	58.5	5.6	2	0	15	21.6	18856	7	1.579	16	6.871
	Amurang	325	58.5	5.6	34	2	15	21.6	259204	7	21.707	16	94.457
	Airmadidi	325	58.5	5.6	15	1	15	21.6	114424	7	9.582	16	41.697
	Ratahan	325	58.5	5.6	9	1	15	21.6	68648	7	5.749	16	25.016
	Boroko	325	58.5	5.6	0	0	15	21.6	803	7	67	16	292
	Ondong Siau	325	58.5	5.6	3	0	15	21.6	21958	7	1.839	16	8.002
	Tutuyan	325	58.5	5.6	0	0	15	21.6	333	7	28	16	121
	Bolang Uki	325	58.5	5.6	4	0	15	21.6	29297	7	2.453	16	10.676
	Manado	325	58.5	5.6	79	5	15	21.6	595798	7	49.895	16	217.115
	Bitung	325	58.5	5.6	51	3	15	21.6	387902	7	32.485	16	141.356
	Tomohon	325	58.5	5.6	26	2	15	21.6	199343	7	16.694	16	72.643
	Kotamobagu	325	58.5	5.6	8	1	15	21.6	59444	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost C1h and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Boroko	Lolak	122	37	20	2,1	0,6	1	58	1	3,38	1	13	127.840	9	27.949	285.864	576.109	2588001
	Tondano end	279	17	12	4,9	0,3	1	56,5	1	0,78	1	18	137.664	11	25.749	262.095	482.289	12824651
	Tahuna end	474	10	11	11,6	0,2	1	41	1	3,38	1	32	33.979	20	6.696	54.448	85.181	2152912
	Melonguane end	575	11	11	14,0	0,3	1	41	1	3,38	1	38	24.757	23	4.819	38.027	56.882	1475783
	Amurang end	228	23	15	3,9	0,4	1	58	1	0,97	1	16	140.219	9	26.600	282.982	542.186	5498146
	Airmadidi end	296	17	12	5,5	0,3	1	53,7	1	0,97	1	19	76.318	11	14.364	141.961	256.385	11716472
	Ratahan end	260	16	12	4,7	0,3	1	55,7	1	0,97	1	17	40.630	10	7.681	79.076	147.724	3164097
	Boroko end	0	20	14	0,0	0,3	1	58	1	3,38	1	5	130	4	37	526	1.329	587544
	Ondong Siau end	376	5	11	9,2	0,1	1	41	1	3,38	1	26	19.678	16	3.948	33.466	55.423	1010580
	Tutuyan end	228	4	11	4,0	0,1	1	57	1	3,38	1	17	196	11	41	386	719	773663
	Bolang Uki end	194	28	15	3,4	0,5	1	57	1	3,38	1	16	16.617	11	3.491	33.238	62.534	647168
	Manado end	230	5	4	3,9	0,1	1	59	1	0,78	1	14	299.203	9	56.427	622.640	1.218.437	14319284
	Bitung end	318	4	4	5,4	0,1	1	59	1	0,78	1	19	262.472	11	48.915	485.228	873.130	4696174
	Tomohon end	274	3	4	4,8	0,1	1	57	1	0,97	1	17	118.329	10	22.359	230.025	429.367	5325908
	Kotamobagu end	175	5	4	3,1	0,1	1	57	1	3,38	1	14	28.705	9	6.181	61.526	120.970	911204

Via Ondong Siau

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	183	41	4.5	38	3	15	12.8	171880	7	24.306	16	105.769
	Tondano	183	41	4.5	29	2	15	12.8	130397	7	18.440	16	80.241
	Tahuna	183	41	4.5	4	0	15	12.8	18200	7	2.574	16	11.200
	Melonguane	183	41	4.5	2	0	15	12.8	11166	7	1.579	16	6.871
	Amurang	183	41	4.5	34	2	15	12.8	153498	7	21.707	16	94.457
	Airmadidi	183	41	4.5	15	1	15	12.8	67761	7	9.582	16	41.697
	Ratahan	183	41	4.5	9	1	15	12.8	40653	7	5.749	16	25.016
	Boroko	183	41	4.5	0	0	15	12.8	475	7	67	16	292
	Ondong Siau	183	41	4.5	3	0	15	12.8	13003	7	1.839	16	8.002
	Tutuyan	183	41	4.5	0	0	15	12.8	197	7	28	16	121
	Bolang Uki	183	41	4.5	4	0	15	12.8	17349	7	2.453	16	10.676
	Manado	183	41	4.5	79	5	15	12.8	352825	7	49.895	16	217.115
	Bitung	183	41	4.5	51	3	15	12.8	229712	7	32.485	16	141.356
	Tomohon	183	41	4.5	26	2	15	12.8	118049	7	16.694	16	72.643
	Kotamobagu	183	41	4.5	8	1	15	12.8	35202	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Ondong Siau	Lolak	346	37	20	8,4	0,9	1	41	1	3,38	1	26	261.289	16	52.395	443.759	615.639	3102142
	Tondano end	177	17	12	4,3	0,4	1	41	1	0,78	1	12	93.669	7	17.978	210.328	340.725	9267627
	Tahuna end	96	10	11	2,3	0,2	1	41	1	3,38	1	10	10.359	7	2.400	26.532	44.732	1051441
	Melonguane end	241	11	11	5,9	0,3	1	41	1	3,38	1	18	11.952	12	2.490	22.893	34.059	860718
	Amurang end	211	23	15	5,1	0,6	1	41	1	0,97	1	15	133.040	9	25.540	274.744	428.241	4602778
	Airmadidi end	173	17	12	4,2	0,4	1	41	1	0,97	1	12	48.493	7	9.413	109.186	176.946	8205416
	Ratahan end	261	16	12	6,4	0,4	1	41	1	0,97	1	17	41.236	10	7.856	79.857	120.510	2758767
	Boroko end	376	20	14	9,2	0,5	1	41	1	3,38	1	27	744	17	149	1.252	1.728	969460
	Ondong Siau end	0	5	11	0,0	0,1	1	41	1	3,38	1	4	2.892	4	895	13.627	26.630	431045
	Tutuyan end	282	4	11	6,9	0,1	1	41	1	3,38	1	20	234	13	48	432	629	739331
	Bolang Uki end	536	28	15	13,1	0,7	1	41	1	3,38	1	36	37.155	22	7.250	57.534	74.883	893565
	Manado end	146	5	4	3,6	0,1	1	41	1	0,78	1	10	201.359	6	39.171	507.540	860.366	10252220
	Bitung end	176	4	4	4,3	0,1	1	41	1	0,78	1	11	153.969	7	29.663	357.472	587.184	3143885
	Tomohon end	177	3	4	4,3	0,1	1	41	1	0,97	1	12	80.429	7	15.661	185.427	303.476	3814664
	Kotamobagu end	330	5	4	8,0	0,1	1	41	1	3,38	1	23	47.712	15	9.676	84.028	119.231	1006299

Via Tutuyan

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	140	54	2.6	38	3	15	9.9	133756	7	24.306	16	105.769
	Tondano	140	54	2.6	29	2	15	9.9	101474	7	18.440	16	80.241
	Tahuna	140	54	2.6	4	0	15	9.9	14163	7	2.574	16	11.200
	Melonguane	140	54	2.6	2	0	15	9.9	8689	7	1.579	16	6.871
	Amurang	140	54	2.6	34	2	15	9.9	119451	7	21.707	16	94.457
	Airmadidi	140	54	2.6	15	1	15	9.9	52731	7	9.582	16	41.697
	Ratahan	140	54	2.6	9	1	15	9.9	31636	7	5.749	16	25.016
	Boroko	140	54	2.6	0	0	15	9.9	370	7	67	16	292
	Ondong Siau	140	54	2.6	3	0	15	9.9	10119	7	1.839	16	8.002
	Tutuyan	140	54	2.6	0	0	15	9.9	154	7	28	16	121
	Bolang Uki	140	54	2.6	4	0	15	9.9	13501	7	2.453	16	10.676
	Manado	140	54	2.6	79	5	15	9.9	274566	7	49.895	16	217.115
	Bitung	140	54	2.6	51	3	15	9.9	178760	7	32.485	16	141.356
	Tomohon	140	54	2.6	26	2	15	9.9	91865	7	16.694	16	72.643
	Kotamobagu	140	54	2.6	8	1	15	9.9	27394	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Tutuyan	Lolak	108	37	20	1,9	0,7	1	56,5	1	3,38	1	12	119.763	8	26.506	276.344	410.100	1985893
	Tondano end	94	17	12	1,7	0,3	1	54	1	0,78	1	7	55.961	5	11.044	165.686	267.160	7082040
	Tahuna end	380	10	11	9,3	0,2	1	41	1	3,38	1	26	28.105	16	5.628	47.506	61.669	1650735
	Melonguane end	481	11	11	11,7	0,3	1	41	1	3,38	1	32	21.153	20	4.164	33.767	42.457	1166187
	Amurang end	80	23	15	1,5	0,4	1	55	1	0,97	1	7	63.368	4	12.780	192.312	311.763	3213394
	Airmadidi end	114	17	12	2,1	0,3	1	54	1	0,97	1	9	34.431	5	6.808	92.519	145.249	6669849
	Ratahan end	57	16	12	1,1	0,3	1	54	1	0,97	1	5	12.651	3	2.641	46.057	77.693	1626362
	Boroko end	228	20	14	4,0	0,4	1	57	1	3,38	1	18	497	12	103	960	1.330	731430
	Ondong Siau end	282	5	11	6,9	0,1	1	41	1	3,38	1	20	15.481	13	3.184	28.506	38.625	744248
	Tutuyan end	0	4	11	0,0	0,1	1	57	1	3,38	1	4	43	4	13	206	359	368230
	Bolang Uki end	140	28	15	2,6	0,5	1	54	1	3,38	1	13	13.457	9	2.924	29.510	43.011	475635
	Manado end	136	5	4	2,7	0,1	1	51	1	0,78	1	9	187.708	5	36.476	491.194	765.760	9249687
	Bitung end	133	4	4	2,5	0,1	1	54	1	0,78	1	9	118.862	5	23.112	315.815	494.575	2631145
	Tomohon end	95	3	4	1,7	0,1	1	55	1	0,97	1	7	46.743	4	9.472	145.552	237.416	2878013
	Kotamobagu end	55	5	4	1,0	0,1	1	55	1	3,38	1	7	14.393	5	3.604	44.638	72.032	546015

Via Bolang Uki

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	314	54	5.8	38	3	15	20.9	281586	7	24.306	16	105.769
	Tondano	314	54	5.8	29	2	15	20.9	213624	7	18.440	16	80.241
	Tahuna	314	54	5.8	4	0	15	20.9	29817	7	2.574	16	11.200
	Melonguane	314	54	5.8	2	0	15	20.9	18293	7	1.579	16	6.871
	Amurang	314	54	5.8	34	2	15	20.9	251470	7	21.707	16	94.457
	Airmadidi	314	54	5.8	15	1	15	20.9	111010	7	9.582	16	41.697
	Ratahan	314	54	5.8	9	1	15	20.9	66600	7	5.749	16	25.016
	Boroko	314	54	5.8	0	0	15	20.9	779	7	67	16	292
	Ondong Siau	314	54	5.8	3	0	15	20.9	21302	7	1.839	16	8.002
	Tutuyan	314	54	5.8	0	0	15	20.9	323	7	28	16	121
	Bolang Uki	314	54	5.8	4	0	15	20.9	28422	7	2.453	16	10.676
	Manado	314	54	5.8	79	5	15	20.9	578021	7	49.895	16	217.115
	Bitung	314	54	5.8	51	3	15	20.9	376329	7	32.485	16	141.356
	Tomohon	314	54	5.8	26	2	15	20.9	193395	7	16.694	16	72.643
	Kotamobagu	314	54	5.8	8	1	15	20.9	57671	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Bolang Uki	Lolak	126	37	20	2,2	0,7	1	56,5	1	3,38	1	13	130.251	9	28.395	288.721	570.307	2575991
	Tondano end	229	17	12	4,2	0,3	1	54	1	0,78	1	15	115.731	9	21.823	236.235	449.859	11774082
	Tahuna end	634	10	11	15,5	0,2	1	41	1	3,38	1	41	43.976	25	8.514	66.264	96.081	2516102
	Melonguane end	735	11	11	17,9	0,3	1	41	1	3,38	1	47	30.891	28	5.935	45.276	63.569	1699712
	Amurang end	188	23	15	3,4	0,4	1	55	1	0,97	1	13	119.619	8	22.920	258.702	510.173	5112483
	Airmadidi end	285	17	12	5,3	0,3	1	54	1	0,97	1	19	73.773	11	13.903	138.956	249.965	11428039
	Ratahan end	193	16	12	3,6	0,3	1	54	1	0,97	1	13	31.423	8	6.026	68.214	134.814	2817277
	Boroko end	194	20	14	3,4	0,4	1	57	1	3,38	1	16	442	10	93	895	1.674	831501
	Ondong Siau end	536	5	11	13,1	0,1	1	41	1	3,38	1	35	26.821	21	5.247	41.908	63.210	1202022
	Tutuyan end	140	4	11	2,6	0,1	1	54	1	3,38	1	12	137	8	30	317	640	663484
	Bolang Uki end	0	28	15	0,0	0,5	1	57	1	3,38	1	5	5.207	4	1.436	19.773	48.195	454697
	Manado end	390	5	4	7,5	0,1	1	52	1	0,78	1	24	492.172	14	91.407	850.589	1.428.610	17945914
	Bitung end	307	4	4	5,7	0,1	1	54	1	0,78	1	19	254.574	11	47.586	476.000	852.329	4585495
	Tomohon end	231	3	4	4,2	0,1	1	55	1	0,97	1	15	101.237	9	19.297	209.870	403.265	4928496
	Kotamobagu end	85	5	4	1,5	0,1	1	55	1	3,38	1	9	17.975	6	4.249	48.864	106.535	768711

Via Manado

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	49	44	1,1	38	3	15	2,1	27718	7	24.306	16	105.769
	Tondano	49	44	1,1	29	2	15	2,1	21028	7	18.440	16	80.241
	Tahuna	49	44	1,1	4	0	15	2,1	2935	7	2.574	16	11.200
	Melonguane	49	44	1,1	2	0	15	2,1	1801	7	1.579	16	6.871
	Amurang	49	44	1,1	34	2	15	2,1	24753	7	21.707	16	94.457
	Airmadidi	49	44	1,1	15	1	15	2,1	10927	7	9.582	16	41.697
	Ratahan	49	44	1,1	9	1	15	2,1	6556	7	5.749	16	25.016
	Boroko	49	44	1,1	0	0	15	2,1	77	7	67	16	292
	Ondong Siau	49	44	1,1	3	0	15	2,1	2097	7	1.839	16	8.002
	Tutuyan	49	44	1,1	0	0	15	2,1	32	7	28	16	121
	Bolang Uki	49	44	1,1	4	0	15	2,1	2798	7	2.453	16	10.676
	Manado	49	44	1,1	79	5	15	2,1	56897	7	49.895	16	217.115
	Bitung	49	44	1,1	51	3	15	2,1	37044	7	32.485	16	141.356
	Tomohon	49	44	1,1	26	2	15	2,1	19037	7	16.694	16	72.643
	Kotamobagu	49	44	1,1	8	1	15	2,1	5677	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Manado	Lolak	200	37	20	3,4	0,6	1	58,5	1	3,38	1	17	173.210	11	36.110	339.396	367.114	2.056.600
	Tondano end	31	17	12	0,6	0,3	1	49,5	1	0,78	1	4	28.137	2	6.036	132.853	153.881	4.761.227
	Tahuna end	244	10	11	6,0	0,2	1	41	1	3,38	1	18	19.607	12	4.082	37.462	40.397	1.188.657
	Melonguane end	345	11	11	8,4	0,3	1	41	1	3,38	1	24	15.939	15	3.216	27.605	29.406	881.311
	Amurang end	65	23	15	1,1	0,4	1	59	1	0,97	1	6	55.448	4	11.338	182.949	207.703	2.543.915
	Airmadidi end	27	17	12	0,6	0,4	1	44	1	0,97	1	4	14.496	3	3.225	69.000	79.927	4.224.798
	Ratahan end	115	16	12	2,2	0,3	1	51,5	1	0,97	1	9	20.687	5	4.095	55.547	62.103	1.614.280
	Boroko end	230	20	14	3,9	0,3	1	58,5	1	3,38	1	18	500	12	104	963	1.040	658.692
	Ondong Siau end	146	5	11	3,6	0,1	1	41	1	3,38	1	12	9.410	9	2.080	21.330	23.427	499.251
	Tutuyan end	136	4	11	2,7	0,1	1	51	1	3,38	1	12	134	8	30	314	346	460.957
	Bolang Uki end	390	28	15	7,5	0,5	1	52,3	1	3,38	1	28	28.212	17	5.589	46.930	49.727	654.577
	Manado end	0	5	4	0,0	0,1	1	46	1	0,78	1	1	24.471	1	6.994	298.476	355.373	4.573.619
	Bitung end	42	4	4	1,0	0,1	1	44	1	0,78	1	4	48.174	2	10.405	232.419	269.463	1.575.829
	Tomohon end	31	3	4	0,6	0,1	1	48	1	0,97	1	3	21.164	2	4.869	115.370	134.406	1.848.540
	Kotamobagu end	184	5	4	3,6	0,1	1	51,5	1	3,38	1	14	29.853	10	6.398	62.891	68.568	638.699

Via Bitung

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	7	44	0.2	38	3	15	0.7	9038	7	24.306	16	105.769
	Tondano	7	44	0.2	29	2	15	0.7	6857	7	18.440	16	80.241
	Tahuna	7	44	0.2	4	0	15	0.7	957	7	2.574	16	11.200
	Melonguane	7	44	0.2	2	0	15	0.7	587	7	1.579	16	6.871
	Amurang	7	44	0.2	34	2	15	0.7	8072	7	21.707	16	94.457
	Airmadidi	7	44	0.2	15	1	15	0.7	3563	7	9.582	16	41.697
	Ratahan	7	44	0.2	9	1	15	0.7	2138	7	5.749	16	25.016
	Boroko	7	44	0.2	0	0	15	0.7	25	7	67	16	292
	Ondong Siau	7	44	0.2	3	0	15	0.7	684	7	1.839	16	8.002
	Tutuyan	7	44	0.2	0	0	15	0.7	10	7	28	16	121
	Bolang Uki	7	44	0.2	4	0	15	0.7	912	7	2.453	16	10.676
	Manado	7	44	0.2	79	5	15	0.7	18553	7	49.895	16	217.115
	Bitung	7	44	0.2	51	3	15	0.7	12079	7	32.485	16	141.356
	Tomohon	7	44	0.2	26	2	15	0.7	6208	7	16.694	16	72.643
	Kotamobagu	7	44	0.2	8	1	15	0.7	1851	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Bitung	Lolak	199	37	20	3,4	0,6	1,0	58	1	3,38	1	17	172.667	11	36.018	338.760	347.798	1.943.651
	Tondano end	39	17	12	0,8	0,4	1,0	46	1	0,78	1	4	31.762	3	6.701	137.145	144.002	4.404.473
	Tahuna end	288	10	11	7,0	0,2	1,0	41	1	3,38	1	21	22.356	13	4.582	40.711	41.669	1.229.298
	Melonguane end	389	11	11	9,5	0,3	1,0	41	1	3,38	1	27	17.626	17	3.522	29.599	30.186	906.369
	Amurang end	108	23	15	1,8	0,4	1,0	59	1	0,97	1	9	77.791	5	15.358	209.313	217.385	2.675.994
	Airmadidi end	21	17	12	0,5	0,4	1,0	46	1	0,97	1	3	13.088	2	2.967	67.334	70.897	3.666.619
	Ratahan end	81	16	12	1,5	0,3	1,0	54	1	0,97	1	7	15.964	4	3.238	49.967	52.105	1.322.323
	Boroko end	311	20	14	5,4	0,3	1,0	58	1	3,38	1	23	630	14	127	1.117	1.142	728.553
	Ondong Siau end	190	5	11	4,6	0,1	1,0	41	1	3,38	1	15	11.374	10	2.437	23.652	24.335	520.684
	Tutuyan end	133	4	11	2,5	0,1	1,0	54	1	3,38	1	11	132	8	30	311	321	425.126
	Bolang Uki end	307	28	15	5,7	0,5	1,0	54	1	3,38	1	23	23.294	14	4.698	41.122	42.034	548.166
	Manado end	42	5	4	1,0	0,1	1,0	44	1	0,78	1	4	75.200	2	16.200	358.411	376.964	4.931.339
	Bitung end	7	4	4	0,2	0,1	1,0	44	1	0,78	1	2	20.657	1	5.412	199.910	211.989	1.168.326
	Tomohon end	51	3	4	1,1	0,1	1,0	46	1	0,97	1	4	29.253	3	6.338	124.927	131.135	1.792.449
	Kotamobagu end	220	5	4	4,0	0,1	1,0	55	1	3,38	1	16	34.100	11	7.156	67.896	69.747	651.057

Via Tomohon

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	daily volume from MT (ton)	frequency (MT=8 ton)	daily volume from HT (ton)	frequency (HT=15 ton)	Loading time in Port (hours)	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
Bitung Port	Lolak	58	46	1,3	38	3	15	0	0	0	0	4	2,3	31636	7	24.306	16	105.769
	Tondano	58	46	1,3	29	2	15	0	0	0	0	4	2,3	24000	7	18.440	16	80.241
	Tahuna	58	46	1,3	4	0	15	0	0	0	0	4	2,3	3350	7	2.574	16	11.200
	Melonguane	58	46	1,3	2	0	15	0	0	0	0	4	2,3	2055	7	1.579	16	6.871
	Amurang	58	46	1,3	34	2	15	0	0	0	0	4	2,3	28252	7	21.707	16	94.457
	Airmadidi	58	46	1,3	15	1	15	0	0	0	0	4	2,3	12472	7	9.582	16	41.697
	Ratahan	58	46	1,3	9	1	15	0	0	0	0	4	2,3	7482	7	5.749	16	25.016
	Boroko	58	46	1,3	0	0	15	0	0	0	0	4	2,3	87	7	67	16	292
	Ondong Siau	58	46	1,3	3	0	15	0	0	0	0	4	2,3	2393	7	1.839	16	8.002
	Tutuyan	58	46	1,3	0	0	15	0	0	0	0	4	2,3	36	7	28	16	121
	Bolang Uki	58	46	1,3	4	0	15	0	0	0	0	4	2,3	3193	7	2.453	16	10.676
	Manado	58	46	1,3	79	5	15	0	0	0	0	4	2,3	64939	7	49.895	16	217.115
	Bitung	58	46	1,3	51	3	15	0	0	0	0	4	2,3	42280	7	32.485	16	141.356
	Tomohon	58	46	1,3	26	2	15	0	0	0	0	4	2,3	21728	7	16.694	16	72.643
	Kotamobagu	58	46	1,3	8	1	15	0	0	0	0	4	2,3	6479	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
Tomohon	Lolak	154	37	20	3,0	0,7	1,0	51,5	1	3,38	1	15	146.931	10	31.450	308.456	340.092	1.898.584
	Tondano end	11	17	12	0,2	0,3	1,0	55	1	0,78	1	3	19.206	2	4.414	122.301	146.302	4.487.520
	Tahuna end	275	10	11	6,7	0,2	1,0	41	1	3,38	1	20	21.544	13	4.434	39.751	43.101	1.275.091
	Melonguane end	376	11	11	9,2	0,3	1,0	41	1	3,38	1	26	17.128	16	3.432	29.010	31.065	934.603
	Amurang end	64	23	15	1,2	0,4	1,0	55	1	0,97	1	6	55.035	4	11.278	182.477	210.729	2.585.197
	Airmadidi end	32	17	12	0,6	0,3	1,0	51,5	1	0,97	1	4	15.584	3	3.412	70.276	82.748	4.399.165
	Ratahan end	42	16	12	0,8	0,3	1,0	55	1	0,97	1	4	10.575	3	2.266	43.606	51.089	1.292.652
	Boroko end	274	20	14	4,6	0,3	1,0	59	1	3,38	1	20	571	13	116	1.047	1.134	722.993
	Ondong Siau end	177	5	11	4,3	0,1	1,0	41	1	3,38	1	14	10.794	10	2.332	22.966	25.359	544.833
	Tutuyan end	95	4	11	1,8	0,1	1,0	54	1	3,38	1	9	107	7	25	281	317	419.011
	Bolang Uki end	231	28	15	4,3	0,5	1,0	54	1	3,38	1	18	18.817	12	3.891	35.837	39.031	506.627
	Manado end	31	5	4	0,6	0,1	1,0	49	1	0,78	1	3	61.727	2	13.729	342.466	407.406	5.435.691
	Bitung end	51	4	4	1,1	0,1	1,0	46	1	0,78	1	4	55.169	3	11.663	240.673	282.952	1.671.469
	Tomohon end	0	3	4	0,0	0,1	1,0	55	1	0,97	1	1	8.678	1	2.609	100.623	122.351	1.641.832
	Kotamobagu end	146	5	4	2,7	0,1	1,0	55	1	3,38	1	12	25.261	8	5.563	57.464	63.943	590.234

Via Kotamobagu

First leg

Origin	Final destination	distance (km)	velocity (km/h)	travel time Port to logistics hub (hr)	daily volume HT (ton)	frequency with HT=15 ton	Load per vehicle	unit GTC HT (euro/ton)	annual GTC HT (eur)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)
	Lolak	227	54	4.2	38	3	15	15.4	207671	7	24.306	16	105.769
	Tondano	227	54	4.2	29	2	15	15.4	157549	7	18.440	16	80.241
	Tahuna	227	54	4.2	4	0	15	15.4	21990	7	2.574	16	11.200
	Melonguane	227	54	4.2	2	0	15	15.4	13491	7	1.579	16	6.871
	Amurang	227	54	4.2	34	2	15	15.4	185461	7	21.707	16	94.457
	Airmadidi	227	54	4.2	15	1	15	15.4	81870	7	9.582	16	41.697
	Ratahan	227	54	4.2	9	1	15	15.4	49118	7	5.749	16	25.016
Bitung Port	Boroko	227	54	4.2	0	0	15	15.4	574	7	67	16	292
	Ondong Siau	227	54	4.2	3	0	15	15.4	15711	7	1.839	16	8.002
	Tutuyan	227	54	4.2	0	0	15	15.4	238	7	28	16	121
	Bolang Uki	227	54	4.2	4	0	15	15.4	20962	7	2.453	16	10.676
	Manado	227	54	4.2	79	5	15	15.4	426294	7	49.895	16	217.115
	Bitung	227	54	4.2	51	3	15	15.4	277544	7	32.485	16	141.356
	Tomohon	227	54	4.2	26	2	15	15.4	142630	7	16.694	16	72.643
	Kotamobagu	227	54	4.2	8	1	15	15.4	42532	7	4.978	16	21.662

Second leg

Origin	Destination	distance of logistics hub to regional	Intra regional distance (km)	distance between loading points (km)	Travel time from hub to regional (hr)	Travel time from regional center to loading points (hr)	loading time in each loading points (hr)	velocity (km/h)	unloading time in regional center (hr)	Road charges	Loading cargo in loading point (hr)	unit GTC MT (euro/ton)	annual GTC MT (euro)	unit GTC HT (euro/ton)	annual GTC HT (euro)	Annual cost Clh and C2nd	Total annual GTC (euro)	Total 2+1 annual GTC
	Lolak	55	37	20	1,0	0,7	1	56,5	1	3,38	1	9	88.881	6	20.943	239.899	447.570	2031634
	Tondano end	144	17	12	2,6	0,3	1	55	1	0,78	1	10	78.053	6	15.021	191.755	349.304	9095649
	Tahuna end	428	10	11	10,4	0,2	1	41	1	3,38	1	29	31.104	18	6.173	51.051	73.041	1896943
	Melonguane end	529	11	11	12,9	0,3	1	41	1	3,38	1	35	22.993	21	4.499	35.942	49.434	1317977
	Amurang end	103	23	15	1,9	0,4	1	55	1	0,97	1	8	75.347	5	14.940	206.451	391.911	3902979
	Airmadidi end	200	17	12	3,8	0,3	1	52,7	1	0,97	1	14	54.260	8	10.390	115.930	197.801	9060880
	Ratahan end	108	16	12	2,0	0,3	1	54,5	1	0,97	1	8	19.685	5	3.909	54.359	103.476	2140729
Kotamobagu	Boroko end	175	20	14	3,1	0,4	1	57	1	3,38	1	15	412	10	88	859	1.434	734748
	Ondong Siau end	330	5	11	8,0	0,1	1	41	1	3,38	1	23	17.624	15	3.574	31.039	46.749	874795
	Tutuyan end	55	4	11	1,0	0,1	1	55	1	3,38	1	7	80	5	20	249	488	498181
	Bolang Uki end	85	28	15	1,5	0,5	1	55	1	3,38	1	10	10.213	7	2.338	25.680	46.642	479536
	Manado end	184	5	4	3,6	0,1	1	52	1	0,78	1	12	245.248	7	46.857	559.115	985.409	11745899
	Bitung end	220	4	4	4,1	0,1	1	54	1	0,78	1	14	186.718	8	35.349	395.908	673.452	3608320
	Tomohon end	146	3	4	2,6	0,1	1	56	1	0,97	1	10	67.123	6	13.138	169.597	312.227	3764138
	Kotamobagu end	0	5	4	0,0	0,1	1	54	1	3,38	1	4	7.822	4	2.420	36.882	79.414	553940

I. Generalized Transportation Cost between Existing and with Logistics Hub Schemes

Bitung	Existing annual GTC (€)	Annual GTC via Bitung (€)	Annual saving (€)	Saving (%)	Annual volume (tons)
Lolak	2,478,911	1,943,651	535,259,90	22%	46,106
Tondano	3,029,505	4,404,473	-	-	189,559
Tahuna	1,629,543	1,229,298	400,244,26	25%	23,501
Melonguane	1,317,965	906,369	411,596,52	31%	14,487
Amurang	2,711,466	2675,994	35,472,02	1%	88,039
Airmadidi	2,110,740	3,666,619	-	-	166,738
Ratahan	1,193,835	1,322,323	-	-	48,095
Boroko	1,051,327	728,553	322,773,74	31%	12,725
Ondong Siau	588,929	520,684	68,245,85	12%	12,527
Tutuyan	450,505	425,126	25,379,13	6%	11,513
Bolang Uki	773,248	548,166	225,081,69	29%	10,079
Manado	3,322,634	4,931,339	-	-	242,810
Bitung	332,723	1,168,326	-	-	72,799
Tomohon	1,300,224	1,792,449	-	-	83,914
Kotamobagu	843,432	651,057	192,374,71	23%	15,830

Manado	Existing annual GTC (€)	Annual GTC via Manado (€)	Annual saving (€)	Saving (%)	Annual volume (tons)
Lolak	2,478,911	2,056,600	422,310,16	17%	130,560
Tondano	3,029,505	4,761,227	-	-	717,371
Tahuna	1,629,543	1,188,657	440,885,43	27%	78,849
Melonguane	1,317,965	881,311	436,654,12	33%	54,449
Amurang	2,711,466	2,543,915	167,550,88	6%	304,052
Airmadidi	2,110,740	4,224,798	-	-	607,178
Ratahan	1,193,835	1,614,280	-	-	158,907
Boroko	1,051,327	658,692	392,635,08	37%	50,752
Ondong Siau	588,929	499,251	89,678,25	15%	39,720
Tutuyan	450,505	460,957	-	-	45,824
Bolang Uki	773,248	654,577	118,670,54	15%	34,881
Manado	3,322,634	4,573,619	-	-	707,337
Bitung	332,723	1,575,829	-	-	219,210
Tomohon	1,300,224	1,848,540	-	-	246,709
Kotamobagu	843,432	638,699	204,733,57	24%	96,872

Tomohon	Existing annual GTC (€)	Annual GTC via Tomohon (€)	Annual saving (€)	Saving (%)	Annual volume (tons)
Lolak	2,478,911	1,898,584	580,326,22	23%	130,560
Tondano	3,029,505	4,487,520	-	-	717,371
Tahuna	1,629,543	1,275,091	354,451,58	22%	78,849
Melonguane	1,317,965	934,603	383,362,73	29%	54,449
Amurang	2,711,466	2,585,197	126,269,46	5%	304,052
Airmadidi	2,110,740	4,399,165	-	-	607,178
Ratahan	1,193,835	1,292,652	-	-	158,907
Boroko	1,051,327	722,993	328,334,20	31%	50,752
Ondong Siau	588,929	544,833	44,096,76	7%	39,720
Tutuyan	450,505	419,011	31,493,94	7%	45,824
Bolang Uki	773,248	506,627	266,620,93	34%	34,881
Manado	3,322,634	5,435,691	-	-	707,337
Bitung	332,723	1,671,469	-	-	219,210
Tomohon	1,300,224	1,641,832	-	-	246,709
Kotamobagu	843,432	590,234	253,198,45	30%	96,872

Tondano	Existing annual GTC (€)	Annual GTC via Tondano (€)	Annual saving (€)	Saving (%)	Annual volume (tons)
Lolak	2,478,911	1,893,179	585,731,90	24%	46,106
Tondano	3,029,505	4,149,416	-	-	189,559
Tahuna	1,629,543	1,283,272	346,270,30	21%	23,501
Melonguane	1,317,965	941,102	376,862,89	29%	14,487
Amurang	2,711,466	2,761,080	-	-	88,039
Airmadidi	2,110,740	4,390,808	-	-	166,738
Ratahan	1,193,835	1,331,493	-	-	48,095
Boroko	1,051,327	746,656	304,670,90	29%	12,725
Ondong Siau	588,929	542,908	46,021,92	8%	12,527
Tutuyan	450,505	414,473	36,032,07	8%	11,513
Bolang Uki	773,248	525,259	247,988,75	32%	10,079
Manado	3,322,634	5,380,037	-	-	242,810
Bitung	332,723	1,568,968	-	-	72,799
Tomohon	1,300,224	1,695,040	-	-	83,914
Kotamobagu	843,432	583,663	259,768,90	31%	15,830

J. Calculation of Cycle Time

Velocity of equipment:

Type of equipment	Velocity (km/hour)	Velocity (m/s)
RS	10	2.8
FL 3 ton	12	3.3
FL 8 ton	15	4.2

Cycle time of RS to unload/load container from container yard to/from heavy truck

Distance travelled from the longest container yard distance to truck = 2 x 300 m
Un/loading time = 240 s
Cycle time = 3600 s / (2 * 240 s + ((2 x 300 m) / 2.8 m/s)) = 456 s/container

Cycle time of RS to unload/load container from CFS to/from heavy truck

Distance travelled from the longest container yard distance to truck = 2 x 600 m
Un/loading time = 240 s
Cycle time = 3600 s / (2 * 240 s + ((2 x 600 m) / 2.8 m/s)) = 672 s/container

Cycle time of RS to unload/load container from container yard to/from CFS

Distance travelled from the longest container yard distance to truck = 2 x 600 m
Un/loading time = 240 s
Cycle time = 3600 s / (2 * 240 s + ((2 x 500 m) / 2.8 m/s)) = 600 s/container

Cycle time of RS to unload/load container from container yard to/from specialized container area

Distance travelled from the longest container yard distance to truck = 2 x 600 m
Un/loading time = 240 s
Cycle time = 3600 s / (2 * 240 s + ((2 x 1000 m) / 2.8 m/s)) = 420 s/container

Cycle time of forklift 3-ton to unload/load dry bulk from warehouse to/from truck

Distance travelled from the longest container yard distance to truck = 2 x 600 m
Un/loading time = 240 s
Efficient load capacity per cycle (1 movement) = 0.6 * 3 ton = 1.8 tons
Cycle time = 3600 s / (2 * 120 s + ((2 x 400 m) / 3.3 m/s)) = 240 s/movement

Cycle time of forklift 3-ton to unload/load general cargo from CFS to/from truck

Distance travelled from the longest container yard distance to truck = 2 x 500 m
Un/loading time = 120 s
Efficient load capacity per cycle = 0.6 * 3 ton = 1.8 tons
Cycle time = 3600 s / (2 * 120 s + ((2 x 500 m) / 3.3 m/s)) = 420 s/1.8 tons

Cycle time of forklift 8-ton to unload/load general cargo from CFS to/from truck

Distance travelled from the longest container yard distance to truck = 2 x 500 m
Un/loading time = 120 s
Efficient load capacity per cycle = 0.6 * 8 ton = 4.8 tons
Cycle time = 3600 s / (2 * 120 s + ((2 x 500 m) / 4.2 m/s)) = 358 s/movement

K. Summary of Stakeholders Interviews

Each notes provides the summary of interviews that have been conducted in Indonesia on March 2016. Interviewer is denoted by *Ir*. Interviewee is denoted by *Ie*.

Regional Government Planning of Bitung City (BAPPEDA Bitung)

Interviewee: Mr. Audy Pangemanan (Ex-Head of BAPPEDA Bitung, now is on his PhD study)
Location and Date: Tinutuan Cafe, March 14th 2016

Ir: "What is the best location of logistics hub in North Sulawesi Province?"
Ie: "Bitung. It is included in planning of Special Economy Zone (SEZ) of Indonesia. Plan of SEZ includes several business activities such as fisheries product and coconut derivative product industries, logistics service, and packaging."
Ir: "What is the obstacle in establishing Bitung as SEZ?"
Ie: "The recent obstacle in the way of SEZ establishment is how investor could be attracted with Bitung City. Another issue is land acquisition. In the developing country, the latest one always distracted national and regional planning. It needs both soft and hard way to communicate with various people both in west and east part of Indonesia. "
Ir: "Who is the regulator of SEZ and what is their role?"
Ie: "It is the job of Coordinating Ministry of Economic Affairs. Coordinating Ministry of Economic Affairs has established their extending agency to cope up with SEZ planning in national and regional level. Its name is Board of SEZ. The Board of SEZ in Bitung is led by the North Sulawesi Province Governor. The managing director of Board of SEZ is the mayor of Bitung City. Role of Board of SEZ should be more active to find the investor and market the concept."
Ir: "How do you think of autonomy of Bitung when they want to finance the new infrastructure?"
Ie: "Bitung City only has limited financing capability. The regional government budget of Bitung City is only around IDR 600 billion (€ 39.1 million). When it comes to spending, it has been cut-off significantly by spending of employee salary, education, health, and infrastructure. If it is spent efficiently, there is only IDR 50 billion (€ 3.3 million) to be spent for other business."
Ir: "So far, what is the shortfall between regional and national government?"
Ie: "Another limitation is the communication between the national and regional government. They both have different vision. Coordinating Ministry of Economy still left regional government without derivative regulation of SEZ. Currently, the regulation of SEZ planning are set in national level: Masterplan for Acceleration and Expansion of Indonesia's Economic (MP3EI), Blueprint of Bitung Port as International Hub Port, and Presidential Decree Number 1 Year 2014. Still, the detailed and technically direction of SEZ should be passed to the lower level of regulation. Yet, the national government asks regional government to prepare the regional-owned enterprise to seek investors of SEZ. In fact, regional government still think that there is less capacity to do that."
Ir: "How about the government effort to improve hinterland connection to Bitung Port maybe also for support SEZ?"
Ie: "Hinterland connection improvement for Bitung Port is started with the toll road construction and railway construction. Railway construction in Sulawesi is started from Makassar. If it is needed to comply with SEZ, the construction should be started from Bitung. Railway connection helps to reduce congestion. Development of SEZ, railway connection, and toll road should be complement to each other. In fact, these planning seems independent between each other, based on their own ministry program."
Ir: "How is the warehousing business in North Sulawesi Province?"
Ie: "Warehousing business now is growing in North Minahasa and Minahasa. The land acquisition is relatively easy there. The SEZ development in Bitung potentially is able to acquire area of Minahasa district since Bitung City is not big enough for future expansion of both Bitung Port and SEZ. Regional Legislative Council (DPRD) has high power in SEZ planning. They are in charge to approving regional decree for SEZ."

Headquarter of Pelindo IV (Makassar Office)

Interviewee: Mr. Kusumahadi Setya Jaya (Head of Planning and Strategy Bureau Pelindo IV)
Location and Date: Headquarter of Pelindo IV, March 10th 2016

Ir: "How is the existing connection between Makassar and Bitung?"
Ie: "The existing connection to connect Makassar to Bitung is only direct connection between these both ports. The future planning of Pelindo IV is to have Bitung Port with feeder function to other eastern part of Indonesia, such as Tobelo, Ternate, and Sorong."
Ir: "In Bitung Port itself, how do you see the connection of it?"
Ie: "There are currently three domestic shipping lines players: Meratus, Temas, Tanto. Maersk line was deactivated since the moratorium of illegal vessels by Fisheries Ministry is reinforced. "
Ir: "What is the recent plan to improve Makassar Port?"
Ie: "Other future plan is implementing new direct call of SITC shipping line (Hong Kong) from Makassar to Hong Kong. China is also planned to be one of the destination. It uses 1000 TEU vessel. It is intended to reduce double handling, transport cost, increase competitiveness of Indonesia 's commodity in the foreign trade. It is able to reduce the transport cost from 140 $/container into 15% reduction (to 120 $/container)."
Ir: "Could you please explain me the trade activity in Makassar Port?"
Ie: "The headquarter of Pelindo IV, Makassar Port has international export flow of 2,000-2,500 TEUs per day. The loading-unloading for domestic trade ranges 1200 TEUs per day with call number in range of 600-800 call. In total for a month, throughput of Makassar Port (both conventional and container terminals) are 45,000-50,000 TEUs/month. Vessel visit is 100-120 call per month. To support this operational trade activity, Makassar Port are planning to acquire two new transtainers, 7 units of CC and 18 units of RTG. In the sense of basic infrastructure, it plans to expand the length of wharf with additional 1,360 m."
Ir: "How about infrastructure in Bitung Port itself? How is the improvement planning there?"
Ie: "Bitung Port has two kind of terminals: conventional and container terminal. To comply with international hub port requirement, it needs at least 1 million TEUs per year. Nevertheless, the recent throughput there is still far less below that par. Government has supported the improvement of Bitung Port by providing state capital of IDR 365 billion (€23.8 million). This amount is intended to expand terminal of Bitung Port with reclamation (5 hectare), extend the wharf length by 131 m addition, and improve supra structures by buying 2 CC, 6 RTG, 10 HT. The total project amount is valued with IDR 500 million (€32.7 million). The future extended location of Bitung Port is Tanjung Merah."
Ir: "Do you think to reduce transport cost and the better hinterland connection, the only thing to be considered is only from port side?"
Ie: "A logical perspective to improve overall logistics cost with considering berth window, hinterland connection, vessel productivity, additional volume of export and import. To have the hinterland connection improvement, improving port side is not the only solution. The integration with freight forwarder, shipper, industries, and regulator should be maintained well. In Bitung itself, the toll road construction to Manado, the capital city, is going on. Manado has 40 km distance from Bitung Port. "
Ir: "How to increase the attractiveness of Bitung Port so that it could be international hub port?"
Ie: "Adding other shipping players and industries are the alternatives. These are obligatory for future plan to compete internationally."
Ir: "There is a concept that logistics hub can also improve the hinterland connection. What strategy do you think to have a viable logistics hub?"
Ie: "To build logistics hub, it is important for cargo owner to move their industry to the target area of logistics hub. The basic infrastructure also need to be there at the first place. Basic infrastructures consist transport infrastructure, electricity, and clean water. The crucial problem occurs also in land acquisition and registration. In some cases, there are more than one certificate in certain land in North Sulawesi Province."

Ir: “How is the shareholder’s formation in Pelindo IV?”
Ie: “The shareholders of ports in Indonesia is formed by relationship between Port Authority and Pelindo IV (Eastern Indonesia Port Corporation). Port Authority (PA) is the landlord of the port and Pelindo IV is the port operator. PA is technical service unit (UPT) from Directorate General of Sea Transportation of Ministry of Transportation in Indonesia. Pelindo IV is State Owned Enterprise) whose capital is owned by country. “

Associations of Logistics and Freight forwarders of Bitung (ALFI/ILFA)

Interviewee: Mr. Syam Panai (Board Member of ALFI/ILFA Bitung)
Location and Date: Regional Legislative Council (DPRD) office, March 14th 2016

Ir: "What is the role of ALFI/ILFA?"
Ie: "We are The associations (ALFI/ILFA) reduce the monopoly of port operators. It has strict regulation to serve registered cargo owner. The important thing to be noticed is that ALFI/ILFA should always have good coordination with port operator and cargo owner."
Ir: "How do you think of SEZ concept in Bitung?"
Ie: "SEZ is considered as a discourse of national government. There is no clear explanation about what industries that are willing to move that area for the next 20 years. Still, the concept of SEZ itself has absurdity in determining where is the best location will be."
Ir: "What is the biggest problem currently in Eastern Indonesia that can be related with need of developing port and its hinterland?"
Ie: "The problem of Eastern Indonesia generally is empty container return to western part of Indonesia. It need government regulation. Bitung Port should be transshipment hub for other eastern ports of Indonesia. As an example of empty return container, the cost of shipping 1 TEU from Surabaya to Bitung is IDR 12 million (€ 783.9). In other way around, cost to shipping 1 TEU from Bitung to Surabaya is IDR 3 million (€ 196). These prices were caused by the imbalance containers between east and west part."
Ir: "In other word, there is also need of coordination between all Pelindo's in Indonesia. But, do you think they are in a good way in communicating and coordinating? How they react with national plan of appointing Bitung as international hub port"
Ie: "Not only Pelindo IV, other Pelindo, such as Pelindo I, II, and III (located in Medan, Jakarta, and Surabaya) are competing to be the best port in Indonesia. This condition is not ideal with the concept of balancing economic activity to eastern Indonesia. Bitung has weak political power if we compare to Makassar. For hub port status, it is not feasible in recent condition, but it is possible to be implemented in next 20 years when the port and our region are ready. At that time, the future port will be relocated in Tanjung Merah (6 km away from Bitung Port)."
Ir: "What is the problem in the sense of having logistics hub in North Sulawesi Province?"
Ie: "There is still warehouse problem in Manado. The hardest thing in Bitung is the land acquisition. North Sulawesi Province is the third highest province with high land price. Land price is affected by market not because the government. Tanjung Merah owns high land price (IDR 500,000 per m^2 or €32.7 per m^2). Strict regulation is needed when it comes to public needs. Don't forget that we have problem also in port side. Forty-percent of total total logistics cost occurs in port. For the commodity itself, since moratorium of illegal fishing is enacted, we lost 50% of market. That's why having logistics hub very depend with commodity volume."
Ir: "Can you explain the hinterland connection situation via truck from/to Bitung Port?"
Ie: "Trucking cost from Bitung to Manado is IDR 1-1.5 million/TEU (€65-98). The distance between Manado and Bitung is 44 km. For one truck, there are 2 return trips per day. Construction of toll road is expected to improve hinterland connection. If the handling cost in Bitung Port is added, total generalized transport cost from Bitung to Manado will be IDR 3-3.5 million/TEU (€195-228)."
Ir: "How is the structure of cost in trucking?"
Ie: "The most dominant spending is for fuel, which ranges up to 70%. The rest are for maintenance, driver, etc. Each ranger 10% of cost."
Ir: "How many members of ALFI/ILFA in Bitung? How is the recent condition of competition between companies?"
Ie: "There are 50 freight forwarders companies in Bitung. Another player from Jakarta and Surabaya also open their branch there. The complaint from most freight forwarders is licensing of enterprises. The company from other cities pay their tax to their origin although the roads that were used in Bitung are damaged by the usage of their trucks."

Ir: “How government prepare their inhabitants to face it?”
Ie: “Bitung owns their logistics academy, called as Bitung Logistics Centre Community. It is prepared to face ASEAN Economic Community (AEC). Related with AEC, government need to limit the invasion of foreign freight forwarder companies to protect national companies.”

Tuna Products Industry (PT. Samudra Mandiri Sentosa)

Interviewee: Mrs. Anita (Logistics Planner PT. SMS)
Location and Date: PT. SMS, Bitung, March 15th 2016

Ir: "Would you please describe a short profile of your company?"
Ie: "We are PT Samudera Mandiri Sentosa (SMS). It is a tuna cannery industry, which is started in year 2012 by acquiring one of the largest tuna cannery in eastern part of Indonesia with daily capacity of 150 metric tonnes. We are supported by massive fishing fleets from our parent company and mostly focusing in Pole and Line (method in fishing tuna) caught tuna. We have exported most of our Pole and Line caught canned tuna to Europe and North America. Our commitment to sustainable fishing, environmental friendly, our premise and systems are run to a precise HACCP (Hazard Analysis and Critical Control Point) plan and certified with international standards such as BRC (global standard for manufactured foods)."
Ir: "What is your opinion of SEZ concept in Bitung or the application of logistics hub in North Sulawesi Province?"
Ie: "Honestly, I still don't really capture the detail of this concept. Therefore, I can't say much about it. We are focusing to improve our industry in this location. In my opinion, government should be investing in logistics hub with bonded zone. Therefore, we can have taxation process inside that area. We can pay full including (un)loading and additional goods tax inside that area."
Ir: "Would you please describe the logistical process in PT. SMS?"
Ie: "First, we collect the fish from traditional fishermen. It is collected in our subsidiary company, which operates in (un)loading fish business. Afterward, it is collected to be processed in this factory."
Ir: "How much is the cost to shipping your products."
Ie: "It is IDR 9 million/TEU (€ 586) to Jakarta. Most of our products are exported internationally to US and Europe market via Jakarta."
Ir: "How is government influence to your industry?"
Ie: "They are supportive in most cases like bureaucracy in export. Nevertheless, we are hit so bad by reinforcement of illegal fishing moratorium by Ministry of Fisheries and Ocean. We lost 60-80% of our production by that law. For example, before the moratorium our production can be 40-45 ton/day. After the moratorium, it declined up to 20-25 ton. Nevertheless, we keep producing in these days. In the other hand, the existence of Maersk Line is very beneficial for us."
Ir: "What is your future strategy regarding to international hub port concept of Bitung?"
Ie: "If it is feasible, we try to add our market to Middle East, like Dubai and so on."
Ir: "What is the current problem you experience in our port system?"
Ie: "Related to ocean freight rates, Indonesia generally has very high cost. Compared to Thailand and Philippines, they have very attractive rate. That is also the point why we still lack of attractiveness in fish trading."

Domestic Shipping Lines (TEMAS Line)

Interviewee: Mr. Edi (Head of Planning and Strategy Bureau Pelindo IV)
Location and Date: Riverside Café, Bitung, March 14th 2016

Ir: “Can you explain TEMAS line activity in Container Terminal (CT) Bitung?”
Ie: “(Un)loading activities of vessel is 600-700 TEUs annually. It comprises full container 150 TEUs and empty container is 450-550 TEUs. In Makassar Port, the commodities are cement, rice. Meanwhile, In Bitung, the dominant commodities are fisheries product and coconut products.
Ir: “How is TEMAS operation in Indonesia?”
Ie: “The head office of TEMAS is in Jakarta with branch offices in Surabaya, Makassar, Bitung, Ambon, Sorong, Manokwari, Biak, Jayapura, Timika, Merauke, Balikpapan, Samarinda, Banjarmasin, Pontianak, Palembang, Dumai, Pekanbaru, Batam, and Belawan. We already in line with concept of national maritime highway. The connection of TEMAS from Bitung only has two destinations: Surabaya and Jakarta.”
Ir: “What is the best location of logistics hub in North Sulawesi Province?”
Ie: “The ideal logistics center is in Bitung. Since it is already being planned by national government and close to port.”
Ir: “What is basically situation in determining price for customer?”
Ie: “Ocean freight cost per TEU is dynamic. It depends with the season and harvesting time. Two conditions of ocean freight cost: If there are lot of demands, the ocean freight cost goes up. In the contrary, the less demands result the low cost”
Ir: “What is the problem in Bitung Container Terminal?”
Ie: “Long process of (un)loading, in fact it should be faster. Window time is also important. In sequence process, if 1 port fail to fulfil the window time, it will fail the next port in the sequence. The current situation is that window time is not on time, delay could reach up to 6 hours. Another problem is: Bitung Port has small port but increasing volume of container annually and lot of operators. In the other hand, there is no significant development in port infrastructure. Transtainer is very important in moving container. But the area is very small.”
Ir: “What is the innovation of TEMAS regarding to Bitung International Hub Port concept?”
Ie: “Temas focus in domestic market. Let alone the international service for Maersk Line. We also want to have a join slot; in which it will be unloaded in Jakarta or Surabaya in the end. Our vision in 2017: TEMAS becomes the #1 domestic shipping line. All services will enter the potential regions. It will need more vessels. For 30 ports, it will need 50 vessels (currently only 30 vessels).”
Ir: “What is the position of TEMAS in Bitung Port?”
Ie: “TEMAS market share ranks #2 in CT Bitung, currently. It has less call than Tanto line. Tanto has more frequent calls with less size of vessels. In the other hand, Temas has less call but bigger vessels. Tanto is #1 in CT Bitung by share of volume.”
Ir: “How is the concept of logistics hub to reduce transportation cost?”
Ie: “It is a very good concept. It will make less stacking in CT Bitung. Thus, it results the easier way to bring the goods. Then, full container unloading is not stacked in CT Bitung. Currently, the way of stacking is not feasible (too much tiers).”
Ir: “How is the hinterland connection to/from to Bitung Port?”
Ie: “It is full with queuing truck, the truck flow to Manado could take 1-1.5 days. 1 container for 1 day. I hope with new logistics hub; it will take quicker time to distribute the goods. It potentially saves cost of storage and demurrage
Ir: “How about the governance in Port?”
Ie: “It is too complicated. We need to improve the online system. All shipping lines who want to be quick, need transportation module.”