STATED PREFERENCE STUDY OF PORT AND INLAND MODE CHOICE FOR CONTAINERIZED EXPORTS FROM JAVA

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“All the Praises be to Allah, the Lord of the worlds.”

Abstract

The aims of this thesis are to understand the issue of intermodal transport in Indonesia and to examine the impact of related policies on shifting to the rail mode; as an attempt to cut GHG emissions from containerized exports from Java.

Stated preference (SP) and Revealed preference (RP) data of exporters and forwarders was collected for this purpose.

This study employed four inland mode attributes (cost, time, reliability and GHG emissions) and two port attributes (port cost and ship calls frequency) to examine the alternatives. The SP-only and combined SP-RP data are employed to estimate the model using Multinomial Logit, Nested Logit, Mixed Multinomial Logit, and Mixed Nested Logit.

The estimation results indicate that increases in inland mode cost, inland mode time, inland mode GHG emissions, and port cost all have very substantial adverse effects on the alternative's utility. Conversely, inland mode reliability and frequency of ship calls have positive influence on the utility.

Five single policies and four combined policies have been simulated using the best model gained from the estimation. Two single policies of cutting fuel subsidies for road mode and giving incentives to rail freight would provide the most important encouragement to modal shift. Nevertheless, the biggest reduction in GHG emissions can be obtained through policies of cutting fuel subsidies for road mode and putting restrictions on times and routes permitted for the road transport operations.

The primary contribution of this research rests on its analysis of the exporters' and freight forwarders' attitudes related to GHG emissions, and the possible effects of policies that may be implemented to reduce GHG emissions. The novelty of this research is in its development of a joint model of port and inland mode choice from the exporters' and forwarders' perspective.

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List of Abbreviations

AHP	Analytical Hierarchy Process
ALI	Asosiasi Logistik Indonesia (Indonesian Logistics Association)
ASC	Alternative-Specific Constant
ASEAN	Association of South East Asia Nations
BAPPENAS	Badan Perencanaan Pembangunan Nasional (National Development Planning Agency)
BI	Bank Indonesia
BPS	Badan Pusat Statistik (Statistics Indonesia)
CA	Conjoint Analysis
CDP	Cikarang Dry Port
CMoEA	Coordinating Ministry for Economic Affairs
CV	Contingent Valuation
DEFRA	Department for Environment, Food and Rural Affair
DGoH	Directorate General of Highways
DGoLT	Directorate General of Land Transportation
DGoR	Directorate General of Railways
DGoST	Directorate General of Sea Transportation
EIA	Energy Information Administration
FCL	Full Container Load
GBDP	Gede Bage Dry Port
GBP	Great Britain Pounds
GDP	Gross Domestic Product
GHG	Green House Gas
HS	Harmonized System
IDR	Indonesian Rupiah

IEA	International Energy Agency
IFEU	Institut für Energie und Umweltforschung (The Institute for Energy and Environmental Research)
IIA	Independence of Irrelevant Alternatives
IID	Independent and identically distributed
ITF	International Transport Forum
JICA	Japan International Cooperation Agency
JICT	Jakarta International Container Terminal
LPI	Logistics Performance Index
LWS	Low Water Spring
MCDM	Multi-Criteria Decision Making
MNL	Multinomial Logit
MoEMR	Ministry of Energy and Mineral Resources
MoPW	Ministry of Public Works
MoT	Ministry of Transportation
MP3EI	Masterplan Percepatan dan Perluasan Pembangunan Indonesia (The Masterplan for Acceleration and Expansion of Indonesia Economic Development)
MXMNL	Mixed Multinomial Logit
MXNL	Mixed Nested Logit
NL	Nested Logit
NPMP	National Port Master Plan
NRMP	National Rail Master Plan
OECD	Organisation for Economic Co-operation and Development
PDRB	Produk Domestik Regional Bruto (Regional Gross Domestic Product)
PELINDO	Pelabuhan Indonesia (Port Management State Owned Enterprise)
PT KAI	PT Kereta Api Indonesia (The Indonesian Railways Corporation, owned by the Indonesian Government)

PUSLOGIN	Pusat Studi Logistik and Optimisasi Industri (Centre for Logistics and Industrial Optimization)
RP	Revealed Preference
RTRW	Rencana Tata Ruang Wilayah (Regional Development Plan)
SISLOGNAS	Sistem Logistik Nasional (National Logistics System)
SP	Stated Preference
SSS	Short Sea Shipping
TEU	Twenty-foot Equivalent Unit
TPKS	Terminal Peti Kemas Semarang (Semarang Container Terminal)
TPS	Terminal Peti Kemas Surabaya (Surabaya Container Terminal)
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNECE	United Nations Economic Commission for Europe
WSC	World Shipping Council
WTO	World Trade Organisation
WTP	Willingness to Pay

Chapter 1

Introduction

1.0 Introduction

Chapter 1 provides a general introduction to this study. The background of the research is outlined in Section 1.1, and this is followed by the context of the research in Section 1.2. From here, Section 1.3 describes the aims and objectives to be achieved by this study followed by the explanation of the novelty and the contribution given by this study in Section 1.4. Chapter 1 ends with a description of the structure of the written thesis in Section 1.5.

1.1 Background of Study

The growth of the international trade is inescapable. This tendency has a significant effect on the freight transport sector since more products have to transfer between an origin and a destination country that will be further away from each other. In terms of transporting manufactured products, a container transport system is the appropriate choice and recently it has grown quickly. The container volume tripled in 2013, compared to 1996. The details of growth and volume of full-containerized international trade can be seen in **Figure 1.1**.

As one of the emerging countries, Indonesia has an economic growth of about a 5.8% per year and the growth of export during 2006-2010 on average was about 13.6% and 14.3% on weight and value of export respectively (WTO, 2011; UN, 2011). As an archipelagic country, most of Indonesia's exports and imports use sea vessels for transporting product from and to Indonesia (Kemendag, 2011). In 2010, Indonesia was at the 8th position on the list of top exporters of containerized cargo with approximately 3.0 million TEUs cargo and 2.8% of the world share (WSC, 2010a).

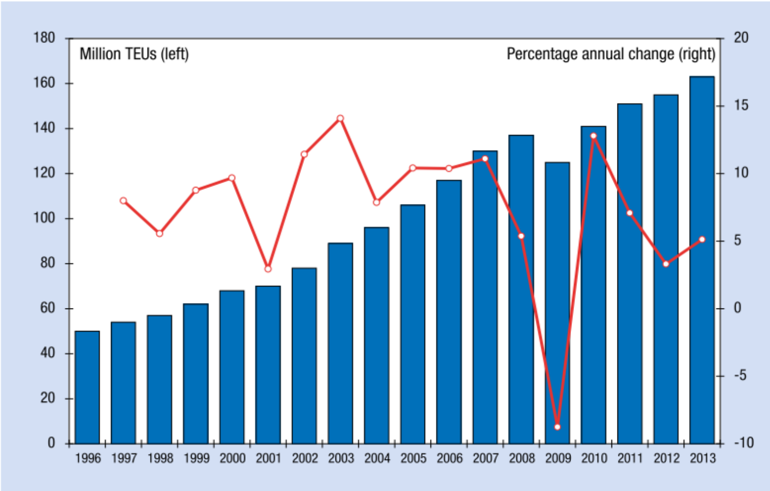

Figure 1.1 World container trade volume (millions of TEUs, bars) and growth rate (line) during 1996-2013. *Source: UNCTAD (2013)*

The containerized exports of Indonesia are primarily shipped from three container ports in Java, namely Tanjung Priok Port (Jakarta Port - JKT), Tanjung Emas Port (Semarang Port - SMG) and Tanjung Perak Port (Surabaya Port - SBY). The three ports contribute almost 70% of total container throughput in Indonesia. Currently in the Tanjung Priok Port there is a new construction to increase the port capacity of about 6 million TEUs to 10.5 million TEUs by 2017 (PELINDO II, 2014). In addition, the Indonesian government also plans to start the construction of new port in Cilamaya (CMY - about 100 km to the east of Port of Tanjung Priok) by 2015 to support the port of Tanjung Priok (BAPPENAS, 2012). The location of the three main container ports is shown in **Figure 1.2** below.

Figure 1.2 Location of main container ports in Java. *Source: http://gis.dephub.go.id/mappingf/Map_Laut.aspx#*

The issue in containerized exports from Java not only connect to the port but also link up to the inland transport system from the origin region to the chosen departure port. Inland mode choice for transporting the container from the shippers' location should not be separated from the port choice itself. Most of the shippers and freight forwarders in Java chose trucks as their preferred mode to deliver the containerized exports from the origin region to the existing three ports above. The truck mode is more favourable than the rail mode for some reasons. The truck mode is more flexible, and the truck mode can reach all cities in Java. In addition, the truck mode needs a lower cost than the rail mode because the cost of fuel used by the truck is subsidized by the government of Indonesia.

The situation above causes several environmental impacts in various ways including Green House Gas (GHG) emissions effects (emission of gases such as CH_4, CO_2 and N_2O), acidification, toxic effects on ecosystems, toxic effects on humans, land use, noise and resource consumption (IFEU, 2011). One of the important impacts is GHG emission that significantly contributes to global warming, almost a quarter of the worldwide CO_2 emissions comes from the transport sector (IEA, 2009).

During 1990-2008, CO_2 emissions in Indonesia increased from 140 million tonnes to 385 million tonnes, or, in other words, the CO_2 emissions grew on average 9.7% per year during the period. The biggest CO_2 emitter in Indonesia was the manufacturing sector that uses coal or peat as their source of energy with a volume of CO_2 emissions of 131 million tonnes. Furthermore, the second largest was energy sector (108 million tonnes of CO_2), and the third largest emitter was transportation sector (76 million tonnes of CO_2) (IEA, 2010) see **Figure 1.3** below.

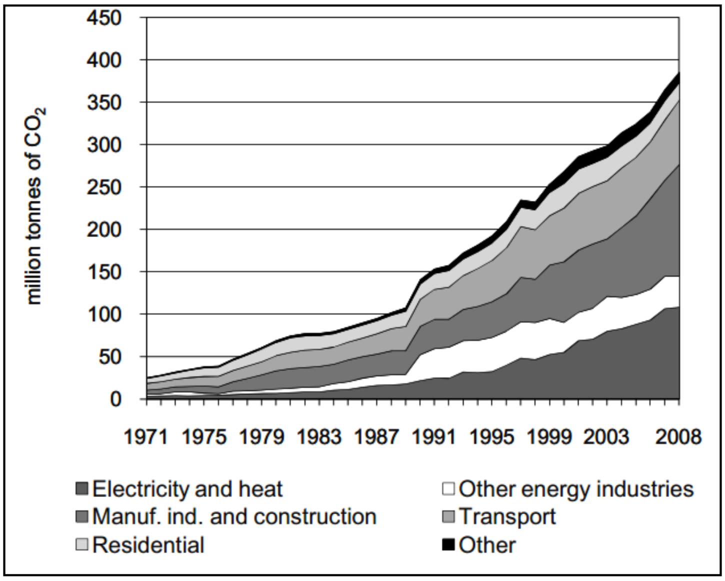

Figure 1.3 CO_2 emissions in Indonesia during 1971-2008 *Source* (IEA, 2010)

According to the Presidential Regulation of Indonesia (PoI, 2011a) and the report from International Transport Forum (ITF and OECD/ITF, 2010), Indonesia has a commitment to reduce the GHG emissions by 26% in 2025.

To reduce the GHG emissions from the road freight transport, a plan to increase the role of rail in freight transport has been launched by the Indonesian Government. The plan consists of re-activate the dry ports that were closed due to low demand from the shippers and developing double-track rail network in Java to enhance the passenger and freight transport capacity through the rail transport system. Furthermore, the government also plans to reduce the fuel subsidy for the road transport and will restrict the route and operation hours of the truck mode.

Based on the facts above, the success of the plan for shifting from the road mode to the rail mode depends partly on the understanding of the behaviour of the shippers and freight forwarder in choosing an inland mode and port. In order to obtain the preferences data, Stated Preference (SP) method is the most appropriate method to evaluate the user's preferences in the selection of an alternative that does not exist (New Cilamaya Port) and some new rail services for freight transport.

1.2 Research Context

This study examines the problem of shippers or freight forwarders on choosing departure port and inland mode to move their containerized products from the origin region to the port of departure. Usually, decision makers in the private sector only consider transportation cost, transfer cost between modes, inventory cost, risk, delivery time, but there are other impacts on society that also should be considered. The availability of transport modes and their environmental characteristics also need to be considered. In accordance with the objective of reducing the GHG emissions, the environmental impact should be considered by the decision makers when selecting the port and inland mode in intermodal transport.

In line with the comparison of freight transport modes, the rail transport mode emits less GHG per tonne-km than the road transport mode (Kruse, Protopapas, Olson, and Bierling, 2009; IFEU, 2011). Unfortunately, most of container movement in Java use the road mode as the main container transport mode instead of the rail mode. As an archipelagic country, Indonesia has specific characteristics related to the container transportation problem. Most of the Indonesian exporters use the sea transport as the main transport mode to deliver their products from Indonesia to the destination countries. Therefore, the port choice is crucial for international container freight transport, where inefficient port operations and or facilities may delay the intermodal transfer process (Min, 1991).

In order to reduce the GHG emissions from the container freight transport in Java, the shifting of container movement by truck to movement by rail is an appropriate choice due to the lower GHG emissions per tonne-km of the rail transport than road transport. To encourage the shippers and freight forwarding companies to use rail transport the government needs to implement the appropriate policies in accordance with the preferences of the shippers and freight forwarders in inland mode choice. This study focuses on a stated preference study of inland mode and port choice from the shippers' or freight forwarders' perspective in Java, Indonesia and analyses and simulates the policies implementation using models obtained from the estimation process.

1.3 Research Aims

The intention of this research is to achieve two aims; the first is to understand issues associated with the container transport system and its environmental impacts in Java, Indonesia. The second aim is to analyse the behaviour of the shippers and examine the impact of policies related to containerized freight transport in Java.

In order to achieve the research aims above, several research tasks should be addressed:

1. Understand the existing freight transportation system in Indonesia. The study includes observing the current situation and identifying the problems on it, especially the container system in Java, Indonesia. The future development plans, including its impact on the environment, are also been studied. (Presented in Chapter 2)
2. Carry out a literature review of previous and existing freight mode choice and port choice studies and relevant areas (Presented in Chapter 3).
3. Propose an appropriate research methodology that can be used to reach the objectives, based on the actual condition of Indonesian intermodal freight transport and the results of the review on related literature (Presented in Chapter 4).
4. Develop an inland mode and port choice model from the shippers' and freight forwarders' perspective, through sub-objectives below:
    - Conduct a stated preference survey to collect the preference data of the shippers and freight forwarders on port choice and inland mode choice (Presented in Chapter 5)
    - Conduct estimation of the parameters to identify and quantify the factors that influence the shippers and freight forwarders in their decision-making process (Presented in Chapter 6)
    - Carry out simulation on the basis of the estimation results for the impact of various policies related to the containerized transport in Java. (Presented in Chapter 7)

1.4 Novelty and Contribution of the Research

In the freight mode choice, most of the previous researchers investigated only on freight mode choice (road, rail, sea, air), although a few researchers attempted to include other factors such as shipment size, firm characteristics and goods characteristics. The main contribution of this research lies in developing a joint model of inland mode and port choice from the shippers' or freight forwarders' perspective. Another contribution is collecting new stated preferences data of shippers and freight forwarders on inland mode and port choice in Java. This research also analyses the shippers' and freight forwarders' attitudes related to GHG emissions. This study also gives an appropriate recommendation for the policy simulation, according to the shippers' and freight forwarders' preferences on mode and port choice, the government of Indonesia could formulate an appropriate policy for containerized freight transport.

1.5 Thesis Structure

The written thesis is consists of eight chapters, and the structure of this thesis is as follows:

1. Chapter 1 presents the background of the study, research objectives, research context, novelty and contribution of research and the structure of the written thesis.
2. Chapter 2 elaborates the current situation economic, logistics and freight transport in Indonesia, especially the intermodal transport system in Java; including the problems and the future plan development.
3. Chapter 3 provides a review of existing and previous works on studies of freight transport modelling with emphasis on inland mode and port choice behaviour. This chapter also presents the issue of GHG emissions estimation and reduction in freight transport sector.
4. Chapter 4 outlines the information related to research methodology employed in this study. The research begins with the preliminary study and continues with a stated preference survey. The next step is the estimation of parameters

using the data collected. The analysis and simulation of policies implementation are conducted to find the appropriate policy to reduce the GHG emissions.

5. Chapter 5 elaborates the details of the experimental design and data collection process, including pilot survey and main survey. This chapter also gives a brief summary of the data collected.

6. Chapter 6 reports the result of estimation parameters using Multinomial Logit, Nested Logit, Mixed Multinomial Logit and Mixed Nested Logit. The estimation is conducted to examine the attributes of the alternatives that influence the choice. The estimation carried out using SP data only and joint SP and RP (revealed preference) data.

7. Chapter 7 presents the simulation results and analysis of the GHG emissions reduction using five single and four combined policies. The simulation is carried out using the best model from the estimation parameter stage.

8. Chapter 8 summarizes all the chapters and then presents the conclusions of the research carried out, and points out the recommendations for the further study.

Chapter 2
Indonesian Logistics and Intermodal Freight Transport in Java

2.0 Introduction

This chapter presents the current situation of the economy, international trade and transportation in the context of Indonesia, with specific attention to the intermodal freight transport in Java. The chapter begins with Section 2.1, which presents the current situation of Indonesian geography, demography, economy and logistics. Section 2.2 explains infrastructure, traffic, service and common problems associated with the intermodal freight transport system in Java. Section 2.3 provides more details in regard to intermodal problems, whilst Section 2.4 presents the future and current government plans and projects related to intermodal transport. This chapter concludes with Section 2.5, which delivers a summary of the situation, problems and policies relating to the transport logistics in Java, specifically in the field of container transport.

2.1 Indonesia

2.1.1 Geography and Demography

Indonesia is located in Southeast Asia, which is dubbed as the Emerging and Developing Countries of Asia, along with China, India, Malaysia, Thailand, Philippines and Vietnam. These seven countries had an average economic growth of nearly 7% per year in 2014—approximately twice the average growth of the world economy that is only 3.4% per year. Indonesia is the largest archipelago in the world and consists of more than 17,000 islands, and in 2010 had a population of approximately 240 million, becoming the fourth largest country in terms of population.

The area, population and Regional Gross Domestic Product (PDRB[1]) of Indonesia are presented in **Table 2.1**.

From **Table 2.1** below, it can be seen that, although the area of Java Island is only 6.8% of the total Indonesian territory, in 2010, Java is the most populous island with some 136 million people (57% of Indonesia's population) in 2010. In addition, Java was the biggest contributor to the Gross Domestic Product (GDP) of Indonesia in 2013, with contributions reaching 58% of total Indonesian GDP.

Table 2.1 Area, population, and PDRB of Indonesia. *Source: Compiled by the author from BPS* (BPS, 2014b; BPS, 2012; BPS, 2014a)

Islands	**Area (km^2)**	**%**	**Population 2010 (million)**	**%**	**PDRB 2013 (trillion IDR)**	**%**
Sumatera	480,793	25.2%	50,631	21.3%	1,805	23.8%
Java	129,438	6.8%	136,611	57.5%	4,394	58.0%
Bali, Nusa Tenggara	73,070	3.8%	13,075	5.5%	191	2.5%
Kalimantan	544,150	28.5%	13,788	5.8%	657	8.7%
Sulawesi	188,522	9.9%	17,372	7.3%	366	4.8%
Maluku, Papua	494,957	25.9%	6,165	2.6%	165	2.2%
	1,910,931	100.0%	237,641	100.0%	7,578	100.0%

2.1.2 The Economic Situation in Indonesia and International Trade

It is given that economic growth positively affects the growth of container traffic in a country. The Indonesian economy grew by an average 5.5% per year between 2000 and 2013, with the container throughput of Indonesian ports, increasing by an average 9.4% per year during the same period (*see* **Figure 2.1** for more details). Foreign trade dominates container port throughputs compared with domestic trade, with the percentage of international trade amounting to 64.5%—almost double that of domestic trade using the containers.

[1] Produk Domestik Regional Bruto (PDRB) or Regional Gross Domestic Product

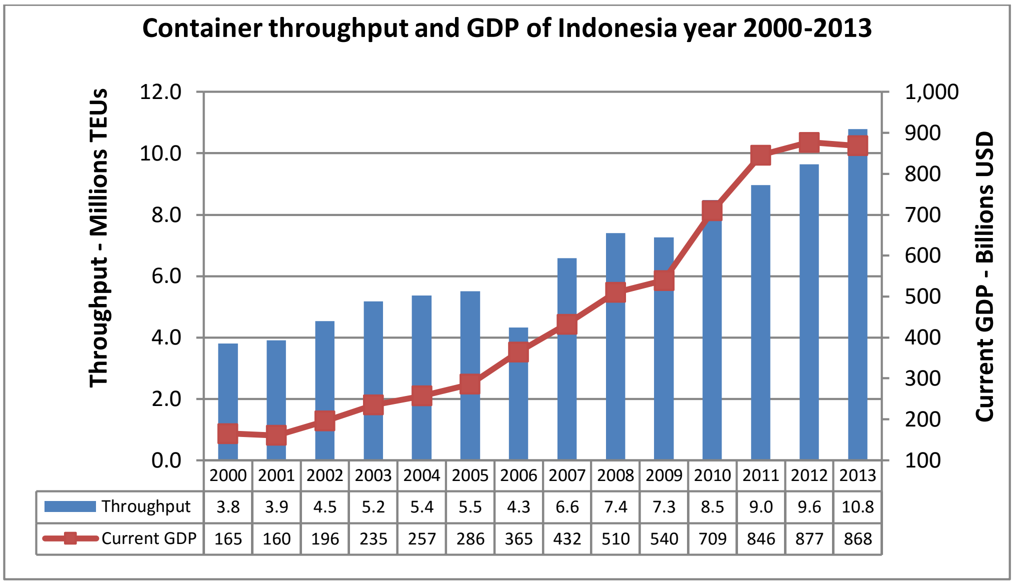

Figure 2.1 Indonesian port container throughput and the GDP of Indonesia in 2000–2013. *Source: Compiled from http://databank.worldbank.org/*

2.1.2.1 International Trade of Indonesia:

The value of Indonesian export has an excellent growth rate of an approximate 9.7% per year during the 2000–2013 period (BPS, 2014c). As shown in **Figure 2.2**, Indonesian export values dropped in 2009 as a result of the economic crisis, when demand from countries in Europe and the United States dramatically decreased. In terms of the volume of export, Indonesia also experienced a sharp decline of export in 2002. Nonetheless, with very high-volume growth in 2001, 2006 and 2010, export volumes still grew by an average 9.8% per year during the 2000–2013 period (BPS, 2014d). The values of Indonesian export also dropped in 2009, but then jumped very high, demonstrating more than 30% growth in 2010 and 2011.

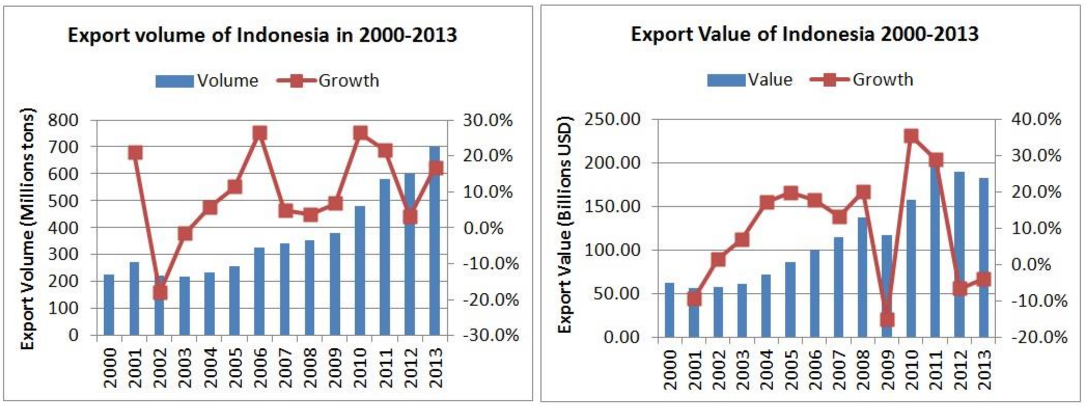

Figure 2.2 Export volume and value of Indonesia in 2000–2013. *Source: presented in graph by the author based on the data from* (BPS, 2014c; BPS, 2014d)

In 2012, the total export value of Indonesia was 212 billion US dollars, which was greater than the import value of 186 billion US dollars. In terms of the value of international trade, the most significant Indonesian trade was carried out by countries in Asia, followed by countries in America, Europe, Australia and Oceania, and least with countries in Africa. The import value also has a similar geographic split. Asia took the largest portion of Indonesian international trade, amounting to approximately 71% of total exports and 75% of total imports. The details of the distribution of export and import values can be seen in **Table 2.2** below.

Table 2.2 Distribution of Indonesian export destinations and import origins based on the value of trade in 2012. *Source from https://atlas.media.mit.edu/en/profile/country/idn/*

Destinations/ Origins	Export		Import	
	Billion USD	%	Billion USD	%
Asia	151	71.0%	141	75.4%
Europe	25	11.7%	17.2	9.2%
North America	20.5	9.6%	13.3	7.1%
Oceania	7.14	3.4%	5.98	3.2%
Africa	6.13	2.9%	4.38	2.3%
South America	3.05	1.4%	5.05	2.7%
Total	212.82	100.0%	186.91	100.0%

As shown in **Figure 2.3**, in 2000–2012, mineral products were the largest commodity of the export value from Indonesia, including coal briquettes, petroleum gas and crude petroleum. As for non-mineral products, the four largest export commodity values in a sequence are animal and vegetables bi-products (for instance, eggs, milk, leather, palm oil and vegetable oil), machines, plastics and rubber products, and textiles. Although the value of mineral exports still constitutes the largest part, the value of non-mineral exports also significantly increased. Non-mineral exports are mostly shipped using containers from various major container ports, such as Tanjung Priok Port, Tanjung Emas Port, and Tanjung Perak Port (in Java), Belawan Port (in Sumatera), Makassar Port (in Sulawesi) and Sorong Port (in Papua).

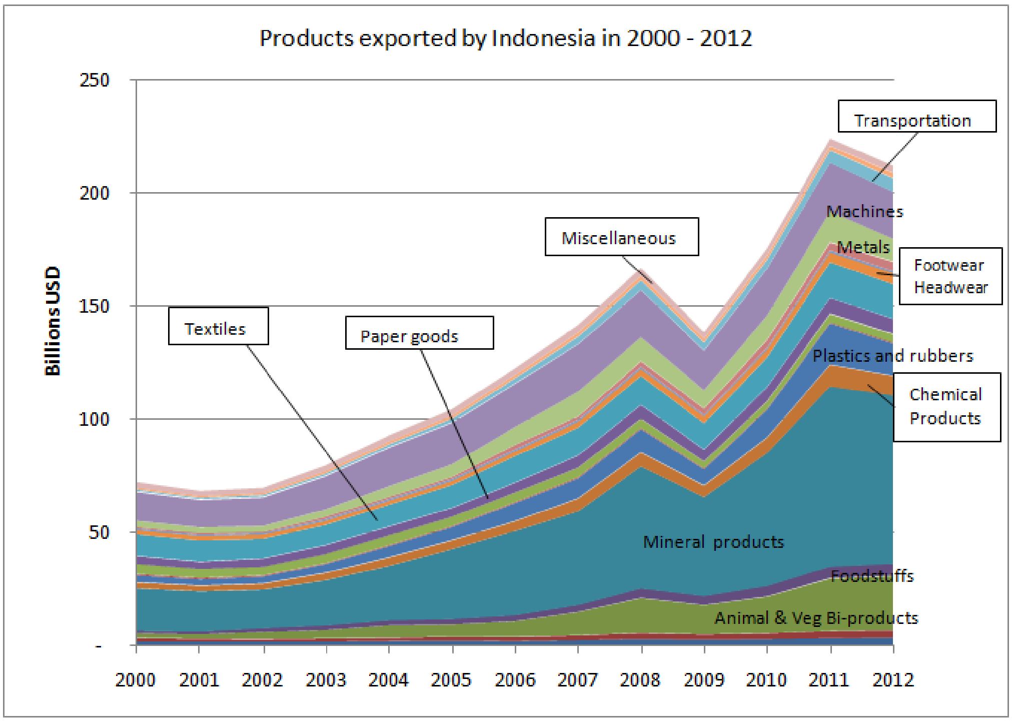

Figure 2.3 Products exported from Indonesia in 2000–2012. *Source adapted from* *https://atlas.media.mit.edu/en/explore/stacked/hs/export/idn/all/show/2000.2012/*

2.1.2.2 Containerized Exports and Imports

As an archipelagic country, most of Indonesia's exports and imports use sea vessels for transporting products to and from Indonesia. In 2010, Indonesia were in 8th position on the list of top exporters, as well as for containerized cargo, with approximately 3 million TEU[2]s cargo and 2.8% of the world share (WSC, 2010a). Indonesia was also at the same position on the list of the top world importers of the 2.5 million TEUs cargo shipped to Indonesia in 2010, demonstrating a rise from 2.1 million TEUs in 2009 (WSC, 2010b).

Based on the destination and origin of containerized trades to and from Indonesia (*see* **Figure 2.4**), in 2007, the majority of container movement was seen to be an intra-Asian continent, namely 61%. Other destinations are the America, Europe, Australia and Africa, with percentages equating to 12.5%, 11.5%, 11.1% and 3.6%, respectively.

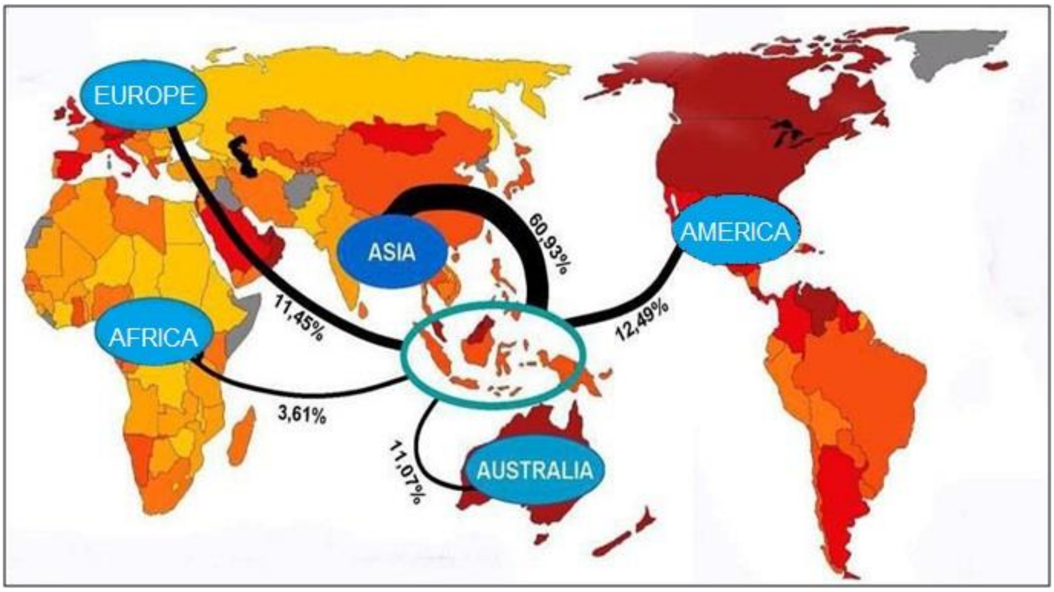

Figure 2.4 Distribution of container movement for export and import from and to Indonesia. *Source: Appendix of Blueprint of National Logistics System Development (MP3EI)* (CMoEA, 2011)

Figure 2.5 below shows that the containers' flow for Indonesian exports and imports to and from Europe, Africa, America and most Asia should be trans-shipped in Singapore and Malaysia. Only a small amount of exports and imports are shipped directly to countries in Asia, and the shipments are handled at the ports located in Java. This situation made the export competitiveness of Indonesia lower than the

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2 TEU Twenty-foot equivalent unit. Term used in containerization and shipping as a measure of capacity or throughput related to a standard 20ft ISO* container (for instance a 40ft container = two TEUs) (Lowe, 2002)

competitiveness of Singapore and Malaysia. International trade to and from Australia and Oceania was carried out directly from Java, Bali and Nusa Tenggara. The direct shipping to Australia is as a result of the shorter distance compared with other continents. The containers flow of the inter-island movements has to be trans-shipped in Java: for instance, the movement from Sumatera to Sulawesi should be trans-shipped in Java.

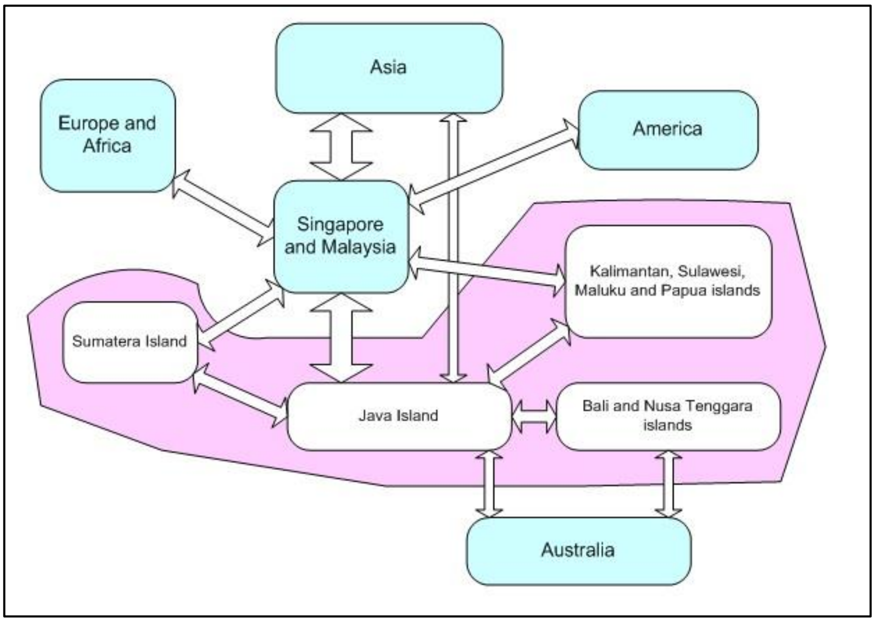


Figure 2.5 Container flow intra-Indonesia and for international trade. *Source: Appendix of Blueprint of National Logistics System Development (MP3EI)*(CMoEA, 2011)

From the bar chart detailed in **Figure 2.6** below, we can see that the containers' traffic in Tanjung Priok Port (near Jakarta) mostly came from international trade (70%) and had the largest throughput with more than 6 million TEUs in 2012. In contrast, the Tanjung Perak Port of Surabaya served more for the domestic container throughput (52%) as opposed to international trade, whilst the Tanjung Emas Port served at most of the international trade.

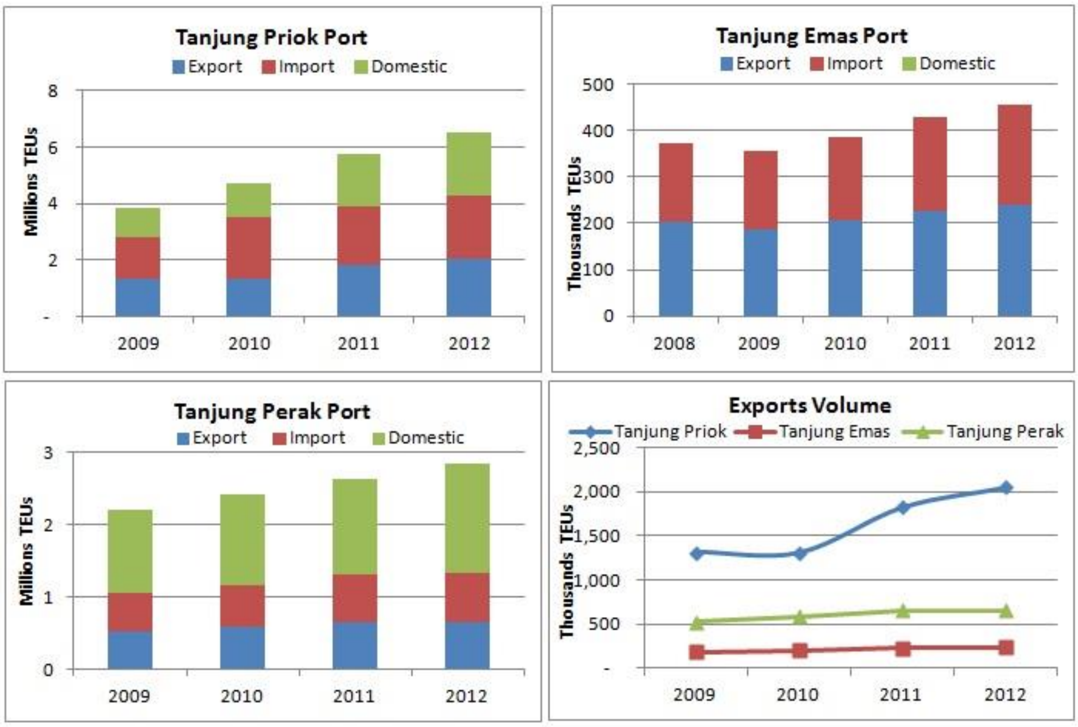


Figure 2.6 Export, import and domestic container traffic in Tanjung Priok Port, Tanjung Emas Port, and Tanjung Perak Port in 2009–2012. *Source: Data compiled from the authority of Tanjung Priok Port, Tanjung Emas Port, and Tanjung Perak Port.*

The growth of containerized export volume in Tanjung Priok Port was the highest during 2009-2012 when compared with Tanjung Emas and Tanjung Perak Port. In 2013, Tanjung Priok Port and Tanjung Perak Port were listed in the top 50 of container ports, with ranks of 22 and 46, respectively (WSC, 2013).

2.1.3 Logistics Performance of Indonesia

According to the report prepared by the Centre of Logistics and Supply Chain ITB, Indonesian Logistics Association (ALI) and World Bank, the percentage of the Indonesian national logistics cost to the Gross Domestic Product (GDP) was 27% in 2007, and subsequently decreased to 24.6% in 2011. This percentage was still very high compared with developed countries, such as Japan (10.6%), the United States (9.9%) and South Korea (16.3%). The largest costs came from the transportation sector, with an average 12% Indonesian GDP (Bahagia *et al.*, 2013).

Moreover, from the World Bank report on the Logistics Performance Index (LPI) and its indicators in 2007, 2010, 2012 and 2014, Indonesia's LPI dropped from rank 43 in 2007 to rank 75 in 2010, out of a total of 155 countries, with its score seen to decline from 3.01 in 2007 to 2.76 in 2010. However, LPI showed improved performance in 2012 and 2014, with increased ranks to 59 and 53, respectively, and score improvement from 2.9 in 2012 to 3.1 in 2014. From **Figure 2.7** below, we can see that, in the Southeast Asia region, Singapore is the best performer in logistics, followed by Malaysia and Thailand. Indonesia, Vietnam and Philippines are at the same level of logistics performance. Nevertheless, Indonesia was only better than Philippines in 2014 and was seen to be the worst in 2010 and 2012 when compared with the selected countries in Southeast Asia.

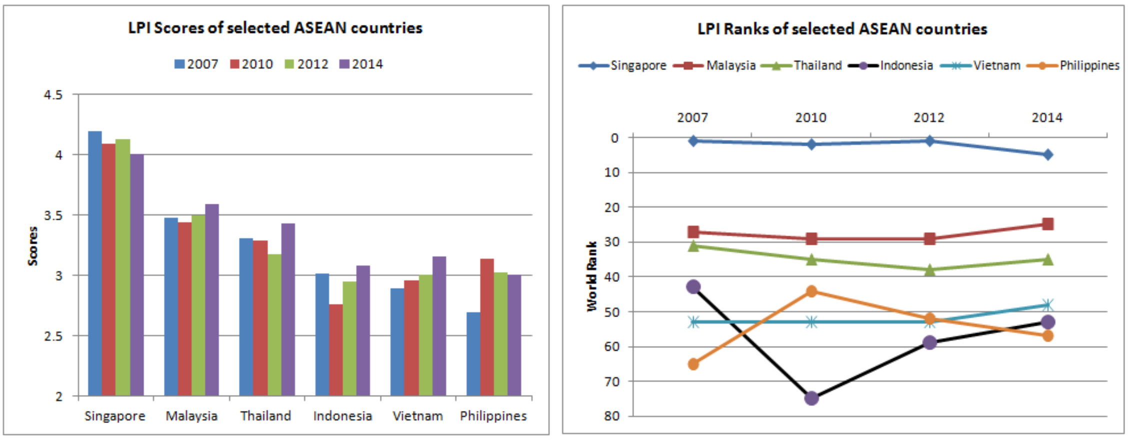


Figure 2.7 Comparison LPI ranks and scores amongst selected ASEAN countries. *Source: Logistics Performance Index of World Bank 2007, 2010, 2012 and 2014* (Arvis *et al.*, 2007; Arvis *et al.*, 2010; Arvis *et al.*, 2012; Arvis *et al.*, 2014)

2.2 Intermodal Freight Transport in Java

Java Island is located between the Indian Ocean and the Java Sea. In addition to being the centre of the Indonesian government in Jakarta, Java is the major economic centre of Indonesia. Based on administrative terms, there are six provinces and 118 regencies or cities. The provinces in Java Island are Banten, West of Java, Jakarta, Central of Java, Special Region of Yogyakarta and East of Java.

The six provinces in Java contributed an approximate 58% of Indonesian GDP in 2013 (*see* **Table 2.1**). The largest contribution to the Indonesian GDP was seen to come from the many manufacturing industries located in Java, especially in the western part of the island of Java (Jakarta, West of Java and Banten). Many industries on the island of Java are strongly attracted by the availability of supporting infrastructure that is better than the other islands. The quality and density of transport infrastructures, such as road transport, railway networks, seaports and airports, are adequate in attracting investors to set up industries on the island of Java. The map of the transportation network in Java is presented in **Figure 2.8**.

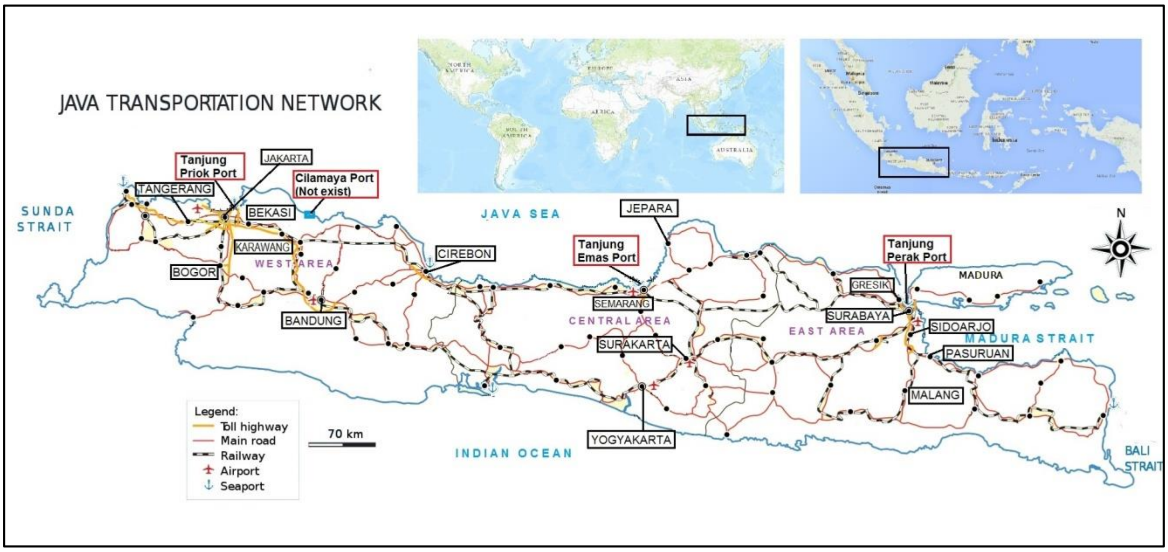


Figure 2.8 Java transportation network. *Source: adapted from http://commons.wikimedia.org/wiki/File:Java_Transportation_Network.svg*

2.2.1 Road Transport

The road infrastructure in Indonesia is classified into three levels of responsibility: national road, provincial road and district road. The road container transport is mostly only allowed on the national road (non-toll) and the toll road due to the maximum load restrictions, established by road class. Some private and state-owned companies operate Indonesian toll roads. As shown in **Table 2.3**, only 34% of the national roads on Java are in good condition, whilst the remains are in average, slightly damaged and severely damaged conditions.

Table 2.3 Length and condition of the National Road on Java in 2013. *Source: (MoPW, 2013)*

Province	Length (km)	Road Condition (km)			
		Good	Average	Slightly Damaged	Severely Damaged
DKI Jakarta	142.65	37.14	102.68	2.82	0
Banten	476.49	266.46	172.58	30.81	6.64
Jawa Barat	1351.13	803.21	462.28	51.91	33.53
Jawa Tengah	1390.57	257.55	1046.63	86.39	0
DI Yogyakarta	223.16	213.85	7.31	2	0
Jawa Timur	2027.01	328.45	1456	165.09	77.47
Total	5611.01	1906.66	3247.48	339.02	117.64
Percentage	100%	34%	58%	6%	2%

Trucks have become the main choice for freight transport across Java Island, partially on the Northern coast of Java corridor (also known as Pantura). Trucking container systems can reach all regencies and cities in Java Island. The Pantura is the most important national road corridor for freight transport and is recognized as the busiest road, where truck traffic share grew from 19% in 2007 to 46% in 2012. The situation was worsened by the high percentage of trucks that exceeded the load allowed by the government regulation to reach 60% (DGoH, 2013). With so many trucks overloaded, roads are easily damaged.

In order to overcome the problems in the road transport sector, the government of Indonesia accelerated the construction of the trans-Java toll road system. Currently, the length of the toll road in Java is only 849 kilometres, with 936.5 kilometres of toll roads agreed for the new construction (BPJT, 2014b; BPJT, 2014a).

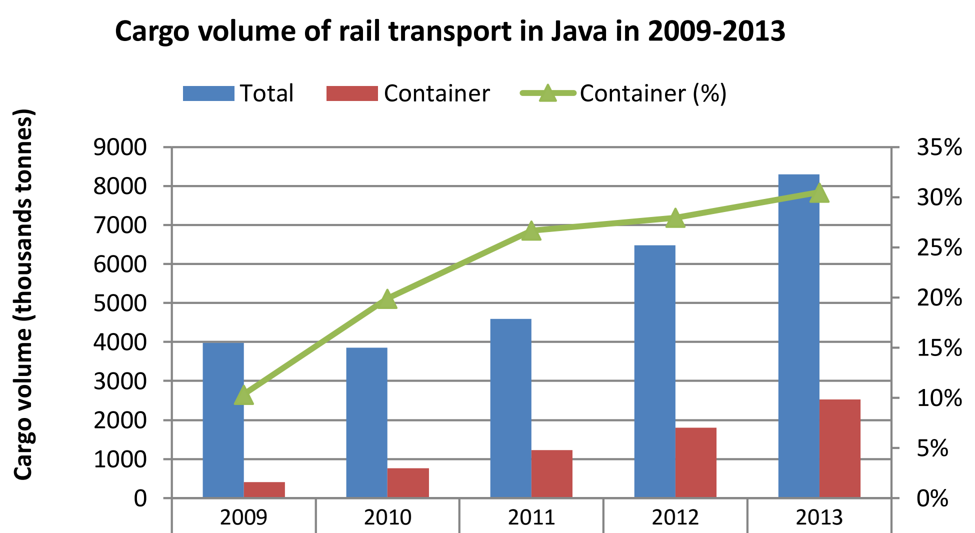
2.2.2 Rail Transport

The length of the railroads on the Java Island is 2,835 kilometres, of which 2,710 kilometres are operated. Most existing railroads were built during the Dutch occupation of Indonesia in the early 1900s. However, in 2004–2008, the total length of railway tracks in Indonesia experienced an average growth of 1.6% per year. The construction of the northern Java double track rail network was completed in 2014, and currently the southern Java double track is under construction.

PT KAI is the only operator of rail in Indonesia, and the company is owned by the government of Indonesia. PT KAI offers the container transport services route

Gedebage (Bandung)–Pasoso (Near Jakarta Port), Tanjung Lagoa (Jakarta)–Kalimas (Surabaya), Surabaya–Tanjung Priok Port and Cikarang–Tanjung Perak Port. In providing container transportation services in Java, PT KAI collaborates with five companies, namely PT. Java Petroleum Transport, PT. Kontenindo Express Buana, PT. Kereta Api Logistik, PT. Aditya Defa Transindo and PT. Artha Duta Selaras.

In 2009–2013, the container transport by rail in Java, grew significantly by 58% per year, with the volume of 0.41 million tonnes in 2009 and jumped to 2.53 million tonnes (approximately 253,000 TEUs) in 2013 (PT-KAI, 2013; PT-KAI, 2012; PT-KAI, 2011a). In the same period, the total cargoes were transported by rail in Java doubled from 3.9 million tonnes in 2009 to 8.3 million tonnes in 2013. The contribution of container cargo to the total cargo volume also increased from 10% in 2009 to 30% in 2013. The details of cargo volume in Java can be seen in **Figure 2.9** below.



	2009	2010	2011	2012	2013
Total	3976	3859	4589	6478	8300
Container	410	768	1224	1810	2530
Container (%)	10%	20%	27%	28%	30%

Figure 2.9 Cargo volumes of the Java railway transportation throughout the 2009–2013 periods. *Source: Compiled from BPS and Annual Report PT KAI 2010, 2011, 2012 and 2013*

The Ministry of Transportation (MoT) plans to develop the rail-based city logistics in Jakarta in an effort to lessen traffic congestion near the Tanjung Priok Port. The rail-based logistics city being developed includes East spokes (Bekasi and vicinity), West spoke (Tangerang and environs) and south spoke (Bandung, Sukabumi and surrounding) (Susantono, 2012). The MoT also plans to direct more attention to the development of the railroads network from the industrial areas to the seaports and the development of the high-speed train from Merak in West Java to Banyuwangi in East Java (MoT, 2011b).

2.2.3 Sea Transport

According to the Decree of Government of Indonesia Number 61 2009 about Ports (GoI, 2009), the hierarchy of Indonesian sea ports is divided into 3 (three) levels: main port, collector port and feeder port. The primary function of the main port is to serve international and domestic sea transport activities and trans-shipment of a particular amount of cargoes, and to act as a place of origin and destination of passengers and freights. The second level, collector port, has only the function to serve domestic sea transport activities both for passengers and cargoes, whereas the function of the feeder port (regional and local feeder) is to serve local maritime transport and as the feeder for main port and collector port (MoT, 2013).

Based on the National Port Master Plan (NPMP) in Java, there are 94 ports, divided into 10 (ten) main ports, 19 collector ports, 34 regional feeder ports and 31 local feeder ports. However, from the 10 (ten) main ports in Java, only three ports that are considered to have a significant container throughputs, namely Tanjung Priok Port, Tanjung Emas Port and Tanjung Perak Port. The container throughput of the three top ports can be found in **Table 2.4** below.

These three ports have a crucial role in the international trade of Indonesia, whilst almost 85% of containerized exports and imports of Indonesia are transported through these ports. Major ports in Indonesia are owned and operated by state-owned enterprises PT Pelabuhan Indonesia (Pelindo) and divided into four geographical areas, namely Pelindo I, Pelindo II, Pelindo III and Pelindo IV.

Table 2.4 Container throughput and market shares of three main container ports in Java 2010-2012

Port	2010		2011		2012	
	TEUs	%	TEUs	%	TEUs	%
Tanjung Priok Port (Jakarta)[3]	4,612,512	62.1%	5,617,562	64.6%	6,217,168	65.3%
Tanjung Emas Port (Semarang)[4]	384,522	5.2%	427,468	4.9%	456,896	4.8%
Tanjung Perak Port (Surabaya)[5]	2,426,802	32.7%	2,643,518	30.4%	2,849,138	29.9%
Total	**7,425,846**	**100.0%**	**8,690,559**	**100.0%**	**9,523,202**	**100.0%**

2.2.3.1 Tanjung Priok Port

Tanjung Priok Port (also known as Jakarta's port) is located in western Java, 14 km from the city centre of Jakarta, the capital city of Indonesia (*see* **Figure 2.8** above, The Java transportation network map).). Tanjung Priok Port is owned and operated by Pelindo II, and adopts a role as the main port for the major manufacturing region around Jakarta and West Java, and deals with both coastal and international trade. Tanjung Priok Port is the largest port in Indonesia and has more than 6 million TEUs containers handled in 2012.

There are four terminals in the surrounding area of Tanjung Priok Port, all of which are operated by a joint operation between private companies and Pelindo II. The terminals are Conventional Terminal, PT MTI (*Multi Terminal Indonesia*), TPK Koja and JICT **(***Jakarta International Container Terminal*. All of the terminals at Tanjung Priok serve containerized exports; however, the Conventional terminal and PT MTI also serve for the containerized inter-island movements.

The growth of this port has been hampered by limited capacity and inefficient operations, including poor road access to the port. The rail access to the port is also obstructed by the unavailability of direct rail access to the port. The nearest railway stations (about 2 km) for the container transport are Pasoso station and Sungai Lagoa station, which still require handling operations using trucks from the rail terminal to the container terminal. The situation of Tanjung Priok Port is presented in **Figure 2.10**.

[3] Data obtained from the annual report of Pelindo II (The authority of Indonesian ports in West Java and South Sumatera, owned by the Government of Indonesia)

[4] Data obtained from the annual report of Pelindo III (The authority of Indonesian ports in Central Java, East Java and Kalimantan, owned by the Government of Indonesia)

[5] Data obtained from the annual report of Pelindo III (The authority of Indonesian ports in Central Java, East Java and Kalimantan, owned by the Government of Indonesia)

(a) Tanjung Priok Port (b) Congestion

Figure 2.10 Situation in Tanjung Priok Port (a) and the congestion near the port (b). *Source: www.priokport.co.id and* (Sihombing, 2013)

The government of Indonesia has set an ambitious goal of developing an international container seaport by developing New Tanjung Priok Port. The government of Indonesia asked Pelindo II, through the Presidential Decree Number 36 2012 (PoI, 2012a), to build and operate the new extension port. In order to fulfil this mission, Pelindo II announced its plans to invest 4 (four) billion USD to enhance the capacity of Tanjung Priok Port in two phases. If the project could be completed in 2023, the facility of Tanjung Priok Port would able to handle up to 18 million TEUs containers per year.

2.2.3.2 Tanjung Emas Port

Port of Tanjung Emas is located in Semarang (the capital city of Central Java Province), overlooking the Java Sea (*see* **Figure 2.8**). The hinterland of Tanjung Emas Port includes the provinces of Central Java and Special Region of Yogyakarta. Pelindo III owns and operates Tanjung Emas Port. Tanjung Emas Port has 2 (two) terminals: Tanjung Emas Conventional Terminal and Semarang Container Terminal (known as TPKS—*Terminal Peti Kemas Semarang*). The conventional terminal only serves for domestic freight transport; this means there is no service for containerized exports or imports at the conventional terminal. The TPKS, on the contrary, only provides service for containerized exports or imports; however, TPKS started from 2013 also serves the transportation of containers for domestic shipments.

In 2012, TPKS handled more than 450,000 TEUs, with the export volume exceeding the import volume. Almost 50% of container exports from Tanjung Emas Port came from Semarang and the surrounding area. Due to rising employment costs associated with the industrial zone near the Tanjung Priok Port, more companies will relocate to the Central Java, especially to the area near the Tanjung Emas Port. The relocation of companies to Central Java is predicted to increase the throughput of Tanjung Emas Port.

Figure 2.11 shows the situation of the Tanjung Emas Port and the tidal flood that obstructs road access to the port. The tidal flood inundates most of the terminal and the access road to TPKS, even during the dry season. In order to overcome the tidal flood issue, the port authority builds a ‘Polder’ system in the form of the construction of embankments and reservoirs, in addition to the installation of the pump. The tidal flood also caused the rail access to the terminal to not be used for 12 years, and in 2015 the Ministry of Transportation sets to reactivate rail access from Tawang Station to the TPKS (PELINDO III, 2015a).

(a) Activities at Tanjung Emas Port (b) Tidal flood

Figure 2.11 Tanjung Emas Container Terminal (a) and the tidal flood (b). *Source: www.tpks.co.id and www.tgemas.co.id*

2.2.3.3 Tanjung Perak Port

Tanjung Perak Port is also known as the Surabaya Port, owned and operated by Pelindo III, located on the northern coast of the island of Eastern Java (*see* **Figure 2.8**). The Tanjung Perak Port has a primary role to play as the principal port for the hinterland in East Java, and also as one of the main gateway ports to the eastern part of Indonesia. In 2013, the port served more than 14,000 vessels, including approximately 1,000 international container ships. The annual container traffic of Surabaya Port is above 2.9 million TEUs in 2013, where the traffic for international trade is smaller than the traffic of inter-island movement (PELINDO III, 2013). This port, which is equipped to accommodate tankers, general cargo vessels and container vessels, has undergone continual physical development, with modifications made to existing berths, and the provision of additional berths specifically designed for container handling operations.

There are 3 (three) terminals in the surrounding area of Tanjung Perak Port: Conventional Terminal, *Terminal Peti Kemas Surabaya*—TPS (Surabaya Container Terminal) and Berlian Jasa Terminal Indonesia—BJTI terminal. The port authority started to construct a new Teluk Lamong terminal in 2014, positioned within 2 km of the existing terminal location. The initial capacity will be 1.6 million TEUs per year and in the long-term, Teluk Lamong terminal will able to handle containers up to 5.5 million TEUs per year.

The situation of rail access to the port of Surabaya is the same as with the rail access in Tanjung Priok Port and Tanjung Emas Port. The trains transporting containers must stop at the nearest station and cannot go further to the port. Even though the rail network has been constructed from the nearest station (Kalimas Station) into the Tanjung Perak Port, the rail system was never utilized since 2006. In April 2015, the Tanjung Perak Port authorities and PT KAI carried out tests to revive railway operations straight into TPS terminal (Wahyudinata, 2015). The service for the container transport from TPS is provided by PT Kereta Api Logistik route TPS—Kalimas Station in Surabaya—Tanjung Lagoa Station in Jakarta (PELINDO III, 2015b). Furthermore, the port of Tanjung Perak also will be equipped with the monorail Automatic Container Transporter (ACT) to facilitate the flow of containers from the current terminal to the Teluk Lamong Terminal and the container depots around the port (Bisnis Indonesia, 2014).

2.2.4 Intermodal Transport

To facilitate the intermodal transport in Java, some dry ports have been developed in Java. Currently, there are only two dry ports in the area that are in operation, namely Cikarang Dry Port and Gedebage Dry Port. Previously, there were several other small dry ports, such as Cibungur, Tonjong (in West Java), Solo (in Central Java) and Rambipuji (in East Java); however, these are now no longer in operation due to a lack of users.

2.2.4.1 Cikarang Dry Port

Cikarang Dry Port (CDP) is located in Bekasi, West Java, 50 km from Tanjung Priok port, and approximately 2,500 industrial companies surround the CDP. Since 2010, CDP has provided integrated logistics and port services for export, import and domestic distribution through Tanjung Priok Port. Container-stacking capacity at CDP is 400,000 TEUs per year, with a total area of 200 hectares.

Although CDP is the largest dry port in Indonesia, few companies use the services in CDP for export or import. The container traffic of CDP in 2013 was 25,808 TEUs and grew rapidly by 37,507 TEUs in 2014 (JABABEKA, 2015). Nonetheless, the container traffic in CDP is still very limited compared to its capacity. **Figure 2.12** below presents the situation of the CDP in Bekasi.

Figure 2.12 Cikarang Dry Port, Bekasi, West Java. *Source: http://www.jababeka.com/cikarang-dry-port*

2.2.4.2 Gedebage Dry Port

Gedebage Dry Port (GBDP) is located in Bandung, West Java, approximately 180 km from Tanjung Priok Port. It started its operations in 1987. In 1994, the number of containers handled by GBDP reached 60,000 TEUs per year; however, in 2009–2012, the number of containers served plummeted to around 9,000 TEUs per year. The decrease in throughput occurred due to declining exports and imports by the textile industries in Bandung area, as well as the operation of the new Bandung – Jakarta toll road (known as Cipularang toll road) in 2004. This toll road allows truck mode to transport containers from Bandung to Port of Tanjung Priok with a faster time (Meyrick, 2012).

In 2013, the transportation of containers to and from Gedebage was served by two trains of containers heading to Pasoso (station near the port of Tanjung Priok), returning every day. Each train can carry a maximum of 24 TEUs per trip whereas travel time from Gedebage to Pasoso is approximately 5 hours.

2.2.5 Fuel Subsidies

The transportation issue in Indonesia cannot be separated from the issue of fuel subsidies because of the huge amount of subsidies to the transportation sector. **Table 2.5** provides the comparison of fuel prices and subsidies or taxation in selected Asian countries in 2012. From the table below, it can be seen that Indonesia is one of the countries providing significant subsidies to the fuel prices; other countries include Malaysia and Brunei, as well as countries in the Middle East region. The fuel subsidy in Indonesia is one of the highest in the Southeast Asia region, with the fuel price in Indonesia the second cheapest amongst ASEAN countries—just higher than Brunei. In the 2012–2013 period, the price of diesel and super gasoline was the same at 47 cents USD per litre (GIZ, 2013).

Table 2.5 Comparison of fuel prices and fuel subsidies or taxation in selected Asian countries in 2012. *Source: GIZ (2013)*

Country	Diesel		Super gasoline	
	Price (US-cents/litre)	Subsidy/Tax	Price (US-cents/litre)	Subsidy/Tax
Saudi Arabia	7	High fuel subsidies	16	High fuel subsidies
Iran	12	High fuel subsidies	33	High fuel subsidies
Kuwait	20	High fuel subsidies	23	High fuel subsidies
Brunei	26	High fuel subsidies	43	High fuel subsidies
Oman	38	High fuel subsidies	31	High fuel subsidies
Indonesia	**47**	**High fuel subsidies**	**47**	**High fuel subsidies**
Malaysia	59	High fuel subsidies	62	High fuel subsidies
India	86	Fuel subsidies	125	Fuel taxation
Thailand	97	Fuel subsidies	156	Fuel taxation
Philippines	101	Fuel subsidies	125	Fuel taxation
Pakistan	120	Fuel taxation	114	Fuel taxation
Mongolia	122	Fuel taxation	129	Fuel taxation
Singapore	126	Fuel taxation	168	High fuel taxation
China	128	Fuel taxation	137	Fuel taxation
Timor Leste	143	Fuel taxation	165	High fuel taxation
Japan	161	Fuel taxation	200	High fuel taxation

South Korea	163	Fuel taxation	180	High fuel taxation

In 2012, in an effort to ensure fuel prices remained at the fixed price, the government of Indonesia were required to spend approximately 310 trillion IDR (equal to 30 billion USD) or about 13% of the Indonesian government expenditure (Diop, 2014; IISD, 2014). This subsidy is expected to increase significantly in line with international fuel price increases or when the IDR currency rate weakens against the USD. The electricity sector also obtains subsidies, especially for residential electricity (*see* **Figure 2.13**). The road mode has the most advantages of the fuel subsidies compared to other modes. The subsidy makes container transport by road cheaper than rail because freight rail transport does not get benefit from the fuel subsidy (Rachmawati, 2014). This policy represents that the government of Indonesia does not fully support the development of mass transport systems, such as rail transport.

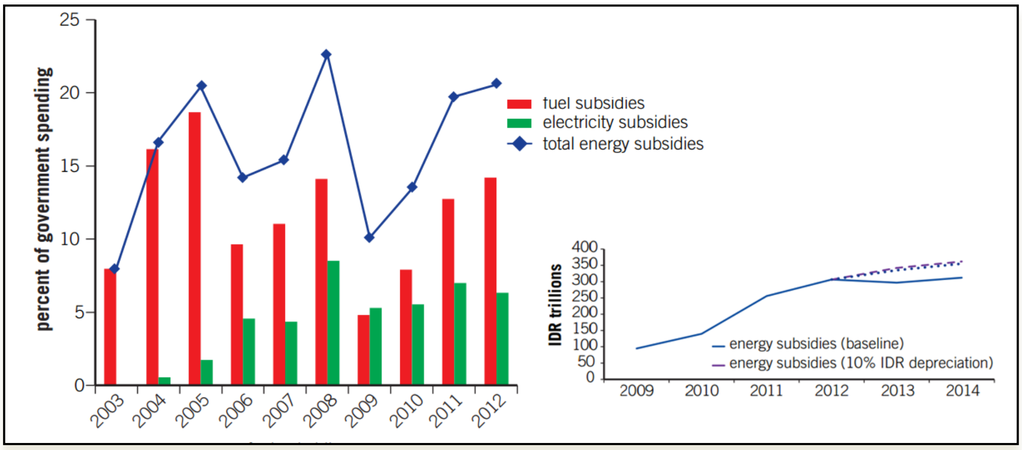


Figure 2.13 The number of fuel subsidies of Indonesia as a percentage of government expenditure in 2003–2012. *Source:* (Diop, 2014)

2.3 Intermodal Freight Transportation Problems

Based on the explanation in Section 2.1 and Section 2.2 above, the problems of intermodal freight transport can be identified and grouped according to road transport, rail transport, sea transport and intermodal transport.

2.3.1 Road Transport

Some problems in the domain of road freight transport in Java have been identified, such as lack of infrastructure, slow delivery and GHG emissions.

2.3.1.1 Lack of Infrastructure Quality and Capacity

Although the road infrastructure in Java received the most attention from the MoT, the quality of the road is not as good as the quality of the road in neighbouring countries, such as Singapore, Thailand and Malaysia, for example. The high percentage of trucks carrying excessive loads is the leading cause of the national road damage in Java. The lack of road capacity and the maintenance process conducted throughout the year also caused disruption and congestion in various truck routes.

2.3.1.2 Slow Delivery

Meyrick (2012) identified one of the biggest problems in road freight transport as the time taken to deliver using trucks: for instance, the transport time of a Jakarta–Surabaya trip is approximately 40–50 hours with trucks, but only 20–24 hours by rail (PT-KAI, 2011b). However, container transport by rail needs more time for container-handling and for transporting the container from the shippers' location to the departure station via road.

2.3.1.3 Emissions from Freight Transport

The transportation sector is the third largest contributor in terms of GHG emissions in Indonesia, following the industry and energy sectors. Almost 90% of GHG emissions from the transportation sector is generated by road transport (BAPPENAS, 2011a). As road mode is the main choice for freight transport, GHG emissions also rise in line with the growth in the volume of freight transport by truck.

2.3.2 Rail Transport

2.3.2.1 Lack of Competition

As the only rail operator, the absence of competitors made PT KAI less innovative in providing passenger and freight transport services. Since 2010, PT KAI, under new management, began to make good progress in providing services both in passenger and freight transport. The development progress of PT KAI was also triggered by Law Number 23 of 2007, which allowed private companies to invest in the rail business (GoI, 2007). However, because of the large investment made in the field of railways, up to now, there is no private company investing in this sector.

2.3.2.2 Lack of Network Capacity

The rail network with Java only reaches cities in the northern and the southern Java corridor, with most still single-lane. Due to the single track, freight transport train has less priority than passenger transport, and therefore often experiences delays. The high growth of container volumes cannot be accommodated if the rail network is not developed, because of the limit of network capacity.

2.3.2.3 Rail Transport as the Second Priority

A lack of attention from the government to the rail transport development also needs to be solved. As stated in Section 2.2.2, growth of the length of the rail network was only 1.6% in 2004–2008; however, in recent years, the government has allocated more budget to constructing new rail tracks and also to developing the double track of the northern and southern Java corridors.

2.3.3 Sea Transport

As we can see from **Figure 2.14**, in the sea transport sector, the poor level port infrastructure in Java is the biggest challenge to be overcome in the context of intermodal freight transport. The world rank of the port infrastructure in Indonesia is just slightly better than Vietnam and Philippines, but far behind Singapore, Malaysia and Thailand. It is an irony that Indonesia, as an archipelago country, has inadequate quality of port infrastructure. However, the new Indonesian government since 2014 has shown a stronger vision for marine transport infrastructure and port development.

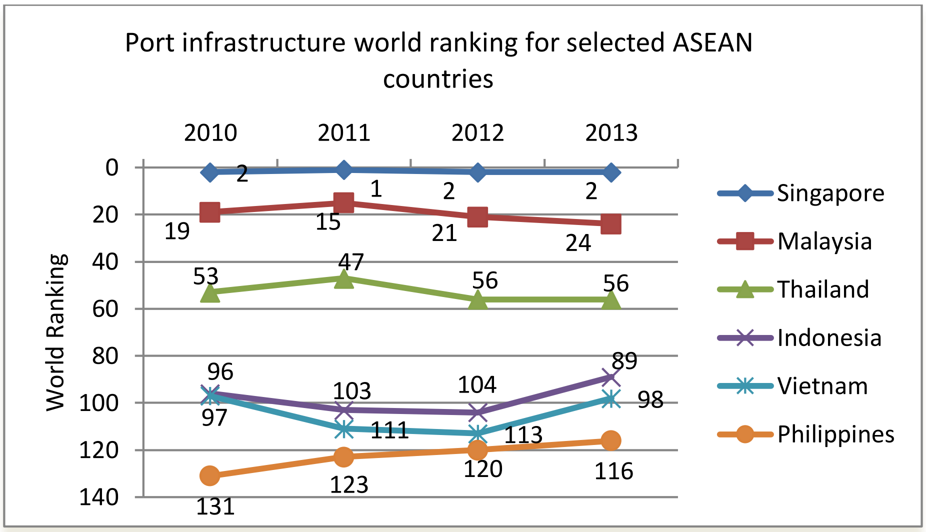


Figure 2.14 Comparison of port infrastructure world ranks amongst selected countries in ASEAN. *Source: compiled from Doing Business 2011, 2012, 2013 and 2014* (World Bank, 2010; World Bank, 2011; World Bank, 2012; World Bank, 2013)

2.3.3.1 Limited Port Capacity

The depth of the berth is the most prominent problem in port capacity. The deepest pond in Tanjung Priok Port is –14 m.LSW, which is located in JICT terminal. Furthermore, the deepest terminal in Tanjung Emas Port is only –10 m.LSW, with the same depth in Tanjung Perak Port. With the current depth, Tanjung Emas and Tanjung Perak Port could serve only vessels with no more 2,000 TEUs or 30,000 GWT for general ships.

With the current terminal depth, no large container ships could call at the three container ports in Java. The export and import of Indonesia to and from Europe and America has to undergo trans-shipment in Singapore or Malaysia so as to be transported by intercontinental vessel. The Tanjung Pelepas port in Malaysia has depths ranging from 15–19 metres, whilst the Port of Singapore has a depth of 16 metres.

2.3.3.2 High Port Access Costs and Time

According to Doing Business in 2011–2013, the time to export from Indonesia took the longest time (20 days) in 2010 compared with the selected ASEAN countries (Singapore, Malaysia and Thailand). The performance of the export time has improved (decreasing to 17 days) in 2011–2013. However, this reduction is still far behind the improvements made in Malaysia. In 2010, Malaysia export time was 18 days; however, the time accelerated significantly to only 11 days in 2013.

Moreover, as can be seen from **Figure 2.15** below, Indonesia also shows a lower performance in terms of export cost per TEU (excluding customs tariff and ocean transport cost). The Indonesian cost to export in 2010 was 714 USD per TEU, which then decreased to 615 USD per TEU in 2013. However, such costs remain very high compared to Malaysia and Singapore, where costs to export were only around 450 USD per TEU. These cost and time factors are very close to the export activities occurring on the hinterland part, especially with activities at the port and inland transport from the shipper location to the port of origin.

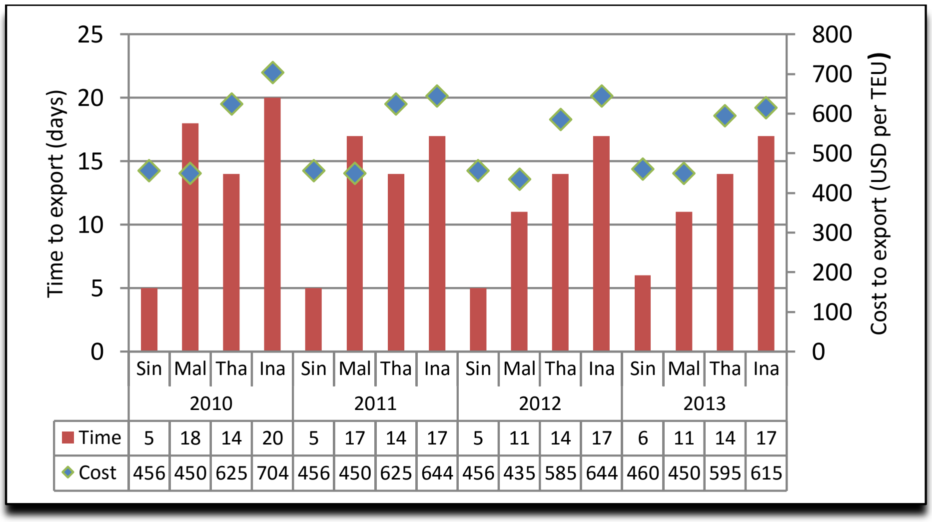


Figure 2.15 Export time and cost in Singapore (Sin), Malaysia (Mal), Thailand (Tha) and Indonesia (Ina) in 2010–2013[6]. *Source: Doing Business 2011, Doing Business 2012, Doing Business 2013, Doing Business 2014* (World Bank, 2010; World Bank, 2011; World Bank, 2012; World Bank, 2013)

[6] Time to export in days (excluding maritime transport time). Cost of export in USD per 20-feet container.

2.3.4 Intermodal Transport

In his study, (Notteboom, 2004) revealed that the inland mode cost contributes 40%–80% of the total intercontinental container shipping costs. This fact is evidence of the importance of the inland transportation leg in the international logistics chain. The issues relating to intermodal transport in Java are discussed as follows:

2.3.4.1 Poor Rail Access to the Port Terminals

Terminal facilities at the Tanjung Priok Port, Tanjung Emas Port and the Tanjung Perak Port in the year 2014 have not been directly connected to the Java rail network system. The container transported by rail must be delivered to the port by truck from the rail station. It was only in April 2015 that Surabaya port became the first port directly linked to the railway network. The deficiency of the rail access to the port terminal makes container transport by rail service less competitive compared with truck or road modes. Transport by rail should be carried out with double handling, resulting in increased costs and time.

2.3.4.2 Limited Number of Inland Terminals (Dry Ports) to Facilitate the Connection to the Port

Compared with selected countries in Asia, Indonesia is lagging behind in the development of the dry port terminals. A lack of dry ports in Java that can be utilized for purposes of transportation logistics is also a complaint by actors in the industries. The development of dry ports in Indonesia was started by operating dry ports in Solo and Gedebage (in Bandung) more than 25 years ago. However, due to a lack of demand and the many problems in rail container transports that still exist, Solo Dry Port was closed. In addition, the GBDP also experienced a very sharp decline in the number of containers handled, from 60,000 TEUs in 1992 to 10,000 in 2013.

It takes more dry ports located in several cities to enable shippers and freight forwarders to shift from road to rail mode. The reactivation of dry ports that currently are not in operation, as in Solo and Semarang, is expected to increase the growth of container transport users by rail mode.

2.4 Future Plan

The government has issued various policies that are being and/or will be executed as an effort to solve the problems in Indonesian logistics and the freight transport in the Java above. Some selected policies are discussed below.

2.4.1 Master Plan for Acceleration and Expansion of Indonesia Economic Development (MP3EI)

In 2011, the President of Indonesia launched a presidential decree of a Master Plan for Acceleration and Expansion of Indonesia Economic Development 2011–2025 (PoI, 2011b). In this document, the acceleration of Indonesian economic development will be carried out across three aspects: (1) Development of 6 (six) economic corridors; (2) Strengthening the connectivity for both national and international connectivity; and (3) Increasing the capacity of science, technology and human resource to support the development of the economic corridors.

The 6 (six) economic corridors are (1) Sumatera (2) Java (3) Bali and Nusa Tenggara (4) Kalimantan (5) Sulawesi, and (6) Papua and Maluku Islands. The Java economic corridor development will be directed towards the centre of industry and services in Indonesia. Partially for the Java Economic corridor, development will be concentrated along the northern coast of Java. Trans-Java highway and railway will be constructed, which will connect the different centres of economic development. The seaport enhancement in Tanjung Priok, Cilamaya, Merak and Lamongan will facilitate the flow of goods, both within and between economic corridors (CMoEA, 2011).

The vision of 'locally integrated and globally connected' was used for the purpose of describing the plan of the Indonesian connectivity development. Connectivity will be achieved by combining policies in transportation development (National Transportation System—SISTRANAS), logistics development (National Logistics System—SISLOGNAS), Regional Development Plan (RTRW) and ICT (Information and Communications Technology) development.

2.4.2 National Logistics System (Sislognas)

In March 2012, the Government of Indonesia launched a Blueprint of a National Logistic System (SISLOGNAS) development for the years 2011–2025 (PoI, 2012b). There are 7 (seven) actions in the national logistics system that will be developed by the Government of Indonesia in the mind of establishing a national logistic system that is integrated with the ASEAN and global network. The seven actions are as follows:

1. The development of commodities as a driver for economic activities,
2. The development of logistics infrastructure,
3. The development of Information and Communications Technology infrastructure,
4. The development of actors and logistics service provider,
5. The development of Human Resources in logistics
6. The development of regulation and policy, and
7. The development of institutional capacity.

The development of the National Logistics System comprises three phases, distinguished by scope of geographical integration. The first phase in 2011–2015 will focus on strengthening the domestic logistics, whilst the second phase will broaden the scope of the ASEAN logistics network. The last phase, spanning 2021–2025, will develop the logistics system to make the integration with the global logistics network. The three phases of the development can be seen in **Figure 2.16**.

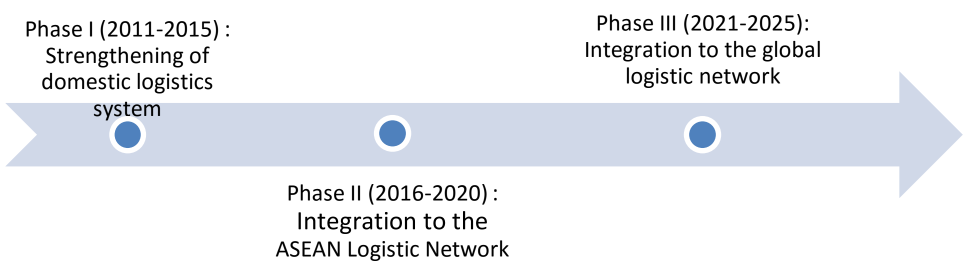


Figure 2.16 Phase of National Logistics System development. *Source: adapted from the appendix of National Logistics System* (PoI, 2012b)

2.4.3 Double Track Rail Network Development

Due to the lack of rail network capacity on Java, the MoT committed to accelerating the construction of the new railway network. Partially in Java, the development of the rail network for passenger and freight transport will be focused on the development of the double track rail network in the northern and southern Java corridor. According to the National Rail Master Plan (NRMP), issued by the Ministry of Transportation Decree Number PM 43 year 2011 (MoT, 2011b), in 2030 the freight transport by rail mode will reach 543 million tonnes per year—a significant leap from the 2013 volume of 24.7 million tonnes. In addition, the NRMP also contains the plan of the establishment of a high-speed rail network. In 2014, the construction of the double track rail network from Jakarta to Surabaya (length 727 km) completed, and the government expect there will be an estimated 1 million TEUs per year of containers transport, shifted from road to rail mode (Susantono, 2013). Recently, the government has also started the construction of southern double track network from Cirebon across Yogyakarta, Solo to Surabaya along 610 km, which is expected to be finished in 2017.

2.4.4 Cilamaya Port Development

The development plan of Cilamaya Port was initiated in the Spatial Plan of West Java Province (Pemprov Jabar, 2010) and then accommodated in the MP3EI in 2011 (CMoEA, 2011). The plans were also reinforced in the Public Private Partnership in 2012 and 2013 documents, offered by National Development Planning Agency (BAPPENAS, 2012; BAPPENAS, 2013). In addition, the Ministry of Transportation also incorporated plans for the development of Cilamaya Port in the Master Plan of National Port Development (MoT, 2013) and the extension plan of Tanjung Priok Port (MoT, 2012). The Japan International Cooperation Agency (JICA) was the institution that funded the feasibility study (JICA, 2012; JICA, 2013) for the project as the Japanese Government held various concerns regarding the number of Japanese businessmen investing in the area around Bekasi, Purwakarta and Karawang (near Cilamaya).

The main purposes of the Cilamaya Port project are centred on reducing the burden on Tanjung Priok port, as well as accelerating the process of transportation of the products from the industrial areas in West Java to the harbour. The Tanjung Priok Port handles most of the shipping trade related to the West Java Province; only a small portion ships their products through the Cirebon Port. The presence of the new Cilamaya port was expected to support the development of the industrial area in West Java (BAPPENAS, 2013; JICA, 2013)

However, this development project was recently cancelled by the new government (Susilo, 2015) owing to the belief that the project could threaten the Pertamina oil and gas production located in the vicinity of the port. Nevertheless, the Indonesian government remains committed to establishing a new port by shifting the location to the east in Subang or Indramayu. The changes in location mean requiring a longer process for the new feasibility analysis, rather than beginning the tender offer in 2015.

2.4.5 Fuel Subsidy Reduction

Reduction in fuel subsidies is an option to reduce the national budget; however, this subsidy reduction will have an impact on the increase of transportation tariffs and the prices of goods. Most of the goods in Indonesia are distributed using road transport that makes use of the subsidized fuel, which will affect the national economic growth in the short-term (MoEMR, 2014; MoEMR, 2015). Cutting the fuel subsidy is also expected to increase the attractiveness of freight transport by rail owing to the rise in the cost of the truck/road mode. The government of Indonesia also promises diverting the budget from fuel subsidies to the infrastructure development, especially to the transportation infrastructure sector.

2.4.6 Tanjung Priok Port Extension

Firstly, the extension of the Tanjung Priok Port is described in the MP3EI in 2011 (PoI, 2011b). As mentioned in Section 2.2.3.1, the government of Indonesia has appointed Pelindo II to establish and operate the new Tanjung Priok Port (PoI, 2012a). The construction of the new port, in detail, can be found in the Master Plan of Tanjung Priok Port Development (MoT, 2012), which is supported by the National Port Master Plan (NPMP), as issued in 2013 (MoT, 2013).

The project of the new port will cost approximately 4 billion USD, with the development divided into two phases of development: the first phase will construct three new container terminals and one product terminal, with each container terminal having a capacity of 1.5 million TEUs per year; in the second stage, 4 (four) container terminals will be established by 2023, with each terminal handling about 2 million TEUs per year. The depth of the container terminal draught is –16.0 m.LSW and is expected to be able to handle a huge container vessel until 18,000 TEUs size. By the end of 2023, the total capacity of Tanjung Priok Port is expected to be 18 million TEUs per year (PELINDO II, 2014). The development plan of the new Tanjung Priok Port includes the construction of the dedicated toll road to the new port to avoid the congestion near the port.

2.4.7 Route and Time Restriction for Truck

Regulation on the route and time restrictions for freight transport is based on the Ministry of Transportation Decree Number 14 2007 regarding container transport vehicles (MoT, 2007). The container trucks are only allowed to pass through certain roads and at specific times. The implementation of this policy depends on the transportation traffic condition.

So far, only Jakarta implemented the route and time restriction based on the Ministry of Transportation Decree Number 62 the year 2011 (MoT, 2011a). This decree stated that the container trucks are not allowed on the Inner Jakarta Toll Road from 5 am to 10 pm. Moreover, in the study by Meyrick (2012), a vehicle booking system was also proposed in the mind of reducing congestion near the Tanjung Priok Port. The restriction caused various consequences to the container trucks, including longer transport time and higher costs than prior to the restriction of operation.

2.4.8 National Action Plan for Greenhouse Gas Emissions Reduction

The national action plan for reducing the GHG emissions has been proposed by the Presidential Decree number 61 the year 2011 (PoI, 2011a; BAPPENAS, 2011b). In this document, the government of Indonesia proposed various national action plans centred on reducing GHG emissions from some sectors, including the transportation sector. According to the transportation sector, GHG emissions reduction, National Council on Climate Change (*Dewan Nasional Perubahan Iklim*—DNPI) proposed some actions, such as fuel quality improvement, increasing the emissions standard from Euro 2 to Euro 4, the restructuring of the motor vehicle tax and vehicle emissions labelling (DNPI, 2010).

Whilst Bappenas (2011a) in the guideline of a national action plan for GHG emissions reduction suggested an ASI (Avoid-Shift-Improve) strategy to reduce emissions from the transport sector. Avoid, in this sense, means reducing the unnecessary travel. The shift is switching to the transportation mode with a lower emission rate, whilst improve means enhancing the technology of the vehicles. Shifting to the greener transportation mode includes shifting from the road mode to the rail or sea mode that subsidizes emissions rates.

2.5 Summary

Indonesia's economic growth was very high in the period 2005–2013 and was followed by the growth of foreign trade. Indonesian exports of non-mineral are mostly transported in containers using three main ports in Java; however, the transportation of exports and imports in Indonesia are still hampered by a variety of problems, especially in terms of transportation infrastructure. The infrastructure of Indonesia for intermodal transportation is still lagging behind compared with various other countries in the Southeast Asia. The logistics performance of Indonesia is also far behind the performance of Malaysia and Singapore.

The problems in intermodal freight transport in Java have been identified for road transport, rail transport, sea transport and intermodal transport. The issues in road transport, including the lack of capacity and slow delivery, have been highlighted, whilst problems in rail transport include a lack of infrastructure and competition. The sea transport sector is hampered by high port access costs and time, and limited port capacity. Poor rail access to the port and a limited number of the inland ports are prominent issues in the intermodal transport in Java.

In order to improve the competitiveness of the Indonesian economy, the Indonesian Government plans to accelerate economic development with an integrated economic plan called MP3EI (*Master Plan for Acceleration and Expansion of Indonesia Economic Development*). Regarding the intermodal transportation enhancement in Java, some policies are to be implemented. The plans include the construction of new Cilamaya Port (recently cancelled by the new government), the improvement and expansion of the Tanjung Priok Port, the construction of a double track rail network on the island of Java, the reduction of fuel subsidies (especially for the road mode), restrictions on hours and route of operation of container trucks, and the reactivation of various inactive dry ports; however, Indonesia has experienced dry port and rail track closure due to a lack of users. Furthermore, the logistics business actors proposed a subsidy for freight transport by rail.

Good understanding of the behaviours of users of freight transport is needed in order to ensure that the policies will reach expectations. The application of appropriate policies in the intermodal freight transport will be centred on avoiding the failures that are not expected. According to the presentation of the situation of Indonesian logistics and intermodal transport above, this research attempts to investigate the behaviour of freight transport users through their stated preferences on the port and inland mode choice. The attributes of the ports and inland mode used in the research are identified in Chapter 3. The results from the estimation can be used to simulate the impact of policies to the port share, mode share and to the GHG emission reduction.

Chapter 3
Literature Review on Port and Inland Mode Choice in Freight Transport

3.0 Introduction

In an effort to gain better insight into the freight transport, especially containerized transport, this chapter provides an overview of intermodal freight transport and the choice of port and inland mode. The definition and advantages of intermodal freight transport are presented in Section 3.1. This section is followed by a presentation of the port choice and the determinant factors in section 3.2, with the inland mode choice determinant factors presented in Section 3.3. Section 3.4 presents the studies of the current trends in GHG emissions reduction from the freight transport. Finally, Chapter 3 ends with a summary in Section 3.6.

3.1 Intermodal Freight Transport

3.1.1 Definition of Intermodal Freight Transport

There are many definitions of *intermodal transport*. This research will use the standard terminology agreed by the UN Economic Commission for Europe (UN/ECE), European Union (EU), and the European Conference of Ministers of Transport (ECMT): '*concerns the movement of goods in one and the same loading unit or vehicle which uses successively several modes of transport without handling of the goods themselves while changing modes*' (UNECE, 2001).

Several types of intermodal transport unit may be used within the goods movement process: container (the most common unit), a road or rail vehicle, swap body or a vessel. An implication of the definition above is that the movement of the empty intermodal transport unit is not part of intermodal transport because no goods are transported. International intermodal transport is usually based on a contract regulating the full multimodal transport (Eurostat, 2009).

3.1.2 Role of Intermodal Freight Transport

The intermodal freight transportation system has an essential role to play in distributing commodities to the entire nation and the world as a whole. The number of movements of world manufactured goods to end users and raw materials to manufacturing sites grew rapidly by 8% in 2006 due to the economic growth, spurring an increase in industrial output (IEA, 2009).

There are some significant benefits associated with intermodal freight transport, which offer the promise of (OECD, 2001):

1. Reduced transportation costs
2. Enhanced national efficiency, productivity and global competitiveness
3. Enhanced infrastructure investments and reduced congestions
4. Improved environmental quality through decreasing energy consumption, particularly air quality.

3.1.3 Containers in Intermodal Freight Transport

Containerization is the major part of intermodal freight transport and became a major choice in international trade (Crainic and Kim, 2007). Since its invention in 1956 and introduction in the 1960s, containerization has grown rapidly. Currently, approximately 90% of non-bulk products in international trade are transported in containers (Pettinger, 2013). The growth of international trade in the last decade has encouraged the use of containers (Bouchery *et al.*, 2015). The international container throughput rose by 5% per year in 2008–2013, from 516 million TEUs in 2008 to 651 million TEUs in 2013 (UNCTAD, 2014).

Containers (also known as freight or shipping containers) are usually constructed of steel, and can be lifted from the top corner by crane or from the bottom by a heavy duty forklift (Lowe, 2005). There are several types of container based on dimensions, weights and design features (Hapag-Lloyd, 2012), with the most typical lengths 20' and 40'. However, containers with 45', 48' and 53' length are beginning to be widely used, especially in the USA. The typical height of the standard container is 8'6', but the 9'6' container high is also often used, known as a high cube container. The details of the dimensions of standard 20' and 40' containers are shown in **Table 3.1** below.

Table 3.1 Dimensions of the standard 20' and 40' container. *Source from Hapag-Lloyd (2012)*

Type	Length (m)	Width (m)	Height (m)	Volume (m^3)	Empty weight (kg)	Payload capacity (kg)	Total weight (kg)
20' (1 TEU)	6.058	2.438	2.591	33.2	2,250	21,750	24,000
40' (2 TEUs)	12.192	2.438	2.591	67.7	3,780	26,700	30,480

Also within a standard container, there is a variety of containers such as a refrigerated contains perishable products, open side or open-top container for the oversized dimensions and ventilated container for the life products.

3.1.4 Container Transport Chain

As shown in **Figure 3.1**, the container transport chain involves various transportation modes and container port or terminal for the container trans-shipment between transport vehicles. The trans-shipment of the container can be between the inland mode vehicles and the ocean transport mode, or may be between inland modes, such as from the road mode to the rail mode. The trans-shipment to the vessel should be carried in the seaport or maritime container terminal, whereas the trans-shipment between inland modes is designated to be performed in the inland container port, also known as a dry port.

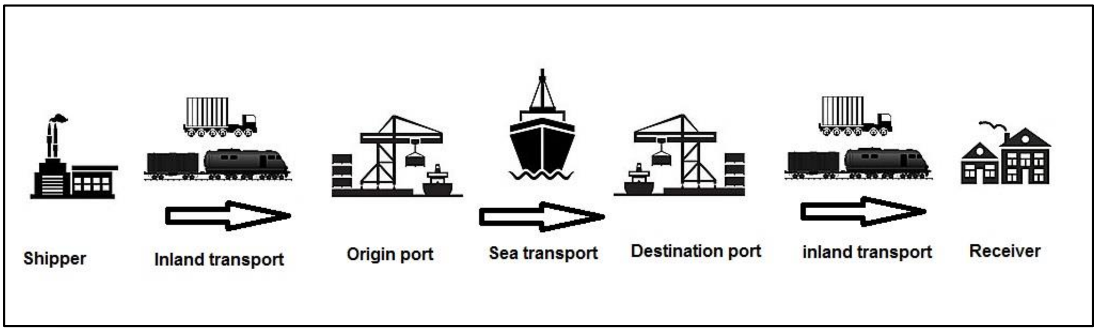


Figure 3.1 Common transport chain of containerized export using maritime shipping. *Source: Adapted from Bouchery et al. (2015)*

Due to the chain of container transport, we can see that, since the beginning of the carriage process, decision choice issues have occurred. The decision problems are partially related to the inland mode choice, port choice and sea transport selection and then continue to the selection of the destination port and inland transport mode in the receiver part. Min (1991) stated two main questions concerning international intermodal choice problems: (1) How to decide on the appropriate selection of an efficient and low cost transport mode and (2) how to choose the export or import port to meet the needs of international container transportation.

In the case of the lack of availability of a seaport in the area, the inland port also has a similar function to the seaport, but is located on the mainland. Inland ports are also known as dry ports and serve as a temporary storage and trans-shipment of a container (Roso *et al.*, 2009; Hanaoka and Regmi, 2011; Regmi, 2012).

3.1.5 National and International Freight Transport Network Model

The discussion regarding national and international freight transport network models starts with the overview of national and international freight transport models carried out by (de Jong, Gunn, *et al.*, 2004), which gives an overview of how freight transport models have been developed and applied. They discussed the specific design of a logistics model in terms of theory and methodology. Some of the models have been reviewed by De Jong *et al.* (2004), especially national freight network models in some European countries.

In their study, De Jong *et al.* (2004) explained that, in passenger transport, there are usually four steps in the context of the freight transport model system, namely: (1) Production and attraction; (2) Distribution; (3) Modal split; and (4) Assignment. The model for inventory and transport logistics needs to be added.

As shown in **Figure 3.2**, Tavasszy (2006) proposed a conceptual framework of the freight transport system, which contains five decision problems related to the freight transport system: (1) Production and consumption; (2) Trade (sales and sourcing); (3) Logistics services; (4) Transportation services; and (5) Network services.

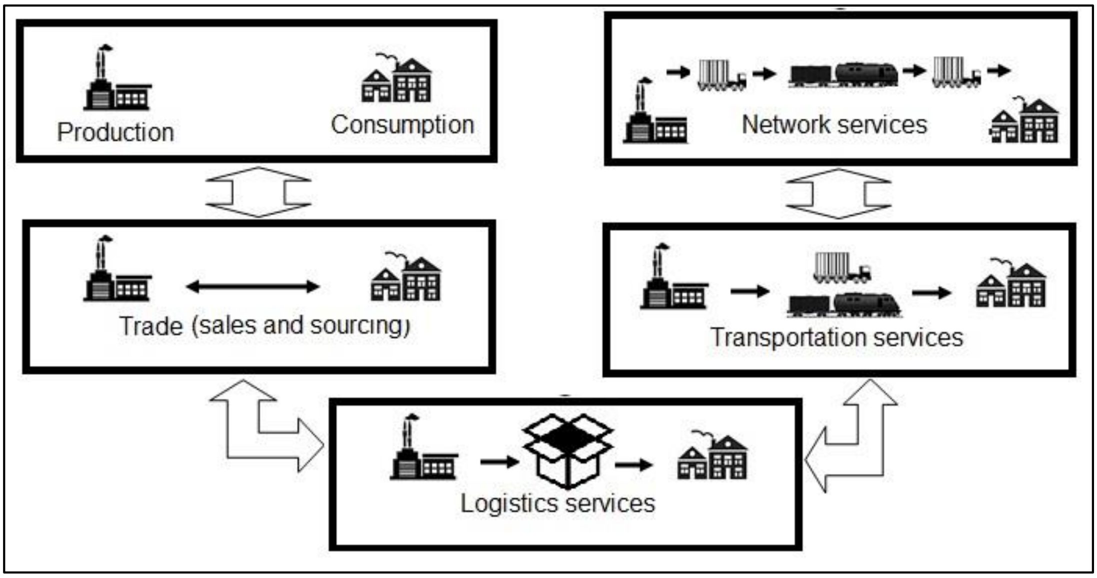


Figure 3.2 Conceptual framework of the freight transport system. *Source: Adapted from Tavasszy (2006)*

De Jong *et al.* (2013) discussed the steps in a full freight model system from economic activities to the assignment of vehicles in networks that are also used in the discussion of the freight transport models:

- Economic activity (production system configuration, consumer choice)
- Zone of production to zone of consumption flows (sales and sourcing by firms and consumers)
- Logistic choices (own account or hire and reward, inventory logistics and transport logistics (transport chains, modes))
- Vehicle flows (vehicle type, scheduling)
- Network assignment (network routing; though this could also be regarded as part of transport logistics).

Several national and European freight transport models have been reviewed by de Jong *et al.* (2013), including (1) Italian National Model System (2) SMILE+ (3) MODEV (4) BVWP model (5) Transtool (6) Worldnet (7) Norway (8) Sweden (Samgods) (9) ADA model for Flinders (10) NODUS model (11) LOGIS and (11) Netherlands (Basgoed). The models have been compared in consideration to several characteristics of the model, especially related to the steps in a full freight model system. One of the useful findings shows a significant gap between ideal and available data on national freight movements, business establishment, shipment and supply chains in the United States and Europe (de Jong *et al.*, 2013).

According to Tavasszy (2006), as shown in **Table 3.2**, some challenges in the freight transport modelling, especially in transportation services, are modal choice, intermodal transport and light goods vehicles.

Table 3.2 Summary of modelling challenges and techniques. *Source from Tavasszy (2006)*

<table>
<tr><th>Decision problem</th><th>Typical modelling challenges</th><th colspan="3">Typical techniques employed</th></tr>
<tr><td>Production and consumption</td><td>Trip generation and facility location
Freight/economy linkage
Consumption patterns</td><td rowspan="2">Land Use Transport Interaction (LUTI - 1970s) and Spatial Computable General Equilibrium (SCGE - 1990s) models</td><td colspan="2">Trip generation model, Input-Output Model (1970s)</td></tr>
<tr><td>Trade</td><td>International trade
Value to volume conversion</td><td>Gravity models, synthetic Origin-Destination models (1970s)</td><td rowspan="4">Agent-based simulation models (1990s)</td></tr>
<tr><td>Logistics services</td><td>Inventory location, supply chain management considerations</td><td colspan="2">Logistics choice models (1990s)</td></tr>
<tr><td>Transportation services</td><td>Choice of mode
Intermodal transport
Light goods vehicles</td><td>Simple trip conversion factors (1970s), discrete choice (1990s)</td><td rowspan="2">Multimodal networks (1980s)</td></tr>
<tr><td>Network and routing</td><td>Routing and Congestion
Tour planning
City access</td><td>Network assignment (1980s), simulation (1990s)</td></tr>
</table>

Zhang (2013), in her study, proposed a new freight transport network model with the capacity to accommodate various challenges in freight transport, such as multimodality, multicommodity and multiactor. The model was validated through implementation to the Dutch container transport network.

3.2 Port Choice in Freight Transport

The port has a significant role in the containerized freight transport chain for international shipment; therefore, port choice is crucial for international container freight transport, where inefficient port operations and/or facilities could delay the intermodal transfer process (Min, 1991), The researchers and port users assigned more attention to the port choice than before, as shown by the large amount of literature made available during recent years. The study distinguishes the port choice according to the perspective of the actors, methodology used, determinant factors and port choice as a part of a chain or network.

3.2.1 Port Choice Perspectives

Considering the standpoint in port choices, port choice can be differentiated into five categories, based on decision-makers' perspective. These perspectives, such as those of shippers, freight forwarders, carriers or shipping lines, port authorities or terminal operators and ship owners, have been considered by previous:

1. Shippers' perspective (Slack, 1985a; Murphy and Daley, 1994; Tiwari *et al.*, 2003; Nir *et al.*, 2003; Song and Yeo, 2004; Cullinane *et al.*, 2005; Ugboma *et al.*, 2006; De Langen, 2007; De Martino and Morvillo, 2008; Yuen *et al.*, 2011; Steven and Corsi, 2012).
2. Freight forwarders' perspective (Slack, 1985a; Bird and Bland, 1988; De Langen, 2007; De Martino and Morvillo, 2008; Grosso and Monteiro, 2008; Tongzon, 2009; Yuen *et al.*, 2011; Onut *et al.*, 2011).
3. Shipping lines or carriers' perspective (Lirn *et al.*, 2004; Song and Yeo, 2004; Guy and Urli, 2006; Tongzon and Sawant, 2007; Yeo *et al.*, 2008; De Martino and Morvillo, 2008; Wiegmans *et al.*, 2008; Yuen *et al.*, 2011; Chou, 2010; Malchow and Kanafani, 2004; Panayides and Song, 2012; Chang *et al.*, 2008; Saeed, 2009).
4. Port authorities and terminal operators' perspective (Lirn *et al.*, 2004; Song and Yeo, 2004; Cullinane *et al.*, 2005; De Martino and Morvillo, 2008; Onut *et al.*, 2011).

5. Shipowners' perspective (Song and Yeo, 2004; Yeo *et al.*, 2008; Onut *et al.*, 2011).

Table 3.3 presents the details pertaining to port choice from different decision-makers' perspectives.

Table 3.3 Port choice from the decision-makers' perspective

References Authors (Year)	Shippers	Freight Forwarders	Shipping Lines/ Carriers	Port Operator/Authorities	Ship Owners
Slack (1985)	✓	✓			
Bird and Bland (1988)		✓			
Murphy *et al.* (1994)	✓				
Tiwari *et al.* (2003)	✓				
Nir *et al.* (2003)	✓				
Lirn *et al.* (2004)			✓	✓	
Song and Yeo (2004)	✓		✓	✓	✓
Cullinane *et al.* (2005)	✓			✓	
Ugboma *et al.* (2006)	✓				
Guy and Urli (2006)			✓		
Tongzon and Sawant (2007)			✓		
De Langen (2007)	✓	✓			
Yeo *et al.* (2008)			✓		✓
Grosso and Monteiro (2008)		✓			
Wiegmans *et al.* (2008)			✓		
Saeed (2009)			✓		
Tongzon (2009)		✓			
Yuen *et al.* (2011)	✓	✓	✓		
Onut *et al.* (2011)		✓		✓	✓
Panayides and Song (2012)			✓		
Steven and Corsi (2012)	✓				
Rosa Pires da Cruz *et al.* (2013)			✓	✓	
Talley and Ng (2013)	✓		✓		
	11	7	11	5	3

It can be seen from **Table 3.3** that most of the researchers examined port choice from the shippers' perspective and carriers' perspective. This finding is in line with the study by Tsamboulas and Kapros (2000), in which the statement is made that, in the intermodal transportation decision-making process, there are three actors involved, namely forwarders, shippers and shipping lines.

Aside from the perspective of decision-makers, researchers also evaluated port selection from others perspectives, such as:

- Researchers' and academics' perspective (Song and Yeo, 2004; Onut *et al.*, 2011),
- The hinterland perspective (Garcia-Alonso and Sanchez-Soriano, 2009; Zhang *et al.*, 2009),

- Logistics network or transport chain perspective (Tran, 2011; Tavasszy *et al.*, 2011; Magala and Sammons, 2008; Talley and Ng, 2013),
- Port competition perspective (Zondag *et al.*, 2010).

3.2.2 Methodology of Evaluating Port Choice

A Multi-Criteria Decision Making (MCDM) method is often exploited in port-selection studies. Some researchers have applied the Analytic Hierarchy Process (AHP) and Analytic Network Process (ANP) in an effort to examine and weight the factors influencing port-selection (Lirn *et al.*, 2004; Song and Yeo, 2004; Ugboma *et al.*, 2006; Yuen *et al.*, 2011; Onut *et al.*, 2011; Rosa Pires da Cruz *et al.*, 2013; Chou, 2010). The AHP is used for its advantages in regard to its ability to solve the problem of multiple-objective and multiple-criteria. Moreover, a Delphi Technique or Focus Group Discussion is usually also applied to acquire the potential factors of the related problems before the AHP process is carried out.

A Revealed Preference (RP) technique was widely used by some researchers in order to analyse the attributes of the available ports (Nir *et al.*, 2003; Tiwari *et al.*, 2003; Tongzon, 2009; Steven and Corsi, 2012; Tongzon and Sawant, 2007). The revealed preference data could be obtained by the survey through respondents according to their current port choice based on the key ports' attributes. In contrast to the use of RP, the Stated Preference (SP) method has been used by only Tongzon and Sawant (2007), who applied it to evaluate the choice of shipping lines in making the decision of the port selection in Singapore and Malaysia.

Yeo *et al.* (2008) and Grosso and Monteiro (2008) employed Factor Analysis with the aim of examining determinant factors in port choice. Grosso and Monteiro (2008) combined Factor Analysis with the Literature Review in an effort to obtain prominent factors. Meanwhile, the Literature Review also performed by (Talley and Ng, 2013; Wiegmans *et al.*, 2008; Grosso and Monteiro, 2008; De Martino and Morvillo, 2008) was centred on identifying the potential attributes of a port, as considered by decision-makers.

The details of the studies in terms of port choice are shown in **Table 3.4** below.

Table 3.4 Summary of previous studies on port choice

References	Perspectives	Port Characteristics	Location/Remark	Methodology
Slack (1985)	Shippers (exporters and freight forwarders)	Port security, size of port, inland freight rates, port charges, port congestion, port equipment, number of sailings service, proximity of port and possibility of intermodal links	North America/ Container shipment	Closed questionnaire survey
Bird and Bland (1988)	Freight forwarders	Frequency of shipping services, loyalty agreement, time, port charges, labour problems, groupage and freight consolidation, delivered price, the spirit of free enterprise looms large.	Europe/Cargo shipment	Survey
Murphy *et al.* (1994)	Shippers (purchasing managers)	Shipment information, loss and damage performance, equipment availability, low freight charges, convenient pickup and delivery, claims handling ability, special handling ability, high volume shipment, large and odd-size freight	USA/International shipment	Survey, Rank correlation
Tiwari *et al.* (2003)	Shippers	Ship calls, total TEU handled at port, number of berths, number of cranes, water depth, route offered, usage factors	China/Export and import shipment	Discrete Choice Analysis, Multinomial Logit
Nir *et al.* (2003)	Shippers	Travel time, travel cost, route, frequency and dummy variables for alternative ports.	Taiwan/Container shipment	Survey, RP data, Multinomial Logit
Lirn *et al.* (2004)	Container carriers, container port authorities	Port physical and technical infrastructure (basic infrastructure, technical infrastructure, intermodal links) Port geographical location: proximity to export and import, proximity feeder ports, proximity to main navigation routes Port management: Efficiency, vessel turn around, port security/safety Carriers' terminal cost: handling cost, storage cost, terminal ownership	Global/Trans-shipment shipping	Delphi technique and Analytic Hierarchy Process
Malchow and Kanafani (2004)	Carriers	Oceanic distance, inland distance, sailing headway, vessel capacity	USA/Export shipments	Choice Model, Multinomial Logit
Song and Yeo (2004)	Ship owners, shipping companies, shippers, terminal operators, researchers	Cargo volume, port facility, port location, service level, port expense	China/Container ports	Analytic Hierarchy Process
Chou (2005)	Carriers, shippers	Shippers: inland transportation cost, freight on sea, calling port, type of liner, frequency of liner	Taiwan/Container ports	Multi-Criteria Decision Making
Cullinane *et al.* (2005)	Shippers, port authorities	Price, generalized cost, natural endowments, quality service improvement, government policies	China/Competition of container ports	Relative Competitive Analysis

Ugboma *et al.* (2006)	Shippers	Port efficiency, adequate infrastructure, frequency of ship visits, quick response to ports users' needs, location, port charges, port reputation of cargo damage	Nigeria/Cargo shipment	Analytic Hierarchy Process
Guy and Urli (2006)	Shipping lines	Port infrastructures (water depth, quay length, cranes, intermodal interfaces), Total transit cost, Service – turn-around time and Geographical location (immediate and extended hinterland, possibility to serve other port within the same loop	North America/Container shipment	Multi-Criteria Analysis
Acosta *et al.* (2007)	Companies related to the container movement	Infrastructure, superstructure, human capital, technology and communication system, competition in the port, demand conditions, government or public sector, support industries	Spain/Container shipment	Extended diamond of Porter Analysis
Tongzon and Sawant (2007)	Shipping lines	Infrastructure, port charges, Efficiency, location, cargo size, connectivity	Singapore and Malaysia/Regional competition	SP and RP data, Binary Logistics Regression
De Langen (2007)	Shippers, freight forwarders	Frequency and quality of shipping services, efficiency of port, port location, risk of delay in other port, connection to hinterland services, equipment of port, customer focus in port, personal relations	Austria/General cargo shipment	Survey
Yeo *et al.* (2008)	Shipping companies	Port service, hinterland condition, availability, convenience, logistics cost, regional centre, connectivity	Korea and China/Container shipment	Survey, Factor Analysis
Grosso and Monteiro (2008)	Freight forwarders	Customs procedures, electronic customs procedures, handling facilities, customs efficiency, customs hours	Italy (Genoa Port)/Container port	Literature review, Survey Factors Analysis
Wiegmans *et al.* (2008)	Deep sea container operators	Port physical and technical infrastructure (nautical accessibility, terminal infrastructure, hinterland accessibility), port location, port efficiency, interconnectivity, reliability, quality and cost of auxiliary services, efficiency and cost of port management, quality and availability of value added activities, port safety/security, port reputation .	Hamburg-Le Havre range/Container shipment	Literature review Interviews
Saeed (2009)	Carriers	Service quality, loading and discharging rate, handling charges, number of TEUs handled, number of ship calls, storage facilities, location, personal contact, convenient pickup, night navigation, switching cost, investment and terminal ownership (public or private)	Pakistan/Container terminal selection	Survey, Factor analysis
Tongzon (2009)	Freight forwarders	Shipping frequency, port efficiency, infrastructure, location, port charges, quick response, ports' reputation for cargo damage	Thailand and Malaysia/Container shipment	Survey, RP data, Linear Regression
Chou (2010)	Carriers	Port charges, taxes, rent and cost, port operation efficiency, load/discharge efficiency, size and efficiency of container yard, hinterland economy, depth of berth	Taiwan/Container shipment	Personal Interview, Analytic Hierarchy Process

Yuen *et al.* (2011)	Shipping lines, shippers and freight forwarders	Port location, costs of port, port facility, shipping services, terminal operators, port information system, hinterland connections, customs and government regulation	China and neighbouring countries/Port competitiveness	Focus Group Interview - Analytic Hierarchy Process
Onut *et al.* (2011)	Academicians, port authorities, freight forwarders, ship-owners	Port location, hinterland economy, physical feature of port, port efficiency, cost (port charge and inland freight rates) other	Turkey/Container shipment	Fuzzy Analytical Network Process
Panayides and Song (2012)	Shipping lines	Adequacy of port facilities, port efficiency, port costs, information system availability, intermodal and value-added services	International sample	Postal and online survey-
Steven and Corsi (2012)	Shippers	Crane productivity, port congestion, terminal management, average vessel size, call frequency.	Pittsburgh – USA/Import shipments	Individual Shipment Data - Conditional logit
Rosa Pires da Cruz *et al.* (2013)	Seaport authorities, terminal operators, ocean carriers	Cost perspective, seaport management, geographical location, physical and technical infrastructure	Portugal and Spain/Seaport competitiveness	Delphi Approach - Analytic Hierarchy Process
Talley and Ng (2013)	Shipping lines, shippers	Shipping lines: port location, ocean distance, port berth availability, port cargo, port price, range of port services, port efficiency, port physical and infrastructure, port hinterland connections, distance between origin location to origin port to exports Shippers: distance between exporter or importer location to the port, port prices, port frequency of ship calls, port frequency of cargo loss and damage, service quality, port efficiency, port equipment availability, port information services, size of the shippers	Maritime transport chain	Literature review

3.2.3 Port Choice Determinants from the Perspectives of Shippers and Freight Forwarders

At first, port choice was commonly carried out in isolation; now, however, it is more widely associated with the transport chain. Thus, the determining factors in port selection are not merely related to the port characteristics itself, but also are connected to the previous and next link in the freight transport chain. For instance, for the export shipments using sea shipping, the previous link of the port is the carriage in the hinterland, whilst the next is sea shipping.

Although there are 12 authors who have examined the selection of the port from the perspective of shippers and eight authors who have evaluated all aspects from freight forwarders' perspective, not all of them present the relevant factors to be considered in the decision-making process.

Port choice behaviour, from shippers' perspective has been studied by various scholars (Slack, 1985a; Murphy and Daley, 1994; Tiwari *et al.*, 2003; Nir *et al.*, 2003; Song and Yeo, 2004; Cullinane *et al.*, 2005; Ugboma *et al.*, 2006; De Langen, 2007; De Martino and Morvillo, 2008; Yuen *et al.*, 2011; Steven and Corsi, 2012). Furthermore, the studies on port choice, from the perspective of the freight forwarders, have been carried out by others (Bird and Bland, 1988; De Langen, 2007; De Martino and Morvillo, 2008; Grosso and Monteiro, 2008; Tongzon, 2009; Yuen *et al.*, 2011; Onut *et al.*, 2011)

Slack (1985) evaluated exporters' behaviour in North America in regard to port selection. The port choice was examined in accordance to the characteristics of ports, namely port security, size of port, inland freight rates, port charges, port congestion, port' equipment, number of sailings service, proximity of port and possibility of intermodal links. The key port choice determinants are number of sailings and port cost.

Murphy and Daley (1994) examined shippers' (purchasing managers') behaviours on selecting the water port in the USA and found that shipment information and loss, damage performance, low freight charges and equipment availability were the main determinants for port choice. In 1988, Bird and Bland found that infrastructure, port cost, time, services and frequency of shipping services were the most prominent factors for freight forwarders in Europe in the selection of port.

Tiwari *et al.* (2003) investigated shippers' behaviours on port selection and carrier selection in China. A choice for a shipper actually is a set of options comprising carrier selection and port selection. Based upon the data available, a shipper has 14 port-carrier alternatives, and the results show that the distance of shippers from the port has a significant negative influence on choosing the port. Meanwhile, the number of berths in the port has a significant positive effect on the decision. Another factor that has an important effect is total TEU handled by a shipping line. From the analysis, Tiwari *et al.* also found that Chinese shippers prefer to choose Chinese shipping lines over foreign shipping lines (Tiwari *et al.*, 2003).

The study conducted by Nir *et al.* (2003) in Taiwan compared three container ports in Taiwan (Port of Keelung, Port of Taichung and Port of Kaohsiung) and adopted three models: basic model, experienced model and competition model. In the basic model, a linear multiple-choice model was established using a number of different variables, including Keelung dummy variable, Kaoshiung dummy variable, travel time, travel cost, route and frequency. In the experienced model, the previous port chosen was included. The competition model includes a distance from the origin to port preference as influence factors. The results show that travel time, cost and origin to port distance have a significant effect on port choice decision-making by shippers. Another finding shows that previous experience will influence the next port choice behaviour.

Using AHP, Song and Yeo (2004) investigated the determinant factors of port choice from the perspectives of shippers, shipowners, shipping companies, terminal operators and researchers in China. The results obtained indicate that cargo volume, port facility, port location and service levels are the primary factors in the selection of port.

A study in Nigeria carried out by Ugboma *et al.* in 2006 investigated shippers' determinant factors in the selection of port using the AHP method. The research revealed that shippers afforded more attention to port efficiency, port services, frequency of ship calls and port location when selecting a port for shipments.

De Langen (2007) examined port choice using various port attributes, including frequency and quality of shipping services, efficiency of port, port location, risk of delay in another port, connection to hinterland services, equipment of port, customer focus in port and personal relations. De Langen established that the frequency and quality of shipping services, equipment of the port, location of the port and hinterland connectivity were all key factors in port choice. De Langen also revealed that the preferences of shippers and freight forwarders in Austria were similar unless the forwarders had a more price-elastic demand than shippers.

Hinterland connectivity was also revealed by Grosso and Monteiro (2008) as being one of the key factors in port choice from the perspective of freight forwarders in Genoa Italy. Using a Literature Review and factor analysis, Grosso and Monteiro also identified that port cost, productivity, electronic information and the logistics of containers featured as prominent factors in port selection in Italy.

Tongzon (2009) attempted to investigate port choice from the freight forwarders' perspective in the context of Malaysia and Thailand. Seven factors were identified as being of vital influence to the port choice decision-maker: (1) frequency of ship visits, more frequent of visits gives more flexibility and lower transit time (2) port efficiency, that means speed and reliability of the port service (3) adequate infrastructure, involves the number of container berths, number and quality of cranes, number of tugs, size of terminal, information system and inter-modal transport (4) location (5) port charges (6) quick response to port users' need and (7) ports' reputation for cargo damage. Tongzon's study shows that, both in Malaysia and Thailand, port efficiency is the most important factor from freight forwarders' perspective. This finding provides insight to port operator managers in terms of improving their port efficiency in an effort to attract more freight forwarders. Tongzon also found that the decision-making process was not simple but complex and required a two-stage process (Tongzon, 2009).

A study on port choice by shippers, freight forwarders and shipping lines was carried out by Yuen *et al.* (2011) in China and neighbouring countries. In term of port competitiveness, Yuen *et al.* concluded that cost at the port, hinterland connection, customs and government regulation, port location and shipping services are all critical consideration for decision-makers.

Another study by Onut *et al.* (2011) revealed the importance of the hinterland economy and port location in the port choice of freight forwarders, port authorities, academicians and ship owners in Turkey for the container shipment. Onut used the Analytical Network Process.

Steven and Corsi (2012) attempted to analyse important factors influencing the attractiveness of the port for the containerized import to the Pittsburgh metropolitan area using individual shipment data, including the point of origin, port of the origin country and port entry in US. The study was carried out in two phases: (1) estimating shipping charges on individual shipment using ocean freight rate model and (2) estimating the port choice using the results from the previous step. Shippers were differentiated into small and large shippers, with the results showing significant differences between small and large shippers' characteristics. Small shippers were found to be more sensitive to the transportation costs of shipment compared to larger shippers. On the other hand, large shippers place more emphasis on the speed of transportation than on transportation costs (Steven and Corsi, 2012).

From **Table 3.5**, it can be seen that there are 12 key factors in the port choice, eight of attributes (infrastructure, cost, time, efficiency, services, ship calls, cargo volume and location) related to the ports itself and four attributes (congestion, distance, cost, distance and connectivity) related to the hinterland of the port. We can conclude that the port cost and port ship calls are the most prominent factors for shippers and freight forwarders in the decision-making of port selection. Furthermore, port infrastructure and services in the port are also considered by freight forwarders and shippers when evaluating port alternatives.

The hinterland factors that influence the selection of ports prove that the selection process cannot be separated from the issue in the hinterland—one of which is closely related to the inland transport leg. UNECE (2010) argued that a weak port and hinterland connectivity reduces a port's competitiveness.

Table 3.5 Summary of port choice determinants from shippers' or freight forwarders' perspective[7].

References	Port								Hinterland				Decision-makers
	1	2	3	4	5	6	7	8	9	10	11	12	
Slack (1985)		✓				✓							Shippers
Bird and Bland (1988)		✓	✓		✓	✓				✓			Freight forwarders
Tiwari *et al.* (2003)	✓						✓			✓			Shippers
Nir *et al.* (2003)		✓	✓			✓							Shippers
Song and Yeo (2004)	✓				✓		✓	✓					Shippers
Ugboma *et al.* (2006)				✓	✓	✓		✓					Shippers
De Langen (2007)	✓				✓	✓						✓	Shippers and freight forwarders
(Grosso and Monteiro, 2008)		✓		✓								✓	Freight Forwarders
Tongzon (2009)	✓	✓		✓		✓							Freight Forwarders
Yuen *et al.* (2011)		✓			✓					✓		✓	Freight Forwarders
Onut *et al.* (2011)								✓			✓		Freight Forwarders
Steven and Corsi (2012)				✓					✓				Shippers
	4	6	2	4	5	6	2	3	1	3	1	3	

3.2.4 Port Choice and Other Choices as a Joint Model

In the port choice area of study, some researchers attempted to combine the port choice with other choices, such as carrier choice (Tiwari *et al.*, 2003; Garrido and Leva, 2004). Moreover, the port choice could be examined as a part of a network or chain: for instance, maritime chain choice (Zondag *et al.*, 2010), network choice (Tang *et al.*, 2011; Tavasszy *et al.*, 2011), maritime transport chain (Talley and Ng, 2013) and supply chain choice (Magala and Sammons, 2008). The summary of studies is shown in **Table 3.6**.

Tiwari *et al.* (2003) found the shippers' probability of choosing an alternative of port and carrier depends on ports', shipping lines' and shippers' characteristics. Some variables from ports' features that influence choice are: (1) ship calls (2) total TEU handled at the port (3) number of berths (4) number of cranes (5) water depth (6) routes offered (7) usage factor and (8) port and loading charges. Shipping line has two main factors that influence the carrier choice by shipper: (1) total TEU handled during the

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[7] (1) Infrastructure (2) Cost (3) Time (4) Efficiency (5) Services (6) Ship Calls (7) Cargo Volume, (8) Location (9) Congestion (10) Distance (11) Hinterland Cost (12) Connectivity.

year by the carrier and (2) fleet size. Shippers' characteristics also known to influence the decision include (1) distance of shipper from port (2) type of trade and (3) distance of the foreign port.

Garrido and Leva (2004) also developed a port and carrier selection model for the export of fruits from Chile to the United States. The data were analysed using a Multinomial Probit model. There was a significant state dependence, serial and spatial correlation in the choice of destination port and carrier. Garrido and Leva (2004) also concluded that the temporal effect and stochastic effect influenced destination port and carrier selection for fruits export from Chile to the USA.

Zondag *et al.* (2010) developed a model of port competition using maritime, port and hinterland characteristics as considerations. A Multinomial Logit model was used to calculate probabilities. In this model, the logistic chain as an alternative from a choice set has three core components: (1) maritime component—cost and time (2) port component—performance and cost and (3) hinterland component—cost.

According to recent insights, it is common for shippers to no longer choose a port per se, but rather to choose a supply chain, namely a bundle of logistics services by which means shippers select a port as an item in a logistics package (Magala and Sammons, 2008). They conclude that the right modelling framework to hold discrete choice modelling can provide both port choice and system. To model a complex decision problem, a Hierarchical Information Integration (HII) approach is useful for solving the problem. For an example of a HII approach, port choice process as an item in a supply chain is shown in **Figure 3.3**.

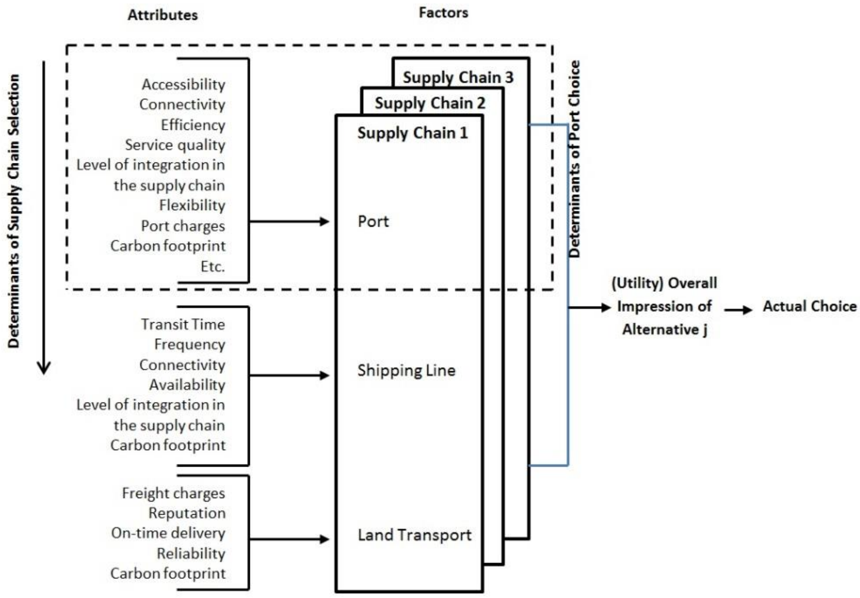

Figure 3.3 Port choice process using HII approach. *Source: Adapted from Magala and Sammons (2008)*

According to **Figure 3.3** above, it can be explained that supply chain selection will use factors such as port, shipping line and land transport as considerations. On the other hand, port selection will use characteristics of available ports based on the attributes of the ports, such as accessibility, connectivity, efficiency, service quality, level of integration in the supply chain, flexibility, port charges and carbon footprint, etc. The port choice in the supply chain also should consider the attributes of shipping lines and inland transportation mode. However, even this approach includes the three parts of the international supply chain components, although this approach remains difficult to implement due to the complexity and availability of related data.

Tavasszy *et al.* (2011) proposed a strategic model with the capacity to predict container flows over the world's main shipping routes. The predicted container flows passing through more than 400 container ports and involving more than 800 maritime container liner services were simulated. The model includes trans-shipment flow, export flow and import flow of containers at ports, as well as the flow of container in the hinterland (Tavasszy *et al.*, 2011).

Table 3.6 provides the summary of the studies on port choice as a joint choice or network/chain choice.

Table 3.6 Summary of port choice as a joint choice or network/chain choice

References	**Description**	**Remark**
Tiwari *et al.* (2003)	Tiwari *et al.* built a shippers' port and carrier choice model using a discrete choice model, based on port characteristics, shipping line characteristics and shippers' characteristics itself	Port and carrier choice
Garrido and Leva (2004)	Garrido and Leva examined the behaviour of fruit exporters in Spain on the destination port and carriers selection using Multinomial Probit model.	Port of destination and carrier selection
Magala and Sammons (2008)	Magala and Sammons proposed a new approach on port choice modelling by integrated port selection as a part of supply chain	Supply chain choice (inland mode, port and shipping line choice)
Zondag *et al.* (2010)	Zondag *et al.* developed a port competition model to find the market share of the port based upon the three components of the logistic chain: maritime, port and hinterland component	Port competition perspective using Logistics chain choice (hinterland, port and maritime choice)
Tavasszy *et al.* (2011)	Tavasszy *et al.* specify and estimate a strategic network model of global container movements (shipping routes) over 437 container ports. Port choice is a part of the strategic network choice	Strategic network choice
Tang *et al.* (2011)	Developed a novel Network-based Integrated Choice Evaluation (NICE) to integrate the component of the network service in a port	Network-based integrated choice
Tran (2011)	Minimization of total transportation cost that consists of sea transport cost, inland transport cost, port cost and inventory cost.	Port selection from the logistics perspective
Talley and Ng (2013)	Talley and Ng investigated the maritime transport chain choice and concluded that the determinants of port choice by shippers and shipping lines are also determinants of maritime transport chain choice	Maritime transport chain choice

Tiwari *et al.* (2003) and Garrido and Leva (2004) used RP data with the aim of analysing port and carrier choice behaviour, whilst Magala and Sammons (2008) only proposed a new approach on port choice modelling. Zondag *et al.* (2010) also used RP data to examine the market share of the port based on three components of logistics. Although the study by Magala and Sammons (2008) includes all factors related to port choice, the model is relatively complicated to apply the model to an SP experiments, because there are many attributes that need to be considered in the decision-making process.

3.3 Mode Choice Model in Freight Transport

There are many publications on mode choice studies in freight transport. The Literature Review carried out in this study centres on mode choice with focus on the perspective of shippers and freight forwarders.

Many researchers have tried to investigate the behaviour and factors influencing mode choice by shippers in freight transport. Most researchers have studied mode choice and its influencing factors from the perspective of the shippers and forwarders in isolation; some researchers performed it in combination with other choices.

3.3.1 Data Source

De Jong (2014) elaborated on some issues associated with mode choice models in freight transport. De Jong distinguished the mode choice models into disaggregate and aggregate models. Disaggregate models use individual observations and relatively more uncommon in freight transport than in passenger transport. On the other hand, the aggregate models use aggregate observations (usually at the zonal levels) and are widely employed in mode choice for the freight transport because it is easier to obtain the data (de Jong, 2014).

It can be seen from **Table 3.8** that the studies relating to mode choice from the perspective of shippers and freight forwarders used Stated Preference (SP) and Revealed Preference data (RP). SP data was used to examine a new service or alternative, whereas RP data was used for evaluating the currently available alternatives.

3.3.2 Mode Choice in Freight Transport from the Shippers' or Freight Forwarders' Perspective

Jeffs and Hills (1990) studied factors influencing the decision-making process on freight transport modal choice. They identified six categories of variable related to customers, products, companies, government, transport facilities and perceptions of decision-makers. Using the factor analysis approach, two factors were found to be major determinants of modal choice. Factor 1 consists of seven variables, namely reliability, control over dispatch, control over delivery time, avoidance of damage, security, transit time and availability, whereas factor 2 includes length of haul and size of shipment (Jeffs and Hills, 1990).

An RP study on freight mode choice in France was conducted by Jiang *et al.* (1999) using a freight demand survey for shippers in France in 1988. A nested logit model was used to analyse the data. The study analysis indicated that the choice of shippers on mode choice depends on demand characteristics, including transportation distance, accessibility to infrastructure, shipment package and shipper's own facilities. From the transport distance characteristics analysis, Jiang *et al.* (1999) found that the distance of 700 kilometres was the point of maximum probability of shippers for choosing road transportation. Meanwhile, that of choosing rail transportation takes place at 1,300 kilometres.

A content analysis Literature Review in the freight route and mode choice literature has been carried out by (Cullinane and Toy, 2000). From the various forms of content analysis (manifest analysis, latent analysis and meta-analysis) undertaken, the result points out that it was difficult to confirm the most influential factors owing to the fact that any single source of literature was not independent of others. However, at least according to the manifest analysis of the literature, the five most often considered factors are cost, speed, transit time reliability, characteristics of goods and service.

Shinghal and Fowkes (2002) presented the empirical results of determinants of mode choice for freight services in India using data gathered from a Leeds Adapted Stated Preference (LASP) survey on the Delhi to Bombay corridor. Four alternatives to transport modes were presented to the respondent: (a) currently used road service (b) a new road service (c) intermodal container service and (d) rail service. Four attributes were considered determinants of mode choice: (a) cost (for door-to-door movement), (b) door-to-door transit time, (c) reliability of service and (d) frequency of service. Shinghal and Fowkes (2002) found that frequency of service was the main determinant of freight mode choice in India.

The only previous SP survey of freight transport in Java, Indonesia was carried out by Norojono and Young (2003). Norojono and Young used Hierarchical SP to simplify the experiment. They investigated the behaviours of shippers on freight mode choice alternatives, namely small truck, large truck and rail. The data were collected from 186 freight companies from six cities in Java (Surabaya, Malang, Bandung, Yogyakarta, Surakarta and Semarang).

In their SP experiment, Norojono and Young (2003) used several attributes of inland mode and their levels—transport cost, delivery time, quality (time reliability, safety, truck condition, travel route and access to rail terminal) and flexibility (train formation, frequency of service, time of departure and responsiveness)—to differentiate amongst alternatives. The data then were analysed using a Nested Multinomial Logit model. The results of the study indicated quality (safety and reliability) and flexibility (responsiveness) as the main considerations by shippers in choosing alternatives between rail or road freight transport.

Garcia-Menendez *et al.* (2004) examined the determinants of mode choice for exports from Spain using data from interviews with exporters and freight forwarders. A conditional logit discrete choice model was used to analyse the elasticity of the road and sea transport. The result showed maritime transport to be much more sensitive than road transport in regard to variations of costs and transport prices.

Large companies (140) and logistics providers (106) in twelve European countries were surveyed in 2006 by the REORIENT project (Grue and Ludvigsen, 2006). This project revealed the differences between the rail and road modes based on shipment and shippers' characteristics, including the product's value per tonne and shipper size. The intermodal expediency factor (duration of transport time, efficiency and suitability of loading unit) was the most important factor for rail mode choice, whereas the four most important factors in road mode choice were service availability, dealing with service failures, technical efficiency and value for money.

A stated, an order preference experiment on inland mode choice was conducted by Beuthe and Bouffioux (2008) to transport managers in Belgium. The attributes were included in the study were frequency, time, reliability, flexibility, safety and cost. The attributes were analysed using goods characteristics, distance and shippers' characteristic on the mode chosen. There were differences in shippers' behaviour on choosing the essential characteristics of freight transport. Cost was found as the dominant factor for a company in switching the mode.

Arunotayanun (2009) performed a more in-depth analysis of the data collected by Norojono and Young (2003). The analysis was conducted by comparing several results from the analysis of three levels of the model: construct level, explanatory level and construct level with contextual variables. Arunotayanun investigated the potential correlation between the alternatives using Multinomial Logit, Nested Logit and Cross Nested Logit. Moreover, Mixed Multinomial Logit, Mixed Nested Logit and Mixed Cross Nested Logit were used to test the heterogeneity across freight agents. The contextual variables at the construct level then were also tested, and it was found that only cargo of the small truck and value of the large truck was significant.

A stated preference study on the inland leg of containerized maritime shipment has been conducted by Feo-Valero *et al.* (2011). In their study, Feo-Valero *et al.* utilized a Mixed Logit to examine the modal choice of the inland leg of containerized transport in Spain. The results of Feo-Valero *et al.* concluded that the frequency of service has an important role to play in terms of freight rail mode competitiveness. Freight forwarding companies at the Port of Valencia corridor–Madrid were willing to pay 17 Euros for each decrease of 1-hour travel time. Furthermore, for each 1% reduction in delay, they were willing to pay 3 Euros and 70 Euros for extra rail service per week.

Ravibabu (2013) examined the inland movement of containerized export cargo in India. The study used Revealed Preference (RP) data from 124 exports companies, also supplemented with data from the transport companies and terminal operator. A Multinomial Logit Model and three variants Nested Logit model were used to explain the mode choice behaviour of the export company. Ravibabu stating that, from the transport attributes, total cost and total transit time were the significant factors in the mode choice, whereas reliability, loss and damage did not have a significant effect. The additional variables came from the attributes of the commodity (suitability for containerization and post-export benefits), consignment (such as urgent orders) and terminal (frequency of service).

The inland mode choice was studied mostly from the perspective of shippers or freight forwarders. The key factors seen to influence their decision is shown in **Table 3.7** below.

Table 3.7 The key factors in inland mode choice from the perspective of shippers or freight forwarders

References (Author, Year)	Transport cost	Transit time	Reliability	Flexibility	Safety/ Security	Distance	Characteristics of Goods
Jiang *et al.* (1999)						✓	✓
Cullinane and Toy (2000)	✓	✓	✓				✓
Shinghal and Fowkes (2002)			✓	✓			
Norojono and Young (2003); Arunotayanun and Polak (2011)			✓	✓	✓		
Garcia-Menendez *et al.* (2004)	✓	✓		✓			
Grue and Ludvigsen (2006)							
Beuthe and Bouffioux (2008)	✓	✓	✓				
Feo *et al.* (2011)	✓	✓	✓	✓			
Brooks *et al.* (2012)	✓	✓	✓				
Ravibabu (2013)	✓	✓					
Reis (2014)	✓	✓	✓	✓			
	7	7	7	5	1	1	2

The summary of the previous studies on mode choice in freight transport from the shippers’ or freight forwarders’ perspective is presented in **Table 3.8**.

Table 3.8 Summary of studies on mode choice of freight transport from the shippers' or freight forwarders' perspective

References (Author, Year)	Alternatives	Decision-makers	Attributes	Key Factors	Methodology	Location
Jeffs and Hills (1990)	Road, rail (distinguished in nine modal categories)	Shippers	Reliability, control, transport cost, security, service to customer, length of haul, size of consignment, transit time, availability	Factor 1: reliability, control, avoidance of damage, security, transit time, availability Factor 2: Length of haul and size of consignment	Survey—Factor Analysis	United Kingdom
Jiang *et al.* (1999)	Private, public Road, rail, combination	Shippers	Firm characteristic: type, structure location, size, truck owner, information system, Goods physical attribute: type, weight, value, packaging Spatial and flow characteristics: frequency and distance	Distance, truck owner, structure location, packaging	RP - Nested Logit (NL)	France
Cullinane and Toy (2000)	N/A	Shippers, Freight forwarders	Cost/Price/Rate, service, transit time reliability, frequency, distance, speed, flexibility, infrastructure availability, capability, inventory, loss/damage, characteristics of goods, sales per year, previous experience, controllability/traceability	Cost/Price/Rate, speed, transit time reliability, characteristics of goods, service	Literature review (Content Analysis), Stated Preference	Europe (mostly Western)
Shinghal and Fowkes (2002)	Current road, new road, rail, intermodal	Shippers	Transport cost, transit time, reliability, frequency	Reliability, Frequency	Adaptive SP survey - Multinomial Logit (MNL)	India
Norojono and Young (2003); Arunotayanun and Polak (2011)	Road, rail	Shippers	Cost, time (delivery and reliability), quality (safety, truck condition), flexibility,	Reliability and Flexibility	Hierarchical SP—Heteroskedastic Extreme Values (HEV), MNL, MMNL and latent class	Java, Indonesia
Garcia-Menendez *et al.* (2004)	Shipping and road	Shippers (exporters)	Frequency of shipment, distance, environment, cost, transport time, damage, delay and consolidation	Cost, transit time, frequency of shipment	SP Survey—Conditional Logit (CL)/MNL	Spain

Table 3.9 (continue)

References (Author, Year)	Alternatives	Decision-makers	Attributes	Key Factors	Methodology	Location
Grue and Ludvigsen (2006)	Rail, rail + Ferry, truck, truck + Roro	Shippers	Service failure, intermodal expedience, cargo intake and discharge Operational efficiency, service availability, service failures, technical efficiency, value for money	Rail mode: intermodal expediency Road mode: service availability, dealing with service failures, technical efficiency, value for money	Survey - Service Quality	Europe
Beuthe and Bouffioux (2008)	Rail, road, Short Sea Shipping (SSS), inland waterways	Transport Managers	Frequency, transit time, delivery time, reliability, flexibility, loss and damage, transport cost	Transport cost, delivery time, reliability	Stated Order Preference Survey—Conditional logit (CL)/MNL	Belgium
Feo *et al.* (2011)	Road, rail	Freight forwarders	Transit time, transport cost, reliability and frequency (maritime and rail)	Transit time, transit cost, reliability, Frequency (rail)	SP -Mixed Logit (MMNL)	Spain
Brooks *et al.* (2012)	Land-based transport (road and rail), coastal shipping (SSS)	Shippers	Frequency, transit time, freight distance, direction, reliability - delivery window, reliability—delay, price	Cost, transit time, reliability—delay	Stated Choice Experiments—MNL and Mixed Logit	Australia
Ravibabu (2013)	Rail container, road container, truck	Exporters	Total transport cost, total transit time, reliability, loss and damage	Total transport cost, total transit time	Structured questionnaire (RP)—Nested Logit (NL)	India
Reis (2014)	Rail and road mode	Shippers, freight forwarders	Reliability, transit time, flexibility, price, frequency of service, monitoring, service level, shippers' market consideration, length of haul and security	Reliability, transit time, flexibility and price	Literature review and Agent-based modelling	N/A

3.3.3 Joint Model of Mode Choice in Freight Transport

In terms of joint model in freight transport, the joint model of mode choice and shipment size are more frequently investigated than other joint models (Abdelwahab, 1998; De Jong and Ben-Akiva, 2007; De Jong and Johnson, 2009; Windisch *et al.*, 2010). Some others' joint models are closely related to mode choice, including (1) mode and supplier choice models, (2) mode and route choice models and (3) mode choice in transport chain models (de Jong, 2014).

A joint choice model of inland mode choice and shipment size was analysed by Abdelwahab (1998). The study examined the intercity freight transport market and focused on the estimation of market demand elasticities and mode choice probabilities elasticities. The binary probit was used to specify the mode choice part, which considered two modes: rail and truck. Data on individual shipments of manufacturing products from the US Commodity Transportation Survey were used in the study.

De Jong and Ben-Akiva (2007) developed a model for the determination of mode and shipment size choice using an inventory logistic and transport logistic approach. The model related to the new logistics model development and its application in Norway and Sweden. The focuses of the model are on three components of a 'transport chain choice', namely frequency/shipment size (inventory problem), number of legs of the transport chain and mode per leg (including vehicle type and loading unit). Whilst only the model structure was proposed, no full estimation was carried out. Data sources were identified.

De Jong and Johnson (2009) investigated the differences in mode choice and shipment size in three disaggregate models: (1) An independent discrete mode choice model, (2) a joint model where both of mode and shipment size choice are discrete and (3) a joint model where mode choice is discrete, and the shipment size selection is continuous. Estimation of the models was performed using the Swedish 2001 Commodity Flow Survey data. The data, differentiated mode options into four alternatives: road transport, rail transport, water transport and air transport. The shipment size was divided into five categories (for road, rail and sea transport) and divided into two groups (for air travel).

Windisch *et al.* (2010) also analysed a joint model for mode choice and shipment size. The study used Multinomial Logit (MNL) models and Nested Logit (NL) for model estimation and employed the data taken from the Swedish Commodity Flow Survey

(CFS) in 2004–2005. They differentiated a shipment based on: (1) origin of shipment, (2) destination of shipment, (3) value of shipment, (4) weight of shipment, (5) cargo type of shipment, (6) commodity type of shipment, (7) sequence of transport modes used, (8) proximity of the sending unit of shipment to and use of private siding for rail transport, (9) proximity of the sending unit of shipment to and use of quay for sea transport and (10) year the shipment was sent. The alternatives of shipment size were divided into 15 alternatives, whereas transport chain (sequence of the transport mode) was differentiated into eight choices.

The summary of the joint choice model of mode and shipment size is provided in **Table 3.10** below.

Table 3.10 Summary of the joint model of mode and shipment size choice

References Authors (Year)	Source of data	Model Proposed	Key findings on attributes
Abdelwahab (1998)	US Commodity Transportation Survey	Elasticities model of a simultaneous mode choice/shipment-size choice	Transport charges, transport time
De Jong and Ben-Akiva (2007)	Swedish 2001 Commodity Flow Survey	Logistics and inventory model	The significant factors: logistics cost, reliability and flexibility
De Jong and Johnson (2009)	Swedish 2001 Commodity Flow Survey	Discrete mode and discrete or continuous shipment size choice models	There were differences in cost and time for influencing the mode choice in three different models.
Windisch *et al.* (2010)	Swedish Commodity Flow Survey (CFS) in 2004-2005	Disaggregate freight transport model of transport chain and shipment size choice	Cargo density of the consignment, value density of shipment and delivery cost,

Fowkes and Toner (2005) proposed a new approach called FLOGIT in order to accommodate a joint model of mode and route choice. A Multinomial Logit was considered not appropriate for the modelling of the joint model of mode and route choice. The model consists of two main stages: calculating the composite cost and allocating traffic (total market) to the mode and route alternative. This model is useful in analysing the impacts of policy change on traffic demand in particular regions.

3.4 Greenhouse Gas Emissions

3.4.1 The Increasing Trend of Greenhouse Gas Emissions

World carbon dioxide emissions are projected to rise from 30.2 billion metric tons in 2008 to 35.2 billion tonnes in 2020 and 43.2 billion tonnes in 2030—an increase of 43% over the projection period (EIA, 2011). International Energy Agency estimated that approximately 25% of worldwide CO_2 emissions are attributable to the transport sector, and approximately 75% of these volume emissions are from cars and trucks. Moreover, aviation and shipping emissions are rising rapidly, with energy use in transport potentially doubled by 2050 (IEA, 2009).

Carbon dioxide (CO_2), the primary GHG associated with the combustion of diesel (and other fossil fuels), accounts for more than 95% of the transportation sector's global warming potential-weighted GHG emissions. Methane (CH_4) and nitrous oxide (N_2O) together account for about 2% of the transportation total GHG emissions (NCFRP, 2010).

3.4.2 Greenhouse Gases Estimation Model

Greenhouse gases can be calculated in two ways: (1) continuous emissions monitoring by recording emissions at source and (2) estimation, by multiplying activity data by relevant emissions conversion factors (DEFRA, 2011). There are many types of activities data, such as litres of fuel consumption by the vehicle, number of KM driven and tonnes of goods transported. The activities data should be multiplied by the conversion factors in order to get the number of kilograms of carbon dioxide equivalent (CO_2e). CO_2e is a universal unit for the comparison of global warming potential amongst different GHG sources.

Using Global Warming Potential (GWP) factors, values of CH_4 and N_2O can be presented as CO_2e, consistent with reporting under the Kyoto Protocol and the second assessment report of the Intergovernmental Panel on Climate Change (IPCC) (DEFRA, 2011; IFEU, 2011). GHG as CO_2 equivalents is calculated as follows (IFEU, 2011):

$$CO_2e = CO_2 + 25*CH_4 + 298*N_2O \quad \textbf{(3.1)}$$

The Department for Environment, Food and Rural Affairs of United Kingdom (DEFRA) released several standards on conversion of emissions GHG to CO_2 equivalent and in the 7th annex about Freight Transport Conversion Tables, consists of 7 categories for conversion of emissions from freight transport, namely:

1. Conversion Factors of Standard Road Transport Fuel
2. Conversion Factors of van/Light Commercial vehicle Road Freight: vehicle-km basis
3. Conversion Factors of van/Light Commercial vehicle Road Freight (UK Average vehicle Loads): tonne-km basis
4. Conversion Factors of Diesel HGV Road Freight: vehicle-km Basis
5. Conversion Factors of Diesel HGV Road Freight (using average vehicle loads in UK): tonne-km basis
6. Conversion Factors of Rail and Air Freight Mileage: tonne-km basis
7. Conversion Factors of Maritime Shipping Freight Distance: tonne-km basis.

IFEU (2011) also developed a methodology to estimate emissions from the freight transport sector. Several standards of emission factors from freight transport modes were proposed by IFEU (2011). The principal rule for calculating the vehicle emissions is stated as follows:

$$EMT_i = D_i * M * (EMV_{tkm,i} + EMU_{tkm,i}) \qquad \textbf{(3.2)}$$

where:

EMT_i = Total emissions of transport (kg)

D_i = Distance of transport for each carrier (km)

M = Mass of freight transported (net tonne)

EMV_{tkn} = Vehicle emissions for each carrier *i* (gram / tonne-km)

EMU_{tkr} = Upstream emissions for each carrier *i* (gram / tonne-km)

IFEU (2011) divided the methodology of emissions estimation into four categories, namely road transport, rail transport, sea transport and air transport. Road transport was classified based on truck type and emission standard.

It is undisputed that the rail mode emits fewer GHG emissions than the truck or road mode for each tonne-km of transported products. Kruse *et al.* (2009) attempted to compare the GHG emissions from domestic freight transport between road, rail and waterway. Mckinnon and Piecyk (2011) provided guidance on the GHG emissions calculation from the chemical industries in Europe. The comparison of emission factors from four sources is presented in **Table 3.11**.

Table 3.11 Comparison of GHG emissions on the road, rail and waterway transport

Transport Mode	GHG Emissions (gr CO_2e/tonne – km)			
	Kruse *et al.* (2009)	**DEFRA (2011)**	**Mckinnon and Piecyk (2011)**	**IFEU (2011)**
Road transport (truck)	44.5	89.5	62	66
Rail transport	16.7	31.6	22	18-35

In freight transport, IFEU (2011) shows various aspects, such as vehicle type, capacity, driving condition, traffic route and total weight, influence energy consumption and emissions.

GHG reduction for freight transport will come from three primary sources:

1. Modal shifting in urban short-distance and long-distance travel of freight transport: for instance, using very large vessels for long-distance cargo or using rail transport instead of the road in short to medium distance travel (Kiss *et al.*, 2010; ADB, 2010; Woodburn and Whiteing, 2010).
2. Efficiency from new technologies that reduce the energy use of the vehicle and from operational improvement for truck transport management.
3. Alternative fuels that allow vehicles to emit less CO_2 per unit of energy used: for instance, using fewer carbon-intensive fuels as an energy source (IEA, 2009a).

Other GHG estimation models from freight transport have been proposed by Demir *et al.* (2011), Liao *et al.* (2011), Berechman and Tseng (2012) and McKinnon and Piecyk (2009). Demir *et al.* (2011) provided a comparison of several vehicle emission models for road freight transportation. Several fuel consumption models have been used to estimate the emissions: (1) An instantaneous fuel consumption model; (2) A four-mode elemental fuel consumption model (included acceleration, deceleration, cruise and idle fuel consumption); (3) A running speed fuel consumption model; (4) Comprehensive modal emission model (engine power, engine speed and fuel rate module); (5) Methodology for calculating transportation emissions and energy consumption (MEET); and (6) Computer programme to calculate emissions from road transportation (COPERT) model (Demir *et al.*, 2011).

A model to estimate CO_2 emissions from inland container transport has been developed by Liao *et al.* (2011) as a function of Gross Domestic Product (GDP), population and oil price. They compared carbon emissions between container highway network and coastal shipping network in Taiwan and found that the carbon emissions would decrease to approximately 60% if the trucking only container movement were to be replaced by intermodal freight transport system by means of coastal shipping and shorter truck movements. However, the intermodal transport would entail greater costs, longer times and lesser flexibility in routes. In this case, coastal shipping is less attractive to shippers than trucking only container transport system in container trans-shipment between cities (Liao *et al.*, 2011).

Berechman and Tseng (2012) estimated the cost of emission of vessels and trucks in the Kaohsiung Port, Taiwan, by calculating annual ship and truck emissions. In the UK, road freight transport emissions estimation methods at the national level were estimated by McKinnon and Piecyk (2009).

3.4.3 Reducing the GHG Emissions from the Freight Transport Sector

In order to reduce emissions from the freight transport sector, some studies have been carried out across modes or only in regard to one mode. The minimization of GHG emissions was examined in two different ways: the direct minimization of GHG emissions (Bauer *et al.*, 2010; Qi and Song, 2012) and indirect minimization by minimizing the total cost or resources (Zhang *et al.*, 2011; Kim *et al.*, 2009; Floden, 2007; Yang *et al.*, 2011). The reduction or minimization of GHG emissions is often depicted as a trade-off between emissions and costs, whereas most of the reductions of GHG emissions are consistently related to an increase in transportation costs and vice versa. The reduction of emissions can be analysed by the operational research approach, such as linear programming, integer programming, goal programming or heuristic approach application. The mode choice and route choice are the problems most commonly examined by researchers, as seen in **Table 3.12**.

Table 3.12 Summary of reducing GHG emissions models from freight transport

References, Author (Year)	Aim of model	Transport Mode	Optimization Technique	Remark
Floden (2007)	Minimization resources consumption (cost, time and social cost)	Rail and Road	Heuristic	Mode and route choice
Kim *et al.* (2009)	Trade off CO2 Emission and transport cost	Rail and road	Multi-objectives optimization	Mode choice
Bauer *et al.* (2010)	Minimization GHG emission	Rail	Integer programming	Design of schedule service
Kengpol *et al.* (2010)	Satisfy budget, time, transport risk and environmental impact	Truck and sea	AHP and Zero-one Goal Programming	Mode and route choice
Zhang *et al.* (2011)	Minimize total cost (transportation cost, transfer cost, penalty cost, inventory cost and cost of carbon emissions)	Road, rail, water and air	Zero-one integer programming	Mode choice
Yang *et al.* (2011)	Minimization cost, time and time variability	Rail, road, sea and air	Goal programming	Route choice
Qi and Song (2012)	Minimization fuel emissions	Sea	Stochastic optimization	Optimising vessel schedule

In the context of the minimization of issues in freight transport, the variables of cost and time became prominent variables in the model (Floden, 2007; Kim *et al.,* 2009; Kengpol *et al.*, 2010; Zhang *et al.*, 2011; Yang *et al.*, 2011), even though some researchers also considered risk (Kengpol *et al.*, 2010) and environmental cost or CO_2 emissions (Kengpol *et al.*, 2010; Zhang *et al.*, 2011; Kim *et al.*, 2009; Floden, 2007).

3.5 Research Approaches in Port and Mode Choice of Freight Transport

Based on the results of literature review of the studies on the port choice in **Table 3.4** and the studies on inland mode choice in **Table 3.8**, the top two prominent methods adopted by the previous researchers are: (1) SP/RP survey and Discrete Choice Modelling and (2) Multi-criteria Decision Making (MCDM), especially Analytical Hierarchy Process (AHP).

Comparing the SP with the RP method, the SP method SP method has the advantage of being able to evaluate the existing and non-existing alternatives under the hypothetical situation. However, the SP method has a drawback in term of its external validity (Sanko, 2001), where there is a possibility the preference expressed by the respondents might not be consistent with their actual behaviour. To overcome the limitation of the SP method, combining data from both SP and RP data sources will obtain the advantages of both data sources (Ben-Akiva *et al.*, 1994; Morikawa, 1989)

AHP is an example of MCDM that can be very useful to solve the problems with the multiple-objective and multiple-criteria (Lam and Dai, 2012; Saaty, 2008). This method combines the rational and the intuitive of the decision makers to select the best choices using pairwise comparison judgments. The comparison is conducted using two types of comparisons: absolute and relative comparison. Nevertheless, in terms of obtaining the preferences of the decision makers, AHP method is more difficult for the respondents to select the preferred alternative than the SP method.

Currently, there are five alternatives as of combination port and inland mode in Java, they are: Jakarta-Road, Jakarta-Rail, Semarang-Road, Surabaya-Road, and Surabaya-Rail. Furthermore, rail service to SMG port will be re-activated to serve the containerized transport. Previously, Semarang-Rail Semarang train service once operated, but was later discontinued due to low of users and then have an impact on the closing of dry port in Surakarta. Moreover, a new container port was planned to be built in Cilamaya (as presented in Section 2.4.4) and then new services will be introduced namely Cilamaya-Road and Cilamaya-Rail.

As discussed in Chapter 2, Indonesia has experienced dry port and rail track closure due to a lack of users. Thus the understanding of the preferences of the users in freight transport is needed in order to ensure that plan meets the users' preferences. In this study stated preference and discrete choice modelling have been chosen because of its advantages in evaluating the alternatives that do not exist. The simplicity for the respondents to choose the preferred alternative also has been considered because the data collection was planned to be carried out using the online survey.

3.6 Summary

This chapter has presented the port choice, inland mode choice and GHG emissions in the intermodal freight transport. In port choice studies, decision-makers' perspective could be distinguished into five actors: shippers, freight forwarders, carriers or shipping lines, port or terminal operators and ship owners. Several methods have been exploited by the previous researchers in examining the determinant factors of port choice. The methods are (1) MCDM method, (2) SP or RP method, (3) Literature review and (4) Factor Analysis. The determinant factors in port choice, from the perspective of shippers and freight forwarders, are port cost, frequency of ship calls and port infrastructure. The attributes of hinterland factors are also included by some researchers as the determinant of port choice. Tongzon and Sawant (2007) are the only researchers known to have used the SP method to examine the port choice in South East Asia.

The prominent factors influence the shippers or freight forwarders on mode choice are (1) transport cost, (2) transit time, (3) reliability and (4) flexibility. In studies that only explain mode choice of freight transport, some of the researchers used RP data for their study (Jiang *et al.*, 1999; Ravibabu, 2013), whilst others used SP data (Shinghal and Fowkes, 2002; Garcia-Menendez *et al.*, 2004; Norojono and Young, 2003; Feo-valero *et al.*, 2011). However, in the joint model of mode choice and shipment size, all of the researchers used RP data (Abdelwahab, 1998; De Jong and Ben-Akiva, 2007; De Jong and Johnson, 2009; Windisch *et al.*, 2010).

The importance of GHG reduction in freight transport has received more attention during more recent times. The reduction model mostly came from the minimization of GHG emissions or trade-off the GHG emissions and transport costs. In terms of port and mode choice, Magala and Sammons (2008) proposed a new approach to select a supply chain containing of the port choice, land transport selection and shipping line choice, including carbon footprint as a determinant factor.

This research attempts to examine port choice as a joint choice with an inland mode choice in intermodal freight transport from the perspective of shippers and freight forwarders. The research uses the disaggregate data that will be derived from the respondents using an SP survey. Relating to GHG emissions reduction from freight transport, this research also will investigate the preference of the decision-makers on the alternative of port and inland mode. Based on the Literature Review above, this research is the only study to carry out a stated preference survey, which combines port choice and inland mode choice as a single alternative.

Chapter 4
Research Methodology

4.0 Introduction

This chapter presents the primary processes of this research; those are divided into five phases: a preliminary study, experimental design, data collection, model estimation, and policies simulation. The research begins with the preliminary study, which is explained in Section 4.1. The next Section 4.2 describes the experimental design, using the results from the preliminary study. Data collection method used in this study is elaborated in Section 4.3. Section 4.4 outlines the theoretical background of model estimation conducted in the research, including several discrete choice models and the data used in the estimation. The last stages, policies simulation and the discussions are detailed in section 4.5. The research methodology framework of this study is shown in **Figure 4.1** below.

4.1 Phase 1: Preliminary Study

Preliminary study is an attempt of the author to identify the research questions in the area of study and formulate the appropriate research framework to address these problems. The preliminary stage is divided into four main activities: (1) define the research objectives, (2) study the intermodal freight transport in Indonesia, (3) conduct a literature review and (4) developing an appropriate methodology.

4.1.1 Defining Research Objectives

The research objectives are defined based on the literature review and the actual situation of the object of research. The research objectives are presented in Section 1.3.

4.1.2 Exploring Intermodal Freight Transport in Indonesia

Furthermore, the actual situation of freight transport in Indonesia needs to be understood, such as the logistics system, the problems and its future development plan. The situation of container transport in Indonesia, international trade data, the Indonesian Government's plan for GHG emissions reduction, and general aspect about Indonesia, particularly freight or cargo transport on Java Island.

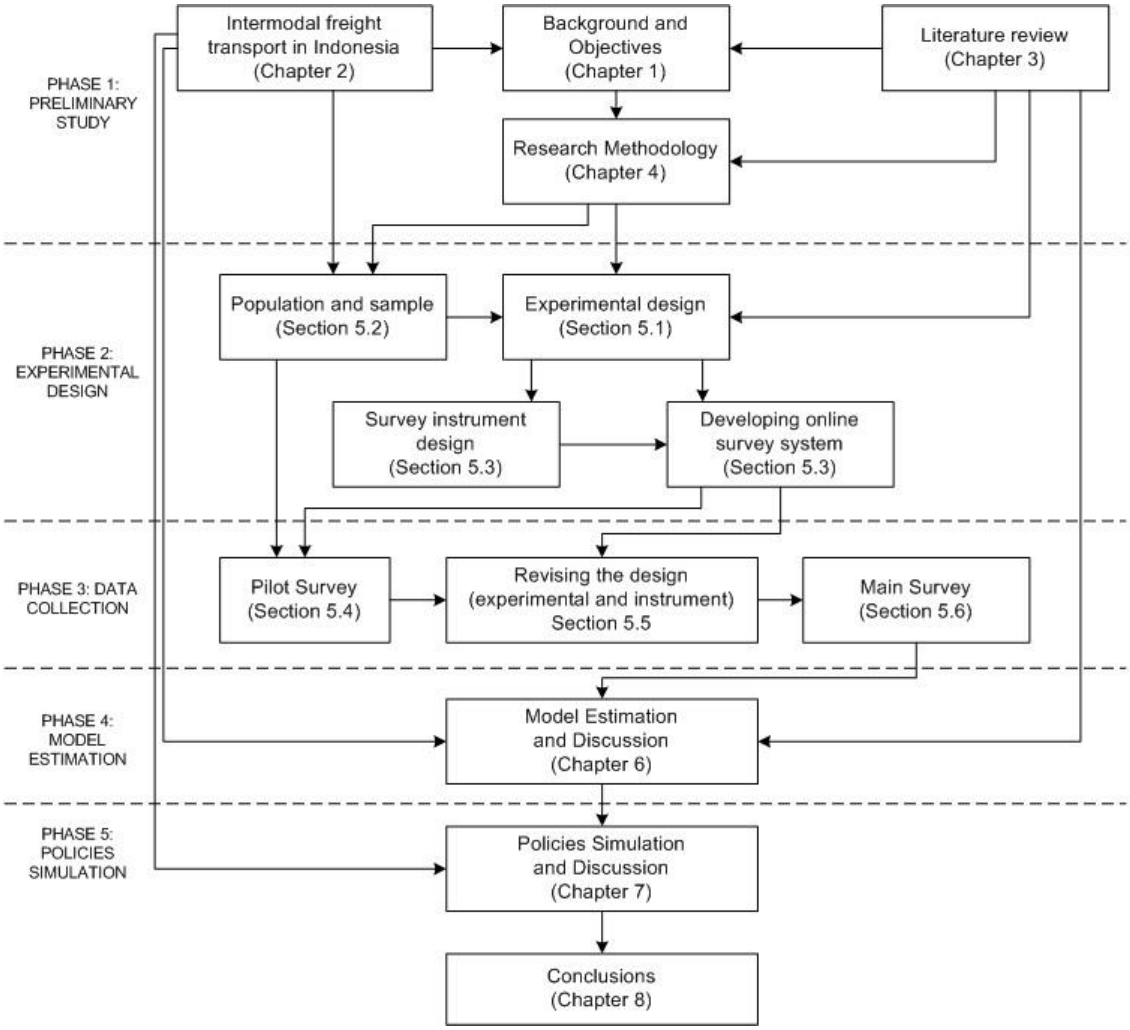

Figure 4.1 Research methodology framework

Some activities were undertaken by the author to understand the situation of Indonesian logistics, partially in intermodal freight transport in Java; the author did it in four different ways:

1. Document Analysis.

   The author analysed the Indonesian governmental and international institutions' documents (data, reports, regulations, and development plans). The process was conducted mostly by accessing and reviewing the documents from the institutions' websites. The Indonesian governmental institutions such as: the Indonesian Statistics Agency (BPS), National Development Planning Agency (BAPPENAS), Ministry of Transports (MoT), Ministry of Public Works

(MoPW), Bank of Indonesia (BI), and Ministry of Energy and Mineral Resources (MoEMR).

Whereas the international institutions, namely World Bank, United Nations Conference on Trade and Development (UNCTAD), and International Energy Agency (IEA). The other documents that were analysed are from the port authority (PT PELINDO) and the rail operator company (PT KAI).

2. Analysing the logistics news.

   The main sources of the news were from the online news portal in Indonesia such as www.kompas.com, www.bisnis.com, www.detik.com, www.kontan.co.id, and www.antaranews.com. This analysis was conducted to find the some facts that are not incorporated in the institutional documents and the latest situation of the intermodal transport in Indonesia.

3. Discussions with experts about the situation of intermodal transport in Java.

   Conducted discussion on the current situation of the freight intermodal transportation system in Java with the experts from the related organisations: (1) Centre for Transport Studies of University of Muhammadiyah Surakarta and (2) Research and Development Agency, Ministry of Transportation, Republic of Indonesia in Jakarta.

4. Visiting and discussion about situation of the existing ports and dry ports in Java with staffs in the following ports: (1) Tanjung Priok Port in Jakarta, (2) Tanjung Emas Port in Semarang, Central Java, (3) Tanjung Perak Port in Surabaya, East Java, (4) former Solo Dry Port in Surakarta, Central Java, and (5) Gedebage Dry Port in Bandung, West Java.

   Discussions with experts and visiting the ports/dry ports were carried out during the fieldwork in Indonesia. The fieldwork was conducted during six weeks from 10 March 2013 – 22 April 2013. The results of the fieldwork and the situation about intermodal freight transport in Indonesia are presented in Chapter 2.

4.1.3 Reviewing the Literature

The literature review helps the author to have a better understanding of the research field (Randolph, 2009) and helps the author to identify the gaps in previous studies and find the proposed research originality.

Firstly, the author strengthens his knowledge of intermodal freight transport model, about the definition, role, and model. The review then continues by reviewing the port choice literature particularly in the perspective of port choice, the methodology used in port choice and the determinant factors in selecting of port for freight transport. As the port choice is closely related to the hinterland transport, the author also analysed the issue of the inland mode selection. The data source, prominent factors and joint choice issue in the mode choice were also reviewed by the author. The GHG emissions from the freight transport issue such as the emissions estimation and the reduction method were also considered by the author. The results of the literature review process are presented in Chapter 3.

4.1.4 Designing Research Methodology

The research methodology is an important part of a research, to ensure the undertaken research is able to answer the questions or to solve the problems posed earlier in Chapter 1. Based on the results of the preliminary study and the literature review, the author then define the proper methodology framework of this study and this methodology is presented in this chapter.

4.2 Phase 2: Stated Preference: Experimental Design

4.2.1 Introduction

As mentioned in Section 3.6, this research uses SP data as the primary data source to address the problems identified in Chapter 2 and to fulfil the research objectives stated in Chapter 1. The main data of this research are collected from the respondents in Java.

The SP method is intended to overcome the limitation of RP method (Ortuzar and Willumsen, 2011):

1. There is no sufficient variability from the observations of real choices, causing difficulties in building a satisfied model for forecasting purpose,
2. A few factors may dominate the observed behaviour, making it harder to identify the relative significance of other variables,

3. Very difficult to collect responses for products, services or policies that are entirely new.

4.2.2 Comparison of SP and RP data

The characteristics of RP and SP data are summarized in **Table 4.1** below.

Table 4.1 The Comparison between RP and SP Data. *Source: Sanko (2001)*

Characteristics	**RP data**	**SP data**
Preference information	Result of the actual behaviour	The expression under the hypothetical situation
	Consistent with the behaviour in the real market	Possibility of inconsistent with the behaviour in the real market
	We can get "Choice" result	We can get "Ranking", "Rating", "Choice", etc.
Alternatives	Only existing alternatives	Existing and non-existing alternatives
Attributes	Measurement error	No measurement error
	Limited range of attributes' levels	Extensibility of the range of attributes' levels
	Possibility of collinearity amongst attributes	Controllability of the collinearity amongst attributes
Choice set	Non-clear	Clear
Number of responses	One response per respondent	One or more response(s) per respondent

On the other hand, SP has a serious disadvantage in term of its external validity. Since the respondent can answer under the hypothetical situation, there is a possibility that the expressed preference which is not consistent with the actual behaviour. Combining RP and SP data can be done to obtain the advantages of both data sources (Morikawa, 1989).

4.2.3 Stated Preference Techniques

There are three main SP techniques: (1) Contingent Valuation (CV), (2) Conjoint Analysis (CA), and (3) Stated Choice (SC) (Ortuzar and Willumsen, 2011). In the transportation research area, the SC technique tends to dominate than the others.

4.2.3.1 Contingent valuation

Primarily, contingent valuation deals with the *Willingness to Pay* (WTP) for existing or offered products or services. In CV study, the respondents will be asked how much their WTP is on various options, whether the products or services are static. Direct questioning, bidding games, payment options, and referendum are the most common CV question formats in practice.

4.2.3.2 Conjoint analysis

The conjoint analysis could be utilized to analyse the preference and WTP. In a CA study, the respondent is asked to rank various products or services. Price or cost is the typical attribute used to examine various products or services. CA has been criticized due to inappropriate use of the statistical method and the respondents in reality do not rank the options.

4.2.3.3 Stated Choice

The stated choice method is quite similar to CA in presenting some hypothetical alternatives to the respondent. The difference is in the response that need be taken from the respondent. In CA, the respondent is asked to rank the alternatives; meanwhile in SC respondents are requested to choose a preferred alternative amongst a subset of number hypothetical alternatives.

Based on the description of each SP technique, the author decided to employ the SC method in this research.

4.2.4 The stages of Stated Preference Survey

An SP survey using a stated choice technique is usually performed through these steps (Louviere *et al.*, 2000; Bateman *et al.*, 2002):

1. Define study objectives; the author needs to define clear objectives to answer the problem, and mostly this process is a difficult step for the author. This research presents the objectives of the study in Chapter 1 whilst Chapter 2 presents the background details and problem to be solved.
2. Conduct a supporting qualitative study; in this step, the author should gather information about the choices/alternatives and decision-making process from the respondents' perspective. Chapter 3 of this research provides a broad explanation of the port and inland mode choice, especially from the perspective of shippers and forwarders.
3. Developing and piloting the data collection instrument; the main activities at this stage is developing experiment design and building the data collection instrument in an easy way for the respondent to understand the experiment. A pilot survey needs to be conducted, to ensure the understanding of decision-makers on

information provided. The development of data collection instruments and the pilot survey are shown in Chapter 5.

4. Define sample characteristics; according to the population characteristics and research objectives, the author needs to determine sample carefully. (Chapter 5)
5. Perform main data collection; in this stage respondent recruitment method, bringing the instrument to the respondent and response collection mechanism are the activities should be considerate. (Chapter 5)
6. Conduct model estimation; estimation model needs to be done using an appropriate discrete choice model; this process could be made easier using statistical software. (Chapter 6)
7. Conduct policy analysis; using a satisfactory model from the previous step, policy analysis should be done related to the study's objectives (Chapter 7)

4.2.5 Experimental Design

The experimental design is the underpinning for any SP research (Hensher *et al.*, 2005). An experimental design is a process to produce a set combination of attributes and levels to be presented to the respondent. An experimental design should be done carefully and should consider several aspects. The experimental design's process and considerations are presented below:

4.2.5.1 Defining the Alternatives, Attributes and Levels

The alternatives in the SP experiment obtained by identifying the available alternatives and the alternatives for each respondent are not necessarily the same (Hensher *et al.*, 2005). The alternatives of this research are differentiated for each respondent depending on the location of origin of the respondents. The alternatives were employed in this research are provided in Section 5.1.1

After having the alternatives, the author needs to determine the attributes and attribute levels. The attributes of the alternatives are the joint attributes of the port and inland mode in terms of freight transport. The major attributes of the alternatives can be found by reviewing the related literature, in focus group discussion or by employing another method such as Analytic Hierarchy Process (AHP). This study determined the attributes of the alternatives using the literature review method. The number of attributes that had been considered in the previous freight transport studies ranged from four to seven, in order to make the survey easier for the respondents to understand and to make it easier to manage (Beuthe and Bouffioux, 2008).

Furthermore, the number of levels can differ for each attribute, and the level of attributes also may vary for each alternative (Hensher *et al.*, 2005). It will be better not to use too many different levels of attributes (Rose and Bliemer, 2009).

The attribute selection of the research can be found in Section 5.1.2, and the presented level of attributes is provided in Section 5.1.5.

4.2.5.2 Generating Experimental Design Using Efficient Design Method

The methods to generate the experimental design generally are divided into two methods: full factorial design and fractional factorial design. The full factorial design is not suitable for experiments with many attributes and levels, because this method will examine all of the possible combination of attribute levels. Thus, it is very difficult to administer the experiment to the respondents.

The fractional factorial design includes orthogonal design and D-efficient design. The orthogonal design is a fractional factorial design that produce an orthogonal (no correlation between attribute levels); but this method still contain useless choice situations and may too many questions for each respondent.

The efficient design method tries to minimize the asymptotic variance-covariance (AVC) matrix to result in the smallest possible standard error in the parameter estimate (ChoiceMetrics, 2012; Zwerina and Kuhfeld, 1996). The design moves from full factorial to fractional factorial by minimizing the choice situation, which also avoids presenting useless situations and improves the reliability of the parameter estimation.

In generating the experimental design using the efficient design method, prior values of parameters are required. The prior values of the parameters can usually be obtained from the work of previous researchers. However, there were no prior values from previous researches that could be used for the pilot survey. The other way of obtaining the prior values is by conducting the expert judgement method. The determination of prior values considered the expected signs of the parameter and the value of the attributes (Louviere *et al.*, 2000).

The efficiency of the design can be measured by the value of D-error and A-error. The best experimental design for each origin region is the design with the minimum value of D-error and A-error (ChoiceMetrics, 2012; Zwerina and Kuhfeld, 1996).

$$D_{-error} = \det\left(\Omega_1\left(X, \breve{\beta}\right)\right)^{1/K} \quad \textbf{(4.3)}$$

$$A_{-error} = \frac{\text{trace}\left(\Omega_1\left(X, \breve{\beta}\right)\right)}{K} \quad \textbf{(4.4)}$$

Where:

Ω_1	=	Asymptotic Variance-Covariance (AVC) matrix
$\breve{\beta}$	=	Prior values
K	=	Number parameters to be estimated
X	=	Matrix of experimental design

The NGENE software was used to aid in generating the efficient design. The efficient design of this study is presented in Section 5.1.6.

4.3 Phase 2: Stated Preference: Data Collection

4.3.1 Data Collection Method

To collect the preference data from the respondent, this research exploited survey method. There are two different methods to collect the data using survey technique: self-completion survey and interview survey. Nowadays, self-completion survey method can be distinguished by how to deliver the questions and answers, and the methods that are widely used by using the mail or online. The self-completion online survey method has advantages: the ability to reach the respondents from wider area, lower cost comparing to self-completion mail survey or interview (Wright 2006; Couper 2000; Kaplowitz *et al.* 2004; Spitz *et al.* 2006).

The web-based self-completion survey is very common to use recently, usually initiated with call or invitation letter and then followed by the reminder (Allen *et al.*, 2012). Web-based survey is faster than conventional survey, easier to administer the data collected, and with logic tests ability it can be programmed to skip some questions and jump to the appropriate one (Fricker and Schonlau, 2002)

Taking into account of the distribution of location of the respondents in 9 cities (in the pilot survey) and 16 cities (in the main survey), the self-completion online survey method was chosen as the method for data collection.

4.3.2 Constructing Data Collection Instrument

The survey instrument design has been approved by the Ethics Committee of the University of Leeds. The survey instrument design for data collection is presented in Section 5.2.1.

An appropriate online application that met the requirement of the SP experiment could not be found, and so this study determined to develop a web-based tool for the data collection. To accommodate the requirements of the research, this study then developed an online survey instrument using PHP (Hypertext Pre-processor) as a programming language and utilizing a MySQL database to store and administer the data for the experiment and survey result. MySQL was chosen as the database management system because it is reliable, fast, easy to use and free. The combination of using PHP and MySQL made it possible to build a complicated experiment and to tailor the exercise for respondents with different origins. The HTML (Hypertext Mark-up Language) was also employed to make the user interface more attractive. The online survey was then uploaded to the online server and presented to the respondents in two language versions: Indonesian and English. The development of the online application is shown in Section 5.2.2.

4.3.3 Pilot Survey

The pilot survey is an important stage of the stated preference study. The advantages of the pilot survey are follows: confirming the attributes and the level of attributes of the alternatives, getting feedback to improve the main survey's instrument, and ensuring that the respondents understand all of the questions and experiments (Sutherland, 2012). Another benefit of the pilot survey in this research is finding the appropriate values for the parameter values used in the designing experiment using the efficient design method.

A pilot survey was also conducted to validate the attributes, levels, and design of the experiment; the results of the pilot survey were used to improve the experiment design for the main survey. The description of the pilot survey that was conducted is presented in Section 5.3.

4.3.4 Revising the Experimental Design

The revising of the experimental design was conducted based on the result of the pilot survey and also considered the feedback from the respondents. The revised design includes the improvement in the experimental design, and improved the survey instrument. The revising of the experimental design is shown in Section 5.4.

4.3.5 Main Survey

The main survey was carried out to collect the responses of the respondents on decision making of inland mode and port choice, according to the scenarios designed. In the working plan, the author predicts the survey stage may take time around six months. However, because of difficulties attracting respondent candidates, the survey process took longer time 10 months (pilot and main survey). The processes and results of the main survey are presented in Section 5.5.

4.4 Phase 4: Model Estimation

The estimation of utility parameters of the random utility discrete choice models was performed using Maximum Likelihood procedures. The BIOGEME software was used to aid the model estimation process. Four discrete choice models were used in the model estimation phase; Multinomial Logit (MNL), Nested Logit (NL) and Mixed Multinomial Logit (MXMNL), and Mixed Nested Logit (MXNL). The primary function of the four models is to capture all the decision-making factors of exporters or freight forwarders on inland mode and port choice. MNL is suitable for model estimation under the assumption there is no correlation between alternatives. Meanwhile, NL should be used to estimate the models with shared unobserved attributes amongst alternatives in the same nest, such as in the nest of the inland mode or nest of the port. Furthermore, the reasons for using MXMNL and MXNL are their capabilities to estimate of model with random taste variation amongst respondents and correlation between unobserved attributes over time (as each respondent was asked to choose the alternatives in eight scenarios).

4.4.1 Introduction

To illustrate the discrete choice models, denote *n* is a decision maker (can be people, firms, organisation or any decision makers) who will choose a single option or alternative from the set of options or alternatives called *choice set* C_n. The choice sets have three characteristics (Train, 2009):

1. The alternatives must be mutually exclusive; it means that the decision maker choose only one alternative and not the other alternative(s),
2. The set of alternatives is exhaustive; assuming that all the possible alternatives must be included
3. The number of alternatives is finite.

The attractiveness of an option or alternative can be described by the concept of *the* utility of the alternative. Each option or alternative $i = 1,\dots,I$ in the choice set is characterized by a utility U_{in}, that is different amongst the decision maker *n*. As a decision rule, the most important assumption in the field of discrete choice modelling is that the individual *n* will choose the *maximum-utility* alternative. The individual *n* will choose an alternative *i* if and only if $U_{in} > U_{jn} \forall j \neq i$, with $i, j \in C_n$. This behavioural model also known as the *Random Utility Maximization* (RUM).

To explain the *irrationalities* that two decision makers with the identical attributes facing the same choice set may choose a different option, we need to include the unobserved component into the utility. Thus, the utility U_{in} can be described as follows:

$$\mathrm{U_{in}} = \mathrm{V_{in}} + \varepsilon_{\mathrm{in}} \qquad \textbf{(4.5)}$$

Where:

$\mathrm{V_{in}}$ = Observed part of utility and usually called representative or systematic component of utility

ε_{in} = Unobserved part of the utility and often called as random or disturbance component of utility

As the result of adding the unobserved part of the utility to the model, U_{in} become probabilistic and the probability of individual *n* to choose an alternative *i* ($\mathrm{P_{in}}$) can be formulated as follows:

$$\mathrm{P_{in}} = \mathrm{P}(\varepsilon_{\mathrm{jn}} - \varepsilon_{\mathrm{in}} < \mathrm{V_{in}} - \mathrm{V_{jn}}, \forall \mathrm{j} \neq \mathrm{i}) \qquad \textbf{(4.6)}$$

4.4.2 Maximum Likelihood Estimation

Maximum likelihood estimation is the most common method for estimating parameters, in addition to the *least square* method. Ben-Akiva and Lerman (1985) stated "*a maximum likelihood estimator is the value of parameters for which the observed sample is most likely to have occurred.*"

Given a sample of N decision makers, then the probability of individual n choosing an alternative i can be expressed as follows:

$$\prod_{i} (P_{in})^{d_{in}} \quad \textbf{(4.7)}$$

Where $d_{in} = 1$ if decision maker n selected alternative i and 0 otherwise.

By the assumption that the decision maker's choice is independent from the other decision makers, the probability of each person in the sample N choosing the alternative that he was actually observed to choose is:

$$\mathcal{L}(\beta) = \prod_{n=1}^{N} \prod_{i} (P_{in})^{d_{in}} \quad \textbf{(4.8)}$$

where β is a coefficient parameter of the model. Then we can define the Log-likelihood function as follows:

$$\mathcal{LL}(\beta) = \sum_{n}^{N} \sum_{i} d_{in} \ln P_{in} \quad \textbf{(4.9)}$$

And the estimator of the model is the value of β that give the maximum result of the function (Train, 2009; Louviere *et al.*, 2000; Walker and Ben-akiva, 2002)

4.4.3 Multinomial Logit

These discrete models result when ε_{in} in Equation (4.5) is assumed to be IID extreme value type I (Ben-Akiva and Lerman, 1985; Ortuzar and Willumsen, 2011; Train, 2009). The choice probability of alternative *i* for individual *n* then become:

$$P_{in} = \frac{e^{V_{in}}}{\sum_{j=1}^{J} e^{V_{jn}}} \quad \textbf{(4.10)}$$

The representative utility V_{jn} is usually assumed linear in parameters.

$V_{jn} = \beta' x_{jn}$, where x_{jn} is a vector of observed variables relating to alternative$j$. Inserting to the formula above, the probability becomes:

$$\mathrm{P_{in}} = \frac{e^{\beta' x_{in}}}{\sum_{j=1}^{J} e^{\beta' x_{jn}}} \quad \textbf{(4.11)}$$

4.4.4 Nested Logit

A Nested Logit (NL) model is appropriate in the situation that choice set can be partitioned into subsets called nests.

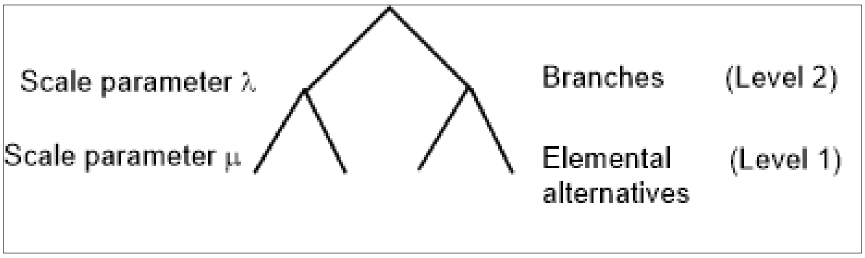

Figure 4.2 Descriptors of two-level Nested Logit structure

Denote the set of alternatives i be partitioned into K non-overlapping subset denoted B_1, B_2, ... , B_K. The utility of alternative j in a nest B_k for a person n is formulated as$U_{jn} = V_{jn} + \varepsilon_{jn}$. If we have two alternatives j and m in the same nest B_k, the unobserved component ε_{jn} is correlated with ε_{mn}. Meanwhile, for any two alternatives in different nests the unobserved part of utility is uncorrelated $Cov(\varepsilon_{jn}, \varepsilon_{mn}) = 0$ for any $j \in B_k$ and $m \in B_l$ with $l \neq k$. There are scale parameters namely μ and λ for elemental alternatives and branches (*see* **Figure 4.2**). The value of λ/μ is known as *Inclusive Value* (IV) and the correlation can be calculated as 1 - IV^2. In case IV $= 1$ for all k, the distribution becomes the product of independence extreme value and the Nested Logit model becomes the Standard Logit model. The probability of person n to choose an alternative $i \in B_k$ can be stated as follows (Train, 2009):

$$P_{in} = \frac{e^{\frac{V_{in}}{\lambda_k}} \left(\sum_{j \in B_k} e^{\frac{V_{jn}}{\lambda_k}}\right)^{\lambda_k}}{\sum_{l=1}^{K} \left(\sum_{j \in B_l} e^{\frac{V_{jn}}{\lambda_l}}\right)^{\lambda_l}} \quad \textbf{(4.12)}$$

The estimation of utility parameters of the Nested Logit model can be conducted through the standard maximum likelihood approach, by substituting probabilities from the formula above into the log-likelihood function.

4.4.5 Mixed Multinomial Logit

The more recently developed Mixed Logit (MXL) is the most flexible tool in discrete choice modelling due to its capability to estimate any random utility model. This model has been developed to obviate the limitations of the standard logit model through: (1) random taste variation is allowed in the model, (2) correlation amongst unobserved factors and (3) unrestricted substitution pattern across alternatives (Train, 2009).

Mixed logit probabilities are integrals of standard logit probabilities over the density of the parameters. In the other words, the probability can be represented as follows:

$$P_{in} = \int \mathcal{L}_{in}(\beta) f(\beta) d(\beta) \quad \textbf{(4.13)}$$

Where:

$\mathcal{L}_{in}(\beta)$ = logit probability evaluated at parameter β.

4.4.5.1 Random Taste Variation

In the standard logit model, the tastes of an individual or $\beta's$ are assumed fixed, which means the $\beta's$ are the same for every person. Thus the utility of an alternative *i* for a person *n* can be defined as follows:

$$U_{in} = \beta x_{in} + \varepsilon_{in} \quad \textbf{(4.14)}$$

Where:

ε_{ni} ~ IID extreme value type I

The mixed logit model allowed the tastes of individual β to be random, thus in the mixed logit model the utility of alternative i for individual n is:

$$U_{in} = \beta_n x_{in} + \varepsilon_{in} \quad \textbf{(4.15)}$$

Where

ε_{ni} ~ IID extreme value

$\beta_n \sim f(\beta_n|\theta)$

Where θ is the parameter of the distribution (for instance mean and variance).

Conditional on β_n, the probability that an individual *n* selects alternative *i* is the standard logit model and can be stated as follows:

$$\mathcal{L}_{in}(\beta_n) = \frac{e^{\beta_n x_{in}}}{\sum_j e^{\beta_n x_{jn}}} \quad \textbf{(4.16)}$$

On the other hand, the unconditional choice probability that an individual *n* selects alternative *i* is the integral of this standard logit model over the density of β_n since β_n is random and not known,

$$P_{in} = \int \mathcal{L}_{in}(\beta) f(\beta|\theta) d(\beta) \quad \textbf{(4.17)}$$

Since β_n is a random variable, the model is also known as the *Random Coefficient Logit* (RCL) model.

4.4.5.2 Correlation of Unobserved Factors over Time

The use of a standard logit for an experiment using panel data is often faced with a problem when a respondent should choose repeated choices over time. To accommodate both of the correlation in unobserved factors over time and the variation of random taste over the individuals, the utility of an alternative *i* at time *t* for individual *n* is formulated as follows (Train, 2009)

$$U_{int} = \beta_n x_{int} + \varepsilon_{int} \quad \textbf{(4.18)}$$

Under the assumption that the *β's* are normally distributed with mean $\bar{\beta}$ and variance σ^2, the utility of individual *n* for alternative *i* at time *t* becomes:

$$U_{int} = (\bar{\beta} + \sigma\eta_n) x_{int} + \varepsilon_{int} \quad \textbf{(4.19)}$$

Where η is a draw from the standard normal distribution density.

$$U_{int} = \bar{\beta} x_{int} + (\sigma\eta_n x_{int} + \varepsilon_{int}) \quad \textbf{(4.20)}$$

$$U_{int} = \bar{\beta}x_{int} + e_{int}$$

Where e_{int} = $(\sigma\eta_n x_{int} + \varepsilon_{int})$ is the collection of the unobserved factors.

The covariance between alternatives *i* and *j* can be presented as follows,

$$Cov(e_{int}, e_{jnt}) = \sigma^2(x_{int}, x_{jnt}) \quad \textbf{(4.21)}$$

Whereas the covariance between time *t* and *q* can be presented as follows:

$$Cov(e_{int}, e_{inq}) = \sigma^2(x_{int}, x_{inq}) \quad \textbf{(4.22)}$$

The conditional probability (conditional on β_n) of the repeated of choices by an individual is the product of the logit probabilities of each individual choice by that person:

$$\mathcal{L}_n(\beta_n) = \prod_t \frac{e^{\beta_n x_{int}}}{\sum_j e^{\beta_n x_{jnt}}} \quad \textbf{(4.23)}$$

The unconditional probability of the repeated of choices is the integral of the formula of logit over the density of β_n since ε_{int} is independent over the time.

$$P_{in} = \int \mathcal{L}_{in}(\beta) f(\beta|\theta) d(\beta) \quad \textbf{(4.24)}$$

4.4.5.3 Simulation

In the Mixed Logit model, to derive the probability, a simulation of P_n was conducted due to the absence of a closed form for the integral that enters the choice probability. The simulation process should be done in four steps below (Train, 2009):

1. Take a draw a value of β from $f(\beta \mid \theta)$ and give the label from the draw β^r , and the first draw should be represented by *r=1.*

2. Calculate for Likelihood value $\mathcal{L}_{in}(\beta^r)$ using the formula above.

3. Repeat steps 1 and 2 as many times as requested, for *r=2, 3, . . . , R*

4. Calculate the average

The average of the simulated probability, and can be expressed as follows:

$$\tilde{P}_{in} = \frac{\sum_r \mathcal{L}_{in}(\beta^r)}{R} \quad \textbf{(4.25)}$$

Where R is the number of draws, and $\widetilde{\mathrm{P}}_{\mathrm{in}}$ is an estimator of P_{in}. To get the simulated log likelihood ($S\mathcal{L}\mathcal{L}$), the simulated probabilities are inserted into the log-likelihood function as presented below:

$$S\mathcal{L}\mathcal{L} = \sum_{n=1}^{N} \sum_{i=1}^{I} d_{in} \ln \widetilde{P}_{in} \quad \textbf{(4.26)}$$

Where $d_{ni} = 1$ if n selected i and 0 otherwise. The value of θ that maximizes $S\mathcal{L}\mathcal{L}$ is the maximum simulated likelihood estimator.

4.4.6 Mixed Nested Logit

Mixed Nested Logit is used to concurrently consider the correlation amongst alternatives and taste the heterogeneity (Teye *et al.*, 2014; Train, 2009). Hess and Bierlaire (2005) presented the aim of using the MXNL which is to reduce the risk of confounding by attempting jointly model of Mixed Logit and Nested Logit.

The conditional probability of alternative *i* for respondent n can be written as follows (Teye *et al.*, 2014):

$$P_{in}(\beta) = \frac{\exp\left(\frac{\beta_n X_{in}}{\mu_m}\right)\left(\sum_{j=1}^{J} \delta_{jm} \exp\left(\frac{\beta_n X_{in}}{\mu_m}\right)\right)^{\mu_m}}{\sum_{j=1}^{J} \delta_{jm} \exp\left(\frac{\beta_n X_{in}}{\mu_m}\right) \sum_{s=1}^{M}\left(\sum_{j=1}^{J} \delta_{js} \exp\left(\frac{\beta_n X_{in}}{\mu_s}\right)\right)^{\mu_s}} \quad \textbf{(4.27)}$$

4.4.7 Combining SP and RP Data Sources

Greater advantages from both types of SP and RP data can be obtained by combining the data together in the study. By entering RP data, the data will be more accurate in describing the behaviour of the respondents because it is not only based on what is in the state, but it also takes into account what has been chosen by the respondents (Ben-Akiva *et al.*, 1994; Polydoropoulou and Ben-Akiva, 2001). The process of combining SP and RP data by pooling both of the data can be carried out using *data enrichment* technique which has been initiated by Morikawa (1989).

The detail of the data enrichment technique has been explained by (Louviere *et al.*, 2000). It was a common practice to set the scale factor of the RP data (λ^{RP}) equal to one, to estimate the scale factor of SP data (λ^{SP}). The scale factor is inversely proportional to the variance of the error and can be defined as follows:

$$\sigma^2 = \frac{\pi^2}{6\lambda^2} \quad \textbf{(4.28)}$$

4.4.8 Model Fit Statistics

Measuring the model fitness was performed by comparing some statistics

Final log-likelihood $\mathcal{LL}(\beta^*)$ is the value of the log-likelihood at model convergence, and can be defined as the sum of the log probabilities of the chosen alternatives that is maximizing the model estimation.

Likelihood ratio test can be calculated as follows:

$$\text{LRT} = -2(\mathcal{LL}(0) - \mathcal{LL}(\beta^*)) \quad \textbf{(4.29)}$$

$\mathcal{LL}(0)$ is the null log-likelihood of the model when all of the parameters are zero.

Rho-square can be obtained by comparing the final log-likelihood with the null log-likelihood as follows:

$$\rho^2 = 1 - \frac{\mathcal{LL}(\beta^*)}{\mathcal{LL}(0)} \quad \textbf{(4.30)}$$

Another measurement of the fitness of a model is $\bar{\rho}^2$(Adjusted rho-square), which is similar to ρ^2but it is corrected for the number of parameters estimated

$$\bar{\rho}^2 = 1 - \frac{\mathcal{LL}(\beta^*) - \text{K}}{\mathcal{LL}(0)} \quad \textbf{(4.31)}$$

K is the number of estimated parameters

A model fits better than the other model if the value of rho-square and adjusted rho-square are higher than the other models. The range of rho-square and adjusted rho-square is from zero to one. According to Louviere *et al.* (2000) the value of rho-square between 0.2 and 0.4 is considered to be good model fits. Domencich and McFadden (1975) conducted a simulation to compare the values of rho-square and value of R^2. They suggested that the value of rho-square between 0.2 and 0.4 in logit model are considered equivalent with the value between 0.4 and 0.8 of R^2 in linear function.

4.5 Phase 5: Policies Simulation and Discussion

Furthermore, policy analysis is conducted by simulation, using the best model from the model estimation stage. The simulation of policies is used to examine the impacts of policy variants to the market share of the inland modes and ports. In this phase, the author also examines the effects of policies to reduce the GHG emissions from the containerized exports of the inland transport segment.

4.5.1 Policies Simulation

The policy simulation is intended to find the best policy to be implemented accordingly to the Indonesia government plan to shift the inland mode users from the road to the rail mode. The policy simulation also examines the effect of the policies to reduce the GHG emissions from the freight transport sector in Java. Some policies related to the attributes of the inland modes and port will be simulated using the best model obtained from the model estimation stage. The simulation is conducted using five single policies and four combined policies.

The formula used to calculate the GHG emissions (Kg CO_2e per year) emitted by the activities of transporting the product of all the respondents can expressed as follows:

$$\mathrm{TE} = \sum_{n=1}^{N}\sum_{i=1}^{J} \mathrm{P_{in}}\,\mathrm{IMG_{in}}\,\mathrm{Q_n} \qquad \textbf{(4.32)}$$

Where:

TE = Total GHG emissions per year (Kg CO_2e)

P_{in} = The probability of the respondent *n* to choose the alternative *i*

IMG_{in} = Emissions for transporting one TEU product of the respondent *n* with alternative *i* (Kg CO_2e)

Q_n = Export volume respondent *n* (in TEUs) per year

And the emission reductions from the containerized export in from the inland transportation leg can be calculated as follows:

$$ER_y = TE_y^B - TE_y^P \qquad \textbf{(4.33)}$$

Where:

ER_y	=	GHG emission reductions in year y (Kg CO_2e)
TE_y^B	=	Total baseline GHG emissions in year y (Kg CO_2e)
TE_y^P	=	Total GHG emissions in year y after implementation of policy p (Kg CO_2e)

The policy simulation process and results are presented in Section 7.1, Section 7.2 and Section 7.3.

4.5.2 Discussion of the Policies Impacts

The impact of the policies that were simulated are then analysed from three aspects. The impact analysis includes (1) port's market shares, (2) the shifting of the inland mode from the road mode to the rail mode, and (3) the GHG emission reductions amongst the various policies. To examine the changes in the port market shares of the existing and the new proposed port, the context of port competition will be applied. The inland mode shifting can be used as the tools to forecast the GHG emissions reduction from the transport sector (Nelldal and Andersson, 2012). On the other hand, the growth of freight transport using truck will raise the carbon emissions (Kamakaté and Schipper, 2009). The discussion is presented in Section 7.4.

4.6 Summary

The methodology framework of the research was presented in this chapter. The research is divided into five stages: (1) preliminary studies, (2) experimental design, (3) data collection, (4) model estimation and (5) policies simulation.

In preliminary stage, the author conducted several activities including define the research objectives, exploring the situation of intermodal freight transport in Java, reviewing related literature and designing the methodology framework. The experimental design is the main activity in the second stage, and then followed by the data collection. During the data collection phase, the author needs to develop an online data collection instrument and conduct the pilot and main survey. The results of SP survey from the third stage then are estimated by some logit models in the next stage. Some logit models including MNL, NL, MXMNL and MXNL model. The estimation also carried out using the joint SP and RP data. The last stage is policy simulation that is performed by simulating some related policies using the best model obtained from the model estimation phase. In this phase, the author then discusses the impact of the policies on the port shares, inland mode shifting and GHG emission reduction.

Chapter 5
Stated Preference Survey

5.0 Introduction

This chapter shows the primary processes in the stated preference study conducted to obtain the shippers' (exporters') and forwarders' preferences on the inland mode and port choice for containerized exports from Java. This chapter is split into five parts, starting with an account of the experimental design in Section 5.1 and continuing with a description of the survey method of information collection in Section 5.2. Section 5.3 depicts a pilot survey carried out before the main survey. The instruments that needed improvement before conducting the main survey and the redesign process are presented in Section 5.4. The procedure followed in the main survey is described in Section 5.5. This chapter then summarizes the experimental design and process of data collection in Section 5.6.

5.1 Experimental Design

As described in Section 4.2 and Section 4.3, which outline the stages, a stated preference survey is divided into two stages: experimental design and data collection. This section describes the details of the experimental design that was carried out in this research.

5.1.1 Alternatives

The experimental design began by identifying the options. From Section 2.2.3, we know that only three main container ports in Java have a significant container throughput, namely Tanjung Priok Port in Jakarta, Tanjung Emas Port in Semarang and Tanjung Perak Port in Surabaya. Alongside the three existing main container ports in Java, this research includes one proposed port (Cilamaya Port) which was scheduled to be built by 2015.

The containerized rail transport mode services are now only available from Bandung, Bekasi, Jakarta and Surabaya to Tanjung Priok Port and Tanjung Perak Port. The Indonesian government plans to increase the rail mode's share in container transport from other potential cities. The Indonesian government has completed the development of the double track railway system in the northern part of Java, and will continue to build the system in southern Java (*see* Chapter 2 for more details).

Based on the existing and proposed plans, this research includes eight possible alternative combinations of port and inland mode, as follows:

1. Alternative 1: Tanjung Priok Port (Jakarta) — Road (JKT-RD)
2. Alternative 2: Tanjung Priok Port (Jakarta) — Rail (JKT-RL)
3. Alternative 3: Tanjung Emas Port (Semarang) — Road (SMG-RD)
4. Alternative 4: Tanjung Emas Port (Semarang) — Rail (SMG-RL)
5. Alternative 5: Tanjung Perak Port (Surabaya) — Road (SBY-RD)
6. Alternative 6: Tanjung Perak Port (Surabaya) — Rail (SBY-RL)
7. Alternative 7: Cilamaya Port (Cilamaya) — Road (CMY-RD)
8. Alternative 8: Cilamaya Port (Cilamaya) — Rail (CMY-RL)

Although there are eight possible alternatives, the SP experiment in this research only shows four alternatives to each respondent, depending on the location of the respondents. The four alternatives for each city/origin region are shown in **Table 5.1** below.

Table 5.1 Alternatives presented for each city or origin region[8]

	Origin region	Alternative 1	Alternative 2	Alternative 3	Alternative 4
1	Jakarta	JKT-RD	JKT-RL	CMY-RD	CMY-RL
2	Bandung	JKT-RD	JKT-RL	CMY-RD	CMY-RL
3	Bekasi	JKT-RD	JKT-RL	CMY-RD	CMY-RL
4	Tangerang	JKT-RD	JKT-RL	CMY-RD	CMY-RL
5	Cirebon	JKT-RD	JKT-RL	CMY-RD	CMY-RL
6	Semarang	SMG-RD	SMG-RL	JKT-RL	SBY-RL
7	Surakarta	SMG-RD	SMG-RL	JKT-RL	SBY-RL
8	Surabaya	SBY-RD	SBY-RL	JKT-RL	SMG-RL
9	Malang	SBY-RD	SBY-RL	JKT-RL	SMG-RL
10	Bogor	JKT-RD	JKT-RL	CMY-RD	CMY-RL
11	Karawang	JKT-RD	JKT-RL	CMY-RD	CMY-RL
12	Yogyakarta	SMG-RD	SMG-RL	JKT-RL	SBY-RL
13	Jepara	SMG-RD	JKT-RD	SBY-RD	CMY-RD
14	Gresik	SBY-RD	SBY-RL	JKT-RL	SMG-RL
15	Sidoarjo	SBY-RD	SBY-RL	JKT-RL	SMG-RL
16	Pasuruan	SBY-RD	SBY-RL	JKT-RL	SMG-RL

[8] The pilot survey was performed in nine origin regions and the main survey has been conducted in 16 origin regions. The origin numbers 1–9 were used in both the pilot survey and the main survey, but the origin numbers 10–16 were used only when carrying out the main survey.

The situation of the 16 origin regions, three existing ports and the proposed port can be found in **Figure 2.8** in Chapter 2. As we can see from **Figure 2.8**, Jepara is the only origin that is not reachable by the rail network. Thus, in this experiment, Jepara has only four alternatives, all of which use the road mode.

5.1.2 Attribute Selection

Attribute selection of the alternatives is important and should be conducted carefully. The major attributes of the alternatives can be found by reviewing the related literature, in focus group discussion or by employing another method such as factor analysis or AHP. This research determined the attributes of the alternatives using the literature review method. The number of attributes that had been considered in the previous freight transport studies ranged from four to seven, in order to make the survey easier for the respondents to understand and to make it easier to manage (Beuthe and Bouffioux, 2008). This research exploited six attributes: four attributes of the inland mode and two port attributes.

5.1.2.1 Attributes of the inland mode choice

Previous researchers have investigated the factors that influence decision-makers in selecting the inland mode of the freight transport for the inland transport leg. According to the literature review that was undertaken in Chapter 3, the prominent factors that influence decision-making in inland mode choice are:

1) *Cost* (Garcia-Menendez *et al.*, 2004; Beuthe and Bouffioux, 2008; Ravibabu, 2013; de Jong and Ben-Akiva, 2007; Windisch *et al.*, 2010; Abdelwahab, 1998; Cullinane and Toy, 2000; Feo *et al.*, 2011; Brooks *et al.*, 2012; Reis, 2014),
2) *Time* (Cullinane and Toy, 2000; Garcia-Menendez *et al.*, 2004; Beuthe and Bouffioux, 2008; Feo *et al.*, 2011; Brooks *et al.*, 2012; Ravibabu, 2013; Reis, 2014),
3) *Reliability* (Shinghal and Fowkes, 2002; Beuthe and Bouffioux, 2008; Norojono and Young, 2003; Cullinane and Toy, 2000; Feo *et al.*, 2011; Brooks *et al.*, 2012; Reis, 2014) and
4) *Frequency/Flexibility* (Shinghal and Fowkes, 2002; Garcia-Menendez *et al.*, 2004; Feo-Valero *et al.*, 2011; Reis, 2014; Norojono and Young, 2003).

Norojono and Young (2003) is the only study that has examined the preferences of shippers in Java for selecting the inland mode of the freight transport. They found that the most important factors in the inland mode selection in Java were safety, flexibility and reliability. In light of one of this study's objectives, which is to determine how the users appraise the GHG emissions, GHG emission was incorporated as one of the attributes used instead of frequency/flexibility. The attributes of inland mode employed in the study are shown in **Table 5.2** below:

Table 5.2 Attributes of the inland mode used in this research

Factor	Attributes	Unit	Definition
Inland Mode	Cost	Thousands IDR/TEU-Trip	Inland mode cost to transport one TEU container from the origin region to the port (including haulage by truck from the shipper's location to the consolidation station, as an alternative to the rail mode).
	Time	Hours/trip	The transport time between the departure from the origin and arrival at the port, including waiting time, if any.
	Reliability	Percentage (%)	Percentage of on time delivery.
	GHG emissions	(Kg CO_2e/TEU-Trip)	Emissions from the alternative inland modes for a trip from the origin region to the port.

5.1.2.2 Attributes of the port choice

From the literature review, the attributes that are exploited in the selection of the port vary depending on the port's users. The carriers use different attributes when selecting ports compared to those used by the terminal operators or shippers. The determining factors in port choice from the shippers' or freight forwarders' perspectives are:

1) *Port cost* (Slack, 1985b; Bird and Bland, 1988; Nir *et al.*, 2003; Grosso and Monteiro, 2008; Tongzon, 2009; Yuen *et al.*, 2011)
2) *Frequency of ship calls* (Bird and Bland, 1988; Slack, 1985b; Nir *et al.*, 2003; Ugboma *et al.*, 2006; De Langen, 2007; Tongzon, 2009)

The frequency of the ship calls to an export destination is represented by the number of international ship calls in the ports. All of the containerized export of Indonesia from Java to America, Europe, Africa and most Asia need to be trans-shipped in Singapore or Malaysia port (*see* **Figure 2.5** for details). Hence, most of the international container ships calling in the ports of Java can be used by the exporters or forwarders to any export destination. Singapore Port in Singapore and Port Kelang and Tanjung Pelepas Port in Malaysia are the premier container hub in Southeast Asia and have bigger frequency of the intercontinental ship calls than posts in Java. For instance, in 2012 Singapore Port served 18,567[9] container vessels, comparing with the Jakarta Port (the largest port in Java) that only served 4,213[10] container ships in the same year.

Table 5.3 presents the attributes of the ports used in the research.

Table 5.3 Attributes of ports used in this research

Factor	Attributes	Unit	Definition
Port	Cost	Thousands IDR/TEU	The port cost is represented by the handling cost of one TEU Full Container Load (FCL) using the port crane.
	Ship calls' frequency	Ship calls/week	Ship calls are the number of international container ship calls per week at the alternative port, including indirect calls.[11]

Summarizing from **Table 5.2** and **Table 5.3**, this research uses the six key factors above and considers GHG emission instead of the frequency of inland mode, to examine the preference of exporters and forwarders with respect to the global warming issue.

Although the port cost and inland mode cost use the same unit (money), however, this study still distinguishes them into two different attributes. The main reason of separating the cost attributes is to determine whether the inland mode cost has different influence to the decision-making compared with the port cost. The results can be used by the port authorities and the container transport service companies in deciding the appropriate tariff of port or transport service.

5.1.3 The Utility of the Alternative

The utility of each alternative can be expressed by Equation (5.1) below:

$$V_{pm} = ASC_{pm} + \beta_{IMC} f\left(IMC_{opm}\right) + \beta_{IMG} f\left(IMG_{opm}\right) + \beta_{IMR} f\left(IMR_{opm}\right) + \beta_{IMT} f\left(IMT_{opm}\right) + \beta_{PC} f\left(PC_{p}\right) + \beta_{PSC} f\left(PSC_{p}\right) \quad \textbf{(5.1)}$$

Where:

V_{pm} = The observed utility of the alternative port *p* using inland mode *m*

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[9] http://www.mpa.gov.sg/sites/global_navigation/publications/port_statistics/port_statistics.page

[10] Data obtained from the annual report of Pelindo II (The authority of Indonesian ports in West Java and South Sumatera, owned by the Government of Indonesia)

[11] Indirect calls are ship calls of the feeder vessels; the container will be trans-shipped to the mother vessels for the intercontinental leg at the hub port. Usually, the trans-shipments of the Indonesian exports were carried out at Singapore Port or Tanjung Pelepas Port, Malaysia.

ASC_{pm} = Alternative-specific constant for alternative port *p* using inland mode *m*

β_{IMC} = Parameter of inland mode cost

IMC_{opm} = Inland mode cost of transporting one TEU FCL container from origin *o* to port *p* using inland mode *m* (in thousands IDR)

β_{IMG} = Parameter of inland mode GHG emissions

IMG_{opm} = Inland mode GHG emissions for transporting 1 TEU FCL container from origin *o* to port *p* using inland mode *m* (Kg CO_2e)

β_{IMR} = Parameter of inland mode reliability

IMR_{opm} = Inland mode reliability for transporting container from origin *o* to port *p* using inland mode *m* (%)

β_{IMT} = Parameter of inland mode time

IMT_{opm} = Inland mode time for transporting one TEU FCL container from origin *o* to port *p* using inland mode *m* (hours)

β_{PC} = Parameter of port cost

PC_p = Port cost for one TEU in port *p* (in thousands IDR)

β_{PSC} = Parameter of port ship calls

PSC_p = Ship calls of international container vessels per week in port *p*.

5.1.4 Base Values of Attributes

5.1.4.1 Base values for the port

The initial value for the port attribute can be obtained from the website of the corresponding port. The port costs for container handling for international containers were initially presented in USD/TEU. The USD value was then converted to IDR currency using the average currency rate provided by Bank Indonesia.

The international container ship calls were derived from the total international container vessel calls in the corresponding port, divided by the number of weeks in a year (52 weeks). The base values of the port's attributes are shown in **Table 5.4** as follows:

Table 5.4 Base value of port cost and international container ship calls

Ports	Port attributes			
	Port cost			International container ship calls/week
	USD	Pilot survey (in thousands IDR)[12]	Main survey (in thousands IDR)[13]	
Tanjung Priok Port	80	800	960	82
Tanjung Emas Port	78	780	940	12
Tanjung Perak Port	82	820	980	23
Cilamaya Port[14]	80	800	960	41

5.1.4.2 Rail and road distance

The calculation of the base value of inland mode cost and time for each origin region requires cost functions, distance data and the average speed for each inland mode. To acquire the road distances between the origins and ports, the "Direction" application in Google Maps was used. The road distance is determined from the centre of the origin to the destination port, whereas the rail distance between the origins and the destination port is determined using the railway network map from PT KAI[15]. The distance from the origin region to the four alternative ports can be seen in **Table 5.5** below.

Table 5.5 Distance from the origin *o* to port *p* using different inland mode *m*

To	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
From	Port-Mode	d_{opm} (km)	Port-Mode	d_{opm} (km)	Port-Mode	d_{opm} (km)	Port-Mode	d_{opm} (km)
Jakarta	JKT-RD	14	JKT-RL	19	CMY-RD	98	CMY-RL	88
Bandung	JKT-RD	155	JKT-RL	188	CMY-RD	122	CMY-RL	157
Bekasi	JKT-RD	35	JKT-RL	50	CMY-RD	51	CMY-RL	63
Tangerang	JKT-RD	34	JKT-RL	35	CMY-RD	128	CMY-RL	122
Cirebon	JKT-RD	246	JKT-RL	226	CMY-RD	164	CMY-RL	193
Semarang	SMG-RD	5	SMG-RL	9	JKT-RL	456	SBY-RL	288
Surakarta	SMG-RD	11	SMG-RL	116	JKT-RL	585	SBY-RL	256
Surabaya	SBY-RD	9	SBY-RL	9	JKT-RL	740	SMG-RL	285
Malang	SBY-RD	100	SBY-RL	97	JKT-RL	833	SMG-RL	378
Bogor	JKT-RD	62	JKT-RL	64	CMY-RD	131	CMY-RL	133
Karawang	JKT-RD	79	JKT-RL	70	CMY-RD	31	CMY-RL	37
Yogyakarta	SMG-RD	131	SMG-RL	173	JKT-RL	524	SBY-RL	313

[12] Average currency rate for 1 USD from 3 June 2013 – 31 July 2013 was 10,036 IDR for 1 USD, and rounded down to 10,000 IDR.

[13] Average currency rate for 1 USD from 1 November 2013 – 31 December 2013 was 11,909 IDR for 1 USD, and rounded up to 12,000 IDR. http://www.bi.go.id/en/moneter/informasi-kurs/transaksi-bi/Default.aspx

[14] The port cost of the Cilamaya Port was assumed to be the average cost of the three existing ports, whilst the ship calls were assumed to be half of those at the Tanjung Priok Port.

[15] Source: Penomoran KA, Kapasitas Lintas, Jarak Antar Stasiun (Berlaku Pada GAPEKA 2011) — Train Identification, Rail Network Capacity and Distance between rail stations (applied during the trips in 2011).

Jepara	SMG-RD	78	JKT-RD	298	SBY-RD	556	CMY-RD	460
Gresik	SBY-RD	23	SBY-RL	32	JKT-RL	752	SMG-RL	397
Sidoarjo	SBY-RD	34	SBY-RL	31	JKT-RL	763	SMG-RL	308
Pasuruan	SBY-RD	70	SBY-RL	68	JKT-RL	800	SMG-RL	345

5.1.4.3 Base values of inland mode cost

The base values of the truck/road mode cost are calculated based on the new tariff for trucks provided by the Association of Jakarta Port transport providers. This research used the new tariff to find the linear regression formula for the mode cost of the trucks. Equation (5.2) represents the linear regression of the inland mode cost of the truck that is a function of the distance from the origin to the port.

$$IMC_{op1} = 1400 + 13.6d_{op1} \quad \textbf{(5.2)}$$

where

IMC_{op1} = Inland mode cost from origin *o* to port *p* using inland mode 1 (truck/road mode)

d_{op1} = The distance between origin *o* to port *p* using inland mode 1 (truck/road mode).

The inland mode cost of alternatives using the train/rail mode is obtained from the addition of the cost for transporting the container from the plant site to the train station using a truck and the inland mode cost from origin station *o* to port *p* using the train/rail mode.

Inland mode cost of train = truck cost from location to train station + train cost from origin station *o* to port *p*.

$$IMC_{op2} = 1700 + 12.5d_{op2} \quad \textbf{(5.3)}$$

where

IMC_{op2} = Inland mode cost from origin *o* to port *p* using inland mode 2 (train/rail mode), including transport cost using a truck from the location of the respondent to the origin train station for trans-shipment

d_{op2} = The rail distance between origin train station *o* to port *p* using inland mode 2 (train/rail mode).

The results of the base value of the inland mode cost for each origin region of the four alternatives can be seen in **Table 5.6**.

Table 5.6 Base value calculation of the inland mode cost.

To / From	Alternative 1 Port-Mode	IMC (1,000s-IDR)	Alternative 2 Port-Mode	IMC (1,000s-IDR)	Alternative 3 Port-Mode	IMC (1,000s-IDR)	Alternative 4 Port-Mode	IMC (1,000s-IDR)
Jakarta	JKT-RD	1,590	JKT-RL	1,938	CMY-RD	2,733	CMY-RL	2,800
Bandung	JKT-RD	3,508	JKT-RL	4,050	CMY-RD	3,059	CMY-RL	3,663
Bekasi	JKT-RD	1,876	JKT-RL	2,325	CMY-RD	2,094	CMY-RL	2,488
Tangerang	JKT-RD	1,862	JKT-RL	2,138	CMY-RD	3,141	CMY-RL	3,225
Cirebon	JKT-RD	4,746	JKT-RL	4,525	CMY-RD	3,630	CMY-RL	4,113
Semarang	SMG-RD	1,468	SMG-RL	1,813	JKT-RL	7,400	SBY-RL	5,300
Surakarta	SMG-RD	1,550	SMG-RL	3,150	JKT-RL	9,013	SBY-RL	4,900
Surabaya	SBY-RD	1,522	SBY-RL	1,813	JKT-RL	10,950	SMG-RL	5,263
Malang	SBY-RD	2,760	SBY-RL	2,913	JKT-RL	12,113	SMG-RL	6,425
Bogor	JKT-RD	2,243	JKT-RL	2,500	CMY-RD	3,182	CMY-RL	3,363
Karawang	JKT-RD	2,474	JKT-RL	2,575	CMY-RD	1,822	CMY-RL	2,163
Yogyakarta	SMG-RD	3,182	SMG-RL	3,863	JKT-RL	8,250	SBY-RL	5,613
Jepara	SMG-RD	2,461	JKT-RD	5,453	SBY-RD	8,962	CMY-RD	7,656
Gresik	SBY-RD	1,713	SBY-RL	2,100	JKT-RL	11,100	SMG-RL	6,663
Sidoarjo	SBY-RD	1,862	SBY-RL	2,088	JKT-RL	11,238	SMG-RL	5,550
Pasuruan	SBY-RD	2,352	SBY-RL	2,550	JKT-RL	11,700	SMG-RL	6,013

5.1.4.4 Base values of inland mode time

The base value of the inland mode time was acquired via the division of the distance by the average speed of the corresponding inland mode. There are no definite data for the container truck speed in Java; this research uses the only information available, which is the average speed of heavy trucks in Sumatera — 27.13 km/hour (Novandi, 2011). However, the average speeds of container trains in Java can be calculated using the data of some container services currently served by PT KAI[16], and the result is 36.24 km/hour.

The inland mode time of a truck from the location to the port is formulated as follows:

$$IMT_{op1} = \frac{d_{op1}}{AS_1} \quad \textbf{(5.4)}$$

where

IMT_{op1} = The inland mode time of the truck/road mode (in hours) from the origin region o to port p

d_{op1} = The distance between the origin region o to port b (in km) using inland mode 1 (truck/road mode)

[16] Source: Penomoran KA, Kapasitas Lintas, Jarak Antar Stasiun (Berlaku Pada GAPEKA 2011) — Train Identification, Rail Network Capacity and Distance between rail stations (applied during the trips in 2011).

AS_1 = The average speed of truck/road mode (km/hour).

The inland mode time for the train/rail mode can be stated as a summation of the truck/road mode time from the location to the trans-shipment train station, the handling and waiting time in the train station and the train time from the origin station to the port. This research assumed that the average time required for transporting a container from the origin to the train station is approximately two hours (including handling and waiting time at the trans-shipment train station). Hence, the inland mode time for an alternative using the train/rail mode can be represented by Equation 5.5 below:

$$IMT_{op2} = 2 + (\frac{d_{op2}}{AS_2}) \quad \textbf{(5.5)}$$

where

IMT_{op2} = Inland mode time of train/rail mode (hours)

d_{op2} = Distance between the origin train station to the port (km)

AS_2 = The average speed of train/rail mode (km/hour).

The results of the base value calculation of inland mode transport time from each origin region to the ports can be seen in **Table 5.7**.

Table 5.7 Base value calculations of inland mode time.

To	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
From	Port-Mode	IMT hours	Port-Mode	IMT Hours	Port-Mode	IMT hours	Port-Mode	IMT Hours
Jakarta	JKT-RD	0.5	JKT-RL	2.5	CMY-RD	3.6	CMY-RL	4.4
Bandung	JKT-RD	5.7	JKT-RL	7.2	CMY-RD	4.5	CMY-RL	6.3
Bekasi	JKT-RD	1.3	JKT-RL	3.4	CMY-RD	1.9	CMY-RL	3.7
Tangerang	JKT-RD	1.3	JKT-RL	3.0	CMY-RD	4.7	CMY-RL	5.4
Cirebon	JKT-RD	9.1	JKT-RL	8.2	CMY-RD	6.0	CMY-RL	7.3
Semarang	SMG-RD	0.2	SMG-RL	2.2	JKT-RL	14.6	SBY-RL	9.9
Surakarta	SMG-RD	0.4	SMG-RL	5.2	JKT-RL	18.1	SBY-RL	9.1
Surabaya	SBY-RD	0.3	SBY-RL	2.2	JKT-RL	22.4	SMG-RL	9.9
Malang	SBY-RD	3.7	SBY-RL	4.7	JKT-RL	25.0	SMG-RL	12.4
Bogor	JKT-RD	2.3	JKT-RL	3.8	CMY-RD	4.8	CMY-RL	5.7
Karawang	JKT-RD	2.9	JKT-RL	3.9	CMY-RD	1.1	CMY-RL	3.0
Yogyakarta	SMG-RD	4.8	SMG-RL	6.8	JKT-RL	16.5	SBY-RL	10.6
Jepara	SMG-RD	2.9	JKT-RD	11.0	SBY-RD	20.5	CMY-RD	17.0
Gresik	SBY-RD	0.8	SBY-RL	2.9	JKT-RL	22.8	SMG-RL	13.0
Sidoarjo	SBY-RD	1.3	SBY-RL	2.9	JKT-RL	23.1	SMG-RL	10.5
Pasuruan	SBY-RD	2.6	SBY-RL	3.9	JKT-RL	24.1	SMG-RL	11.5

5.1.4.5 Base values of inland mode GHG emissions

The calculation of the base value of the GHG emissions is determined by considering three factors: (1) the emission factor of the transport mode, (2) the weight of the goods being transported and (3) the distance from the location to the port. This calculation method is adapted from the IFEU model that appears in Section 3.4.2.

According to the statistics of the Indonesian Railway Company (PT KAI), in 2012 it delivered 156,000 TEUs with 1,813,416 tonnes in weight. The average weight per TEU is 11.6 tonnes/TEU. The experimental design exploits the emissions factors of the inland mode taken from McKinnon and Piecyk (2011). According to McKinnon and Piecyk, the average emission factor for a truck is 62 grams of CO_2 per tonne-km, whereas the average emission factor for a train is 22 grams of CO_2 per tonne-km.

The GHG emissions of the truck/road mode are expressed as follows:

$$IMG_{op1} = (d_{op1} * EF_1 * W)/1000 \tag{5.6}$$

where

IMG_{op1}	=	Inland mode GHG emissions from origin *o* to port *p* using truck/road mode (kg CO_2e)
d_{op1}	=	The road distance between origin region *o* to port *p* (km)
EF_1	=	Average emission factor of the truck (62 grams of CO_2e per tonne-km)
W	=	Average weight of one TEU container (11.6 tonnes/TEU).

The calculation of inland mode GHG emissions of the train mode is carried out using this formula:

$$IMG_{op2} = ((10 * EF_1 * W) + (d_{op2} * EF_2 * W))/1000 \tag{5.7}$$

where

IMG_{op2}	=	Inland mode GHG emissions from origin *o* to port *p* using train/rail mode (kg CO_2e)
d_{op2}	=	The rail distance between train stations at origin region *o* to port *p* (km)
EF_1	=	Average emission factor of the truck (62 grams of CO_2e per tonne-km)
EF_2	=	Average emission factor of the train/rail mode (22 grams of CO_2e per tonne-km)
W	=	Average weight of one TEU container (11.6 tonne/TEU).

This research assumed that the average distance from the location of the respondent to the trans-shipment train station is 10 km.

The results of the base value calculation of the inland mode GHG emissions from each origin region to the ports can be seen in **Table 5.8**.

Table 5.8 Base value calculation of inland mode GHG emissions.

To	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
From	Port-Mode	IMG Kg-CO_2e	Port-Mode	IMG Kg-CO_2e	Port-Mode	IMG Kg-CO_2e	Port-Mode	IMG Kg-CO_2e
Jakarta	JKT-RD	10.7	JKT-RL	12.3	CMY-RD	75.0	CMY-RL	29.1
Bandung	JKT-RD	118.7	JKT-RL	53.5	CMY-RD	93.4	CMY-RL	45.9
Bekasi	JKT-RD	26.8	JKT-RL	19.8	CMY-RD	39.0	CMY-RL	23.0
Tangerang	JKT-RD	26.0	JKT-RL	16.2	CMY-RD	98.0	CMY-RL	37.4
Cirebon	JKT-RD	188.3	JKT-RL	62.7	CMY-RD	125.6	CMY-RL	54.7
Semarang	SMG-RD	3.8	SMG-RL	9.8	JKT-RL	118.7	SBY-RL	77.8
Surakarta	SMG-RD	8.4	SMG-RL	35.9	JKT-RL	150.2	SBY-RL	70.0
Surabaya	SBY-RD	6.9	SBY-RL	9.8	JKT-RL	187.9	SMG-RL	77.1
Malang	SBY-RD	76.6	SBY-RL	31.3	JKT-RL	210.6	SMG-RL	99.7
Bogor	JKT-RD	47.5	JKT-RL	23.2	CMY-RD	100.3	CMY-RL	40.1
Karawang	JKT-RD	60.5	JKT-RL	24.7	CMY-RD	23.7	CMY-RL	16.7
Yogyakarta	SMG-RD	100.3	SMG-RL	49.8	JKT-RL	135.3	SBY-RL	83.9
Jepara	SMG-RD	59.7	JKT-RD	228.1	SBY-RD	425.7	CMY-RD	352.2
Gresik	SBY-RD	17.6	SBY-RL	15.5	JKT-RL	190.8	SMG-RL	104.4
Sidoarjo	SBY-RD	26.0	SBY-RL	15.2	JKT-RL	193.5	SMG-RL	82.7
Pasuruan	SBY-RD	53.6	SBY-RL	24.2	JKT-RL	202.5	SMG-RL	91.7

5.1.5 Presented Level of Attributes

Table 5.9 illustrates the attribute levels chosen for each alternative and the expected signs of the attribute. The attributes of port cost, port ship calls, mode cost and mode time are differentiated into four levels each, namely 50%, 75%, 125% and 150% of the initial value. The mode reliability uses four percentage levels of reliability (70%, 80%, 90% and 100%). The GHG emission is the only attribute that is differentiated into two levels: 75% and 125% of the base value. According to the previous studies, the expectations of this research is that the port costs, mode costs, mode times and GHG emissions will have negative signs. Moreover, the frequency of ship calls and the mode reliability are expected to have positive signs.

Table 5.9 Attributes of alternatives, levels, values and expected signs

Attributes	Levels				Value	Expected Signs
	1	2	3	4		
Inland Mode: Cost	50%	75%	125%	150%	Continuous	Negative
Inland Mode: GHG Emissions	75%	125%	-	-	Continuous	Negative
Inland Mode: Reliability	70%	80%	90%	100%	Percentage	Positive
Inland Mode: Time	50%	75%	125%	150%	Continuous	Negative
Port: Cost	50%	75%	125%	150%	Continuous	Negative
Port: Ship Calls	50%	75%	125%	150%	Continuous	Positive

In addition, in order to avoid dominant alternatives, the researcher made some manual adjustments to some attributes' values. The adjustments are needed in several cases, such as alternatives for the origin region of Surakarta. The alternatives SMG-RD and SMG-RL need to be made less attractive; on the other hand, the JKT-RL and SBY-RL alternatives need to be made more attractive. This dominance also occurs for Semarang, Yogyakarta, Jepara, Surabaya, Malang, Gresik, Sidoarjo and Pasuruan.

5.1.6 Efficient Design

According to Louviere *et al.* (2000 p. 121), an experiment with four alternatives, six attributes and four levels needs at least 96 set scenarios for the smallest design. In this experiment, each origin is represented by 128 scenarios that were divided into 16 blocks, with each block containing eight scenarios (choice situations) to be shown to the respondent. The statistical design was generated as an efficient design using NGENE software (ChoiceMetrics, 2012).

We used unlabelled alternatives for the ports' names to avoid biased preferences of the respondent. The respondents were requested to focus on the attribute of the alternatives presented in the experiment. We used Port A for Tanjung Priok Port, Port B for Tanjung Emas Port, Port C for Tanjung Perak Port and Port D for Cilamaya Port. However, we still used the actual names of the inland modes. Thus, the options for those that were presented to the respondents were (1) Port A — Road, (2) Port A — Rail, (3) Port B — Road, (4) Port B — Rail, (5) Port C — Road, (6) Port C — Rail, (7) Port D — Road and (8) Port D — Rail.

The prior values of parameters used in the efficient design of the pilot survey can be seen in **Table 5.10**.

Table 5.10 Prior values of parameters used in the efficient design for pilot survey

Parameters	Prior value	Source
β_{IMC} — Mode cost	-0.0002	Expert Judgement
β_{IMG} — GHG emissions	-0.0100	Expert Judgement
β_{IMR} — Reliability	0.2000	Expert Judgement
β_{IMT} — Mode time	-0.0030	Expert Judgement
β_{PC} — Port cost	-0.0002	Expert Judgement
β_{PSC} — Port ship calls	0.0500	Expert Judgement

The NGENE software performed thousands of iterations to generate an efficient design. Because the iteration process took a long time, the author had to stop the iteration process if satisfied with the D-error. In this research, the iteration process has generated a considered, sufficiently low D-error and A-error after more than 3,000 iterations, and then the iterations were stopped after more than 15,000 had been performed. The iteration process and the errors of the pilot survey design are shown in **Table 5.11** below.

Table 5.11 Iteration process and errors in the efficient design of the pilot survey

Origin	Error and OOD measure of Final Output			
	Iteration No	D-error	A-error	D-optimality
Jakarta	15411	0.000030	0.094612	69.81%
Bandung	15867	0.000018	0.08611	67.58%
Bekasi	15666	0.000030	0.089476	68.58%
Tangerang	15569	0.000027	0.09301	68.65%
Cirebon	15695	0.000015	0.094472	71.18%
Semarang	15624	0.000027	0.096383	68.08%
Surakarta	15626	0.000021	0.096619	68.67%
Surabaya	15621	0.000020	0.092077	67.41%
Malang	15683	0.000017	0.091634	67.11%

The example of the NGENE syntax and the results of an efficient experiment design generated by the software can be found in Appendix A1 and Appendix A2, respectively.

In terms of getting a reliable parameter estimated, the ‘wrong’ or inefficient design will make the researcher has to use a greater sample size. The 50% lower A-error and D-error will result four times less sample size required (Rose and Bliemer, 2010; Bliemer and Rose, 2005a; Bliemer and Rose, 2005b)

5.2 Developing the Survey Instrument for the Data Collection

5.2.1 Survey Instrument Design

The survey instrument design has been approved by the Ethics Committee of the University of Leeds. The survey instrument design contains:

1. Information about the research
2. Consent form
3. Respondent’s details
    - Respondent’s name (*optional*)
    - Email address of the respondent

- Position of the respondent in the company
- Involvement of the respondent in the inland mode and port selection[17]: (1) Yes, (2) No
- Company name
- Company Type: Exporter, Freight Forwarder.

4. **Part 1**: Export product/commodity and shipment details (the commodity that has the biggest exported volume in the firm over the last 12 months).

    - Q01 — Type of commodity according to a two-digit HS-Code[18]
    - Q02[19] — The perishability of the commodity (1) Yes, (2) No
    - Q03 —Volume of exports per month (in TEUs)
    - Q04 — Frequency of shipments per month
    - Q05 — Number of containers per shipment (in TEUs)
    - Q06[20] — The average value of product per TEU (in millions IDR)
    - Q07 — Main export destination; the respondent needs to choose his/her primary export destination from the list: (1) Southeast Asia, (2) East Asia, (3) Middle East, (4) South Asia, (5) North America, (6) South America, (7) Europe, (8) Australia and Oceania, (9) Africa.
    - Q08 — Origin region of product: (1) Jakarta, (2) Bandung, (3) Bekasi, (4) Tangerang, (5) Cirebon, (6) Semarang, (7) Surakarta, (8) Surabaya, (9) Malang, (10) Bogor, (11) Karawang, (12) Yogyakarta, (13) Jepara, (14) Gresik, (15) Sidoarjo, (16) Pasuruan.

5. **Part 2:** Current port and inland mode were chosen by the respondent's firm.

    - Q09 — Main choice of port; current port chosen for the export (1) Tanjung Priok Port, (2) Tanjung Emas Port, (3) Tanjung Perak Port
    - Q10 — Current port cost (in thousands IDR)
    - Q11 — Frequency of international container ship calls at the selected port (ship calls per week)
    - Q12 — Main choice of inland mode; (1) Truck /road mode, (2) Train/rail mode
    - Q13 — Inland mode transportation cost from the selected origin region to the selected port (in thousands IDR)

[17] The question of the respondent's involvement in the inland mode and port choice was only put to the main survey's respondents.

[18] HS-Code is Harmonized System Code. This is a standard and very widely adopted code for classifying goods in international trade.

[19] The characteristic of perishable products was only asked about in the main survey.

[20] The value of commodity per TEU was only asked about in the main survey.

- Q14 — Inland mode transport time from the selected origin region to the chosen port (in hours)
- Q15 — Maximum lateness of selected inland mode (in hours)
- Q16 — Percentage of inland mode reliability; the default reliability is 80%. The respondents could use their own percentage of on time delivery (reliability) if they have it.

6. **Part 3**: Stated choice experiments, containing eight exercises.

5.2.2 Developing an Online Survey Instrument

As remarked in Chapter 4, this research utilizes a web-based survey instrument to gather the data from the respondents.

The online survey instrument was developed based on the survey instrument design, and consists of four modules:

1) **Module 1**: Information about the research, login page and respondent details
2) **Module 2 (Part 1)**: Data about the export commodity and shipments
3) **Module 3 (Part 2)**: Current port and inland mode choice, as the RP data
4) **Module 4 (Part 3)**: Exercise of a choice experiment for the SP data collection, feedback to the researcher and confirmation of completing the survey.

The flow of the online survey and the relationship between tables and files can be seen below in **Figure 5.3**.

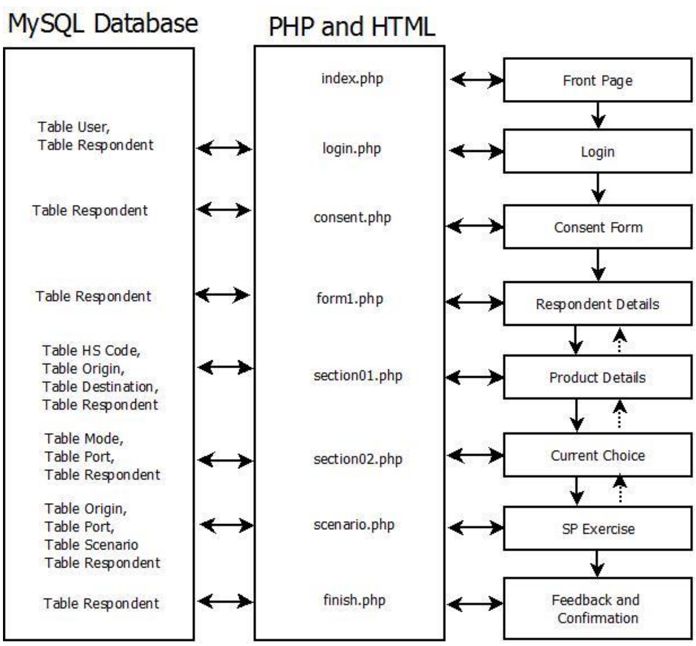


Figure 5.3 The online survey system design developed in this research

5.2.2.1 Creating and Inputting Data to the MySQL Database

The required data in the online survey should be stored in the database, in order that it might be easily retrieved and presented to the respondents. The data that is stored in the MySQL online database consists of the following tables:

1. Table Respondent: the data of the respondents' details and answers to the stated choice experiment.
2. Table Scenario: all of the choice sets acquired from the experimental design are stored in this table.
3. Table User: this table is used to store the usernames and passwords of the respondents (for the main survey only). Each respondent has a unique username and password that are used to log in to the online survey system.
4. Table HS-Code: the definitions and 99 two-digit HS-codes' data are stored in this table. These data will be presented when the respondent is selecting the product category.
5. Table Origin: containing the data of 16 origin regions in Java and the distance from the origin to the existing or proposed container ports in Java.
6. Table Destination: this table contains nine different export destinations.
7. Table Port: contains the port data, including the base value of the port cost and port ship calls.
8. Table Mode: definition of the inland mode.

The two main tables are the respondent table and the scenario table, which are supported by the others. To log in to the online system, a respondent has to input the username and password from the Table User. The respondent then fills in the respondent data (details of the respondent, product characteristics and shipment characteristics) that will be stored in the Table Respondent. In the experiment, a set of choice alternatives (containing eight situations) will be presented to the respondents, which are retrieved from the Table Scenario and based on their origin regions. The answers of the stated choice experiment are also stored in Table Respondent. We can discover the relationship between the tables in the database from **Figure 5.4**.

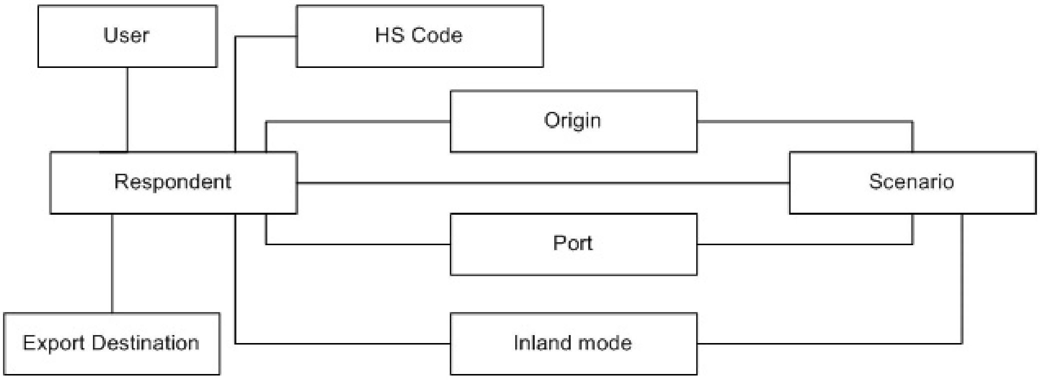


Figure 5.4 Relationship between tables in the MySQL database

5.2.2.2 Module 1: Information about the Research and Login Page

The front page provides brief information about the research and three menus: Home, Information and Contact. The information menu presents the details of the research and gives the download links to any relevant files, such as a sample of the completed questionnaire; a cover letter from the Institute for Transport Studies (ITS), University of Leeds and a cover letter from the Centre for Logistics and Industrial Optimization (PUSLOGIN), Universitas Muhammadiyah Surakarta. Furthermore, the contact details of the researcher can be found in the contact menu. The front-page view is shown in **Figure 5.5**.

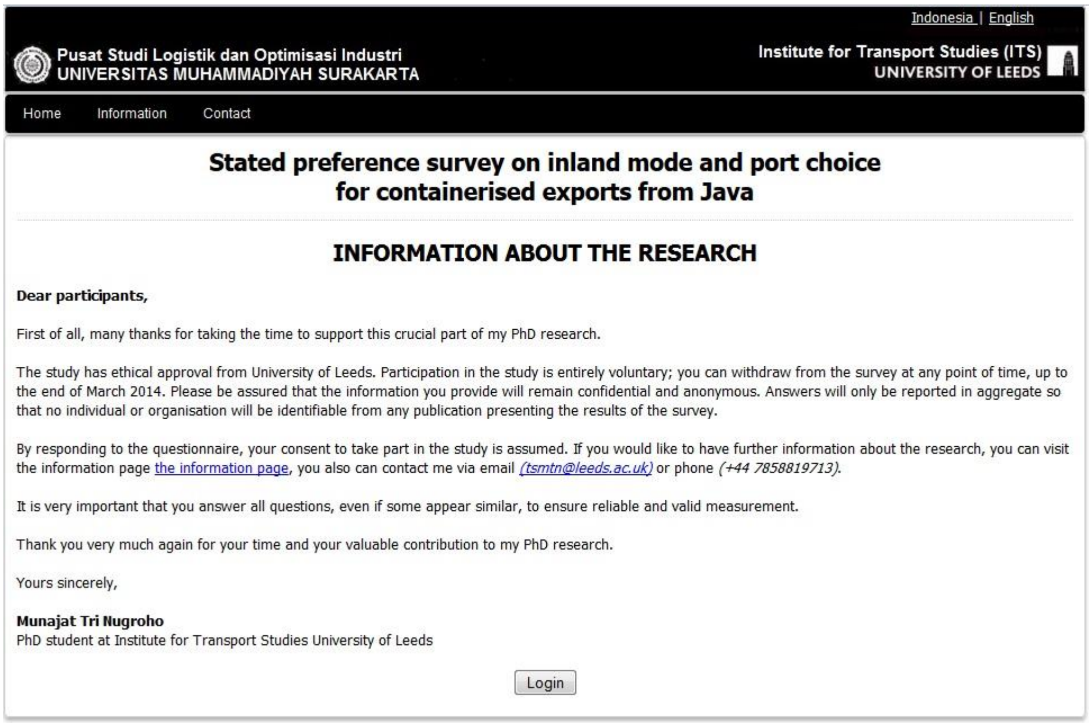


Figure 5.5 Front-page view of the online survey

In the pilot survey, the respondent had to complete the survey in a single session. Because of this condition, some respondents could not complete the survey because they had limited time. In the main survey, a login page has been added to the online survey system to allow the respondents to fill in the questionnaire at different times, and also to determine how long a respondent took to complete the survey. In the main survey, respondents have to log in with the unique usernames and passwords sent to them by emails or letters. The login form page is presented in **Figure 5.6** below.

Figure 5.6 Login form interface of the online survey

Not all the questions put to respondents are compulsory; they must answer the questions about decision-making involvement in the inland mode and port selection, and the type of company to which they belong. The remaining questions are optional. The user interface of the respondent details can be seen in **Figure 5.7** below.

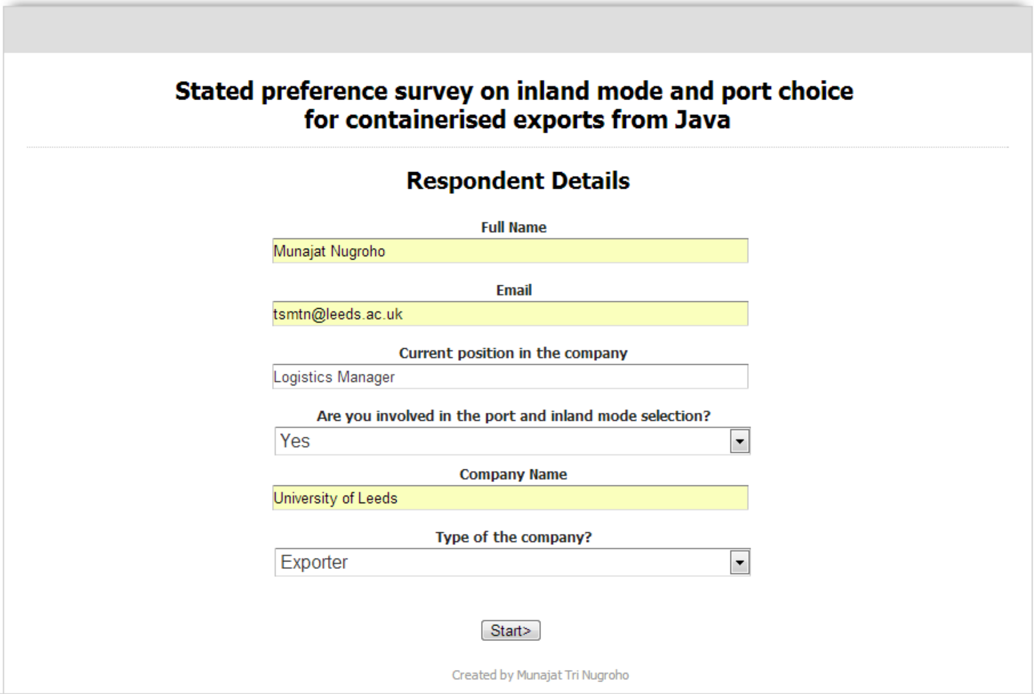


Figure 5.7 Respondent details

5.2.2.3 Module 2 (Part 1): Data about the Firm, Commodity and Shipments

In this module, the respondents were asked the questions in Part 1 about the product and shipment details, namely Q01, Q02, Q03, Q04, Q05, Q06, Q07 and Q08 (*see* Section 5.2.1). A sample of an interface for Q07 is shown in **Figure 5.8**, whereas the completed user interface for Module 2 can be found in Appendix B1.

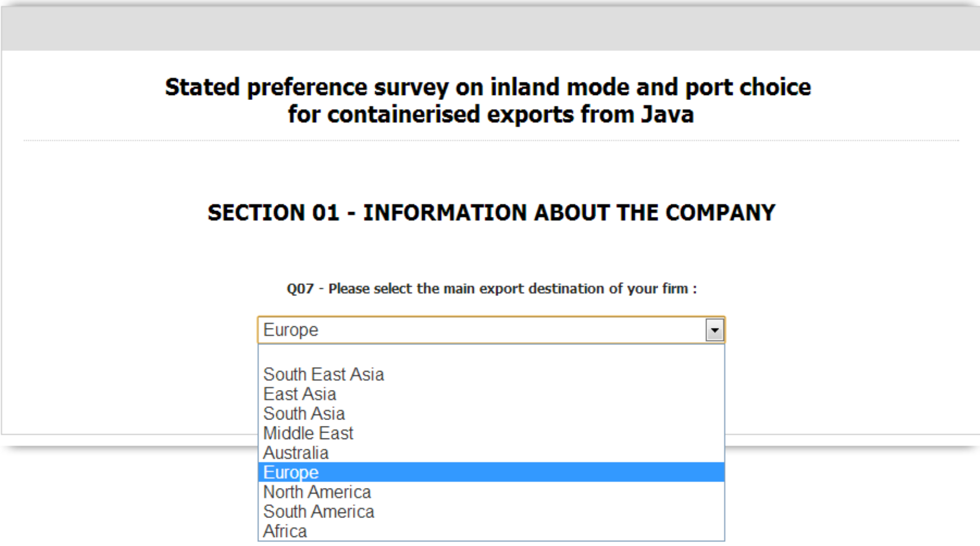


Figure 5.8 User interface for Q07 — main export destination

5.2.2.4 Module 3 (Part 2): Current Choice (Revealed Preference Data)

The questions in Part 2 relating to the current choice of port and mode — Q09, Q10, Q11, Q12, Q13, Q14, Q15 and Q16 — are presented in Module 3. To facilitate answering the questions, the online system provides a default value for the questions that are associated with port cost (Q10), post ship calls (Q11), inland mode cost (Q13), inland mode time (Q14), maximum lateness (Q15) and inland mode reliability (Q16). The respondent could enter their own value if they have it, or leave it as the default. A sample of an interface for Q12 is shown in **Figure 5.9**, whereas the rest of the user interface for Module 3 can be found in Appendix B2.

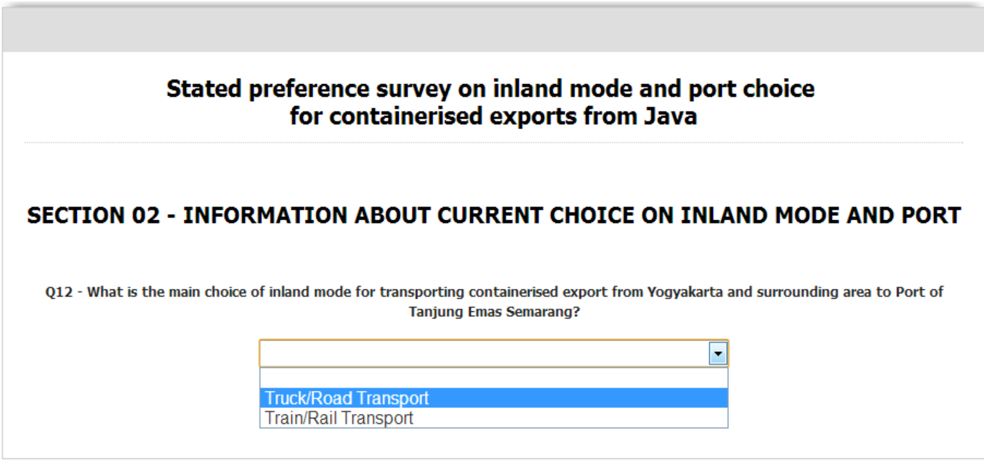


Figure 5.9 User interface of Q12 — current choice of inland mode.

5.2.2.5 Module 4 (Part 3): Exercise of the Choice Experiment (SP Data)

Module 4 is the most important part of the online survey; this module provides set choices that contain eight scenarios of a choice experiment for each respondent according to the selected origin. The example of the first of eight choice experiments for the respondent from Surakarta and the surrounding area is demonstrated in **Figure 5.10** below:

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 1 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 1,410,000	Rp 940,000	Rp 960,000	Rp 735,000
- Oversea ship calls frequency per week	12 calls	12 calls	82 calls	19 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 2,900,000	Rp 3,200,000	Rp 9,000,000	Rp 4,067,000
- Inland mode transport time (hours/trip)	5.1 hours	6.9 hours	15.0 hours	7.6 hours
- Percentage of inland mode reliability	100%	80%	80%	80%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	128 Kg CO2-e	36 Kg CO2-e	75 Kg CO2-e	70 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE	(•)	( )	( )	( )
CHOOSE THE WORST ALTERNATIVE	( )	(•)	( )	( )

<Back Next>

Figure 5.10 Example of a stated choice experiment for the respondent from Surakarta and the surrounding area.

After completing the survey, the online system will send a confirmation to the respondent's email address. The summary of the completed survey will also be sent to the respondent's email address as a PDF file attachment.

5.3 Pilot Survey

5.3.1 Population and Sample

The potential participants are the decision-makers in selecting both 'inland mode' and 'port choice' in the exporter or freight forwarder companies from Java. The respondent candidates for the pilot survey were selected from two main sources. The data of exporters in Java were obtained from the *Directory of 8000 Indonesian Exporters* whilst data for freight forwarder companies were derived from the *Directory of Indonesian Logistics and Guide Book*[21]. In the pilot survey, the sample was chosen from the nine selected origins in Java: namely Jakarta, Bandung, Bekasi, Tangerang, Cirebon, Semarang, Surakarta, Surabaya and Malang.

5.3.2 Data Collection

To recruit the respondent candidates, 700 companies (consisting of 525 exporters and 175 forwarder companies) were contacted during the pilot survey using faxes and emails. The faxes were sent using an internet-based fax service. The pilot survey was conducted between July 2013 and October 2013. As shown in **Table 5.12**, the respondents were selected from nine origins; namely Jakarta, Bandung, Bekasi, Tangerang, Cirebon, Semarang, Surakarta, Surabaya and Malang. The distribution of those respondents that were successfully contacted in the pilot survey and how they were contacted are shown in **Table 5.12** below.

Failures to contact the potential respondents using email were caused by several reasons, such as non-routable address, over quota and unknown user. Moreover, failures in sending the faxes were caused by the following reasons: the wrong number, poor transmission and the machine not answering. The sending of both faxes and emails were conducted by the author from Leeds.

Table 5.12: Distribution of the candidates of the respondent population in the pilot survey

Origin	Successfully contacted by			Failed	Total	%
	Fax and Email	Fax only	Email only			
Jakarta	91	98	31	65	285	40.71%
Bandung	21	21	7	10	59	8.43%
Bekasi	28	23	8	9	68	9.71%
Tangerang	26	15	10	10	61	8.71%
Cirebon	10	3	5	3	21	3%
Semarang	19	19	11	8	57	8.14%
Surakarta	12	7	4	8	31	4.43%
Surabaya	39	26	15	13	93	13.29%
Malang	7	10	5	3	25	3.57%
Total	253	222	96	129	700	100%
Percentage	36.14%	31.71%	13.71%	18.43%	100%	

[21] The *Directory of Indonesian Logistics and Guide Book* was published by the Indonesian Logistics Association (ALI) and PPM Management School.

From the 700 companies contacted, 26 respondents have completed the questionnaire adequately, providing 208 SP choice observations. One respondent had to be excluded from the model estimation because some key data were not available, leaving 25 respondents with 200 observations. The distribution of respondents based on their origin region was Jakarta (four respondents, 16%), Bandung (two respondents, 8%), Bekasi (three respondents, 12%), Tangerang (0%), Cirebon (four respondents, 16%), Semarang (four respondents, 16%), Surakarta (four respondents, 16%), Surabaya (two respondents, 8%) and Malang (two respondents, 8%). Based on the company type, 20 (80%) respondents were exporters, and five of them were freight forwarding companies.

5.3.3 Pilot Survey Findings

The model estimation of data collected in the pilot survey was carried out using the simple MNL model. From the **Table 5.13** below, we can see that all of the parameters have the correct signs. Four attributes (port ship calls, inland mode cost, inland mode time and inland mode reliability) are significant at 5% level whilst the port cost is nearly significant at 10% level. The inland mode GHG emission is significant at the 10% level.

Table 5.13 Estimated results using the MNL model on data from the pilot survey.

Attributes	Coefficient	T-test value
β_{IMC} – Mode cost	-0.000693	-6.58**
β_{IMG} – GHG emissions	-0.00544	-1.87*
β_{IMR} – Reliability	0.0504	6.05**
β_{IMT} – Mode time	-0.195	-5.01**
β_{PC} – Port cost	-0.000468	-1.64
β_{PSC} – Port ship calls	0.0254	4.39**
Statistics		
Observations		200
Null log-likelihood ($\mathcal{LL}(0)$)		-277.259
Final log-likelihood ($\mathcal{LL}(\beta^*)$)		-182.610
Likelihood ratio test		189.297
Rho-square (ρ^2)		0.341
Adjusted rho-square ($\bar{\rho}^2$)		0.320

*Note: * Significant at the 10% level, ** Significant at the 5% level*

Coefficients for the inland mode cost, inland mode time, inland mode GHG emissions and port cost all display negative signs, meaning that increases in any of these factors will reduce the utility of the alternative. Conversely, positive coefficients for inland mode reliability and ship calls indicate that improvements in these factors will increase the utility of the alternative. These findings support the expected signs of the parameters in **Table 5.9**, and the six attributes will continue to be used in the main survey.

The pilot survey also provided the possibility for the respondents to give any feedback related to the research; the useful feedbacks obtained from the pilot survey are:

- The characteristics of products should be considered in the survey; for example, perishable products usually need to be transported in the shortest possible time.
- The online questionnaire system would be better with direct confirmation (such as email) to ensure that the respondent has completed the questionnaire.
- The survey also needs to ask the respondent about the problems of freight transport.

5.4 Revising the Design for the Main Survey

5.4.1 Experimental Design

The efficient design of the main survey was carried out using the prior values obtained from the pilot survey. From the data in **Table 5.14**, we can see that all of the D-error and A-error values for the main survey (for the 16 origins) are smaller than the values used in creating an efficient design for the pilot survey (*see* **Table 5.11**). The smaller D-error and A-error values indicate that the design of the main survey is more efficient than the experimental design used in the pilot survey.

Table 5.14 Iteration process, D-error, A-error and D-optimality measures for the efficient design of the main survey

	Error and OOD measure of Final Output			
Origins	**Iteration**	**D-error**	**A-error**	**D-optimality**
Jakarta	15723	0.000011	0.001561	69.02%
Bandung	15901	0.000004	0.000259	68.40%
Bekasi	15882	0.000008	0.000738	70.26%
Tangerang	15020	0.000010	0.001343	70.98%
Cirebon	15674	0.000003	0.000209	68.25%
Semarang	15445	0.000006	0.000427	69.28%
Surakarta	15234	0.000004	0.000376	70.36%
Surabaya	15328	0.000008	0.000585	69.06%
Malang	15693	0.000004	0.000313	70.03%
Bogor	15527	0.000006	0.000715	71.69%
Karawang	15745	0.000006	0.000613	72.96%
Yogyakarta	15586	0.000003	0.000252	71.16%
Jepara	15189	0.000004	0.000248	70.32%
Gresik	15709	0.000007	0.000466	72.33%
Sidoarjo	15476	0.000007	0.000474	70.52%
Pasuruan	15639	0.000005	0.000353	72.15%

5.4.2 Improving the Survey Instrument and Online System Design

The feedback from the respondents in the pilot survey was accommodated in the main survey instrument. The main survey instrument was improved by adding questions about (1) the involvement of the respondent in the port and mode choice decision-making, (2) characteristics of the product exported (perishability of products) and (3) the value of the commodity per TEU.

In addition, the online survey system was enhanced by adding some features: (1) the capability to save the survey to be continued at a different time, (2) an automatic email confirmation sent to the respondents on completion and (3) recording the time that was spent by the respondents in completing the survey.

5.5 Main Survey

5.5.1 Population and Sample

The population of the main survey was the same as for the pilot survey. The sample for the research was chosen using the systematic random sampling technique from the selected origin. The respondent candidates from the exporter companies that were contacted are the logistics or export managers. Meanwhile, the candidates from the freight forwarder companies were the people who acted as operation managers or branch managers.

5.5.2 Carrying out the Main Survey

The main survey was carried out between January 2014 and April 2014. To recruit the prospective respondents, 3,893 companies were contacted via emails or postal letters. To encourage the candidates to fill out the questionnaire, they also received reminders in the last month before the end of the main survey. Using both emails and postal letters, the candidates received some documents: (1) the invitation statement, (2) information about the research, (3) a sample of the completed surveys, (4) cover letter from Institute for Transport Studies (ITS) the University of Leeds and (5) a supporting letter from the PUSLOGIN UMS. The letters were sent using a tracked service, in order to ensure that the letters were received by the candidates' companies.

The main problem in contacting the respondents was that there were many detailed contacts in the directory without valid email addresses or postal addresses. This problem caused many of the emails and postal letters to be returned to the senders. The reasons for returned emails were namely: an invalid email address, rejection by the receiving email server and the address being unrecognized by the host email. Meanwhile, the reasons for returned postal letters were: the receiver had moved, the address was unknown, the company had closed, and the address was wrong. The failure rate of contacting the prospective respondents in the main survey was higher than in the pilot survey: 28.9% and 18.4%, respectively. The details of the success and failure rates in contacting the respondents in the main survey can be seen in **Table 5.15** below.

Table 5.15 The success rate of contacting respondents in the main survey

	By email		By post		Total for the main survey					
Origins	**Success**	**Failed**	**Success**	**Failed**	**Success**	**%**	**Failed**	**%**	**Total**	**%**
Jakarta	317	240	389	154	706	64.2%	394	35.8%	1,100	28.3%
Bandung	75	42	160	26	235	77.6%	68	22.4%	303	7.8%
Bekasi	47	65	182	18	229	73.4%	83	26.6%	312	8%
Tangerang	77	57	113	15	190	72.5%	72	27.5%	262	6.7%
Cirebon	56	24	74	8	130	80.2%	32	19.8%	162	4.2%
Bogor	30	26	98	21	128	73.1%	47	26.9%	175	4.5%
Karawang	17	20	67	5	84	77.1%	25	22.9%	109	2.8%
Semarang	90	39	101	34	191	72.3%	73	27.7%	264	6.8%
Surakarta	30	14	54	19	84	71.8%	33	28.2%	117	3%
Yogyakarta	60	38	91	30	151	68.9%	68	31.1%	219	5.6%
Jepara	43	34	59	19	102	65.8%	53	34.2%	155	4%
Surabaya	93	52	131	28	224	73.7%	80	26.3%	304	7.8%
Malang	4	8	29	10	33	64.7%	18	35.3%	51	1.3%
Gresik	31	18	54	6	85	78%	24	22%	109	2.8%
Sidoarjo	48	13	56	12	104	80.6%	25	19.4%	129	3.3%
Pasuruan	23	17	70	12	93	76.2%	29	23.8%	122	3.1%
Total	1,041	707	1,728	417	2,769	71.1%	1124	28.9%	3,893	100%

The process of sending emails to the candidates was administered directly by the researcher from Leeds, whereas the process of sending the letters (due to financial and time reasons) was performed from Indonesia and administered by the staff of PUSLOGIN UMS.

5.5.3 Data Cleaning

The overall responses obtained from the main survey came from 200 respondents, but only 156 respondents completed the questionnaire partly or fully, giving 1,209 observations. Furthermore, the online survey results show that the average time to answer the survey is 27 minutes with a standard deviation of 21 minutes. After data cleaning, 17 respondents were excluded because their completion time was less than 10 minutes, and their answers indicate that they did not answer the stated choice experiment accurately (for instance, they gave the same answers for eight different scenarios). Finally, only data from 139 respondents (1,087 observations) in the main survey were eligible and could be utilized for the next step. The data from the main survey were then combined with the data collected in the pilot survey. Thus, the full dataset of SP data consists of 164 respondents with 1,287 observations. The details of data before and after the cleaning of the combined pilot and main survey are presented in **Table 5.16**.

Table 5.16 Data source and comparison before and after data cleaning

Data source	Before cleaning		After cleaning	
	Respondents	Observations	Respondents	Observations
Main survey: incomplete[22]	44	0	0	0
Main survey: partly completed[23]	8	25	6	23
Main survey: fully completed	148	1,184	133	1,064
Data from the pilot survey	26	208	25	200
	226	1,417	164	1,287

5.5.4 Non-response Bias Test

The response rate of the pilot survey is 3.7% (26 out of 700), and the response rate of the main survey is 5.1% (200 out of 3,893). A non-response bias test was conducted in light of the low survey-response rate. As data relating to non-respondents were not available in this research, the non-response bias test investigates whether early and late respondents to the survey provided significantly different responses. There are 735 observations from 93 respondents in the group of early respondents, and 552 observations from 71 respondents in the group of late respondents.

The non-response bias test employs the simple multinomial logit (MNL) to compare the characteristics of early respondents with those of late respondents. According to the test results, there are no significant differences between the two respondent groups. All

[22] Incomplete respondents are the respondents who only filled out the survey up to Part 2.
[23] Partly completed respondents are the respondents who only filled out the survey up to Part 2.

choice parameters have the same signs in both respondent groups. The results of the non-response bias test are presented in **Table 5.17**.

Table 5.17 Comparison results of model estimation, using data from early respondents and late respondents

Name	Early respondents[24]			Late respondents		
	Value	Robust std err	Robust t-test	Value	Robust std err	Robust t-test
ASC_1 JKT-RD	0			0		
ASC_2 JKT-RL	-0.859	0.15	-5.73	-1.43	0.199	-7.16
ASC_3 SMG-RD	0.619	0.346	1.79	0.605	0.404	1.5
ASC_4 SMG-RL	-0.863	0.368	-2.34	-1.29	0.43	-3
ASC_5 SBY-RD	0.583	0.367	1.59	-0.233	0.43	-0.54
ASC_6 SBY-RL	-0.63	0.356	-1.77	-1.05	0.397	-2.65
ASC_7 CMY-RD	-0.448	0.144	-3.11	-0.713	0.168	-4.24
ASC_8 CMY-RL	-1.19	0.178	-6.67	-1.36	0.21	-6.45
β_{IMC} — Mode cost	-0.292	0.0468	-6.24	-0.204	0.0533	-3.83
β_{IMG} — GHG emissions	-0.825	0.154	-5.37	-0.807	0.168	-4.81
β_{IMR} — Reliability	2.24	0.377	5.95	1.55	0.454	3.42
β_{IMT} — Mode time	-0.942	0.19	-4.95	-0.807	0.233	-3.47
β_{PC} — Port cost	-0.357	0.127	-2.81	-0.464	0.154	-3.01
β_{PSC} — Port ship calls	0.628	0.268	2.34	0.704	0.372	1.89
Statistics						
Number of observations		735			552	
Number of estimated parameters		13			13	
Null log-likelihood ($\mathcal{LL}(0)$)		-1,018.926			-765.234	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)		-779.967			-579.978	
Likelihood ratio test		477.918			370.513	
Rho-square (ρ^2)		0.235			0.242	
Adjusted rho-square ($\bar{\rho}^2$)		0.222			0.225	

5.5.5 Characteristics of Respondents

From **Table 5.18** we can see that 67% of the respondents are involved in the decision-making process of inland mode and port selection; and 18% of respondents are not involved. The 15% of respondents who did not answer the involvement question come from the data of the pilot survey.

The exporters are accounted as the most respondents, with the 88.4% (145 of 164) of the total number, and the freight forwarders accounted for only one eighth of the exporters (11.6%). The population of the exporters in Java according to the *Directory of 8000*

[24] Early respondents are those who completed the surveys after they received the first invitation. Late respondents are those who completed the surveys after they received the reminder.

Indonesian Exporters is 4936, and population of the freight forwarders is 489[25], thus the percentage of exporters to the population of respondents is 90.9% and 9.1% of forwarders. This comparison shows that based on the company type, the respondents of the survey can be representative of the population.

Table 5.18 Summary of respondents' involvement in the decision-making process and the company type of the respondents

Questions	Answer	Respondents	%	Cum %
Involvement of respondents in the port and mode choice	Not answered	25	15.0%	15%
	Involved	109	66.5%	82%
	Not Involved	30	18.3%	100%
Company type	Exporter	145	88.4%	88.4%
	Forwarder	19	11.6%	100%

5.5.6 Characteristics of Products

Table 5.19 presents the product characteristics exported in containers according to the type of commodity and the goods' perishability. The respondents which produce miscellaneous manufacturing products (21.6%), wood products (20.4%), textiles products (11.7%), plastics and rubbers (6.8%) and chemical products (6.8%) are the top respondents according to the type of commodities exported. The types of products exported by the respondents are very varied, with only three types of commodities unnamed by respondents: (1) animal and vegetable by-products, (2) mineral products and (3) arms and ammunition. The absence of respondents from those type commodities are reasonable, because most of the mineral products are not suitable to be shipped in the container, and also Indonesia there was no exported arm and ammunition in 2012.

Compare with the actual data of the exporters based on their commodity type, commodity exported from Java in 2012, the classification of the exporters: textiles products (13.5%), miscellaneous products (10.9%), machineries products (9.1%), wood products (7.7%) and chemical products (7.1%). While the three groups with the smallest percentage are: arm and ammunition (0.2%), precious metals (0.3%) and works of art (1%)[26].

[25] Compiled from *Panduan and Direktori Logistik Indonesia*

[26] Data was compiled from the *Directory of 8000 Indonesian Exporters*

Perishability of the products is differentiated into two groups, namely perishable and non-perishable products. However, only one respondent states that the products is perishable.

Table 5.19 Summary of product characteristics exported by respondents

Questions	Answer	Respondents	%	Cum %
Type of commodity	XX. Miscellaneous	35	21.6%	21.6%
	IX. Wood products	33	20.4%	42%
	XI. Textiles	19	11.7%	54%
	VI. Chemical products	11	6.8%	60%
	VII. Plastics and rubbers	11	6.8%	67%
	XXI. Works of art	8	4.9%	72%
	IV. Foodstuffs	7	4.3%	77%
	XVI. Machines	6	3.7%	80%
	XVII. Transportation	6	3.7%	84%
	XII. Footwear and headwear	5	3.1%	87%
	II. Vegetable products	4	2.5%	90%
	VIII. Animal hides	4	2.5%	92%
	X. Paper goods	3	1.9%	94%
	XIII. Stone and glass	3	1.9%	96%
	XVIII. Instruments	3	1.9%	98%
	XIV. Precious metals	2	1.2%	99%
	I. Animal products	1	0.6%	99%
	XV. Metals	1	0.6%	100%
	III. Animal and vegetable by-products	0	0.0%	100%
	V. Mineral products	0	0.0%	100%
	XIX. Arms and ammunition	0	0.0%	100%
Perishability of product	Not perishable	138	84.1%	84.1%
	Perishable	1	0.6%	85%
	Not answered	25	15.2%	100%

5.5.7 Characteristics of Shipments

As is shown in **Table 5.20**, most of the respondents (55%) exported 1-10 TEUs container product per month, and this group represents the small and medium companies. The percentage of small and medium company size is close to the actual percentage of company size based on the number of employee, where almost 52%[27] (2556 of 4936) exporter companies in Java are small and medium enterprises[28].

Furthermore, than half of respondents (57%) have a relatively low frequency of shipments per month (1–5 shipments per month). However, 7% of respondents had a

[27] Data was compiled from the *Directory of 8000 Indonesian Exporters*

[28] The Statistics Indonesia Agency defines that the small and medium company is a company with 5-99 employees, and the large company is defined as company with 100 employees or more

high frequency of shipments per month (more than 30). According to the value of products, the range of 2,500 – 25,000 GBP is the largest proportion of the value of commodity per TEU. Unfortunately, there is no data available to compare the respondents and the population based on the frequency of shipments and the value of the commodity.

Table 5.20 Summary of shipments

Attribute of shipment	Characteristics	Respondents	%	Cum %
Volume of export TEUs per month	Not answered	5	3%	3%
	1–10 TEUs	91	55.5%	58.5%
	11–20 TEUs	19	11.6%	70.1%
	21–50 TEUs	24	14.6%	84.8%
	51–100 TEUs	15	9.1%	93.9%
	> 100 TEUs	10	6.1%	100%
Frequency of shipment per month	Not answered	4	2.4%	2.4%
	1–5 shipment(s)	94	57.3%	60%
	6–10 shipments	26	15.9%	76%
	11–30 shipments	30	18.3%	94%
	>30 shipments	10	6.1%	100%
Value of commodity GBP per TEU	Not answered	36	22%	22 %
	1–2,500 GBP	11	6.7%	29%
	2,501–5,000 GBP	24	14.6%	43%
	5,001–10,000 GBP	31	18.9%	62%
	10,001–25,000 GBP	38	23.2%	85%
	25,001–50,000 GBP	16	9.8%	95%
	> 50,000 GBP	8	4.9%	100%

Information provided in **Table 5.21** below reveals that the most frequent export destinations of the respondents are Europe (at 30%) and then Southeast Asia (at 20%). However, if we combine the destinations of Southeast Asia, East Asia, the Middle East and South Asia, we find that Asia is the largest destination at 46%. This percentage is in line with the data on the distribution of container movement for exports and imports from Indonesia. In 2007, about 61% of containerized exports and imports of Indonesia were shipped to and from Asia (*see* **Figure 2.4**).

Five origins — namely Jakarta, Surabaya, Bandung, Semarang and Cirebon — contribute 57% of the number of respondents. In contrast, four origins — Malang, Karawang, Sidoarjo and Gresik — only contribute about 4% of the total respondents.

Table 5.21 Summary of origin and export destinations

Questions	Destination/Origin	Respondent	%	Cum %
Export destination	Europe	49	29.9%	29.9%
	Southeast Asia	32	19.5%	49%
	East Asia	31	18.9%	68%

	North America	21	12.8%	81%
	Middle East	9	5.5%	87%
	Australia	9	5.5%	92%
	South America	7	4.3%	96%
	South Asia	4	2.4%	99%
	Africa	2	1.2%	100%
Origin region	Jakarta	22	13.4%	13.4%
	Surabaya	20	12.2%	26%
	Bandung	19	11.6%	37%
	Semarang	17	10.4%	48%
	Cirebon	15	9.1%	57%
	Bekasi	13	7.9%	65%
	Yogyakarta	12	7.3%	72%
	Surakarta	11	6.7%	79%
	Tangerang	10	6.1%	85%
	Jepara	7	4.3%	89%
	Bogor	6	3.7%	93%
	Pasuruan	5	3%	96%
	Malang	3	1.8%	98%
	Karawang	2	1.2%	99%
	Gresik	1	0.6%	99%
	Sidoarjo	1	0.6%	100%

5.5.8 Current Port and Inland Mode Choice

We can see from **Table 5.22**, more than half of the respondents chose Tanjung Priok Port as their current choice for the export shipments, followed by Tanjung Emas Port (chosen by 27% of respondents) and Tanjung Perak Port (selected by 18% of respondents).

The road mode dominates the inland mode choice of 97% of respondents, and only 2.4% of respondents utilize the rail mode for transporting their export commodity from its origins to the departure port. This percentage is close to the actual share of 3.67% of the containerized movements in Java carried out by the train/rail mode.

Table 5.22 Summary of current choice of port and inland mode

Port/Inland mode	Choices	Respondent	%	Cum %
Port	Tanjung Priok Port	89	54.3%	54.3%
	Tanjung Emas Port	45	27.4%	82%
	Tanjung Perak Port	30	18.3%	100%
Inland mode	Truck/Road Transport	160	97.6%	97.6%
	Train/Rail Transport	4	2.4%	100%

As can be seen from the data in **Table 5.23** below, Tanjung Priok Port in Jakarta is mostly chosen by the respondents in Jakarta, Bandung, Bekasi, Tangerang, Cirebon, Bogor and Karawang, who are located in the western region of Java. Only one respondent from outside the western part of Java chose Tanjung Priok Port as their preferred port. As well as Tanjung Emas Port, nearly all respondents who selected it come from Semarang, Surakarta, Yogyakarta and Jepara, which are located in the central Java region. All respondents who chose Tanjung Perak Port as their main selection came from places in East Java. This fact gives strong evidence that, traditionally, the hinterland of Tanjung Priok Port is located in the western part of Java, the hinterland of Tanjung Emas Port is located in the central region of Java and the eastern part of Java is the hinterland of Tanjung Perak Port.

Table 5.23 The distribution of the port and inland mode choice based on the respondents' origins

Origin	Total	Road Mode			Rail Mode		
		JKT	SMG	SBY	JKT	SMG	SBY
Jakarta	22	21	0	1	0	0	0
Bandung	19	17	0	0	2	0	0
Bekasi	13	12	0	0	1	0	0
Tangerang	10	10	0	0	0	0	0
Cirebon	15	14	0	0	1	0	0
Semarang	17	1	16	0	0	0	0
Surakarta	11	0	11	0	0	0	0
Surabaya	20	0	1	19	0	0	0
Malang	3	0	0	3	0	0	0
Bogor	6	6	0	0	0	0	0
Karawang	2	2	0	0	0	0	0
Yogyakarta	12	2	10	0	0	0	0
Jepara	7	0	7	0	0	0	0
Gresik	1	0	0	1	0	0	0
Sidoarjo	1	0	0	1	0	0	0
Pasuruan	5	0	0	5	0	0	0
Total	164	85	45	30	4	0	0

5.6 Summary

To summarize, this chapter describes the stated preference survey that was conducted by the researcher. The survey begins by designing the stated choice experiment; this consists of the determination of alternatives, attribute and level selection and construction of the experimental design. Six alternative attributes were employed to examine the preferences of the exporters and forwarders. Two port attributes are port cost and frequency of ship calls, whereas four attributes of the inland mode used in this research were cost, time, reliability, and GHG emissions. The experimental design was generated by the Efficient Design method to minimize standard error in parameter estimation. The efficiency of the design was measured by the minimum D-error and A-error. The design was produced using the NGENE software.

A pilot survey was conducted to ensure that the survey instrument was easy to complete by the respondent. To confirm the attributes of the alternatives, the pilot survey data have been used to estimate a simple MNL model. The estimation results show that the attributes used in the survey significantly influenced the decision-makers in choosing port and inland modes. Before conducting the main survey, the survey instrument was improved according to the pilot survey's results and the feedback from the respondents.

The response rates for both the pilot and main surveys were very low, only about 4%. A non-response bias test was carried out to test the differentiation between the early respondents and late respondents. The surveys' results show that 164 respondents from the pilot and main survey, with 1,287 observations of SP data, were valid to be used in the next process. Characteristics of respondents, characteristics of products, and characteristics of export are summarized in this chapter. The summary of current choice of inland mode and port – as an RP data – also shown in this chapter. Most of the respondents selected road mode as their preferred alternative, and Tanjung Priok Port are used by the respondents most. Data collected from the SP survey were then utilized in the model estimations that are presented in Chapter 6.

Chapter 6
Model Estimation

6.0 Introduction

This chapter discusses the process of estimation and the empirical results obtained from the model specification. Firstly, this chapter presents the estimation process performed by this study in Section 6.1. This section then is followed by a presentation of the estimation results from four logit models using the SP data only. The estimation result Multinomial Logit (MNL) is presented in Section 6.2, Nested Logit (NL) in Section 6.3, Mixed Multinomial Logit (MXMNL) and Mixed Nested Logit (MXNL) in Section 6.4. In Section 6.2.2, the author also conducted the estimation of parameters by segmenting the respondent characteristics. Part 6.5 shows the results of estimation using the combined SP and RP data, but limited to only Multinomial Logit (MNL) and Mixed Multinomial Logit (MXMNL). Section 6.6 compares the empirical results of estimation, both of SP and joint SP/RP data. The discussion on the attractiveness of alternatives, the determinant factors of port and mode choice and segmentation then are discussed in Section 6.7. A summary of the chapter is provided in Section 6.8.

6.1 Estimation Process

The estimation was conducted with the help of the Bierlaire's Optimization Toolbox for General Extreme Value Model Estimation (BIOGEME) software (Bierlaire, 2003). The main BIOGEME results include: (1) maximum likelihood estimation results for the sign and empirical magnitude of the utility function coefficients for the attributes; (2) the likelihood ratio test indicates the better model from the deviation of the final log likelihood value from that under the null hypothesis of zero coefficients (Louviere *et al.*, 2000); (3) *t*-statistics of attribute coefficients; for instance, within the 5% significance level the value of the *t*-test should be greater than 1.96 or less than -1.96; (4) adjusted ρ^2, where according to Louviere *et al.* (2000), the values between 0.2 and 0.4 are considered to be a good model fit; (5) coefficient ratio, which shows the comparison between the coefficients in relation to the impact on the utility.

During the estimation process, the BIOGEME software suggested scaling the data so that the values of the parameters are around 1.0. Thus the unit of the data used in the estimation process is as follows:

1. Scaled port cost = port cost / 1000
2. Scaled frequency of ship calls = frequency of ship calls / 100
3. Scaled inland mode cost = inland mode cost / 1000
4. Scaled inland mode time = inland mode time / 10
5. Scaled inland mode reliability = inland mode reliability / 100
6. Scaled inland mode GHG emissions = inland mode GHG emissions / 100

A sample of the BIOGEME syntax and results are presented in Appendix C.

6.2 Multinomial Logit (Model A) using SP Data only

The model estimation using the Multinomial Logit (MNL) model aims at examining the data under the assumption that there is no correlation between alternatives. Moreover, the estimation of an MNL model was also carried out by completing some segmentation to evaluate the preferences of the respondents according to the characteristics of the shipments. The utility of an alternative is described by Equation (5.1), whilst the probability of respondents to select an alternative was calculated by Equation (4.11)

All of the eight alternatives mentioned in Section 5.1.1 were considered in the MNL model. The model specification for the MNL model is illustrated in below:

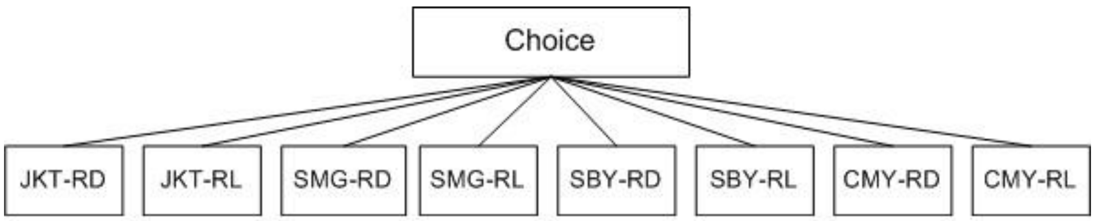


Figure 6.1 MNL model specification

6.2.1 Simple MNL (Model A0)

In this section, the effect of Alternative-Specific Constants (ASCs) in the MNL model is evaluated. The estimation began with a simple MNL model, A0.1 (without ASCs) and A0.2 (including ASCs to the model).

Adding the ASCs to the simple MNL model produced a significantly enhanced model, which can be seen from Likelihood ratio test, rho-square and adjusted rho-square. The rho-square improved substantially from 0.152 to 0.234; similarly the likelihood ratio test jumped from 540.83 to 834.18, as well as for the seven ASCs coefficients, thus demonstrating a significant increase.

Furthermore, it can be certainly seen from **Table 6.1** that, there is a significant difference between the results in Model A0.1 and Model A0.2. In the former model, the port cost parameter (β_{PC}) has a positive sign, but is not statistically significant. In Model A0.2, on the other hand, all of the six parameters are statistically significant at the 5% level and have the expected signs. The GHG emissions (β_{IMG}) factor shows a significant adjustment from -0.212 in Model A0.1 to -0.817 in Model A0.2. In contrast, the inland mode time parameter value decreased from -1.72 to -0.863.

Table 6.1 Comparison of the results using the simple MNL models, between model A0.1 and model A0.2.

Parameters	Model A0.1		Model A0.2	
	Value	Robust t-test	Value	Robust t-test
ASC_1 JKT-RD			0 (fixed)	n/a
ASC_2 JKT-RL			-1.08	-9.16**
ASC_3 SMG-RD			0.658	2.55**
ASC_4 SMG-RL			-0.999	-3.64**
ASC_5 SBY-RD			0.248	0.9
ASC_6 SBY-RL			-0.78	-2.98**
ASC_7 CMY-RD			-0.557	-5.12**
ASC_8 CMY-RL			-1.26	-9.32**
β_{IMC} – Mode cost	-0.385	-11.49**	-0.257	-7.31**
β_{IMG} – GHG emissions	-0.212	-2.42**	-0.817	-7.17**
β_{IMR} – Reliability	1.84	6.8**	1.93	6.69**
β_{IMT} – Mode time	-1.72	-12.08**	-0.863	-5.83**
β_{PC} – Port cost	0.0382	0.53	-0.406	-4.19**
β_{PSC} – Port ship calls	0.667	4.38**	0.683	3.18**
Statistics				
Number of estimated parameters	6		13	
Number of observations	1287		1287	
Null log-likelihood ($\mathcal{LL}(0)$)	-1784.16		-1784.16	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1513.74		-1367.07	
Likelihood ratio test	540.83		834.18	
Rho-square (ρ^2)	0.152		0.234	
Adjusted rho-square ($\bar{\rho}^2$)	0.148		0.226	

Note: * Significant at the 10% level, ** Significant at the 5% level

6.2.2 Segmenting Estimation Based on the Model A0.2

Model A0.2 then was used to be the base model for the other estimation. In an effort to examine the difference of the preferences of the respondents, this research carried out a segmenting estimation, where the segmentation was performed based on six type of segments: the volume of exports per month, frequency of shipment, export destination, company type, number of container per shipment and value of products.

In an effort to compare the estimation result between two different segments, this research calculates *t*-value as follows (Ben-Akiva and Lerman, 1985):

$$\frac{\beta_i^1 - \beta_i^2}{\sqrt{var(\beta_i^1) + var(\beta_i^2)}} \tag{6.1}$$

where

β_i^1 = Parameter value *i* for segment 1

β_i^2 = Parameter value *i* for segment 2

The calculation of *t* value then is compared to the critical value of t-test, usually at ± 1.96 (95% confidence interval) or ±1.65 (90% confidence interval). We have to accept the null hypothesis ($\beta_i^1 = \beta_i^2$) if the *t* value falls between the critical value intervals.

6.2.2.1 Segmentation by Volume of Exports per Month (Model A1)

Table 6.2 provides the estimation results based on the segmentation of the export volume per month. The segmentation by the volume of exports uses a distinction in two groups; those are (1) LARGE-VOLUME of exports (more than 10 TEUs per month) and (2) SMALL-VOLUME of exports (up to 10 TEUs per month).

As we can see in **Table 5.20**, more than 55% respondents exported products with the volume ranging 1-10 TEUs per month. The models fit the data well with ($\bar{\rho}^2$) = 0.258 and 0.224 for Model A1.1 and Model A1.2, respectively. All of the β parameters for both groups have the expected signs and are statistically significant at the 5% level, with the exception the port cost of the smaller volume. The results in **Table 6.2** show that larger companies are significantly more sensitive on GHG emissions and port cost than companies with a smaller volume of exports. The two segments also have different preferences on the unobserved attributes (represented by ASCs) for alternative SMG-RL (significant at the 10% level) and CMY-RL (significant at the 5% level).

Table 6.2 Comparison of estimation results between companies with the LARGE-VOLUME (model A1.1) and SMALL-VOLUME of exports per month (model A1.2).

Parameters	Model A1.1		Model A1.2		Segment t-test
	Value	Robust t-test	Value	Robust t-test	
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a	
ASC_2 JKT-RL	-1.08	-6.2**	-1.16	-6.73**	0.33
ASC_3 SMG-RD	0.394	0.81	0.853	2.65**	-0.79
ASC_4 SMG-RL	-1.75	-3.34**	-0.7	-2.04**	-1.67*
ASC_5 SBY-RD	0.375	0.74	0.00753	0.02	0.60
ASC_6 SBY-RL	-0.885	-1.9*	-0.766	-2.28**	-0.21
ASC_7 CMY-RD	-0.664	-3.82**	-0.487	-3.31**	-0.78
ASC_8 CMY-RL	-1.64	-7.59**	-0.949	-5.31**	-2.46**
β_{IMC} – Mode cost	-0.344	-6.13**	-0.229	-4.81**	-1.56
β_{IMG} – GHG emissions	-1.03	-5.73**	-0.642	-4.22**	-1.65*
β_{IMR} – Reliability	2.26	4.93**	1.98	5.07**	0.46
β_{IMT} – Mode time	-1.01	-4**	-0.863	-4.49**	-0.46
β_{PC} – Port cost	-0.776	-4.85**	-0.216	-1.69*	-2.73**
β_{PSC} – Port ship calls	0.733	2.1**	0.734	2.59**	0.00
Statistics					
Number of parameters	13		13		
Number of observations	544		703		
Null log-likelihood ($\mathcal{LL}(0)$)	-754.14		-974.56		
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-546.21		-743.39		
Likelihood ratio test	415.87		462.33		
Rho-square (ρ^2)	0.276		0.237		
Adjusted rho-square ($\bar{\rho}^2$)	0.258		0.224		

Note: * Significant at the 10% level, ** Significant at the 5% level

6.2.2.2 Segmentation by Frequency of Shipments per Month (Model A2)

The frequency of shipments per month is one of the characteristic where respondents' behaviour, in terms of port and inland mode choice might differ. The segmentation of the frequency of exports uses two segments namely (1) MORE-FREQUENT shipments (six or more shipments per month) and (2) LESS-FREQUENT shipments (one to five shipments per month).

Table 6.3 presents the estimation results for the both segments. We can see from **Table 6.3** that respondents with a higher frequency of shipments are more sensitive to port cost (β_{PC}) than the respondents with a lower frequency of shipments. The segment t-test results show that the two groups are not statistically different on five attributes: inland mode cost, inland mode GHG emissions, inland mode time, inland mode reliability and port ship calls. On the other hand, respondents with more frequent shipments per month give more attention on port cost than respondents with less frequent shipments.

Table 6.3 Comparison of estimation results between the respondents from the company with MORE-FREQUENT (Model A2.1) and LESS-FREQUENT shipments (Model A2.2)

Parameters	Model A2.1		Model A2.2		Segment t-test
	Value	Robust t-test	Value	Robust t-test	
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a	
ASC_2 JKT-RL	-1.2	-6.52**	-1.06	-6.55**	-0.57
ASC_3 SMG-RD	1.1	1.9*	0.561	1.86*	0.83
ASC_4 SMG-RL	-1.29	-2.2**	-0.852	-2.62**	-0.65
ASC_5 SBY-RD	0.723	1.23	-0.0712	-0.22	1.18
ASC_6 SBY-RL	-0.698	-1.28	-0.786	-2.49**	0.14
ASC_7 CMY-RD	-0.445	-2.41**	-0.671	-4.69**	0.97
ASC_8 CMY-RL	-1.15	-5.67**	-1.44	-7.4**	1.03
β_{IMC} – Mode cost	-0.254	-4.17**	-0.259	-5.66**	0.07
β_{IMG} – GHG emissions	-1.05	-4.73**	-0.7	-4.92**	-1.33
β_{IMR} – Reliability	2.33	4.96**	1.86	4.78**	0.77
β_{IMT} – Mode time	-0.603	-2.19**	-1.03	-5.66**	1.29
β_{PC} – Port cost	-0.707	-4.12**	-0.273	-2.22**	-2.05**
β_{PSC} – Port ship calls	0.357	0.94	0.897	3.4**	-1.17
Statistics					
Number of parameters	13		13		
Number of observations	525		730		
Null log-likelihood ($\mathcal{LL}(0)$)	-727.81		-1011.99		
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-522.27		-781.04		
Likelihood ratio test	411.07		461.9		
Rho-square (ρ^2)	0.282		0.228		
Adjusted rho-square ($\bar{\rho}^2$)	0.265		0.215		

Note: * Significant at the 10% level, ** Significant at the 5% level

6.2.2.3 Segmentation by Export Destination (Model A3)

The segmented estimation results by the destination of exports are given in **Table 6.4**. The segmentation of the export destination uses two segments namely (1) CLOSE-DESTINATION segment (including Southeast Asia, East Asia, South Asia, Middle East, and Australia — Model A3.1) and (2) FAR-DESTINATION segment (including Europe, North America, South America and Africa — Model A3.2).

The results in **Table 6.4** depict that the frequency of ship call is not a critical factor for companies with export destinations to Europe, America and Africa. Moreover, the companies exporting the products to Asia and Oceania direct more attention to inland mode cost than the companies that exporting to Europe, America and Africa. This finding is plausible as the percentage of inland mode cost to the total transport cost for the closer destination of export is higher than for the farther destination of export. The inland mode cost and pre-shipment cost contribute up to 40% of total containerized logistics cost from Indonesia (Carana, 2004).

Table 6.4 Comparison of estimation results between the respondents from the company with CLOSE-DESTINATION (Model A3.1) and FAR-DESTINATION of export (Model A3.2)

Parameters	Model A3.1		Model A3.2		Segment t-test
	Value	Robust t-test	Value	Robust t-test	
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a	
ASC_2 JKT-RL	-0.957	-6.52**	-1.31	-6.65**	1.44
ASC_3 SMG-RD	0.202	0.48	0.842	2.51**	-1.18
ASC_4 SMG-RL	-1.34	-2.96**	-0.896	-2.55**	-0.77
ASC_5 SBY-RD	-0.271	-0.57	0.545	1.54	-1.38
ASC_6 SBY-RL	-1.14	-2.57**	-0.656	-1.97**	-0.87
ASC_7 CMY-RD	-0.535	-3.81**	-0.578	-3.24**	0.19
ASC_8 CMY-RL	-1.45	-7.58**	-1.07	-5.29**	-1.37
β_{IMC} – Mode cost	-0.323	-6.33**	-0.196	-3.92**	-1.77*
β_{IMG} – GHG emissions	-0.887	-5.25**	-0.785	-4.95**	-0.44
β_{IMR} – Reliability	1.9	4.78**	1.95	4.57**	-0.09
β_{IMT} – Mode time	-0.928	-4.24**	-0.785	-3.77**	-0.47
β_{PC} – Port cost	-0.448	-3.4**	-0.352	-2.4**	-0.49
β_{PSC} – Port ship calls	0.885	2.75**	0.411	1.3	1.05
Statistics					
Number of parameters	13		13		
Number of observations	668		619		
Null log-likelihood ($\mathcal{LL}(0)$)	-926.04		-858.11		
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-733.85		-623.59		
Likelihood ratio test	384.38		469.05		
Rho-square (ρ^2)	0.208		0.273		
Adjusted rho-square ($\bar{\rho}^2$)	0.194		0.258		

Note: * Significant at the 10% level, ** significant at the 5% level.

6.2.2.4 Segmentation by Company Type (Model A4)

As mentioned in Section 5.3.1 and Section 5.5.1, the respondents of the survey came from two different company types: exporter and forwarder companies. **Table 6.5** shows the estimation results of the segmented type of companies. This segmentation is intended to assess whether exporters have different preferences on the port and inland mode choice than forwarders.

From the data in **Table 6.5**, it can be seen that GHG emissions and port costs are not important factors for forwarders in port and inland mode selection. The table also reveals that exporters are different to forwarders in some criteria: GHG emissions, inland mode reliability, port cost and port ship calls. The forwarders consider the reliability of transport mode and frequency of ship calls as more important attributes when compared to exporters' consideration. In contrast, GHG emissions and port cost are significantly important for exporters, but not significantly important for freight forwarders. The segment t-test results also reveal that there are no significant differences between exporters and forwarders in inland mode cost and inland mode time.

Table 6.5 Comparison of estimation results between EXPORTER (Model A4.1) and FORWARDER companies (Model A4.2)

Parameters	Model A4.1		Model A4.2		Segment t-test
	Value	Robust t-test	Value	Robust t-test	
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a	
ASC_2 JKT-RL	-1.13	-8.89**	-0.792	-2.35**	-1.88*
ASC_3 SMG-RD	0.64	2.31**	0.71	0.81	-0.18
ASC_4 SMG-RL	-1.1	-3.7**	-0.251	-0.28	-2.02**
ASC_5 SBY-RD	0.0429	0.14	2.23	2.31**	-5.07**
ASC_6 SBY-RL	-0.936	-3.26**	0.29	0.36	-3.02**
ASC_7 CMY-RD	-0.606	-5.19**	-0.251	-0.8	-2.15**
ASC_8 CMY-RL	-1.4	-9.44**	-0.392	-1.13	-4.82**
β_{IMC} – Mode cost	-0.266	-6.99**	-0.195	-1.97**	-1.32
β_{IMG} – GHG emissions	-0.887	-6.93**	-0.209	-0.7	-3.75**
β_{IMR} – Reliability	1.73	5.53**	3.6	4.38**	-4.21**
β_{IMT} – Mode time	-0.831	-5.21**	-1.02	-2.25**	0.84
β_{PC} – Port cost	-0.444	-4.24**	-0.199	-0.69	-1.67*
β_{PSC} – Port ship calls	0.581	2.47**	1.47	2.4**	-2.67**
Statistics					
Number of parameters	13		13		
Number of observations	1135		152		
Null log-likelihood ($\mathcal{LL}(0)$)	-1573.44		-210.72		
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1185.41		-168.39		
Likelihood ratio test	776.07		84.65		
Rho-square (ρ^2)	0.247		0.201		
Adjusted rho-square ($\bar{\rho}^2$)	0.238		0.139		

Note: * Significant at the 10% level, ** significant at the 5% level.

6.2.2.5 Segmentation by Number of Containers per Shipment (Model A5)

This research also distinguishes model estimation by the volume of containers per shipment. The segmentation of the number of containers per shipment has two segments: (1) BIG-SIZE of shipment (equal or more than three TEUs per shipment); and (2) SMALL-SIZE of shipment (one or two TEUs per shipment). The estimation results of Model A5.1 and Model A5.2 are shown in **Table 6.6**. All of the alternative's attributes are statistically significant at the 5% level (except port cost for respondents with smaller size shipments that is significant at the 10% level), which show the anticipated signs, as reported in **Table 5.9**.

The results in the table below indicate that the companies with bigger shipment size pay more attention to cost attributes (both inland mode cost and port cost) than the companies with smaller shipment size. The results also reveal that both big shipment and small shipment size companies do not have significantly different preferences on GHG emissions of inland mode, inland mode reliability, inland mode time and frequency of container ship calls.

Table 6.6 Comparison of estimation results between the respondents from the company with BIG-SIZE (Model A5.1) and SMALL-SIZE shipments (Model A5.2)

Parameters	Model A5.1		Model A5.2		Segment t-test
	Value	Robust t-test	Value	Robust t-test	
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a	
ASC_2 JKT-RL	-0.973	-5.29**	-1.18	-7.38**	0.85
ASC_3 SMG-RD	1.15	1.71*	0.626	2.21**	0.72
ASC_4 SMG-RL	-1.02	-1.47	-0.977	-3.19**	-0.06
ASC_5 SBY-RD	0.97	1.44	0.0188	0.06	1.28
ASC_6 SBY-RL	-0.181	-0.28	-0.951	-3.17**	1.09
ASC_7 CMY-RD	-0.588	-3.33**	-0.583	-4.11**	-0.02
ASC_8 CMY-RL	-1.44	-6.54**	-1.2	-6.71**	-0.85
β_{IMC} – Mode cost	-0.355	-6.06**	-0.216	-4.85**	-1.89*
β_{IMG} – GHG emissions	-1.04	-5.54**	-0.686	-4.72**	-1.49
β_{IMR} – Reliability	2.13	4.51**	1.93	5.12**	0.33
β_{IMT} – Mode time	-0.922	-3.55**	-0.879	-4.58**	-0.13
β_{PC} – Port cost	-0.808	-5.04**	-0.212	-1.7*	-2.94**
β_{PSC} – Port ship calls	0.869	2.28**	0.598	2.2**	0.58
Statistics					
Number of parameters	13		13		
Number of observations	467		796		
Null log-likelihood ($\mathcal{LL}(0)$)	-647.39		-1103.49		
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-491.39		-825.36		
Likelihood ratio test	312.01		556.24		
Rho-square (ρ^2)	0.241		0.252		
Adjusted rho-square ($\bar{\rho}^2$)	0.221		0.24		

Note: * Significant at the 10% level, ** significant at the 5% level.

6.2.2.6 Segmentation by Value of Products (Model A6)

The segmented estimation results by the value of products are provided in **Table 6.7**. The segmentation by the value of products uses two groups: (1) HIGH-VALUE products (more than 200 million IDR, approximately 10,000 GBP per TEU—Model A6.1); and (2) LOW-VALUE products (equal or less than 200 million IDR — Model A6.2).

The results in the table below show that respondents with HIGH-VALUE products do not consider the frequency of ship calls as an important parameter in port choice. Surprisingly, the estimation results also reveal inland mode reliability, port cost and frequency of ship calls as not important factors for companies with LOW-VALUE products. The value of t-test of the segmentation shows that the preference of two groups is only statistically different on the port cost attribute.

An interesting result was found where respondents with low-value products give less attention to port cost than respondents with high value products. However, calculation of the Value of Transport Time (VOTT[29]) and Value of Transport Reliability (VOTR[30]) indicates that companies with HIGH-VALUE products have higher VOTT and VOTR than companies with LOW-VALUE products. Companies with HIGH-VALUE products have VOTT £18.7 per transport per TEU-hour and VOTR £3.3 for 1% change in the reliability percentage. Furthermore, the LOW-VALUE products companies have VOTT of £14.7 per transport per TEU-hour and VOTR £2.2 for 1% change in the reliability percentage.

The values of VOTT and VOTR above are consistent with findings by de Jong *et al.*, (2004) which revealed that VOTT and VOTR of low-value raw material and semi-finished goods are lower than VOTT and VOTR of high-value raw material and semi-finished goods in Netherlands. The VOTT of low-value group is 38 Euro per transport versus 49 Euro per transport per hour for the high-value group using road mode. Another study of VOT in freight transport by Kurri *et al.*, (2007) also presented similar results, where the low-value (dairy products) products has lower VOT than the high-value products (electronic industries) for both of the road and the rail mode in Finland. New VOTT calculation was presented by (De Jong *et al.*, 2014) and revealed that the VOTT for container transport using the road mode is 59 euro/hour per vehicle with price level 2010.

[29] Value of Transport Time (VOTT) of inland mode is calculated by dividing the value of transport time parameter (β_{IMT}) by the value of inland mode cost parameter (β_{IMC})

[30] Value of Transport Reliability (VOTR) of inland mode is calculated by dividing the value of transport reliability parameter (β_{IMR}) by the value of inland mode cost parameter (β_{IMC})

Table 6.7 Comparison of estimation results by the value of products – HIGH-VALUE Model A6.1 and LOW-VALUE Model A6.2 – using the MNL model A.

Parameters	Model A6.1		Model A6.2		Segment t-test
	Value	Robust t-test	Value	Robust t-test	
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a	
ASC_2 JKT-RL	-1.3	-6.98**	-1.22	-6.19**	-0.30
ASC_3 SMG-RD	0.497	0.78	0.685	2.09**	-0.26
ASC_4 SMG-RL	-1.93	-2.98**	-1.07	-2.99**	-1.17
ASC_5 SBY-RD	-0.315	-0.51	0.0491	0.13	-0.51
ASC_6 SBY-RL	-1.39	-2.38**	-0.837	-2.43**	-0.81
ASC_7 CMY-RD	-0.51	-3.18**	-0.74	-4.04**	0.94
ASC_8 CMY-RL	-1.18	-6.02**	-1.54	-6.54**	1.17
β_{IMC} – Mode cost	-0.24	-4.39**	-0.161	-2.96**	-1.02
β_{IMG} – GHG emissions	-0.858	-4.54**	-0.758	-4.2**	-0.38
β_{IMR} – Reliability	1.59	3.35**	0.719	1.52	1.30
β_{IMT} – Mode time	-0.898	-3.43**	-0.474	-1.94*	-1.18
β_{PC} – Port cost	-0.712	-4.41**	-0.159	-0.93	-2.35**
β_{PSC} – Port ship calls	0.276	0.7	0.162	0.48	0.22
Statistics					
Number of parameters		13		13	
Number of observations		484		521	
Null log-likelihood ($\mathcal{LL}(0)$)		-670.96		-722.26	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)		-530.06		-531.83	
Likelihood ratio test		281.79		380.85	
Rho-square (ρ^2)		0.21		0.264	
Adjusted rho-square ($\bar{\rho}^2$)		0.191		0.246	

Note: * Significant at the 10% level, ** significant at the 5% level.

6.2.3 Distinguishing the Selected Respondent's Characteristics in the MNL Model (Model A7)

This research also performed an estimation of parameters by distinguishing selected characteristics of the respondent to the single MNL model (see **Table 6.8**). All of the parameters estimated are statistically significant at the 5% level, including the ASCs for all alternatives.

From these results, we can explore that respondents with BIG-SIZE shipments are more affected by the inland mode cost than respondents with smaller size shipments. This finding is in line with the segmentation results in Model A5.1 and Model A5.2 above. Furthermore, the companies with a LARGE-VOLUME of export per month have a slightly different influence on GHG emissions than smaller companies. Another finding suggests that forwarding companies are much more affected by the inland mode reliability and port ship calls than exporters. Time is the attribute of the mode that distinguishes the preference of companies based on the value of products. Respondents with MORE-FREQUENT shipments per month are much more sensitive to port cost than LESS-FREQUENT shipments companies.

Table 6.8 Distinguishing the selected respondent characteristics using MNL (Model A7)

Parameters	Model A7		
	Value	**Robust Std err**	**Robust t-test**
ASC_1 JKT-RD	0 (fixed)	n/a	n/a
ASC_2 JKT-RL	-1.03	0.116	-8.92**
ASC_3 SMG-RD	0.942	0.252	3.74**
ASC_4 SMG-RL	-0.746	0.27	-2.76**
ASC_5 SBY-RD	0.525	0.262	2**
ASC_6 SBY-RL	-0.496	0.25	-1.98**
ASC_7 CMY-RD	-0.611	0.11	-5.56**
ASC_8 CMY-RL	-1.24	0.134	-9.27**
β_{IMC1} – Mode cost for BIG-SIZE shipments	-0.347	0.0548	-6.33**
β_{IMC2} – Mode cost for SMALL-SIZE shipments	-0.222	0.0419	-5.3**
β_{IMG1} – Mode GHG emissions for LARGE-VOLUME of exports	-0.929	0.157	-5.94**
β_{IMG2} – Mode GHG emissions for SMALL-VOLUME of exports	-0.703	0.158	-4.46**
β_{IMR1} – Mode reliability for EXPORTER	1.64	0.304	5.4**
β_{IMR2} – Mode reliability for FORWARDER	3.53	0.778	4.54**
β_{IMT1} – Mode time for HIGH-VALUE products	-1.07	0.241	-4.43**
β_{IMT2} – Mode time for LOW-VALUE products	-0.771	0.206	-3.74**
β_{PC1} – Port cost for MORE-FREQUENT shipments	-0.651	0.152	-4.29**
β_{PC2} – Port cost for LESS-FREQUENT shipments	-0.284	0.124	-2.29**
β_{PSC1} – Port ship calls for EXPORTER	0.534	0.227	2.35**
β_{PSC2} – Port ship calls for FORWARDER	1.08	0.445	2.44**
Statistics			
Number of estimated parameter		19	
Observations		1287	
Null log-likelihood ($\mathcal{LL}(0)$)		-1784.16	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)		-1371.58	
Likelihood ratio test		825.17	
Rho-square (ρ^2)		0.231	
Adjusted rho-square ($\bar{\rho}^2$)		0.221	

Note: * Significant at the 10% level, ** significant at the 5% level.

6.3 Nested Logit (Model B)

As stated in Section 4.4.4, the NL model was employed to estimate the models with shared unobserved attributes amongst alternatives in the same nest, such as in the nest of the inland mode or nest of the port. The estimation in this research uses two nested structures; in the first structure, it is assumed that the inland modes are correlated in the port nest; in the second structure, it is assumed that the ports are correlated in the inland mode nest.

The lambda coefficient can be a representation of the correlation[31] or similarity between alternatives in the same nest. If the lambda = 1, it means there is no correlation between the alternatives in the same nest, and the model will become an MNL model. The issue of 'path-overlap' is closely related to the route choice problem in transportation. Some modification of logit model have been introduced to overcome the route choice problem, such as C-logit (Cascetta *et al.*, 1996), Path-size logit (Ben-Akiva and Bierlaire, 1999; Hoogendoorn-Lanser *et al.*, 2005) and Path Size Correction Logit (Bovy *et al.*, 2008).

6.3.1 Nested Logit of Port Nest (Model B1)

Figure 6.2 below describes the nested structure of the Model B1. The structure comprises four branches, labelled JKT Port, SMG Port, SBY Port, and CMY Port. Each branch contains two elemental alternatives on inland mode choices, namely the road and rail modes. Model B1.1 was estimated based on Model A0.2, whereas Model B1.2 was estimated based on model A7. The estimation results of Model B1.1 and Model B1.2 are shown in **Table 6.9**.

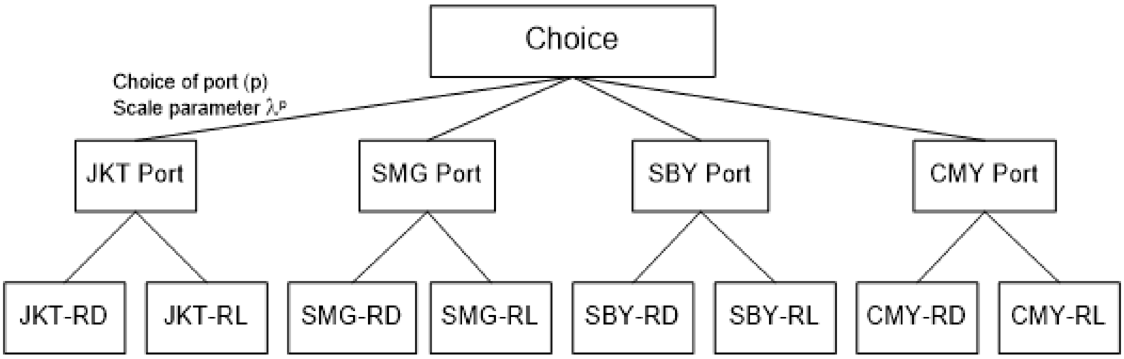


Figure 6.2 Nested structure for NL model B1

In both models B1.1 and B1.2, all the beta parameters are statistically significant at the 5% level and show the expected signs. The results also point out that the model is stable and fits the data, despite being estimated using different logit models. In Model B1.1, the scale parameters (λ) of JKT port nest, CMY port nest and SBY port nest are set to fixed value = 1, that indicates there is no correlation between inland modes in three ports above. The scale parameter of SMG port nest (λ = 0.561, and the correlation is 0.685) shows a

[31] Correlation amongst the alternatives in the same nest is measured by the value of $1 - (\lambda/\mu)^2$

correlation between the road mode and the rail mode at the SMG Port. There are different findings in Model B1.2: the results depict that only for the SBY Port there is no correlation between the inland modes; conversely, the other ports indicate a presence of correlation between unobserved attributes of the alternatives, with the scale parameters (λ) for JKT port nest, SMG port nest and CMY port nest of 0.831, 0.507 and 0.586 respectively.

Table 6.9 Estimation results using the NL of Port Nest (model B1.1 and model B1.2)

Parameters	Model B1.1		Model B1.2	
	Value	**Robust t-test**	**Value**	**Robust t-test**
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-1.07	-9.04**	-1.21	-5.29**
ASC_3 SMG-RD	0.72	2.65**	0.826	2.77**
ASC_4 SMG-RL	-1.84	-4.54**	-1.99	-4.63**
ASC_5 SBY-RD	0.088	0.31	0.074	0.24
ASC_6 SBY-RL	-0.79	-2.95**	-0.762	-2.55**
ASC_7 CMY-RD	-0.56	-5.17**	-0.865	-3.2**
ASC_8 CMY-RL	-1.25	-9.26**	-1.88	-3.54**
β_{IMC} – Mode cost	-0.257	-7.06**		
β_{IMG} – GHG emissions	-0.793	-6.68**		
β_{IMR} – Reliability	1.99	6.59**		
β_{IMT} – Mode time	-0.807	-5.24**		
β_{PC} – Port cost	-0.47	-4.6**		
β_{PSC} – Port ship calls	0.724	3.34**		
β_{IMC1} – Mode cost for BIG-SIZE shipments			-0.415	-6.07**
β_{IMC2} – Mode cost for SMALL-SIZE shipments			-0.237	-4.66**
β_{IMG1} – Mode GHG emissions for LARGE-VOLUME of exports			-1.1	-5.02**
β_{IMG2} – Mode GHG emissions for SMALL-VOLUME of exports			-0.755	-3.94**
β_{IMR1} – Mode reliability for EXPORTER			1.89	5.23**
β_{IMR2} – Mode reliability for FORWARDER			3.86	3.92**
β_{IMT1} – Mode time for HIGH-VALUE products			-1.16	-4.06**
β_{IMT2} – Mode time for LOW-VALUE products			-0.718	-2.96**
β_{PC1} – Port cost for MORE-FREQUENT shipments			-0.872	-4.84**
β_{PC2} – Port cost for LESS-FREQUENT shipments			-0.414	-2.81**
β_{PSC1} – Port ship calls for EXPORTER			0.663	2.3**
β_{PSC2} – Port ship calls for FORWARDER			1.17	2.35**
Scale parameters of nest (λ)				
λ of CMY_PORT nest	1 (fixed)	n/a	0.586	3.27**
λ of JKT_PORT nest	1 (fixed)	n/a	0.831	4.77**
λ of SBY_PORT nest	1 (fixed)	n/a	1 (fixed)	n/a
λ of SMG_PORT nest	0.561	7.19**	0.507	7.33**
Statistics				
Number of estimated parameters	14		22	
Observations	1287		1287	
Null log-likelihood ($\mathcal{LL}(0)$)	-1784.16		-1784.16	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1360.9		-1359.38	
Likelihood ratio test	846.52		849.57	

Rho-square (ρ^2)	0.237	0.238
Adjusted rho-square ($\bar{\rho}^2$)	0.229	0.226

Note: * Significant at the 10% level, ** significant at the 5% level.

6.3.2 Nested Logit of Inland Mode Nest (Model B2)

The second nested logit structure is defined under the assumption that the alternatives can be partitioned into the same inland mode nest. **Figure 6.3** below describes the nested structure of the Model B2. The nesting structure comprises two branches, namely labelled Road Mode and Rail Mode, where each contains four elemental alternatives of ports. Model B2.1 was estimated based on Model A0.2, whereas Model B2.2 is based on Model A7. The estimation results of Model B2.1 and Model B2.2 are shown in **Table 6.10**.

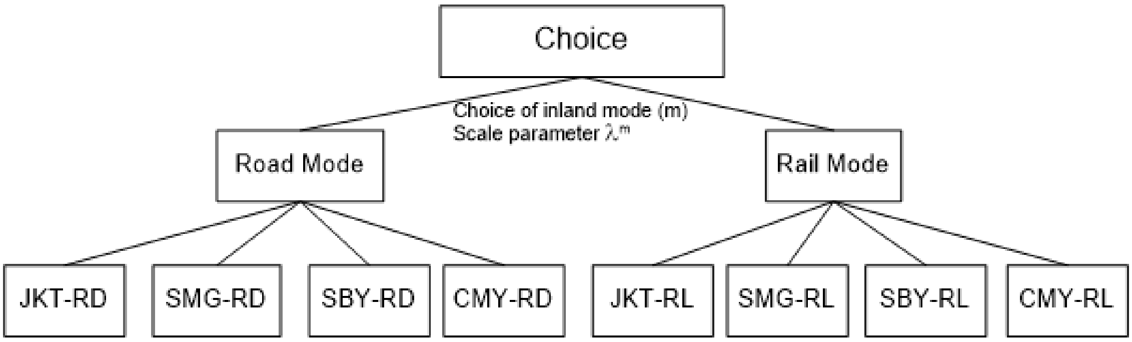


Figure 6.3 Nested structure for NL model B2

As can be seen from **Table 6.10**, the estimation results of Model B2.1 and Model B2.2 are quite similar to the results of Model B1.1 and B1.2 in the previous section. All of the beta parameters estimated are statistically significant at the 5% level and show the anticipated signs. The statistics indicate that the Model B2.1 has a higher rho-squared than Model B2.2. The scale parameters (λ) of RAIL_MODE nest are 0.801 and 0.893, respectively for Model B2.1 and Model B2.2, whereas the scale parameters of ROAD_MODE nest are 0.909 for Model B2.1 and set to fixed value 1 for Model B2.2. Comparatively, the correlation amongst the ports in the same inland mode nest is not as strong as the correlation amongst the inland mode in the same port nest.

Table 6.10 Estimation results using NL model 2 (Model B2.1 and Model B2.2)

Parameters	Model B2.1		Model B2.2	
	Value	**Robust t-test**	**Value**	**Robust t-test**
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-1.21	-5.98**	-1.11	-6.12**

ASC_3 SMG-RD	0.83	2.37**	1.01	3.4**
ASC_4 SMG-RL	-1.08	-3.16**	-0.802	-2.62**
ASC_5 SBY-RD	0.387	1.12	0.588	1.98**
ASC_6 SBY-RL	-0.771	-2.51**	-0.499	-1.86*
ASC_7 CMY-RD	-0.614	-3.75**	-0.615	-5.53**
ASC_8 CMY-RL	-1.43	-5.56**	-1.34	-6**
β_{IMC} – Mode cost	-0.287	-6.62**		
β_{IMG} – GHG emissions	-0.892	-6.07**		
β_{IMR} – Reliability	2.18	5.43**		
β_{IMT} – Mode time	-0.944	-5.32**		
β_{PC} – Port cost	-0.45	-3.97**		
β_{PSC} – Port ship calls	0.728	3.12**		
β_{IMC1} – Mode cost for BIG-SIZE shipments			-0.362	-5.72**
β_{IMC2} – Mode cost for SMALL-SIZE shipments			-0.232	-5.12**
β_{IMG1} – Mode GHG emissions for LARGE-VOLUME of exports			-0.954	-5.84**
β_{IMG2} – Mode GHG emissions for SMALL-VOLUME of exports			-0.72	-4.4**
β_{IMR1} – Mode reliability for EXPORTER			1.73	5.02**
β_{IMR2} – Mode reliability for FORWARDER			3.65	4.44**
β_{IMT1} – Mode time for HIGH-VALUE products			-1.09	-4.39**
β_{IMT2} – Mode time for LOW-VALUE products			-0.786	-3.75**
β_{PC1} – Port cost for MORE-FREQUENT shipments			-0.667	-4.23**
β_{PC2} – Port cost for LESS-FREQUENT shipments			-0.298	-2.27**
β_{PSC1} – Port ship calls for EXPORTER			0.539	2.29**
β_{PSC2} – Port ship calls for FORWARDER			1.14	2.4**
Scale parameters of nest (λ)				
λ of RAIL_MODE nest	0.801	5.47**	0.893	5.32**
λ of ROAD_MODE nest	0.909	5.81**	1 (fixed)	n/a
Statistics				
Number of estimated parameters	15		20	
Observations	1287		1287	
Null log-likelihood ($\mathcal{LL}(0)$)	-1784.16		-1784.16	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1366.33		-1371.34	
Likelihood ratio test	835.66		825.64	
Rho-square (ρ^2)	0.234		0.231	
Adjusted rho-square ($\bar{\rho}^2$)	0.226		0.22	

Note: * Significant at the 10% level, ** significant at the 5% level.

6.4 Mixed Logit (Model C)

The Mixed Logit (MXL) model was utilized in the parameter estimation to investigate the presence of heterogeneity across respondents. The MXL model applies to any probabilities that can be expressed as an integral of standard logit probabilities over a distribution of the parameters (Ortuzar and Willumsen, 2011; Train, 2009). During the parameter estimation process, various models have been tested mainly using normal and lognormal distribution probability function[32]. The estimation of Mixed Logit models was carried out using 1000 draws. The estimation using the SP data only estimated the parameters using two MXL models: Mixed Multinomial Logit (MXMNL) and Mixed Nested Logit (MXNL) model.

6.4.1 Mixed Multinomial Logit (Model C1)

Model C1.1 examines the σ_{IMC} under the normal distribution probability function, whilst Model C1.2 examines under the log normal distribution probability function. As can be seen from **Table 6.11**, the standard deviations for both normal and lognormal distribution of the inland mode cost indicate a considerable degree of heterogeneity across the respondents. However, after many attempts, the model is unable to identify the existence of heterogeneity in other attributes. As expected, the statistics of MXMNL models are improved compared with the non-random specification (MNL) model. The adjusted rho-square of MXMNL Model C1.1 just slightly higher than the MNL Model A0.2 (0.228 > 0.226).

Table 6.11 Estimation results using the MXMNL model (Model C1.1 and Model C1.2)

Parameters	Model C1.1		Model C1.2	
	Value	Robust t-test	Value	Robust t-test
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-1.12	-9.11**	-1.11	-9.02**
ASC_3 SMG-RD	0.773	2.76**	0.755	2.73**
ASC_4 SMG-RL	-0.883	-3.02**	-0.906	-3.13**
ASC_5 SBY-RD	0.378	1.26	0.357	1.20
ASC_6 SBY-RL	-0.677	-2.41**	-0.699	-2.52**
ASC_7 CMY-RD	-0.574	-5.04**	-0.576	-5.05**
ASC_8 CMY-RL	-1.3	-9.22**	-1.3	-9.15**
β_{IMC} – Mode cost	-0.303	-7.23**	-0.297	-6.94**
σ_{IMC} – Standard deviation of mode cost	0.311	3.97**	0.52	3.13**
β_{IMG} – GHG emissions	-0.848	-7.31**	-0.837	-7.22**
β_{IMR} – Reliability	2.01	6.79**	1.98	6.71**
β_{IMT} – Mode time	-0.955	-6.04**	-0.935	-5.96**
β_{PC} – Port cost	-0.417	-4.13**	-0.412	-4.08**
β_{PSC} – Port ship calls	0.685	3.07**	0.666	2.96**
Statistics				
Number of estimated parameters	14		14	
Number of observations	1287		1287	

[32] This study also tests the mixed logit models using the other probability distribution function such as uniform and triangular probability distribution function.

Null log-likelihood ($\mathcal{LL}(0)$)	-1784.16	-1784.16
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1363.57	-1364.51
Likelihood ratio test	841.17	839.29
Rho-square (ρ^2)	0.236	0.235
Adjusted rho-square ($\bar{\rho}^2$)	0.228	0.227

Note: * Significant at the 10% level, ** significant at the 5% level.

After many attempts at estimation, the results in **Table 6.12** show the presence heterogeneity of mode cost for respondents with small size shipments. Model C1.13 examines the standard deviation (σ_{IMC}) of the mode cost for small size shipments under the normal distribution probability function, and Model C1.4 examines under the log normal distribution probability function. The result of Model C1.3 shows that the result in Model C1.3 has smaller standard deviation than in Model C1.4. In practice, we can ignore the sign of the standard deviation, and if the estimated σ result is negative, we can treat it as positive value (Hole, 2007). From the table below we can also find that all of the attributes have the expected signs and statistically significant at the 5% level.

Table 6.12 Estimation results using the MXMNL model (Model C1.3 and Model C1.4)

Parameters	**Model C1.3**		**Model C1.4**	
	Value	**Robust t-test**	**Value**	**Robust t-test**
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-1.02	-8.51**	-1.02	-8.51**
ASC_3 SMG-RD	0.853	2.93**	0.81	2.87**
ASC_4 SMG-RL	-0.779	-2.59**	-0.835	-2.85**
ASC_5 SBY-RD	0.486	1.59	0.426	1.44
ASC_6 SBY-RL	-0.546	-1.88*	-0.603	-2.14**
ASC_7 CMY-RD	-0.626	-5.53**	-0.624	-5.52**
ASC_8 CMY-RL	-1.25	-9.16**	-1.24	-9.11**
β_{IMC1} – Mode cost for BIG-SIZE shipments	-0.34	-6.23**	-0.34	-6.25**
β_{IMC2} – Mode cost for SMALL-SIZE shipments	-0.273	-5.35**	-1.83	-4.33**
σ_{IMC2} – Standard deviation of mode cost for SMALL-SIZE shipments	-0.291	-3.33**	1.07	1.9*
β_{IMG1} – Mode GHG emissions for LARGE-VOLUME exports	-0.894	-5.76**	-0.891	-5.76**
β_{IMG2} – Mode GHG emissions for SMALL-VOLUME exports	-0.701	-4.28**	-0.679	-4.21**
β_{IMR1} – Mode reliability for EXPORTER	1.69	5.32**	1.64	5.22**
β_{IMR2} – Mode reliability for FORWARDER	3.63	4.32**	3.62	4.34**
β_{IMT1} – Mode time for HS-Code group 1	-0.961	-4.35**	-0.918	-4.26**
β_{IMT2} – Mode time for HS-Code group 2	-1.03	-5.63**	-1	-5.54**
β_{PC1} – Port cost for MORE-FREQUENT shipments	-0.655	-4.05**	-0.645	-4**
β_{PC2} – Port cost for LESS-FREQUENT shipments	-0.274	-2.08**	-0.267	-2.03**
β_{PSC1} – Port ship calls for EXPORTER	0.487	2.06**	0.476	2.03**

β_{PSC2} – Port ship calls for FORWARDER	1.32	2.72**	1.27	2.66**
Statistics				
Number of estimated parameters	20		20	
Number of observations	1287		1287	
Null log-likelihood ($\mathcal{LL}(0)$)	-1784.16		-1784.16	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1364.1		-1365.06	
Likelihood ratio test	840.13		838.19	
Rho-square (ρ^2)	0.235		0.235	
Adjusted rho-square ($\bar{\rho}^2$)	0.224		0.224	

Note: * Significant at the 10% level, ** significant at the 5% level. HS-Code group 1 comprises code number 44 (Wood and articles of wood) and 94 (Furniture; bedding; lamps and lighting fittings). The rest of HS-Codes are in group 2.

6.4.2 Mixed Nested Logit (Model C2)

The MXNL model was employed to examine the presence of heterogeneity across the respondents and also to estimate the models with shared unobserved attributes amongst alternatives in the same nest. **Table 6.13** and **Table 6.14** present the estimation results using nested structure 1 (based on Model B1.1), where the model tastes the heterogeneity of the mode cost over the respondents using normal distribution function (Model C2.1) and log normal distribution function (Model C2.2). The results of Model C2.1 and Model C2.2 are similar, except the standard deviation of mode cost in Model C2.2 (0.514), which is much bigger than in the Model C2.1 (0.306).

Table 6.13 Estimation results using the MXNL model (Model C2.1 and Model C2.2)

Parameters	Model C2.1		Model C2.2	
	Value	**Robust t-test**	**Value**	**Robust t-test**
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-1.11	-8.88**	-1.11	-8.95**
ASC_3 SMG-RD	0.842	2.84**	0.822	2.80**
ASC_4 SMG-RL	-1.71	-4.09**	-1.74	-4.18**
ASC_5 SBY-RD	0.221	0.71	0.199	0.65
ASC_6 SBY-RL	-0.687	-2.34**	-0.709	-2.44**
ASC_7 CMY-RD	-0.581	-5.10**	-0.585	-5.13**
ASC_8 CMY-RL	-1.3	-9.15**	-1.3	-9.15**
β_{IMC} – Mode cost	-0.303	-6.89**	-0.297	-6.81**
σ_{IMC} – Standard deviation of mode cost	0.306	3.41**	0.514	3.12**
β_{IMG} – GHG emissions	-0.825	-6.82**	-0.814	-6.73**
β_{IMR} – Reliability	2.08	6.69**	2.05	6.66**
β_{IMT} – Mode time	-0.894	-5.42**	-0.881	-5.40**
β_{PC} – Port cost	-0.483	-4.56**	-0.478	-4.51**
β_{PSC} – Port ship calls	0.725	3.24**	0.709	3.14**
Scale parameters of nest (λ)				
λ of CMY_PORT nest	1 (fixed)	n/a	1 (fixed)	n/a
λ of JKT_PORT nest	1 (fixed)	n/a	1 (fixed)	n/a

λ of SBY_PORT nest	1 (fixed)	n/a	1 (fixed)	n/a
λ of SMG_PORT nest	0.559	6.78**	0.558	6.80**
Statistics				
Number of estimated parameters	15		15	
Number of observations	1287		1287	
Null log-likelihood ($\mathcal{LL}(0)$)	-1784.16		-1784.16	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1358.22		-1358.27	
Likelihood ratio test	851.87		851.78	
Rho-square (ρ^2)	0.239		0.239	
Adjusted rho-square ($\bar{\rho}^2$)	0.23		0.23	

Note: * Significant at the 10% level, ** significant at the 5% level.

Similar results to Model C2.1 and Model C2.2 also found in the estimation of the attributes using MXNL model with distinction on some attributes in Model C2.3 and Model C2.4. **Table 6.14** below presents the results of estimation using Model C2.3 (under normal distribution assumption) and Model C2.3 (under log normal distribution assumption). Comparing the estimation results using Model C2.3 and Model C2.4 show that all of the coefficients of the parameters are similar (both the sign and the value). However, the coefficient and standard deviation of inland mode cost for the small size shipments in Model C2.4 is much higher than in Model C2.3.

Table 6.14 Estimation results using the MXNL model (Model C2.3 and Model C2.4)

Parameters	**Model C2.3**		**Model C2.4**	
	Value	**Robust t-test**	**Value**	**Robust t-test**
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-1.3	-5.21**	-1.27	-5.25**
ASC_3 SMG-RD	0.694	2.03**	0.839	2.58**
ASC_4 SMG-RL	-1.99	-4.46**	-1.98	-4.53**
ASC_5 SBY-RD	0.009	0.03	0.0772	0.22
ASC_6 SBY-RL	-0.846	-2.43**	-0.77	-2.32**
ASC_7 CMY-RD	-0.786	-3.33**	-0.872	-3.37**
ASC_8 CMY-RL	-1.74	-4.05**	-1.91	-3.9**
β_{IMC1} – Mode cost for BIG-SIZE shipments	-0.41	-5.86**	-0.421	-5.96**
β_{IMC2} – Mode cost for SMALL-SIZE shipments	-0.312	-4.91**	-1.77	-4.2**
σ_{IMC2} – Standard deviation of mode cost for SMALL-SIZE shipments	-0.329	-3.53**	1.12	2.14**
β_{IMG1} – Mode GHG emissions for LARGE-VOLUME exports	-1.08	-5.34**	-1.14	-5.51**
β_{IMG2} – Mode GHG emissions for SMALL-VOLUME exports	-0.757	-3.91**	-0.778	-4.13**
β_{IMR1} – Mode reliability for EXPORTER	1.99	5.18**	1.94	5.18**
β_{IMR2} – Mode reliability for FORWARDER	4.17	4.01**	3.98	3.87**
β_{IMT1} – Mode time for HS-Code group 1	-1.08	-4.08**	-1.21	-4.37**
β_{IMT2} – Mode time for HS-Code group 2	-1.06	-4.93**	-0.787	-3.32**
β_{PC1} – Port cost for MORE-FREQUENT shipments	-0.879	-4.55**	-0.892	-4.62**

β_{PC2} – Port cost for LESS-FREQUENT shipments	-0.411	-2.62**	-0.415	-2.66**
β_{PSC1} – Port ship calls for EXPORTER	0.684	2.34**	0.688	2.38**
β_{PSC2} – Port ship calls for FORWARDER	1.54	2.82**	1.22	2.38**
Scale parameters of nest (λ)				
λ of CMY_PORT nest	0.622	3.9**	0.572	3.65**
λ of JKT_PORT nest	0.751	5.05**	0.79	4.97**
λ of SBY_PORT nest	1 (fixed)	n/a	1 (fixed)	n/a
λ of SMG_PORT nest	0.519	7.19**	0.506	7.34**
Statistics				
Number of estimated parameters	23		23	
Observations	1287		1287	
Null log-likelihood ($\mathcal{LL}(0)$)	-1784.16		-1784.16	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1352.99		-1358.01	
Likelihood ratio test	862.33		852.29	
Rho-square (ρ^2)	0.242		0.239	
Adjusted Rho-square ($\bar{\rho}^2$)	0.229		0.226	

Note: * Significant at the 10% level, ** significant at the 5% level. HS-Code group 1 comprises code number 44 (Wood and articles of wood) and 94 (Furniture; bedding; lamps and lighting fittings). The rest of HS-Codes are in group 2.

6.5 Model Estimation using Combined SP and RP Data (Model D)

The aim of the use of the joint SP and RP data for estimation is an attempt at making the model closer to the real observed situation. Models on SP data only are not really suited for forecasting since there is a possibility of the respondents to select an alternative that is different to their stated choices.

The joint SP and RP data set comprises 1451 observations (1287 of SP data and 164 of RP data), with the estimation conducted by adding a scale parameter (λ) of data source to the model. Since the RP data refer to the actual observations, the scale parameter of RP data (λ^{RP}) is set to one, and the scale parameter of the SP data (λ^{SP}) will be estimated relative to the λ^{RP}. The data set of joint SP and RP consists of 13 alternatives, eight SP alternatives and five RP alternatives. The estimation was performed based on the data pooling technique (as shown in Section 4.4.7).

The estimation using the combined SP and RP data was carried out using MNL, NL, MXMNL and MXNL model; however, after many attempts, the estimation using NL and MXNL models never reached convergence. Thus, the results reported in this section come from only the estimation using the MNL and MXMNL model.

6.5.1 Multinomial Logit – MNL (Model D1)

Table 6.15 presents the estimation results of MNL using a combined SP and RP data. As we can see from the table below, all the attributes of the alternative show the signs as expected and are statistically significant at the 5% level (except for the coefficient of the port cost of less frequent shipments, which is significant at the 10% level). The coefficients of inland mode cost (β_{IMC}), inland mode time (β_{IMT}), inland mode emission (β_{IMG}) and port cost (β_{PC}) have the negative signs, whereas inland mode reliability (β_{IMR}) and frequency of ship calls at port (β_{PSC}) have positive signs. The estimation results point out the model is stable, even despite the fact we combined the SP and RP data sources. In Model D1.2, the distinction of the respondents is different to the attributes of GHG emission, inland mode reliability, port cost and frequency of ship calls. These results are relatively the same with the results of the MNL model using only the SP data.

Table 6.15 Estimation results using the MNL model (Model D1.1 and Model D1.2)

Parameters	Model D1.1		Model D1.2	
	Value	Robust t-test	Value	Robust t-test
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-1.82	-4.8**	-1.64	-4.69**
ASC_3 SMG-RD	0.122	0.42	0.143	0.51
ASC_4 SMG-RL	-2.28	-3.86**	-2.06	-3.75**
ASC_5 SBY-RD	-0.482	-1.34	-0.371	-1.12
ASC_6 SBY-RL	-1.98	-3.74**	-1.75	-3.62**
ASC_7 CMY-RD	-0.88	-3.86**	-0.92	-4.02**
ASC_8 CMY-RL	-1.97	-4.72**	-1.8	-4.64**
β_{IMC} – Mode cost	-0.411	-5.48**	-0.392	-5.33**
β_{IMG} – GHG emissions	-1.34	-4.44**		
β_{IMR} – Reliability	2.93	4.55**		
β_{IMT} – Mode time	-1.35	-4.94**	-1.44	-5.01**
β_{PC} – Port cost	-0.562	-3.39**		
β_{PSC} – Port ship calls	1.02	3.03**		
β_{IMG1} – Mode GHG emissions for LARGE-VOLUME exports			-1.33	-3.98**
β_{IMG2} – Mode GHG emissions for SMALL-VOLUME exports			-1.05	-3.48**
β_{IMR1} – Mode reliability for EXPORTER			2.32	4.02**
β_{IMR2} – Mode reliability for FORWARDER			5.29	3.66**
β_{PC1} – Port cost for MORE-FREQUENT shipments			-0.881	-3.4**
β_{PC2} – Port cost for LESS-FREQUENT shipments			-0.329	-1.85*
β_{PSC1} – Port ship calls for EXPORTER			0.736	2.36**
β_{PSC2} – Port ship calls for FORWARDER			1.66	2.72**
Scale parameters				
Scale for RP data (λ^{RP})	1 (fixed)	n/a	1 (fixed)	n/a
Scale for SP data (λ^{SP})	0.671	-2.69**	0.708	-2.95**
Statistics				
Number of estimated parameters	14		18	
Number of observations	1451		1451	

Null log-likelihood ($\mathcal{LL}(0)$)	-1989.43	-1989.43
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1419.11	-1422.44
Likelihood ratio test	1140.65	1133.99
Rho-square (ρ^2)	0.287	0.285
Adjusted rho-square ($\bar{\rho}^2$)	0.28	0.276

Note: * Significant at the 10% level, ** significant at the 5% level.

6.5.2 Mixed Multinomial Logit (Model D2)

The estimation results of Mixed Multinomial Logit (MXMNL) model using join SP and RP data are presented in **Table 6.16** and **Table 6.17**. In **Table 6.16**, Model D2.1 shows the estimation based on assumption that the inland mode cost are distributed normally, and distributed log-normally in Model D2.2. By comparing the two models, the coefficients of the parameters in Model D2.2 are smaller than in Model D2.1, except in the case of the standard deviation of mode cost in D2.2, which is higher than in Model D2.1.

Table 6.16 Estimation results using the MXMNL model (Model D2.1 and Model D2.2)

Parameters	Model D2.1		Model D2.2	
	Value	Robust t-test	Value	Robust t-test
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-3	-3.88**	-2.71	-3.89**
ASC_3 SMG-RD	0.171	0.39	0.163	0.41
ASC_4 SMG-RL	-3.79	-3.45**	-3.35	-3.38**
ASC_5 SBY-RD	-0.785	-1.46	-0.598	-1.21
ASC_6 SBY-RL	-3.33	-3.43**	-2.92	-3.36**
ASC_7 CMY-RD	-1.5	-3.28**	-1.35	-3.27**
ASC_8 CMY-RL	-3.38	-3.81**	-3.02	-3.78**
β_{IMC} – Mode cost	-0.856	-3.94**	-0.744	-3.74**
σ_{IMC} – Standard deviation of mode cost	0.741	3.25**	1.16	2.69**
β_{IMG} – GHG emissions	-2.27	-3.64**	-2.02	-3.69**
β_{IMR} – Reliability	5.25	3.67**	4.58	3.69**
β_{IMT} – Mode time	-2.76	-3.88**	-2.33	-3.92**
β_{PC} – Port cost	-0.982	-2.96**	-0.858	-2.97**
β_{PSC} – Port ship calls	1.76	2.73**	1.5	2.74**
Scale Parameters for data source				
Scale for RP data (λ^{RP})	1 (fixed)	n/a	1 (fixed)	n/a
Scale for SP data (λ^{SP})	0.394	-6.43**	0.444	-5.24**
Statistics				
Number of estimated parameters	15		15	
Number of observations	1451		1451	
Null log-likelihood ($\mathcal{LL}(0)$)	-1989.43		-1989.43	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1409.64		-1413.16	
Likelihood ratio test	1159.59		1152.54	
Rho-square (ρ^2)	0.291		0.29	
Adjusted rho-square ($\bar{\rho}^2$)	0.284		0.282	

Note: * Significant at the 10% level, ** significant at the 5% level.

Table 6.17 below reports the estimation results of the estimation using MXMNL based on Model A7, by distinguishing the characteristics of respondent except for the coefficient of inland mode time. In both Model D2.3 (normal distribution) and Model D2.4 (log normal distribution), all of the coefficients have the expected signs and are significant at the 5% level (except in the case of port cost for less frequent shipment, which is significant at the 10% level. Similar to the previous mixed logit result, the presence of heterogeneity is found only in the mode cost attribute. The standard deviations of mode cost are comparatively different between the two models, where the σ_{IMC} in Model D2.4 is 1.29 compared to 0.771 in Model D2.3

Table 6.17 Estimation results using the MXMNL model (Model D2.3 and Model D2.4)

Parameters	Model D2.3		Model D2.4	
	Value	Robust t-test	Value	Robust t-test
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-2.93	-3.75**	-2.63	-3.65**
ASC_3 SMG-RD	0.131	0.30	0.123	0.31
ASC_4 SMG-RL	-3.78	-3.29**	-3.29	-3.21**
ASC_5 SBY-RD	-0.74	-1.39	-0.53	-1.1
ASC_6 SBY-RL	-3.29	-3.31**	-2.84	-3.17**
ASC_7 CMY-RD	-1.71	-3.31**	-1.52	-3.29**
ASC_8 CMY-RL	-3.35	-3.66**	-2.97	-3.58**
β_{IMT} – Mode cost	-0.885	-3.73**	-0.783	-3.53**
σ_{IMC} – Standard deviation of mode cost	0.771	3.10**	1.29	2.67**
β_{IMG1} – Mode GHG emissions for LARGE-VOLUME export	-2.46	-3.32**	-2.17	-3.24**
β_{IMG2} – Mode GHG emissions for SMALL-VOLUME export	-1.94	-2.99**	-1.72	-2.94**
β_{IMR1} – Mode reliability for EXPORTER	4.48	3.29**	3.88	3.3**
β_{IMR2} – Mode reliability for FORWARDER	10	3.11**	8.72	3.12**
β_{IMT} – Mode time	-3.07	-3.77**	-2.61	-3.9**
β_{PC1} – Port cost for MORE-FREQUENT shipments	-1.66	-2.91**	-1.44	-2.93**
β_{PC2} – Port cost for LESS-FREQUENT shipments	-0.598	-1.72*	-0.509	-1.69*
β_{PSC1} – Port ship calls for EXPORTER	1.34	2.19**	1.13	2.15**
β_{PSC2} – Port ship calls for FORWARDER	3.04	2.62**	2.61	2.61**
Scale Parameters of data source				
Scale for RP data (λ^{RP})	1 (fixed)	n/a	1 (fixed)	n/a
Scale for SP data (λ^{SP})	0.385	-6.39**	0.441	-5.1**
Statistics				
Number of estimated parameters	19		19	
Number of observations	1451		1451	
Null log-likelihood ($\mathcal{LL}(0)$)	-1989.43		-1989.43	
Final log-likelihood ($\mathcal{LL}(\beta^*)$)	-1412.27		-1415.08	
Likelihood ratio test	1154.33		1148.71	

Rho-square (ρ^2)	0.29	0.289
Adjusted rho-square ($\bar{\rho}^2$)	0.281	0.279

Note: * Significant at the 10% level, ** significant at the 5% level.

6.6 Comparison of the Empirical Results

6.6.1 Empirical Results of Estimation Using SP Data Only

According to the value of final log-likelihood, likelihood ratio test, ρ^2, adjusted ρ^2, and the signs of the estimated parameters, the MXNL (Model C2.3) model was selected as the best model for the SP data. The Model C2.3 has the highest value of final likelihood (-1352.99), likelihood ratio test (862.335), ρ^2 (0.242) and adjusted ρ^2 (0.229). The comparison of the statistics of models is reported in **Table 6.18** below.

Table 6.18 Comparison of the statistics of the models for estimation results using only SP data

Model		K*	$\mathcal{LL}(\boldsymbol{\beta}^*)$	LRT	ρ^2	$\bar{\rho}^2$	Remarks
MNL	Model A0.1	6	-1513.74	540.83	0.152	0.148	
	Model A0.2	13	-1367.07	834.18	0.234	0.226	The best MNL
	Model A7	19	-1371.58	825.16	0.231	0.221	
NL	Model B1.1	14	-1360.9	846.52	0.237	0.229	
	Model B1.2	22	-1359.38	849.57	0.238	0.226	The best NL
	Model B2.1	15	-1366.33	835.66	0.234	0.226	
	Model B2.2	20	-1371.34	825.64	0.231	0.220	
MXMNL	Model C1.1	14	-1363.57	841.17	0.235	0.228	The best MXMNL
	Model C1.2	14	-1364.51	839.29	0.235	0.227	
	Model C1.3	20	-1364.1	840.13	0.235	0.224	
	Model C1.4	20	-1365.06	838.19	0.235	0.224	
MXNL	Model C2.1	15	-1358.22	851.87	0.239	0.230	
	Model C2.2	15	-1358.27	851.78	0.239	0.230	
	Model C2.3	23	-1352.99	862.33	0.242	0.229	**The best MXNL**
	Model C2.4	23	-1358.01	852.29	0.239	0.226	

Note: * K is the number of parameters estimated in the model.

All of the estimation results from the SP data only models show that all of the parameters have anticipated signs. The best model is Model C2.3, an MXNL model with the inland mode cost coefficient normally distributed. All coefficients of attributes are significant at the 5% level and show the expected signs. The cost of inland modes, inland mode time, GHG emissions and cost of ports have negative signs. Meanwhile, the number of ship calls at the port and the reliability of inland modes have positive signs. For the discussion that follows, we refer to the Model C2.3 as the MXNL-SP model.

6.6.2 Empirical Results of Estimation Using Combined SP and RP data

As mentioned before, the estimation using combined SP and RP data provides only the estimation results from MNL and MXMNL model, and the results statistics are compared in **Table 6.19** below. The results are similar to the SP data only estimation results where the MXMNL model fits the data better than the MNL model. It can be summarized from table below that MXMNL Model D2.1 is the best fitting model with the value of final likelihood (-1409.64), likelihood ratio test (1159.597), ρ^2 (0.29) and adjusted ρ^2 (0.284). However, the comparison of LRT of D2.1 and D2.3 exhibit that both models are not statistically different (5.262 falls between $\chi^2_{0.05}$ for degree of freedom =4 is -9.488). For the next section, we refer to Model D2.3 as the MXMNL-SPRP model.

Table 6.19 Comparison of the statistics of the models for the estimation results using combined SP and RP data

Model		K*	$\mathcal{LL}(\boldsymbol{\beta}^*)$	LRT	ρ^2	$\bar{\rho}^2$	Remarks
MNL	Model D1.1	14	-1419.11	1140.65	0.287	0.28	
	Model D1.2	18	-1422.44	1133.99	0.285	0.276	
MXMNL	Model D2.1	15	-1409.64	1159.59	0.291	0.284	The best MXMNL
	Model D2.2	15	-1413.16	1152.54	0.29	0.282	
	Model D2.3	19	-1412.27	1154.33	0.29	0.281	The best MXMNL
	Model D2.4	19	-1415.08	1148.71	0.289	0.279	

Note: *K is the number of parameters estimated in the model.

6.7 Discussions

6.7.1 Attractiveness of the Alternatives

The ASC of an alternative is a constant that represents the unobserved factors of alternative in the utility (Train, 2009). In this research, the ASC_1 JKT-RD is normalized to zero, whilst the other ASCs are interpreted as the impact of excluded factors on the utility of the alternatives relative to alternative JKT-RD. The comparison of the estimated ASCs for the model and MXMNL-SPRP model is presented in **Table 6.20**.

Table 6.20 Comparison of the ASCs of MXNL-SP model and MXMNL-SPRP model.

ASCs	MXNL – SP		MXMNL – SPRP	
	Value	**Robust t-test**	**Value**	**Robust t-test**
ASC_1 JKT-RD	0 (fixed)	n/a	0 (fixed)	n/a
ASC_2 JKT-RL	-1.3	-5.21**	-3	-3.88**
ASC_3 SMG-RD	0.694	2.03**	0.171	0.39
ASC_4 SMG-RL	-1.99	-4.46**	-3.79	-3.45**
ASC_5 SBY-RD	0.009	0.03	-0.785	-1.46
ASC_6 SBY-RL	-0.846	-2.43**	-3.33	-3.43**
ASC_7 CMY-RD	-0.786	-3.33**	-1.5	-3.28**
ASC_8 CMY-RL	-1.74	-4.05**	-3.38	-3.81**

Note: * Significant at the 10% level, ** significant at the 5% level.

From **Table 6.20** above, we can observe that the values of ASCs indicate the dominance of the JKT-RD alternative over the other alternatives (except SMG-RD). It means the JKT-RD and SMG-RD alternatives have considerable advantages in terms of the unobserved factors such as port infrastructure, port congestion, location, port efficiency and the frequency and flexibility of inland mode services.

The JKT-RL alternative is less attractive than the JKT-RD alternative, which might be because the JKT-RL alternative still needs additional road/truck haulage to carry the container from the origin to the nearest rail freight terminal, and from the intermodal station to the JKT Port terminal. This double handling process implies the JKT-RL will take a longer time and incur higher costs than JKT-RD alternative for the respondents that are located the near JKT Port. However, the JKT-RL alternative is more attractive when compared with the rail mode in other ports alternatives.

The least attractive alternative is the SMG-RL alternative, where the ASCs range from -3.79 to -1.99. On the contrary, the other alternative at SMG Port (SMG-RD) is the most favoured alternative, which is the only alternative that has a positive ASC. These findings could be explained from the location of SMG Port in Central Java area. This location means that distances from the origins to the port are not sufficient in making rail haulage attractive to users. Jiang *et al.* (1999) found that the distance of 700 kilometres was the maximum distance for shippers to select road mode. The longest distance to the SMG Port is from Pasuruan, which is 345km only (see **Table 5.5** for details). On the other hand, a shorter distance meant users preferred choosing the SMG-RD alternative rather than SMG-RL alternative.

The range of ASCs for the alternatives using the road mode is from -1.5 (CMY-RD) to 0.694 (SMG-RD), whereas for the rail mode the range is from -3.79 (SMG-RL) to -0.846

(SBY-RL). These ranges of ASCs for each inland mode signify that the road mode is more attractive to the respondents, compared with the rail mode, for all ports. These results reveal that strong policies will be needed in order to encourage the users (exporters and freight forwarders) to switch their choices to the rail mode.

Furthermore, the port infrastructure at Tanjung Priok Port also contributes to the attractiveness of the JKT-RD alternative.

6.7.2 Attributes of Port Choice and Inland Mode Choice

The comparison of the coefficients of the observed attributes from the MXNL-SP model and MXMNL-SPRP model is presented in **Table 6.21**.

Table 6.21 Comparison of the coefficients of attributes of MXNL-SP model and MXMNL model

Attributes	MXNL – SP		MXMNL – SPRP	
	Value	**Robust t-test**	**Value**	**Robust t-test**
β_{IMC1} – Mode cost for BIG-SIZE shipments	-0.41	-5.86**		
β_{IMC2} – Mode cost for SMALL-SIZE shipments	-0.312	-4.91**		
σ_{IMC2} – Standard deviation of mode cost for SMALL-SIZE shipments	-0.329	-3.53**		
β_{IMT} – Mode cost			-0.885	-3.73**
σ_{IMC} – Mode cost			0.771	3.10**
β_{IMG1} – Mode GHG emissions for LARGE-VOLUME exports	-1.08	-5.34**	-2.46	-3.32**
β_{IMG2} – Mode GHG emissions for SMALL-VOLUME exports	-0.757	-3.91**	-1.94	-2.99**
β_{IMR1} – Mode reliability for EXPORTER	1.99	5.18**	4.48	3.29**
β_{IMR2} – Mode reliability for FORWARDER	4.17	4.01**	10	3.11**
β_{IMT1} – Mode time for HS-Code group 1	-1.08	-4.08**		
β_{IMT2} – Mode time for HS-Code group 2	-1.06	-4.93**		
β_{IMT} – Mode time			-3.07	-3.77**
β_{PC1} – Port cost for MORE-FREQUENT shipments	-0.879	-4.55**	-1.66	-2.91**
β_{PC2} – Port cost for LESS-FREQUENT shipments	-0.411	-2.62**	-0.598	-1.72*
β_{PSC1} – Port ship calls for EXPORTER	0.684	2.34**	1.34	2.19**
β_{PSC2} – Port ship calls for FORWARDER	1.54	2.82**	3.04	2.62**

Note: * Significant at the 10% level, ** significant at the 5% level. HS-Code group 1 comprises code number 44 (Wood and articles of wood) and 94 (Furniture; bedding; lamps and lighting fittings). The rest of HS-Codes are in group 2.

As we can see from the results of Model C2.3 and D2.3 in **Table 6.21** above, all of the attribute coefficients have the anticipated signs, and the robust t-test values indicate that all of the coefficients are significant at the 5% level (only Port cost for LESS-

FREQUENT shipments that are significant at the 10% level). These results are consistent with findings by previous researchers, both for inland port mode choice and choice (see Section 3.2 and Section 3.3). Coefficients of parameters for inland mode cost, inland mode time, inland mode GHG emissions, and port cost display negative signs, meaning that increases in any of these factors will reduce utility. Conversely, positive coefficients for inland mode reliability and ship calls indicate that improvements in these factors will increase the utility of the alternative.

The attributes of inland mode examined in this research include inland mode cost, inland mode time, inland mode reliability, and inland mode GHG emissions. The inland mode cost for shipments of up to two TEUs per shipment is the only attribute, to show significant observed and unobserved heterogeneity of the individual decision makers. The results also suggest that inland mode cost is less important for decision makers with the SMALL-SIZE shipments (up to two TEUs per shipment).

Exporters and freight forwarders with bigger volumes of exports (more than 10 TEUs per month) are more sensitive to changes in GHG emissions than companies with smaller export volumes. This finding suggests that bigger companies have a greater awareness to GHG emission reductions.

Inland mode reliability is the only inland mode attribute with a positive sign. Exporters and freight forwarders have different preferences for port and inland mode selection for their export activities based on inland mode reliability. For freight forwarders, inland mode reliability is a very significant factor that influences their decisions. In contrast, the importance of inland mode reliability is much less from the exporters’ perspective. Freight forwarders may pay more attention to inland mode reliability owing to the fact they wish to minimize complaints from their clients and/or have to ensure their services are fully utilized.

For exporters and freight forwarders with MORE-FREQUENT shipments (more than five times per month), the port cost is found to be a more important consideration than for companies making LESS-FREQUENT shipments. Many researchers have revealed that port cost is one of the key factors for shippers when selecting their preferred port. The frequency of ship calls is a factor that has a positive sign, as expected. This factor is a more important consideration for freight forwarders than for exporters when choosing between alternative port/inland mode combinations.

6.7.3 Segmentation

Table 6.22 reports the attributes that significantly different between the segments. GHG emission (IMG) is the attribute with substantially different coefficients depending on the volume of export and the type of company. LARGE-VOLUME companies give more attention to GHG emissions than SMALL-VOLUME respondents. GHG emission, on the other hand, is a more important factor in choosing inland mode and port for exporters than for forwarders. This finding indicates that exporters and bigger companies have a greater awareness on the GHG emission issue than exporter and smaller firms.

Inland Mode Cost (IMC) is a more important factor for respondents with CLOSE-DESTINATION of export than respondents with export to FAR-DESTINATION. This evidence is consistent with the study of Notteboom (2004), where inland mode cost contributes 40%–80% of the total intercontinental container shipping costs. This means that closer destination of exports has a higher percentage of inland mode cost. Moreover, respondents with BIG-SIZE shipments are more sensitive to the inland mode cost than the SMALL-SIZE shipments companies.

Table 6.22 The attributes and segmentation

Segment 1	Attributes[33]						Segment 2
	IMG	IMC	IMR	IMT	PC	PSC	
LARGE-VOLUME	>				>		SMALL-VOLUME
MORE-FREQUENT					>		LESS-FREQUENT
CLOSE-DESTINATION		>					FAR-DESTINATION
EXPORTER	>		<		>	<	FORWARDER
BIG-SIZE		>			>		SMALL-SIZE
HIGH-VALUE					>		LOW-VALUE

Note: The sign '>' indicates that segment 1 is more affected by the attribute, and < sign indicates segment 2 is more affected.

Inland Mode Reliability (IMR) only differs by the type of respondent's company, where reliability is recognized as more important for FORWARDER than for EXPORTER. Inland mode time is the only attribute not significantly different to all segments.

[33] (1) IMG: Inland mode GHG emission; (2) IMC: Inland mode cost; (3) IMR: Inland mode reliability, (4) IMT: Inland mode time; (5) PC: Port cost and (6) PSC: Port ship calls.

Port Cost (PC) is the attribute that distinguishes most between different segments. Larger companies direct more attention than smaller companies, more frequent shipment companies pay more attention than less frequent shipment companies, exporters are more sensitive than forwarders, companies with big shipments are more sensitive than companies with small shipments, high-value products are more sensitive to port costs than low-value commodity. Port Ship Calls (PSC) is more important for forwarders than exporters.

6.8 Summary

To sum up, this chapter presents model estimation results using various selected models. The estimation was carried out using MNL, NL, MXMNL and MXNL models, and two data types, namely SP data only, and combined SP and RP data. The estimation for segmented respondents was also undertaken using the MNL model, and estimated on the SP data only. Various segments were exploited in the estimation such as export volume, frequency of shipment, export destination, company type, the number of containers per shipment, and value of products per TEU.

The best model obtained from the SP data only estimation is MXNL Model C2.3, whereas the best model of the joint SP and RP data estimation is MXMNL Model D2.1 or D2.3. For the next step, this research will employ the MXNL-SP (Model C2.3) model and MXMNL-SPRP (Model D2.3) model in order to simulate various policies related to the intermodal freight transport in Java; the simulation and its results are presented in Chapter 7.

From the two best models obtained, we can conclude that all of the attributes of the alternative significantly influence decision-makers in the port and inland mode selection. All of the attributes also have the correct signs, as expected. Coefficients of parameters for inland mode cost, inland mode time, inland mode GHG emissions and port cost display negative signs implying negative effects on the alternatives' utility concerned. Besides, coefficients for inland mode reliability and ship calls demonstrate positive effects on the utility of the alternatives.

Chapter 7
Policies Simulation and Discussion

7.0 Introduction

Chapter 7 begins with Section 7.1, which describes the policies applied in the simulation and further presents the calibration of Alternative-Specific Constants (ASCs) to the observed market shares. The simulation was carried out using two different sources of Emission Factors (EFs), which Section 7.2 presents the simulation results using McKinnon and Piecyk's EF, followed by Section 7.3, which compares the simulation results using DEFRA's EF. The port's market shares amongst the alternative ports are discussed in Section 7.4, which further examines users' shifting between road modes and rail modes. This section further analyses the GHG emission reductions from the freight transport in Java, and also analysis the total of logistics cost Chapter 7 is concluded with a summary of the chapter in Section 7.4.5.

7.1 Policies Simulation

The simulation is intended to evaluate the impacts of the policies on the market shares of each alternative, port market shares and inland mode shares variations. The simulation also examined the impact of the policies on the GHG emissions reduction from the containerized transport on Java.

The simulation is undertaken using the best models obtained from the Chapter 6; those are MXNL-SP Model C2.3 (see **Table 6.18**) and MXMNL-SPRP Model D2.3 (see **Table 6.19**). The RP data were used in the simulation, comprising 164 actual port and inland mode choices from 164 respondents. Owing to the unavailability of GHG emission data in the RP data, the GHG emissions of the RP data were calculated based on their choices using Equation (5.6) and (5.7).

The calculation was performed by employing Emission Factor (EF) from two different sources: (1) McKinnon and Piecyk (2011) and (2) DEFRA (2011). Two sources of emission factor were employed in the simulation were exploited to evaluate the impact of different emission factor to the market share, as the GHG emission is a part of the observed attribute of the alternative.

The characteristics of the simulations performed in this research can be found in **Table 7.1** below.

Table 7.1 Characteristics of the simulations K, L, M and N

Simulation	Model	Emission Factor's source
Simulation K	MXNL-SP (Model C2.3)	(McKinnon and Piecyk, 2011)
Simulation L	MXMNL-SPRP (Model D2.3)	(McKinnon and Piecyk, 2011)
Simulation M	MXNL-SP (Model C2.3)	(DEFRA, 2011)
Simulation N	MXMNL-SPRP (Model D2.3)	(DEFRA, 2011)

Simulations K and M are the simulations based on MXNL-SP Model C2.3 using McKinnon and Piecyk's emission factor and DEFRA's emission factor, respectively. Simulations L and N, on the other hand are performed based on MXMNL-SPRP Model D2.3 using the McKinnon and Piecyk's EF and DEFRA's EF consecutively.

The McKinnon and Piecyk's EF for the average truck is 62 grams CO_2e/tonne-km, and for the average rail is 22 grams CO_2e/tonne-km. Meanwhile, the DEFRA's EF for the articulated truck 60% laden is 89.5 grams CO_2e/tonne-km and for the average diesel train is 31.6 grams CO_2e/tonne-km (see **Table 3.11**). The average weight of containerized export is 11.6 tonnes per TEU. For the alternatives using the rail mode, this research assumes that the distance from the site to the nearest rail station for loading-unloading the container is 10 km on average.

The results of the simulation are presented in Section 7.2 and Section 7.3.

7.1.1 Policies Employed in the Simulation

During the simulation nine policies were tested, which are separated into two groups: single policy group (five policies) and combined policy group (four policies).

7.1.1.1 Single Policy

- *Route and Operational Hours Restriction (Policy 1)*

  Limitation of routes and operational hours for the containerized trucks was initiated in Jakarta in 2011 (see Section 2.4.7 for more details). The restriction also may be implemented in several cities that are hampered by truck congestion. The implementation of this policy, is made with the assumption that the mode cost of the alternative using truck/road will increase by 5%, and will raise the road mode time by 10%.

- *Fuel Subsidy Reduction (Policy 2)*

  According to (Ginanjar and Arief, 2007), the fuel cost of the container trucks constitutes on average 47% of the total transport cost for the shipment a container from Bandung to Jakarta. Thus, reducing fuel subsidies by the Indonesian government will increase fuel price by 50%, leading to an increase in truck/road cost of 25%. This policy has been started by the current government of Indonesia, it was expected the government will save approximately 200 trillion IDR equal to 10 billion GBP (Sari, 2014)

- *Development of the Double Track Rail Network (Policy 3)*

  The development of dual track rail network between Jakarta and Surabaya will make the trip faster, which is expected to reduce the rail mode transport time by 20%. This policy also was anticipated to raise the network capacity to enable transporting more than 1 million TEUs containers per year (Taufiq, 2012). The development has been accomplished in September 2014.

- *Developing New Tanjung Priok Port (Policy 4)*

  The expansion plan of Tanjung Priok Port (JKT Port) consists of two phases, wherein the first phase, the port's capacity will increase from 6 million TEUs/year to 9 million TEUs/year in 2016 and 10.5 million TEUs in 2017 (PELINDO II, 2014). It is assumed that this expansion will increase ship calls at Tanjung Priok port by 30% in 2016, from 82 international container vessels per week to approximately 107 vessels.

- *Providing Subsidy for Rail Freight Transport (Policy 5)*

  Provision of subsidy to rail freight transport to reduce the rail tariff by 20%. This policy is not planned by the current government of Indonesia (Rachmawati, 2014), but was proposed by the previous government (Herlina KD, 2011)

7.1.1.2 Combined Policy

A combined policy is the implementation of two or more single policies at the same time. Four combined policies are used in the simulation.

- *Reducing the Utility of the Road Mode (Policy 6)*

  Reducing the utility alternatives using road mode by combining Policy 1 and Policy 2

- *Increasing the Utility of the Rail Mode (Policy 7)*

  Increasing the utility of the alternatives using the rail mode by combining Policy 3 and Policy 5.

- *Reducing the Utility of the Road Mode and Increasing the Utility of the Rail Mode at the Same Time (Policy 8)*

  This policy is carried out by combining Policy 6 and Policy 7.

- *Reducing the Utility of Road Mode, Increasing the Utility of Rail Mode and Extension of the Tanjung Priok Port (Policy 9)*

  This policy is a combination of all single policies (Policy 1 – Policy

7.1.2 Calibrating the ASCs

ASCs represent the mean distribution of the unobserved effects in the random component. Owing to the fact that the initial result of simulation does not reflect actual market shares, the ASC for the model should be corrected to obtain a predicted share result is closer to the actual share. The calibration can be conducted iteratively until the predicted share is sufficiently close to the actual share using this formula (Louviere *et al.*, 2000; Train, 2009):

$$\mathrm{ASC}_\mathrm{i}^{*} = \mathrm{ASC}_\mathrm{i}^{0} + \ln \frac{\mathrm{RS}_\mathrm{i}}{\mathrm{PS}_\mathrm{i}} \qquad \textbf{(7.1)}$$

Where

ASC_i^{*} = Calibrated ASC for alternative *i*

ASC_i^{0} = Estimated ASC for alternative *i*

RS_i = Actual market share of alternative *i*

PS_i = Predicted market share of alternative *i* from the previous model

As the alternative 4, 7 and 8 do not exist, the alternatives' actual market shares were derived from the port capacity divided by all ports' capacity and from the inland mode market shares.

The comparison of the estimated and corrected ASCs is shown in **Table 7.2** below:

Table 7.2 Actual shares, estimated and corrected ASCs of simulations K, L, M and N

Alternative-Specific Constants	RS_i (%)	Simulation K		Simulation L		Simulation M		Simulation N	
		ASC_i^0	ASC_i^*	ASC_i^0	ASC_i^*	ASC_i^0	ASC_i^*	ASC_i^0	ASC_j^*
ASC_1 JKT-RD	54.33	0	0.00	0	0.00	0	0.00	0	0.00
ASC_2 JKT-RL	2.07	-1.3	-6.35	-2.93	-8.27	-1.3	-6.57	-2.93	-9.63
ASC_3 SMG-RD	3.99	0.69	-7.15	0.131	-18.12	0.69	-8.11	0.131	-20.47
ASC_4 SMG-RL	0.15	-1.99	-11.36	-3.78	-20.72	-1.99	-12.32	-3.78	-23.13
ASC_5 SBY-RD	24.90	0.01	-2.90	-0.74	-7.65	0.01	-3.31	-0.74	-8.75
ASC_6 SBY-RL	0.95	-0.84	-7.39	-3.29	-14.33	-0.84	-8.02	-3.29	-16.27
ASC_7 CMY-RD	13.11	-0.78	-1.67	-1.71	-2.61	-0.78	-1.72	-1.71	-2.82
ASC_8 CMY-RL	0.50	-1.74	-8.88	-3.35	-10.10	-1.74	-1.72	-3.35	-9.25

The corrected ASCs then were used in the simulation, rather than the ASCs obtained from the estimation stage. The step-by-step of the ASCs calibration is presented in Appendix E.

7.2 Simulation Results using McKinnon and Piecyk's Emission Factor (Simulations K and L)

The simulation of Policy 1 to Policy 9 using the EF from McKinnon and Piecyk's source are performed using MXNL-SP Model C2.3 (Simulation K) and using MXMNL-SPRP Model D2.3 (Simulation L).

7.2.1 Policy 1 Simulation Results (Simulations K1[34] and L1)

Table 7.3 compares the simulation results of simulations K1 and L1. The table presents the predicted market shares of all alternatives using the business as usual (BAU) scenario (PS_{iK0} and PS_{iL0}) compared with the predicted market share using Policy 1 (PS_{iK1} and PS_{iL1}). From **Table 7.3** below, we can observe that the restriction of the route and operational hours for container trucks has positive impacts on the increase of the rail

[34] K1 means simulation K for Policy 1, and L1 is simulation L for Policy 1

mode's market share; however, surprisingly, the ALT-3 (SMG-RD) is the only alternative using road mode that does not decrease by this policy in the two simulations. This finding might be explained by the fact that the location of Tanjung Emas Port (SMG Port) in the middle of Java allows the road mode users from the other ports to switch their choice to the SMG-RD alternative rather than switch to the rail mode.

Table 7.3 Policy 1 simulation results (simulations K1 and L1)

Alternatives (i)	Simulation K1			Simulation L1		
	PS_{iK0}	PS_{iK1}	Δ	PS_{iL0}	PS_{iL1}	Δ
ALT-1 JKT-RD	54.30%	53.04%	-1.27%	54.14%	51.82%	-2.32%
ALT-2 JKT-RL	2.07%	2.29%	0.22%	2.07%	3.68%	1.61%
ALT-3 SMG-RD	4.00%	4.71%	0.72%	4.01%	4.71%	0.70%
ALT-4 SMG-RL	0.15%	0.19%	0.04%	0.15%	0.28%	0.12%
ALT-5 SBY-RD	24.92%	25.14%	0.22%	25.11%	24.54%	-0.57%
ALT-6 SBY-RL	0.95%	1.13%	0.18%	0.96%	1.37%	0.42%
ALT-7 CMY-RD	13.10%	12.94%	-0.16%	13.06%	12.68%	-0.38%
ALT-8 CMY-RL	0.50%	0.55%	0.05%	0.50%	0.93%	0.43%

7.2.2 Policy 2 Simulation Results (Simulations K2 and L2)

Similar to the result of Policy 1, the simulation results of Policy 2 have the expected share changes except for the ALT-3. Comparing to the result of Policy 1 in **Table 7.3**, Policy 2 has a slightly greater impact on the market share changes. From **Table 7.3** and **Table 7.4**, it can be seen that the results show a consistent impact when the road mode's utility decreases.

Table 7.4 Policy 2 simulation results (simulations K2 and L2)

Alternatives (i)	Simulation K2			Simulation L2		
	PS_{iK0}	PS_{iK2}	Δ	PS_{iL0}	PS_{iL2}	Δ
ALT-1 JKT-RD	54.30%	52.95%	-1.36%	54.14%	52.31%	-1.84%
ALT-2 JKT-RL	2.07%	2.37%	0.30%	2.07%	3.31%	1.24%
ALT-3 SMG-RD	4.00%	5.08%	1.09%	4.01%	4.89%	0.88%
ALT-4 SMG-RL	0.15%	0.24%	0.09%	0.15%	0.55%	0.40%
ALT-5 SBY-RD	24.92%	24.77%	-0.16%	25.11%	23.50%	-1.61%
ALT-6 SBY-RL	0.95%	1.29%	0.34%	0.96%	1.92%	0.96%
ALT-7 CMY-RD	13.10%	12.72%	-0.38%	13.06%	12.53%	-0.53%
ALT-8 CMY-RL	0.50%	0.58%	0.08%	0.50%	0.99%	0.49%

7.2.3 Policy 3 Simulation Results (Simulations K3 and L3)

Table 7.5 provides a comparison of simulation results of Policy 3 (developing double-track railway network) compared to the BAU simulation results. This policy is expected to increase the utility of alternatives using rail mode, as transport time will decrease by approximately 20%. As seen in **Table 7.5**, all alternatives using the rail mode are expected to rise, and vice versa, the road mode is supposed to decrease. The simulation K3 results are likely to have smaller market share changes than the simulation L3 results. Alternative 2 (JKT-RL) has the most increase in market share, both in simulations K3 and L3 with a rise of 0.29% and 1.93% respectively compared to the BAU scenario.

Table 7.5 Policy 3 simulation results (simulations K3 and L3)

Alternatives (i)	Simulation K3			Simulation L3		
	PS_{iK0}	PS_{iK3}	Δ	PS_{iL0}	PS_{iL3}	Δ
ALT-1 JKT-RD	54.30%	54.16%	-0.14%	54.14%	53.28%	-0.86%
ALT-2 JKT-RL	2.07%	2.36%	0.29%	2.07%	4.00%	1.93%
ALT-3 SMG-RD	4.00%	3.94%	-0.06%	4.01%	3.81%	-0.20%
ALT-4 SMG-RL	0.15%	0.16%	0.01%	0.15%	0.18%	0.03%
ALT-5 SBY-RD	24.92%	24.73%	-0.20%	25.11%	24.18%	-0.93%
ALT-6 SBY-RL	0.95%	1.05%	0.10%	0.96%	1.17%	0.21%
ALT-7 CMY-RD	13.10%	13.04%	-0.06%	13.06%	12.45%	-0.61%
ALT-8 CMY-RL	0.50%	0.56%	0.06%	0.50%	0.93%	0.43%

7.2.4 Policy 4 Simulation Results (Simulations K4 and L4)

The results of simulation of Policy 4 using Model A and Model B are shown in **Table 7.6**. The table below illustrates the impact of the development of the Tanjung Priok Port (Policy 4) to overall market shares. If the port of Tanjung Priok has increased the capacity, it is estimated there will be an increase in market share for alternative either ALT-1 or ALT-2. The implementation of Policy 4 is anticipated as having an adverse impact on all other alternatives, especially to alternatives 7 and 8. This finding is plausible due to Cilamaya Port being located closest to the Port of Tanjung Priok in comparison with other ports.

Table 7.6 Policy 4 simulation results (simulations K4 and L4)

Alternatives (i)	Simulation K4			Simulation L4		
	PS_{iK0}	PS_{iK4}	Δ	PS_{iL0}	PS_{iL4}	Δ
ALT-1 JKT-RD	54.30%	56.36%	2.05%	54.14%	56.72%	2.57%
ALT-2 JKT-RL	2.07%	2.22%	0.15%	2.07%	2.48%	0.40%
ALT-3 SMG-RD	4.00%	3.83%	-0.16%	4.01%	3.89%	-0.11%
ALT-4 SMG-RL	0.15%	0.14%	-0.01%	0.15%	0.15%	0.00%
ALT-5 SBY-RD	24.92%	24.42%	-0.50%	25.11%	24.61%	-0.50%
ALT-6 SBY-RL	0.95%	0.93%	-0.02%	0.96%	0.93%	-0.02%
ALT-7 CMY-RD	13.10%	11.64%	-1.46%	13.06%	10.79%	-2.26%
ALT-8 CMY-RL	0.50%	0.45%	-0.05%	0.50%	0.43%	-0.07%

7.2.5 Policy 5 Simulation Results (Simulations K5 and L5)

The effect of giving incentive to the rail freight transport (Policy 5) compared to the BAU policy was simulated using simulations K and L, where the simulation results are presented in **Table 7.7**. The simulation results show that the incentive provision to reduce the cost of transport of containers by rail will encourage modal shift from the road mode to the rail mode. From the table below it can be seen that all alternatives using the rail mode will increase its market shares; on the contrary, all market shares of the alternatives using the road modes will decline.

Table 7.7 Policy 5 simulation results (simulations K5 and L5)

Alternatives (i)	Simulation K5			Simulation L5		
	PS_{iK0}	PS_{iK5}	Δ	PS_{iL0}	PS_{iL5}	Δ
ALT-1 JKT-RD	54.30%	54.13%	-0.17%	54.14%	53.82%	-0.32%
ALT-2 JKT-RL	2.07%	2.46%	0.39%	2.07%	3.76%	1.69%
ALT-3 SMG-RD	4.00%	3.85%	-0.15%	4.01%	3.37%	-0.64%
ALT-4 SMG-RL	0.15%	0.18%	0.03%	0.15%	0.29%	0.14%
ALT-5 SBY-RD	24.92%	24.58%	-0.35%	25.11%	23.53%	-1.58%
ALT-6 SBY-RL	0.95%	1.20%	0.25%	0.96%	1.64%	0.69%
ALT-7 CMY-RD	13.10%	13.01%	-0.09%	13.06%	12.50%	-0.56%
ALT-8 CMY-RL	0.50%	0.59%	0.09%	0.50%	1.08%	0.58%

7.2.6 Policy 6 Simulation Results (Simulations K6 and L6)

Table 7.8 below demonstrates the impact of the combined policies on diminishing the attractiveness of the road mode in intermodal freight transport compared to the BAU policy. The combined policy includes route and time restriction and also reduces the fuel subsidies for the road vehicle. Both simulations K6 and L6 present the surprising result as we found in previous simulations for Policy 1 and Policy 2. The alternative ALT-3 SMG-RD is expected to experience a decrease in market share, but instead increased significantly. In both simulations, the market share for alternative 3 rises by 1.76% and 1.05% for simulation K6 and L6 respectively. This finding is plausible when considering that road mode users from the other three ports are still considering the road mode more attractive than the rail mode. Thus, they prefer to continue using the road mode but switch to a closer port, rather than switching to the rail mode. This result is reinforced by the fact that SMG Port is located in the middle of Java Island.

Table 7.8 Policy 6 simulation results (simulations K6 and L6)

Alternatives (i)	Simulation K6			Simulation L6		
	PS_{iK0}	PS_{iK6}	Δ	PS_{iL0}	PS_{iL6}	Δ
ALT-1 JKT-RD	54.30%	51.80%	-2.50%	54.14%	50.28%	-3.86%
ALT-2 JKT-RL	2.07%	2.62%	0.55%	2.07%	5.06%	2.98%
ALT-3 SMG-RD	4.00%	5.76%	1.76%	4.01%	5.06%	1.05%
ALT-4 SMG-RL	0.15%	0.30%	0.15%	0.15%	0.77%	0.62%
ALT-5 SBY-RD	24.92%	24.76%	-0.16%	25.11%	22.41%	-2.70%
ALT-6 SBY-RL	0.95%	1.55%	0.60%	0.96%	2.62%	1.67%
ALT-7 CMY-RD	13.10%	12.57%	-0.53%	13.06%	12.30%	-0.76%
ALT-8 CMY-RL	0.50%	0.63%	0.13%	0.50%	1.49%	0.99%

7.2.7 Policy 7 Simulation Results (Simulations K7 and L7)

The second joint policy is by combining the policies that increase the utility of alternative which uses the rail mode. Policy 3 and Policy 5 altogether will raise alternatives' utility by reducing transport time and transport cost. **Table 7.9** below shows the results of simulation of Policy 7 using Model K and Model L. Comparing the simulation results K7 and L7, we can state that the simulation L7 has a greater impact on changes in alternatives' market shares compared with the results of simulation K7. For instance, the market share of alternative 2 rises from 2.07% to 6.42% in simulation L7, but only rose to 2.81% in simulation K7.

Table 7.9 Policy 7 simulation results (simulations K7 and L7)

Alternatives (i)	Simulation K7			Simulation L7		
	PS_{iK0}	PS_{iK7}	Δ	PS_{iK0}	PS_{iL7}	Δ
ALT-1 JKT-RD	54.30%	53.98%	-0.33%	54.14%	52.89%	-1.25%
ALT-2 JKT-RL	2.07%	2.81%	0.74%	2.07%	6.42%	4.35%
ALT-3 SMG-RD	4.00%	3.76%	-0.23%	4.01%	2.88%	-1.13%
ALT-4 SMG-RL	0.15%	0.19%	0.04%	0.15%	0.29%	0.14%
ALT-5 SBY-RD	24.92%	24.33%	-0.60%	25.11%	22.12%	-2.99%
ALT-6 SBY-RL	0.95%	1.34%	0.39%	0.96%	1.93%	0.97%
ALT-7 CMY-RD	13.10%	13.01%	-0.09%	13.06%	12.50%	-0.56%
ALT-8 CMY-RL	0.50%	0.65%	0.15%	0.50%	1.70%	1.20%

7.2.8 Policy 8 Simulation Results (Simulations K8 and L8)

Simulation of Policy 8 was conducted by combining Policy 6 and Policy 7. The results of simulation can be seen in **Table 7.10** below. Overall, the simulation results of K8 are similar to the simulation results of L8 except for alternative SMG-RD. The predicted market share of this choice will increase from 4% to 5.2% in the simulation K8, but will decline to 2.57% in the simulation L8. The comparison between two simulations also reveals that simulation L8 will lead to greater changes in predicted market share than the simulation K8, as in previous simulations.

Table 7.10 Policy 8 simulation results (simulations K8 and L8)

Alternatives (i)	Simulation K8			Simulation L8		
	PS_{iK0}	**PS_{iK8}**	**Δ**	**PS_{iL0}**	**PS_{iL8}**	**Δ**
ALT-1 JKT-RD	54.30%	51.42%	-2.89%	54.14%	48.87%	-5.27%
ALT-2 JKT-RL	2.07%	3.70%	1.63%	2.07%	11.10%	9.03%
ALT-3 SMG-RD	4.00%	5.20%	1.21%	4.01%	2.57%	-1.43%
ALT-4 SMG-RL	0.15%	0.36%	0.21%	0.15%	0.64%	0.49%
ALT-5 SBY-RD	24.92%	23.82%	-1.10%	25.11%	19.16%	-5.95%
ALT-6 SBY-RL	0.95%	2.32%	1.37%	0.96%	3.63%	2.67%
ALT-7 CMY-RD	13.10%	12.35%	-0.76%	13.06%	10.90%	-2.16%
ALT-8 CMY-RL	0.50%	0.83%	0.33%	0.50%	3.13%	2.63%

7.2.9 Policy 9 Simulation Results (Simulations K9 and L9)

The last combined policy simulation was carried out by combining all of the single policies, to examine the overall effect of the policies if they were to be implemented at the same time. As can be seen from **Table 7.11**, the simulation results are quite similar to the simulation using Policy 8. Alternative ALT-5 SBY-RD will have the biggest reduction with -6.32% in simulation L9, and, on the other hand, the alternative JKT-RL will lead to the biggest increment in market share by 1.95% in simulation K9 and 10.61% in simulation L9.

Table 7.11 Policy 9 simulation results (simulations K9 and L9)

Alternatives (i)	Simulation K9			Simulation L9		
	PS_{iK0}	**PS_{iK9}**	**Δ**	**PS_{iL0}**	**PS_{iL9}**	**Δ**
ALT-1 JKT-RD	54.30%	53.24%	-1.06%	54.14%	50.74%	-3.40%
ALT-2 JKT-RL	2.07%	4.02%	1.95%	2.07%	12.68%	10.61%
ALT-3 SMG-RD	4.00%	5.01%	1.02%	4.01%	2.37%	-1.64%
ALT-4 SMG-RL	0.15%	0.35%	0.20%	0.15%	0.59%	0.44%
ALT-5 SBY-RD	24.92%	23.39%	-1.53%	25.11%	18.80%	-6.31%
ALT-6 SBY-RL	0.95%	2.26%	1.31%	0.96%	3.34%	2.38%
ALT-7 CMY-RD	13.10%	10.96%	-2.15%	13.06%	8.91%	-4.15%
ALT-8 CMY-RL	0.50%	0.76%	0.26%	0.50%	2.57%	2.07%

7.3 Simulation Results using DEFRA's Emission Factor (Simulations M and N)

7.3.1 Policy 1 Simulation Results (Simulations M1 and N1)

Table 7.12 compares the simulation results of simulation M1 and N1. As we can observe from the table below, the results of simulation M1 and N1 are quite similar to the results of simulation K1 and L1. Implementing Policy 1 is expected to reduce the market shares of alternatives that use the road mode. However, a surprising result is found where the predicted market shares PS_{iM1} of alternative SMG-RD and SBY-RD will increase, rather than decrease, as anticipated. The results of simulation N1 show the biggest changes will be experienced by the alternatives in JKT Port, where the predicted market share (PS_{iN1}) of JKT-RD will decline by 2.21% (in simulation N1). On the other hand, the JKT-RL will increase by 1.66% (in simulation N1).

Table 7.12 Policy 1 simulation results (simulations M1 and N1)

Alternatives (i)	Simulation M1			Simulation N1		
	PS_{iM0}	PS_{iM1}	Δ	PS_{iN0}	PS_{iN1}	Δ
ALT-1 JKT-RD	54.22%	52.96%	-1.26%	54.24%	52.03%	-2.21%
ALT-2 JKT-RL	2.07%	2.33%	0.26%	2.07%	3.73%	1.66%
ALT-3 SMG-RD	4.00%	4.72%	0.72%	4.00%	4.65%	0.65%
ALT-4 SMG-RL	0.15%	0.20%	0.05%	0.15%	0.28%	0.13%
ALT-5 SBY-RD	25.01%	25.15%	0.14%	24.99%	24.25%	-0.74%
ALT-6 SBY-RL	0.95%	1.17%	0.22%	0.95%	1.44%	0.49%
ALT-7 CMY-RD	13.09%	12.91%	-0.18%	13.10%	12.67%	-0.42%
ALT-8 CMY-RL	0.50%	0.56%	0.06%	0.50%	0.95%	0.45%

7.3.2 Policy 2 Simulation Results (Simulations M2 and N2)

Comparable with the results of simulations M1 and N1 above, the simulation results of Policy 2 (M2 and N2) have the anticipated predicted market share changes except for the ALT-3. Comparing to the result of Policy 1 in **Table 7.12**, Policy 2 has a slightly greater impact on the market share changes, partially for the alternatives in SBY Port. For instance, PS_{iM2} of SBY-RD will only slip by 0.17%, but will fall by 1.56% in simulation N2 result (PS_{iN2}) compared to the predicted market share of the BAU policy (PS_{iM0} and PS_{iN0}).

Table 7.13 Policy 2 simulation results (simulations M2 and N2)

Alternatives (i)	Simulation M2			Simulation N2		
	PS_{iM0}	PS_{iM2}	Δ	PS_{iN0}	PS_{iN2}	Δ
ALT-1 JKT-RD	54.22%	52.97%	-1.25%	54.24%	52.65%	-1.59%
ALT-2 JKT-RL	2.07%	2.37%	0.30%	2.07%	3.12%	1.04%
ALT-3 SMG-RD	4.00%	4.93%	0.93%	4.00%	4.69%	0.69%
ALT-4 SMG-RL	0.15%	0.24%	0.09%	0.15%	0.52%	0.37%
ALT-5 SBY-RD	25.01%	24.84%	-0.17%	24.99%	23.43%	-1.56%
ALT-6 SBY-RL	0.95%	1.32%	0.37%	0.95%	1.96%	1.00%
ALT-7 CMY-RD	13.09%	12.75%	-0.34%	13.10%	12.70%	-0.39%
ALT-8 CMY-RL	0.50%	0.58%	0.08%	0.50%	0.94%	0.44%

7.3.3 Policy 3 Simulation Results (Simulations M3 and N3)

The impact of developing double-track railway network to the market shares changes is represented by the simulation results in **Table 7.14**. With the establishment a double track network, the travel time using the rail mode will be faster than before. As seen from the table below, the market shares of all alternatives match with the expectation, where all of the alternatives using the road will decrease and the rail mode will experience an increment in the predicted market share. However the changes are minor, compared to the results of Policy 1 and Policy 2. Predicted market share JKT-RL has the biggest advantage of Policy 3, where PS_{iM3} and PS_{iN3} of ALT-2 will increase to 2.38% and 3.88% respectively. As the biggest decline is predicted in ALT-5 SBY-RD, some users might switch their choice to ALT-2 JKT-RL where the distance is about 800 km. This result indicates that rail users prefer the rail mode for the longer journey.

Table 7.14 Policy 3 simulation results (simulations M3 and N3)

Alternatives (i)	Simulation M3			Simulation N3		
	PS_{iM0}	PS_{iM3}	Δ	PS_{iN0}	PS_{iN3}	Δ
ALT-1 JKT-RD	54.22%	54.09%	-0.13%	54.24%	53.53%	-0.71%
ALT-2 JKT-RL	2.07%	2.38%	0.31%	2.07%	3.88%	1.81%
ALT-3 SMG-RD	4.00%	3.93%	-0.07%	4.00%	3.79%	-0.21%
ALT-4 SMG-RL	0.15%	0.16%	0.01%	0.15%	0.18%	0.03%
ALT-5 SBY-RD	25.01%	24.80%	-0.22%	24.99%	24.06%	-0.93%
ALT-6 SBY-RL	0.95%	1.06%	0.11%	0.95%	1.18%	0.23%
ALT-7 CMY-RD	13.09%	13.02%	-0.07%	13.10%	12.49%	-0.61%
ALT-8 CMY-RL	0.50%	0.56%	0.06%	0.50%	0.90%	0.40%

7.3.4 Policy 4 Simulation Results (Simulations M4 and N4)

Policy 4 is the only policy related to the port (JKT Port). The results of simulations M4 and N4 are presented in **Table 7.15**. The results are in accordance with the previous expectation that Policy 4 has positive impacts to raise the ALT-1 and ALT-2 market shares. As we can see from the table, the biggest increase will occur in ALT-1, with the 2.41% market share change, whereas ALT-7 will experience the largest decline with 2.18% reduction. Certainly, this policy only significantly affects to the changes in road mode's share rather than the rail mode's changes.

Table 7.15 Policy 4 simulation results (simulations M4 and N4)

Alternatives (i)	Simulation M4			Simulation N4		
	PS_{iM0}	PS_{iM4}	Δ	PS_{iN0}	PS_{iN4}	Δ
ALT-1 JKT-RD	54.22%	56.16%	1.94%	54.24%	56.65%	2.41%
ALT-2 JKT-RL	2.07%	2.23%	0.16%	2.07%	2.47%	0.40%
ALT-3 SMG-RD	4.00%	3.85%	-0.14%	4.00%	3.90%	-0.10%
ALT-4 SMG-RL	0.15%	0.14%	-0.01%	0.15%	0.15%	0.00%
ALT-5 SBY-RD	25.01%	24.57%	-0.45%	24.99%	24.55%	-0.44%
ALT-6 SBY-RL	0.95%	0.93%	-0.02%	0.95%	0.93%	-0.02%
ALT-7 CMY-RD	13.09%	11.66%	-1.43%	13.10%	10.92%	-2.18%
ALT-8 CMY-RL	0.50%	0.46%	-0.05%	0.50%	0.43%	-0.07%

7.3.5 Policy 5 Simulation Results (Simulations M5 and N5)

The results of simulations M and N of Policy 5 are shown in **Table 7.16**. Information of the predicted market shares in the table below illustrates the impact of the incentive provision to reduce the cost of transport of containers by rail (Policy 5) to all alternatives. Under the assumption that the incentive will reduce the rail freight transport cost by 20%, it is expected that more road mode users will switch their choices to the rail mode. The results below indicate that cost decrement in rail mode will increase the rail mode’s shares; however, there are only small changes, ranging from 0.03% (SMG-RL) to 1.52% (JKT-RL). The largest decline of road mode share will be experienced by the ALT-5 (-1.58%), which might be moving mostly to ALT-2 (JKT-RD).

Table 7.16 Policy 5 simulation results (simulations M5 and N5)

Alternatives (i)	Simulation M5			Simulation N5		
	PS_{iM0}	PS_{iM5}	Δ	PS_{iN0}	PS_{iN5}	Δ
ALT-1 JKT-RD	54.22%	54.07%	-0.15%	54.24%	54.04%	-0.20%
ALT-2 JKT-RL	2.07%	2.47%	0.40%	2.07%	3.59%	1.52%
ALT-3 SMG-RD	4.00%	3.84%	-0.16%	4.00%	3.39%	-0.61%
ALT-4 SMG-RL	0.15%	0.18%	0.03%	0.15%	0.28%	0.13%
ALT-5 SBY-RD	25.01%	24.63%	-0.38%	24.99%	23.42%	-1.58%
ALT-6 SBY-RL	0.95%	1.23%	0.27%	0.95%	1.66%	0.71%
ALT-7 CMY-RD	13.09%	13.00%	-0.10%	13.10%	12.59%	-0.51%
ALT-8 CMY-RL	0.50%	0.59%	0.09%	0.50%	1.04%	0.54%

7.3.6 Policy 6 Simulation Results (Simulations M6 and N6)

The simulation results in **Table 7.17** below demonstrate the impact of joint policies in reducing the attractiveness of the road mode in the freight transport. This policy is expected to have a bigger impact on the predicted market shares changes, especially in terms of increasing the rail mode's market share. As can be seen from **Table 7.17**, all of the alternatives using rail modes experience a significant increment of predicted market shares. However, this combined policy still garnered an unexpected result, as the ALT-3 SMG-RD, which was expected to fall, instead experienced a significant rise, especially for simulation M6. This finding might be explained by the fact that the location of SMG Port in the middle of Java allows for road mode users from other ports to switch their choices to the SMG-RD alternative rather than switch to the rail mode.

Nevertheless, the results proved that combined policy will have a larger impact than single policy, such as the market share of ALT-2 JKT-RL which was seen to double from only 2.07% to 4.78%. Even the predicted market share of ALT-6 SBY-RL will increase three times more than before, with an increase of 0.95% (PS_{iN0}) jumping to 2.73% (PS_{iN6}).

Table 7.17 Policy 6 simulation results (simulations M6 and N6)

Alternatives (i)	Simulation M6			Simulation N6		
	PS_{iM0}	PS_{iM6}	Δ	PS_{iN0}	PS_{iN6}	Δ
ALT-1 JKT-RD	54.22%	51.82%	-2.40%	54.24%	50.73%	-3.51%
ALT-2 JKT-RL	2.07%	2.66%	0.59%	2.07%	4.78%	2.71%
ALT-3 SMG-RD	4.00%	5.59%	1.59%	4.00%	4.84%	0.84%
ALT-4 SMG-RL	0.15%	0.30%	0.15%	0.15%	0.74%	0.59%
ALT-5 SBY-RD	25.01%	24.76%	-0.25%	24.99%	22.25%	-2.74%
ALT-6 SBY-RL	0.95%	1.64%	0.68%	0.95%	2.73%	1.78%
ALT-7 CMY-RD	13.09%	12.59%	-0.50%	13.10%	12.50%	-0.59%
ALT-8 CMY-RL	0.50%	0.64%	0.14%	0.50%	1.43%	0.93%

7.3.7 Policy 7 Simulation Results (Simulations M7 and N7)

As stated in Section 7.1, Policy 7 is a joint policy aimed at increasing the attractiveness of the rail mode by combining the policy of developing a double-track rail network (Policy 3) and accordingly giving incentives to reduce the rail freight cost (Policy 5). **Table 7.18** below shows the results of simulations M and N for Policy 7. Similar to the results in simulations K7 and L7, the simulation results M7 has a weaker impact on the changes alternatives' market shares compared with the results of simulation N7. For instance, the predicted market share of alternative 5 will fall from 25.01% (PS_{iM0}) to 24.35% (PS_{iM7}), and further will decline from 24.99% (PS_{iN0}) to 22.06% (PS_{iN7}).

Table 7.18 Policy 7 simulation results (simulations M7 and N7)

Alternatives (i)	Simulation M7			Simulation N7		
	PS_{iM0}	PS_{iM7}	Δ	PS_{iN0}	PS_{iN7}	Δ
ALT-1 JKT-RD	54.22%	53.92%	-0.30%	54.24%	53.31%	-0.92%
ALT-2 JKT-RL	2.07%	2.85%	0.78%	2.07%	5.97%	3.90%
ALT-3 SMG-RD	.00%	3.74%	-0.26%	4.00%	2.93%	-1.07%
ALT-4 SMG-RL	0.15%	0.18%	0.03%	0.15%	0.28%	0.13%
ALT-5 SBY-RD	25.01%	24.35%	-0.66%	24.99%	22.06%	-2.93%
ALT-6 SBY-RL	0.95%	1.38%	0.42%	0.95%	1.95%	1.00%
ALT-7 CMY-RD	13.09%	13.00%	-0.10%	13.10%	12.59%	-0.51%
ALT-8 CMY-RL	0.50%	0.66%	0.16%	0.50%	1.60%	1.10%

7.3.8 Policy 8 Simulation Results (Simulations M8 and N8)

The simulation of Policy 8 was carried out by combining Policy 7 and Policy 8, and the simulation results are shown in **Table 7.19**. This policy is expected to give larger changes in the predicted market shares, especially on the switching of road users to the rail mode. As we can see from the table below, alternative JKT-RL will receive the biggest increment of market shares by 7.59% whereas the SBY-RD alternative is predicted to experience the greatest loss of market share by -5.70% when compare with BAU policy. The table below demonstrates that the incorporation of a policy to reduce the attractiveness of road mode and increase the attractiveness of rail modes will provide a great impact on the market shares changes. Policy 8 simulation results also reinforce the results of the previous simulation, that simulation N has a more tangible impact on changes in market share compared with simulation M. An interesting finding is found, where alternative SMG-RD's market share is predicted to increase by 1% in simulation M8, but will decline from 4% to 2.67% in simulation N8.

Table 7.19 Policy 8 simulation results (simulations M8 and N8)

Alternatives (i)	Simulation M8			Simulation N8		
	PS_{iM0}	PS_{iM8}	Δ	PS_{iN0}	PS_{iN8}	Δ
ALT-1 JKT-RD	54.22%	51.46%	-2.76%	54.24%	49.81%	-4.42%
ALT-2 JKT-RL	2.07%	3.82%	1.75%	2.07%	9.66%	7.59%
ALT-3 SMG-RD	4.00%	5.00%	1.00%	4.00%	2.67%	-1.33%
ALT-4 SMG-RL	0.15%	0.35%	0.20%	0.15%	0.60%	0.45%
ALT-5 SBY-RD	25.01%	23.73%	-1.28%	24.99%	19.29%	-5.70%
ALT-6 SBY-RL	0.95%	2.46%	1.50%	0.95%	3.68%	2.72%
ALT-7 CMY-RD	13.09%	12.34%	-0.75%	13.10%	11.43%	-1.66%
ALT-8 CMY-RL	0.50%	0.84%	0.34%	0.50%	2.86%	2.36%

7.3.9 Policy 9 Simulation Results (Simulations M9 and N9)

The results of simulation M and N for Policy 9 are detailed in **Table 7.20**. The extension of Tanjung Priok Port is added to Policy 8, in mind of examining the overall effect of policies on market shares. The results are comparably similar to the results of Policy 8, except this policy gives more positive impact to alternative JKT-RL with an 8.92% increment of market share (simulation N9). On the contrary, the SBY-RD and CMY-RD will experience a significant decline (-6.03 % and -3.62%, respectively), and it is predicted that the users of the two alternatives might switch their choices to the JKT-RL.

Table 7.20 Policy 9 simulation results (simulations M9 and N9)

Alternatives (i)	Simulation M9			Simulation N9		
	PS_{iM0}	PS_{iM9}	Δ	PS_{iN0}	PS_{iN9}	Δ
ALT-1 JKT-RD	54.22%	53.18%	-1.04%	54.24%	51.72%	-2.51%
ALT-2 JKT-RL	2.07%	4.17%	2.10%	2.07%	10.99%	8.92%
ALT-3 SMG-RD	4.00%	4.83%	0.83%	4.00%	2.48%	-1.52%
ALT-4 SMG-RL	0.15%	0.34%	0.19%	0.15%	0.55%	0.40%
ALT-5 SBY-RD	25.01%	23.34%	-1.67%	24.99%	18.96%	-6.03%
ALT-6 SBY-RL	0.95%	2.39%	1.44%	0.95%	3.40%	2.45%
ALT-7 CMY-RD	13.09%	10.97%	-2.12%	13.1%	9.48%	-3.62%
ALT-8 CMY-RL	0.5%	0.77%	0.27%	0.5%	2.41%	1.91%

7.4 Discussion: Impact of the Policies

Simulations using the MXNL-SP model (simulations K and M) comparatively have a smaller impact on the predicted market shares than the simulations using the MXMNL-SPRP model (simulations L and N). Moreover, as the MXMNL-SPRP model is obtained from the estimation using joint SP and RP data, the simulation results are most likely to better represent the actual situation than the simulation results from the MXNL-SP model.

When we compare the simulation results of the two EFs, the results demonstrate that there is just a slight difference between the McKinnon and Piecyk's EF and DEFRAS's EF simulation results.

7.4.1 Market Shares of Port

From **Figure 7.1**, **Figure 7.2**, **Figure 7.3**, and **Figure 7.4**, we can see that the SBY Port is the only port that will receive an adverse impact from all of the policies simulated, in simulations L and N. The other ports will obtain a mixed impact (positive and negative) from the policy implementation. It is suggested that SBY Port needs to direct additional effort to maintaining market shares.

Policies 1, 2 and 6 (diminishing the attractiveness of the road mode) will induce different impacts to market shares compared with policies 3, 5 and 7 (improving the attractiveness of the rail mode). It can be seen from the figure below, if policies 1, 2 and 6 are applied, the SMG Port then will be the port to gain the most, on the contrary, the JKT Port will lose most in terms of market share. This case indicates that some of the exporters and forwarders would prefer to change their port choice to the closer port, rather than switching their inland mode choice to the rail mode. The explanation of this case can be found in Section 6.7.1.

However, if policies 3, 5 and 7 are implemented, JKT Port is predicted to garner the highest gain, and conversely SMG Port and SBY Port will experience a bigger lost in market shares. When we track from **Table 7.3** to **Table 7.20**, we find that some users at both ports might opt to change their choices to JKT-RL rather than choose other alternatives.

As expected, the implementation of Policy 4 will increase the market share of JKT Port, and partially the market share of JKT-RL. CMY Port lost the most as CMY Port is located only approximately 100 km from JKT Port.

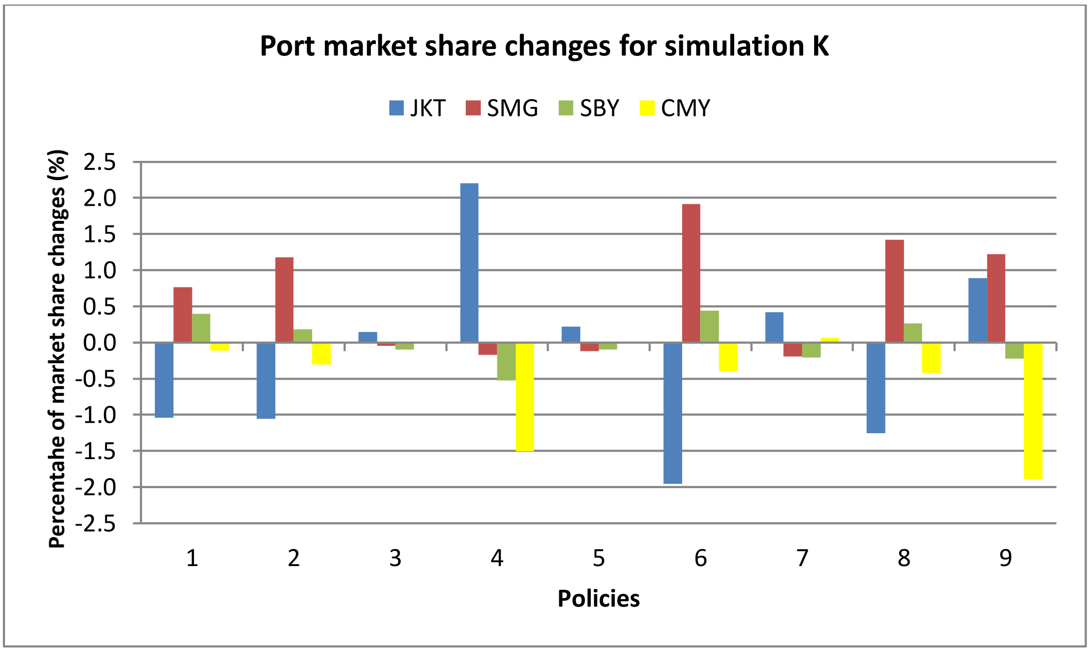


Figure 7.1 Predicted changes in port market shares for simulation K for all policies

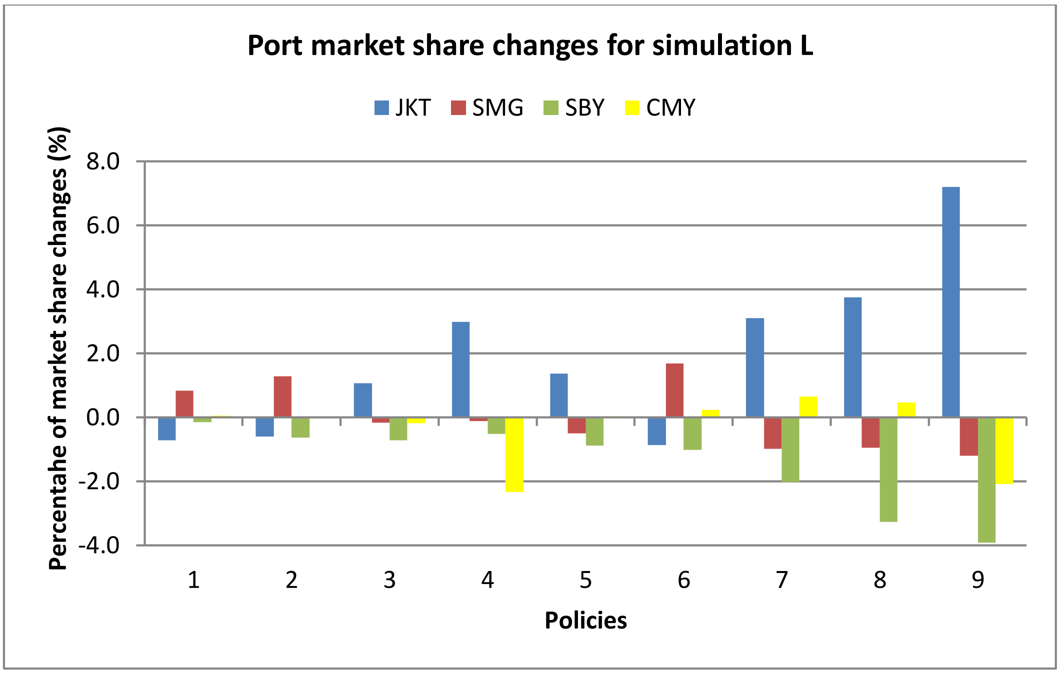


Figure 7.2 Predicted changes in port market shares for simulation L for all policies

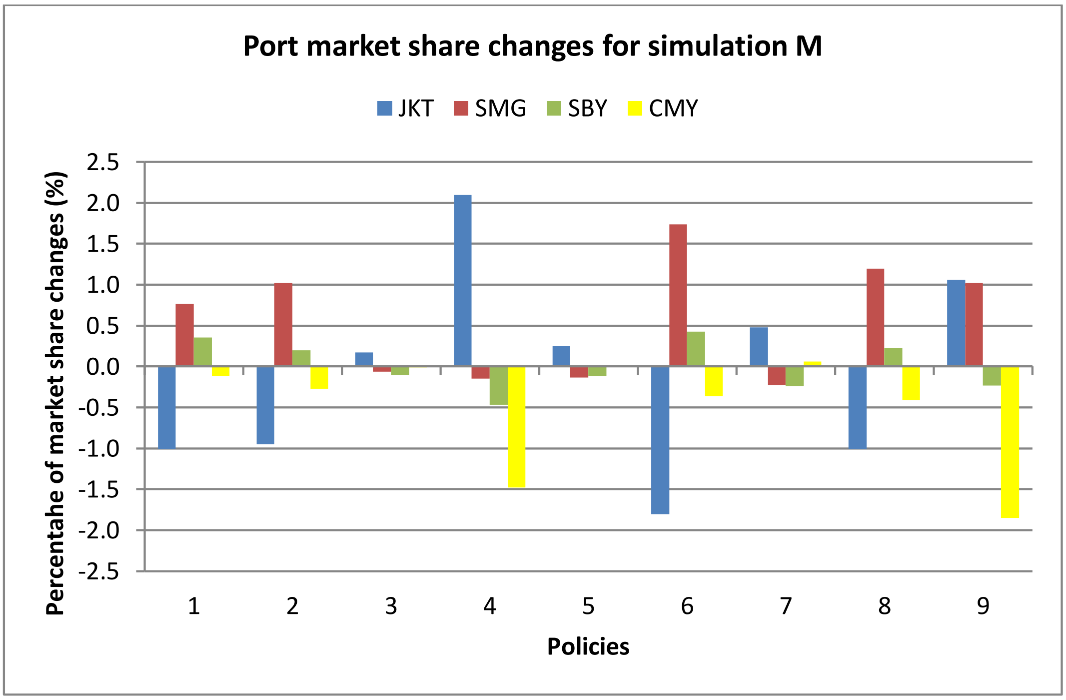


Figure 7.3 Predicted changes in port market shares for simulation M for all policies

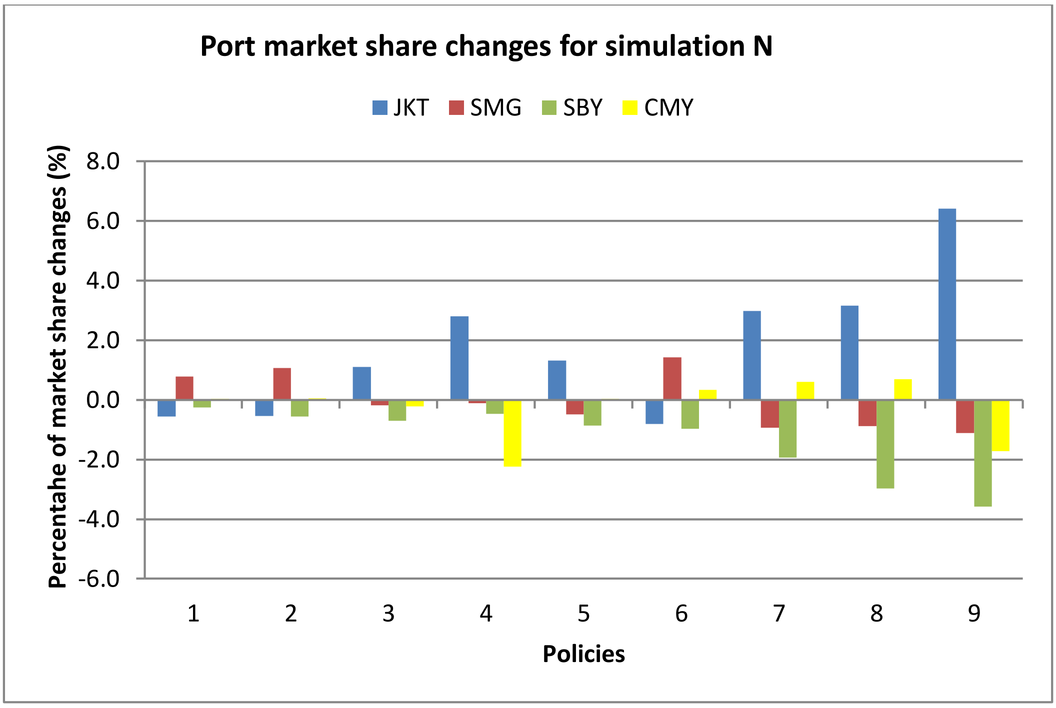


Figure 7.4 Predicted changes in port market shares for simulation N for all policies

The information in **Table 7.21** describes the impact of the policies on the combined port shares using both road and rail modes with simulations K, L, M and N. For the single policy, the biggest market share increases will be experienced by JKT Port when Policy 4 is applied. Furthermore, the SMG Port will have the second largest increment as the government implements Policy 2. As for the joint policies simulation, Policy 9 will provide the greatest impact to the JKT Port, rising by 7.21% in simulation L. On the contrary, the SBY Port will decrease by -3.92%.

Comparing the port shares of the BAU simulation results in **Table 7.21** with the existing port shares in **Table 2.4** indicates that the major impact of the development of CMY Port will be on the JKT Port's market share, reducing it from approximately 65% to only 56%. Nevertheless, the market shares of SMG Port and SBY Port also will be impacted by the establishment of the CMY Port. The reduction in market share of the JKT Port is mainly triggered by the shifting of users' choices in areas that are closer to CMY Port than to JKT Port. The closer areas to CMY Port are include Bekasi, Karawang and Cirebon. The expansion of the JKT Port's capacity, on the other hand, will raise its market share from about 56% to 59% (Policy 4 - simulations L and N) and will rise to about 63% (Policy 9 – simulations L and N). Obviously, this increment will reduce all other ports' market shares.

Table 7.21 Combined port market shares from simulation K, simulation L, simulation M and simulation N for all policies

Policies		Simulation K Port shares (%)				Simulation L Port shares (%)				Simulation M Port shares (%)				Simulation N Port shares (%)			
		JKT	SMG	SBY	CMY	JKT	SMG	SBY	CMY	JKT	SMG	SBY	CMY	JKT	SMG	SBY	CMY
BAU	*Share*	*56.37*	*4.15*	*25.88*	*13.6*	*56.22*	*4.16*	*26.06*	*13.56*	*56.29*	*4.15*	*25.97*	*13.59*	*56.31*	*4.15*	*25.95*	*13.6*
Policy 1	Share	55.33	4.91	26.27	13.49	55.5	4.98	25.91	13.61	55.29	4.92	26.32	13.47	55.76	4.93	25.69	13.62
	Δ	-1.04	0.76	0.39	-0.11	-0.72	0.82	-0.16	0.05	-1	0.77	0.35	-0.12	-0.55	0.78	-0.26	0.02
Policy 2	Share	55.32	5.33	26.06	13.3	55.62	5.44	25.42	13.52	55.34	5.17	26.17	13.32	55.76	5.21	25.39	13.64
	Δ	-1.06	1.18	0.18	-0.3	-0.6	1.28	-0.64	-0.04	-0.95	1.02	0.2	-0.27	-0.55	1.06	-0.56	0.04
Policy 3	Share	56.52	4.1	25.78	13.6	57.29	3.99	25.35	13.38	56.47	4.09	25.86	13.58	57.41	3.97	25.25	13.38
	Δ	0.15	-0.05	-0.09	0	1.07	-0.17	-0.72	-0.18	0.17	-0.06	-0.1	-0.01	1.1	-0.18	-0.7	-0.21
Policy 4	Share	58.58	3.98	25.35	12.09	59.19	4.04	25.54	11.23	58.39	4	25.5	12.11	59.12	4.05	25.48	11.35
	Δ	2.2	-0.17	-0.52	-1.51	2.98	-0.12	-0.52	-2.33	2.1	-0.15	-0.47	-1.48	2.81	-0.1	-0.46	-2.24
Policy 5	Share	56.59	4.03	25.78	13.6	57.58	3.66	25.17	13.59	56.54	4.01	25.86	13.59	57.63	3.67	25.08	13.62
	Δ	0.22	-0.12	-0.1	0	1.37	-0.5	-0.89	0.03	0.25	-0.13	-0.11	0	1.32	-0.48	-0.87	0.03
Policy 6	Share	54.42	6.06	26.31	13.21	55.34	5.84	25.04	13.79	54.49	5.89	26.4	13.23	55.5	5.58	24.98	13.93
	Δ	-1.96	1.92	0.44	-0.4	-0.88	1.68	-1.03	0.23	-1.8	1.74	0.43	-0.36	-0.8	1.43	-0.96	0.34
Policy 7	Share	56.79	3.95	25.66	13.67	59.32	3.18	24.04	14.2	56.77	3.93	25.73	13.65	59.29	3.21	24.01	14.19
	Δ	0.42	-0.2	-0.21	0.07	3.1	-0.98	-2.02	0.64	0.48	-0.22	-0.24	0.06	2.98	-0.94	-1.93	0.59
Policy 8	Share	55.12	5.56	26.14	13.18	59.97	3.21	22.79	14.03	55.28	5.35	26.19	13.18	59.47	3.26	22.97	14.29
	Δ	-1.26	1.42	0.27	-0.43	3.75	-0.95	-3.27	0.47	-1.01	1.2	0.22	-0.41	3.16	-0.89	-2.98	0.7
Policy 9	Share	57.27	5.36	25.65	11.72	63.42	2.96	22.14	11.48	57.35	5.17	25.73	11.74	62.71	3.04	22.37	11.88
	Δ	0.89	1.22	-0.22	-1.89	7.21	-1.2	-3.92	-2.08	1.06	1.02	-0.23	-1.85	6.41	-1.11	-3.58	-1.71

Traditionally a port has a relatively stable hinterland, with its market share largely dependent on the hinterland size and the connections between the hinterland to the port (Notteboom, 2008). The hinterland area of Tanjung Priok Port covers the surrounding areas of West Java including Jakarta, Bandung, Bekasi, Tangerang, Cirebon, Bogor and Karawang. These areas contribute more than 90% of exports from Tanjung Priok Port[35]. Meanwhile, the hinterland of Tanjung Emas Port is the Central area of Java, namely Semarang, Jepara, Surakarta and Yogyakarta, which provides 72%[36] of the port's exports. The traditional hinterland of Tanjung Perak Port is the region in East Java – parts of Surabaya, Malang, Gresik, Sidoarjo and Pasuruan.

7.4.2 Inland Mode Shifting of Containerized Export for Hinterland Transport Leg

Table 7.22 shows that the joint SP and RP data simulation models (simulations L and N) give quite a different result from the pure SP simulation models (simulations K and M). Simulations L and N show higher forecasted increment in market shares for the rail mode than for simulations K and M. For instance for Policy 8 and Policy 9, the simulation result gives an average 14% increment in simulations L and N, but an increase of only less than 4% for simulations L and N.

Table 7.22 Inland mode shares comparison of simulations K, L, M and N for all policies)

Policies		**Simulation K**		**Simulation L**		**Simulation M**		**Simulation N**	
		Mode shares (%)		**Mode shares (%)**		**Mode shares (%)**		**Mode shares (%)**	
		RD	**RL**	**RD**	**RL**	**RD**	**RL**	**RD**	**RL**
BAU	*Share*	96.33	3.67	96.32	3.68	96.32	3.68	96.32	3.68
Policy 1	Share	95.83	4.17	93.74	6.26	95.75	4.25	93.6	6.4
	Δ	-0.5	0.5	-2.58	2.58	-0.57	0.57	-2.72	2.72
Policy 2	Share	95.52	4.48	93.23	6.77	95.49	4.51	93.47	6.53
	Δ	-0.81	0.81	-3.09	3.09	-0.83	0.83	-2.85	2.85
Policy 3	Share	95.87	4.13	93.72	6.28	95.84	4.16	93.86	6.14
	Δ	-0.46	0.46	-2.6	2.6	-0.48	0.48	-2.46	2.46
Policy 4	Share	96.25	3.75	96.01	3.99	96.24	3.76	96.02	3.98
	Δ	-0.08	0.08	-0.31	0.31	-0.08	0.08	-0.3	0.3
Policy 5	Share	95.57	4.43	93.22	6.78	95.53	4.47	93.43	6.57
	Δ	-0.76	0.76	-3.1	3.1	-0.79	0.79	-2.89	2.89
Policy 6	Share	94.89	5.11	90.06	9.94	94.76	5.24	90.32	9.68

[35] Based on the interview with the staff of Pelindo II in Jakarta.

[36] Data from the authority of the Tanjung Emas Port

	Δ	-1.44	1.44	-6.26	6.26	-1.56	1.56	-6	6
Policy 7	Share	95.08	4.99	90.4	10.34	95.01	5.07	90.89	9.81
	Δ	-1.25	1.32	-5.92	6.66	-1.31	1.39	-5.43	6.13
Policy 8	Share	92.79	7.21	81.51	18.49	92.53	7.47	83.21	16.79
	Δ	-3.54	3.54	-14.81	14.81	-3.79	3.79	-13.11	13.11
Policy 9	Share	92.61	7.39	80.82	19.18	92.33	7.67	82.64	17.36
	Δ	-3.72	3.72	-15.5	15.5	-3.99	3.99	-13.68	13.68

For the single policy, the market shares of all the alternatives using rail modes increased by the all proposed policies. Policy 2 (reducing fuel subsidies) and Policy 5 (giving incentive to the rail freight transport) lead to the most significant increments in the rail mode shares. In the simulation using MXNL-SP model, the rail mode share increased from 3.67% to 4.48% (Policy 2) or 4.43% (Policy 5), and in the simulation using MXMNL-SPRP model the shares increased from 3.68% to 6.77% or 6.78%, respectively.

Policy 6 and Policy 7 give similar impact to the shifting of road users to the rail mode. Moreover, implementation of Policy 8 and Policy 9 will give the most encouragement to the users to switch their choice to the rail mode. The results in Policy 6, Policy 7, Policy 8 and Policy 9 demonstrate that the impacts are linear to the single policy impacts.

According to the implementation, Policy 2 is also easier to implement than Policy 5, and the government would not need to spend any budget to apply this policy. Nevertheless, implementation of Policy 2 might raise the logistics cost in general. Furthermore, the extension of JKT Port (Policy 4) has the least positive impact – a plausible finding since this policy is not directly related to the inland mode attributes.

7.4.3 GHG Emissions Reduction of Containerized Exports from Java

Table 7.23 presents the calculation of GHG emission reduction using simulation K, L, M and N. The GHG emission of the *Business As Usual* (BAU) policy in a year *y* is defined as the total baseline emission TE_y^B (see Equation (4.33) and the projected GHG emission in a year *y* after implementation of policy *p* is TE_y^P. The calculation results of the baseline emissions for simulation K, L, M, and N are 4,368 tonnes, 4,144 tonnes, 5,698 tonnes and 5,407 tonnes CO_2e respectively. The calculation of projected GHG emission for all policies and the emission reductions in a year *y* (ER_y in tonnes and %) are shown in the table below.

Table 7.23 GHG emission reductions of simulations K, L, M and N for all policies

Policies	Simulation K			Simulation L			Simulation M			Simulation N		
	TE_y^P	ER_y		TE_y^P	ER_y		TE_y^P	ER_y		TE_y^P	ER_y	
	Tonne	Tonne	%	Tonne	Tonne	%	Tonne	Tonne	%	Tonne	Tonne	%
Policy 1	4,172	196	4.5	3,817	326	7.88	5,427	272	4.8	4,996	411	7.6
Policy 2	4,140	227	5.2	3,893	251	6.05	5,414	284	5	5,116	291	5.4
Policy 3	4,355	13	0.3	3,998	145	3.51	5,683	15	0.3	5,245	162	3
Policy 4	4,422	-54	-1.2	4,162	-18	-0.44	5,768	-70	-1.2	5,429	-21	-0.4
Policy 5	4,349	19	0.4	4,046	98	2.35	5,679	20	0.3	5,315	92	1.7
Policy 6	3,962	406	9.3	3,629	515	12.4	5,175	523	9.2	4,804	604	11.2
Policy 7	4,334	34	0.8	3,894	249	6.02	5,661	37	0.6	5,169	238	4.4
Policy 8	3,926	442	10.1	3,515	629	15.2	5,138	560	9.8	4,763	644	11.91
Policy 9	3,967	401	9.2	3,526	618	14.9	5,190	509	8.9	4,788	620	11.46

Although the volume of GHG emission reductions of simulation N is bigger than the other simulations, but, simulation L has the largest percentage of emission reduction. This is seen to be owing to the fact baseline Total Emission (TE) in simulation L is much smaller than in simulation N. The lower TE calculation of simulations K and L compared to simulation M and N, reflects the difference level of emission factors used in the simulation. The McKinnon and Piecyk's emission factor is comparatively lower than the DEFRA's emission factor.

As can be seen from **Table 7.23** above, all simulation results show that all policies – with the exception of Policy 4 – have positive impacts on GHG emissions reductions from the containerized exports sector in Java. Each policy has different level of reduction; for single policies Policy 1 yields the largest emission reduction (411 tonnes - simulation N) and also has the largest percentage reduction (7.88% - simulation L). For the combined policies, Policy 8 is expected to reduce emission by 644 tonnes CO_2e in simulation N. Policy 8 is also expected to reduce the highest percentage emission reduction, which will reduce by 15.2% in simulation L.

The results of simulation L and N (MXMNL-SPRP) have a greater impact on the GHG emissions reduction than results of simulation K and M (MXNL-SP). These results are quite promising when considering the MXMNL-SPRP model is more representative in describing the actual situation than the MXNL-SP model.

Total volume of exports by the all of respondents represents approximately 2% of total export volume of Indonesia from Java Island (about 60,000 of 3 million TEUs). If we assume that other firms demonstrate the same behaviour, we can estimate the GHG emission reduction from the containerized exports from Java as approximately 50 times the reduction from the respondents. The reduction level is about 32,200 tonnes CO_2e by applying Policy 8 in simulation N.

We find that currently planned policies, as simulated in this study, even in combination, are not sufficient to reduce GHG emissions from the containerized exports by the required (targeted) amounts. Further policies are required to reduce the GHG emissions from freight transport, partially the emission reduction from the trucks mode. The other strategies to reduce the emissions including the use of new technology (such as hybrid engine vehicles), de-carbonizing fuel (utilization of alternative fuels such as biofuel), and improving drivers ability in eco-driving (ITF and OECD/ITF, 2010; Frey and Kuo, 2007). Moreover, the reduction of the GHG emission should be applied to the manufacturing and energy sector, as they were the first and the second biggest GHG emitter in Indonesia (*see* **Figure 1.3**).

7.4.4 Effect of Inland Mode Shifting to GHG Emission Reductions

The percentage of inland mode-shifting is the increment of the rail mode shares; in other words, it demonstrates a decrease in the proportion of road mode users. **Figure 7.5** below describes the effect of inland mode shifting to the GHG emissions reduction from the containerized exports in Java. All of the policies show that mode-shifting from the road mode to the rail mode will contribute to GHG reduction, except in the case of Policy 4. This policy is expected to lead to the migration of a small portion of the users to Tanjung Priok from further origins.

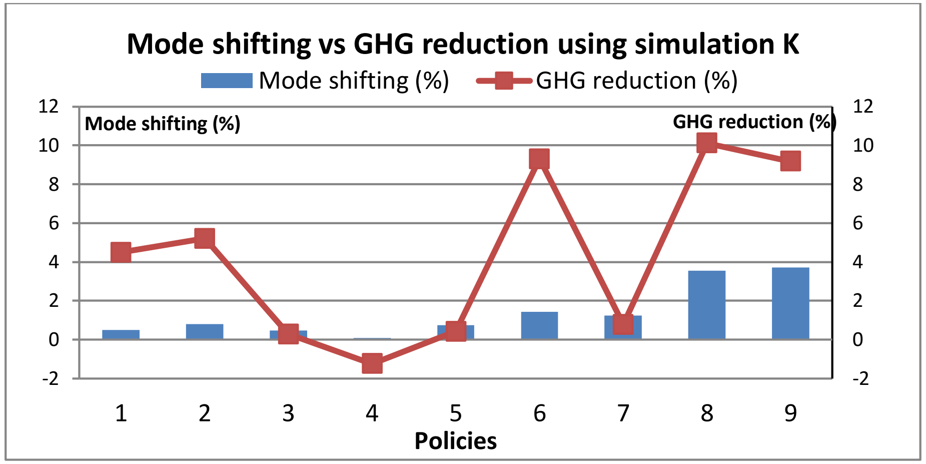
Policy 1 and Policy 2 have a considerable influence in terms of reducing GHG emissions in the simulation of both MXNL-SP and MXMNL-SPRP models. These two policies are directly related to the alternatives with the road mode, whereas Policy 3 and Policy 5 are linked to the alternatives using the rail mode. The findings indicate that policies directly impacting on the road mode have a greater impact in terms of GHG emissions reduction than policies targeted at the rail mode.

The expansion of Jakarta Port (Policy 4) has an unexpected result to the GHG emission reduction, as the GHG emissions will increase even though the rail mode shares increase. All simulations (K, L, M and N) of Policy 4 contribute to the increasing of GHG emission ranging 0.4%-1.2% compared to the existing GHG emission levels. This may be owing to the fact that most of the switches from road mode to rail mode occurs for a shorter distance inland transport legs, for which the reduction in GHG emissions is comparatively small.

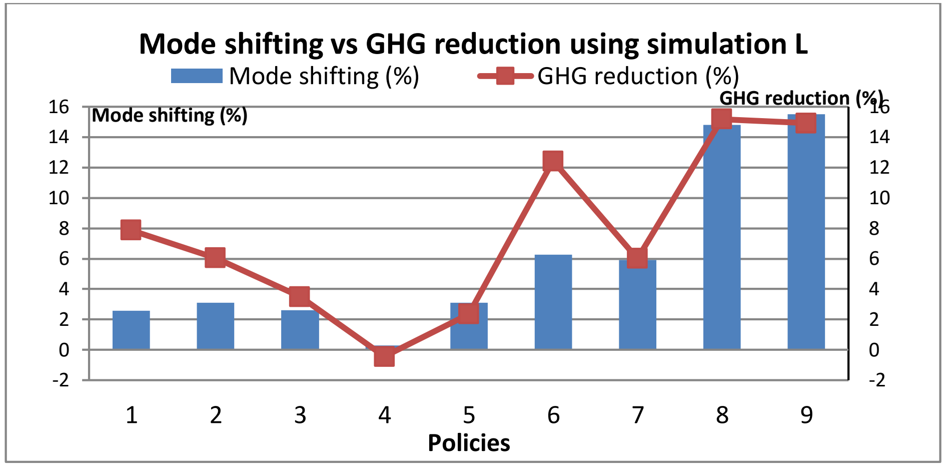
The difference level of emission reduction from the two policies approach—reducing road mode attractiveness versus improving rail mode attractiveness—also can be seen when comparing the simulation result of Policy 6 and Policy 7. Policy 6 contributes substantially to GHG emission reduction, compared with Policy 7 does, where even the percentage of shifting to the rail mode is approximately the same. For instance, in simulation K, the percentage of modal shifting to rail in Policy 6 and Policy 7 is about the same at 1.5%, although GHG emission reduction is very different (around 9% in Policy 6 and only less than 1% in Policy 7)

The simulations of MXNL-SP (simulations K and M) produced different effects of modal shifting to emission reduction compared to the results of the simulation MXMNL-SPRP (simulations L and N). It can be seen in **Figure 7.5**, Policy 8 and Policy 9 in simulations K and M give emission reductions equal to approximately 9% as a result of around 4% modal shifting to the rail mode. On the other hand, in simulation L the percentage of modal shifting and the percentage of emission reduction is about the same at 15%. The result in simulation N indicates a lower percentage of emission reduction (about 12%) than the percentage of modal shifting (about 14%).

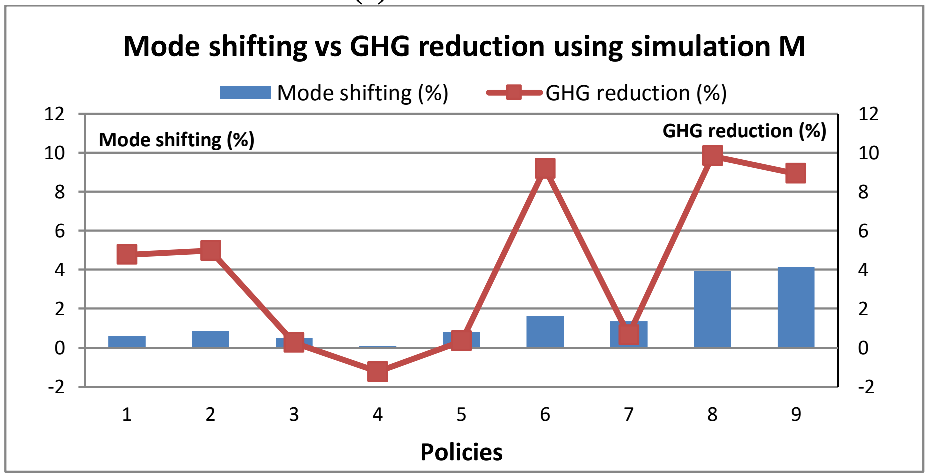
The results of the simulation seem to be consistent with the findings of other previous researchers. Musso and Marcucci (2010), for example, revealed in their analysis that policies such as restricting the vehicle characteristics, controlling access time, and establishing urban distribution centre can be used to encourage users to switch their selection to the rail mode. In another study, Woodburn *et al.* (2007) did a literature review on the impacts of fiscal and regulation policies of the modal shift from road mode to the rail or waterways mode. Regmi (2012) in his doctoral dissertation revealed how the development of dry port could influence the modal shift from the road mode to the rail mode in some countries in Asia. The study also found that GHG emissions could be reduced by an average 30% by developing dry port scenario compared to the BAU scenario.



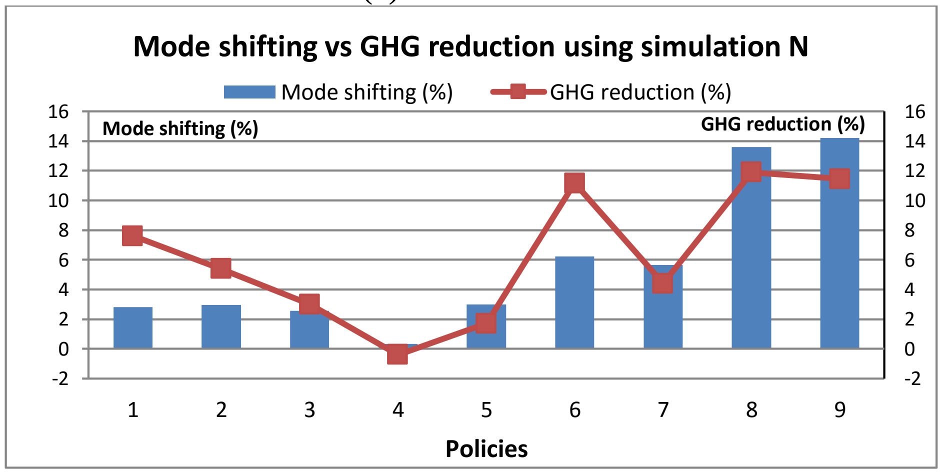
(a) Simulation K



(b) Simulation L



(c) Simulation M



(d) Simulation N

Figure 7.5 The comparison of inland mode shifting and the GHG emission reduction using simulations K, L, M and N for all policies.

7.4.5 Total Inland Mode and Port Cost Reductions

Total cost of the inland mode and port cost is calculated by simulation using RP data considering the cost of inland mode and port chosen by the respondents. **Table 7.24** provides the total cost calculation and its reduction of the nine policies compared to the BAU policy. The total cost of the BAU policy as the baseline for simulation K, L, M, and N are 222.45 billion IDR (11.41 million GBP[37]), 221.24 billion IDR (11.34 million GBP), 213.94 billion IDR (10.97 million GBP), and 212.22 billion IDR (10.88 million GBP) successively.

As shown in **Table 7.24,** Policy 1 and Policy 2 as a single policy will reduce the total cost compared to Policy 3, Policy 4 and Policy 5 that will raise the total cost. This fact is in line with the finding where Policy 1 and Policy 2 are better in terms of reducing GHG emission than the other policies. Furthermore, Policy 6 contributes the highest total cost reduction among the other combined policies. The reduction of total cost using Policy 6 ranging from 1.27 billion IDR (0.6%) to 6.07 billion IDR (2.7%). On the contrary, Policy 7 contributes to the highest increase of the total cost. Furthermore, Policy 8 and Policy 9 gave different results in total cost calculation, where Simulation K and simulation M reduce the total cost, but the policies will raise the total cost in Simulation L and Simulation N. Policy 9 in Simulation N will contribute the highest total cost increase by 7.82 billion IDR (3.7%)

Table 7.24 Total Cost reductions of simulations K, L, M and N for all policies

Policies	**Simulation K**		**Simulation L**		**Simulation M**		**Simulation N**	
	Cost Reduction		**Cost Reduction**		**Cost Reduction**		**Cost Reduction**	
	Billion IDR	**%**	**Billion IDR**	**%**	**Billion IDR**	**%**	**Billion IDR**	**%**
Policy 1	-3.03	-1.4%	-2.23	-1.0%	-2.62	-1.2%	-1.01	-0.5%
Policy 2	-3.42	-1.5%	-1.97	-0.9%	-2.51	-1.2%	-0.83	-0.4%
Policy 3	0.30	0.1%	1.80	0.8%	0.35	0.2%	2.32	1.1%
Policy 4	1.13	0.5%	1.09	0.5%	0.92	0.4%	1.04	0.5%
Policy 5	0.48	0.2%	1.49	0.7%	0.55	0.3%	2.07	1.0%
Policy 6	-6.07	-2.7%	-3.09	-1.4%	-4.62	-2.2%	-1.27	-0.6%
Policy 7	0.87	0.4%	4.07	1.8%	1.01	0.5%	5.14	2.4%
Policy 8	-4.54	-2.0%	4.61	2.1%	-3.13	-1.5%	5.96	2.8%

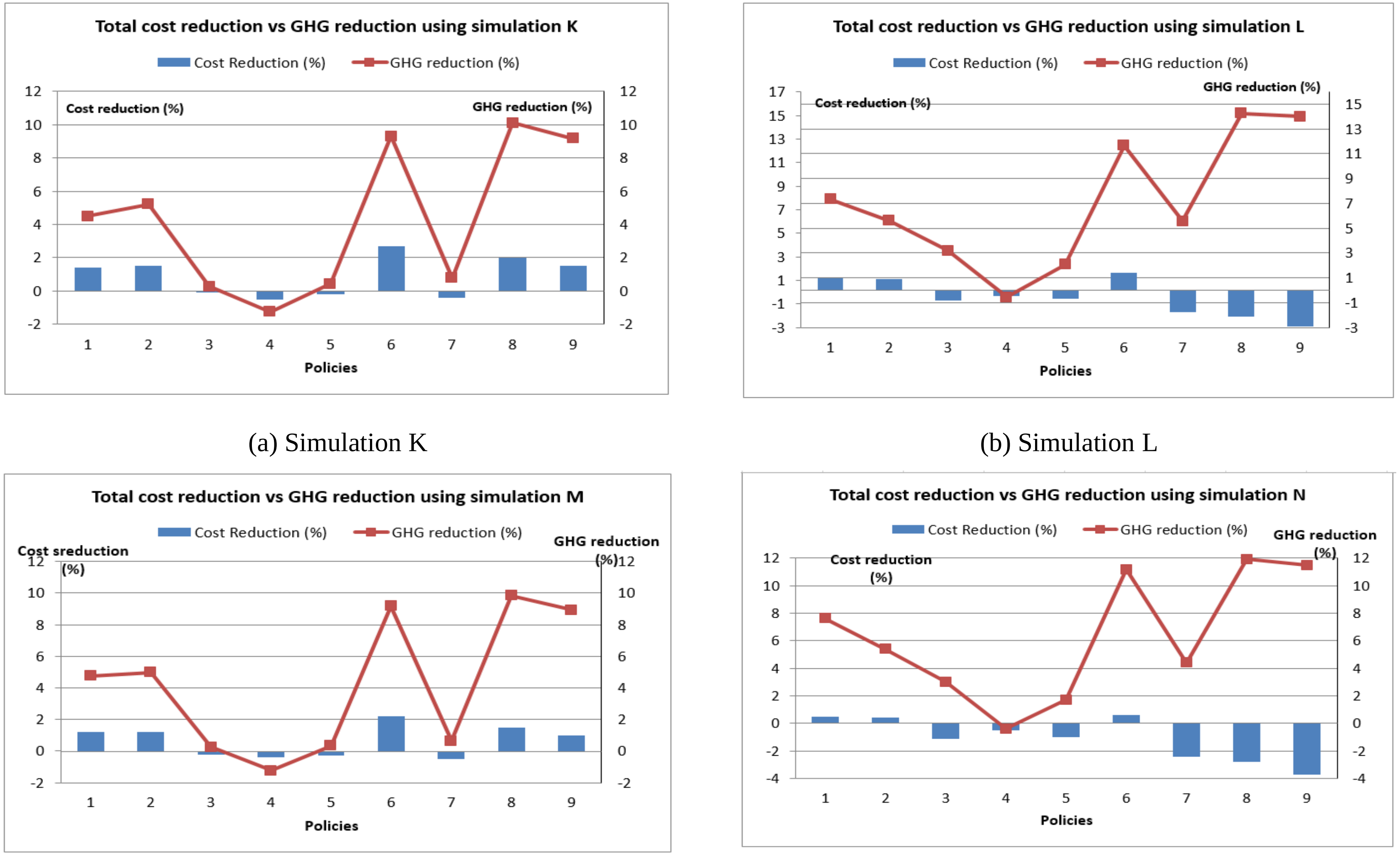
[37] 1 GBP is equivalent to 19,500 IDR according to the exchange rate in February 2016

Policy 9	-3.41	-1.5%	6.38	2.9%	-2.24	-1.0%	7.82	3.7%

The comparison of the total cost reduction and GHG emission reduction is shown in **Figure 7.6** below. The percentage of total cost reduction is clearly lower than the percentage of GHG emission reductions. Moreover, the simulation of policies 3, 4, 5 and 7 in all simulations (simulation K, L, M and N) yields unexpected results. The simulations of policies 3, 4, 5 and 7 are expected to lower the total cost, but the simulations show the opposite results. This finding is particularly likely to happen when users switch their preferred mode to the shorter distance rail services, which are relatively more expensive than the road mode.

Furthermore, although Policies 8 and 9 have the biggest GHG emission reduction, simulation of policies 8 and 9 will have different effect to the cost reduction. The total cost of Policies 8 and 9 will decrease in simulation K and N, but the total cost will increase in simulation L and N. However, the total cost reduction calculation does not include the indirect cost of the GHG emission. Thus, the total cost reduction might be better if the indirect cost is included in the cost reduction calculation.

When comparing the GHG emission reduction in **Table 7.23** and the total cost calculation and its reduction in **Table 7.24**, it can be concluded that Policy 1, Policy 2 and its combination (Policy 6) are the best choice to be applied in terms of GHG emission and total cost reduction of intermodal transport in Java.



(a) Simulation K

(b) Simulation L

(c) Simulation M

(d) Simulation N

Figure 7.6 The comparison of total cost reduction and the GHG emission reduction using simulations K, L, M and N for all policies.

7.5 Summary

To sum up, this chapter presents the policy simulation using the two best models selected in the previous step. The simulation was carried out using five single policies and four joint policies.

The simulation results show the predicted port's market shares of JKT Port will gain the most benefit from all policies, in contrast, the SBY Port will experience the worst impact. The development of the CMY Port is predicted to substantially reduce JKT Port's market share.

The policies diminish the utility alternative using the road mode (policies 1, 2 and 6) are more effective in terms of encouraging users to switch their choices from the road mode to the alternative mode than policies that increase the attractiveness of the rail mode (policies 3, 5 and 7). The policies 1, 2 and 6 also will give the advantage in term of reduction the total cost.

The inland mode shifting from the road mode to the rail mode was proven to contribute to the GHG emission reduction from the freight transport sector.

Chapter 8

Summary and Conclusion

8.0 Introduction

This chapter provides the summary and conclusion of the entire study. Chapter 8 starts with Section 0, which describes the summary of the research, comprising the summary of the Indonesian intermodal freight transport, findings from the literature review, description of the data collection, model estimation and policy simulation. Section 8.2 highlights the fulfilment of the research aims stated in Chapter 1. Section 8.3 outlines the conclusions of the research. Limitations of the research and recommendations for further study are presented in Section 8.4.

8.1 Summary

8.1.1 Situation of Indonesian Economic and Intermodal Freight Transport

After conducting a field work centred on the three main ports in Java and accordingly reviewing many articles, documents and news reports, the results can be summarised as follows:

- Although Indonesia experienced high growth in international trade, Indonesia remains hampered by transportation infrastructure in terms of supporting international trade.

- Java is the most important island, contributing approximately 60% of Indonesian GDP and inhabited by almost 136 million people (58% of Indonesian population) in 2010.

- Three main container ports in Java (Tanjung Priok Port in Jakarta – JKT Port, Tanjung Emas Port in Surabaya – SMG Port, Tanjung Perak Port in Surabaya – SBY Port) constitute to approximately 85% of Indonesian trade in terms of containerized exports and imports.

- The problems in intermodal freight transport in Java, including the lack of capacity, poor infrastructure, high cost and slow delivery, have been highlighted, whilst problems in rail transport include a lack of infrastructure and lack of competition PT KAI is the only rail operator in Indonesia. The sea transport sector is hampered by high port access costs and time, and limited port capacity. Poor rail access to the port and the limited number of the dry ports are prominent issues in the intermodal transport in Java.

- In order to improve the competitiveness of the Indonesian economy, the Indonesian government plans to accelerate economic development with an integrated plan namely MP3EI (*Master Plan for Acceleration and Expansion of Indonesia Economic Development*). In regard to the logistics aspect, the government launched SISLOGNAS (*National Logistics System*) to improve the LPI (*Logistics Performance Index*).

- In terms of emission reduction, Indonesia has a commitment to reduce the GHG emissions by 26% in 2025. Various activities and targets have been proposed in the national action plan for GHG reduction.

- Regarding the intermodal transportation enhancement in Java, various policies are to be implemented. The plans include the construction of new Cilamaya Port (recently cancelled by the new government), the improvement and expansion of the Tanjung Priok Port, the construction of a double track rail network on the island of Java, the reduction of fuel subsidies (especially for the road mode), restrictions on hours and route of operation of container trucks, and the reactivation of various inactive dry ports.

- According to the presentation of the situation of Indonesian logistics and intermodal transport, this research attempts to investigate the behaviour of freight transport users through their stated preferences on the port and inland mode choice.

8.1.2 Findings from the Literature Review

After reviewing the related literature, partially in port and inland mode choice and the GHG emission from the freight transport, some findings can be presented as follows:

- In port choice studies, the decision-makers' perspective could be distinguished for five actors: shippers, freight forwarders, carriers or shipping lines, port or terminal operators and ship owners. Generally each actor has a different perspective

- Several methods have been exploited by previous researchers in examining the determinant factors of port choice. The methods are: (1) Multi Criteria Decision Making (MCDM) method, (2) Stated Preference (SP) or Revealed Preference (RP) method, (3) Literature review, and (4) Factor Analysis.

- The prominent factors in port selection from the perspective of shippers and freight forwarders include: (1) port cost, (2) frequency of ship calls, and (3) port infrastructure. The prominent factors influencing shippers or freight forwarders on mode choice are: (1) transport cost, (2) transit time, (3) reliability, and (4) flexibility.

- In terms of port and mode choice as a joint choice model, various alternatives of port be combined by the carrier, and some others choose the port as the part of a logistics or supply chain choice. The mode choice is supposed to be combined by shipment size.

- The importance of GHG reduction in freight transport has received more attention during more recent times. The reduction model mostly came from the minimisation of GHG emissions or trade-off the GHG emissions and transport costs.

- As an attempt at reducing GHG emissions from the freight transport sector, switching the current choice from the road mode to the greener transport mode, such as rail mode, is an appropriate choice.

8.1.3 Summary of Data Collection

As a main part of the research, this study conducted an SP survey to collect the stated and revealed preference of the respondents on port and inland mode selection for containerized exports form Java. The data collection process can be summarised as follows:

- The survey begins by designing the stated choice experiment; this consists of the determination of alternatives, attribute and level selection, and construction of the experimental design.
- Six alternative attributes were employed to examine the preferences of the exporters and forwarders. Two port attributes include port cost and port ship calls, whereas four attributes of the inland mode used in this research are cost, time, reliability, and GHG emissions.
- The experimental design was generated by the Efficient Design method to minimize standard error in parameter estimation using NGENE software. The efficiency of the design was measured by the minimum of D-error and A-error.
- A pilot survey was carried out, the results of which show that the attributes used in the investigation significantly influenced decision-makers in choosing port and inland modes.
- An online survey system has been developed by this study to accommodate the requirement of the pilot and main survey.
- The respondents of the survey came from nine origins (Jakarta, Bandung, Bekasi, Cirebon, Tangerang, Semarang, Surakarta, Surabaya and Malang) for the pilot survey, and sixteen origins for the main survey (the nine origins and Bogor, Karawang, Yogyakarta, Jepara, Gresik, Sidoarjo and Pasuruan).
- The response rates for both the pilot and main surveys were very low, only approximately 4%. A non-response bias test was carried out to test the differentiation between early respondents and late respondents.
- The surveys' results show that 164 respondents from the pilot and main survey, with 1,287 observations of SP data, were valid for use in the next process. The survey also collected 164 of the current choice of port and inland mode as RP data.

8.1.4 Model Estimation

To examine the attributes of the alternatives, the research carried out a series of estimations using the only SP data and the joint SP and RP data.

- Parameter estimation of SP data only was carried out using four models—Multinomial Logit (MNL), Nested Logit (NL), Mixed Multinomial Logit (MXMNL) and Mixed Nested Logit (MXNL)—whereas the estimation of join SP and RP data employed only the MNL and MXMNL model.
- The data employed in estimation using the SP/RP data consists of 1,451 observations, 1,287 observations of which were derived from the SP data, whilst the rest (164 observations of RP data) were obtained from the actual port and inland mode choice of the respondents.
- In order to select the best model from the several models available, all models were examined based on the value of final log-likelihood, likelihood ratio test, ρ^2, adjusted ρ^2 and signs of the estimated parameters.
- Using MXMNL model, several segments were exploited in the estimation such as export volume per month, frequency of shipment per month, export destination, company type, the number of containers per shipment, and value of products per TEU.
- Estimation results suggested that the best model for estimation using only SP data is Mixed Nested Logit (MXNL) with the port nest—and known as MXNL-SP, whilst Mixed Multinomial Logit (MXMNL) is the best model for estimation using the join SP and RP data—known as MXMNL-SPRP model.
- Estimation results using both the MXNL-SP and MXMNL-SPRP model show that all inland mode attributes and port attributes are significant and have the expected signs. Coefficients of parameters for inland mode cost, inland mode time, inland mode GHG emissions and port cost display negative signs, thus implying adverse effects on the utilities of the alternatives concerned, whilst coefficients for inland mode reliability and port ship calls, on the other hand, demonstrate positive effects on the utilities of the alternatives.

8.1.5 Policies Simulation

Based on the presentation in Chapter 7, a summary of the policy simulation using the two best models selected from the previous step are as follows:

- The simulation was conducted using the two best models from the estimation stage, namely MXNL-SP and MXMNL-SPRP. Two different sources of

Emission Factor (EF) were employed, namely McKinnon & Piecyk (2011) and DEFRA (2011) emission factors. The simulations were carried out of in four different form of simulation (as a combination of two different models and two emission factors).

- The simulation was carried out using five single policies and four joint policies. The single policies are: (1) restricting route and operational hour, (2) fuel subsidy reduction, (3) developing double track railway network, (4) expansion of JKT Port, and (5) giving incentives for rail freight transport. The four combined policies are: (6) reducing road mode attractiveness— combining Policy 1 and 2, (7) improving rail mode attractiveness—combining policy 3 and 5, (8) combining Policy 6 and Policy 7, and (9) combining all of the single policies.
- The simulation begins by calibrating the ASCs, where the simulation was performed using the RP data collected from respondents as there is no RP data available that can be used by this research.
- Policy 4 will increase the market share of the JKT Port, as expected. However, the development of CMY Port will reduce the JKT Port market share from about 65% to 56% in Business As Usual (BAU) scenario.
- In terms of the shifting of the road mode to the rail mode, the impact of policies 1, 2 and 6 (reducing the road mode attractiveness) on mode shifting is quite similar to the impact of policies 3, 5 and 7 (improving the rail mode attractiveness).
- Different findings were obtained, where the policies that diminish the utility alternative using the road mode (policies 1, 2 and 6) were found to be more effective in reducing the GHG emissions from the freight transport when compared with the policies that raise the attractiveness of rail mode (policies 3, 5 and 7).
- As expected, Policy 8 and Policy 9 gave the highest encouragement for switching to the rail mode, and the highest GHG emission reduction as well.

8.2 Fulfilment of the Research Aims

This research was conducted with the aims of (1) understanding the issues associated with the container transport system and its environmental impacts in Java, Indonesia; (2) examining the impact of policies related to containerized freight transport in Java as an attempt to reduce the GHG emissions.

The first aim of this study is centred on understanding the existing intermodal transportation system in Indonesia and related issues, especially in Java, which has been fulfilled by conducting a field study and reviewing the related documents. The study includes observing the current situation and identifying the problems on it, especially the container system in Java, Indonesia. The future development plans, including its impact on the environment, also have been studied and presented in Chapter 2.

To fulfil the second aim, this research has conducted several activities, beginning by reviewing the related literature to derive the determinant factors of inland mode and port choice. The related literature to port and inland mode choice was presented in Chapter 3. The literature review then followed by defining a research methodology framework, as presented in Chapter 4. The study then continued by conducting a stated preference survey in mind of collecting the stated and revealed preference data from the exporters and forwarders in Java (reported in Chapter 5). The results of the survey then have been estimated using some logit models to examine the behaviour of exporters and forwarders on port and inland mode choice. The behaviour of the respondents was examined in Chapter 6.

To examine the impact of related policies, a simulation based on some policies related to the containerized freight transport in Java was performed. The simulation results were analysed according to the changes in port market share, inland mode market shares and the reduction of GHG emission. The process and results of simulation are presented in Chapter 7.

8.3 Conclusions

The conclusion of this research is distinguished into general conclusion, data collection, model estimation and policy simulation and presented, as discussed below.

8.3.1 General Conclusions

- The results from the field study and document analysis point out a prominent problem on containerized exports, such as port departure choice and inland mode used to carry the container from the origins to the port selected.
- The main factors influence the decision makers in port selection from the perspective of shippers and freight forwarders are: (1) port cost, (2) frequency of ship calls and (3) port infrastructure. The prominent factors influencing the shippers or freight forwarders on mode choice are (1) transport cost, (2) transit time, (3) reliability and (4) flexibility.
- According to the literature review, this study is the first research examining the joint choice model of port and inland mode choice from the perspective of exporters and freight forwarders.

8.3.2 Conclusions in the Data Collection Part

Several aspects from the data collection performed can be concluded as follows:

- This study has collected the SP and RP data of port and inland mode choice from the perspective of exporters and forwarders in Java. The respondents of the survey came from 16 origin regions Java.
- The SP survey is appropriate method to collect the data from respondents when some of the alternatives do not exist (such as CMY Port and the rail mode services from and to SMG Port).
- Online survey system is an appropriate tool to performing an SP survey from the respondents which located in many different area, and as unavailability of a suitable online system, this study has developed an online survey system to accommodate the data collection of the stated preference.
- The estimation results of the pilot survey reveals that most of the alternatives' attributes are statistically significant and have the expected signs. The pilot survey results also can be used to validate the prior values of the Efficient Design
- A non-response bias test was conducted and shows that there is no difference result between the early respondents (who completed the surveys after they

received the first invitation) and the late respondents (who completed the surveys after they received the reminder).

8.3.3 Conclusions in the Model Estimation Part

From the part of the estimation model, some critical findings can be reported as follows:

- Estimation results suggest that the best model for estimation using SP data only is MXNL, whilst MXMNL is the best model for estimation using the join SP and RP data. The heterogeneity across the respondents can be found in the inland mode cost attribute, partially for the respondents with the small size shipments (up to two TEUs per shipments).
- In general, the mixed logit models employed in the simulation (MXNL and MXMNL) show a higher value of final likelihood, likelihood ratio test, rho-square and adjusted rho square than the values in simple MNL and NL models.
- The use of combined SP and RP data in the estimation show improvements in statistics such as rho-square and adjusted rho square than the values of using the pure SP data.
- The attractiveness of the alternative could be evaluated using its Alternative-Specific Constant (ASC) value. The ASCs reveal that SMG-RD and JKT-RD alternatives have considerable advantages in terms of the unobserved factors such as port infrastructure, port congestion, port efficiency and flexibility of inland mode services. In facts, generally the alternatives using the rail modes are less favourable than the alternatives using the road modes.
- The segmented estimation reveals that:
    - Respondents with larger volume of exports (more than 10 TEUs per month) are more sensitive to inland mode GHG emissions and port costs compared to the respondents with smaller volume of exports (up to 10 TEUs per month).
    - Companies with a higher frequency of shipment (six or more shipments per month), considering more to the port cost than less frequent of shipment (one to five shipments per month) companies.
    - Exports to far distance destination (Europe, America and Africa) are less sensitive to inland mode cost than exports to close destination (Asia and Australia)

    - Inland mode GHG emissions and port cost are more important for exporters than for forwarders. Nevertheless, forwarding companies give more attention to the reliability of inland mode and frequency of ship calls compared to exporters.
    - Inland mode cost and port cost are significantly more important for respondents with a bigger size of shipments (equal or more than three TEUs per shipment) than smaller size of shipments companies (one or two TEUs per shipment)
    - Respondents with a higher value of exports (more than 200 million IDR, approximately 10,000 GBP per TEU) are more sensitive to the port cost than companies with a lower value of commodities.
- The estimation results from both MXNL-SP and MXMNL-SPRP models show that coefficients of parameters for inland mode cost, inland mode time, inland mode GHG emissions and port cost have a negative effect on utility.
- Two attributes—inland mode reliability and port ship calls—demonstrate positive effects on the utilities of port and mode alternatives both in MXNL-SP and MXMNL-SPRP models. These are consistent with the findings garnered by the previous researchers.

8.3.4 Conclusions in the Policy Simulation Part

According to the policy simulation process and results, various conclusions can be presented as follows:

- Simulations using the MXNL-SP model resulting smaller impacts to the predicted port shares than simulations using MXMNL-SPRP model. Overall, Policy 1, 2 and 6 (diminish the attractiveness of road mode) has different impacts compared to the Policy 3, 5 and 7 (improving the rail mode's attractiveness). SMG Port will gain the most by implementation of Policy 1, 2 and 6, but JKT Port will get the highest gain by implementing Policy 3, 5 and 7.
- As the GHG emission is a part of the alternatives' utility functions, then the simulation results could be different when the simulation was conducted using the different emission factor, such as DEFRA's EF versus McKinnon and Piecyk's EF in this study.

- The simulation results of MXMNL-SPRP model is better than MXNL-SP results, in terms of GHG emission reduction using both emission factors above.
- The policies diminishing the utility alternative using the road mode (Policy 1—route and operational hours restriction, Policy 2—fuel subsidy reduction, and Policy 6—combining restriction of route and operational hours and fuel subsidy reduction policies) are more effective in reducing GHG emissions from the freight transport than policies raising the attractiveness of rail mode (Policy 3—development of double track rail network, Policy 5—providing subsidy for rail freight transport, and Policy 7—combining development of the double track rail network and providing incentive for rail freight transport). However, the impact of policies 1, 2 and 6 (reducing the road mode attractiveness) on mode shifting is quite similar to the impact of policies 3, 5 and 7 (improving the rail mode attractiveness).
- Regarding to the impact of the policies to GHG emission reduction, Policy 8 (comprises four single policies: restriction of operational hours and route, reduction of fuel subsidy for road transport, development of double track rail network, and giving subsidy for rail freight transport) in Simulation L is expected to gain the highest emission reduction for combined policies; and Policy 1 (restricting the operational hour and route for trucks policy) is the best action in terms of emission reduction for single policy.
- From the all policy tests conducted, the shifting of users from road mode to rail mode demonstrate a substantial contribution of the shifting to the emission reduction, with the exception of Policy 4 (extension of JKT Port) that is not directly related to the transport factor.
- An interesting fact was found in the SMG-RD alternative, where the market shares increased when the policies of reducing utility of the road mode were applied in the simulation. This facts is in contrast than expected, which the policies are expected to reduce the road market shares.
- The simulation of total port and mode cost results indicate small reduction of the cost in Policies 1, 2 and 6. However, Policies 3, 4, 5, and 7 will increase the total cost, instead of lower the total cost as expected.

8.4 Limitations and Recommendations

8.4.1 Limitations of the Research

This research is the first study that developed a joint model of inland mode and port choice from the shippers' or freight forwarders' perspective using SP data. This research also contributes to the study of freight transport in Indonesia, particularly in the investigation of the development of freight transport that takes into account user preferences. However, some aspects should be mentioned in this section as the limitations of this research:

- The study mainly focused on identifying the issues and problems of the port inland mode and port choice for the single journey to the port, and did not consider empty container transport from the depot to the origin of respondents. This limitation gives a consequence that GHG emissions are actually larger than has been simulated. However, this limitation does not affect to the results of total cost simulation, because the costs incurred for transportation includes the cost of transporting empty containers. This limitation is relevant to the definition of intermodal transport in Section 3.1.1 stating that movement of the empty intermodal transport unit is not part of intermodal transport.
- The RP data of this study is limited to only the data attained from the survey; thus, the data may not give a good representation of the entire population. Given the difficulties on data collection, the RP data only consists of 164 respondents, which is quite small for a comprehensive analysis. Nevertheless, for a discrete choice research in freight transport, the number of respondent is sufficient and the results obtained from this study remain valid using SP data from 1287 observations. Moreover, the distribution of the respondents is quite close to the population distribution.
- The experimental design of the study was designed for the Multinomial Logit (MNL) model; however, the data were used to estimate using various logit models, namely Multinomial Logit, Nested Logit (NL), Mixed Multinomial Logit (MXMNL) and Mixed Nested Logit (MXNL). The experimental design for MNL model was used for its simplicity and the possibility to be extended to the more complicated design.
- As the data collection process was conducted using an online system, it was difficult to ensure the respondents were the right people (actual decision-makers

on mode and port choice). Nonetheless, this study has attempted to invite the respondent candidates who fit the criteria. Also, this research has developing an online survey tool to minimize the possibility of having respondents who do not meet the criteria.

8.4.2 Recommendations for Further Studies

From the findings in Section 8.1, some further investigations could be carried out on the data, model estimation, and simulation as follows:

- *Data*
  - Current alternatives of the research has included eight possible alternatives as combinations of the port and inland mode. The current Indonesian government initiated to establish a maritime connection between major port and collector ports (*see* Section 2.3.3). Further studies can be performed by including the Short Sea Shipping (SSS) services as the third transport mode alternative for the origins situated in the coastal area, such as Jakarta, Cirebon, Semarang, Jepara, Surabaya, Gresik and Pasuruan (*see* **Figure 2.8**). However, including the SSS as the other alternative will make the experiment more complicated and discrete choice model might be not an appropriate method anymore to solve the problem.
  - The data gathered from containerized products can be expanded through the addition of containerized import and also domestic container transport in Indonesia. Including domestic container transport will ease in a more comprehensive analysis at the aggregate level. The intermodal transportation demand on inland or in ports and their impact on the environment can be simulated as needed.
- *Estimation Model*
  - Further model specification search can be carried out by employing various other models, such as the Latent Class (LC) model. This model can be used to identify the hidden class and its membership. In LC model, the population might consist of several hidden classes, where the coefficient of parameters are different for different classes, and all individuals in the same class have the same coefficient parameters (Train, 2009). The main purpose of the LC analysis is to develop better strategies and policies for each different class in the population (Bierlaire, 2011). The LC model was widely adopted in

marketing, and then got more attention from the researchers in transport field. Some researchers have attempted to employ the LC model in transport research, particularly mode choice for passenger transport (Hess *et al.*, 2011; Bierlaire, 2011; Hurtubia *et al.*, 2010; Wen and Lai, 2010; Wen *et al.*, 2012; Lee *et al.*, 2003; Temme *et al.*, 2008) For instance, Bierlaire (2011) using two latent classes, revealed that people in Switzerland with high income who are lively in their social life are less elastic to the changes in the transport offer This research has attempted to estimate the coefficient parameters using the LC model, unfortunately there was a failure in installing the Python Biogeme software (which includes LC estimation) to a Linux PC.

- *Simulation*
  - Some other plans and policies, such as the development of Teluk Lamong Terminal at SBY Port (*see* Section 2.2.3.3), increasing the emissions standard, restructuring the vehicle tax and emissions labelling (*see* Section 2.4.8), could be simulated to examine the impact of the policy to the port-mode market shares and the GHG emission reduction.

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Appendix A: Syntax and Output of Experimental Design Using NGENE

A.1 Sample of NGENE Syntax for Origin Bandung

Design

;alts = alt1, alt2, alt3, alt4

;rows = 128

;eff = (mnl,d)

;block = 16

;model :

U(alt1) = b1[-0.000468] * PortCost1[480,720,1200,1440] + b2[0.0254] * ShipsCalls1[41,55,68,82] + b3[-0.000683] * ModeCost1[1900,2850,4750,5700] + b4[-0.195] * ModeTime1[3.4,5,8.4,10.1] + b5[0.0504] * ModeReliability1[70,80,90,100] + b6[-0.00544] * GHGEMissions1[90,150] /

U(alt2) = b1[-0.000468] * PortCost2[480,720,1200,1440] + b2[0.0254] * ShipsCalls2[41,55,68,82] + b3[-0.000683] * ModeCost2[2050,3075,5125,6150] + b4[-0.195] * ModeTime2[3.6,5.4,9,10.8] + b5[0.0504] * ModeReliability1[70,80,90,100]+ b6[-0.00544] * GHGEMissions2[41,68] /

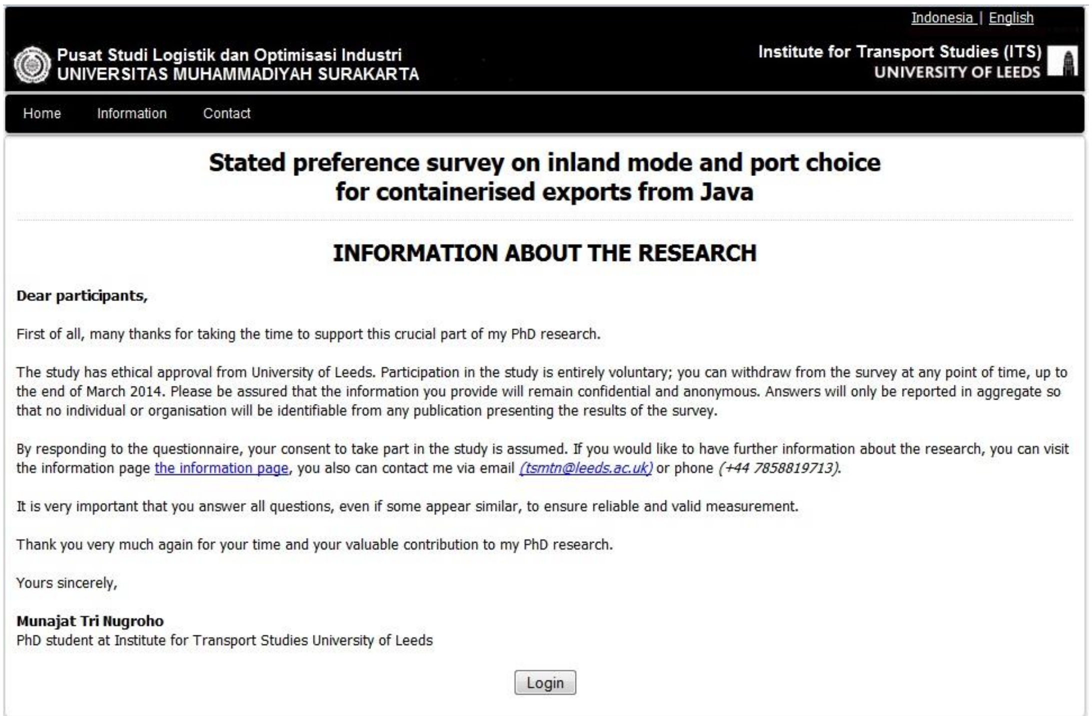
U(alt3) = b1[-0.000468] * PortCost3[480,720,1200,1440] + b2[0.0254] * ShipsCalls3[21,31,51,62] + b3[-0.000683] * ModeCost3[1550,2325,3875,4650] + b4[-0.195] * ModeTime3[2.8,4.1,6.9,8.3] + b5[0.0504] * ModeReliability1[70,80,90,100]+ b6[-0.00544] * GHGEMissions3[70,116] /

U(alt4) = b1[-0.000468] * PortCost4[480,720,1200,1440] + b2[0.0254] * ShipsCalls4[21,31,51,62] + b3[-0.000683] * ModeCost4[1850,2775,4625,5550] + b4[-0.195] * ModeTime4[3.2,4.7,7.9,9.5] + b5[0.0504] * ModeReliability1[70,80,90,100]+ b6[-0.00544] * GHGEMissions4[35,58] $

A.2 Sample of Efficient Design Result for Origin Bandung

Choice situation	Alternative 1: Jakarta-Road						Alternative 2: Jakarta-Rail						Alternative 3: Cilamaya-Road						Alternative 4: Cilamaya-Rail						Block
	Port cost	Ship calls	Mode cost	Mode time	Mode relia bility	GHG emis sions	Port cost	Ship calls	Mode cost	Mode time	Mode relia bility	GHG emis sions	Port cost	Ship calls	Mode cost	Mode time	Mode relia bility	GHG emis sions	Port cost	Ship calls	Mode cost	Mode time	Mode relia bility	GHG emis sions	
9	1209	69	1700	3.7	1	130	403	55	4500	10.2	0.7	30	602	21	3750	7.2	0.8	56	602	21	3900	7	0.8	21	1
30	1008	82	5100	9.3	1	78	403	82	1800	3.4	0.7	50	602	51	3125	8.7	0.9	93	1203	62	1950	8.4	1	21	1
31	1209	55	2550	5.6	1	130	605	69	5400	10.2	0.7	30	1003	51	1250	2.9	1	93	602	31	1950	4.2	1	34	1
64	1008	55	4250	9.3	0.7	78	605	69	1800	5.1	1	30	1203	51	1875	8.7	0.7	93	602	31	3900	4.2	0.8	34	1
65	403	69	2550	11.2	0.7	78	1008	55	4500	5.1	0.9	50	602	21	3125	4.3	0.9	56	1203	51	1300	2.8	1	21	1
76	403	69	1700	11.2	0.7	78	1209	55	4500	3.4	0.9	50	1003	21	3125	7.2	0.8	56	1203	51	3250	2.8	1	21	1
84	605	41	2550	5.6	0.8	78	403	82	4500	10.2	0.7	50	1003	62	3750	2.9	1	93	1203	62	1300	2.8	1	21	1
96	605	55	4250	5.6	0.8	78	1209	69	2700	8.5	1	30	401	62	1875	2.9	0.7	93	1003	21	3250	7	0.8	34	1
19	1008	41	2550	5.6	0.8	78	1008	69	4500	8.5	0.9	50	1003	31	3750	7.2	0.9	56	401	62	1300	4.2	1	21	2
26	1209	82	1700	11.2	1	78	605	55	2700	5.1	0.8	50	401	62	3750	4.3	0.7	56	401	62	3900	2.8	0.7	34	2
38	605	55	2550	9.3	0.9	130	605	41	4500	5.1	0.8	50	401	62	1250	2.9	1	93	1203	62	3900	8.4	0.7	21	2
66	1209	69	1700	11.2	1	130	403	41	1800	3.4	0.8	30	401	21	3750	4.3	0.7	56	602	31	3900	4.2	0.7	34	2
68	605	41	2550	5.6	0.9	78	1209	82	5400	8.5	0.7	30	401	62	1250	2.9	1	93	602	21	1950	7	0.9	34	2
78	403	82	5100	5.6	1	78	1209	82	1800	5.1	0.7	30	602	51	1875	8.7	0.9	56	602	51	3250	7	1	34	2
118	1008	55	4250	3.7	0.8	78	1008	82	4500	10.2	1	50	1003	31	1875	7.2	0.9	56	401	62	1300	2.8	0.7	21	2
119	1008	55	4250	9.3	0.8	78	605	55	4500	5.1	0.9	50	401	62	1875	2.9	1	93	1203	62	1300	7	0.7	21	2

Appendix B: Online Survey Interfaces



Indonesia | English

Pusat Studi Logistik dan Optimisasi Industri
UNIVERSITAS MUHAMMADIYAH SURAKARTA

Institute for Transport Studies (ITS)
UNIVERSITY OF LEEDS

Home Information Contact

Stated preference survey on inland mode and port choice for containerised exports from Java

INFORMATION ABOUT THE RESEARCH

Dear participants,

First of all, many thanks for taking the time to support this crucial part of my PhD research.

The study has ethical approval from University of Leeds. Participation in the study is entirely voluntary; you can withdraw from the survey at any point of time, up to the end of March 2014. Please be assured that the information you provide will remain confidential and anonymous. Answers will only be reported in aggregate so that no individual or organisation will be identifiable from any publication presenting the results of the survey.

By responding to the questionnaire, your consent to take part in the study is assumed. If you would like to have further information about the research, you can visit the information page the information page, you also can contact me via email *(tsmtn@leeds.ac.uk)* or phone *(+44 7858819713)*.

It is very important that you answer all questions, even if some appear similar, to ensure reliable and valid measurement.

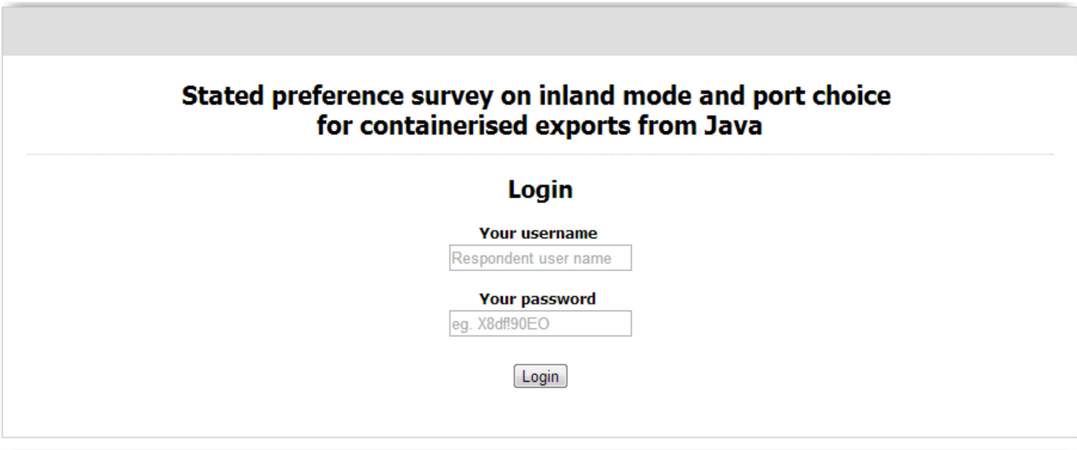
Thank you very much again for your time and your valuable contribution to my PhD research.

Yours sincerely,

Munajat Tri Nugroho
PhD student at Institute for Transport Studies University of Leeds

Login

Figure B.1 Welcome and Information of the Research



Stated preference survey on inland mode and port choice for containerised exports from Java

Login

Your username

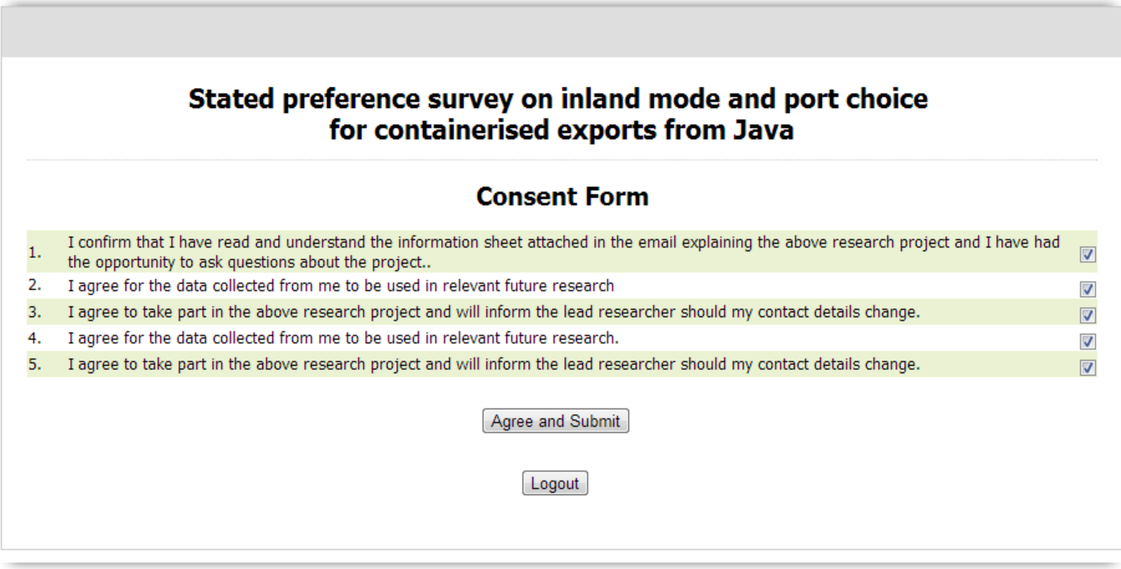
Respondent user name

Your password

eg. X8dfl90EO

Login

Figure B.2 Login form



Stated preference survey on inland mode and port choice
for containerised exports from Java

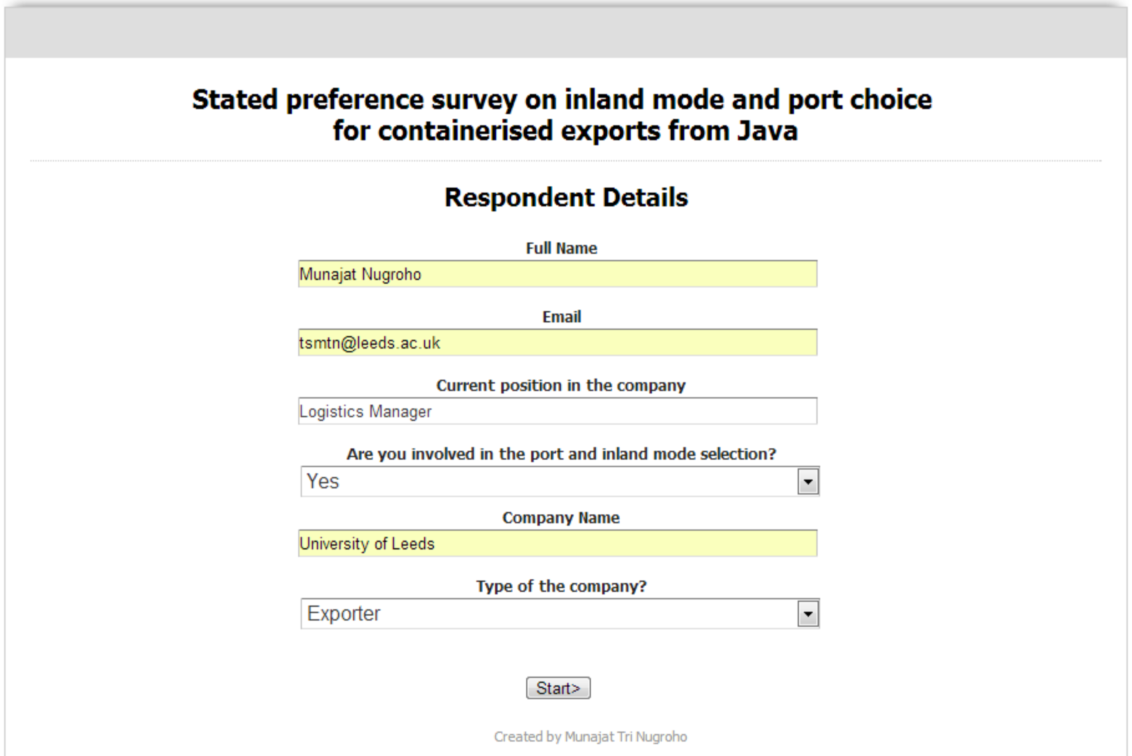
Consent Form

1. I confirm that I have read and understand the information sheet attached in the email explaining the above research project and I have had the opportunity to ask questions about the project..
2. I agree for the data collected from me to be used in relevant future research
3. I agree to take part in the above research project and will inform the lead researcher should my contact details change.
4. I agree for the data collected from me to be used in relevant future research.
5. I agree to take part in the above research project and will inform the lead researcher should my contact details change.

Agree and Submit

Logout

Figure B.3 Consent Form



Stated preference survey on inland mode and port choice
for containerised exports from Java

Respondent Details

Full Name
Munajat Nugroho

Email
tsmtn@leeds.ac.uk

Current position in the company
Logistics Manager

Are you involved in the port and inland mode selection?
Yes

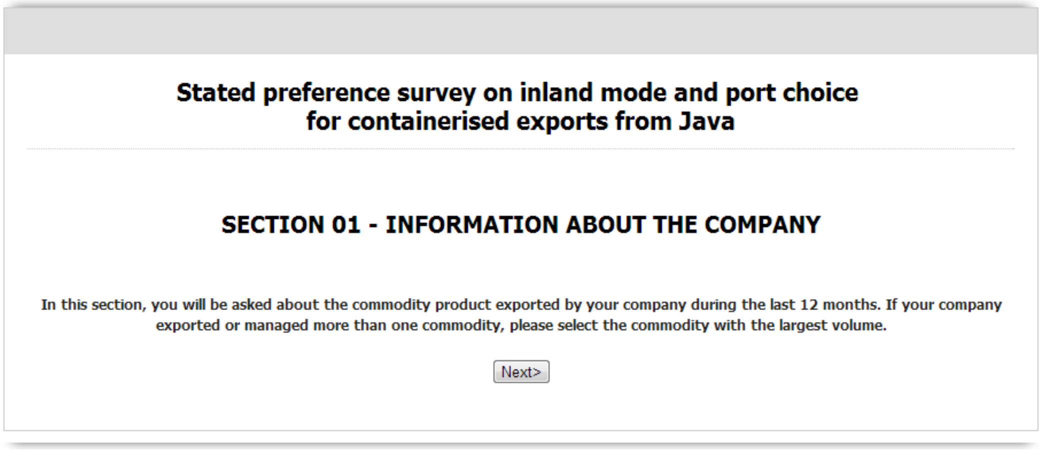
Company Name
University of Leeds

Type of the company?
Exporter

Start>

Created by Munajat Tri Nugroho

Figure B.4 Respondent Details



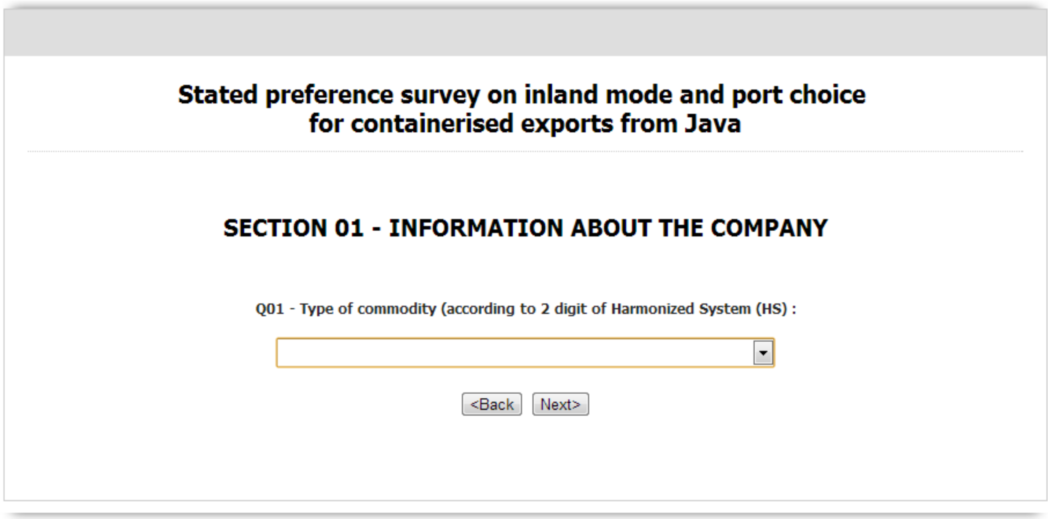
Stated preference survey on inland mode and port choice for containerised exports from Java

SECTION 01 - INFORMATION ABOUT THE COMPANY

In this section, you will be asked about the commodity product exported by your company during the last 12 months. If your company exported or managed more than one commodity, please select the commodity with the largest volume.

Next>

Figure B.5 Part 1: Information about the company



Stated preference survey on inland mode and port choice for containerised exports from Java

SECTION 01 - INFORMATION ABOUT THE COMPANY

Q01 - Type of commodity (according to 2 digit of Harmonized System (HS) :

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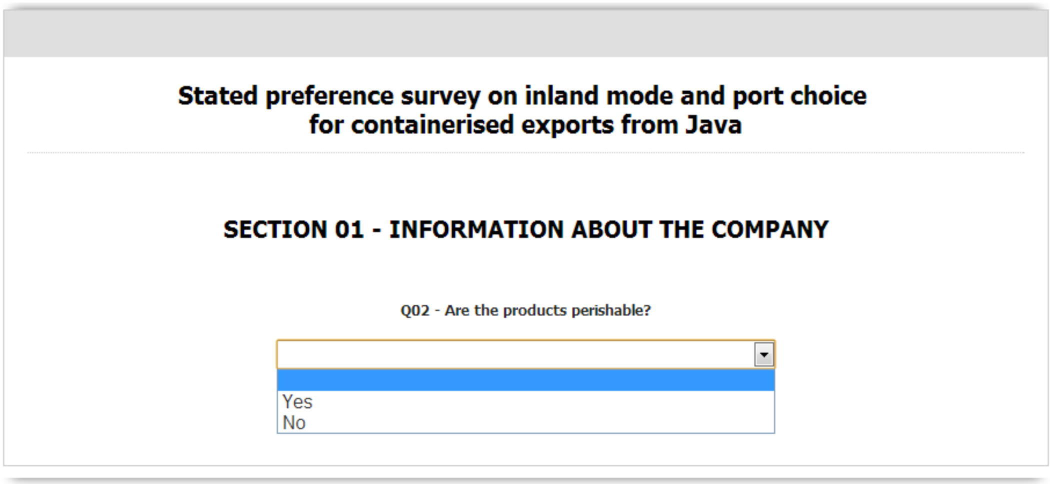
Figure B.6 Q01 - Type of commodity according to 2 digit HS-Code



Stated preference survey on inland mode and port choice for containerised exports from Java

SECTION 01 - INFORMATION ABOUT THE COMPANY

Q02 - Are the products perishable?

Yes
No

Figure B.7 Q02 - Are the products perishable? : Yes or No

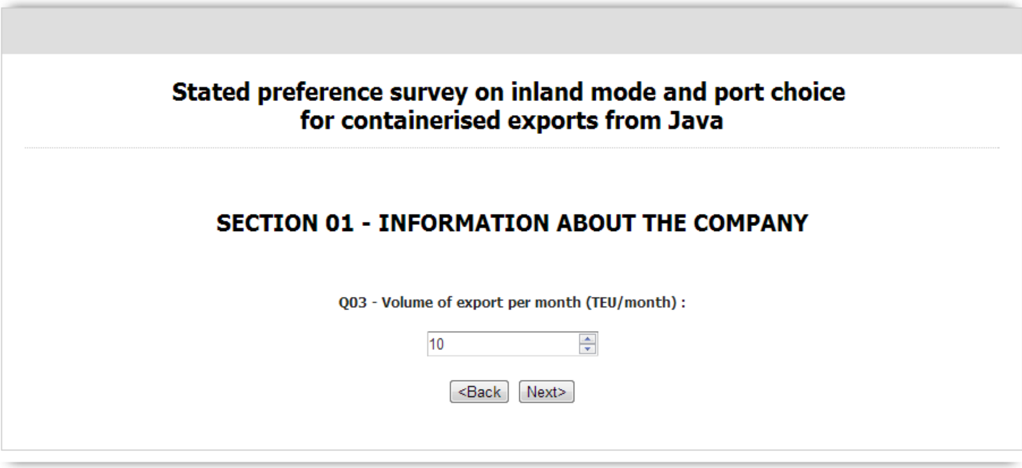


Figure B.8 Q03 –Volume of export per month

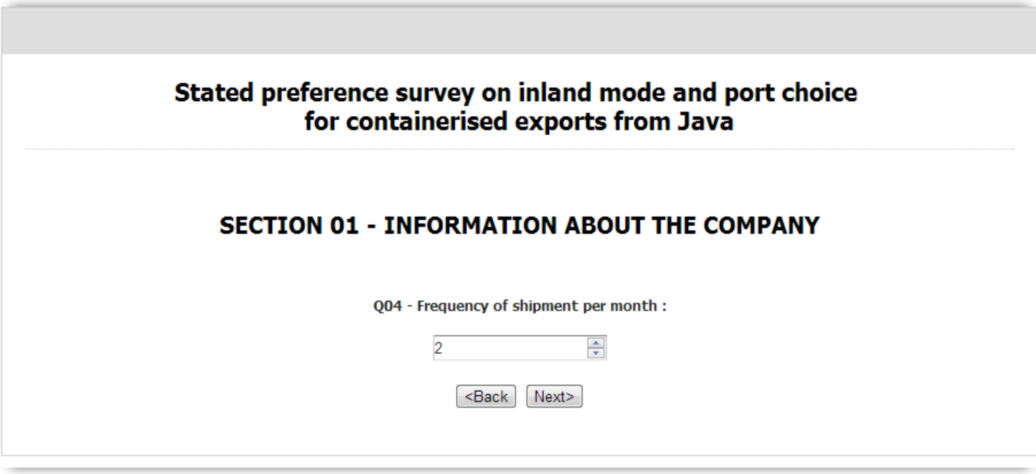


Figure B.9 Q04 – Frequency of shipment per month

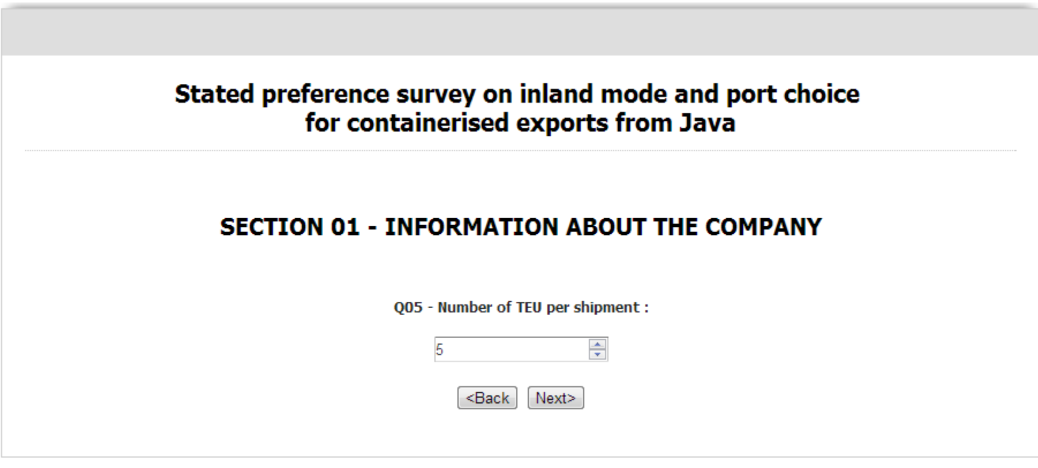


Figure B.10 Q05 – Frequency of shipment per month

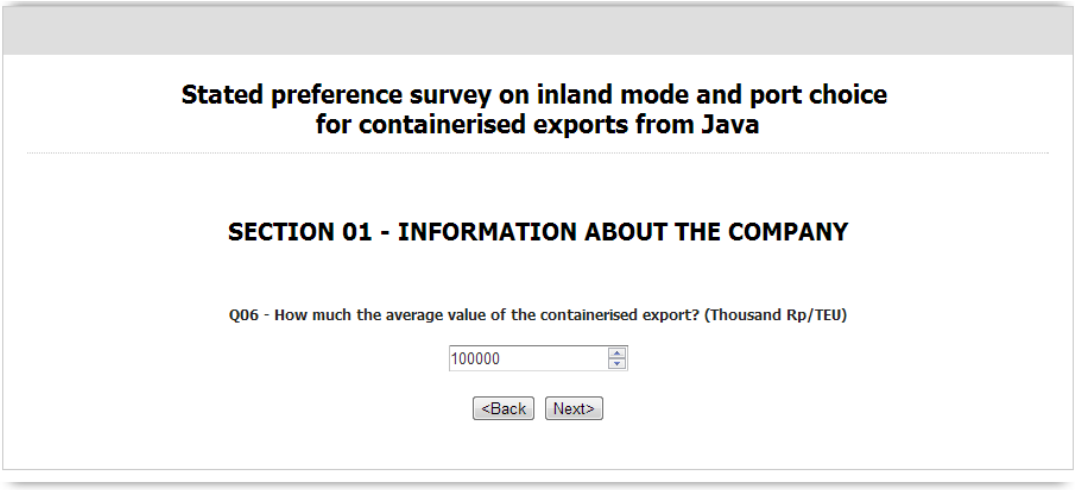


Figure B.11 Q06 – The average value of product per TEU

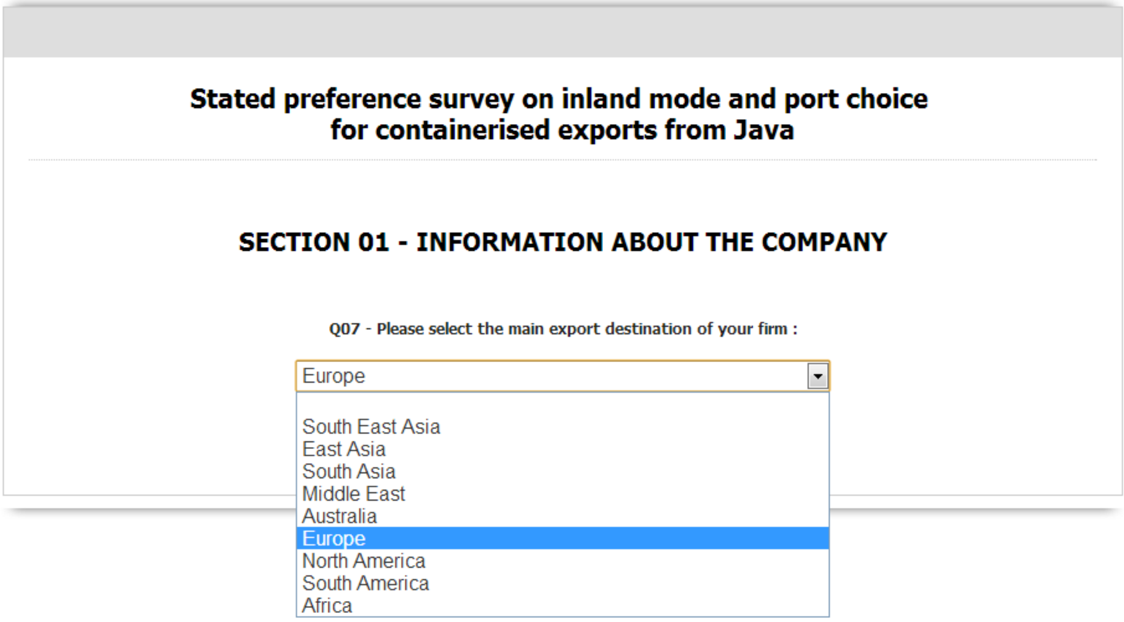
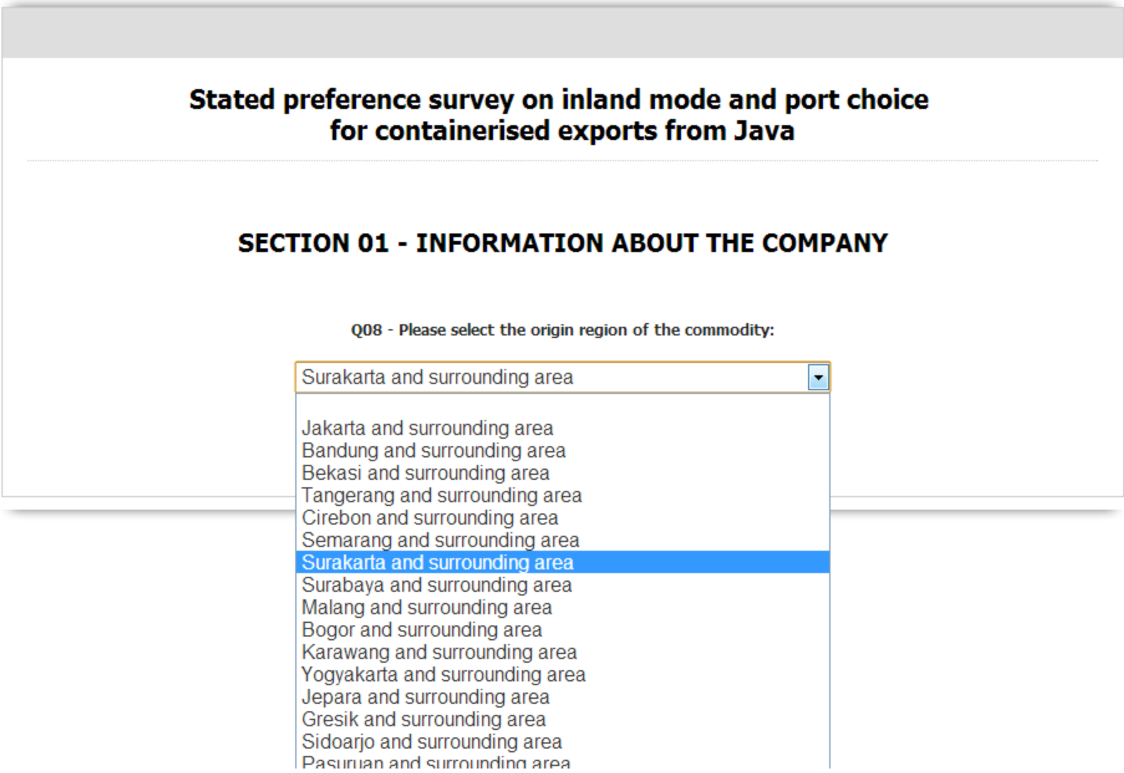


Figure B.12 Q07 – Main export destination


Stated preference survey on inland mode and port choice
for containerised exports from Java

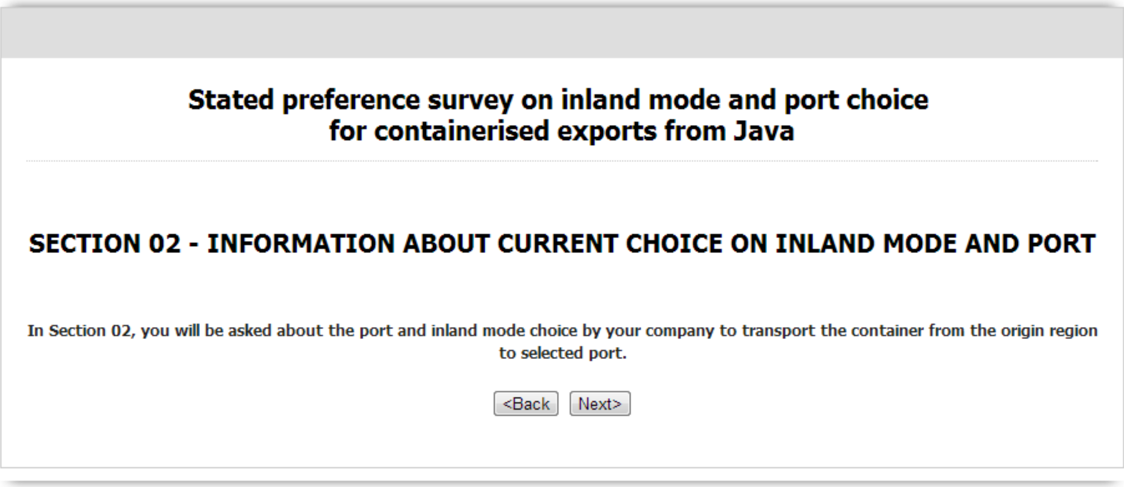
SECTION 01 - INFORMATION ABOUT THE COMPANY

Q08 - Please select the origin region of the commodity:

Surakarta and surrounding area

Jakarta and surrounding area
Bandung and surrounding area
Bekasi and surrounding area
Tangerang and surrounding area
Cirebon and surrounding area
Semarang and surrounding area
Surakarta and surrounding area
Surabaya and surrounding area
Malang and surrounding area
Bogor and surrounding area
Karawang and surrounding area
Yogyakarta and surrounding area
Jepara and surrounding area
Gresik and surrounding area
Sidoarjo and surrounding area
Pasuruan and surrounding area

Figure B.13 Q08 – Origin region of product


Stated preference survey on inland mode and port choice
for containerised exports from Java

SECTION 02 - INFORMATION ABOUT CURRENT CHOICE ON INLAND MODE AND PORT

In Section 02, you will be asked about the port and inland mode choice by your company to transport the container from the origin region to selected port.

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Figure B.14 Part 2: Information about current choice

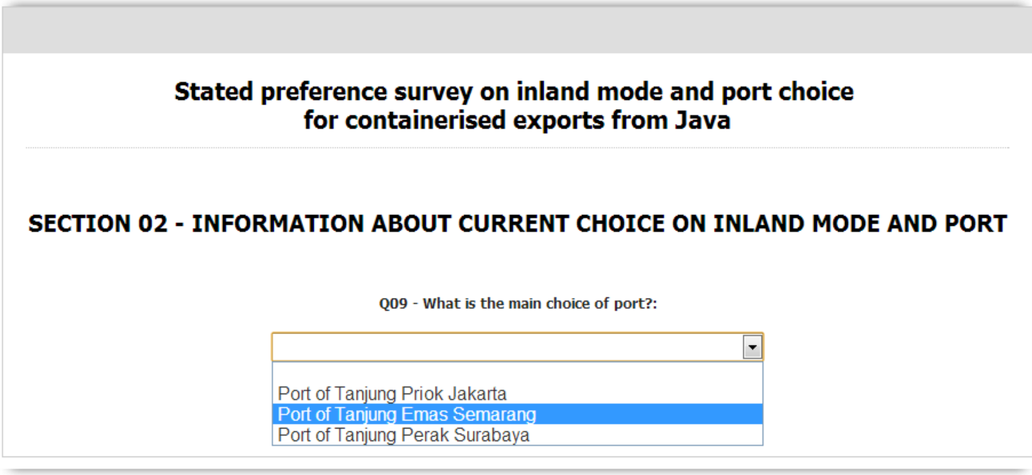


Figure B.15 Q09 – Main choice of port

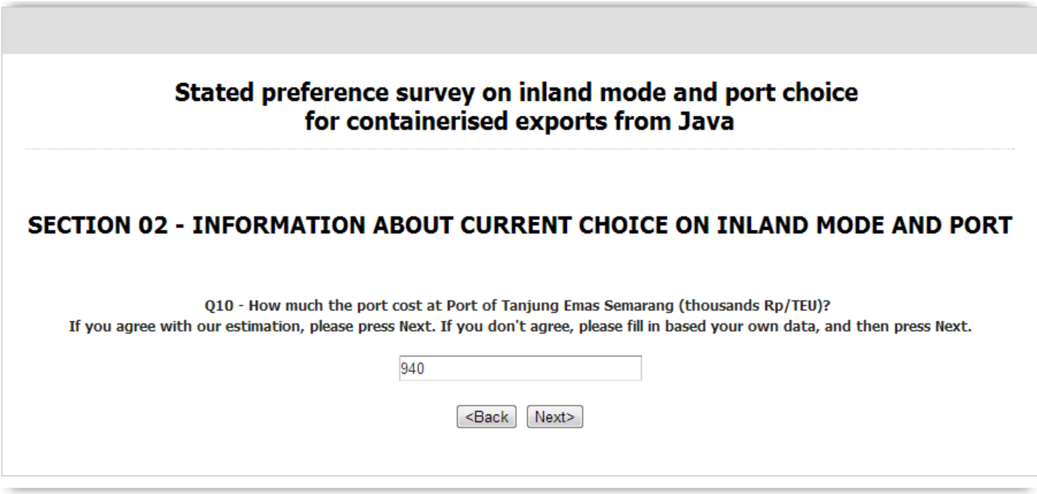


Figure B.16 Q10 - Port cost

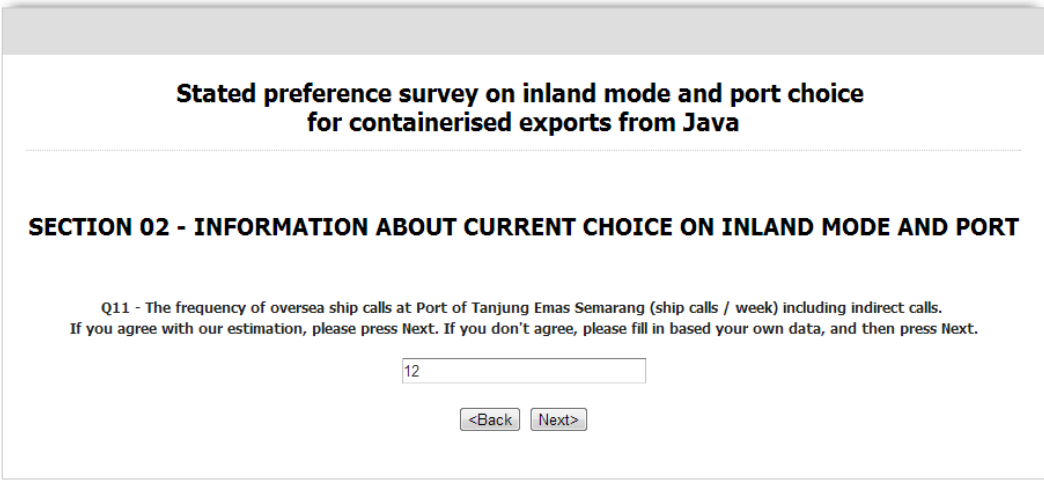
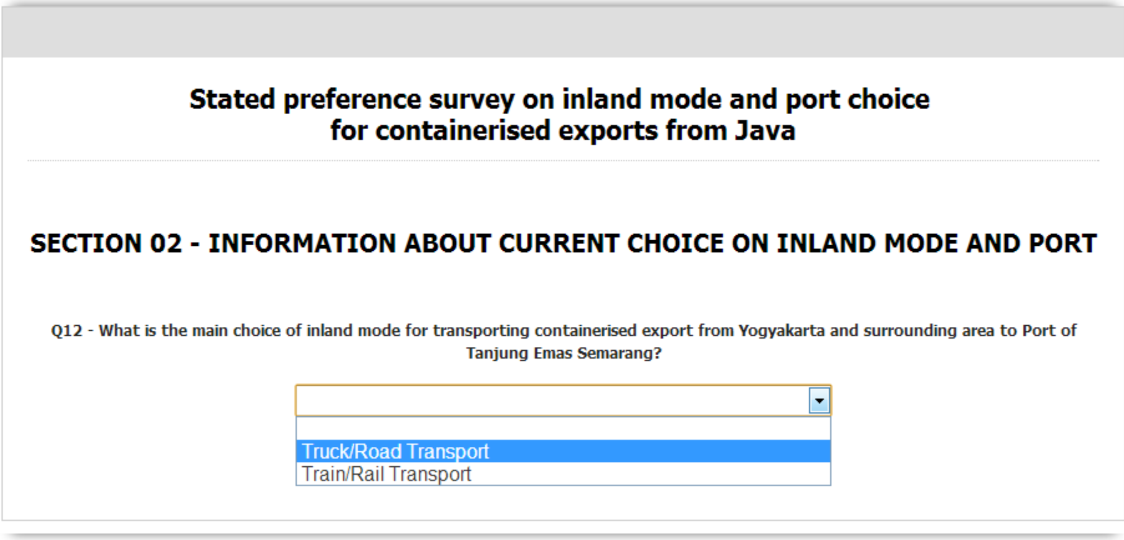


Figure B.17 Q11 - Frequency of ship calls at the selected port



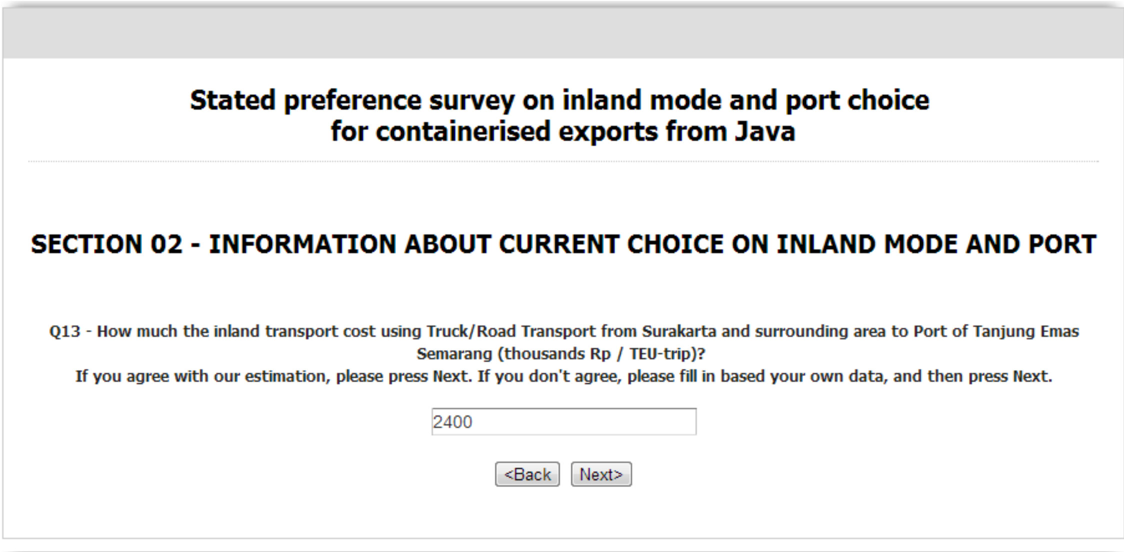
Stated preference survey on inland mode and port choice
for containerised exports from Java

SECTION 02 - INFORMATION ABOUT CURRENT CHOICE ON INLAND MODE AND PORT

Q12 - What is the main choice of inland mode for transporting containerised export from Yogyakarta and surrounding area to Port of Tanjung Emas Semarang?

Truck/Road Transport
Train/Rail Transport

Figure B.18 Q12 – Main choice of inland mode



Stated preference survey on inland mode and port choice
for containerised exports from Java

SECTION 02 - INFORMATION ABOUT CURRENT CHOICE ON INLAND MODE AND PORT

Q13 - How much the inland transport cost using Truck/Road Transport from Surakarta and surrounding area to Port of Tanjung Emas Semarang (thousands Rp / TEU-trip)?
If you agree with our estimation, please press Next. If you don't agree, please fill in based your own data, and then press Next.

2400

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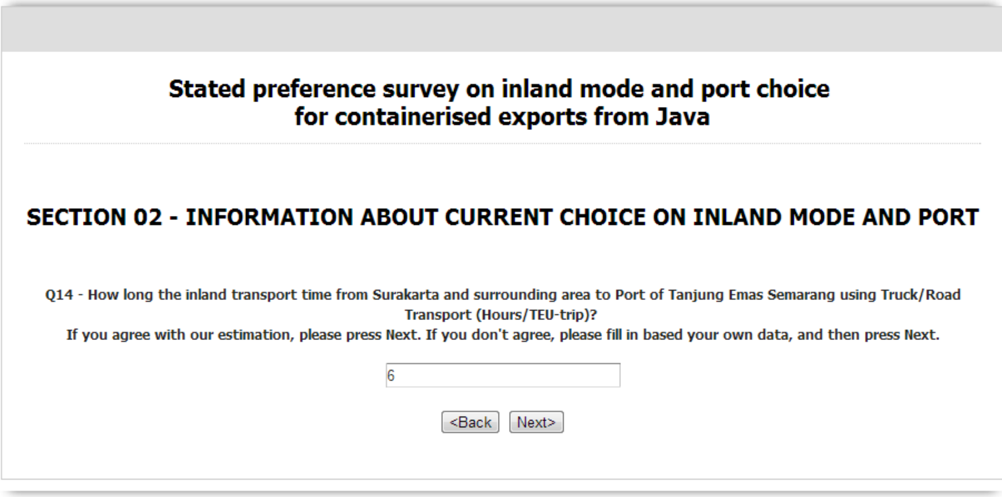
Figure B.19 Q13 – Inland mode transport cost



Stated preference survey on inland mode and port choice
for containerised exports from Java

SECTION 02 - INFORMATION ABOUT CURRENT CHOICE ON INLAND MODE AND PORT

Q14 - How long the inland transport time from Surakarta and surrounding area to Port of Tanjung Emas Semarang using Truck/Road Transport (Hours/TEU-trip)?
If you agree with our estimation, please press Next. If you don't agree, please fill in based your own data, and then press Next.

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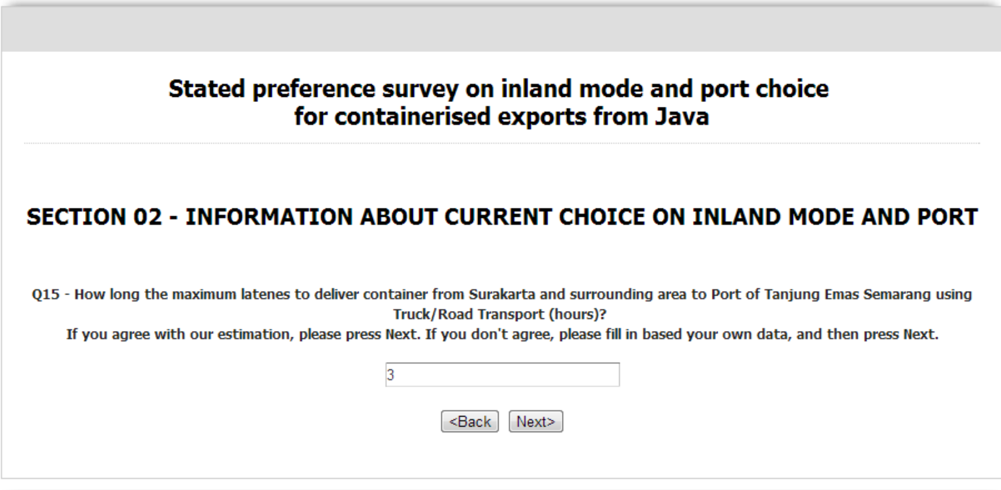
Figure B.20 Q14 – Inland mode transport time



Stated preference survey on inland mode and port choice
for containerised exports from Java

SECTION 02 - INFORMATION ABOUT CURRENT CHOICE ON INLAND MODE AND PORT

Q15 - How long the maximum latenes to deliver container from Surakarta and surrounding area to Port of Tanjung Emas Semarang using Truck/Road Transport (hours)?
If you agree with our estimation, please press Next. If you don't agree, please fill in based your own data, and then press Next.

3

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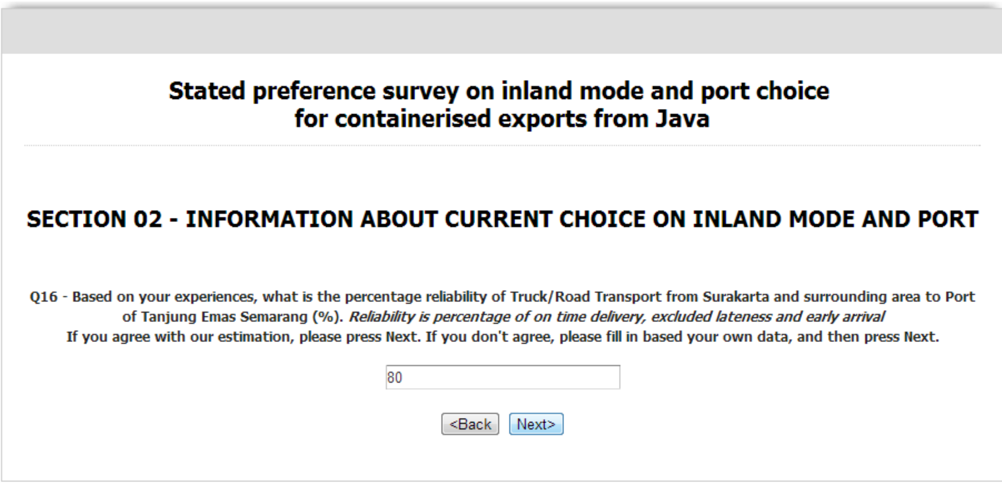
Figure B.21 Q15 –Maximum lateness of selected inland mode



Stated preference survey on inland mode and port choice
for containerised exports from Java

SECTION 02 - INFORMATION ABOUT CURRENT CHOICE ON INLAND MODE AND PORT

Q16 - Based on your experiences, what is the percentage reliability of Truck/Road Transport from Surakarta and surrounding area to Port of Tanjung Emas Semarang (%). *Reliability is percentage of on time delivery, excluded lateness and early arrival*
If you agree with our estimation, please press Next. If you don't agree, please fill in based your own data, and then press Next.

80

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Figure B.22 Q16 – The percentage of inland mode reliability

Stated preference survey on inland mode and port choice for containerised exports from Java

SECTION 03 - SCENARIOS FOR INLAND MODE AND PORT CHOICE

In section 03 you will be asked to choose the best and the worst choice according your preference in 8 hypothetical scenarios of port and inland mode choice from your origin area.
You will be shown by 4 alternatives of port-inlnad mode from your origin area, and each alternative is described using the 6 attributes:

1. Port cost
2. Ships calls
3. Inland mode cost
4. Inland mode time
5. Inland mode reliability
6. Inland mode GHG emissions.

Some of alternatives may appear unrealistic but for the purpose of this research you are requested to consider them as they have been shown.

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Figure B.23 Part 3: Scenarios for the inland mode port choice

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 1 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 1,410,000	Rp 940,000	Rp 960,000	Rp 735,000
- Oversea ship calls frequency per week	12 calls	12 calls	82 calls	19 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 2,900,000	Rp 3,200,000	Rp 9,000,000	Rp 4,067,000
- Inland mode transport time (hours/trip)	5.1 hours	6.9 hours	15.0 hours	7.6 hours
- Percentage of inland mode reliability	100%	80%	80%	80%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	128 Kg CO2-e	36 Kg CO2-e	75 Kg CO2-e	70 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE	◉	○	○	○
CHOOSE THE WORST ALTERNATIVE	○	◉	○	○

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Figure B.24 Scenario 1 of 8

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 2 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 1,097,000	Rp 1,253,000	Rp 640,000	Rp 1,225,000
- Oversea ship calls frequency per week	12 calls	10 calls	109 calls	19 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 3,383,000	Rp 4,267,000	Rp 7,500,000	Rp 4,900,000
- Inland mode transport time (hours/trip)	6.8 hours	5.2 hours	15.0 hours	7.6 hours
- Percentage of inland mode reliability	70%	100%	80%	90%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	128 Kg CO2-e	36 Kg CO2-e	75 Kg CO2-e	70 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE				
CHOOSE THE WORST ALTERNATIVE				

Figure B.25 Scenario 2 of 8

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 3 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 1,097,000	Rp 1,097,000	Rp 480,000	Rp 1,470,000
- Oversea ship calls frequency per week	6 calls	6 calls	96 calls	23 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 4,350,000	Rp 4,800,000	Rp 4,500,000	Rp 3,283,000
- Inland mode transport time (hours/trip)	6.8 hours	6.9 hours	18.1 hours	4.6 hours
- Percentage of inland mode reliability	70%	80%	100%	70%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	85 Kg CO2-e	54 Kg CO2-e	150 Kg CO2-e	35 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE				
CHOOSE THE WORST ALTERNATIVE				

Figure B.26 Scenario 3 of 8

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 4 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 940,000	Rp 1,253,000	Rp 800,000	Rp 1,470,000
- Oversea ship calls frequency per week	8 calls	12 calls	109 calls	19 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 3,383,000	Rp 3,733,000	Rp 6,000,000	Rp 4,067,000
- Inland mode transport time (hours/trip)	6.0 hours	5.2 hours	15.0 hours	6.1 hours
- Percentage of inland mode reliability	80%	90%	90%	90%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	128 Kg CO2-e	36 Kg CO2-e	75 Kg CO2-e	35 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE	( )	(•)	( )	( )
CHOOSE THE WORST ALTERNATIVE	( )	( )	( )	(•)

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Figure B.27 Scenario 4 of 8

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 5 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 1,097,000	Rp 1,410,000	Rp 960,000	Rp 490,000
- Oversea ship calls frequency per week	8 calls	6 calls	123 calls	12 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 3,867,000	Rp 4,800,000	Rp 6,000,000	Rp 3,283,000
- Inland mode transport time (hours/trip)	6.8 hours	7.8 hours	9.1 hours	9.1 hours
- Percentage of inland mode reliability	70%	100%	70%	90%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	85 Kg CO2-e	54 Kg CO2-e	75 Kg CO2-e	70 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE	( )	( )	( )	(•)
CHOOSE THE WORST ALTERNATIVE	( )	( )	(•)	( )

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Figure B.28 Scenario 5 of 8

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 6 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 1,097,000	Rp 1,097,000	Rp 480,000	Rp 1,470,000
- Oversea ship calls frequency per week	8 calls	8 calls	96 calls	23 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 4,350,000	Rp 4,267,000	Rp 4,500,000	Rp 4,067,000
- Inland mode transport time (hours/trip)	6.0 hours	7.8 hours	18.1 hours	4.6 hours
- Percentage of inland mode reliability	70%	70%	100%	80%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	85 Kg CO2-e	54 Kg CO2-e	150 Kg CO2-e	35 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE	○	○	○	●
CHOOSE THE WORST ALTERNATIVE	○	○	●	○

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Figure B.29 Scenario 6 of 8

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 7 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 1,410,000	Rp 1,253,000	Rp 800,000	Rp 490,000
- Oversea ship calls frequency per week	12 calls	6 calls	82 calls	15 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 3,383,000	Rp 4,267,000	Rp 9,000,000	Rp 4,067,000
- Inland mode transport time (hours/trip)	6.0 hours	7.8 hours	15.0 hours	6.1 hours
- Percentage of inland mode reliability	70%	100%	70%	100%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	85 Kg CO2-e	36 Kg CO2-e	150 Kg CO2-e	70 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE	○	●	○	○
CHOOSE THE WORST ALTERNATIVE	○	○	●	○

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Figure B.30 Scenario 7 of 8

Stated preference survey on inland mode and port choice for containerised exports from Java

Scenario 8 of 8 scenarios (for respondents from Surakarta and surrounding area)

Attributes of alternatives	Aternatives (Port - Inland Mode)			
	Port B - Truck	Port B - Train	Port A - Train	Port C - Train
- Port cost (Rp/TEU)	Rp 940,000	Rp 1,253,000	Rp 800,000	Rp 1,225,000
- Oversea ship calls frequency per week	8 calls	12 calls	109 calls	15 calls
- Inland mode transport cost (Rp/TEU-trip)	Rp 3,867,000	Rp 4,267,000	Rp 4,500,000	Rp 3,283,000
- Inland mode transport time (hours/trip)	5.1 hours	5.2 hours	18.1 hours	7.6 hours
- Percentage of inland mode reliability	100%	70%	100%	70%
- Inland mode GHG emissions (Kg CO2e/TEU-trip)	128 Kg CO2-e	36 Kg CO2-e	75 Kg CO2-e	35 Kg CO2-e
CHOOSE THE BEST ALTERNATIVE	◉	○	○	○
CHOOSE THE WORST ALTERNATIVE	○	○	○	◉

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Finish>

Figure B.31 Scenario 8 of 8

Stated preference survey on inland mode and port choice for containerised exports from Java

Suggestion for this research(optional)

Submit and Finish>

Figure B.32 Suggestion or feedback (optional)

Appendix C: Syntax and Output of Estimation Using BIOGEME

C.1 Sample of BIOGEME Syntax for Model A0.2

```
// Author: Munajat Tri Nugroho, ITS University of Leeds
// Date: Mon Oct 27 16:43:52 2014
// Multinomial Logit model A0.2
// Eight alternatives: A-Truck, A-Train, B-Truck, B-Train, C-Truck, C-Train, D-Truck,D-Train
// SP data

[ModelDescription]
"Joint choice model of Port and inland mode for containerized exports from Java"
"1 Alternative1 Port A (Tanjung Priok - JKT) – Truck/Road"
"2 Alternative2 Port A (Tanjung Priok - JKT) – Train/Rail"
"3 Alternative3 Port B (Tanjung Emas - SMG) – Truck/Road"
"4 Alternative4 Port B (Tanjung Emas - SMG) – Train/Rail"
"5 Alternative5 Port C (Tanjung Perak - SBY) – Truck/Road"
"6 Alternative6 Port C (Tanjung Perak - SBY) – Train/Rail"
"7 Alternative7 Port D (Cilamaya - CMY) – Truck/Road"
"8 Alternative8 Port D (Cilamaya - CMY) – Train/Rail"

[Choice]
BEST

[Beta]
ASC_1       0    -10    10    1
ASC_2       0    -10    10    0
ASC_3       0    -10    10    0
ASC_4       0    -10    10    0
ASC_5       0    -10    10    0
ASC_6       0    -10    10    0
ASC_7       0    -10    10    0
ASC_8       0    -10    10    0
B_P_COST    0    -10    10    0
B_P_SHIP    0    -10    10    0
B_M_COST    0    -10    10    0
B_M_TIME    0    -10    10    0
B_M_RELI    0    -10    10    0
B_M_GHG     0    -10    10    0
```

[Utilities]

1 A1_Alter1 Alternative1_AV ASC_1 * One + B_P_COST * P_COST1_SCALED + B_P_SHIP * P_SHIP1_SCALED + B_M_COST * M_COST1_SCALED + B_M_TIME * M_TIME1_SCALED + B_M_RELI * M_RELI1_SCALED + B_M_GHG * M_GHG1_SCALED

2 A2_Alter2 Alternative2_AV ASC_2 * One + B_P_COST * P_COST2_SCALED + B_P_SHIP * P_SHIP2_SCALED + B_M_COST * M_COST2_SCALED + B_M_TIME * M_TIME2_SCALED + B_M_RELI * M_RELI2_SCALED + B_M_GHG * M_GHG2_SCALED

3 A3_Alter3 Alternative3_AV ASC_3 * One + B_P_COST * P_COST3_SCALED + B_P_SHIP * P_SHIP3_SCALED + B_M_COST * M_COST3_SCALED + B_M_TIME * M_TIME3_SCALED + B_M_RELI * M_RELI3_SCALED + B_M_GHG * M_GHG3_SCALED

4 A4_Alter4 Alternative4_AV ASC_4 * One + B_P_COST * P_COST4_SCALED + B_P_SHIP * P_SHIP4_SCALED + B_M_COST * M_COST4_SCALED + B_M_TIME * M_TIME4_SCALED + B_M_RELI * M_RELI4_SCALED + B_M_GHG * M_GHG4_SCALED

5 A5_Alter5 Alternative5_AV ASC_5 * One + B_P_COST * P_COST5_SCALED + B_P_SHIP * P_SHIP5_SCALED + B_M_COST * M_COST5_SCALED + B_M_TIME * M_TIME5_SCALED + B_M_RELI * M_RELI5_SCALED + B_M_GHG * M_GHG5_SCALED

6 A6_Alter6 Alternative6_AV ASC_6 * One + B_P_COST * P_COST6_SCALED + B_P_SHIP * P_SHIP6_SCALED + B_M_COST * M_COST6_SCALED + B_M_TIME * M_TIME6_SCALED + B_M_RELI * M_RELI6_SCALED + B_M_GHG * M_GHG6_SCALED

7 A7_Alter7 Alternative7_AV ASC_7 * One + B_P_COST * P_COST7_SCALED + B_P_SHIP * P_SHIP7_SCALED + B_M_COST * M_COST7_SCALED + B_M_TIME * M_TIME7_SCALED + B_M_RELI * M_RELI7_SCALED + B_M_GHG * M_GHG7_SCALED

8 A8_Alter8 Alternative8_AV ASC_8 * One + B_P_COST * P_COST8_SCALED + B_P_SHIP * P_SHIP8_SCALED + B_M_COST * M_COST8_SCALED + B_M_TIME * M_TIME8_SCALED + B_M_RELI * M_RELI8_SCALED + B_M_GHG * M_GHG8_SCALED

[Expressions]

One = 1
P_COST1_SCALED = P_COST1 / 1000
P_SHIP1_SCALED = P_SHIP1 / 100.00
M_COST1_SCALED = M_COST1 / 1000
M_TIME1_SCALED = M_TIME1 / 10
M_RELI1_SCALED = M_RELI1 / 100.00
M_GHG1_SCALED = M_GHG1 / 100.00

```
P_COST2_SCALED = P_COST2 / 1000
P_SHIP2_SCALED = P_SHIP2 / 100.00
M_COST2_SCALED = M_COST2 / 1000
M_TIME2_SCALED = M_TIME2 / 10
M_RELI2_SCALED = M_RELI2 / 100.00
M_GHG2_SCALED = M_GHG2 / 100.00
P_COST3_SCALED = P_COST3 / 1000
P_SHIP3_SCALED = P_SHIP3 / 100.00
M_COST3_SCALED = M_COST3 / 1000
M_TIME3_SCALED = M_TIME3 / 10
M_RELI3_SCALED = M_RELI3 / 100.00
M_GHG3_SCALED = M_GHG3 / 100.00
P_COST4_SCALED = P_COST4 / 1000
P_SHIP4_SCALED = P_SHIP4 / 100.00
M_COST4_SCALED = M_COST4 / 1000
M_TIME4_SCALED = M_TIME4 / 10
M_RELI4_SCALED = M_RELI4 / 100.00
M_GHG4_SCALED = M_GHG4 / 100.00
P_COST5_SCALED = P_COST5 / 1000
P_SHIP5_SCALED = P_SHIP5 / 100.00
M_COST5_SCALED = M_COST5 / 1000
M_TIME5_SCALED = M_TIME5 / 10
M_RELI5_SCALED = M_RELI5 / 100.00
M_GHG5_SCALED = M_GHG5 / 100.00
P_COST6_SCALED = P_COST6 / 1000
P_SHIP6_SCALED = P_SHIP6 / 100.00
M_COST6_SCALED = M_COST6 / 1000
M_TIME6_SCALED = M_TIME6 / 10
M_RELI6_SCALED = M_RELI6 / 100.00
M_GHG6_SCALED = M_GHG6 / 100.00
P_COST7_SCALED = P_COST7 / 1000
P_SHIP7_SCALED = P_SHIP7 / 100.00
M_COST7_SCALED = M_COST7 / 1000
M_TIME7_SCALED = M_TIME7 / 10
M_RELI7_SCALED = M_RELI7 / 100.00
M_GHG7_SCALED = M_GHG7 / 100.00
P_COST8_SCALED = P_COST8 / 1000
P_SHIP8_SCALED = P_SHIP8 / 100.00
M_COST8_SCALED = M_COST8 / 1000
M_TIME8_SCALED = M_TIME8 / 10
M_RELI8_SCALED = M_RELI8 / 100.00
M_GHG8_SCALED = M_GHG8 / 100.00
```

[Exclude]

(BEST == 0) + ((filling_time <= 600) * (filling_time > 0))

[Model]

$MNL

C.2 Sample Estimation Result from BIOGEME for Model A0.2

```
// This file has automatically been generated.
// Michel Bierlaire, EPFL

biogeme 2.2 [Thu Mar 15 14:58:02 WEST 2012]
Michel Bierlaire, EPFL

  Joint choice model of Port and inland mode for containerized exports from Java
  1 Alternative1 Port A (Tanjung Priok - JKT) – Truck/Road
  2 Alternative2 Port A (Tanjung Priok - JKT) – Train/Rail
  3 Alternative3 Port B (Tanjung Emas - SMG) – Truck/Road
  4 Alternative4 Port B (Tanjung Emas - SMG) – Train/Rail
  5 Alternative5 Port C (Tanjung Perak - SBY) – Truck/Road
  6 Alternative6 Port C (Tanjung Perak - SBY) – Train/Rail
  7 Alternative7 Port D (Cilamaya - CMY) – Truck/Road
  8 Alternative8 Port D (Cilamaya - CMY) – Train/Rail

Model: Multinomial Logit
Number of estimated parameters: 13
Number of observations: 1287
Number of individuals: 1287
Null log-likelihood: -1784.161
Init log-likelihood: -1784.161
Final log-likelihood: -1367.071
Likelihood ratio test: 834.181
Rho-square: 0.234
Adjusted rho-square: 0.226
Final gradient norm: +1.168e-002
Diagnostic: Convergence reached...
Iterations: 8
Run time: 00:00
Variance-covariance: from analytical hessian
Sample file: SP_data_main_and_pilot_survey.dat

Utility parameters
******************
Name     Value  Std err   t-test p-val   Rob. std err Rob. t-test Rob. p-val
----     -----  -------   ------ -----   ------------ ----------- ----------
ASC_1    0.00   --fixed--
```

ASC_2	-1.08	0.119	-9.07	0.00		0.118	-9.16	0.00	
ASC_3	0.658	0.276	2.39	0.02		0.259	2.55	0.01	
ASC_4	-0.999	0.290	-3.45	0.00		0.275	-3.64	0.00	
ASC_5	0.248	0.298	0.83	0.41	*	0.276	0.90	0.37	*
ASC_6	-0.780	0.282	-2.76	0.01		0.262	-2.98	0.00	
ASC_7	-0.557	0.110	-5.04	0.00		0.109	-5.12	0.00	
ASC_8	-1.26	0.133	-9.43	0.00		0.135	-9.32	0.00	
B_M_COST	-0.257	0.0332	-7.74	0.00		0.0352	-7.31	0.00	
B_M_GHG	-0.817	0.109	-7.49	0.00		0.114	-7.17	0.00	
B_M_RELI	1.93	0.293	6.61	0.00		0.289	6.69	0.00	
B_M_TIME	-0.863	0.146	-5.90	0.00		0.148	-5.83	0.00	
B_P_COST	-0.406	0.101	-4.02	0.00		0.0970	-4.19	0.00	
B_P_SHIP	0.683	0.225	3.03	0.00		0.215	3.18	0.00	

Utility functions
****

1 A1_Alter1 Alternative1_AV ASC_1 * One + B_P_COST * P_COST1_SCALED + B_P_SHIP * P_SHIP1_SCALED + B_M_COST * M_COST1_SCALED + B_M_TIME * M_TIME1_SCALED + B_M_RELI * M_RELI1_SCALED + B_M_GHG * M_GHG1_SCALED

2 A2_Alter2 Alternative2_AV ASC_2 * One + B_P_COST * P_COST2_SCALED + B_P_SHIP * P_SHIP2_SCALED + B_M_COST * M_COST2_SCALED + B_M_TIME * M_TIME2_SCALED + B_M_RELI * M_RELI2_SCALED + B_M_GHG * M_GHG2_SCALED

3 A3_Alter3 Alternative3_AV ASC_3 * One + B_P_COST * P_COST3_SCALED + B_P_SHIP * P_SHIP3_SCALED + B_M_COST * M_COST3_SCALED + B_M_TIME * M_TIME3_SCALED + B_M_RELI * M_RELI3_SCALED + B_M_GHG * M_GHG3_SCALED

4 A4_Alter4 Alternative4_AV ASC_4 * One + B_P_COST * P_COST4_SCALED + B_P_SHIP * P_SHIP4_SCALED + B_M_COST * M_COST4_SCALED + B_M_TIME * M_TIME4_SCALED + B_M_RELI * M_RELI4_SCALED + B_M_GHG * M_GHG4_SCALED

5 A5_Alter5 Alternative5_AV ASC_5 * One + B_P_COST * P_COST5_SCALED + B_P_SHIP * P_SHIP5_SCALED + B_M_COST * M_COST5_SCALED + B_M_TIME * M_TIME5_SCALED + B_M_RELI * M_RELI5_SCALED + B_M_GHG * M_GHG5_SCALED

6 A6_Alter6 Alternative6_AV ASC_6 * One + B_P_COST * P_COST6_SCALED + B_P_SHIP * P_SHIP6_SCALED + B_M_COST * M_COST6_SCALED + B_M_TIME * M_TIME6_SCALED + B_M_RELI * M_RELI6_SCALED + B_M_GHG * M_GHG6_SCALED

7 A7_Alter7 Alternative7_AV ASC_7 * One + B_P_COST * P_COST7_SCALED + B_P_SHIP * P_SHIP7_SCALED + B_M_COST * M_COST7_SCALED + B_M_TIME * M_TIME7_SCALED + B_M_RELI * M_RELI7_SCALED + B_M_GHG * M_GHG7_SCALED

8 A8_Alter8 Alternative8_AV ASC_8 * One + B_P_COST * P_COST8_SCALED + B_P_SHIP * P_SHIP8_SCALED + B_M_COST * M_COST8_SCALED + B_M_TIME * M_TIME8_SCALED + B_M_RELI * M_RELI8_SCALED + B_M_GHG * M_GHG8_SCALED

Appendix D: t-test for Lambda (λ) Coefficients of Nested Logit and Mixed Nested Logit Models

In order to investigate whether the lambda parameters are sometimes not significantly different from 1, a t-test of lambda parameters against 1 is calculated using this formula:

$$t = \frac{\lambda - 1}{\sqrt{var(\lambda)}}$$

The results of t-tests against 0 and 1 are presented in four tables below:

Table D.1: t-test for lambda (λ) NL of port nest (Model B1)

Parameters	Nested Logit B1.1				Nested Logit B1.2			
	Value	Std-err	t-test(0)	t-test(1)	Value	Std-err	t-test(0)	t-test(1)
λ of CMY_PORT nest	$0.943^{\#}$	0.217	4.35^{**}	-0.263	0.586	0.164	3.57^{**}	-2.524^{**}
λ of JKT_PORT nest	$0.986^{\#}$	0.0785	12.56^{**}	-0.178	0.831	0.162	5.13^{**}	-1.043
λ of SBY_PORT nest	$0.999^{\#}$	3.55E-02	28.14^{**}	-0.028	$0.999^{\#}$	6.71E-02	14.89^{**}	-0.015
λ of SMG_PORT nest	0.561	0.0818	6.86^{**}	-5.367^{**}	0.507	0.0684	7.41^{**}	-7.208^{**}

Table D.2: t-test for lambda (λ) in NL of mode nest (Model B2)

Parameters	Nested Logit B2.1				Nested Logit B2.2			
	Value	Std-err	t-test(0)	t-test(1)	Value	Std-err	t-test(0)	t-test(1)
λ of rail mode nest	0.802	0.146	5.49^{**}	-1.356	0.893	0.147	6.07^{**}	-0.728
λ of road mode nest	0.909	0.156	5.83^{**}	-0.583	0.999^{*}	8.08E-03	123.64^{**}	-0.124

Table D.3: t-test for lambda (λ) in MXNL of port nest using normal distribution

Parameters	Mixed Nested Logit C21				Mixed Nested Logit C22			
	Value	Std-err	t-test(0)	t-test(1)	Value	Std-err	t-test(0)	t-test(1)
λ of CMY_PORT nest	$0.913^{\#}$	0.208	4.39^{**}	-0.418	$0.916^{\#}$	0.217	4.22^{**}	-0.387
λ of JKT_PORT nest	$0.938^{\#}$	0.127	7.39^{**}	-0.488	$0.947^{\#}$	0.131	7.23^{**}	-0.405
λ of SBY_PORT nest	$0.999^{\#}$	7.87E-02	12.69^{**}	-0.013	$0.999^{\#}$	5.41E-02	18.47^{**}	-0.018
λ of SMG_PORT nest	0.559	0.0828	6.75^{**}	-5.326^{**}	0.557	0.0821	6.78^{**}	-5.396^{**}

Table D.4: t-test for lambda (λ) in MXNL of port nest using log-normal distribution

Parameters	Mixed Nested Logit C23				Mixed Nested Logit C24			
	Value	Std-err	t-test(0)	t-test(1)	Value	Std-err	t-test(0)	t-test(1)
λ of CMY_PORT nest	0.553	0.149	3.71**	-3.000**	0.558	0.151	3.70**	-2.927**
λ of JKT_PORT nest	0.739	0.151	4.89**	-1.728*	0.746	0.152	4.91**	-1.671*
λ of SBY_PORT nest	0.999#	4.94E-02	20.22**	-0.020	0.999#	3.51E-02	28.46**	-0.028
λ of SMG_PORT nest	0.509	0.0701	7.26**	-7.004**	0.507	0.0694	7.31**	-7.104**

Note: # these values were set to fixed value λ =1 instead of using the estimated λ in the report.

* significant at the 10% level ($|t|$>1.65), ** significant at the 5% level ($|t|$>1.96)

According to the results of the above t-test against 1 (t-test(1)), all of the lambda parameters which were set to 1 are not significantly different from 1.

Appendix E: Details of ASC's Calibration

The calibration of ASCs is initiated by calculating the actual share of the rail mode and inland mode for containerized products. In 2013, the capacity of the rail mode for containerized products was 6,000 – 7,000 TEUs / week, or approximately 350,000 TEUs per year. The total container throughput for three main container ports in 2013 is 9.523 million TEUs (*see* **Table 2.4**). According to this data, market share of rail mode is approximately only 3.67% and 96.33% for the market share of road mode.

The simulation was carried out under assumption that Cilamaya Port (CMY Port) will have capacity 1.5 million TEUs per year, thus the calculation of the Port-Mode share for each alternative can be seen in the table below.

Table E.1: Actual shares of the alternatives

Port	Capacity (TEUs)	Port Share (%)	Mode Share (%)		Port-Mode Share (RS_i %)	
JKT Port	6,217,168	56.40%	Road Mode	96.33%	JKT-RD	54.33%
			Rail Mode	3.67%	JKT-RL	2.07%
SMG Port	456,896	4.14%	Road Mode	96.33%	SMG-RD	3.99%
			Rail Mode	3.67%	SMG-RL	0.15%
SBY Port	2,849,138	25.85%	Road Mode	96.33%	SBY-RD	24.90%
			Rail Mode	3.67%	SBY-RL	0.95%
CMY Port	1,500,000	13.61%	Road Mode	96.33%	CMY-RD	13.11%
			Rail Mode	3.67%	CMY-RL	0.50%
	11,023,202	100.00%				100.00%

Then the calibration was carried out using this formula:

$$\mathrm{ASC}_i^* = \mathrm{ASC}_i^0 + \ln \frac{\mathrm{RS}_i}{\mathrm{PS}_i}$$

Where

ASC_i^* = Calibrated ASC for alternative *i*

ASC_i^0 = Estimated ASC for alternative *i*

RS_i = Actual market share of alternative *i*

PS_i = Predicted market share of alternative *i* from the simulation using previous model

Table E2: The calculation for the 1st iteration

ASC_i^0	PS_i	RS_i	**ln(RSi/PSi)**	ASC_i^*	**Normalized** ASC_i^*
0	22.92%	54.33%	0.863067	0.863067	0
-2.93	11.73%	2.07%	-1.7346	-4.6646	-5.52767
0.131	19.89%	3.99%	-1.60643	-1.47543	-2.33849
-3.78	5.05%	0.15%	-3.51651	-7.29651	-8.15957
-0.74	12.28%	24.90%	0.706896	-0.0331	-0.89617
-3.29	7.54%	0.95%	-2.07152	-5.36152	-6.22458
-1.71	12.51%	13.11%	0.046847	-1.66315	-2.52622
-3.35	8.08%	0.50%	-2.78254	-6.13254	-6.99561

Table E3: The calculation for the 20th iteration

ASC_i^0	PS_i	RS_i	**ln(RSi/PSi)**	ASC_i^*	**Normalized** ASC_i^*
0	51.55%	54.33%	0.052574	0.052574	0
-7.75829	2.11%	2.07%	-0.0185	-7.77679	-7.82936
-17.0328	4.40%	3.99%	-0.09748	-17.1303	-17.1828
-19.6016	0.17%	0.15%	-0.09687	-19.6984	-19.751
-6.4116	27.58%	24.90%	-0.10211	-6.51371	-6.56628
-13.1363	1.05%	0.95%	-0.10029	-13.2366	-13.2892
-2.48166	12.64%	13.11%	0.036877	-2.44478	-2.49736
-9.46743	0.52%	0.50%	-0.03473	-9.50215	-9.55473

Table E4: The calculation for the 41st iteration (the last iteration)

ASC_i^0	PS_i	RS_i	**ln(RSi/PSi)**	ASC_i^*	**Normalized** ASC_i^*
0	54.16%	54.33%	0.003187	0.003187	0
-8.26233	2.08%	2.07%	-0.00547	-8.2678	-8.27099
-18.1113	4.01%	3.99%	-0.00541	-18.1167	-18.1199
-20.7095	0.15%	0.15%	-0.00365	-20.7131	-20.7163
-7.63422	25.14%	24.90%	-0.00958	-7.6438	-7.64699
-14.321	0.95%	0.95%	-0.00521	-14.3262	-14.3294
-2.61753	13.00%	13.11%	0.008256	-2.60928	-2.61247
-10.0934	0.50%	0.50%	-0.00504	-10.0984	-10.1016

Appendix F: Presentations of the Results in Conferences

1	Title	:	*A Model for the Joint Choice of Port and Inland Mode in Freight Transport Based on Stated Preference Data*
	Author(s)	:	Munajat Tri Nugroho, Anthony Whiteing, Gerard de Jong
	Conference	:	46th Universities' Transport Study Group Conference
	Venue	:	Newcastle University, United Kingdom
	Date	:	6-8 January 2014

2	Title	:	*Port and Inland Mode Choice from the Exporters' and Forwarders' Perspectives*
	Author(s)	:	Munajat Tri Nugroho, Anthony Whiteing, Gerard de Jong
	Conference	:	The World Conference on Transport Research Society (WCTRS) SIG2 (Port and Maritime) 2015 Conference
	Venue	:	University of Antwerp, Belgium
	Date	:	11 – 12 May 2015

This paper was invited to be published in the Research in Transportation and Business Management Journal.

3	Title	:	*Containerized Exports from Java: the Impact of Policies to reduce GHG Emissions*
	Author(s)	:	Munajat Tri Nugroho, Anthony Whiteing, Gerard de Jong
	Conference	:	The 20th International Symposium on Logistics (ISL 2015)
	Venue	:	University of Bologna, Italy
	Date	:	5 – 8 July 2015

This paper was invited to be published in the International Journal of Logistics and Management