Port and Inland Mode Choice from the Exporters' and Forwarders' Perspectives: Case Study – Java, Indonesia

Abstract

This paper identifies the critical factors influencing the port and inland mode choice from the perspective of shippers and forwarders using data from a stated preference (SP) survey in Java, Indonesia. The best model from estimation is Mixed Nested Logit (MXNL) with the inland mode cost coefficient distributed normally and with port nests. The cost of inland modes, inland mode time, greenhouse gas (GHG) emissions and cost of ports have negative signs, whilst the number of ship calls at port and the reliability of inland modes have positive signs. Simulation results show that reducing fuel subsidies for road transport and giving incentives to reduce rail freight rates would provide the most significant encouragements to modal shift from road transport to rail transport.

Keywords: Stated Preference, Port Choice, Inland Mode Choice, Intermodal Freight transport

1. Introduction

This paper identifies the critical factors influencing both the port and inland mode choice from the perspective of shippers and forwarders, using data from a stated preference (SP) survey in Java, Indonesia. There has been little previous research into the joint choice of port and inland mode, although there is significant literature into each of these two areas separately. Considering firstly from the standpoint of port choice, this choice can be differentiated into three categories, i.e. based on the perspectives of shippers or freight forwarders, of carriers or shipping lines, and of port authorities or terminal operators and ship owners. Examples of previous papers from each perspective include the following:

1. Shippers' or freight forwarders' perspective (Bird & Bland, 1988; Cullinane, Teng, & Wang, 2005; De Langen, 2007; De Martino & Morvillo, 2008; Grosso & Monteiro, 2008; Murphy & Daley, 1994; Nir, Lin, & Liang, 2003; Onut, Tuzkaya, & Torun, 2011; Slack, 1985; Song & Yeo, 2004; Steven & Corsi, 2012; Tiwari, Itoh, & Doi, 2003; Tongzon, 2009; Ugboma, Ugboma, & Ogwude, 2006; Yuen, Zhang, & Cheung, 2011).
2. Shipping lines or carriers' perspective (Chang, Lee, & Tongzon, 2008; Chou, 2010; De Martino & Morvillo, 2008; Guy & Urli, 2006; Lirn, Thanopoulou, Beynon, & Beresford, 2004; Malchow & Kanafani, 2004; Panayides & Song, 2012; Saeed, 2009; Song & Yeo, 2004; Tongzon & Sawant, 2007; Wiegmans, Hoest, & Notteboom, 2008; Yeo, Roe, & Dinwoodie, 2008; Yuen et al., 2011).
3. Port authorities and terminal operators' perspective (Cullinane et al., 2005; De Martino & Morvillo, 2008; Lirn et al., 2004; Onut et al., 2011; Song & Yeo, 2004).

Previous researchers have revealed that the most prominent factors influencing shippers and freight forwarders in port selection are: *port cost* (Bird & Bland, 1988; Grosso & Monteiro, 2008; Nir et al., 2003; Slack, 1985; Tongzon, 2009; Yuen et al., 2011), *ship call frequency* (Bird & Bland, 1988; De Langen, 2007; Nir et al., 2003; Slack, 1985; Tongzon, 2009; Ugboma et al., 2006), *port infrastructure* (De Langen, 2007; Song & Yeo, 2004; Tiwari et al., 2003; Tongzon, 2009), *port services* (Bird & Bland, 1988; De Langen, 2007; Song & Yeo, 2004; Ugboma et al., 2006; Yuen et al., 2011) and *port efficiency* (Grosso & Monteiro, 2008; Steven & Corsi, 2012; Tongzon, 2009; Ugboma et al., 2006). All of the researchers in the above literature used Revealed Preference (RP) data to examine the preferences of shippers and freight forwarders.

In the port choice area of study, some researchers have attempted to combine the port choice with other choices, such as carrier choice (Garrido & Leva, 2004; Tiwari et al., 2003). Moreover, port choice could be examined as a part of a network or chain: for instance, maritime chain choice (Zondag, Bucci, Gutzkow, & de Jong, 2010), network choice (Tang, Low, & Lam, 2011; Tavasszy, Minderhoud, Perrin, & Notteboom, 2011), maritime transport chain (Talley & Ng, 2013) and supply chain choice (Magala & Sammons, 2008). However, this paper reports on the first research that has attempted to investigate port choice and inland mode choice as a single alternative.

Secondly, many researchers have tried to investigate the behaviour of shippers or freight forwarders in terms of inland freight transport mode choice and the factors influencing such choice. Previous researchers used both Revealed Preference (RP) (Jiang, Johnson, & Calzada, 1999; Ravibabu, 2013) and Stated Preference (SP) data (Beuthe & Bouffioux, 2008; Brooks, Puckett, Hensher, & Sammons, 2012; Feo, Espino, & García, 2011; Norojono & Young, 2003; Shinghal & Fowkes, 2002) to examine such preferences of shippers or freight forwarders.

The four most important factors found to influence the decision makers on inland mode choice are; (1) *inland mode transport cost* (Beuthe & Bouffioux, 2008; Brooks et al., 2012; Cullinane & Toy, 2000; Feo et al., 2011; Garcia-Menendez, Martinez-Zarzoso, & De Miguel, 2004; Ravibabu, 2013; Reis, 2014), (2) *inland mode transit time* (Beuthe & Bouffioux, 2008; Brooks et al., 2012; Cullinane & Toy, 2000; Feo et al., 2011; Garcia-Menendez et al., 2004; Ravibabu, 2013; Reis, 2014), (3) *inland mode reliability* (Beuthe & Bouffioux, 2008; Brooks et al., 2012; Cullinane & Toy, 2000; Feo et al., 2011; Norojono & Young, 2003; Reis, 2014; Shinghal & Fowkes, 2002) and (4) *flexibility/frequency of service* (Feo et al., 2011; Garcia-Menendez et al., 2004; Norojono & Young, 2003; Reis, 2014; Shinghal & Fowkes, 2002). More details on the factors influencing the decision on inland mode choice can be seen in **Table 1** below.

Table 1: 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 & Toy (2000)	✓	✓	✓				✓
Shinghal & Fowkes (2002)			✓	✓			
Norojono & Young (2003);			✓	✓	✓		
Garcia-Menendez et al. (2004)	✓	✓		✓			
Beuthe & Bouffioux (2008)	✓	✓	✓				
Feo et al. (2011)	✓	✓	✓	✓			
Brooks et al. (2012)	✓	✓	✓				

Ravibabu (2013)	✓	✓					
Reis (2014)	✓	✓	✓	✓			
	7	7	7	5	1	1	2

The main objective of this paper is to investigate the behaviour of exporters or freight forwarders in their choice of the inland modes and ports to move their export containers from their points of origin. The main contribution of this paper lies in investigating a joint model of inland mode and port choice from the shippers' or freight forwarders' perspective. This research also examines the potential impacts of various policies that might be implemented to influence switching of users' choices from road to rail for the inland transportation leg used for such containerised export movements.

The remainder of this paper is organized as follows: Section 2.1 provides the problem statement and the experimental design for the survey, Section 2.2 presents the population and sample for the survey, and Section 3 discusses the specification of the utility functions of the models, the policies and the simulation results. Section 4 provides the discussion of the results, including the attractiveness of the alternatives, the attributes of port and inland mode choice and the markets shares of the port. Section 5 gives the conclusions of the paper.

2. Stated Preference Survey and Problem Statement

A stated preference (SP) study was used to examine the preferences of exporters and freight forwarders in Java relating to port and inland mode choice. The primary reason the SP method was chosen is its capability to carry out a discrete choice experiment for accommodating non-existing alternatives (such as Cilamaya Port) and the extensive attributes of all available alternatives at different attribute levels (Sanko, 2001). The SP survey method was also selected because of the unavailability of Revealed Preference (RP) data on the shippers' and freight forwarders' preferences in Java.

The SP study in this research is performed using the following steps (Louviere et al., 2000): (1) Define the study objectives; (2) Conduct a supporting qualitative study; (3) Develop and pilot the data collection instrument, partially designing the experiment; (4) Define sample characteristics; (5) Perform the main data collection; (6) Conduct model specification; (7) Conduct policy analysis using the most satisfactory model from the previous step.

2.1 Problem Statement and Experimental design

Containerisation has become popular in international trade since its introduction in the 1950s, and in the Indonesian context of this paper, non-oil and mining exports are now mostly shipped using containers. Such containerised exports have been growing quickly in recent years; between 2005-2013 Indonesia achieved economic growth averaging some 5.9% per year, leading to export growth of on average 13.5% in weight and 12.2% in export value (WTO, 2013). Three ports on Java, namely Tanjung Priok Port in Jakarta, Tanjung Emas Port in Semarang and Tanjung Perak Port in Surabaya account for almost 70% of total container throughput in all Indonesian ports, with shares of this 70% of around 65%, 5% and 30% respectively in 2012. (*See* **Table 2**)

Table 2: Container throughput and market shares of three main container ports in Java 2010-2012

Port	2010		2011		2012		
	TEUs[1]	%	TEUs	%	TEUs	%	Ship Calls/year
Tanjung Priok Port (Jakarta)[2]	4,612,512	62.1%	5,617,562	64.6%	6,217,168	65.3%	4213
Tanjung Emas Port (Semarang)[3]	384,522	5.2%	427,468	4.9%	456,896	4.8%	530
Tanjung Perak Port (Surabaya)[4]	2,426,802	32.7%	2,643,518	30.4%	2,849,138	29.9%	1077
Total	**7,425,846**	**100.0%**	**8,690,559**	**100.0%**	**9,523,202**	**100.0%**	

Tanjung Priok Port currently faces capacity problems due to the high export growth, and there is traffic congestion near the port as the road mode carries most of the containers from the regions of origin to the seaport terminal. To address these problems, the Government of Indonesia plans to build a new port at Cilamaya (100 km east of Jakarta) to support Tanjung Priok Port. In addition to this new port, the authority of Tanjung Priok Port also plans to extend its current capacity by adding extra capacity of some 4.5 million TEUs/year in the first phase development plan to be completed in 2017[5].

Port throughput depends on the preferences of users – whether they choose to use a port in preference to other alternatives. This paper focuses on issues relating to port selection, not merely about port selection in itself, but also relating to the inland mode chosen to carry containers from the origin locations to the selected port. Most exporters and freight forwarders in Java choose truck as their preferred mode of delivery of containerised exports from the origin region to the three ports above. Less than 4% of the total volumes of containers from and to the three ports above are currently transported by the rail mode.

To encourage shippers and freight forwarding companies to use rail transport, the government of Indonesia needs to implement appropriate policies that will take into account the preferences of shippers and freight forwarders with respect to inland mode choice. Hence, the success of plans to shift containerised freight from road to rail will depend partly on the behaviour of the shippers and freight forwarders in choosing combinations of inland modes and ports.

[1] TEU refers to a twenty foot equivalent unit container

[2] 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)

[3] 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)

[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] The details of Tanjung Priok Port's development plan can be found at http://www.indonesiaport.co.id/newpriok/sub/development-program.html

The experimental design began by identifying the options. The experiment included the three main existing container ports in Java have a significant container throughput (Tanjung Priok Port in Jakarta, Tanjung Emas Port in Semarang, Tanjung Perak Port in Surabaya) and one proposed port (Cilamaya Port) which was scheduled to be built by 2015.

The containerized rail transport mode services are currently only available from Bandung, Bekasi, Jakarta, and Surabaya to Tanjung Priok Port and Tanjung Perak Port. There is no rail service to Tanjung Emas port. The Indonesian government plans to increase the rail mode share in container transport from other cities. It 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.

The inland modes included in the experiments are the road/truck mode and rail/train mode, the existing and the proposed services. The experimental design allowed for the study of port and mode choice scenarios for respondents from 16 cities/origins in Java (7 origins in the West Area, 4 origins in the Central Area and 5 origins in the East Area). The location of the current ports, the proposed port, and the 16 origins are shown in **Figure 1**.

There are eight combinations (alternatives) of port and inland mode, as follows:

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

Although there are eight possible alternatives, only four alternatives were shown to each respondent, depending on the location of the respondents, in order to ease decision-making for participants. The four alternatives excluded were the ones deemed least relevant to the paper's objective. The four alternatives for each region are combinations of two or three ports and two available inland modes (except for Jepara, where only the road mode is available, to four alternative ports). The four different alternatives for each city/origin region are shown in **Table 3**.

Figure 1: Map of Java and the locations of the origins and the existing and proposed ports. Source: Edited from http://commons.wikimedia.org/wiki/File:Java_Transportation_Network.svg

Table 3: Alternatives presented to respondents in different cities / origins

To From	Alternative 1		Alternative 2		Alternative 3		Alternative 4	
	Port-Mode	**d_{opm} (km)**	**Port-Mode**	**d_{opm} (km)**	**Port-Mode**	**d_{opm} (km)**	**Port-Mode**	**d_{opm} (km)**
1 Jakarta	JKT-RD	14	JKT-RL	19	CMY-RD	98	CMY-RL	88
2 Bandung	JKT-RD	155	JKT-RL	188	CMY-RD	122	CMY-RL	157
3 Bekasi	JKT-RD	35	JKT-RL	50	CMY-RD	51	CMY-RL	63
4 Tangerang	JKT-RD	34	JKT-RL	35	CMY-RD	128	CMY-RL	122
5 Cirebon	JKT-RD	246	JKT-RL	226	CMY-RD	164	CMY-RL	193
6 Semarang	SMG-RD	5	SMG-RL	9	JKT-RL	456	SBY-RL	288
7 Surakarta	SMG-RD	11	SMG-RL	116	JKT-RL	585	SBY-RL	256
8 Surabaya	SBY-RD	9	SBY-RL	9	JKT-RL	740	SMG-RL	285
9 Malang	SBY-RD	100	SBY-RL	97	JKT-RL	833	SMG-RL	378
10 Bogor	JKT-RD	62	JKT-RL	64	CMY-RD	131	CMY-RL	133
11 Karawang	JKT-RD	79	JKT-RL	70	CMY-RD	31	CMY-RL	37
12 Yogyakarta	SMG-RD	131	SMG-RL	173	JKT-RL	524	SBY-RL	313
13 Jepara	SMG-RD	78	JKT-RD	298	SBY-RD	556	CMY-RD	460
14 Gresik	SBY-RD	23	SBY-RL	32	JKT-RL	752	SMG-RL	297
15 Sidoarjo	SBY-RD	34	SBY-RL	31	JKT-RL	763	SMG-RL	308
16 Pasuruan	SBY-RD	70	SBY-RL	68	JKT-RL	800	SMG-RL	345

Note: d_{opm} is distance between origin o to port p using inland mode m

Each alternative shown to the respondent is described using two port attributes (cost and number of ship calls), and four inland mode attributes (cost, time, reliability and greenhouse gas[6] (GHG) emissions). The definition and dimension of the attributes of the alternatives can be seen in **Table 4**.

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 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.

According to Louviere et al. (2000), an experimental design with four alternatives, six attributes and four levels needs at least 96 sets of scenarios for the smallest design. In this experiment, a set of scenarios for each city/origin was represented by 128 sets of scenarios, which were divided into 16 blocks, with each block containing eight scenarios (choice situations) to be shown to the respondent. Overall, 1152 sets scenarios were employed in the pilot survey (128 x 9 origins) and 2048 scenarios for the main survey (128 x 16 origins). This number of scenarios made the data collection

[6] Gases that trap heat in the atmosphere are called greenhouse gases, mostly are Carbon dioxide (CO2), Methane (CH4), Nitrous Oxide (N2O). Source: http://www3.epa.gov/climatechange/ghgemissions/gases.html.

process more difficult to administer manually, and the computer was used as a tool to manage the survey.

Table 4: The attributes of port and inland mode used in this research

Factor	Attributes	Unit	Definition	Levels
Inland Mode	Cost	Thousands IDR[7]/TEU-Trip	Inland mode cost to transport 1 TEU container from the origin to the port (including haulage by truck from the shipper location to the consolidation station for an alternative using rail mode).	4
	Time	Hours/trip	The transport time between the mode departure from the origin and arrival at the port, including waiting time if any.	4
	Reliability	Percentage (%)	Percentage of on-time delivery	4
	GHG emissions	(Kg CO2e / TEU-Trip)	Emissions from the alternative inland modes for a trip from the origin region to the port	2
Port	Cost	Thousands IDR/TEU	The port cost is represented by the handling cost of 1 TEU FCL[8] using the port crane	4
	Ship Calls	Ship calls / week	Ship calls are the number of international container ship calls per week at the port concerned, including indirect calls[9]	4

The statistical design was generated by an efficient design using the NGENE software (CHOICEMETRICS, 2012). Unidentifiable ('unlabelled') alternatives for the port were used to focus on the importance of the presented attributes (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, rather than the actual port names), but this research still used the name of the mode.

In addition, in order to avoid dominant alternatives (these are alternatives that within a choice task are best on all attributes), the author made various manual adjustments to the values for some attributes. Such adjustments were needed in several cases, such as alternatives for the origin region of Surakarta. The alternatives SMG-RD and SMG-RL needed to be made less attractive; whilst the JKT-RL and SBY-RL alternatives needed to be made more attractive. This dominance also occurs for the origins of Semarang, Yogyakarta, Jepara, Surabaya, Malang, Gresik, Sidoarjo, and Pasuruan.

2.2 Population and Sample

The population of the survey is the set of exporters and freight forwarders in Java. The candidate respondents for the pilot survey were selected from two main sources. The data of exporters in Java was obtained from the Directory of 8000 Indonesian

[7] 1 GBP (British Pound Sterling) ≈ 20,000 IDR (Indonesian Rupiah)

[8] FCL is Full Container Load

[9] Indirect calls are the ship calls of feeder vessels, from which the container will be transshipped to a mother vessel for the intercontinental leg at a hub port. Usually the transshipments of the Indonesian exports are carried out at Singapore Port or Tanjung Pelepas, Port Malaysia.

Exporters book[10], whilst data on freight forwarder companies was derived from the Directory of Indonesian Logistics and Guide book[11].

The SP experiment was carried out in two phases: a pilot survey was conducted in September/October 2013, and the main survey was conducted between January and April 2014. Both surveys also collected the current choice of port and inland mode for the exports, as RP data. During the recruitment of the prospective respondents, 4593 companies were contacted by email, faxes, and postal letter. To encourage the candidates to fill out the questionnaire, they received reminders in the last month before the end of the main survey. The participation rate was 4%, with 181 companies completing the online survey. However 17 respondents were excluded from the parameter estimation process, either because some answers were irrational (for example giving the same answers for the all eight experiments) and/or their completion times were very short (less than 10 minutes). In these cases, it was deemed that data may not be valid for use in the estimation process. Hence, data from only 164 respondents was used.

The 164 respondents consisted of 145 (88%) exporters and 19 (12%) forwarders, which is in line with the population in Java (91% exporters and 9% freight forwarders). With regard to the firm size, 91 (55%) respondents were small companies while remaining 73 (45%) respondents were large companies. As for exports by country of destination, the Asian destinations represent the largest group with 46%, which is consistent with data on Indonesia exports and imports (61% relating to Asia).

3. Model Specification and Simulation

To illustrate the discrete choice models, denote *n* as a decision maker (which could be for example an individual, a firm, or other organisation) who will choose a single option or alternative from the set of options or alternatives, called *choice set* C_n.

The attractiveness of an option or alternative can be described by the concept of the *utility* of the alternative. Each option or alternative $i = 1, \ldots, I$ in the choice set is characterized by a utility U_{in}, that differs amongst the decision makers *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 is also known as the *Random Utility Maximization* (RUM) model. To explain the anomaly 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:

$$U_{in} = V_{in} + \varepsilon_{in} \quad \textbf{(1)}$$

Where:

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 the random or disturbance

[10] The Directory of 8000 Indonesian Exporters book, was published by The Indonesian Statistics and Indonesian Exim Bank in 2011.

[11] The Indonesian Logistics Directory and Guide book was published by the Indonesian Logistics Association (ALI) and PPM Management School

component of utility

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

$$\mathrm{P_{in}} = \mathrm{P}(\varepsilon_{jn} - \varepsilon_{in} < \mathrm{V_{in}} - \mathrm{V_{jn}}, \forall \mathrm{j} \neq \mathrm{i}) \quad \textbf{(2)}$$

The choice probability of alternative *i* for individual *n* for a Multinomial Logit (MNL) model can be stated as follows:

$$P_{in} = \frac{e^{V_{in}}}{\sum_{j=1}^{J} e^{V_{jn}}} \quad \textbf{(3)}$$

3.1 Utility Model of the Alternative

The utility of each alternative can be expressed by the following formula:

$$V_{pm} = ASC_{pm} + \beta_1 f(PC_p) + \beta_2 f(PSC_p) + \beta_3 f(IMC_{opm}) + \beta_4 f(IMT_{opm}) + \beta_5 f(IMR_{opm}) + \beta_6 f(IMG_{opm}) \quad \textbf{(4)}$$

where:

V_{pm} = The observed utility of the alternative *p* using inland mode *m*
ASC_{pm}= Alternative specific constant for alternative port *p* using inland mode *m*
β_1 = parameter of port cost
PC_p = port cost for 1 TEU in port *p* (thousands IDR)
β_2 = parameter of port ship calls
PSC_p = ship calls of international container vessels per week in port *p*
β_3 = parameter of inland mode cost
IMC_{opm}= inland mode cost for transporting 1 TEU FCL container from origin *o* to port *p* using inland mode *m* (thousands IDR)
β_4 = parameter of inland mode cost
IMT_{opm}= inland mode time for transporting 1 TEU FCL container from origin *o* to port *p* using inland mode *m* (hours)
β_5 = parameter of inland mode reliability
IMR_{opm}= inland mode reliability for transporting container from origin *o* to port *p* using inland mode *m* (%)
β_6 = 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)

3.2 Model Estimation

The estimation of parameters has been carried out using Multinomial Logit (MNL), Nested Logit (NL), Mixed Multinomial Logit (MXMNL), and Mixed Nested Logit (MXNL) models. The models were estimated using BIOGEME (Bierlaire's Optimisation Toolbox for General Extreme Value Model Estimation) version 2.2, free software for estimation of various discrete choice models (Bierlaire, 2003). The estimation used joint SP and RP data as well as solely the SP data, obtained from both the pilot and the main survey. However, this paper presents and analyses the results from estimation using the 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 has been selected as the best model for the SP data. The MXNL has the highest value of final likelihood (-1352.993), likelihood ratio test (862.335), ρ^2 (0.242) and adjusted ρ^2 (0.229). The comparison of Likelihood Ratio Test (LRT) of MXNL and MNL exhibit that both models are statistically different (two times the difference between 1366.12 and 1352.993 equals 26.254 and this falls outside of the critical range which for $\chi^2_{0.05}$ for four degrees of freedom is 9.488). The comparison of the models parameters is presented in **Table 5**.

Table 5: Comparison of the statistics of the models

Model	K*	Final Likelihood Value	Likelihood Ratio Test (LRT)	ρ^2	Adjusted ρ^2	Parameters Signs
Multinomial Logit (MNL)	19	-1366.12	836.091	0.234	0.224	All parameters have expected signs
Nested Logit (NL)	22	-1355.5	857.332	0.24	0.228	All parameters have expected signs
Mixed Multinomial Logit (MXMNL)	20	-1364.097	840.128	0.235	0.224	All parameters have expected signs
Mixed Nested Logit (MXNL)	23	-1352.993	862.335	0.242	0.229	All parameters have expected signs

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

The best model is MXNL with the inland mode cost coefficient normally distributed and with port choice nested above inland mode choice. All coefficients of attributes are significant at the 95% confidence 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. If we compare the alternatives based on the uncorrected ASCs only, SMG-RD and SBY-RD are the most attractive alternatives. However if the comparison made is based on the corrected ASCs (which reflect the real market shares), then JKT-RD is the most attractive alternative with about 63% of the current market share. The corrected ASCs are calculated by reducing the estimated ASCs by the natural logarithm of the ratio of the real share for all container exports from Java to the sample share, this process being iterated until the simulation results were found to be very close to the actually observed shares.

Table 6: Estimation results of the Mixed Nested Logit Model using SP Data

Utility Parameters	Value	Robust Std err	Robust t-test
Alternative Specific Constant 1 (JKT-RD)	0 (0)	-	-
Alternative Specific Constant 2 (JKT-RL)	-1.3 (-6.347)	0.243	-5.33***
Alternative Specific Constant 3 (SMG-RD)	0.694 (-7.151)	0.325	2.14**
Alternative Specific Constant 4 (SMG-RL)	-1.990 (-11.36)	0.443	-4.5***
Alternative Specific Constant 5 (SBY-RD)	0.010 (-2.901)	0.33	0.03
Alternative Specific Constant 6 (SBY-RL)	-0.846 (-7.389)	0.319	-2.65***
Alternative Specific Constant 7 (CMY-RD)	-0.786 (-1.673)	0.242	-3.25***
Alternative Specific Constant 8 (CMY-RL)	-1.740 (-8.881)	0.452	-3.85***
Mode Cost for number of TEUs per shipment > 2	-0.410	0.068	-6.02***
Mode Cost for number of TEUs per shipment up to ≤ 2	-0.312	0.064	-4.9***
Mode Cost Std Deviation for number of TEUs per shipment ≤ 2	-0.329	0.103	-3.19***
Mode GHG Emissions for Volume export > 10 TEUs/month	-1.080	0.217	-5.01***
Mode GHG Emissions for Volume export ≤ 10 TEUs/month	-0.757	0.2	-3.79***
Mode Reliability for Exporters	1.990	0.377	5.28***
Mode Reliability for Forwarders	4.170	1.02	4.09***
Mode Time for the product with HS[12] Code = 44 or HS Code = 94	-1.08	0.278	-3.9***
Mode Time for the product with others HS Code	-1.06	0.224	-4.74***
Port Cost for shipment frequency > 5 times per month	-0.879	0.186	-4.73***
Port Cost for shipment frequency ≤ 5 times per month	-0.411	0.15	-2.73**
Port Ships calls for Exporters	0.684	0.29	2.36**
Port Ships calls for Forwarders	1.54	0.555	2.78**
Nesting Parameters			
Cilamaya Port (New Port)	0.622	0.168	3.71***
Tanjung Priok Port (Existing Port)	0.751	0.155	4.84***
Tanjung Perak Port (Existing Port)	1		
Tanjung Emas Port (Existing Port)	0.519	0.0733	7.08***
Number of estimated parameter		23	
Number of Observations		1287	
Null log-likelihood		-1784.161	
Final log-likelihood		-1352.993	
Likelihood ratio test		862.335	
ρ^2		0.242	
Adjusted ρ^2		0.229	

Note: - * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.
- The values of ASCs in parentheses are the corrected ASCs.

3.3 Policies

Five policy scenarios have been simulated using the MXNL model to examine the impact of each policy for the inland transportation leg of containerised exports from Java. These policies were not presented to the respondents during the survey to avoid the policy bias when the participants give their preferences. The policies employed in the simulations are:

- Route and time restrictions for the truck/road mode, on an assumption that truck/road cost will increase by 5% on average and truck/road time will increase by 10%.

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

- Reducing fuel subsidies, which will increase fuel price by 50%, leading to an increase in truck/road mode cost of 25%.
- Establishment of the rail network between Jakarta and Surabaya, which will reduce the rail transport time by 20%.
- The expansion of Tanjung Priok Port, which will increase its capacity from 6 million TEUs/year to 9 million TEUs/year by 2016. It is assumed that this expansion will increase ship calls at Tanjung Priok Port by 30%.
- Provision of subsidy to rail freight transport, to reduce the rail tariff by 20%.

3.4 Simulation Results

The simulation process was carried out using the best model obtained from the estimation process on the SP data; the RP data was used in the simulation stage as a sample for model application; the corrected ASCs were used to reflect closely the real situation. Eight alternatives were used in the simulation, instead of four alternatives presented to the respondents during the survey. The market share for each alternative is the average probability of the respondents to select the alternative, based on their current choice. The simulation results for the five policies using this combined RP-SP approach are shown in **Table 7**.

Table 7: Market share of the alternatives using the combined RP-SP approach

Port-Mode Alternative	Without Policy Share (%)	With Policy Scenario 1 Share (%)	With Policy Scenario 2 Share (%)	With Policy Scenario 3 Share (%)	With Policy Scenario 4 Share (%)	With Policy Scenario 5 Share (%)
JKT-RD	54.30	53.04$^-$	*52.95*$^-$	54.16$^-$	**56.36**$^+$	54.13$^-$
JKT-RL	*2.07*	2.29$^+$	2.37$^+$	2.36$^+$	2.22$^+$	**2.46**$^+$
SMG-RD	4.00	4.71$^+$	**5.08**$^+$	3.94$^-$	*3.83*$^-$	3.85$^-$
SMG-RL	0.15	0.19$^+$	**0.24**$^+$	0.16$^+$	*0.14*$^-$	0.18$^+$
SBY-RD	24.92	**25.14**$^+$	24.77$^-$	24.73$^-$	*24.42*$^-$	24.58$^-$
SBY-RL	0.95	1.13$^+$	**1.29**$^+$	1.05$^+$	*0.93*$^-$	1.20$^+$
CMY-RD	13.10	12.94$^-$	12.72$^-$	**13.04**$^-$	*11.64*$^-$	13.01$^-$
CMY-RL	0.50	0.55$^+$	0.58$^+$	0.56$^+$	*0.45*$^-$	**0.59**$^+$
Combined alternative share (Port Alternative – Mode Alternative)						
Tanjung Priok Port	56.37	55.33$^-$	55.32$^-$	56.52$^+$	**58.58**$^+$	56.59$^+$
Tanjung Emas Port	4.15	4.91$^+$	**5.33**$^+$	4.10$^-$	3.98$^-$	4.03$^-$
Tanjung Perak Port	25.88	**26.27**$^+$	26.06$^+$	25.78$^-$	25.35$^-$	25.78$^-$
Cilamaya Port	13.60	13.49$^-$	13.30$^-$	**13.60**$^\#$	12.09$^-$	**13.60**$^\#$
Road mode	96.33	95.83$^-$	95.52$^-$	95.87$^-$	**96.25**$^-$	95.57$^-$
Rail mode	3.67	4.17$^+$	**4.48**$^+$	4.13$^+$	3.75$^+$	4.43$^+$

Note: The numbers in italic format are the minimum shares, and the numbers in bold are the maximum shares. The $^-$ signs indicate that the market shares decrease, the $^+$ signs indicate that the shares increase compared to the 'without policy' condition. The $^\#$ signs indicate that the result is unchanged from the previous shares.

4. Discussion

4.1 Attractiveness of the Alternatives

The values of corrected ASCs indicate the dominance of the JKT-RD alternative over the other alternatives. The JKT-RD alternative is superior to other alternatives because most exporters in Java are located near Tanjung Priok Port and the road mode offers the quicker and cheaper alternative inland mode compared to the rail mode for such shorter distance haulage. Furthermore, the high number of international container ship calls in Tanjung Priok Port also contributes to the attractiveness of the JKT-RD alternative *(see* **Table 2***)*. The JKT-RL alternative is less attractive than the JKT-RD alternative as the JKT-RL alternative still needs road/truck haulage to carry the container from the origin to the nearest rail freight terminal. However, the JKT-RL alternative is a relatively more attractive as a rail option than the use of the rail mode for the other port alternatives.

The least attractive alternative is the SMG-RL alternative, with a corrected ASC of -11.36. This is the least attractive alternative because the location of Tanjung Emas Port is in Central Java area. This location means that distances from the traffic origins to the port are insufficient to make rail haulage attractive. The longest distance to the Tanjung Emas Port is from Pasuruan, which is 345km (*see* **Table 3**). However, the SMG-RD alternative is also the least competitive port for the road mode, and this finding is relevant as Tanjung Emas Port has the fewest international container ship calls (530 ship calls in 2012).

The range of corrected ASCs for the alternatives using the road mode is from -7.151 (SMG-RD) to 0 (JKT-RD alternative), whereas for the rail mode the range is from -11.36 (SMG-RL) to -6.347 (JKT-RL). These ranges of ASCs for each inland mode signify that the road mode is more attractive to respondents, compared with the rail mode, for all ports. These results reveal that strong policies will be needed to increase the attractiveness of the rail mode to exporters and freight forwarders.

4.2 Attributes of Port and Inland Mode

All of the utility parameter coefficients have the expected signs, and the robust t-test values indicate that all of the coefficients are significant or highly significant (*see* **Table 6**). These results are consistent with findings by previous researchers, both for inland mode choice (Beuthe & Bouffioux, 2008; Brooks et al., 2012; Cullinane & Toy, 2000; Feo et al., 2011; Garcia-Menendez et al., 2004; Ravibabu, 2013; Reis, 2014) and port choice (Bird & Bland, 1988; De Langen, 2007; Grosso & Monteiro, 2008; Nir et al., 2003; Slack, 1985; Tongzon, 2009; Ugboma et al., 2006; Yuen et al., 2011). 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 which shows significant observed and unobserved heterogeneity of the individual decision makers, and suggests that inland mode cost is less important for decision makers with shipment sizes of up to two TEUs per shipment. This research also tried to estimate separately the impact of inland mode time for those products with HS code numbers 44 and 94 (wood products) compared to other products, but no significant difference between these two groups was found.

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 of GHG emissions.

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 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 because they wish to minimise complaints from their clients and/or they have to ensure their services are fully utilised.

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 found to be a more important consideration for freight forwarders than for exporters when choosing between alternative port/inland mode combinations.

4.3 Market Shares

Comparing the simulation results in **Table 7** with the current market shares in **Table 2** indicates that the major impact of the development of Cilamaya port will be on the Tanjung Priok Port market share, reducing it from about 65% to only 56%. Nevertheless, the market shares of Tanjung Emas Port and Tanjung Perak Port will also be impacted by the establishment of Cilamaya Port. The reduced market share of the Tanjung Priok Port is mainly caused by the shifting of user choices in areas which are closer to Cilamaya Port than to Tanjung Priok Port. These areas include Bekasi, Karawang and Cirebon. The expansion of the Tanjung Priok Port capacity, on the other hand, will raise its market share from 56% to 58% and will reduce all other port's market shares.

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[13]. Meanwhile, the hinterland of Tanjung Emas Port is the Central area of Java, namely Semarang, Jepara, Surakarta and Yogyakarta, which provide 72%[14] 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.

From the simulation results in **Table 7**, we can also observe that all of the suggested policies will reduce the market share of the JKT-RD alternative, with the exception of

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13 Based on the interview with the staff of Pelindo II in Jakarta.

14 Data from the authority of the Tanjung Emas Port

the policy of expanding the capacity at Tanjung Priok Port, which will make more exporters and freight forwarders shift their choices to that port. The policy of reducing fuel subsidies will lead to the largest decrease in the market share of the JKT-RD alternative. All policies will have a positive impact on the JKT-RL alternative, with the largest increase in market share being obtained when the incentive to reduce the freight rail tariff is applied.

There are surprising results obtained from simulations for alternative SMG-RD, policies 1 and 2. Whilst it was anticipated that these policies would lower the market share for the SMG-RD alternative, it is found that the market share is projected to increase from 4% to 4.71% and 5.08% respectively. This finding might be explained by the fact that the location of Tanjung Emas Port in the middle of Java allows for road mode users from other ports to switch to the SMG-RD alternative rather than switch to the rail mode. All the policies have positive impacts on the SMG-RL alternative, except for Policy 4. This result is very reasonable because the other four policies act to increase the utility of alternatives using the rail mode or to reduce the utility of the road mode alternatives.

All the policies decrease the market share of the SBY-RD alternative, with the exception of the policy of route and time restrictions for the road mode. This result is particularly interesting because it is hypothesised that such route and time restrictions will reduce the market share of alternatives using the road modes. However, it may be the case that this policy has the largest impact on the JKT-RD alternative due to the traffic congestions near Tanjung Priok Port. The introduction of this policy will have direct negative impact on the JKT-RD alternative that will cause the road users to switch to other ports such as Tanjung Emas and Tanjung Perak.

The market shares of the CMY-RD alternative decline as a result of all of the proposed policies. The largest decrease results from the extension of Tanjung Priok Port, because of the location of Cilamaya Port just 100km away. The only decrease in share for the CMY-RL alternative is that resulting from the extension of Tanjung Priok Port and the biggest increase in market share for that option is caused by the introduction of subsidies to reduce the freight rail tariff.

The market shares of all the alternatives using rail modes are increased by the proposed policies, with the largest positive impacts on the rail modes resulting from Policy 2 (reducing fuel subsidies). This policy is also easier to implement, and the government would not need to spend any budget to apply this policy. Furthermore, the extension of Tanjung Priok Port has the least positive impact – a plausible finding since this policy is not directly related to the inland mode attributes.

5. Conclusion

This paper has examined port and inland mode choice from the perspective of exporters and freight forwarders using SP data collected for this purpose. Data collection has been carried out in 16 cities in Java using SP methods and conducted in two phases - a pilot and a main survey. Parameter estimation was conducted using four models: MNL, NL, MXMNL, and MXNL. The MXNL model was chosen as the best model based on the value of final log-likelihood, likelihood ratio test, ρ^2, adjusted ρ^2, and the signs of the estimated parameters. In addition, the MXNL model also was chosen to concurrently consider the correlation amongst alternatives and investigate the presence of heterogeneity across respondents (Teye, Davidson, & Culley, 2014; Train, 2009).

Estimation results using the MXNL model show that all of the inland mode attributes and the 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 implying negative effects on the utilities of the alternatives concerned, whereas coefficients for inland mode reliability and ship calls demonstrate positive effects on utilities of the alternatives. Exporters and freight forwarders display somewhat different preferences with respect to both inland mode reliability and port ship calls. An additional advantage of the MXNL model is that the coefficient of attribute inland mode cost can be random for each individual respondent, in contrast to the constant coefficient in the MNL model.
The JKT-RD alternative is the alternative with the largest market share. However, the market share of Tanjung Priok Port will be the most affected by the establishment of the new Cilamaya Port. Implementation of Policy 2 (reducing fuel subsidies) has the largest potential for shifting inland mode choice from the road mode to the rail mode. However, the increase in the rail market share would be very small - just less than 1%.

Further investigation can be conducted by simulating the other models (MNL, MXMNL) perhaps using different emission factors taken from other literature and data sources. There is also potential for further study by redesigning the survey instrument with the inclusion of Short Sea Shipping (SSS) services for various origins located in coastal regions, such as Jakarta, Cirebon, Semarang, Jepara, Surabaya, Gresik, and Pasuruan.

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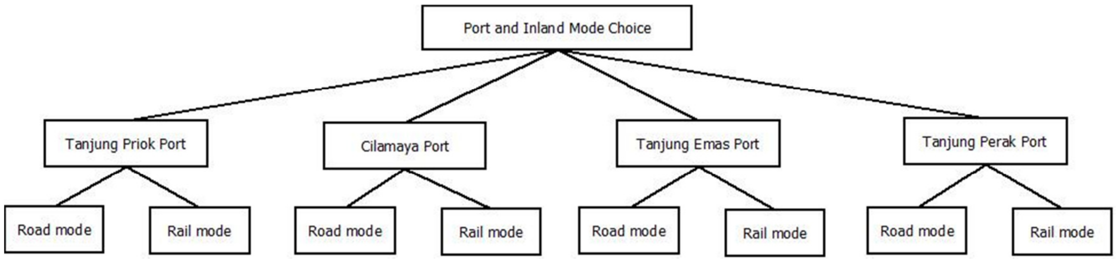
Appendix A: The nesting structure for NL and MXNL models



Appendix B: Non-response bias test

A non-response bias test has been conducted in the light of the low survey response rate of around 4%. As data relating to non-respondents was not available for this research, the procedure adopted was to investigate 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 test used the simple Multinomial Logit (MNL) to compare the characteristics of early respondents with those of late respondents.

According to the test results, almost all of the parameters are not significantly different between the two respondents groups. The only difference relates to the Alternative Specific Constant for alternative JKT-RL. The results of the test are presented in Table B.1 below.

Table B.1: Comparison results of model estimation, using data for early respondents and late respondents

Name	Early respondents[15]			Late respondents			Segment t-test
	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***	2.291**
ASC_3_SMG-RD	0.619	0.346	1.79*	0.605	0.404	1.5	0.026
ASC_4_SMG-RL	-0.863	0.368	-2.34**	-1.29	0.43	-3***	0.754
ASC_5_SBY-RD	0.583	0.367	1.59	-0.233	0.43	-0.54	1.443
ASC_6_SBY-RL	-0.63	0.356	-1.77*	-1.05	0.397	-2.65***	0.788
ASC_7_CMY-RD	-0.448	0.144	-3.11***	-0.713	0.168	-4.24***	1.198
ASC_8_CMY-RL	-1.19	0.178	-6.67***	-1.36	0.21	-6.45***	0.618
B_M_COST	-0.292	0.0468	-6.24***	-0.204	0.0533	-3.83***	-1.241
B_M_GHG	-0.825	0.154	-5.37***	-0.807	0.168	-4.81***	-0.079
B_M_RELI	2.24	0.377	5.95***	1.55	0.454	3.42***	1.169
B_M_TIME	-0.942	0.19	-4.95***	-0.807	0.233	-3.47***	-0.449
B_P_COST	-0.357	0.127	-2.81***	-0.464	0.154	-3.01***	0.536

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

B_P_SHIP	0.628	0.268	2.34**	0.704	0.372	1.89*	-0.166
Number of observations		735			552		
Number estimated parameters		13			13		
Init log-likelihood:		-1018.926			-765.234		
Final log-likelihood:		-779.967			-579.978		
Likelihood ratio test:		477.918			370.513		
Rho-square:		0.235			0.242		
Adjusted rho-square:		0.222			0.225		

Note: - * Significant at the 10% level, ** Significant at the 5% level, *** Significant at the 1% level.

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