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Exploring Users' Direct Choice Elasticity and Willingness to Pay for Third-Party Logistics Service Attributes

Seu Keow Cheng*

Third-party logistics (3PL) outsourcing has become a common strategic management practice for many businesses to date. Previous studies show that users consider service attributes associated with improvement in customer service quality, reduction in logistics costs, and ability to focus on core-business activities as important when selecting an outsourcing partner. However, little is known about how sensitive users' are towards a particular service attribute when changes occur in the attribute (direct choice elasticity), and how much users are willing to pay (WTP) for specific levels of service attributes. This has important implications on the provision and utilisation of logistics services. The objective of this study is to fill this gap by examining the selection of service attributes by a sample of Australian exporters. A series of discrete choice models were used to analyse the data collected from a range of stated choice experiments. The empirical findings provide not only a better understanding of the direct choice elasticity of users on selected service attributes but they also provide an insight into how 3PL providers could strategically develop their scope of services at values users deem to be value for money.

1. Introduction

In line with the increase in industry competition and in end-customers' demand for better service quality, the traditional 'individualistic-internal' firm approach centred on in-sourcing of activities in the supply chain has become less popular. More firms are adopting a 'collective-external' firm approach as a strategy of co-operating to compete in the interests of minimising costs and maximising service quality and performance (Min, Roath, Daugherty, Genchev, Chen and Arndt, 2005; Holweg, Disney, Holmstrom and Smaros, 2005; Lambert, Knemeyer and Gardner, 2004; Horvath, 2001). Among other forms of supply chain collaboration, third-party logistics (3PL) outsourcing has become a common competitive strategy for many businesses to date. In general, 3PL outsourcing involves the logistics provider taking responsibility for activities that are traditionally performed in-house by the user. As an important economic agent in the microstructure of most markets, 3PL providers contribute to resource allocation (Spulber, 1996; Rubinstein and Wolinsky, 1987) by performing the entire process or selected logistics functions within a process for their users (Sohal, Millen and Moss, 2002).

Improvement in users' customer services and cost performances hence depends on the capability of 3PL providers, and on the users' choice of 3PL provider as an outsourcing partner. A large number of previous studies have focused merely on identifying various 3PL service attributes that are important in the partner selection process.

*Dr Seu Keow Cheng, School of Economics and Finance, University of Tasmania, email: seu.cheng@utas.edu.au

Consequently, little is known about how sensitive users' are towards a particular service attribute when changes occur in the attribute (direct choice elasticity), and how much users are willing to pay (WTP) for specific levels of service attributes. This has important implications on the effective provision and efficient utilisation of logistics services. Therefore, the objective of this study is to fill this gap.

2. Literature Review

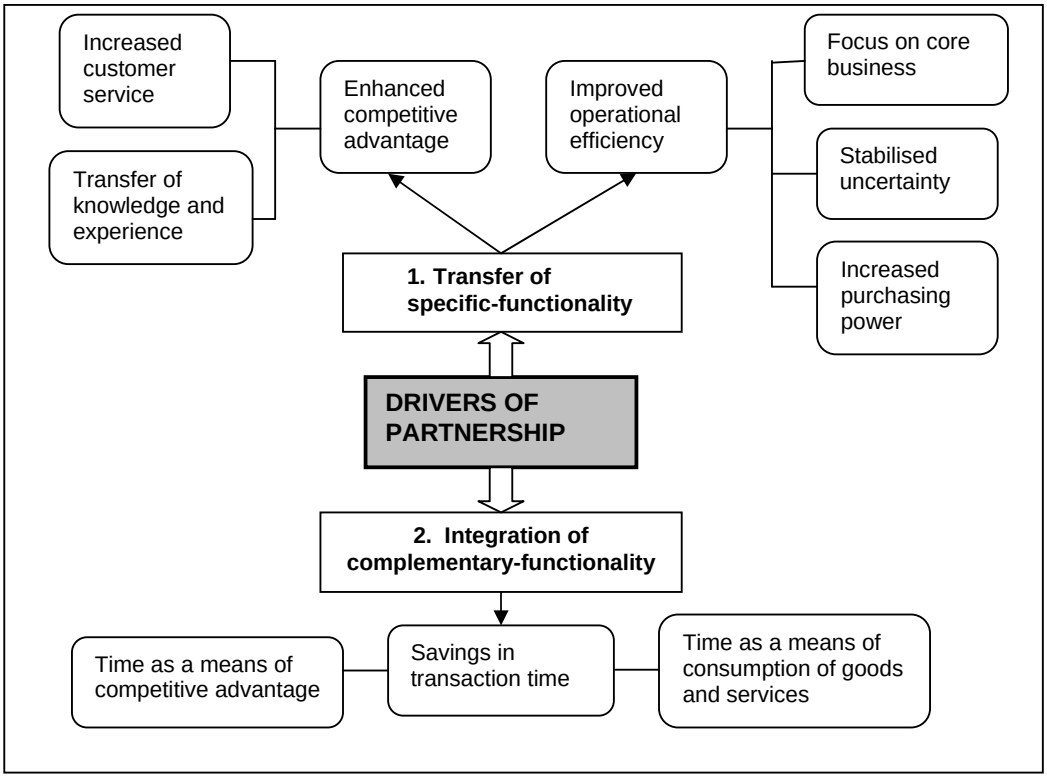
Since early 1990s, many supply chain researchers have examined the development process and the motivations behind supply chain collaborations using different theoretical perspectives. The core of their frameworks have always rooted in the theory of the firm (Coase 1937), transaction cost economics (Williamsons 1979; Klein, Crawford and Alchian, 1978) and value chain (Porter, 1990). A review of the literature reveals that the most commonly mentioned motivations are pertaining to improve customer service and productivity; focus on core competencies; upgrade information and knowledge; reduce overall distribution costs; achieve effective capital utilization, participate in more rapid technological development, increase flexibility to demand variations; increase profitability; and to improve resource allocation (Kranton and Minehart, 2001; Bolumole, 2001; Logan, 2000).

In summary, these characterizations can be reclassified into two driving forces with the first being the 'transfer of specific-functionality', and the second being the 'integration of complementary-functionality' (Figure 1). The former can be further divided into the enhanced competitive advantage component and the improved operational efficiency component. In our conceptualization, these two components represent part of the benefits resulting from the transfer of specific-functionality (such as warehousing) from a user of 3PL to a 3PL provider through outsourcing partnership. This implies that stakeholders' competitive advantage is closely associated to increase customer service and transfer of knowledge and experience. Similarly, improvement in users' operational efficiency can be attributed to the ability to focus on core business activities, to stabilize uncertainty and to increase purchasing power.

The second driver refers to the strategic element resulting from the efficiency and ability of a 3PL provider in integrating various complementary function-specific services required to execute an outsourced process. Meeting the needs of a distribution transaction requires different information, expertise and time. Most importantly, the length of time associated with acquiring each function-specific service varies with sizes and/or characteristics of operations. According to Dyer, Cho and Chu (1998), the sizes of operation and transaction costs are positively related. The acquisition of transaction-related services can be articulated as a problem of asymmetric information (Bianchi, 1995), with transaction costs associated with governing or administering a transaction (Stank and Daugherty 1997). In essence, time can be interpreted as a means of consumption of good and services and hence savings in

transaction time has important implication on stakeholders' competitive advantage.

Figure 1 A Synthesis of the Strategic Elements in Partnership Formation



In line with the rapidly growing importance of 3PL outsourcing, previous studies from Europe and North America have generally focused on identifying the types of logistics functions commonly outsourced by users of 3PL (Lieb and Randell, 1999; Sheffi, 1990; Virum, 1993), assessing manufacturers and/or 3PL providers' perception of providers' service attributes (Holcomb and Manrodt, 2000; Leib, 1992), and determining the service attributes of outsourcing partners (Leahy, Murphy and Poist, 1995; Murphy and Daley, 1997). While in Australia, only a limited number of studies have been undertaken to examine the collaborative interaction between providers and users of 3PL services. For example, Power and Moosa (2006) investigate the perception and expectations of providers and users of 3PL services, Rahman, Barber and Ray (2004) and Sohal, Millen and Moss (2002) explore the current status and trends of users of 3PL services, and ALPHA research consortium (2004) identify the characteristics and trends for third-party and fourth-party logistics.

In general, all of these studies have relied on descriptive statistics using revealed preference data (i.e. description of a service attribute based on its current or real characteristics) or stated preference data (i.e. description of a

service attribute based on hypothetical characteristics develop by researcher) collected from field surveys. Consequently, the findings from these studies are incomplete and do not fully address the need for strategic marketing and management of logistics services provision. Based on a sample of Australian exporters (i.e. users of 3PL providers), the aim of this study, therefore, is to address this limitation by estimating users' direct choice elasticity of selected 3PL service attributes and their willingness to pay for specific levels of the selected service attributes.

3. Methodology and Research Design

In order to determine users' direct choice elasticity and WTP for 3PL service attributes, a list of thirty two 3PL service attributes was compiled from a literature review and through personal consultation with three 3PL providers located in Canberra in May 1997. However, the list was reduced to a total of eight service attributes and twenty nine elemental attributes (Table 1) to avoid task complexity, learning and fatigue effects as emphasize by Louviere, Hensher and Swait (2000), and Bhat (1998).

Among other service attributes, it is worth nothing that transaction time was included as a proxy of the operational efficiency of 3PL providers. Specifically, it refers to the total amount of time required to carry out the transaction-related activities, such as selection of appropriate transport modes and scheduling, freight rates negotiation, customs clearance, freight tracking and door-to-door delivery, which are necessary to execute an outsourced process. Its interpretation is similar to that of transit time in the context of a transport mode. The shorter the time taken (relative to the industry standard), the more efficient it indicates that the 3PL provider is.

Table 1 The Preliminary Design of 3PL Provider Service Attributes and Levels

Service Attribute	*Unit of Measurement*	*Number of Attribute Levels*	*Magnitude of Attribute Levels*
Price	Dollar (A$)	4	Same as the 'current' value 25% less than the 'current' value 50% less than the 'current' value 25% more than the 'current' value
Non-damage	Percentage	4	Same as the 'current' value 10% less than the 'current' value 20% less than the 'current' value 30% less than the 'current' value
Punctuality	Percentage	4	Same as the 'current' value 5% less than the 'current' value 10% less than the 'current' value 20% less than the 'current' value
Ability to settle claims	Minutes	3	Less than 30 minutes less than 60 minutes more than 60 minutes
Credit terms	Number of days	4	15 days 30 days 45 days 60 days
Transaction time	Minutes	4	Same as the 'current' value 20% more than the 'current' value 20% less than the 'current' value 30% more than the 'current' value
Experience in distribution system	Number of years	3	Less than 1 year 2 to 3 years more than 3 years
Operational network	Geographical entity	3	Interstate only international only interstate and international

Choice Experiments

Since most of the service attributes of interest did not exist, it was not possible to rely on revealed preference data for that purpose. Therefore, a choice experiment was conducted to evaluate users' choice of 3PL service attributes. The basic idea of the stated choice (SC) experiment was to create a structured approach in eliciting the choices of users for different hypothetical service attributes. A total of five sets of choice experiments were developed and each choice set comprised one ''current'' value option and three SC experiment options. 'Current' value option described the existing situation of a service attribute (e.g. the existing percentage of punctuality is 98% per shipment). The 'current' value option was used to avoid selection of attributes that were well outside the range of the respondents' experience (Louviere, Hensher and Swait, 2000). Using this mechanism, respondents were able to position their responses in a reliable and consistent manner.

Validation of the choice experiments was conducted in June 1997 through a mailed-out pilot survey consisting of a sample of 20 exporters with 5 exporters respectively located in Melbourne, Perth, Sydney and Brisbane. Based on the comments received from seven respondents through the pilot survey, the service attributes was further reduced to consider only price, non-damage, punctuality and transaction time (Table 2). Besides reducing the complexity in the choice sets selection process to ensure reliability and consistency of responses (Louviere, Hensher and Swait, 2000; Bradley 1988), the four selected attributes was also deemed to be the most important and commonly cited as partner selection criteria by the exporters.

Table 2 An Example of a Final Experimental Choice Set

Option	*Service Attribute*			
	Price (A$)	***Non-damage (%)***	***Punctuality (%)***	***Transaction time (Minutes)***
SC_1	'Current': _____	'Current': _____	'Current': _____	'Current': _____
SC_2	25% more than the 'current' value.	20% less than the 'current' value.	10% less than the 'current' value.	Same as the 'current' value.
SC_3	50% less than the 'current' value.	10% less than the 'current' value.	5% less than the 'current' value.	20% more than the 'current' value.
SC_4	Same as the 'current' value.	Same as the 'current' value.	20% less than the 'current' value.	Same as the 'current' value.

Sample

The details of the exporters were obtained from The Business Who's Who in Australia databases (1997 and 1999). A sample of 45 exporters in computer products and 30 exporters in pharmaceutical products was selected given the similar nature of these products (i.e. fragile, high-value and non-perishable). Initial contact was established with exporters by telephone to ensure that they were users of 3PL services and that they had a contractual partnership of not less than 6 months with their respective 3PL providers. This requirement was deemed important as it served as an indication that the evaluation of 3PL service attributes was based on a reasonable level of experience and understanding of logistics outsourcing practices.

The main survey was subsequently conducted by the author in Sydney in July 1997 (19 exporters) and in March 2000 (56 exporters) via face-to-face interviews. The interviews were conducted with outsourcing executives of each selected company. During the interviews, each logistics executive was required to answer only one of the three groups of experiments. Each group was made up of four experimental choice sets. Consequently, the total sample produced 300 cases (i.e. 75 x 4) of SC data for modelling purposes.

Choice Model

The choice model reflected exporters' choice of price, non-damage, punctuality, and transaction time. Model estimation was limited to the four attributes common across the SC alternatives plus an alternative specific constant in the SC_1 utility function. Since the SC alternatives were defined as abstract alternatives, the parameters of these SC alternatives were treated as generic. Based on these considerations, the relevant SC utility functions are expressed as follows:

$$U(SC_1) = \text{Constant}_1 + \beta_1(\text{Price}) + \beta_2(\text{Non-damage}) + \beta_3(\text{Punctuality}) + \beta_4(\text{TT})$$

$$U(SC_2) = \beta_1(\text{Price}) + \beta_2(\text{Non-damage}) + \beta_3(\text{Punctuality}) + \beta_4(\text{TT})$$

$$U(SC_3) = \beta_1(\text{Price}) + \beta_2(\text{Non-damage}) + \beta_3(\text{Punctuality}) + \beta_4(\text{TT})$$

$$U(SC_4) = \beta_1(\text{Price}) + \beta_2(\text{Non-damage}) + \beta_3(\text{Punctuality}) + \beta_4(\text{TT})$$

Where,
$U(SC_1)$: Utility expression for 'current' level of 3PL provider service attributes in the SC experiment;
$U(SC_i)$: Utility expression for hypothetical 3PL provider service attributes alternative i in the SC experiment (i=2,3,4);
Price: Average service charge (measured in A$ per shipment);
Non-damage: Shipment without damage (measured in percentage per shipment);
Punctuality: Punctuality in door-to-door delivery (measured in percentage per shipment); and
TT: Transaction time (measured in minutes per shipment);

$\beta_1 = \text{Estimated coefficient for price;}$

$\beta_2 = \text{Estimated coefficient for non-damage;}$

$\beta_3 = \text{Estimated coefficient for punctuality;}$

$\beta_4 = \text{Estimated coefficient for transaction time, and}$

$\text{Constant}_1 = \text{Alternative specific constant for } SC_1.$

4. Discussion of Findings

In total, the survey constituted 60% of exporters in computer products and 40% in pharmaceutical products. In terms of country of destination for their exports, 34% of the total respondents exported to Fiji, 29% to Hong Kong and 17% to Indonesia. Using number of employees as a measure of company size, the majority of the exporters (35%) had between 20 and 30 employees. In addition, the respondents were also asked to indicate whether they had used the 3PL provider for a minimum of 6 months, 12 months or more than 24 months. The results showed that 56% had been using them for 12 months and only 13% for 6 months. The distribution of respondents with respect to the number of years they had been in business showed that a large proportion of the companies (49%) had between 5 and 8 years of operating experience. Table 3 summarises the selected profiles of the respondents.

Table 3 Selected Profiles of Respondents

Description	*Category*	*Proportion of Respondent*
Number of employees (person)	< 20	29%
	20 – 30	35%
	31 – 40	23%
	> 41	13%
Length of outsourcing partnership (month)	6	13%
	12	56%
	> 24	31%
Experience in business (year)	< 5	30%
	5 – 8	49%
	> 8	21%

With respect to the data profiles for the sample, an examination of the data suggested that on average, the levels of non-damage (98.27%) and punctuality (98.34%) for the 'current' market situation as represented by the alternative SC_1, were the highest as compared to the levels offered in the rest of the SC alternatives (Table 4). The number of respondents recorded in each SC alternative demonstrated that 35.3% of the exporters interviewed preferred the SC_1 alternative. This follows that the proportions of exporter who selected SC_2, SC_3, and SC_4 alternatives with hypothetical attributes levels were 20.7%, 21.0% and 23.0% respectively.

Table 4 Stated Choice Profiles: Means of Service Attributes

Service Attribute (measurement)	*Alternative*			
	SC_1	***SC_2***	***SC_3***	***SC_4***
Price (A$ per shipment)	852.8	564.4	436.2	572.5
Non-damage (percentage per shipment)	98.3	84.0	89.7	88.9
Punctuality (percentage per shipment)	98.3	93.8	88.3	91.6
Transaction time (minutes per shipment)	128.2	123.6	122.9	136.9
Number of times each alternative was chosen	*106*	*62*	*63*	*69*

Modelling Results

Using the collected SC data, the model was initially estimated using a series of discrete choice models such as multinomial logit (MNL), nested logit (NL), heteroscedastic extreme value (HEV) and latent class (LC). In estimating the NL model, the scale parameter of the SC_1 alternative was set to unity, with the scale parameters for SC_2, SC_3 and SC_4 alternatives freely estimated. The HEV model was estimated to explore the effects of relaxing the constant variance assumption. The results obtained using the NL and HEV models, however, did not yield any further improvement in correcting for the differences in variance. In particular, the parameters obtained were either with wrong signs or statistically insignificant. Consequently the results of these models are not reported.

The rationale for using the LC model was to investigate the implications of capturing unobserved heterogeneity and other potential sources of variability in observed sources of utility that are not considered by the MNL model (Green and Hensher 2002). The discussion in the following sections will be centred on the procedures and results obtained using these two models.

When estimating the LC model, two, three and four classes were investigated as appropriate representations of the distribution of unobserved heterogeneity in the sampled population. Based on statistical criteria and interpretation of the behavioural outputs, two latent classes were selected as the preferred model specification for the analysis of this study.

It was expected a-priori that the signs of the parameter estimate of price and transaction time to be negative, and of non-damage and punctuality to be positive. The estimation results obtained using the MNL model specification depicted that all the estimates were with correct signs and were statistically significant at the 95 percent confidence level (Table 5). The results obtained using the LC model also demonstrated that all the signs of the parameter estimate were correct. However, only non-damage, punctuality and transaction time (or non-price attributes) were statistically significant in class 1. In contrast, both the price and the non-price attributes were statistically significant in class 2. The observed differences demonstrated the existence of variations due to unobserved heterogeneity and other potential sources of variability in unobserved sources of utility (Green and Hensher, 2002).

Table 5 Parameter Estimates of MNL and LC Models

	Utility Parameter Estimates		
		LC Model	
Parameter	**MNL Model**	**Class 1**	**Class 2**
Alternative specific constant (SC1)	-1.26916 (-5.694)	-1.46356 (-4.768)	-1.0803 (-4.424)
Price	-0.00059 (-2.039)	-0.000015 (-0.38)	-0.00124 (-3.287)
Non-damage	0.07696 (8.114)	0.03875 (2.839)	0.10953 (9.949)
Punctuality	0.08777 (6.737)	0.19821 (7.125)	0.03749 (2.634)
Transaction time	-0.01414 (-4.886)	-0.01136 (-3.099)	-0.02042 (-5.413)
Goodness of Fit			
Latent class probability		0.427 (4.760)	0.573 (6.394)
Log-likelihood	-341.7198	-334.2004	
Pseudo-R^2	0.183	0.196	
Number of cases	300	300	

Note: Numbers in parentheses are t-statistics

Direct Choice Elasticity

The direct choice elasticity derived using the MNL model specification indicated that exporters' choice was highly sensitive to changes in punctuality, followed by non-damage, transaction time, and price (Table 6). Although the order of exporters' sensitivities towards each attribute, as shown in the LC model, was similar to that of the MNL model, the magnitude of elasticity was slightly different. Specifically, the elasticities of price, punctuality and transaction time were slightly higher while non-damage was slightly lower.

The sensitivity of the choice predictions to changes in the explanatory variables is a function of the overall scale of the parameters relative to the variance of error term. Therefore when observations have a variance much different from that in the context for which predictions are made, the model tended to over or under estimate the actual changes in choice probabilities (Louviere, Hensher and Swait, 2000).

Table 6 Probability Weighted Direct Choice Elasticity by Models

Attribute	*MNL Model*	*LC Model*
Price	-0.23	-0.24
Non-damage	4.33	4.19
Punctuality	5.13	5.74
Transaction time	-1.14	-1.22

Implied Willingness to Pay

The question of how much a shipper is willing to pay to obtain a unit of improvement or to avoid the occurrence of any adverse effect in a service attribute is important for marketing strategy development and public policy planning. It provides a way of establishing the relative importance of each attribute in common units (typically in dollars). It is measured by the ratio of parameter estimates representing the attribute of interest and an attribute measured in monetary units (see for example Bhat, 1998; Ben-Akiva and Lerman, 1985). The implied WTP derived from the base model can be obtained only for cases where price and a selected service attribute were both statistically significant at the 95 percent confidence level. This is due to the fact that insignificant variables yielded meaningless estimates and hence were not relevant for strategic business decision-making. Based on this reasoning, the implied WTP for class 1 of the LC model were not derived (as its price variable was statistically insignificant).

The WTP obtained using the MNL model specification indicated that exporters were willing to pay, on average, $149 to avoid the occurrence of a one percent increase in delay, $130 to avoid the occurrence of a one percent increase in damage, and $24 for a one minute reduction in transaction time per shipment (Table 7). For exporters in class 2 of the LC model, the WTP derived suggested that exporters were willing to pay more on non-damage ($88), followed by punctuality ($30) and transaction time ($16).

Table 7 Summary of WTP Estimated by Model

Service Attribute	*MNL Model*	*LC Model*
Non-damage	$130	$88
Punctuality	$149	$30
Transaction time	$24	$16

Further comparisons of the WTP between the MNL and the LC models revealed that the WTP of the former are systematically higher for all the individual attributes. Specifically, non-damage, punctuality and transaction time were higher by approximately 32.3%, 79.7% and 31.3% respectively. These differences may be attributed to the limiting MNL assumption of a single and constant random error variance in contrast to the additional latent

class coefficient in the LC model to account for additional sources of unobserved variance that is class-specific (Green and Hensher, 2002).

5. Remarks and Conclusion

The direct choice elasticity suggests that the exporters were relatively more responsive towards changes in punctuality, non-damage and transaction time as compared to changes in price. Furthermore, exporters were willing to pay a higher premium to avoid damage as compared to for improvement in punctuality and transaction time. The results were consistent considering the nature of the products under study. The identified trade-offs among non-damage, punctuality and transaction time indicated that savings in transaction time was indeed important, and that exporters were willing to pay a premium to improve the savings in time spent in acquiring various function-specific services. Savings in transaction time reflects the efficiency of a distribution system and the effectiveness of integrating the complementary transaction function- specific service components by 3PL providers. However, we must be careful in transferring the actual values derived from the context of this study to other settings. This is due to the fact that the characteristics of shipment, organisation and types of product had significant influence on the variation of the behavioural value of transaction time. Specifically, the sample of this study is made up of exporters only and about 87% of them were relatively small in size with less than 41 employees. Nevertheless, the conceptual approach is transferable.

The comparison of results obtained using the MNL and LC models highlighted that the parameter estimates using the former approach should be used with care. This is attributed to the simplifications of the distributional properties of random component of the indirect utility expressions (Green and Hensher, 2002). Through the application of the LC model, we were able to identify simultaneously the differences in choice behaviour and the classification of exporters into segments with its own distinctive choice composition. As a result, the LC model contributed to enhance the explanatory power of the choice model, but also our understanding of the heterogeneity inherits in exporters' choices behaviour.

Finally, the findings in this study also suggested that 3PL providers should explore different competitive strategies to differentiate their services from their competitors. Potential gains in market share can be achieved by adopting a process-oriented service design and its marketing approach. In particular, the significance of savings in transaction time suggests that 3PL providers could aim to reduce time spent in acquiring various function-specific services. These savings can be further improved through the formation of an integrated system which may involve the coordination and cooperation of various government agencies including the Department of Transport, Department of International Trade, and the Customs Services Department. Successful coordination among the relevant public agencies would contribute to better communications, transport and logistics systems linkages, and hence facilitate the efficient utilisation and operation of the distribution system as a whole.

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