The Development of Measures to Assess the Operational Performance of Third-Party Logistics Providers

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ABSTRACT

The recognition of third-party logistics (3PL) as a separate industrial services industry is only two decades old. With a strong sense of the growing strategic importance of logistics, manufacturers have shifted their focus to their core business and sought competent 3PL providers to handle their logistics activities. Along with the industry's growth, some research has begun to identify customer concerns about performance issues with their 3PL providers.

Measuring performance is one way to increase effectiveness and efficiency, both for processes and for people handling those processes. Performance measurement is done by monitoring performance indicators for the various processes. As a management function, performance measurement is more meaningful if a few key representative measures that can best capture the performance levels of the processes can be identified.

Using literature review and interviews with nine logistics managers in the electronics manufacturing industry in Thailand, a set of thirty-eight operational performance measures covering the two major 3PL services, warehousing and transportation, was identified. Drawing on survey responses from 207 logistics managers in the same

industry, these measures were categorized into three tiers: moderate importance, moderate-to-high importance, and high importance.

Exploratory and confirmatory factor analyses were used to derive and test a twenty-two-item, five-dimension 3PL operational performance scale. The five dimensions are: delivery, order quality, in-storage handling, personnel quality and flexibility. Although structural equation modeling coefficients indicate that delivery and order quality are slightly stronger reflections of 3PL operational performance, (followed by flexibility, in-storage handling and personnel quality), the moderately high correlations between the five dimensions suggest that 3PL operational performance requires a fairly tightly packaged bundle of competencies.

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CHAPTER ONE

Introduction

1.1 Logistics and Its Importance

This thesis is concerned with measuring the operational performance of third-party logistics (3PL, also referred to as logistics outsourcing, or contract logistics). Logistics, in its most basic definition, is the flow and storage of goods from their point of origin to the point of consumption. The word *logistics* was first used by the military service to describe the process of supplying a war zone with troops, supplies and equipment. The term is now used more commonly in the commercial sector.

In the past, the academic and practitioner literature gave logistics a variety of names: physical distribution, distribution, materials management, and supply chain management. Physical distribution and distribution refer to the outbound flow of goods from the end of the production process to the consumer. Materials management refers to the inbound flow of material to the production process. As the importance of coordinating the entire flow of material from the raw materials to the end consumer became recognized, the term logistics became widely used to reflect the broader notion of end-to-end flow. The term supply chain management has come into

use to reflect the importance of forming alliances and partnerships to streamline the flow of materials from end to end (Stock & Lambert 2000).

In 1991, the Council of Supply Chain Management Professionals (CSCMP) modified its 1976 definition of physical distribution changing the term to logistics. Their current definition of logistics "is that part of the supply chain processes that plans, implements, and controls the efficient, effective forward and reverse flow of goods and storage of goods, services and, related information between the point of origin and the point of consumption in order to meet customers' requirements." (Council of Supply Chain Management Professionals 2008). We sometimes see *logistics* and *supply chain* being used interchangeably, but as indicated in CSCMP's definition, logistics is *a part* of the supply chain. Harrison and Van Hoek (2002) asserted that logistics is a key enabler for supply chain management. They defined supply chain management as "The alignment of upstream and downstream capabilities of supply chain partners to deliver superior value to the end customer at less cost to the supply chain as a whole." (p. 6).

Logistics involves the integration of information, transportation, inventory, warehousing, material handling, and packaging. Bowersox, Closs and Cooper (2003) estimated that, in the United States, for an individual firm, logistics expenditures typically range from five to thirty five percent of sales depending on the type of business, geographical area of operations, and weight/value ratio of products and materials. Logistics cost is second only to materials in manufacturing or cost of goods sold in wholesaling or retailing. Logistics justifies this high cost through its

marketing enhancing ability providing time and place utility to products and efficient movement of products to customers.

Logistics is important not only because of its high cost, but also due to its strategic role. Over the past two decades, the role of logistics has "moved from an operational orientation to a tactical orientation to a strategic orientation." (LaLonde 1990, p. 46). Even strategy scholar Michael Porter (1985) highlighted the importance of logistics to a manufacturing firm's overall competitive position describing it as two (inbound and outbound) of the five primary value-adding functions – the other three functions are: operations, marketing and sales, and service (see Fig. 1.1). Logistics has become a critical factor of competitive advantage (Christopher 2005, Harrison & Van Hoek 2002, Lambert et al. 2000, Porter 1985).

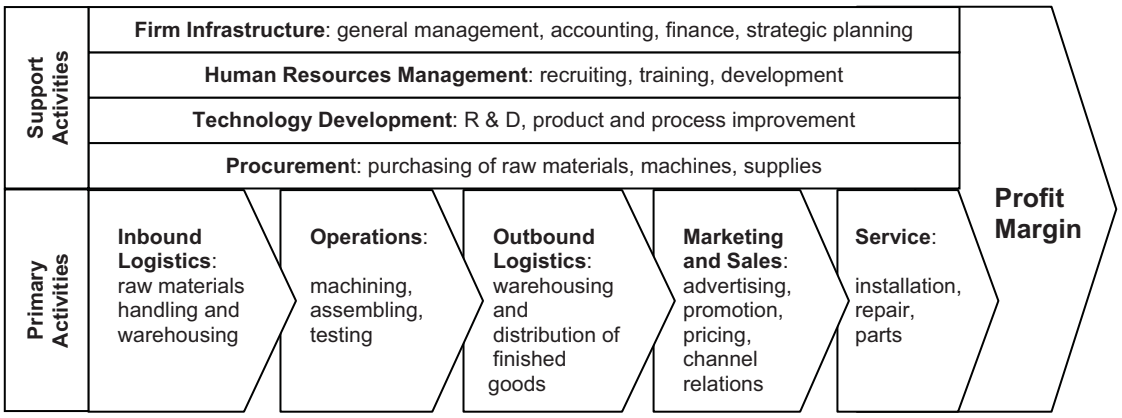

Figure 1.1: Porter's Value Chain Model for a Traditional Manufacturing Firm.
Source: Porter, M.E. 1985, *Competitive Advantage: Creating and Sustaining Superior Performance*, Free Press, New York.

Prior to the 1950s, logistics activities were typically performed purely on a functional basis (Bowersox et al. 2003), and were kept in-house (insourcing) until the late 1970s. Firms started outsourcing logistics operations only from the early 1980s, beginning with public warehousing (Aghazadeh 2003, Gattorna 1998). Thus the development of 3PL (i.e. firms outsource one or more logistics functions previously performed in-house to external service providers) has mainly happened only in the last two to three decades.

1.2 Third-Party Logistics

Africk and Calkins (1994, p. 49) defined 3PL as "a relationship between a shipper and third party which, compared with basic services, has more customized offerings encompassing a broader number of service functions and is characterized by a longer-term, more mutually beneficial relationship." The focus on the long-term, contractual relationship between 3PL providers and their customers distinguishes contemporary 3PL from the traditional transaction-by-transaction, ad hoc logistics services (Africk & Calkins 1994, Leahy, Murphy & Poist 1995, Murphy & Poist 2000).

More recently, Coyle, Bardi and Langely (2003) defined a 3PL provider as a provider of industrial logistics services that performs the logistics functions on behalf of their clients. This broad definition suggests that outsourcing of any logistics activity – transportation, warehousing, or inventory management – can qualify as third-party logistics (Knemeyer & Murphy 2005). Some authors use 3PL and LSP (logistics service providers) interchangeably. The researcher prefers 3PL because it emphasizes

the *triangular relationship* between the three parties: shipper, 3PL provider and customer.

Due to this triangular relationship, 3PL providers serve two customers – shippers (also known as depositors for warehousing services) and their customers (ultimate customer). For distribution warehouse and outbound transportation, selection of 3PL provider is usually made by shippers, while for production warehouse and inbound transportation, selection is by customers. Firms outsourcing both inbound and outbound logistics functions usually award both contracts to the same provider.

The increasing importance of efficiency and a focus on core competencies have opened up many business opportunities for 3PL services (Christopher 2005). Manufacturing firms have increasingly relied on specialists to assume logistics activities previously performed in-house, and the outsourcing of logistics services has grown steadily (Coyle, Bardi & Langley 2003, Peters, Cooper, Lieb & Randall 1998). 3PL providers often come from related businesses such as freight forwarding, transportation, or warehousing entering into this industry by extending their service portfolio to meet the requirements of customers. A full portfolio might include traditional services like warehousing, transportation, freight consolidation and forwarding, and newer services such as contract manufacturing, product testing, procurement, and reverse logistics (Aghazadeh 2003, Meade & Sarkis 2002, Van Hoek 2000).

1.3 Problem Statement

Considering the role, and the complex linkages logistics functions have with other functions within and between firms, outsourcing them to 3PL providers raises many concerns. One most frequently cited concern is the potential loss of direct control. Other concerns include the true cost of using a 3PL, quality of 3PL employees, service levels, and information security (Aghazadeh 2003, Lieb et al. 1996, Sink & Langley 1997). Many customers select 3PL providers based on their past performance records (Straight 1999) and make use of logistics performance measures to assess their performance (Bhatnagar et al. 1999). Van Hoek (2001) noted that the ability to provide quantitatively measurable performance is among the most important criteria when choosing a provider; and Spira (1999) stressed the necessity to include performance measures in service contract.

Logistics creates value by accommodating customers' delivery requirements in a cost effective manner. 3PL performance, therefore, assesses a provider's ability to consistently deliver requested product within the requested delivery time frame at an acceptable cost (Bowersox et al. 2003). The term *3PL performance* is twofold: it can be considered from the point of view of the company that employs 3PL providers (customer), or the company that provides 3PL services (provider). In this study, the researcher sought to develop an operational performance scale that can be used by 3PL providers to assess their operational performance. Considering that the ultimate judge of how well a 3PL provider performs is the customers, the researcher gathered information from customers in order to identify those aspects of performance which are important to them.

Stank, Goldsby, Vickery and Savitskie (2003) developed a three-dimension 3PL service performance scale consisting of operational, relational and cost measures. For operational performance, the focus of the current research, they identified three items: "meets promised deadlines", "delivers undamaged orders" and "delivers accurate orders" (i.e. items ordered arrived, no unordered items). Given the wider range of activities being performed by 3PL, it is, however, questionable if three items are adequate to capture the necessary dimensions of 3PL operational performance. Furthermore, if we consider that some 3PL services, such as onsite warehousing, are produced and consumed simultaneously, relational elements, (e.g. responsiveness, assurance and empathy in customer relationship management), should be integral parts of the daily operations of 3PL services. Thus, relational elements should be included in operational performance measurement, but they are missing from Stank et al.'s (2003) scale.

1.4 The Present Study

The present study built on research undertaken by Stank et al. (2003) and Rafiq and Jaafar (2007) (discussed in detail in Chapter Two). It sought to reinvestigate the operational dimension of 3PL performance to develop an up-to-date, more comprehensive multi-dimension instrument with good reliability and validity that 3PL managers can use to assess the firm's operational performance (Fig. 1.2).

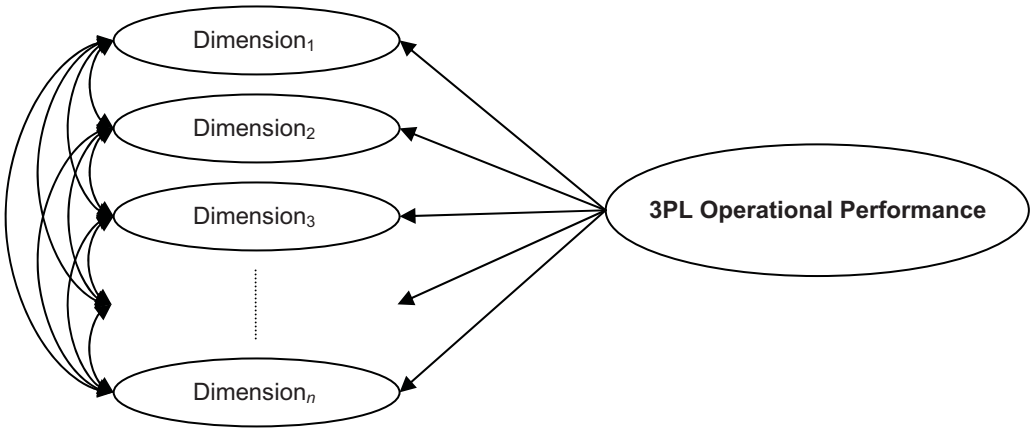

Figure 1.2: Conceptualization of 3PL Operational Performance

Even though 3PL has expanded to cover newer, higher value-added activities such as final assembly, transportation and warehousing remain the two most frequently outsourced logistics functions (Ashenbaum, Maltz & Rabinovich 2005). Also, other than inventory carrying cost, transportation and warehousing are the two largest cost factors in logistics services (Frazelle 2002, Swenseth & Godfrey 2002). Thus the current study focused on the evaluation of these two key 3PL services.

1.5 Significance of the Study

There are three good reasons why the researcher should focus on study into 3PL services: First, for developing markets, including Thailand, growing industrialization has resulted in higher demand for logistics services (Knee 2003). Second, customer interest in outsourcing a wider range of logistics services has increased and the scope of 3PL service offerings is expanding. The trend is towards more complex outsourcing where several logistics activities or even the entire logistics process is

contracted out (Andersson & Norrman 2002, Langley, Allen & Dale 2004). Finally, due to the increasing competition, 3PL providers are aggressively improving their service quality (Bask 2001).

Despite much local discussion about the importance of logistics and the emerging role of 3PL, there are not many studies available for understanding logistics management and 3PL in developing markets. In terms of academic contribution, this study aimed to fill a gap in the literature by producing an up-to-date, more comprehensive multi-dimension instrument for assessing customer perception and evaluation of 3PL operational performance. To the managers of 3PL provider firms, the measures may be used individually to monitor and control firm's operational performance at activity level (service micro level), or collectively at dimensional level (service macro level). They may also be used for customer satisfaction survey (a requirement of ISO 9000) recasting them into perception statements to obtain customer perceptions about the 3PL firm whose performance is being assessed.

1.6 Research Methodology

This research was conducted in two phases combining qualitative and quantitative approaches. The first phase used semi-structured interviews to identify as far as possible the measures used by 3PL customer managers to evaluate the operational performance of their providers. In the second phase, a questionnaire survey was used to test the measures derived from the qualitative phase in a wider context. The survey instrument was drawn from the previous phase with three major aspects of

performance being the main focus: 3PL general performance measures, 3PL warehousing performance measures, and 3PL transportation performance measures.

The sample was drawn from the electronics manufacturing industry in Thailand. The respondents, from both contractual and transactional 3PL customer firms, were mainly supervisors and first- or second-line managers with primary functional responsibilities related to daily logistics operations.

1.7 Thesis Outline

This thesis is organized in five chapters including this introductory chapter. Chapter Two examines existing literature starting with logistics development, 3PL industry, and then focusing on 3PL operational performance measures. The purpose of this literature review is to understand and classify how to evaluate the operational performance of 3PL. Chapter Three describes the qualitative data collection and analysis, and is followed by the fourth chapter covering the quantitative research where the results obtained from the qualitative phase are tested in a wider context. The last chapter discusses the results in relation to the literature and methodology, limitations and suggestions for future research, managerial implications and conclusions.

CHAPTER TWO

Literature Review

2.1 Introduction

The objective of this review is to provide a background to the current study on 3PL operational performance measurement. It is organized in six sections beginning with this brief introduction. Section two discusses logistics development. Section three provides more details of the 3PL industry (which was briefly touched upon in Chapter One) to give a more complete picture of this unique subset of the industrial services industry that spans the boundaries between suppliers and customers. Section four reviews literature on service quality and performance measurement relevant to 3PL. Viewed with functional and technical components (Grönroos 2007), service quality is regarded as analogous to performance. Section five discusses two service quality models, SERVQUAL and Grönroos's (2007) Six Criteria of Good Perceived Service Quality, and a supply-chain process reference model, the SCOR (Supply-Chain Operations Reference) to provide guidelines for how measures may be classified into an *a priori* conceptualization of appropriate dimensions. The chapter ends with a summary in section six.

2.2 Logistics Development

Evolving over the last three to four decades from the narrowly defined distribution management to the integrated management of the global supply chains, logistics development can be classified into four stages:

1 **Physical distribution**: The first phase of the logistics development began during the 1970s when firms focused only on the outbound flow of finished products from the end of the production line to the consumers. Developing markets are in this lowest level of logistics development.

2 **Internally integrated logistics**: The second phase of logistics development occurred in the 1980s when physical distribution functions were integrated with pre-production activities such as material sourcing and work-in-process inventory to form end-to-end material flow management. Most newly industrialized markets are in this stage.

3 **Externally integrated logistics**: This third stage started in the 1990s and extended the concept beyond one firm to all firms involved in the whole supply chain, outsourcing the internally supplied materials and products to external suppliers. Most developed and some newly industrialized markets such as Hong Kong and Singapore are classified in this stage.

4 **Global logistics**: The fourth evolution has taken place from around 2000 when firms started to source parts and components in different countries for assembly in another country into products destined for markets in several others. Advanced markets such as the United States, UK and Germany are in this category. In developed markets, a major force driving logistics management to be more efficient is the business practices of

multi-national corporations. Their logistics management techniques have brought about revolutionary changes to the international distribution systems. These techniques have enabled them to carry out global marketing and sourcing which are now becoming increasingly important determinants of the worldwide trading pattern (Juhel 1999, Ojala, Andersson & Naula 2006).

Aspiring to become newly industrialized, most firms in developing markets (including Thailand, the focus of the current study), have been working hard to become part of the world economy. The Thai government has taken an integrative approach to logistics management encouraging Thai companies, particularly the small and medium-sized enterprises, to invest in more advanced logistics management i.e. internally integrated or externally integrated logistics (Suthiwartnarueput 2007).

2.3 Third-Party Logistics – A Further Look at the Industry

2.3.1 Types of Third-Party Logistics Providers

Third-party logistics was recognized as a separate industrial services industry only in the late 1980s. Since then there have been numerous studies of the industry as it has grown (Ashenbaum et al. 2005). The use of 3PL has been assessed both in single studies (e.g. Bardi and Tracey 1991, Maltz 1993, Rabinovich, Windle, Dresner and Corsi 1999, Sheffi 1990, Sink and Langley 1997) and in annually repeated, macro-

level, longitudinal analyses (Langley 1996, 1997; Langley et al. 1998, 1999, 2000, 2001, 2002, 2003 and 2004; Lieb et al. 1996, 1999, 2000, 2002, 2004 and 2005).

There are two models of 3PL operations: multi-client 3PL and contract 3PL. ***Multi-client 3PL providers*** house many customers in the same facility managed by the same employees. This type of provider is generally a small to medium-sized logistics firm willing to take on small customers for a shorter period of time serving them with standard packages or with very minimal customization. In this study, customers who perform most of the logistics activities in-house and seek services from multi-client 3PL providers on an ad-hoc basis are termed "transactional customers".

Contract 3PL providers might have multiple customers with a long-term agreement but generally these customers are not in the same facility. If the customers are in the same facility, the 3PL operates as a separate business with dedicated equipment and employees. Contract 3PL providers generally serve large companies requiring dedicated, customized services. Customers who outsource part or all of their logistics activities to contract 3PL providers are called "contractual customers". This model of 3PL operations is more consistent with Africk and Calkins' (1994) definition used in this study (see Section 1.2).

3PL providers often come from simple logistics businesses such as warehousing, transportation, and customs brokerage. Today, 3PL providers assume a significant role in supply chain operations, performing a wider range of more value-added activities such as material planning and final assembly. According to Berglund,

Van Laarhoven, Sharman and Wandel (1999) there were three waves of entrants into the 3PL industry:

1. **Asset-based providers**, which offer dedicated logistics services primarily through the use of their own asset, e.g. trucks and warehouses.
2. **Skill-based providers**, which are companies that typically do not own physical logistics assets but provide consultancy and financial services, IT services and management skills.
3. **Network logistics providers**, which are express parcel companies that have built up global transport and communication networks in order to expedite shipments.

3PL providers can be further classified into three categories based on the degree of their involvement in the customer's logistics systems: solution providers, distribution providers and transport providers. **Solution providers** are most heavily involved in all aspects of the customer's logistics systems and offer a complete solution. **Distribution providers** have a broader service offering providing both transportation and warehousing related services, but are less involved in customers' logistics systems, especially those activities pertaining to strategic design. **Transportation providers** focus on transportation related services, and are the least involved in the various logistics activities (Berglund 2000).

Given the growth of the 3PL market, particularly in value added services and management and/or information based services, it might be expected that most, if not all 3PL providers gear towards becoming solution providers. This, however, has not proved to be the case because the distribution and transportation providers lack the

required resources and technical skills. Apparently, these two types of provider compete solely on the basis of the most efficient asset utilization. Solution providers, on the other hand, seem to have the competence to address the growing demands of their outsourcing customers and deliver better logistics performance than transport and distribution providers (Ojala et al. 2006).

For the past few years, skill-based and solution 3PL providers have attracted special attention (Fulconis, Saglietto & Paché 2007). Accenture, a global consulting firm, calls their approach "fourth-party logistics – 4PL". They defined a 4PL firm as "an integrator that assembles the resources, capabilities, and technology of its own organization and other organizations to design, build and run comprehensive supply chain solutions." (Sollish & Semanik 2007, p. 281). This type of provider owns only information systems and intellectual capital and uses other logistics providers to supply service to customers.

According to CSCMP, 4PL differs from 3PL in the following ways: 1) 4PL is often a separate entity established as a joint venture or long-term contract between a primary customer and one or more partners, 2) 4PL acts as a single interface between the customer and multiple logistics service providers, 3) ideally, all aspects of the customer's supply chain are managed by the 4PL, and 4) it is possible for a major 3PL provider to form a 4PL firm within its existing structure (Council of Supply Chain Management Professionals 2009).

Although purchasers of logistics services try to keep the number of their providers to the minimum for better performance controlling and cost savings, there are still relatively few providers that operate on a truly global scale and can fully meet the current customer requirements. A survey conducted by Armstrong (2005) in the United States revealed that the top twenty largest 3PL customers employed more than ten providers (Table 2.1). The 3PL market is still considered to be very fragmented.

Firm	Number of 3PL Providers in Use	Firm	Number of 3PL Providers in Use
1. General Motors	43	11. Georgia-Pacific	16
2. Daimler Chrysler	32	12. IBM	16
3. Ford Motor	30	13. Nestlé	16
4. Volkswagen	28	14. Royal Philips	16
5. Hewlett-Packard	26	15. Toyota Motor	16
6. Unilever	24	16. Home Depot	15
7. Procter & Gamble	22	17. Sara Lee	15
8. General Electric	21	18. Altria Group	14
9. Siemens	19	19. Coca-Cola	13
10. BMW	17	20. Nissan Motor	12

Table 2.1: Top 20 Largest 3PL Buyers in the United States (2004)
Source: Armstrong, R. 2005, The Top 25 Companies in North America, *Logistics Quarterly*, vol. 11, no. 4.

With more providers serving the same customers, competition becomes intensified. This is one of the reasons why 3PL providers are aggressively improving their service quality (Bask 2001). The literature indicates that, in the eyes of customers, operational performance (e.g. delivering correct, undamaged shipments on time) and cost performance (e.g. competitive price) are recognized only as "order qualifiers", and it is their relational performance such as communications and responsiveness that differentiates a 3PL service provider from their competitors (Stank et al. 2003).

However, this should not be interpreted as saying that relational performance is more important than operational and cost performances. Order qualifiers are factors that are regarded by the customers as an 'entry ticket'. Unless the service meets basic performance standards, it will not be taken seriously (Harrison & Van Hoek 2002). Practitioners recognize the importance of operational performance in maintaining existing and securing new customers. Without solid order qualifiers, particularly the operational performance, 3PL firms will have no foundation upon which to establish relationships. The ability to customize operational services with a high level of relational performance represents an "order winning" combination (Stank et al. 2003).

2.3.2 Thailand's Third-Party Logistics Industry

With the entry of international 3PL providers in the late 1990s and the emergence of a number of local 3PL firms, Thailand's logistics service industry has become even more competitive. Thai 3PL providers, being smaller and less sophisticated, especially in information technology capability, have focused on local Thai customers offering cheaper standard service packages. International 3PL providers, in addition to their complete range of specialized solutions targeted at multi-national corporations, have also adapted themselves to the local market developing standard service offerings aimed at small and medium-sized local companies (Logistics Bureau 2002).

According to Air-Sea Guide, the most widely used locally published monthly airlines timetable, there are currently over 250 logistics service providers operating in Thailand. Similar to elsewhere, most of the local 3PL firms come from simple freight forwarding, transportation or warehousing business. The international 3PL providers came into Thailand mostly through the acquisition of, or partnering with local firms to gain an immediate employee base and local expertise. For example, USA-based EGL Eagle Global Logistics bought a Thai logistics firm WorldBridge and changed the name to EGL Eagle Global Logistics (Thailand) Ltd. In August 2007, Apollo Management L.P. purchased EGL and merged it with CEVA Logistics and now operates worldwide under the CEVA brand name (CEVA 2008). Based on annual expenditure, the two most outsourced logistics functions in Thailand are transportation and warehousing, followed by freight forwarding and other supply chain related services (Logistics Bureau 2002).

The outsourcing concept is still considered to be quite new for Thailand. Multi-national companies, due to their exposure to more advanced logistics management (e.g. externally integrated or global logistics), better understand the strategic benefits of 3PL. Large local companies, on the other hand, are somewhat skeptical about 3PL. These companies are willing to outsource only some external logistics activities – those performed outside their premises such as transportation and freight forwarding – and keep the internal or onsite functions (e.g. production warehousing, logistics administration) in-house. For small to medium-sized local firms, the understanding is even less because the scale of operations is limited, making benefits less discernible (Logistics Bureau 2002).

With respect to human resources, the education system in Thailand previously did not provide for a workforce for the logistics industry. Although some universities have started to embed logistics study into degrees such as business administration or industrial engineering, and even developed logistics degrees for students, most logistics people in Thailand gain the knowledge directly from their companies. The in-house training of 3PL providers is still very important (Logistics Bureau 2002, Suthiwartnarueput 2007).

2.3.3 Advantages and Disadvantages of Logistics Outsourcing

Companies' needs to focus on core competence, reduced logistics costs and improved service are the driving force behind the use of 3PL services. Research often cites three primary reasons for outsourcing of logistics functions:

1. cost reduction realized from expertise and economies of scale of 3PL providers (Zineldin & Bredenlow 2003, Wilding & Juriado 2004);
2. service improvements resulting from 3PL provider focus and efficiency (Greaver 1999, Lynch 2004); and
3. asset reduction (Sink, Langely & Gibson 1996, Razzaque & Sheng 1998) and headcount reduction (Bardi & Tracey 1991).

Logistics outsourcing is not without disadvantages. Right after a 3PL takes over the operations, cost and service can be negatively affected, as it takes some times for the 3PL personnel to get accustomed to their customers' logistics systems (Andersson 1995), and higher initial costs resulting from duplication of resources (Ojala et al. 2006). Reduction in fixed assets investment and higher capital turnover are of

growing importance in the modern business. By outsourcing to a 3PL, a company can pay for the capacity it needs and gain a greater degree of flexibility (Andersson 1997). But this is largely true for advanced markets with a predictable operational environment and a plentiful supply of logistics services. In many developing countries, the ownership of transport and warehousing assets may be the only way to secure flexible operations (Ojala et al. 2006).

2.4 Third-Party Logistics Operational Performance Measures

Although seemingly a straightforward concept, there is a lack of consensus about what the term *performance* means, and consequently, how it is to be measured. Some authors use productivity and performance interchangeably, while others distinguish them and suggest a number of measurement criteria (Euske 1984, Kearney 1985). For Mentzer and Konrad (1991), performance is a function of effectiveness and efficiency. They defined effectiveness as "the extent to which goals are accomplished," and efficiency "is the measure of how well the resources expended are utilized." (p. 34). Measuring performance is thus an evaluation of both effectiveness and efficiency in accomplishing goals.

The effectiveness component of performance measurement addresses the dual criteria of cost and service quality levels. Effectiveness can be measured as the ratio between the actual outputs and the normal level of outputs (Van der Meulen & Spijkerman 1985). To indicate that one is 100 percent effective implies full success at achieving a particular goal. Although effectiveness levels may be set arbitrarily (Mentzer &

Konrad 1991), it is important to consider what level of output would be required by the customers.

The efficiency component compares an actual measure to a standard. The actual measure refers to the actual use of some company resource such as time (e.g., man-hours or equipment-hours), space, or unit of energy. The standard measure is usually expressed as the amount budgeted or planned, or a stand amount used.

Supply Chain Management Process Standards: Deliver published by CSCMP suggests a number of warehousing and transportation performance standards (Supply Chain Visions 2004). Some suggested productivity metrics are: units processed per hour, day, month and/or week; labor cost per piece (or pallet) received or issued. Utilization metrics include: amount of storage space utilized at end of day, week or month; employees (regular full time, regular part time, temporary) used in each process versus employees available. For warehousing performance: hours required to complete each stage of the receiving process and hours overall (broken down by employee, product category/class, time period); accuracy level of each employee in terms of number of items handled, number of errors, and percentage correct decision (Supply Chain Visions 2004). However, a recent study by Stock and Mulki (2009) revealed that few U.S. companies or industries use standards and the extent of use varied.

Generally, there are three main objectives in measuring performance: monitoring, controlling and directing (Bowersox et al. 2003). ***Monitoring measures*** track historical performance which typically includes cost and service level components.

Monitoring is accomplished by the establishment of appropriate metrics to track system performance for reporting to management.

Controlling measures track ongoing performance and are used to refine a process in order to bring it into compliance when it exceeds control standards (e.g., warehouse damage tracking). If there is discrepancy between the actual and desired value of a metric, knowledge about the behavior of the organization is used to modify the process. At the tactical or strategic level, the control loop is used to evaluate the operational level and adjust its goals (Lohman, Fortui, & Wouters 2004).

Directing measures are related to employee motivation and reward for performance. Typical examples are "pay for performance" practices used to encourage warehouse or transportation personnel to achieve higher levels of productivity. It is important that both positive and negative performance be measured – the completion of an assigned task, such as material picking, in less than the standard time must not be traded-off with increased errors or damage (Bowersox et al. 2003). Given the operational focus of the current research, it dealt with only the monitoring and controlling measures.

Letza (1996) argued that the main function of performance measurement in a strategic context is to provide the means of control to achieve the objectives required to fulfill the company's mission or strategy statement. This reinforced the position of Neely et al. (1994) who viewed performance measurement as a key part of strategic control. Fawcett, Smith and Cooper (1997) and Neely et al. (1994) indicated the need for

performance measurement to exercise this control through: helping managers to identify good performance, setting targets, and demonstrating success or failure.

A performance measurement system consists of three components: individual measures, the set of measures, and supporting infrastructure (Neely 1998). ***Individual measures*** are the measures that quantify the efficiency and effectiveness of actions. Generally, measures fall into two categories: performance and diagnostic. The first measures how one is doing. The second analyzes why a process is not performing as expected (Trimble 1996). In the context of the current study, the researcher was discussing performance measures rather than diagnostic measures.

Individual measures may be grouped according to their characteristics to form ***a set of measures*** that combine to assess the performance as a whole. They must be compatible, comparable, and capture all aspects of the actual inputs and outputs (Mentzer & Konrad 1991).

The third component, ***supporting infrastructure***, enables data to be acquired, collated, sorted, analyzed, interpreted and disseminated. It is worth noting here that the human behavior element is considered equally, if not more important than the physical infrastructure. It should be carefully monitored to avoid misrepresentation problems such as deliberate manipulation, or grooming of data by provider staff resulting in a reported behavior that differs from actual behavior (Smith & Goddard 2002).

As an industrial, business-to-business (B2B) service, 3PL is a somewhat intangible and subjectively experienced process, and in many cases, production and consumption

activities take place simultaneously. As with other similar services, the quality of 3PL service as it is perceived by customers may have two dimensions – a technical or outcome dimension and a functional or process dimension (Grönroos 2007).

Technical quality is what the customer receives, e.g. a manufacturer gets its products transported from its factory to a customer. Functional quality refers to how the customer receives the service and how he or she experiences the simultaneous production and consumption process, e.g. 3PL truck driver has a neat appearance and strictly follows the safety rules and regulations of the customer while on the customer's premises.

Third-party logistics technical quality lends itself to more objective evaluation using direct quantitative measures and data are usually easy and inexpensive to collect. Functional quality, on the other hand, tends to be more subjective. Measures used can be either perceptual (no direct numerical measurement, even if some aspects of them may be quantified) or direct.

One example of 3PL customer perception measurement is the scale developed by Knemeyer and Murphy (2004). Based on Morgan and Hunt's (1994) view that trust is a key mediating variable within effective relational exchanges, Knemeyer and Murphy used a seventeen-item measure of 3PL performance (Table 2.2) developed by Newton, Langley and Allen (1997) to survey 388 U.S. companies using 3PL. They concluded that customers with higher levels of trust toward their provider exhibited a significantly higher perception of the 3PL provider's operational performance. This

scale, however, seems to be measuring the perceived benefits of a 3PL relationship, rather than performance of a 3PL provider.

Third-Party Logistics Performance
Logistics Operations Performance - Cronbach's alpha = 0.93 This relationship has improved our logistics system responsiveness. This relationship has improved our logistics system information. This third-party continuously works to reduce our costs, even if it means a reduction in their price. This relationship has reduced our risk. This relationship has provided us specialized services. This relationship has improved our product/service availability. This relationship has allowed us to achieve logistics cost reductions. This relationship has improved our information technology. This relationship has enabled us to implement changes faster/better. This relationship has provided us more specialized logistics expertise.
Marketing Channel Performance - Cronbach's alpha = 0.82 This relationship has reduced our order cycle time. This relationship has enabled us to move from a "push" to a "pull" system. This relationship has increased post-sale customer support. This relationship has expanded our geographic coverage. This relationship has helped us integrate our supply chain.
Asset Reduction – Cronbach's alpha = not applicable This relationship has reduced our level of owned assets. This relationship has reduced our employee base.

Table 2.2: Measures of Third-Party Logistics Performance
Source: Knemeyer, A.M. & Murphy, P. R. 2004, 'Evaluating the Performance of Third-Party Logistics Arrangement: A Relationship Marketing Perspective', *Journal of Supply Chain Management*, vol. 40, no. 1.

To help further understand, and conduct research in the area of supply chain management (SCM), Tracey, Fite and Sutton (2004) developed a Supply Chain Management Explanatory Model comprising six dimensions: technology utilization, internal relationships, external relationships, product development, transportation and inventory management. The latter two are applicable to 3PL. The transportation dimension has one seven-item subdimension termed transport effectiveness.

Inventory management consists of two subdimensions, namely inventory control (7 items), and warehousing and packaging (6 items) (Table 2.3).

Transportation Dimension
Subdimension: Transport Effectiveness – Cronbach's alpha = 0.85
TR1 Outbound transportation delivers shipments in the condition they were presented for transport
TR2 Inbound transportation meets delivery schedules
TR3 Inbound transport provides a timely reply to inquiries
TR4 Inbound transport reacts quickly to special requests
TR5 Outbound transport meets delivery schedules
TR6 Outbound transport provides a timely response to inquiries
TR7 Inbound transportation delivers shipments in the condition they were presented for transport
Inventory Management Dimension
Subdimension: Inventory Control – Cronbach's alpha = 0.94
IM1 We have accurate inventory records regarding the quantities of production material on hand
IM2 We update inventory records for production material promptly
IM3 Finished goods warehousing responds promptly for customer requests
IM4 Our packaging department facilitates efficient handling and transport of our outputs
IM5 We update finished goods inventory records promptly
IM6 We have accurate records concerning the quantities of finished product on-hand
IM7 We have accurate records concerning the location of finished goods in the warehouse system
Subdimension: Warehousing & Packaging – Cronbach's alpha = 0.85
IM8 Production support responds expediently to special requests
IM9 Our finished goods are warehoused with little damage or loss
IM10 Finished goods warehousing picks orders accurately
IM11 Labeling on our packaged products is accurate and distinguishable
IM12 We meet the packaging specification of our customers
IM13 Packaging sustains our production plan

Table 2.3: Transportation and Inventory Management Performance Measurement Items
Source: Tracey, M., Fite, R.W. & Sutton, M.J. 2004, 'An Explanatory Model and Measurement Instrument: A Guide to Supply Chain Management Research and Applications', *Mid–American Journal of Business*, vol. 19, no. 2.

To measure a manufacturer's logistics performance within the supply chain context, Tracey et al. (2004) distinguished the inbound from outbound logistics functions (e.g. items TR2, TR3, TR7 for inbound transport, and TR5, TR6 and TR1 for the corresponding reverse activities). When conducting a survey of 3PL performance, similar items from the two functions may be combined into one item (e.g. TR1 and TR7 become "3PL transportation delivers shipments in the condition they were presented for transport"), or measured separately should researchers expect that customers may have different perceptions for the two functions.

Four items TR1 and TR7 "... in the *condition* they were presented for transportation", IM12 "We meet the *packaging specification* of our customers", and IM4 "Our packaging department facilitates *efficient handling and transport* of our outputs" imply "damage" issue. Damaged products need to be replaced or claimed, and either be scraped by the customer or returned to the vendor for scrap or rework. Return to vendor (RTV) causes the products to flow back through the supply chain, so called "reverse logistics". In the United States, it has been reported that the value of products being returned exceeds an estimated US$ 100 billion per year and averages about six percent of sales (Guide et al. 2006, Stock 2001). While the use of 3PL for reverse logistics has been widely discussed in the business press and many case studies about companies who successfully outsourced these activities have been presented, the vast majority of firms still kept these activities in-house (Stock & Mulki 20009). One possible reason for this might be the lack of critical volume and economies of scale (Gorick 2005).

Drawing measures from two earlier studies of a focal company's logistics performance (Mentzer et al. 1999, 2001) and applying them directly in a 3PL context, Rafiq and Jaafar (2007) proposed a 3PL Service Quality Scale consisting of thirty-two items classified into nine dimensions: information quality, order procedures, order release quantities, timeliness, order accuracy, order quality, order condition, order discrepancy handling and personnel contact quality. The thirty-two items in the scale focus more on inventory management (warehousing) and contained many items that are not relevant to 3PL services (see Appendix I for detailed discussion of this scale).

Table 2.4 lists the sixteen items that are relevant to 3PL operational performance against the dimensions they were designed to measure.

Dimension	Item
Information Quality	1. The information communicated by the 3PL is timely. 2. The information communicated by the 3PL is accurate. 3. The information communicated by the 3PL is complete.
Timeliness	1. Time between placing a requisition and receiving delivery is short. 2. Deliveries arrive on the date promised.
Order Accuracy	1. Shipments rarely contain the wrong items. 2. Shipments rarely contain an incorrect quantity.
Order Condition	1. Damage rarely occurs as a result of the transport mode or carrier.
Order Discrepancy Handling	1. Correction of delivered quality discrepancies (Report of Discrepancy) is satisfactory. 2. The Report of Discrepancy process is adequate. 3. Response to Quality Discrepancy Reports is satisfactory.
Personnel Contact Quality	1. The designated 3PL contact personnel makes an effort to understand my situation. 2. Problems are resolved by the designated 3PL contact person. 3. The product knowledge/experience of 3PL personnel is adequate.

Table 2.4: Relevant Measurement Items from Rafiq and Jaafar (2007) 3PL Service Quality Scale

Although the three earlier studies discussed above provide some useful information for the present study, there are some shortcomings that need to be addressed. Knemeyer and Murphy's (2004) 3PL performance items were designed to measure 3PL benefits, not performance. Tracey et al.'s (2004) Transportation and Inventory Management Performance Scale was designed to measure a firm's logistics performance in the supply chain context, while Rafiq and Jaafar's (2007) 3PL Service Quality Scale contained too many items irrelevant to 3PL.

Due to its multidimensionality, 3PL performance requires a large set of measures. One important criterion to consider in choosing a set of performance measures is *representativeness* (Smith 1993), that is, the set of measures should capture those dimensions of performance which both 3PL providers and customers find useful in monitoring and controlling the performance of the outsourced logistics operations. Thus, there is scope for further work in developing a set of measures for 3PL operational performance.

2.5 Classification Schemes for Measures

As was discussed in the preceding section, Tracey et al. (2004) classified twenty performance items into two broad dimensions based on the function to which the items belong: transportation and inventory management, whereas Rafiq and Jaafar (2007) used function, outcome and attribute to classify thirty-two measures into two functional dimensions (order procedures and order discrepancy handling); five outcome dimensions (order release quantities, order accuracy, order quality, order condition and timeliness); and two attribute dimensions (information quality and

personnel contact quality). Classification by function or outcome has a lower level of abstraction, hence lower generalizability than classification by attribute. This section discusses three models that use attribute to classify their measures, namely SERVQUAL, Six Criteria of Good Perceived Service Quality, and the SCOR to provide the reader with an overview of how measures may be classified into cross-functional dimensions.

2.5.1 The SERVQUAL Model

SERVQUAL – probably the best known service quality evaluation model – developed by Parasuraman, Zeithaml and Berry (1985, 1988, 1991), classifies twenty-two items into five broad service dimensions: 1) *reliability* – ability to perform the promised service dependably and accurately; 2) *responsiveness* – willingness to help customers and provide prompt service; 3) *assurance* – knowledge and courtesy of employees and their ability to convey trust and confidence; 4) *empathy* – caring, individualized attention, which the firm provides its customers; and 5) *tangibles* – appearance of physical facilities, equipment, personnel, and communication materials.

While many scholars claim that the SERVQUAL model is applicable to all kinds of services, including logistics (Rafele 2004), empirical evidence suggests that the proposed five service quality dimensions are not consistent when compared across different types of service industry, or even the same type of industry but in different geographical locations, e.g. hospitality industry in the United States and in Turkey (Akbaba 2006, Babakus & Boller 1992, Carman 1990, Cronin & Taylor 1992, 1994, Ekinci 2001, Finn & Lamb 1991, Yoon & Ekinci 2003). Researchers are advised to

carefully assess which issues are important to service quality in their particular situations (Brown, Churchill & Peter 1993).

Bienstock, Mentzer and Bird (1997) argued that SERVQUAL, focusing on service delivery or processes, is more appropriate in the business-to-consumer (B2C) context where people receiving intangible services that are not physically separated from the consumer. Business-to-business (B2B) logistics services, on the other hand, are offered in a context in which some people elements are replaced with "things" and in many cases, the customer and provider are physically separated. Thus an "alternative conceptualization" is necessary for logistics service quality.

Apparently Bienstock et al. (1997) did not take onsite services into consideration. Operating on customer's premises, 3PL can be considered a high contact service where customer managers and employees participate in the production process at least to some extent, and are able to observe and evaluate the provider's performance both during and after the service completed. The researcher was, therefore, of the opinion that SERVQUAL, although it focuses on service delivery, is an important framework which provides a useful initial guide for how measures may be grouped into appropriate dimensions.

2.5.2 Six Criteria of Good Perceived Service Quality

Integrating a number of empirical studies, Grönroos (2007) compiled a list of six criteria of good perceived service quality: 1) *professionalism and skills* – service providers, their employees, operational systems and physical resources, have the knowledge and skills required to solve customer problems in a professional way; 2) *attitudes and behavior* – service employees are concerned about customers and interested in solving their problems in a friendly and spontaneous way; 3) *accessibility and flexibility* – the service provider, its location, operating hours, employees, and operational systems, are designed and operate so that it is easy to get access to the service and the service provider is prepared to adjust to the demands and wishes of the customer in a flexible way; 4) *reliability and trustworthiness* – whatever takes place or has been agreed upon, the customers can rely on the service provider, its employees and systems, to keep promises and perform with the best interest of the customer at heart; 5) *recovery* – whenever something goes wrong or something unpredictable happens, the service provider will immediately and proactively take action to stay in control of the situation and find a new, acceptable solution; and 6) *reputation and credibility* – the operations of the service provider can be trusted, the provider gives adequate value for money and is recognized for good performance and values which can be shared by customers and the service provider.

The first criterion, professionalism and skills, is outcome related and thus a technical quality dimension. The second to fifth criteria are process related representing the functional quality dimension. The last criterion is image related fulfilling a filtering function.

2.5.3 The Supply-Chain Operations Reference Model

The Supply-Chain Operations Reference (SCOR) model, a process reference model developed and endorsed by the Supply-Chain Council (SCC) as the cross-industry standard diagnostic tool for supply-chain management (Supply-Chain Council 2009), provides a useful framework that considers the performance requirements of member firms in a supply chain, including 3PL providers. It recognizes that logistics is an enabler in a supply chain that facilitates the physical (and information) flows of goods from a point of origin (supplier) to a point of destination (customer).

In line with Mentzer and Konrad (1991) who viewed performance as a function of effectiveness and efficiency, the SCOR (version 9.0) considers the performance expectations of member firms on both the input and output sides of supply chain activities as a series of interlocking interorganizational processes with five measurement criteria: 1) *reliability*; 2) *responsiveness*; 3) *agility*; 4) *cost*; and 5) *assets*. The first three criteria deal with effectiveness-related (customer-facing) performance measures, while the other two are efficiency-related (internal-facing) performance measures of a firm. Customer-facing measures are concerned with how well a supply chain delivers products or services to customers, e.g. delivery performance. Internal-facing measures are concerned with the efficiency with which a supply chain operates, e.g. cycle time (Lai, Ngai & Cheng 2002, 2004, Supply-Chain Council 2009).

Table 2.5 summarizes the dimensions of the three models discussed above:

Proposed Dimensions	Model/Author
Reliability / Trustworthiness	SERVQUAL, Grönroos, SCOR
Responsiveness / Accessibility and Flexibility / Agility	SERVQUAL, Grönroos, SCOR
Assurance / Professional and Skills, Reputation and Credibility	SERVQUAL, Grönroos
Empathy / Attitudes and Behavior	SERVQUAL, Grönroos
Tangibles / Assets	SERVQUAL, SCOR
Recovery	Grönroos
Cost	SCOR

Table 2.5: Summary of Schemes for Classifying Measures

Comparing SERVQUAL, Grönroos (2007) and SCOR, only the latter recognizes cost. The first version of SERVQUAL considered the price or cost of service as part of communication. In the subsequent version, communication was combined with other dimensions (credibility, security, competence and courtesy) to form a new dimension – assurance, and cost was no longer defined (Parasuraman et al. 1988).

Although the literature indicates that cost is one of the most frequently cited reasons for outsourcing (Zineldin & Bredenlow 2003, Wilding & Juriado 2004), a study by Wilding and Juriado (2004) suggested that many customers choose to outsource primarily in order to benefit from the competencies of the 3PL provider. Customers are aware of the fact that not every outsourcing decision decreases costs and therefore they do not expect cost cuts in the first place.

A substantial amount of literature in manufacturing and service operations supports for treating cost as a separate dimension of service performance (Ferdows & De Meyer 1990, Roth & Miller 1990, Roth & Van der Velde 1991, Wood, Ritzman &

Sharma 1990). Grönroos (2007), in particular, argued that the role of cost (or price) in a service quality context is not very clear and thus in reports on research into service quality, cost is not discussed very much.

In the context of 3PL, service contracts usually involve incentives and penalties, thus there is an impact on price/cost due to incentives being paid to, or penalties being paid by, the 3PL providers. Taking incentives and penalties for good and bad service into account, 3PL providers' operational performance does affect their cost. Considering the above, the researcher agrees with Stank et al. (2003) that cost should be treated as a separate factor. Cost performance is related with two other factors, operational and relational performance, and together, all three contribute to the overall performance of 3PL.

2.6 Summary

Measuring performance is an evaluation of both effectiveness and efficiency in accomplishing goals (Mentzer & Konrad 1991). It has three main objectives: monitoring, controlling and directing (Bowersox et al. 2003). Given the operational focus of the current research, this review has focused only on the first two objectives.

A performance measurement system consists of three components: *individual measure* assessing the effectiveness or efficiency of an activity or process, *the set of measures* that combine to assess the performance as a whole, and *supporting infrastructure* to collect, collate, sort, analyze, interpret and disseminate the performance data (Neely 1998). In the 3PL context, individual measures can assess 3PL firm's performance at activity or process level, e.g. data entry accuracy, to

provide operational level management with an indication of the current level of performance of a specific activity or process. At the same time, a set of measures, grouped according to their characteristics, can assess performance across a number of functions, e.g. overall on-time performance, to provide a cross-functional view of performance suitable for use by tactical or strategic level management.

Thus far, 3PL performance studies have relied on measures established for logistics performance. Applying these measures directly in the 3PL context may produce meaningless or even misleading results (e.g. product specification and performance). Hence the current study attempted to develop a representative set of measures specifically for 3PL based on the requirements and expectation of the customers.

As the primary objective of this study was to explore the important but still unclear measures of 3PL operational performance, the researcher decided to undertake it in two phases combining qualitative and quantitative methods. The description of the qualitative method and the results obtained is presented in Chapter Three, and is followed by Chapter Four for the quantitative phase where the measures were tested in a wider context.

CHAPTER THREE

Qualitative Research

3.1 Introduction

The purpose of this qualitative study was to develop constructs and item pools related to 3PL operational performance. For most qualitative questions, eight respondents are sufficient to achieve case saturation (McCracken 1988, Yin 2003). There were nine respondents from four large electronics manufacturing firms participated in this study. These nine respondents were appropriate for this study because of their logistics and 3PL experiences. They were first- or second-line managers or section heads in the logistics, traffic or distribution department who were directly involved with the daily operations of their 3PL providers.

Due to the busy schedule and diverse locations of the target respondents, it was very difficult, if not impossible to organize focus groups. Individual interviews at the respondents' workplace were carried out instead. Three rounds of interviews were conducted with the nine respondents. The first two rounds were used to identify as many performance measures as possible regardless of their relevance and importance, and the last round to finalize and select measures for the second phase of this

research. Each session lasted about one to two hours. Due to respondents' concern about being audio recorded, only written notes were used.

To enable comparisons to be made and also to allow some flexibility in the responses made by the respondents, interviews were designed to be answered purely on the basis of the respondents' direct experience with their 3PL providers. Questions included:

1. How do you find the overall performance of your 3PL provider(s)?
2. In what areas do you find them performing satisfactorily?
3. In what areas do you find them performing unsatisfactorily?
4. What indicators do you use to evaluate those areas in which you find them performing satisfactorily?
5. What indicators do you use to evaluate those areas in which you find them performing unsatisfactorily?
6. On the basis of your experience, are there any other areas you may want to evaluate in a future assessment?

These types of questions could generate many answers that are difficult to fully predict in advance. However, aiming to leave no stone unturned, the researcher encouraged the respondents to suggest as many items as possible. To avoid leading the respondents, non-directive probes (such as "Can you tell me more about ...?" or "What do you mean by …?") were used.

The researcher transcribed and interpreted the conversations about experiences pertinent to the research questions, and sorted for measurement items immediately after each interview. Using only written notes, interviews could not be transcribed

verbatim. Since only one person, the researcher, examined and classified the interview responses, the respondents were asked in the subsequent interview to check the statements, interpretations and the items sorted. They agreed with most of the researcher's interpretations and provided clarifications and corrections. This approach ensured trustworthiness – that the transcripts and interpretations are accurate (Lincoln & Guba 1985, Maxwell 2002).

Where available, the researcher also collected relevant secondary data, e.g. minutes of weekly operations meeting, quarterly business review. These data allowed the researcher to crosscheck the primary data gather from the interview. For instance, the weekly operations performance results showed that the provider had been performing at an acceptable level, but the customer manager still rated them as unsatisfactory.

Two broad types of threats to validity are often raised in relation to qualitative research: bias and reactivity. *Bias* refers to ways in which data collection or analysis are distorted by the researcher's theory, values, or preconceptions. *Reactivity* is the effect of the researcher on the setting or individuals studied (Maxwell 2002). For the current research, biases were avoided through the use of non-directive questions and the transcripts and interpretations were verified by the respondents for interpretive validity. Reactivity was not considered a problem since the interviews were conducted at the respondents' workplace, hence the researcher was likely to be less of an influence on the respondents than was the setting itself (Becker 1970).

3.2 Subject Companies and Participants

The electronics industry was chosen for this study because it is the largest group of users of 3PL services and provides a large enough population from which a sufficient sample can be drawn. It is one of the largest industries in Thailand's manufacturing sector and was worth nearly US$ 30 billion and accounted for more than thirty percent of Thailand's export revenues in 2007. The main electronic exports are hard disk drives (HDD) and integrated circuits (IC), which account for about fifty-four and twenty-nine percent of total electronic exports, respectively. Having overtaken Singapore in 2006, Thailand is now ranked as the top HDD and components manufacturing base worldwide. It holds a similarly prominent place in the IC and semiconductor industries, and boasts one of the largest assembly bases for these products in Southeast Asia (Board of Investment 2008).

Targeting eight or more respondents, the researcher selected the six largest electronics manufacturers (each employing over 5,000 staff) from the customer profiles of the company in which the researcher works (see section 4.2.1 for detailed discussion of these profiles). Three were contractual and the other three were transactional customers located in two major industrial zones (central and the eastern seaboard). The researcher contacted them to identify key informants (i.e. managers responsible for the firm's logistics activities) and seek their participation. Nine respondents from four companies (three contractual and one transactional) agreed to participate. Of these four companies, three were globally operating electronics manufacturers – one from the United States and two from Japan. The fourth company was a Thai original equipment manufacturing (OEM) firm.

3.2.1 Company US

The US case company (referred as Company US for anonymity), an HDD manufacturer, expanded their production base from Malaysia to Thailand in 2001 by taking over a Japanese HDD manufacturing firm in Thailand. This firm classified its inbound (production) logistics flows into two main categories: VMI (vendor managed inventory) and COI (customer's own inventory). Their Malaysian factory had been using a 3PL provider for inbound VMI flow and outbound finished goods distribution (finished goods inventory – FGI). When setting up their Thailand operations, they decided to contract out both the production (VMI and COI flows) and distribution warehouses (FGI flow).

The initial contract was for three years on a build-operate-transfer basis. The customer provided warehouse space, central air-conditioning system, power and water. The 3PL provider acquired the necessary equipment such as forklift, rack, computer hardware and when the initial contract expired, to transfer all these equipment to the customer. In return, the provider charged back the costs (on an amortization basis) plus management fee on a monthly basis. Adopting a single sourcing policy, no bidding was called, but the Bangkok office of the same provider servicing their Kuala Lumpur base was asked to submit a preliminary quotation, and after a few rounds of negotiation, the contract was awarded.

Company US used five 3PL providers: one for inbound and outbound logistics (import and export customs clearance, transportation, freight forwarding and production and distribution warehousing), three for outbound logistics (transportation

and freight forwarding) and two for cross-border (Malaysia and Thailand) overland transportation.

The logistics manager and logistics section head agreed to participate in this study. Both had more than ten years of experience in logistics. Although they joined Company US even before its official incorporation, they were not involved in the selection of 3PL providers and the setting up of the 3PL warehouses. They, however, felt comfortable with the 3PL warehouse provider as it took over almost the whole warehouse team from the previous company they worked for.

3.2.2 Company J1

The first Japanese case company (Company J1) also produced HDD. This company classified its inbound logistics flows into three categories namely HGA (head gimbals assembly) flow, VMI flow, and DNF (do-not-file) flow. The HGA flow of components and materials is a logistics flow that contains deliveries of HGA from sequence suppliers. The VMI flow is a logistics flow that contains deliveries of more or less expensive key component parts that are not kept in any large quantity; and DNF flow contains cheap components and materials that are kept in stock.

Exposed to an extremely keen competitive environment, Company J1 adopted VMI and other lean manufacturing principles starting with the setting up of an external VMI warehouse fully owned and operated by a 3PL provider for key component parts in 1999. Three years later, the company outsourced two other categories: HGA and DNF. A few large international 3PL firms were invited to submit their bids and the

contract was awarded based on five criteria: warehouse location and design, information systems, staff qualification and experience, firm reputation, and cost.

Company J1 used three providers: one for inbound logistics (import and export customs clearance, transportation and VMI warehouse) and two for outbound logistics (transportation and freight forwarding).

Three participants were from Company J1: the logistics director, logistics manager, and part planning manager. The logistics director had more than ten years of logistics experience. Prior to joining Company J1, she worked for an international shipping company as operations manager. She was one of the committee members that evaluated and selected the inbound logistics service provider.

The logistics manager, an information science graduate, joined Company J1's logistics department as a data entry clerk and gradually progressed until she was promoted to be logistics manager looking after both the inbound and outbound logistics.

The part planning manager was actively involved in the setting up of the onsite 3PL warehouse. Although she was not involved in the day-to-day operations of the warehouse, she participated in the quarterly and annual contractor performance review.

3.2.3 Company J2

The second Japanese case company (Company J2) produced a range of electronic products from three manufacturing sites in Thailand. Although each site produced different products, there were a number of common parts and materials that could be used by all sites. But because each site had its own inventory control system inaccessible from the other sites, each had to keep quite a large quantity, including buffer, in stock. Excess stock (due to production change, line switching, end-of-life, etc.) at one site could not be used by the others due to inventory invisibility. Realizing this situation, Company J2 decided to outsource the inbound logistics function of all three plants to a 3PL provider.

By using the provider's contract warehouse (a facility that performs the warehousing operation on behalf of one or more customers) and a single warehouse management system (WMS), inventory became visible to all sites enabling a more coordinated, integrated control. The purchasing department was able to issue a single order to cover the requirements of all three plants further reducing order administration cost. Suppliers sending in larger quantity per order to one location, instead of previously three separate smaller shipments to three locations, enjoyed reduced freight cost. Having no prior 3PL experience, Company J2 selected their contract warehouse provider based on the recommendation of one of their customers who had been using the provider for a few years. Considerations included location, facility, operating hours and cost.

Company J2 used four 3PL providers: one for inbound logistics (import customs clearance, transportation and contract warehouse), and three for outbound logistics (two for inland transportation and one for export customs clearance, transportation and freight forwarding).

There were two participants from Company J2: the logistics manager and the director of sales. The logistics manager joined Company J2 five years ago as warehouse manager looking after one of the three warehouses. She was promoted to logistics manager overseeing the outbound logistics of the three plants and the 3PL operations when the firm contracted out their inbound logistics function.

Considering logistics as a marketing enabler, the director of sales was instrumental in the firm's 3PL initiative. New to 3PL operations, they adapted the key performance indicators previously used to evaluate their own warehouses, and come to audit the 3PL warehouse regularly.

3.2.4 Company OEM

The Thai case company (Company OEM) was an OEM manufacturing HDD for Company J1. Previously this Thai OEM company insourced all their warehousing activities. After the successful 3PL implementation, Company J1, as a major customer, pressured Company OEM to adopt a 3PL/VMI strategy. As part of the supplier performance improvement initiatives, Company J1 helped Company OEM in redesigning the inbound logistics flows and sourcing for a 3PL provider. Like their major customer, Company OEM classified their inbound logistics flows into three

categories: HGA, VMI, and DNF. Reluctant to relinquish all responsibilities to the 3PL provider, Company OEM retained the HGA function (HGA is the most expensive and critical component) and outsourced only the VMI and DNF categories.

Being an OEM factory, for outbound logistics, Company OEM had to use many 3PL providers appointed and paid for by the customers. Inbound logistics was handled by two 3PL providers – one nominated by their main customer, Company J1, to handle Company J1's orders (import customs clearance, transportation and VMI warehouse), and one by Company OEM themselves to handle other non-Company J1 orders (import customs clearance and transportation).

The part planning manager and warehouse supervisor from Company OEM agreed to be interviewed. The part planning manager had been working for Company OEM for more than ten years. Learning about the benefits of 3PL from her counterpart in Company J1, she was enthusiastic about the 3PL operations and actively involved in the development of the business processes integration architecture between the 3PL warehouse management system and their enterprise resource planning system.

The warehouse supervisor had been working for Company OEM for about seven years. He admitted that he felt threatened when he learned about the company's decision to outsource part of the production warehouse to a 3PL provider. But after a few months of 3PL operations, he realized that the 3PL relationship actually provided him with a chance to learn new logistics technology and practices. Company OEM adopted similar criteria to Company J1 to evaluate their 3PL provider.

Possessing more than five years of experience in logistics and having been working closely with 3PL, these nine individuals were considered to be in a good position to evaluate the operational performance of 3PL providers. Table 3.1 summarizes their position, qualifications and experience in logistics.

Company	Position	Qualification	Experience in Logistics	Involvement with 3PL (Direct / Indirect)
US	Logistics Manager	Bachelor's degree	> 10 years	Direct
	Logistics Section Head	Bachelor's degree	> 10 years	Direct
J1	Logistics Director	Master's degree	> 10 years	Direct
	Logistics Manager	Bachelor's degree	> 5 years	Direct
	Part Planning Manager	Master's degree	> 5 years	Indirect
J2	Logistics Manager	Bachelor's degree	> 5 years	Direct
	Director of Sales	Bachelor's degree	> 5 years	Direct
OEM	Part Planning Manager	Bachelor's degree	> 10 years	Direct
	Warehouse Supervisor	Higher Vocational	> 5 years	Direct

Table 3.1: Interviewee Background Details

3.3 Results Obtained

The four subject companies were in the same industry. Dealing with the same or similar logistics service providers having similar activities and processes, their measurement items bore a resemblance, but the way in which they were assessed differed, i.e. evaluating the same activities with the same measures but with different criteria or targets. Company J1 attached to their measurement items three levels of importance (high, medium and low), while Company US weighed all items equally. The degree of formality also differed: Companies J1 and US held a regular weekly or monthly operations performance meeting where the performance results (based on

guidelines and quantitative data) of the past week or month was communicated to their providers, while Companies J2 and OEM did not have such a meeting and based their evaluation more on experience.

Eight out of the nine respondents rated the overall operational performance of their providers as "satisfactory". Their responses to the question, "How do you find the overall performance of your logistics service provider(s)?" included:

> They are doing OK. I do not see the [warehouse] manager much but his assistant is quite good. I think he's the one who actually takes care of this warehouse. But he is a bit too young and I don't know if people listen to him. I see some supervisors challenge him … We have some problems with their appointed truckers, but the sales coordinator most of the time can help us sort things out promptly. They are quite strong in customs formality. (Section head, Company US; translated from Thai).

> This provider has been operating our VMI (vendor managed inventory) [external] warehouse for about six years. Three years ago we outsourced also our COI (customer's own inventory) [onsite] warehouse, and we were able to convince our headquarters to extend the VMI SOW (scope of work) to cover the COI operations instead of calling for new bids. After the COI, we outsourced the distribution function (import and export documentation) and local inland transportation to this provider. (Logistics director, Company J1; translated from Thai).

> They have been operating our warehouse for about three years. They could have fared better, but their scores are improving. Our senior management is giving them full support wanting them to be the best contractor. (Logistics manager, Company J1; translated from Thai).

> We have just started using third-party logistics [less than a year]. Our provider is very professional. Although their warehouse is a bit old, it is very clean. We like their warehouse management system. The daily transaction and stock balance reports are very helpful. (Director of sales, Company J2; translated from Thai).

> They are professional and friendly. We position one staff at their warehouse and she feels comfortable there – we were afraid at first that she would be treated sort of an outsider. We are happy with this relationship. (Warehouse manager, Company J2; translated from Thai).

One interesting observation is that while Company US complained much about 3PL staff e.g. attitude, willingness, appearance, these subjective evaluations, however, had not been discussed in the weekly performance meeting. Only four objective items (production line support, inventory records accuracy, document discrepancy, damaged cargo/irregularity), and one subjective item (storekeeping) were included. The weekly operations performance results of the past few weeks showed that Company US's provider had achieved the acceptable level, yet the logistics manager bluntly rated them as unsatisfactory. This indicated that, even with a high degree of formality with clear guidelines and evaluation criteria, performance assessment can still be somewhat perceptual; and poor performance in one area may overshadow the other successful areas rendering a negative perception towards the overall performance.

> I really want to throw in the towel. We chose this provider because of our corporate global sourcing policy. They have been handling our Malaysia factory for a few years. It seems they simply just couldn't care less about us … I know that the warehouse manager was transferred from the sales department and prior to that, he

had no warehousing experience at all. But then again, he's been here for a few years now, and if we are talking about learning curve, that should be more than enough. He is still a sales person – good at talking but not doing. And I don't know if he likes his warehouse job … There are many things that need to be improved ... Question is we hire them, but we still have to do most of the work ourselves ... (Logistics manager, Company US; translated from Thai).

Another interesting observation is that two logistics executives of Company J1 mentioned that they would like to evaluate their service providers on a more aggregate level suggesting that 3PL customer managers may perceive and evaluate the operational performance of their providers as a second-order factor rather than numerous first-order factors.

We have been assessing them using the same KPIs we used when we were operating the warehouse by ourselves. I must admit that I can't think of any other criteria. You see the tasks are more or less the same. The only difference is these people are under the provider's payroll. The second-line manager [respondent's direct super-ordinate] mentioned to me a few times that she would like to evaluate them on a higher [aggregate] level. She said we had been too detailed. (Logistics manager, Company J1; translated from Thai).

3.4 Tentative Performance Measurement Items

After completing the first round of interviews, the researcher examined the responses to each question. Each aspect of 3PL performance mentioned was extracted from the respondents' statements. These aspects of performance are listed as tentative measurement items in Table 3.2. The mapping of items to questions and statements appears in Appendix II (Tables A2.1 to A2.4).

Subject	Item
Personnel	Qualified, competent staff Staff training, certification Staff willingness Staff attitude Staff service-mindedness Staff appearance Staff attendance, punctuality
Capability	Resource synergy Sufficient manpower Extra manpower (to support extra workload) Manager availability Warehouse space availability Air cargo space availability
Information system	Warehouse management system System integration System compatibility Process automation
Responsiveness and flexibility	Timely response to enquiries Quick response to special requests Critical shipment handling (transport) Expediting urgent shipments (warehouse) Delivery frequency Pull frequency
On-time performance	Lead time Truck arrival at origin, departure from origin and arrival at destination Transportation meets delivery schedules Dock-to-stock time

Continued

Subject	Item
Delivery	Uplift complete shipment Deliver to wrong destination
Safety and security	Security system Adherence to safety rules and regulations Accident prevention Damage due to careless handling Corrective/preventive action/accident report Storekeeping
Procedures	Compliance to rules and regulations Workflow control, information follow up FIFO control
Miscellaneous	Accurate invoice Customer communication Ongoing improvement User's requirement
Methods/ measures used	Staff attendance records Staff roster Warehouse patrol Nature of violation and number of case KPIs Level of importance Point or rating system (0 - 10) Error rate: 0.02% Inventory accuracy - zero variance Self-evaluation reports Aggregate evaluation

Table 3.2: Tentative Performance Measurement Items

The researcher added four warehouse quality performance items "putaway accuracy", "storage accuracy", "picking accuracy" and "shipping accuracy" suggested by the literature (Frazelle 2002) to the list and presented it to the respondents in a second round of interviews to review and to add any additional items. To prompt the respondents, the researcher asked: *"Your report shows these measures, please explain them in more detail."*, *"Literature suggests/ other 3PL users use these measures, do you think they are useful?"* and *"On the basis of your experience, are there any other areas you may want to evaluate in a future assessment?"*

By this second round, the respondents could come up with only a few more items. The researcher decided that the data had reached saturation when all respondents agreed "That would be all." Table 3.3 shows the additional fourteen items identified in this round of interviews (see Appendix II, Table A2.5 for items to questions and statements mapping).

Subject	Item
Personnel	Drug/physical test
Capability	Truck availability
Warehouse handling	Data input accuracy Putaway accuracy Storage accuracy Picking accuracy Shipping accuracy
Safety and security	Theft/pilferage protection
Delivery	Booking confirmation Documentation accuracy Under-/ over-delivery
On-time performance	Order cycle time On-time delivery On-time pick up

Table 3.3: Additional Tentative Performance Measurement Items

During a third and final interview session with the participants, the researcher asked them to help evaluate and select the measures. Items chosen by five or more (out of nine) participants as relevant and important to 3PL operational performance evaluation were considered "candidate" measurement items to be tested in a wider context in the following quantitative study. This resulted in a final list of thirty-eight items which the researcher classified into four dimensions according to the SERVQUAL/SCOR/Grönroos (2007) classification schemes (Table 3.4).

Dimension	No.	Measures
Capacity (3 items)	1	Sufficient manpower
	2	Adequate warehouse space
	3	Cargo space confirmation
Personnel Quality (5 items)	4	Staff education, skills and experience
	5	Staff training
	6	Staff punctuality
	7	Staff appearance
	8	Physical check-up and drug test
Responsiveness and Flexibility (6 items)	9	Additional manpower at short notice
	10	Prompt react to special requests
	11	Prompt response to enquiries
	12	Expedite receiving/issuing process
	13	Expedite emergency delivery
Reliability (25 items)	14	Responds with accurate information
	15	Accurate inventory records
	16	Accurate inventory reports
	17	Accurate data entry
	18	Accurate putaway
	19	Accurate storage location
	20	Accurate order picking
	21	Issuing procedure (FIFO, LIFO)
	22	Correct order
	23	Damage inside warehouse
	24	Thefts inside warehouse
	25	Dock-to-stock time
	26	Order cycle time
	27	Storekeeping
	28	Adherence to rules and regulations
	29	Work/information flow control
	30	On-time pick up
	31	On-time delivery
	32	Deliver complete order
	33	Deliver to correct destination
	34	Damage due to transportation
	35	Thefts during transit
	36	Complete and correct invoice
	37	Complete and correct delivery document
	38	Complete and correct shipping document

Table 3.4: Four-Dimension 3PL Operational Performance Scale

Three items dealing with human and physical assets (manpower and cargo/storage space) were classified as Capacity. While personnel, aircraft, ocean liner, truck and warehouse, by themselves are '*tangibles*', staff on duty, air cargo, vessel, truck or warehouse shelf space are '*intangibles*' in the sense that they perish. A person sitting idle, air cargo, vessel container, truck, or warehouse shelf space unfilled means "lost" – they cannot be stored for next day's use or sales. Hence the researcher labeled this factor as Capacity instead of Tangibles (as in SERVQUAL) or Assets (in SCOR).

There were five items pertaining to personnel quality, e.g. qualification, training, appearance. Grönroos (2007) termed this group of items "Professionalism and Skills". Professionalism relates more to highly professional services such as finance, banking, legal or health care. Logistics, on the other hand, is considered to be basic, involving somewhat labor-intensive tasks requiring lower skilled personnel. The researcher felt that a softer-toned term "Personnel Quality" would be more appropriate. Five items concerning customer enquiries and exceptional requests (including extra manpower) were classified as "Responsiveness and Flexibility"; and twenty five process items were classified as Reliability.

With three or more items, all four dimensions were "identified" for the purpose of quantitative modeling (Hair et al. 2006). The last dimension, Reliability, contained twenty-five items. Although an overidentified model is the preferred type of identification for a structural equation model (SEM), more items are not always necessarily better. Assigning too many indicators to a construct may include a subset of items that inadvertently focuses on some specific aspect of a problem.

The researcher reclassified the twenty-five reliability items based on the activity or process they represent – similar to Mentzer et al. (1999, 2001) and Rafiq and Jaafar's (2007) classification method – into five dimensions: information quality, in-storage handling, order quality, order condition, and punctuality. For the last dimension, the researcher opted for an objective label "punctuality" which defines "arriving, doing something or happening at *the expected, correct time; not late*" instead of "timeliness" which defines "... *at a suitable moment*" as used by Mentzer et al. (1999, 2001) and Rafiq and Jaafar (2007). This reclassification increased the number of dimension from four to eight (Table 3.5).

Dimension	No.	Measures
Capacity (3 items)	1	Sufficient manpower
	2	Adequate warehouse space
	3	Cargo space confirmation
Personnel Quality (5 items)	4	Staff education, skills and experience
	5	Staff training
	6	Staff punctuality
	7	Staff appearance
	8	Physical check-up and drug test
Responsiveness and Flexibility (5 items)	9	Additional manpower at short notice
	10	Prompt react to special requests
	11	Prompt response to enquiries
	12	Expedite receiving/issuing process (Warehouse)
	13	Expedite emergency delivery (Transport)
Information Quality (4 items)	14	Responds with accurate information
	15	Accurate inventory records (WMS)
	16	Accurate inventory reports
	17	Complete and correct invoice
In-Storage Handling (7 items)	18	Accurate data entry
	19	Accurate putaway
	20	Accurate storage location
	21	Accurate order picking
	22	Storekeeping
	23	Work/information flow control
	24	Adherence to rules and regulations

Continued

Dimension	No.	Measures
Order Quality (6 items)	25	Issuing procedure (FIFO, LIFO)
	26	Correct order (Warehouse)
	27	Complete and correct delivery document (Warehouse)
	28	Compete and correct shipping document (Transport)
	29	Deliver complete order
	30	Deliver to correct destination
Order Condition (4 items)	31	Damage inside warehouse
	32	Thefts inside warehouse
	33	Damage due to transportation
	34	Thefts during transit
Punctuality (4 items)	35	Dock-to-stock time
	36	Order cycle time
	37	On-time pick up
	38	On-time delivery

Table 3.5: Eight-Dimension 3PL Operational Performance Scale

As was discussed in Chapter Two, three dimensions proposed by Mentzer et al. (1999, 2001) and Rafiq and Jaafar (2007), namely order procedure, order release quantities and order quality were irrelevant to 3PL and no items derived from the interviews fit into any of these three categories. Another dimension, order discrepancy handling, was not identified in the current study. Although respondents mentioned corrective or preventive actions and accident reporting, their comments were specifically related to safety issues (accident report), not process quality. Furthermore, during the final selection of items, respondents suggested dropping these items as they concerned only onsite warehouse services where 3PL employees operate the movement equipment (e.g. stacker or reach truck) on customers' premises. In the case of offsite warehouses, 3PL operators are usually not required to provide safety reports to the customers.

3.5 Summary

The qualitative phase of the current study was based upon three HDD and one HDD component parts manufacturers in Thailand. Nine respondents working in the logistics, traffic or distribution department of these four companies participated. Through a series of interviews, a total of thirty-eight performance measurement items were identified.

These thirty-eight measures may be classified into four broad dimensions based on their attributes, namely: capacity, personnel quality, responsiveness and flexibility, and reliability. The latter dimension, consisting of twenty-five items, may be further classified into five subdimensions based on the activity or process the items represent: information quality, in-storage handling, order quality, order condition and punctuality. This produced an eight-dimension 3PL operational performance scale.

Due to the limited scope of this qualitative study, the identified eight-dimension 3PL operational performance scale was further tested in a wider context. The next chapter describes the quantitative approach taken to test the scale.

CHAPTER FOUR

Quantitative Research

4.1 Introduction

The purpose of this quantitative phase was to test the measurement items derived from the previous qualitative phase in a wider context. This chapter has four sections including this short introduction. The second section provides descriptions of the methods by which the study was conducted. It is divided into four subsections: 1) sample selection and sample size, 2) questionnaire development, 3) data collection, and 4) data analysis.

The third section presents the results obtained in two subsections: 1) the descriptive data, and 2) the model estimation and testing. The first subsection discusses general findings and the importance of individual performance measures, comparing the views of contractual and transactional customers. In the second subsection, the initial eight-dimension, and a subsequent modified first- and second-order factor 3PL operational performance models were tested. The final section summarizes the discussion of this chapter.

4.2 Research Methodology

4.2.1 Sample Selection and Sample Size

The results of this research were expected to be relevant to both multi-client and contract 3PL providers. In order to identify performance measures that are useful to these firms, data were obtained from logistics managers working in 3PL customer firms in the electronics manufacturing industry in Thailand. The respondents worked in firms that were current and prospective (those currently using other logistics companies) customers of the researcher's firm. Selection of respondents was based mainly on the customer profiles available from the company in which the researcher works. The profiles (year 2006) contained over 600 entries drawn from the Thailand Exporters Directory issued by the Department of Export Promotion, Ministry of Commerce, and factory listings of the Industrial Estate Authority of Thailand. As entries were originally drawn from the two largest listings issued by the authorities covering a wide range (e.g. by products and size) of electronics manufacturing firms, the target respondents were expected to be representative of the population. By using these profiles, the researcher was ensured of accessibility to the target respondents because of the already established contacts.

Structural equation modeling (SEM) was the primary statistical technique used in this study. It requires a ratio of sample size to number of model parameters of 5:1 and preferably 10:1 (Hair et al. 2006, Kline 2005, Schumacker & Lomax 2004). There were thirty-eight measurement items derived from the previous qualitative study, thus a minimum sample size of 190 would be needed. However, it has been recommended

that a sample size of 200 is critical to provide a sound basis for maximum likelihood estimation, the most commonly employed SEM estimation procedure (Hair et al. 2006). This study, therefore, targeted a sample size of 200 plus.

Based on the customer profiles, there were about 72 local contractual customer firms (electronics manufacturers). In each firm, about three to four operational managers (e.g. logistics, traffic, procurement, part planning) were directly involved in 3PL operations. Targeting mainly the logistics or traffic managers, around 80 to 100 responses (1 to 2 from each firm) were expected from the contractual customers. These responses would be matched with a similar number from the transactional customers.

4.2.2 Research Questionnaire

4.2.2.1 Questionnaire Development

While some researchers suggest that grouping items according to topics (construct headings e.g. capacity, personnel or responsiveness) helps improve the readability of the questionnaire, others argue that doing so may introduce bias to the survey, as prior questions could lead subsequent responses (Dillman 1978). Instead of listing the thirty-eight measures under the construct headings as shown in Table 3.4, the researcher reclassified them into three performance areas: general performance, warehousing performance, and transportation performance. The initial questionnaire was pre-tested with the qualitative phase participants. The final questionnaire, shown in Appendix III, consisted of four sections (A – D):

Section A collected simple demographic information to describe and classify respondents e.g. size of organization (number of employees), contractual or transactional customer of 3PL services, and number of years experience in dealing with 3PL providers.

Sections B, C and D contained statements designed to obtain data about the measures and their importance – "Please rate the level of importance of the following general 3PL performance, 3PL warehousing performance, and 3PL transportation performance measures". Measures used in these sections were developed from the preceding phase interview results as described in Chapter Three. As the items were derived from direct questions about factors that result in customer satisfaction or dissatisfaction, it was expected that respondents would tend to rate them as important or higher. Hence nine-point scales with "5" as the midpoint (1 = very low importance; 3 = low importance; 5 = moderate importance; 7 = high importance; 9 = very high importance) were used to provide the respondents with a wider range above the mid-point to rate the items.

4.2.2.2 Pre-Testing the Questionnaire

Prior to administering the questionnaire, a pre-test was conducted to check, clarify and refine the final form of the questionnaire, and to check the time taken to complete it. This pre-test was conducted over a two-week period with the nine qualitative phase participants. After a few changes in wording and item sequencing, the participants found the questionnaire to be appropriate. Four participants who were modest users of English commented about the questionnaire being in English. As

most of the target Thai respondents are not fluent in English, they may have found it difficult to understand the questions and this could lead to wrong answers or even non-response. They suggested that the questionnaire should be translated into and offered in Thai.

4.2.2.3 Translation of the Questionnaire

The researcher decided to translate the questionnaire into Thai using the back-translation technique (Brislin, MacNab & Bechtold 2004, Sperber 2004). Firstly, the researcher developed two forms of the questionnaire, one in English and another one in Thai. The English version was given to a professional translator (first translator) to translate into Thai. The original Thai and the translated version were compared for similarity of wording and meaning to produce the final Thai language questionnaire. The final Thai questionnaire was then back-translated by a bilingual 3PL manager (second translator) into English. Finally, the second translator and the researcher together compared the original English and the back-translated English versions, and agreed that they showed high similarity of meaning, thus concluding that the target language (Thai) questionnaire could be used with confidence. This translation procedure is illustrated in Figure 4.1.

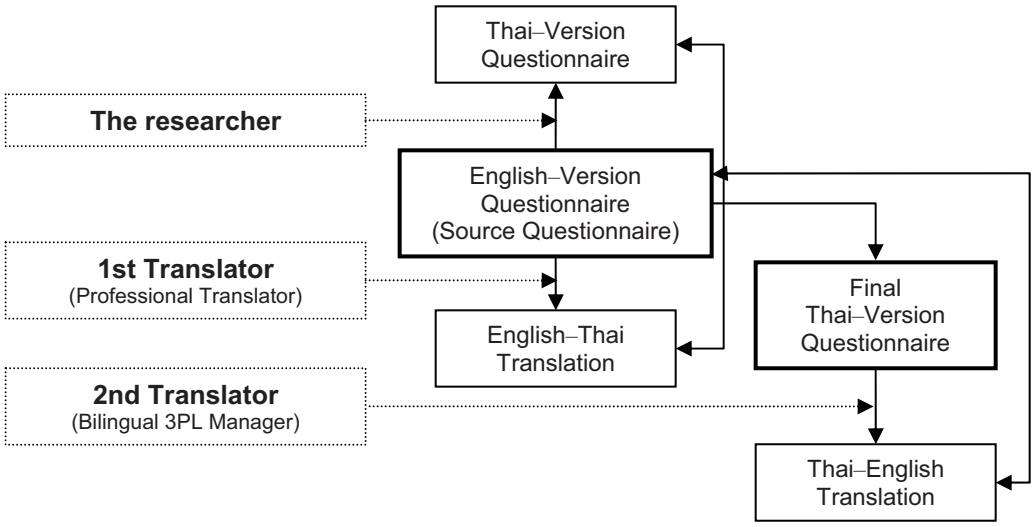

Figure 4.1: Questionnaire Translation Procedure

4.2.3 Data Collection

A self-completion questionnaire survey was used because of its convenience, efficiency, and inexpensiveness. As this study was designed to collect data from both current and prospective contractual and transactional 3PL customers, it would be quicker, more convenient to administer, and less expensive to employ a self-completion questionnaire than other methods. The company's sales representatives, on their sales visits, personally delivered the questionnaires, or faxed the questionnaire to the respondents with a telephone call explaining the objectives and benefits of the study, and urged them to complete the questionnaire.

Since the questionnaire required only about twenty minutes to complete, the sales representatives were asked to collect them on the same day they were delivered. For those respondents who were unable to answer the same day, a follow up call was

made a week later and the completed questionnaires collected on the next sales visit. By using this method, the sales representatives were able to motivate respondents to cooperate, answer respondents' questions about the survey, and monitor respondents' compliance with the instructions. To make sure that the sales representatives fully understood the questionnaire and were able to answer any questions the respondents might have, a short training session was held to train them prior to distributing the questionnaire.

To ensure the respondents knew that questions asked for their perceptions of 3PL services in general and not of the company in which the sales representatives work, and the study was for educational purposes, a cover letter (participant's information sheet) with the logo of the University of Western Australia (Appendix IV) accompanied each questionnaire. It was also hoped that the cover letter would provide the respondents with a sense of reward, thereby increasing their willingness to respond.

A total of 225 questionnaires were distributed and 207 complete, usable responses from 105 contractual and 102 transactional customers were received. This represents an effective response rate of ninety-two percent, which suggests that non-response biases were not a problem.

4.2.4 Data analysis

Data analyses were undertaken in two stages: preliminary analysis and structural equation modeling.

4.2.4.1 ***Stage I: Preliminary analysis*** was conducted using SPSS. The results were summarized using univariate statistics to provide a basic understanding of the respondents and characteristics of the data. The initial summary statistics included those relating to demographic information and the mean scores of the performance measures. The measures were ranked according to their mean score so the measure with the highest score had the highest rank, and so on.

4.2.4.2 ***Stage II: Structural Equation Modeling*** – The initial 3PL operational performance model was conceptualized as a second-order construct consisted of eight dimensions derived following the qualitative research: capacity, personnel quality, responsiveness and flexibility, information quality, in-storage handling, order quality, order condition, and punctuality (Fig. 4.2).

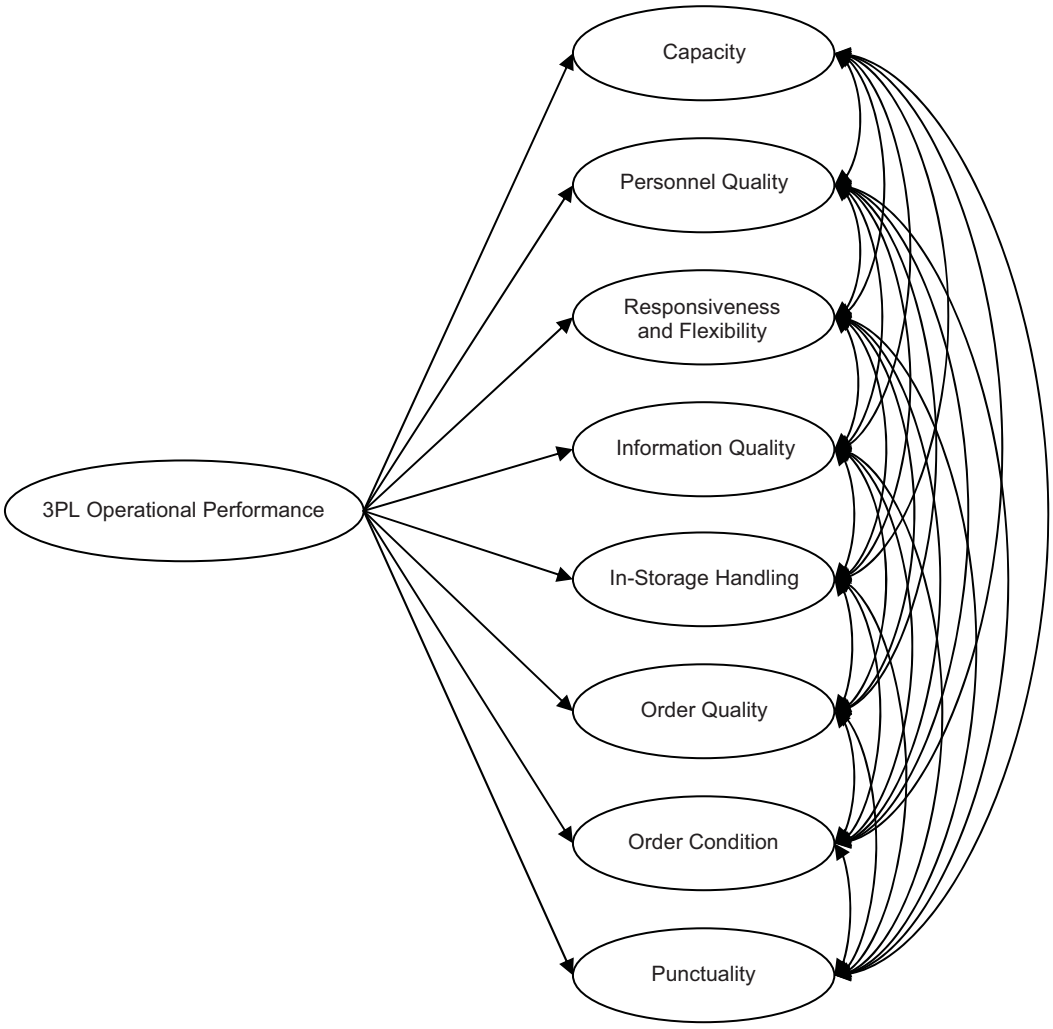

Figure 4.2: Eight-Dimension 3PL Operational Performance Model

It was a reflective model based on the assumption that latent constructs cause the measured variables and that the error results in an inability to fully explain these measures. For instance, a high perceived importance on 3PL capacity performance would tend to cause high scores on each of the indicators loading on the capacity construct. Structural equation modeling with LISREL 8.8 was used to estimate:

1. the relationship between each dimension and a set of measured indicators,
2. correlational relationship between the dimensions, and

3. relationship between these dimensions and the second-order construct, the 3PL operational performance.

All constructs in the model were latent constructs represented by a set of manifest variables (questionnaire items). However, since manifest variables might not fully represent a latent construct, measurement error is present in the estimation. SEM is a statistical model that can represent such latent constructs and account for measurement error in the estimation process. It provides a measurement model that specifies the correspondence rules between the manifest and the latent variables, which allows the researcher to use one or more manifest variables to estimate a single concept (e.g. flexibility) and then estimate, or specify its reliability.

The researcher can also assess the loading of each item on a latent variable and incorporate its reliability into the estimation of the relationships between dependent and independent variables, thus accounting for measurement error in the models tested (Hair et al. 2006, Schumacker & Lomax 2004). These benefits provide strong support for using SEM in the current study.

In the measurement model, the researcher first specified the specific questions that are associated with each construct (e.g. questions on manpower and warehouse space availability are associated with capacity, but not in-storage handling or order quality). Then SEM assessed the contribution of each item in representing its associated construct, measured how well this set of measures represents the concept (its reliability), and incorporated this information into the estimation of the relationships between the constructs.

Measurement model validity depends on goodness-of-fit and specific evidence of construct validity. Typically, using three to four fit indices of different types provides adequate evidence of model fit (Hair et al. 2006). In addition to the chi-square value and ratio of chi-square to degrees of freedom, four indices that are commonly used in the published literature, the root mean square error of approximation (RMSEA), the goodness-of-fit index (GFI), adjusted goodness-of-fit index (AGFI) and Tucker Lewis index (TLI or non-normed fit index, NNFI, as reported in LISREL) were used in this study. Rules of thumb for satisfactory model fit are shown in Table 4.1.

Model fit criterion	**Guidelines to fit**
Chi-square (χ^2)	Non-significant χ^2 ($p > .05$)
Ratio of χ^2 to degrees of freedom (χ^2/df)	< 3:1 (Chin & Todd 1995)
Root mean square error of approximation (RMSEA)	< 0.05 indicates a good model fit, between 0.05 and under 0.08 reasonable fit, between 0.08 and 0.1 mediocre fit, and > 0.1 poor fit (MacCallum, Browne & Sugawara 1996)
Goodness-of-fit index (GFI)	> 0.9 (Schumacker & Lomax 2004)
Adjusted goodness-of-fit index (AGFI)	> 0.8 (Segars & Grover 1993)
Tucker-Lewis index (TLI) – reported as Non-normed fit index (NNFI) in LISREL	> 0.9 (Hair et al. 2006)

Table 4.1: Model Fit Criteria and Acceptable Fit Interpretation

4.3 Results Obtained

The results were prepared in two parts: 1) descriptive statistics, and 2) the results of model estimation and testing. The first part provided respondents demographic information and the mean scores of the performance measures. In the second part, the initial 3PL operational performance model and a subsequent modified version were tested.

4.3.1 Descriptive Statistics

Consistent with the industry structure, most of the contractual 3PL customers who responded were large in size, with approximately seventy percent employing more than 5,000 staff. Transactional customers were of medium to large size with forty-four percent employing 3,000 or more staff and twenty-eight percent more than 5,000 staff. For the contractual customers of 3PL services, respondents' experience with 3PL services ranged from ten months to seven years. Transactional customer managers had three to thirteen years of experience in logistics related functions. These figures indicated that the respondents were a credible source of information about logistics operational performance.

As was explained in the questionnaire development section, the respondents were asked to rate the importance of the measures on a nine-point scale where 1 = very low importance; 3 = low importance; 5 = moderate importance; 7 = high importance; and 9 = very high importance. Table 4.2 shows the results where the measures are classified into three importance categories: moderate importance, moderate-to-high importance, and high importance, using hierarchical cluster analysis (between-groups linkage cluster method, block interval measure).

Performance Measures	Mean Scores			Sig.
	Overall (*n = 207)*	Contractual Customers (*n* = 105)	Transactional Customers (*n* = 102)	
High Importance				
TP8 Thefts during transit	7.78	7.76	7.80	
WP3 Accurate inventory records	7.67	7.63	7.71	
WP11 Accurate inventory reports	7.64	7.59	7.70	
WP4 Accurate data entry	7.48	7.49	7.48	
WP14 Damage inside warehouse	7.43	7.50	7.35	
WP9 Correct order	7.39	7.46	7.32	
TP3 On-time pick up	7.35	7.42	7.28	
TP7 Damage due to transportation	7.29	7.27	7.32	
GP8 Responds with accurate information	7.10	7.16	7.04	
Moderate-to-High Importance				
TP2 Expedite emergency delivery	7.02	7.04	7.01	
WP2 Expedite receiving/issuing urgent shipment	6.99	7.19	6.78	*
GP6 Prompt react to special requests	6.78	6.88	6.68	
TP9 Complete and correct shipping document	6.73	6.80	6.67	
WP15 Thefts inside warehouse	6.69	6.78	6.59	
WP7 Issuing procedure (FIFO, LIFO)	6.65	6.74	6.56	
WP10 Complete and correct delivery document	6.63	6.80	6.45	
GP7 Prompt response to enquiries	6.43	6.45	6.41	
GP2 Additional manpower at short notice	6.38	6.46	6.30	
Moderate Importance				
GP1 Sufficient manpower	6.31	6.57	6.04	*
GP4 Staff training	6.31	6.20	6.42	
GP11 Work/information flow control	6.28	6.29	6.27	
WP13 Order cycle time	6.14	6.23	6.06	
TP5 Deliver to correct destination	6.14	6.21	6.07	
WP16 Adherence to rules and regulations	6.12	6.26	5.98	*
GP3 Staff education, skills and experience	6.01	6.00	6.02	
TP4 On-time delivery	6.00	5.94	6.05	
TP1 Cargo space confirmation	5.98	6.15	5.79	*
WP6 Accurate storage location	5.91	6.16	5.66	*
WP8 Accurate order picking	5.84	6.09	5.59	*
WP17 Storekeeping	5.84	5.97	5.70	*
GP12 Complete and correct invoice	5.84	5.94	5.74	
WP12 Dock-to-stock time	5.83	5.98	5.67	
GP9 Staff punctuality	5.81	6.25	5.35	*
WP5 Accurate putaway	5.76	6.01	5.50	*
WP1 Adequate warehouse space	5.74	5.82	5.66	
TP6 Deliver complete order	5.73	5.93	5.52	*
GP5 Physical check-up, drug test	5.54	5.70	5.36	*
GP10 Staff appearance	5.29	5.71	4.86	*

Table 4.2: Performance Measures Mean Scores (1 Min, 9 Max)
Asterisks denote ratings of contractual/transactional customers were statistically different at alpha = 0.05

Mostly both contractual and transactional customer managers perceived items to be of similar importance but twelve items (four general performance items GP1, GP5, GP9, GP10; six warehousing performance WP2, WP5, WP6, WP8, WP16, WP17; and two transportation performance TP1, TP6) were found to be statistically different (alpha = 0.05).

The significantly more important ratings given by contractual customer managers to intermediate-activity items implies that what customers receive in their interactions with the 3PL firms is important to them and to their performance evaluation. For example, in the case of onsite warehouse operations, the appearance and behavior of warehouse operators (items GP9, GP10, WP16) and how they performance their tasks (WP5, WP6, WP8, WP17) influence the customers' view of the service.

4.3.2 Assessing the Eight-Dimension 3PL Operational Performance Model

In Chapter Three, following the results obtained from the in-depth interviews, an eight-dimension 3PL operational performance scale was identified. The scale is reproduced, with questionnaire item number, in Table 4.3. Using these items, a first attempt was made to fit the model presented in Figure 4.2 (p. 67).

Dimension	Item No.	Measures
Capacity	GP1	Sufficient manpower
	WP1	Adequate warehouse space
	TP1	Cargo space confirmation
Personnel Quality	GP3	Staff education, skills and experience
	GP4	Staff training
	GP5	Physical check-up and drug test
	GP9	Staff punctuality
	GP10	Staff appearance
Responsiveness and Flexibility	GP2	Additional manpower at short notice
	GP6	Prompt react to special requests
	GP7	Prompt response to enquiries
	WP2	Expedite receiving/issuing urgent shipment
	TP2	Expedite emergency delivery
Information Quality	GP8	Responds with accurate information
	WP3	Accurate inventory records
	WP11	Accurate inventory reports
In-Storage Handling	WP16	Adherence to rules and regulations
	WP4	Accurate data entry
	WP5	Accurate putaway
	WP6	Accurate storage location
	WP8	Accurate order picking
	GP11	Work/information flow control
	WP17	Storekeeping
Order Quality	WP7	Issuing procedure (FIFO, LIFO)
	WP9	Correct order
	WP14	Damage inside warehouse
	WP15	Thefts inside warehouse
	TP5	Deliver to correct destination
	TP6	Deliver complete order
	TP7	Damage due to transportation
	TP8	Thefts during transit
Document Quality	GP12	Complete and correct invoice
	WP10	Complete and correct delivery document
	TP9	Compete and correct shipping document
Punctuality	WP12	Dock-to-stock time
	WP13	Order cycle time
	TP3	On-time pick up
	TP4	On-time delivery

Table 4.3: Eight-Dimension 3PL Operational Performance Scale (with questionnaire item number)
GP = general performance, WP = warehousing performance,
TP = transportation performance

The first SEM run encountered a non-positive definite problem. Typical reasons for the sample covariance matrix not being positive definite are pairwise deletion of missing data, and collinearity among the observed variables (Diamantopoulos & Siguaw 2007). Since the earlier descriptive analysis of the data set revealed no missing data, the researcher proceeded to check the relationships between the items (including collinearity) using the SPSS factor analysis procedure. Maximum likelihood (ML) extraction was used to simulate the maximum likelihood estimation that LISREL uses.

A check of the correlation matrix found four pairs of variables with correlations above 0.8: "Accurate data entry" and "correct order" (0.843); "accurate putaway" and "accurate order picking" (0.830); "prompt response to enquiries" and "staff training" (0.814); and "thefts during transit" and "accurate inventory records" (0.807). The researcher removed one variable at a time starting with the variable that had the highest average correlation with all other variables in the data set from each pair.

Four items were deleted: "accurate data entry", "accurate order picking", "prompt response to enquiries" and "thefts during transit". To make sure that there was no multicollinearity across the data set as the whole, the researcher checked the communality matrix and found no squared multiple correlation (SMC) higher than 0.8 apart from the four items duly deleted.

Having dealt with collinearity between pairs of variables and multicollinearity across the data set, the researcher reran the LISREL model and found the non-positive definite problem still persisted. This might imply incompatibility between the data

and the specified model, i.e. the data are inadequate for the model or the model is wrong for the data.

To see if the data might suggest a different conceptualization of 3PL operational performance (e.g. how many constructs really exist and which variables belong with which constructs) and a new model may be more consistent with the data, a maximum likelihood (ML) and principal-axis factoring (PAF) factor analyses were performed in SPSS. Since the variables were designed to measure a single (albeit high level) construct and the factors extracted were expected to be highly correlated, an oblique method (Oblimin) was used to rotate the solution.

4.3.3 Alternative Five-Dimension 3PL Operational Performance Model

The PAF/Oblimin pattern matrix showed better results than the ML model, so this matrix was interpreted. The first PAF run produced a thirty-six-item, six-factor solution. Twelve items that had no or low loading on any factor (< 0.4) or communality lower than 0.5 considered as not having sufficient explanation were removed (Hair et al. 2006). After repeating the procedure, two more low loading items were deleted. Another two items were found to be too different conceptually from other items in the set causing difficulty in interpreting the factor substantively, and these were also removed from the analysis.

Two items "order cycle time" and "staff education, skills and experience" had only minimally acceptable factor loadings (0.49 and 0.43 respectively), but the researcher decided to retain them in the analysis due to their contribution to interpretation of the factor.

Table 4.4 summarizes the deleted items.

EFA Iteration	Item No.	Measure	Reason for deletion
1	GP1	Sufficient manpower	No loading
1	GP8	Responds with accurate information	Loaded ambiguously on three factors (0.348, 0.306, 0.440)
1	GP9	Staff punctuality	Low loading (0.383)
1	GP10	Staff appearance	Low loading (0.316); low communality (0.481)
1	GP11	Work/information flow control	Low loading (0.380)
1	GP12	Complete and accurate invoice	Low communality (0.430)
1	WP1	Adequate warehouse space	Low loading (0.325)
1	WP7	Issuing procedure (FIFO, LIFO)	Low loading (0.302)
1	WP14	Damage inside warehouse	Low communality (0.430)
1	WP15	Thefts inside warehouse	Low loading (0.356)
1	WP16	Adherence to rules and regulations	Low loading (0.386)
1	TP2	Expedite emergency delivery	Low loading (0.335)
2	WP10	Complete and correct delivery document	Low loading on two factors (0.332, 0.317)
2	TP9	Complete and correct shipping document	Low loading on two factors (0.343, 0.339)
2	GP5	Physical check-up and drug test	Too different from the other items in the group (designed to deal with personnel but loaded on flexibility)
2	WP17	Storekeeping	Too different from the other items in the group (designed to deal with in-storage but loaded on delivery)

Table 4.4: Item Deletion Summary

PAF/Oblimin was again run on the remaining twenty-two items and five factors were extracted. Table 4.5 displays the final solution. Each factor is labeled in the table.

Item	Latent Variable					CMNL
	DELV	ORD	INST	PERS	FLEX	
TP5 Deliver to correct destination	0.719					0.647
TP4 On-time delivery	0.640					0.657
TP6 Deliver complete order	0.634					0.638
TP1 Cargo space confirmation	0.550					0.520
WP13 Order cycle time	0.488					0.546
TP8 Thefts during transit		-0.819				0.784
WP3 Accurate inventory records		-0.785				0.681
WP11 Accurate inventory reports		-0.746				0.687
WP4 Accurate data entry		-0.698				0.804
WP9 Correct order		-0.581				0.731
TP3 On-time pick up		-0.545				0.543
TP7 Damage due to transportation		-0.523				0.582
WP8 Accurate order picking			-0.888			0.831
WP5 Accurate putaway			-0.876			0.771
WP6 Accurate storage location			-0.732			0.659
WP12 Dock-to-stock time			-0.515			0.694
GP4 Staff training				0.930		0.820
GP7 Prompt response to enquiries				0.800		0.807
GP3 Staff education, skills and experience				0.431		0.619
GP2 Additional manpower at short notice					-0.803	0.746
GP6 Prompt react to special requests					-0.674	0.757
WP2 Expedite urgent shipment					-0.524	0.649
Percentage of Variance Explained	49.203	6.651	6.173	4.049	3.265	

Table 4.5: EFA-Derived Five-Dimension 3PL Operational Performance Scale
DELV= delivery, ORD = order quality, INST = in-storage handling
PERS = personnel quality, FLEX = flexibility, CMNL = communality

Together, these five factors, delivery, order quality, in-storage handling, personnel quality and flexibility, accounted for sixty-nine percent of the variance. They were self-explanatory in describing what is expected of 3PL providers. Factor one consisted of six items covering order preparation and delivery activities (labeled "Delivery"). Logistics is a deadline-driven activity. With similar technology and price, vendors now compete on "time" – who can deliver first wins the order. 3PL

traffic planning is expected to be able to secure cargo space (air, sea or truck) confirmation from airlines, ocean liners, or truck operators as quickly as possible (TP1). Some major customers may even demand fixed space allotment during peak season. Warehouse operators are expected to be able to complete issuing of a new order within the agreed elapsed time (WP13) ready for delivery to the customer in the case of domestic shipment, or to the truck depot, container yard or air cargo terminal to catch the truck, vessel or flight booked in the case of overland or overseas shipment.

Delivery to correct destination (TP5) in full (TP6) at the time promised (TP4) is important. Compared to passenger checked baggage, cargo delivery to a wrong destination is rare. However, it does happen. Incorrect shipping documents and wrong or cross labeling are the major culprits. For the latter, warehouse operators may mistakenly paste a wrong shipping label on a pallet, or cross label two or more pallets prepared for different destination. On-time delivery cannot be achieved if the shipments end up arriving at a wrong destination, or even worse, (embarrassingly) a wrong customer.

Factor two was made up of four warehousing items and three transportation items which together concern order quality. Many providers boast about their sophisticated warehouse management system (WMS) and web-based portal that enables their customers to view and manage inventories on a real-time basis. Technology, however, is only as good as the quality of data input into the system. Third-party warehouse operators need to have a high degree of accuracy in setting up a WMS shipment notice upon taking delivery of a new receipt and subsequent updating of the

records when preparing (allocating) and issuing (shipping out) a new order (WP4) so that the data in the system is correct and up-to-date (WP3), enabling timely submission of accurate inventory reports to the suppliers and customers (WP11).

Orders must be picked and issued accurately according to the WMS release orders (pick tickets, WP9) ensuring correct orders are delivered to the customers. It is also expected that 3PL providers come to pick up the orders on time so that they do not sit idle on the shipping dock exposing to damage or pilferage (TP3).

Technology companies require their 3PL providers to be safety and security conscious making sure that their high price, readily saleable products are well protected against damage from careless material handling and theft by 3PL employees and thieves (TP7, TP8). 3PL providers' liability for damaged cargo (TP7) is limited and the amount is much lower than the products' cost of goods sold. Should customers require full value to be covered, providers may purchase transit coverage and include it in the fee, or apply a valuation charge. This causes duplicate expense due to duplicate coverage since customers generally have obtained insurance through some type of corporate umbrella policy but subject to a deductible. Anticipating that freight is naturally subject to a certain amount of rough handling, manufacturers package their goods accordingly and expect that their products are transported with little or no damage.

Of the thirty-eight measures, "thefts during transit" (TP8) was the most important (highest mean score). Electronic products are likely to be stolen because they are highly priced and easily sold. HDD manufacturers continue to experience theft issues

with airlines and trucking companies. To safeguard their shipments, manufacturers have sought assistance from their 3PL providers to secure designated, limited access storage areas with CCTV (closed circuit television) coverage inside airport cargo terminals. Truck containers must be locked with security seals before leaving the customers' premises and seals must be intact upon arrival at their destination. Truck drivers must undergo background and drug testing (to the extent permissible by law) and vehicles must be equipped with a two-way radio or cellular phone allowing the drivers to communicate immediately with a dispatcher, other driver, or police department.

Taken together, four items (WP4, WP9, TP3, TP7 and TP8) measure the preparatory part of the "perfect order" – *picking up the correct product and quantity in good condition at the time promised*, while items WP3 "accurate inventory records" and WP11 "accurate inventory reports" facilitate the information flow.

Factor three, labeled "In-Storage Handling", consisted of one warehouse cycle time performance (WP12) and three warehouse quality performance items (WP5, WP6 and WP8). "Dock-to-stock time" (WP12) is the elapsed time from when a new receipt arrives on the warehouse premises until it is placed in its assigned location ready for picking or shipping. "Putaway" (WP5) is an inbound handling activity moving a pallet or case from the staging area to the location pre-assigned by WMS. "Order picking" (WP8) is an outbound activity taking the pallet or case out from the location preparing for delivery. Storage accuracy refers to the physical location of a pallet or case matched with that in WMS.

Factor four had three items concerning the qualifications of 3PL personnel (GP3 and GP4) and their attentiveness e.g. the extent to which they attend to customer enquiries (GP7). This factor was labeled "Personnel Quality". To effectively manage day-to-day operations, 3PL managers and supervisors need to possess a broad background to meet all the responsibilities of the positions, and continue to learn in the various categories of supervisory duties and responsibilities to keep their skills current. While most warehouse operators possess only lower secondary education and are not literate in English, they are required to be able to read pick tickets and shelf or pallet locations, and do some simple WMS transactions in English. Driving a powered industrial truck (e.g. counterbalanced truck or narrow-aisle reach truck) is very much different from a car. Only trained and certified operators shall be permitted to operate powered industrial vehicles.

The last factor consisted of three items. Operating within a highly volatile, uncertain environment, manufacturers need high flexibility. A demand surge or drop cannot really be predicted in advance. High-demand products like video games, MP3 players and game consoles have a large percentage of sales occurring within the first few days of product release. It is expected that 3PL providers are able to supply additional manpower at short notice (GP2), react to special requests promptly (GP6), and expedite the receiving or issuing of urgent orders (WP2). This factor was labeled "Flexibility".

This five-dimension 3PL operational performance model is shown graphically in Figure 4.3.

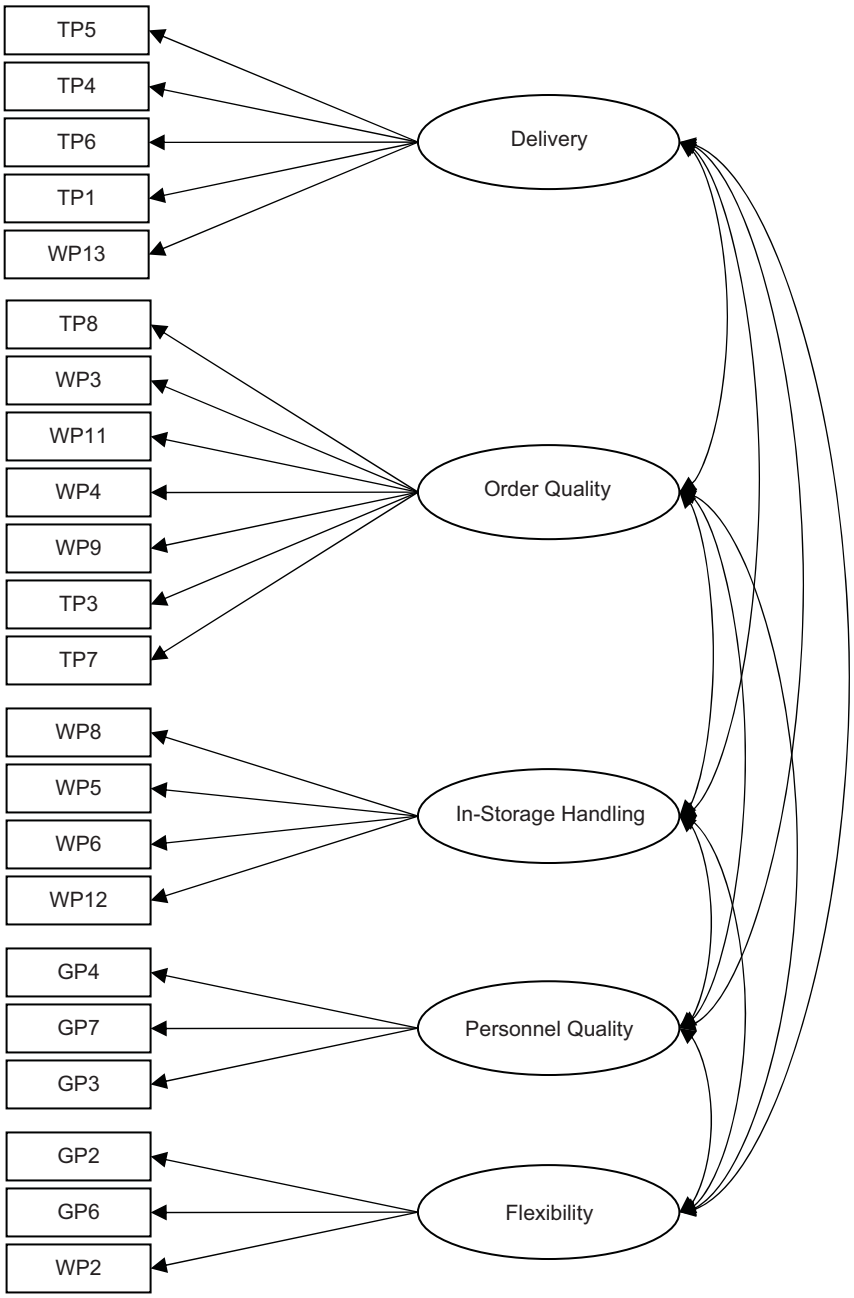

Figure 4.3: Five-Dimension 3PL Operational Performance Model

4.3.3.1 Overall Fit Assessment

LISREL 8.8 was used to "confirm" the EFA-derived five-dimension 3PL operational performance scale. (The risks associated with using the same data for both EFA and CFA are discussed in section 5.3.) Based on the fit guidelines presented in Table 4.1, the selected fit indices indicated that the model had a mediocre fit to the data. The chi-square was large (594.41) compared to the number of degrees of freedom (199). Although this result was statistically significant ($p < 0.01$), the chi-square to degrees of freedom ratio 2.9:1 was within the 3:1 acceptable threshold. RMSEA 0.98 suggested a mediocre fit. GFI 0.79 and AGFI 0.74 also suggested mediocre fit, although NNFI 0.96 was acceptable.

4.3.3.2 Assessment of the Measurement Model

In evaluating the measurement model, the researcher first examined the relationships between the latent variables and their indicators. The aim was to determine the reliability and validity of the indicators used to represent the dimensions of interest. ***Indicator reliability*** was examined using the squared multiple correlation, R^2, of the indicators. R^2 is the percent variance of each item explained by each latent variable in the model (Dunn, Seaker & Waller 1994). A high R^2 denotes high reliability for the item concerned. The closer to 1, the better the item reflects the corresponding latent variable (Diamantopoulos & Siguaw 2007). An inspection of the parameter estimates (Table 4.6) found the R^2 values were moderate to high (0.47 to 0.86) suggesting that the items were reasonably successful as reflections of the latent variables.

Indicator validity can be assessed technically by examining the magnitude and significance of the paths between each latent variable and its indicators. A significant indicator loading is indicated when the *t*-value exceeds 1.96 in absolute term (Diamantopoulos & Siguaw 2007). As shown in Table 4.6, all items loaded significantly strongly on their latent constructs as indicated by *t*-values well in excess of 1.96 in absolute term and loadings exceeded 0.5 with about half higher than 0.7.

Item	Latent Variable					*T*	R^2
	DELV	ORD	INST	PERS	FLEX		
TP5 Deliver to correct destination	0.78					12.77	0.60
TP4 On-time delivery	0.81					13.67	0.66
TP6 Deliver complete order	0.78					12.91	0.61
TP1 Cargo space confirmation	0.74					11.83	0.54
WP13 Order cycle time	0.68					10.72	0.47
TP8 Thefts during transit		0.85				15.02	0.72
WP3 Accurate inventory records		0.81				13.84	0.65
WP11 Accurate inventory reports		0.82				14.30	0.68
WP4 Accurate data entry		0.89				16.05	0.78
WP9 Correct order		0.85				15.04	0.72
TP3 On-time pick up		0.73				11.98	0.53
TP7 Damage due to transportation		0.69				11.12	0.48
WP8 Accurate order picking			0.90			16.34	0.81
WP5 Accurate putaway			0.91			16.53	0.82
WP6 Accurate storage location			0.81			13.77	0.65
WP12 Dock-to-stock time			0.81			13.86	0.66
GP4 Staff training				0.88		15.29	0.77
GP7 Prompt response to enquiries				0.91		16.14	0.82
GP3 Staff education, skills and experience				0.71		11.31	0.50
GP2 Additional manpower at short notice					0.80	13.26	0.63
GP6 Prompt react to special requests					0.92	16.61	0.86
WP2 Expedite urgent shipment					0.76	12.50	0.58

Table 4.6: Five-Dimension Model: SEM Coefficients, *t*-Values and Squared Multiple Correlations
DELV= delivery, ORD = order quality, INST = in-storage handling
PERS = personnel quality, FLEX = flexibility

Composite reliability, which is considered a superior measure compared to Cronbach's alpha, was used to assess ***construct reliability*** (CR). CR overcomes several limitations associated with Cronbach's alpha such as the tendency to underestimate scale reliability and the assumption that all items have equal reliabilities (Bacon, Sauer & Young 1995, Fornell & Larcker 1981). To calculate CR,

the researcher used the information on the indicator loadings and error variances from the completely standardized solution and applied the following formula suggested by Diamantopoulos and Siguaw (2006):

$$CR = (\sum\lambda)^2/[(\sum \lambda)^2+\sum(\theta)] \quad (1)$$

where λ = indicator loading

θ = indicator error variances

$\sum$ = summation over the indicators of the latent variable

The generally agreed upon lower limit for CR is 0.7 (Hair et al. 2006). High CR indicates that internal consistency exists, meaning that the measures all consistently represent the same latent construct.

Reliability is also an indicator of convergent validity. ***Convergent validity*** is the extent to which indicators accurately measure a construct. For this study, average variance extracted (AVE) was used to test convergent validity. AVE shows directly the amount of variance that is captured by the construct in relation to the amount of variance due to measurement error (Hair et al. 2006). If a construct has an AVE greater than 0.5, the construct contains less than fifty percent error variance, supporting its convergent validity (Fornell & Larcker 1981). To calculate AVE, the researcher used the same information as for CR and applied the following formula (Diamantopoulos and Siguaw 2006):

$$AVE = (\sum\lambda^2)/[\sum \lambda^2+\sum(\theta)] \quad (2)$$

where λ, θ and $\sum$ are defined as above.

Table 4.7 displays CR, AVE, inter-construct correlations and square roots of AVE (in bold on the diagonal). From the table, it can be seen that all CR and AVE values well exceeded the minimum requirement. This provided adequate evidence of construct reliability and convergent validity.

Construct	CR	AVE	DELV	ORD	INST	PERS	FLEX
DELV	0.87	0.58	**0.76**				
ORD	0.93	0.67	0.72	**0.82**			
INST	0.92	0.69	0.72	0.65	**0.83**		
PERS	0.87	0.70	0.61	0.60	0.48	**0.84**	
FLEX	0.87	0.74	0.62	0.65	0.56	0.69	**0.86**

Table 4.7: Five-Dimension Model: Composite Reliability, Average Variance Extracted, Inter-Construct Correlations and Square Roots of Average Variance Extracted
DELV = delivery, ORD = order quality, INST = in-storage handling,
PERS = personnel quality, FLEX = flexibility

Discriminant validity is the degree to which measures of different constructs are unique from each other, and each construct is theoretically different from the other constructs in a model (Hair et al. 2006). Measuring discriminant validity is essential where the constructs are interrelated (Fornell & Larcker 1981). Discriminant validity is supported when each measure loads more highly on its own construct than on other constructs, and the average variance shared between a construct and its measures is greater than the variance shared by the construct and all other constructs in the model (Chin 1998). The researcher assessed discriminant validity by calculating the square root of AVE of each construct and comparing them to their corresponding construct

inter-correlations. As shown in Table 4.7, the square roots of AVE were all greater than their corresponding construct inter-correlations, confirming discriminant validity in this case.

Having evidence of both convergent and discriminant validity, the researcher concluded that, ***construct validity***, the extent to which the set of measured variables actually represent the latent construct (Hair et al. 2006), was supported.

Taking account of both the model's fit and the presence of construct validity, it was concluded that the suggested model has satisfactory measurement properties for an initial study of this kind, even if (as discussed in the next chapter) some improvement might be made. The researcher then turned to the next question: How do these five dimensions represent the overall all operational performance of 3PL?

4.3.4 Second-Order Factor Model

A second-order factor model is present when first-order factors are explained by some higher order factor structure. For the current study, the five common factors, namely delivery, order quality, in-storage handling, personnel quality and flexibility were hypothesized to reflect a single second-order factor, 3PL Operational Performance (Fig. 4.4).

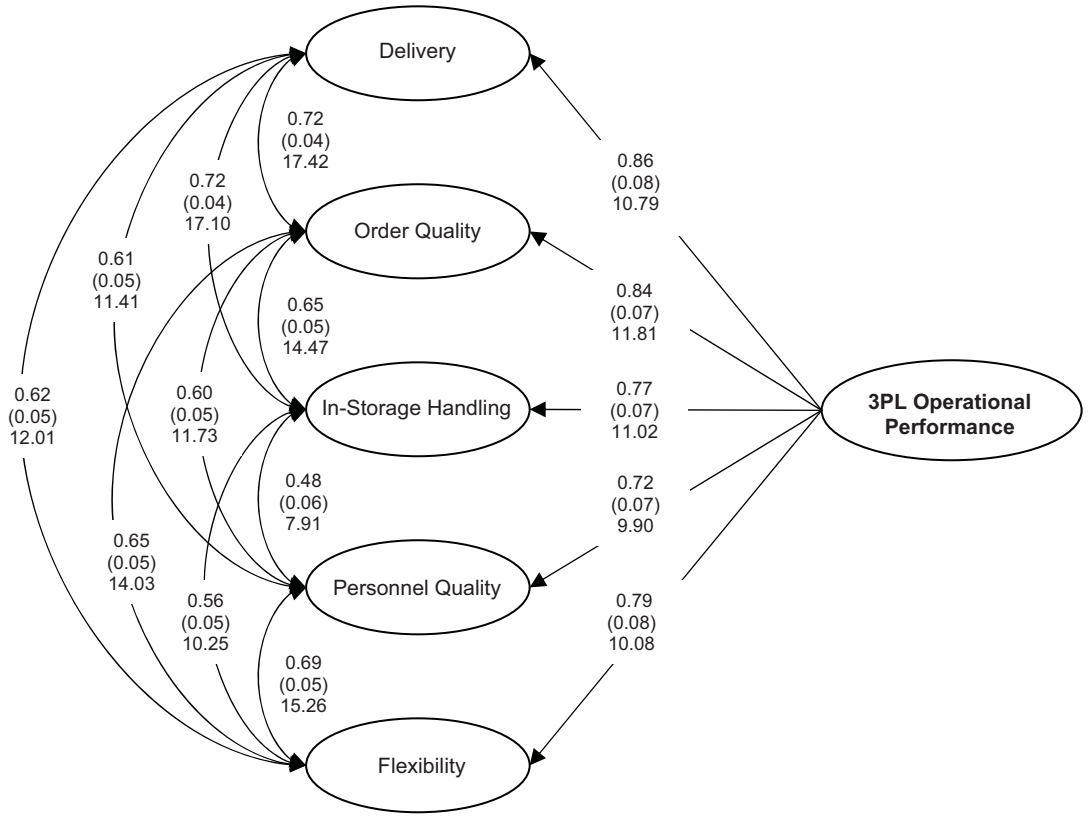

Figure 4.4: 3PL Operational Performance Second-Order Factor Model

The model fit indices indicated that the hypothesized second-order factor model had a mediocre fit. Chi-square was significant (χ^2 = 614.64; *df* = 204; $p < 0.001$) but chi-squares to degrees of freedom ratio 3:1 was acceptable. RMSEA of 0.98, GFI 0.79 and AGFI 0.74 suggested mediocre fit. NNFI 0.96 indicated an acceptable fit.

As can be seen from Figure 4.4, all five factors were moderately highly correlated. With regard to the strength of relationship between the five factors and the higher order factor, the standardized coefficients (Table 4.8) indicated that delivery and order quality were slightly stronger reflections of 3PL operational performance, followed by flexibility, in-storage handling and personnel quality.

Construct	Unstandardized Coefficient	Standardized Coefficient	Standard Error	*t*-value
Delivery	0.86	0.86	0.08	10.79
Order Quality	0.84	0.84	0.07	11.81
In-Storage Handling	0.77	0.77	0.07	11.02
Personnel Quality	0.72	0.73	0.07	9.90
Flexibility	0.79	0.79	0.08	10.08

Table 4.8: SEM Unstandardized, Standardized Coefficients, Standard Errors and *t*-Values

4.4 Summary

Of the thirty-eight measures derived from the previous qualitative phase study, respondents rated most of the intermediate-activity measures, e.g. in-storage handling – putaway, storage and picking accuracy, as moderately important while they rated the end-activity or outcome measures, e.g. correct order, inventory records accuracy, as highly important. This might infer that the customers were more concerned about the results (what gets done) than the processes (what they do and how they do it). However, noting the significantly higher ratings of intermediate-activity items (e.g. onsite warehouse operations) by the contractual-customer respondents, it may be said that these managers, having these activities more visible to them, become interested to monitor, not only the end results, but also the intermediary processes.

The scale developed in this study attempted to measure how the customers perceive and evaluate 3PL operational performance. It consisted of five dimensions, namely delivery, order quality, in-storage handling, personnel quality and flexibility. SEM standardized coefficients indicated that delivery and order quality had stronger bearing on 3PL operational performance, followed by flexibility, in-storage handling and personnel quality.

CHAPTER FIVE

Discussion and Conclusions

5.1 Introduction

The methods and results of the two phases of the current study were presented in Chapters Three and Four, in particular:

- Chapter Three described the methods and the results of the preparatory qualitative study through which a set of thirty-eight 3PL operational performance measures was derived.
- Chapter Four presented the quantitative methods and descriptive analyses, and described how the twenty-two-item, five-dimension 3PL operational performance scale was developed and assessed.

This chapter discusses the key results in relation to the literature reviewed and methodology, limitations of the study with suggestion for future research, managerial implications and conclusions.

5.2 Discussion of the Key Results

Third-party logistics operational performance became an issue of interest following research suggesting that customers have become concerned about performance issues with their 3PL providers (Lieb et al. 2005, Maloni et al. 2006). Through a series of interviews with nine 3PL customer managers, the current study compiled a list of thirty-eight operational performance measures. Based upon these measures, a five-dimension 3PL Operational Performance Scale was developed and tested. Sixteen items were removed during a scale purification process. An examination of the content of the final twenty-two items making up each of the five dimensions suggested the following labels and definitions (see Table 5.1 for the items associated with each dimension and suggested performance metrics):

Delivery:	Ability to secure cargo space, arrange orders within the agreed elapse time, and deliver them in full to the correct destination at the time promised.
Order Quality:	Ability to maintain and provide accurate inventory information enabling suppliers to plan, build, and replenish products to warehouse in a timely manner so that products are readily available for customer orders. Orders contain correct products and are received by customers in good condition.
In-Storage Handling:	Ability to perform intermediary warehousing activities dependably and accurately.

Personnel Quality: Knowledge and skills of personnel and their responsiveness.

Flexibility: Ability to provide additional resources and willingness to adjust to meet customers' unexpected demand.

Dimension	Measures	Metrics
Delivery	Order cycle time	% orders issued within the agreed elapsed time
	Cargo space confirmation	% confirmed space booking request
	Deliver on-time	% orders delivered on-time
	Deliver complete order	% orders delivered in full
	Deliver to correct destination	% orders delivered to correct destination
Order Quality	Accurate data entry	% data input accurately
	Accurate inventory records	% correct inventory records
	Accurate inventory reports	% correct inventory reports
	Correct order	% orders contain correct products
	Pick up on-time	% transportation meets schedules
	Damage due to transport	% orders delivered in the condition they were presented for transportation
	Thefts during transit	Number of cases
In-Storage Handling	Dock-to-stock time	% new receipts processed within the agreed elapsed time
	Accurate putaway	% perfect putaway
	Accurate storage location	% locations without discrepancies
	Accurate order picking	% perfect picking orders
Personnel Quality	Staff education, skills and experience	Work related education and experience
	Staff training	Number and type of training courses
	Prompt response to enquiries	% enquiries responded within the promised time
Flexibility	Additional manpower at short notice	% additional manpower requests entertained
	Prompt react to special requests	% special requests reacted within the promised time
	Expedite urgent shipments	% urgent orders completed within the promised time

Table 5.1: List of Final Twenty-Two 3PL Operational Performance Measures and Suggested Metrics

A previous 3PL service quality study by Rafiq and Jaafar (2007) identified nine performance dimensions: information quality, order procedures, order release quantities, timeliness, order accuracy, order quality, order condition, order discrepancy handling, and personnel contact quality. As discussed in Appendix I, information quality should be considered in terms of timeliness, completeness and accuracy. In the current study, three items pertaining to information quality, namely data entry accuracy, inventory records accuracy, and inventory reports accuracy were treated as integral parts of order quality as was explained in section 4.3.3.

With respect to ordering procedures, the effectiveness or ease of use of the procedures should not be considered the responsibility of 3PL providers since the procedures are either laid down by retailers (in the case of 3PL retail distribution services), or by suppliers and customers (in the case of B2B distribution services), and 3PL providers simply follow the procedures given. Hence this factor was not considered in the current study. Order release quantities was also excluded as backorder and substituted products are not caused by the 3PL providers, but by the suppliers who fail to replenish the products to the distribution warehouse.

Rafiq and Jaafar's (2007) order quality construct dealt with product quality (e.g. product meets technical specification), which does not concern 3PL. For the current study, order quality was defined as "correct products delivered to the customers in good condition." Thus it included two other factors proposed by Rafiq and Jaafar (2007) – order accuracy and order condition.

The current study did not identify items pertaining to discrepancy handling. As discussed in section 3.4, some items pertaining to safety issues and accident reporting came up during the interviews (Table 3.1). But since they dealt mainly with onsite warehouse operations, the respondents suggested dropping these items.

Developed specifically in the context of 3PL, the twenty-two-item, five-dimension 3PL Operational Performance Scale appeared to offer a more precise measurement of 3PL operational performance compared to the thirty-two-item, nine-dimension 3PL Service Quality Scale proposed by Rafiq and Jaafar (2007). Table 5.2 summarizes the similarities and differences of the two scales as discussed above.

Rifiq and Jaafar (2007) 3PL Service Quality Scale	**3PL Operational Performance Scale**
Information Quality Order Accuracy Order Condition Timeliness	Order Quality
Order Condition Timeliness	Delivery
Personnel Contact Quality	Personnel Quality
	In-Storage Handling
	Flexibility
Order Discrepancy Handling	*Not identified*
Order Procedures Order Release Quantities Order Quality (items measure product quality Rather than correct orders or quantities)	*Does not concern 3PL performance*

Table 5.2: Comparison of 3PL Operational Performance Scale to Rafiq and Jaafar (2007) 3PL Service Quality Scale

Given the diversity of services, some services are in one way or another different from each other (Grönroos 2007) even if they are in the same industry. For example, in retailing, some retailers offer facilitating services such as sales assistance and delivery, to help sell goods; some retailers sell services directly, in addition to offering facilitating services; while some other retailers sell only services (Parasuraman et al. 1988). It would be too ambitious to develop a *universal* service quality scale that is applicable to all types of service. Compared with SERVQUAL, Grönroos's (2007) Six Criteria of Good Perceived Service Quality and the SCOR model discussed in Chapter Two, the 3PL Operational Performance Scale appears to be similar, but has the advantage of being specific to 3PL (Table 5.3).

SERVQUAL	Six Criteria of Good Perceived Service Quality	SCOR	3PL Operational Performance
Tangibles	—	Assets	*Capacity* Not identified
Reliability	Reliability and Trustworthiness	Reliability	Delivery Order Quality In-Storage Handling
Responsiveness	Accessibility and Flexibility	Responsiveness / Agility	Flexibility
Assurance	Professionalism and Skills	—	Personnel Quality
Empathy	Attitudes and Behavior	—	
	Reputation and Credibility	—	Not identified
—	Recovery	—	Not identified
—	—	Cost	Not within the scope of this study

Table 5.3: Comparison of 3PL Operational Performance Scale to other Service Quality and Operations Reference Scales

During the qualitative phase study, three items pertaining to capacity – which is similar to tangibles in SERVQUAL or assets in SCOR (GP1 sufficient manpower, WP1 warehouse storage space, TP1 air cargo, ocean cargo, truck space) – were identified. The first two items (GP1 and WP1) were later removed during a scale purification process, and the remaining item (TP1) was included in delivery. Thus a specific capacity dimension was considered but not identified in this study.

Three process dimensions, namely delivery, order quality and in-storage handling correspond to the reliability dimension in SERVQUAL, Grönroos's (2007) Six Criteria of Good Perceived Service Quality and SCOR, but each measures a specific aspect of 3PL services. The Six Criteria of Good Perceived Service Quality reputation and credibility dimension is an image-related criterion dealing more with customer's trust rather than the knowledge and courtesy of provider employees as does SERVQUAL's assurance. This dimension was not identified in the current study. The recovery dimension corresponds to Rafiq and Jaafar's (2007) order discrepancy handling, and as explained above, this dimension was not identified in this study. Finally, SCOR's cost dimension was not considered in this study as discussed in Chapter Two.

Based on the magnitudes of SEM coefficients, Rafiq and Jaafar (2007) concluded that five dimensions, namely: information quality, ordering procedures, timeliness, personnel contact quality, and order discrepancy handling are the major dimensions that influence the perception of service quality provided by the 3PL service firms (loadings 0.7 or above), followed by order condition (0.695), order accuracy (0.615), order release quantities and order quality (loadings 0.380 for both factors). These

findings indicated that Rafiq and Jaafar's (2007) respondents emphasized the means of 3PL service provision (e.g. qualified personnel, effective procedures) more than the results (e.g. an accurate order delivered in good condition).

The current study obtained different results. As was discussed in Chapter Four, the respondents in this study rated most of the intermediate-activity measures as moderately important, while the end-activity or outcome measures were highly important. This suggests that they were more concerned about the results than the means. The SEM results suggest that all five dimensions contributed similarly to the overall operational performance of 3PL with delivery (standardized coefficient 0.86) and order quality (0.84) slightly stronger, followed by flexibility (0.79), in-storage handling (0.77) and personnel quality (0.73). This suggests that a 3PL's operational performance is a function of all five dimensions.

The moderately high correlations between the five dimensions indicate that 3PL customers view them as moderately strongly connected. A 3PL provider that performs well in one dimension may be expected to perform well in other dimensions. For example, having well trained, qualified warehouse operators (personnel quality), warehouse processes are expected to be handled accurately (in-storage handling) and orders are prepared correctly (order quality). In order to perform satisfactorily in all dimensions, 3PL providers require a fairly tightly packaged bundle of competencies.

5.3 Limitations and Further Research

As in all research, the current study has its limitations. First, the results are constrained by the sample. The population of 3PL customers from which the sample was drawn is small and limited to the electronics manufacturing industry in Thailand. Because Thailand's logistics development is still in the later stage of "physical distribution" where most firms focus only on the outbound flow of finished products from the end of the production line to the consumers (Suthiwartnarueput 2007), despite many potential benefits of outsourcing, some Thai firms still keep their logistics activities, particularly warehousing, in-house. The most commonly outsourced functions are transportation and freight forwarding, yet still mainly on a transactional basis.

With a small sample size, the researcher was not able to cross-validate the model using the split-sample approach whereby the total sample is randomly split (usually 50:50) into a calibration sample (to be used for developing and modifying the model) and a validation sample (for testing the derived model). Technically, the nature of the alternative five-dimension model analysis was no longer confirmatory but became exploratory even if the model was later tested with LISREL. Theoretically, it is not acceptable to use the same data set for both model generation and model testing purposes (Hair et al. 2006). It is possible that the accepted model may only fit the set of data for which the model has been developed (Saris & Stronkhorst 1984).

The suggested five-dimension 3PL Operational Performance Scale had high reliability and high variance extracted for the constructs, but the fit was mediocre. The

modification indices suggested nineteen paths and twenty-one error covariances may be added to improve the model's fit. However, literature has cautioned that only the paths that can be substantively interpreted/justified may be added (Diamantopoulos & Siguaw 2007), and freeing error covariance terms is not recommended because it violates the principles of good measurement (Hair et al. 2006). Adding a path (or more) also causes the observed variable to cross-load on two (or more) factors making interpretation of the output difficult.

Second, since the data was collected at one point in time, and the sample was taken from only one industry segment, generalizability of this study across other segments may be limited. Each industry has its own unique requirements beyond the basic logistics capabilities, so there is possibility that results might vary across industries as well as product categories. For example, the automotive industry, having more stable production schedules than the electronics industry, may emphasize capacity (e.g. larger vehicle to transport bulky component parts) rather than flexibility (availability of small pick-up van to deliver urgent small electronic parts at short notice). It is suggested that future research to focus on other industry segments e.g. automotive, apparel or retail to verify the generalizability of the current study.

Third, as was explained in Chapter Two, there have been four stages of logistics development: physical distribution, internally integrated logistics, externally integrated logistics, and global logistics. Mentzer et al. (1999, 2001) conducted their studies in the United States and proposed a nine-dimension logistics service quality scale for a focal company. Rafiq and Jaafar (2007) tested and validated this scale in the context of the 3PL industry in the UK. Both the United States and UK are in the

most advanced stage of logistics development, global logistics, whereas the current study was conducted in Thailand which is considered to be still in the primary stage endeavoring to progress into the secondary stage, internally integrated logistics, and produced different results, both in terms of measurement items and dimensions.

The researcher suspects that the different results are due more to the context of the different studies. Mentzer et al.'s (1999, 2001) studies were based on a focal organization serving its own internal customers, and Rafiq and Jaafar (2007) drew the items and applied them directly in a 3PL context, whereas the current study reexamined the industry from scratch and thus was able to derive a set of items more relevant to 3PL services. Nevertheless, the researcher would recommend that future research replicating the current study be conducted in the internally integrated and externally integrated logistics contexts to see if a different state of logistics development may have any influence on the perception and evaluation of 3PL performance.

In doing a replicate study, the researcher would recommend that the sixteen deleted items (see Table 4.4) be added back. Although the decision to remove them was based on good methodological reasons, during the model estimation process, the researcher frequently encountered non-positive definite matrix, suggesting some data-related problems. Individually, some of these deleted items were rated as highly important, e.g. GP8 responds with accurate information (mean score 7.10) and WP14 damage inside warehouse (7.43), but had to be removed from the analysis due to ambiguous cross loading or low communality. It would be useful to include these deleted items in replication studies to verify if they are actually redundant as this

study suggests, or were removed from the scales in this study because only for sample specific reasons.

Forth, the current study focused on only one of the three performance dimensions of 3PL, operational performance. Future research may include the other two dimensions, relational and cost performances as suggested by Stank et al. (2003) and extend the research to measure also the expectation and satisfaction of 3PL customers. Finally, during an interview, the researcher observed some onsite 3PL employees complaining about being mistreated by the customer managers, "We are just second-class citizens here." With more and more in-house logistics operations being contracted out and 3PL staff coming to work full-time on customers' premises (vendor on premise – VOP), a study concerning how characteristics of 3PL staff, and in particular, their job satisfaction (especially how happy they are with the onsite workplace and the treatment given to them by their managers and the customer managers and employees) affect their customer focus (to what extent they focus on solving customer problems), their job performance (satisfactory/unsatisfactory performance) and their loyalty (intention to stay/resign, low/high staff turnover) could be another interesting research topic.

5.4 Managerial Implications

Too often performance is mentioned as an internal goal without defining what it is, especially how it is perceived by customers, and how it can be measured (Grönroos 2007). Considering that quality is whatever the customers say it is, and the quality of a particular service is whatever the customer perceives it to be (Buzzell & Gale 1987),

the current study developed a twenty-two-item, five-dimension 3PL Operational Performance Scale that can be used by 3PL managers to assess their operational performance based on the views of 3PL customers. In practice, 3PL firms with an established performance measurement system may already have a larger number of performance items, of which some may be similar to the twenty-two items proposed in this study.

The twenty-two items identified in the current study were seen by the customers – the ultimate judges of 3PL performance – as the most important items. This, however, by no means suggests that 3PL managers can pay less attention on the other performance items, especially those measuring the internal processes which are invisible or less visible to the customers. 3PL managers should strive to maintain a balanced focus on all measures, and optimize the use of these perceived-to-be-more-important measures to reinforce positive customer perception of their operational performance.

At the individual item level, 3PL managers can examine performance on each individual item to identify specific areas in need of special attention. For instance, consider items TP3 on-time pick up and TP4 on-time delivery: frequent delays in picking up or delivering orders may signal a need to investigate the firm's fleet capacity and dispatching system or the communication and coordination between the fleet and customer service department. 3PL managers can also use this list of measures for customer satisfaction surveys, recasting the items into perception statements to obtain customer perceptions about the 3PL firm whose performance is being assessed.

Conceptualizing 3PL operational performance at higher levels, i.e. as first- and second-order constructs provides managers with an opportunity to evaluate their performance at a higher level of abstraction beyond the individual items. Classifying the items into five cross-function dimensions provides managers with a broader view of overall performance, rather than the specific view of functional performance (e.g. warehousing or transportation). This not only allows managers to identify areas for improvement or formulate strategic initiatives (e.g. personnel development, capacity expansion), but also helps avoid local optimization – the tendency that functional managers focus only on the performance of their function or department without considering or even realizing the effects their actions may have on the other functions or departments. For example, where transportation department acquires larger vehicles to achieve lower per ton kilometer operating cost, while the warehousing department needs smaller vehicles to deliver small shipments more frequently to achieve delivery flexibility required by customers.

The slightly higher relative importance of the two process dimensions – delivery and order quality – implies that they are the basis of 3PL operational performance. Good care should be exercised to ensure that processes are accurately carried out across the 3PL functions (including warehouse in-storage handling) so that correct orders are delivered to the customers in good condition at the time promised. This, augmented by knowledgeable, responsive personnel and the flexibility to accommodate customers' unexpected requirements, will certainly provide 3PL firms the advantages to compete effectively in this growing industry.

5.5 Conclusions

Since its inception in the late 1980s, 3PL has grown as an option to help increase supply chain effectiveness (Maloni et al. 2006). Ashenbaum et al. (2005) demonstrated the strong presence of the 3PL industry, revealing annual growth rate between five to ten percent for the last decade. Despite such growth, some research has begun to identify customer concerns about the performance of their 3PL providers (Lieb et al. 2005). This is not to say that 3PL provider performance has deteriorated, but more likely that the requirements of 3PL customers have evolved to higher levels of complexity and precision (Maloni et al. 2006).

Because logistics services are a series of linked activities or processes that are produced and to some extent, consumed simultaneously, it is difficult to manage performance. In order to develop an appropriate performance measurement system for 3PL providers, it is important to understand what customers are really looking for and what they evaluate. When 3PL managers understand how their services are evaluated by the customers, it is possible to identify how to manage these evaluations and how to influence them in a desired direction.

The current study attempted to develop a concise multi-item scale with good reliability and validity that 3PL managers can use to assess their operational performance. Through a series of interviews with nine logistics managers in four electronics manufacturing firms, the researcher identified thirty-eight performance measures. These measures were then tested in a wider context using questionnaire survey. Based on 207 responses from logistics managers in the same industry, the

measures were classified into three tiers of importance: moderate importance, moderate-to-high importance, and high importance.

During the scale purification process, twelve measures that had low loading, cross loaded ambiguously on two or more factors, or had low communality were dropped. The remaining twenty-two items formed a five-dimension scale. Although the final scale showed high reliability and variance extracted for the five dimensions, it had only a mediocre fit to the data, which suggests that its validity could be further improved. The five dimensions in the scale measure performance in terms of delivery, order quality, in-storage handling, personnel quality and flexibility. The first two dimensions, delivery and order quality, appear to have stronger bearing on the overall 3PL operational performance, followed by flexibility, in-storage handling and personnel quality.

The results suggest that a 3PL's operational performance is basically a function of delivery and order quality with complementary flexibility to meet the customers' exceptional requirements. The quality to carry out regular, day-to-day in-storage processes and qualified personnel enhance the overall operational performance as perceived by the customer. The moderately high correlations between the five dimensions suggest that 3PL operational performance requires a fairly tightly packaged bundle of competencies.

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APPENDIX I – Rafiq and Jaafar (2007) 3PL Service Quality Scale

As was briefly discussed in Chapter Two, Rafiq and Jaafar (2007) drew measures from two earlier studies of a focal company's logistics performance (Mentzer et al. 1999, 2001) and applied them directly in a 3PL context. They proposed a nine-dimension 3PL service quality scale (Table A1.1).

Dimension	Item
Information Quality CR = 0.96	1. The information communicated by the 3PL is timely. 2. The information communicated by the 3PL is accurate. 3. The information communicated by the 3PL is adequate. 4. The information communicated by the 3PL is complete. 5. The information communicated by the 3PL is credible.
Order Procedures CR = 0.96	1. Requisitioning procedures are effective. 2. Requisitioning procedures are easy to use. 3. Requisitioning procedures are simple. 4. Requisitioning procedures do not take much effort. 5. Requisitioning procedures do not take much time. 6. Requisitioning procedures are flexible.
Ordering Release Quantities CR = 0.82	1. Requisition quantities are not challenged. 2. Difficulties never occur due to maximum release quantities. 3. Difficulties never occur due to minimum release quantities.
Timeliness CR = 0.87	1. Time between placing a requisition and receiving delivery is short. 2. Deliveries arrive on the date promised. 3. The amount of time a requisition is on backorder is short.
Order Accuracy CR = 0.89	1. Shipments rarely contain the wrong items. 2. Shipments rarely contain an incorrect quantity. 3. Shipments rarely contain substituted items.
Order Quality CR = 0.73	1. Substituted items sent by the 3PL work fine. 2. Products ordered from the 3PL meet technical requirements. 3. Equipment and/or parts are rarely non-conforming.
Order Condition CR = 0.87	1. Material received from the 3PL depots is undamaged. 2. Material received direct from vendors is undamaged. 3. Damage rarely occurs as a result of the transport mode or carrier.

Continued

Dimension	Item
Order Discrepancy Handling CR = 0.92	1. Correction of delivered quality discrepancies (Report of Discrepancy) is satisfactory. 2. The Report of Discrepancy process is adequate. 3. Response to Quality Discrepancy Reports is satisfactory.
Personnel Contact Quality CR = 0.89	1. The designated 3PL contact personnel makes an effort to understand my situation. 2. Problems are resolved by the designated 3PL contact person. 3. The product knowledge/experience of 3PL personnel is adequate.

Table A1.1: Rafiq and Jaafar (2007) 3PL Service Quality Scale
CR = Composite Reliability

This scale contains many items not relevant to 3PL (e.g. product specification), and some items are duplicate with other items in the set (e.g. items 1, 2 and 3 in the order condition dimension). Item "material received direct from vendors is undamaged" does not concern 3PL unless transport is arranged by a 3PL picking up material from supplier and delivering it directly to customer (by-passing 3PL warehouse or depot). Even if this is the case, this item simply duplicates the first one "material received from the 3PL depots is undamaged", as for both cases, transportation is performed by the 3PL and only the routing is different – from the 3PL depot or from the supplier's premises, to the customer.

With respect to ordering release quantities, timeliness and order accuracy, items "requisition quantities are not challenged", "the amount of time a requisition is on backorder is short" and "shipments rarely contain substituted items", 3PL providers challenge requisition quantities only when the available inventory could not meet the requested quantities. Backorder and substituted items are caused by the items being ordered are unavailable. It should be the suppliers who fail to replenish the materials, not the 3PL, to be held responsible for such low stock level or stock-out. In the case

of production warehouse, 3PL operators are usually instructed not to offer substituted items, but to deny issuing.

The remaining two items of ordering release quantities are confusing and need clarification – Does "difficulties never occur due to maximum release quantities" mean there is inventory available, but the 3PL provider could not meet the workload required to deliver the maximum quantities (due to lack of manpower, space, or transport)? "Difficulties never occur due to minimum release quantities" refers to a 3PL provider being unwilling to handle small, minimum-quantity shipments considering the effort, and hence the high cost versus the low margin from small shipments? Or because they do not have suitable equipment (e.g. small pick-up van to deliver small packages is unavailable)? Whatever the case may be, the researcher was of the opinion that these two issues should have been discussed and solutions agreed upon before concluding the 3PL standard operating procedures.

All three order quality items pertaining deal with product specification and performance "substituted items sent by the 3PL work fine", "products ordered from the 3PL meet technical requirements" and "equipment and/or parts rarely non-conforming". They do not concern 3PL services, unless a 3PL provider is involved in final assembly of the products and the non-conformance is actually due to the 3PL, not the manufacturer. In the context of 3PL services, order quality should deal with order accuracy (correct item and quantity) and order condition (undamaged).

For information quality subscale, Rafiq and Jaafar (2007) adopted Mohr and Spekman's (1994) five communication quality measures each describing a desirable

attribute of communication: timeliness, accuracy, adequacy, completeness and credibility of information exchanged. These five items were originally developed to measure the communication behavior in a partnership context.

Broadly defined, information is data with meaning for decision making and use to *a particular recipient* in *a particular context* (Avison & Fitzgerald 1995). In the 3PL context, information regularly exchanged between the suppliers, the 3PL provider, and the customers are those pertaining to inventory levels, replenishment details, order details, or shipment status. It would be easier for the customers to evaluate 3PL information quality more specifically e.g. "*Timely* submission of daily inventory report", "The daily inventory report contains *complete* information" and "The daily inventory report contains *correct* information". With many 3PLs boasting about their sophisticated web-based portal that allows their customers to view and manage inventories on a real time basis, information accessibility may be included in this dimension.

The researcher would suggest dropping the "adequacy" and "credibility" items. A complete report (the 4th item "The information communicated by the 3PL is complete.") has all the information required by the suppliers, the customers or other external users e.g. customs authority, thus by itself, meets the adequacy criterion. Credibility is the quality that somebody/something has that makes people believe or trust them. Credibility involves company name, company reputation, personal characteristics of the contact personnel, and the degree of hard sell involved in interactions with the customer (Parasuraman et al. 1985). In the B2C context,

information credibility becomes important when a customer is buying a high price, unfamiliar product about which the customer has little or no knowledge.

For B2B, credibility is important when the information is of strategic level, exchanged on an exceptional basis. In a 3PL operation, most, if not all information provided by the 3PL provider is of operational level, on a routine basis (again, daily inventory report, for example). A report that is complete, correct and submitted on time should meet the requirements of 3PL customers. With regard to the credibility of the 3PL firm (e.g. firm reputation), the customer should have evaluated this well before awarding the service contract to the provider.

The ordering procedures subscale is questionable. Originally, this subscale had only two items namely "requisitioning procedures are effective" and "requisitioning procedures are easy to use". Deriving from Dabholkar's (1994) consumer choice model, Rafiq and Jaafar (2007) added four new items measuring simplicity, flexibility of the ordering procedures, time and effort taken. As was discussed earlier, logistics service is a B2B business with many operational elements different from the B2C context. For B2C, a simple, easy to use, and flexible ordering procedure affords customer to make fast, low price, irregular purchase decisions (e.g. verbal versus touch screen ordering at a fast food chain outlet). In the case where a 3PL provider is hired to perform B2C logistics services, e.g. warehousing and dispatching services for a mail order retailer, the customer ordering procedures are laid down by the retailer, not the 3PL provider.

For B2B, industrial purchasing is far more complicated and controlled than B2C in the sense that purchaser (e.g. procurement manager) cannot change his/her decision at will. Due to the high order value and long-term contract, it involves longer sourcing time and team decision. 3PL requisitioning or pull procedures must be pre-specified (and the six attributes listed above should be taken into consideration when formulating the procedures) and all parties involved – the suppliers (e.g. customer service unit, outbound logistics, finance), the 3PL provider, and the customers (e.g. order planner, procurement, inbound logistics, finance) are well informed of and familiar with such procedures. It is worth emphasizing here that high quality procedures alone do not necessarily result in high quality outputs. When the procedures are in place, not only the service providers, but also the customers and the suppliers, are required to follow the procedures properly.

Out of the thirty-two items proposed by Rafiq and Jaafar (2007), only sixteen measure 3PL performance. They were summarized and presented in Table 2.4 in Chapter Two.

APPENDIX II – Verbalization Classification

Table A2.1: Satisfactory Performance

Question: In what areas do you find them performing satisfactorily?	
Statement	**Item**
"They have two warehouse managers. One is strong in operations and another in IT. These two managers are not positioned here full time but sort of taking turn. I was puzzled at first why two managers and pointed this out to our general procurement manager when we were checking their cost structure – they charged us only one position. Now seeing these two managers coming to work alternately and realizing that they are looking after other warehouses as well, I will say they share their time and expertise effectively." "They have many competent staff. Actually I would like to have one of their supervisors to be on my team. But we have a gentleman agreement that we will not approach and hire each other's staff … " "The key account coordinator team is very strong. They reply to our enquiries very quickly. If they can't answer and need more time, they keep us posted of the progress. This shows that they care… Pity that the weak operations team drags them down."	Competent staff Resource synergy Timely response to Enquiry
"We use their WMS (warehouse management system) to manage our COI (customer's own inventory) as well. We have our own Oracle system, but we do not have the warehouse management module. Their WMS and our Oracle work together quite well. We thought about integrating their system with ours, but because of our IS policy, this has been put on hold … " "Our Business Unit Manager likes the provider's warehouse management system very much. We could tell she was very enthusiastic when we were working on user [reports] requirements. We discontinued our warehouse management module when they came to manage our COI and now use our SAP only for GR (goods receiving) and GI (goods issuing) transactions [inventory management sub module] and we do not have to key in GR GI data anymore. They are now automatically transferred from their system to our SAP." "Their IT staff reacts to our requests very quickly … Writing a few small programs running around the main WMS extracting data and generating reports in the format we specified … We changed the report formats back and forth a few times, and he never complained … "	WMS System integration System compatibility Process automation Quick response to special requests/ flexibility Staff willingness

Continued

Statement	Item
"They changed our bin card [stock card] form and use their WMS to print out the card automatically. Previously we had to xerox the form and write it with marking pen, and you know our operators' handwriting … It looks very professional now … The MIQI [material issued for quality inspection] form is also now automatically printed out by their WMS saving a lot of time… Before we used A4 paper, and now it is half–A4… From bin card, they also reduced the size of the pallet ID [self-adhesive label]. It is now about one-third of the previous size … Our ISO 14000 team was very pleased with this… They gave them something to boast about… "	Process automation Ongoing improvement
"We sometimes experienced hand-to-mouth situation because of material shortage and they were able to expedite our hot shipments enabling us to keep the lines." "Hand-to-mouth means we have zero stock of one or more component parts required for production and are expecting such parts to arrive in time to keep the line running. We request our [overseas] suppliers to deliver these parts using swiftmode [urgent air shipment] … To ensure that shipments arrive at our plant in time, customs clearance has to be condensed and truck must meet delivery schedule." "We have been able to increase production pull frequency from two to four pulls per day. This helped reduce our WIP (work in process) inventory in the cleaning department from half-day to one-fourth." "Our workload fluctuates unpredictably. We may be shipping about twenty pallets today, but a hundred tomorrow. And we only know this in the evening when our corporate [US headquarters] drops us the orders. One good thing about this provider is that they have a huge pool of operators. When we need extra hands, they can mobilize workers from other warehouses … They have close relationships with airlines and have been able to secure fixed allotments [cargo space] for us. This helps a lot especially during peak season when flights are overbooked and shipments get either offloaded last minute or onboard only partially."	Ability in expediting urgent shipments Transportation meets delivery schedules Increased delivery frequency Inventory reduction Staff availability to support extra workloads Air cargo space availability / fixed allotments Offloaded/ partial Shipment
"The [COI] warehouse is much cleaner than before. The [3PL] warehouse manager seems very particular on this. Our staff even teased him if he wanted to turn the warehouse into a living room." "Our ISO team audits their warehouse every quarter and finds their warehouse is of high standard … They also have a very sophisticated security system. "	Storekeeping Security system

End Table A2.1

Table A2.2: Unsatisfactory Performance

Question: In what areas do you find them performing unsatisfactorily?	
Statement	**Item**
"I never see the account holder comes to the site to see things for himself. What he does is accepting whatever his subordinates tell him … The real harm is he does not seem to understand our requirements … Instead of sparing some times to listen to us, he seems to have everything pre-determined… " "When facing any problem, the supervisors just have to wait for the manager and no one knows when he will be in …"	Manager availability Competent staff User's requirement
"The warehouse manager is always late. They give us their staff roster, but they just don't follow the roster ... Operators always come late or are just absent. He [warehouse manager] does not take any action. What can I say? He himself does the same thing… Most of the time I have to call his mobile… " "No substitutes or backups. If there are two or three operators absent and this happens quite often, then the whole shift slows down." "Quite a lot of operators are absent during the weekend. This causes problems supporting our production line." "Sometimes they do not have enough operators to support night shift and weekend. I heard that some operators come to clock in and then disappear and show up again to clock out. They should have at least a duty supervisor attending night shift and weekend to make sure that these things do not happen."	Staff attendance/ punctuality Staff availability/ workforce adequacy
"The warehouse manager seems to forget that we are the customer. He likes to negotiate or simply says no. He is just not willing to try … " "The supervisors lack enthusiasm and so are the operators. They are not helpful. Many times we have hot shipments that need to be unloaded from the truck urgently and the forklift drivers are just nowhere to be found, and those operators who can drive the forklift, some just sit there with such none-of-my-business expression on their face, and some pretend to be busy and walk away."	Staff attitude Service-mindedness Staff willingness
"I don't know why they can't keep their shirt tucked in their trousers… Jeans are allowed here. Our staff wear jeans, but not that worn out. I will say they purposely slashed their jeans… I do not expect warehouse operators to be well groomed. Long hair is OK, but should be trimmed and I just can't stand those goatees … We require all operators working with movement machines wear safety shoes. But I see some of them wearing sneakers. They said safety shoes are too heavy. Well, let's see what they will say when they lost their toes… "	Staff appearance Adherence to safety rules and regulations

Continued

Statement	Item
"A few costly accidents. Our materials are very expensive – one pallet dropped could mean two hundred thousand Baht (US$ 5,000). Accidents will happen. We realize that not everything can be prevented. But most of these cases were due to the operators ignoring the safety rules and regulations." "The warehouse is quite congested making it difficult for forklift drivers to maneuver around and they accidentally poke some cartons with the forklift blades. Though mostly these damages are cosmetic, we cannot leave things to chance. So instead of sampling, we have to do 100 percent screening. This not only causes extra workload, but also the materials get stuck in the IQA (incoming quality assurance) a few more days." "Safety department complained about careless [forklift] driving. They do not adhere to our safety rules and regulations, especially the speed limit. Our director experienced this himself – they drove like Formula-1 in front of him and that really scared him. He specifically instructed the safety department to give formal warning to the provider and demand that their forklift drivers must undergo a driving test and possess a valid licence."	Accident prevention Adherence to safety rules and regulations Sufficient warehouse space Damage due to careless handling Test/ licence
"We lodged quite a big claim when one pallet of HGA (head gimbals assembly) collapsed inside the truck container. There were only two pallets loaded but they did not secure them with lashing. We suspected that the driver was speeding causing the pallets to gave way and hit each other… "	Damage due to improper loading/ careless driving
"We are ISO 14000 and 18000 certified and we require that all our contractors comply with our ISO requirements. It doesn't seem they are giving us their full cooperation. We still can find garbage and reusable materials not properly segregated."	Compliance to rules and regulations
"They do not pay enough attention to our critical shipments. I suspect that is because they do not get storage charge on these direct-to-production line shipments. One morning about five o'clock the production department woke me up complaining that a critical shipment ETA (estimated time of arrival) plant 02:00AM was still stuck on the truck because the receiving operators were too busy with normal shipments. They did not give that critical shipment priority even if the production line was about to go down."	Critical shipment/ shipment priority
"Because of BOI [Board of Investment – a Thai government agency responsible for investment policy advocacy and its implementation, and investment promotion and facilitation] control, component parts imported under a given plant's quota must be used by that plant. That means, two shipments of the same component part, shipment A is consigned to plant A, and B for plant B, they must be delivered to their designated plant, no switching. But many times, the airport guys get mixed up and deliver A to B, and B to A."	Wrong delivery

Continued

Statement	Item
"The warehouse is quite messy. They do not store pallets or cartons properly. Carton lids are just wide open… We repeatedly asked them, after each pull round, somebody should go inside the storage area to see if things have been put back on the rack properly."	Storekeeping
"They definitely have a communication problem, particularly between shifts. We have even suggested them using log book. They should have their own procedure making sure that communication flows properly since they are working on two shifts 24 hours a day."	Workflow control/ information follow-up
We communicate with them using email since we cannot really rely on telephone [verbal communication]. But then again after we send the email, we still need to call them to make sure they read the mail. We are just tired of their usual excuse, 'We have not received your email yet… '"	Customer Communication
"We receive wrong or incorrect invoices many times. They charge wrong items, or apply wrong rates. We have to check with their accounting department back and forth … We sometimes receive double billing – they bill us twice for the same job!"	Billing accuracy

End Table A2.2

Table A2.3: Performance Evaluation Indicators

Question: What indicators do you use to evaluate those areas in which you find them performing satisfactorily/ unsatisfactorily?

Statement	Item
"What indicator do you need to see if someone is here or not? I just do not see the warehouse manager in the morning. Our warehouse operates 24 hours and of course I do not expect him to be here 24 hours. Just the normal office hours will do." "We randomly check their roster and attendance records to see if staff come to work according to the roster and if the number of staff is sufficient."	Staff attendance records Staff roster
"How should I put this? You cannot really measure service-mindedness, can you? But even if you cannot measure you still can tell. I will say it is the way he [warehouse manager] responds. Sometimes I feel he intentionally ignores me… "	Service-mindedness
"For housekeeping, we check the warehouse six times a day, three each shift. Our supervisors check the warehouse every four hours. They have a copy of the warehouse layout and check the storage area row by row and the staging area for cleanliness and orderliness. They mark each row … 10 is excellence and 7 is satisfactory. Below 7 they need to improve." "The first six months we had weekly operations meetings with them, and after things became stable, we changed to monthly. We use a number of KPIs (key performance indicators). Our materials control department set up an audit team. For warehouse management [storekeeping] the audit team patrols the warehouse and notes down anything they find improper, like violation of safety requirement, say, putting partial pallet not securely fastened with strap on high level rack."	Warehouse patrol Score (0 – 10) KPIs Nature of violation
"Our company uses six-sigma so we use the same criteria evaluating our contractor. Take documentation as an example, we demand 99.98 percent accuracy. So for every one thousand delivery notes, we accept only two mistakes…" "For GR and GI, we check the number of reversal requests (SAP receiving and issuing transactions, once completed, cannot be modified. If data entry clerk inputs wrong information and needs to modify the record, a reversal request is needed). For inventory accuracy, we perform RIC (random inventory count) and variance must be zero on second count."	Evaluation criteria/ performance targets Error rate: 0.02% Variance: 0% Inventory accuracy

Continued

Statement	Item
"In case of an accident, an initial report with corrective action must be submitted [by the provider] within the next working day. Judging from the report, our safety department may ask to co-investigate. Full detail of the investigation and preventive measures must be submitted within the next two working days to our safety department for their approval. Each fiscal year, our safety department gives us targets in terms of number of case or Baht value." "We deduct more points on safety violation because it has high impact."	Corrective action/ preventive action/ accident report number of case, value Point system Level of importance
"For our inter-plant shipments, we have the agreed lead-time of four hours. Our staff at pick-up point enters truck arrival time, loading completed time, departure time, and receiving point enters destination arrival time."	Lead-time Truck arrival at origin/ departure from origin/ destination arrival time

End Table A2.3

Table A2.4: Other Areas to be Included in a Future Assessment

Question: On the basis of your experience, are there any other areas you may want to evaluate in a future assessment?

Statement	Item
"Our warehouse is quite crowded and we have only one dock for both incoming and outgoing shipments. Sometimes the incoming shipments get stuck at the dock. This can be a problem if one of the shipments is urgently needed to be received in and delivered to the production line at once. We are moving our warehouse to a new, more spacious building soon and we will have a dock specifically for incoming shipment. Then I would like to track the whole receiving process like how long it takes to unload a truck, issue pallet IDs, stock cards, etc. until all pallets are putaway into location. You know, like production line where we can time each process."	Dock-to-stock time
"Their staff turnover rate is quite high. I see new faces all the time. They train their new staff on the job. I do not mind that. But they do not have any formal assessment to see if their staff really understand and know how to do their work properly, especially the computerized warehouse control system. They should have some kind of formal training and test."	Qualified staff Staff training Certification
"We just had a meeting on inventory aging control the other day. Our procurement department complained that the provider has not followed FIFO (first-in, first-out) in issuing parts to the production line, causing P/O (purchase order) problems and EOL (end-of-life – model no longer produced)."	FIFO control
"Actually I am thinking about evaluating them less. I want to make better use of our staff, the audit team I mentioned. Instead of having them collect data and prepare those vendor performance reports, I want to assign them some other productive tasks. And I will ask the provider to do their own internal assessments and present them to us, maybe on a quarterly basis." "We have been assessing them using the same KPIs we used when we were operating the warehouse by ourselves. I must admit that I can't think of any other criteria. You see the tasks are more or less the same. The difference is only these people are under the provider's payroll. The second line manager [respondent's direct super-ordinate] mentioned to me a few times that she would like to evaluate them on a higher [aggregate] level. She said we had been too detailed."	Self-evaluation reports Aggregate level Evaluation

End Table A2.4

Table A2.5: Additional Performance Measures

Questions:
1. *Your report shows these measures. Please explain them in more detail?*
2. *Literature suggests/ other 3PL users use these measures, do you think they are useful?*
3. *On the basis of your experience, are there any other areas you may want to evaluate in a future assessment?*

Statement	Item
"By line support we mean materials are delivered to the cleaning department at exactly the time specified in the PRS (parts requisition slip). For regular pull, we release PRS to the warehouse customer service unit about two hours before [the delivery time] allowing them enough time to allocate, pick, kit, and deliver the parts to the production floor."	On-time delivery Order cycle time
"Yes, inventory accuracy is very important. Our finance department conducts PI (physical inventory) twice a year and they demand zero variance. Variance can be caused by wrong putaway, wrong ASN (advanced shipment notice) [receipts data] or wrong issuing."	Inventory accuracy Putaway accuracy Data input accuracy
"We use a broader term 'inventory management' instead of 'storage accuracy'. Storage accuracy is somewhat overlapping with putaway accuracy – I mean if you put a pallet into a wrong location, its physical location will be mismatched with the system. So when you do cycle count you will find storage discrepancy. But I will say it is quite difficult to set a check point for putaway accuracy..... "	Storage accuracy
"We ship our products to many destinations and each has peculiar requirements, especially China. It is important that the boys pick the correct products and pack them correctly according to our customers' specification. Invoice, packing list and export entry must be complete and correct. Operating in a Free Zone [FZ – a designated area for industrial or commercial operation or any other operations contributing to economic growth and development. Foreign and domestic merchandize entering into FZ is eligible for tax and duty privileges as indicated by the law. FZ is considered to be outside Thailand and Thai Customs territory], we do not want to have any problem with the customs authority." "Picking correct product and quantity is important. Under- or over-delivery is usually caused by wrong picking. All our local customers are either in Free Zone or under BOI, reconciling shortage or overage can be very troublesome."	Picking accuracy Shipping accuracy Documentation accuracy Under-/ over-delivery

Continued

Statement	Item
"Our orders are mostly shipped to local customers or neighboring countries so we use more truck transportation. Like air freight, I will say truck availability and instant booking confirmation are desirable. Most importantly, the truck should pick up and deliver goods on time. Depending on the distance and traffic conditions en route, we allow half to two hours delay."	Truck availability Booking confirmation Pick up and delivery meet schedules
"If we are talking about responsibility and authority, I don't think we could hold a freight forwarder responsible for last minute offloading or partial uplifting. That's beyond their control. Our shipments are heavy – about 500 kilos per pallet [average pallet density 200 kilos]. During winter when they [airlines] face head wind [westbound flights, e.g. from Bangkok to Europe] and weight limitation [to uplift more fuel] problems, even if space is available, they still cannot uplift any cargo. What worries us is that our products get stolen at the cargo terminal if they stay there too long." "As I said we ship most of our orders by truck mode so we don't have shipment offloading or partial uplifting problems. Using trucks, we are more concerned about pilferage, especially when they have to transfer load to a new truck at the border."	Shipment offloading/ partial uplifting Pilferage
"We do not require the VMI warehouse security system to be the same standard as the production building. Since we do not have production lines [machines] in that building, we do not require a sprinkler system. Most of the component parts are moisture sensitive, so in case of fire, some burned is better than all wet. Also commercially, VMI parts are not yet ours." "Though our products [component parts] are not readily saleable, they are every expensive. Our insurance company requires the third-party warehouse to be equipped with security system, at least comparable to ours. Otherwise, they will have to charge a higher premium."	Security system: Damage/ pilferage Protection
"Our OS&H (occupational safety and health) and HR (human resource) demand that employees of all onsite contractors must undergo periodic drug testing, at least once a year. Those working with movement equipment (e.g. forklift truck) must also undergo physical checkup including colorblindness. Safety is top priority. I will say these measures are important."	Drug/ physical test

End Table A2.5

APPENDIX III – Questionnaire

The Development of Measures to Assess the Operational Performance of Third-Party Logistics Providers

Section A **Please tell us something about your organization and yourself.**

(Please tick ✓ or fill in the appropriate boxes).

DEM1 Which of the following best estimates the number of employees in your organization?

- ☐ < 500
- ☐ 500 – 1000
- ☐ 1001 – 3000
- ☐ 3001 – 5000
- ☐ > 5000

DEM2 Is your firm currently using the services of a third-party logistics (3PL) provider on a

- ☐ contractual basis
- ☐ transaction-by-transaction basis

DEM3 How long have you been actively involved in 3PL services?

☐☐ years ☐☐ Months

Continued page 2

Section B **Please rate the level of importance of the following general 3PL performance measures. Please circle only one number for each statement.**

Item	Measure	Importance								
		very low		low		moderate		high		very high
GP1	The 3PL provides sufficient manpower	1	2	3	4	5	6	7	8	9
GP2	The 3PL is able to provide additional manpower at short notice	1	2	3	4	5	6	7	8	9
GP3	The 3PL staff possess appropriate education, skills and experience	1	2	3	4	5	6	7	8	9
GP4	The 3PL provides their staff adequate training e.g. forklift truck driving, warehouse management system, etc.	1	2	3	4	5	6	7	8	9
GP5	The 3PL staff undergo a general physical check up and /or drug test at least once a year	1	2	3	4	5	6	7	8	9
GP6	The 3PL reacts to special requests expediently	1	2	3	4	5	6	7	8	9
GP7	The 3PL responds to enquiries in a timely manner	1	2	3	4	5	6	7	8	9
GP8	The 3PL responds to enquiries with accurate information	1	2	3	4	5	6	7	8	9
GP9	The 3PL staff report to duty on time	1	2	3	4	5	6	7	8	9
GP10	The 3PL staff dress appropriately and presentably e.g. clean uniform	1	2	3	4	5	6	7	8	9
GP11	The 3PL has a clear, effective procedure for work/ information flow control ensuring that follow up actions are taken by concerned sections or shifts	1	2	3	4	5	6	7	8	9
GP12	The 3PL billing is accurate showing correct items and charges	1	2	3	4	5	6	7	8	9

Continued page 3

Section C **Please rate the level of importance of the following 3PL warehousing performance measures. Please circle only one number for each statement.**

Item	Measure	Importance								
		very low		low		moderate		high		very high
WP1	The 3PL provides adequate warehouse storage space	1	2	3	4	5	6	7	8	9
WP2	The 3PL warehouse is able to expedite the receiving and issuing processes of critical/ urgent shipments	1	2	3	4	5	6	7	8	9
WP3	The 3PL warehouse maintains the correct balance quantity of production materials or finished products on hand	1	2	3	4	5	6	7	8	9
WP4	The 3PL warehouse enters/ updates inventory data accurately	1	2	3	4	5	6	7	8	9
WP5	The 3PL warehouse putaways items correctly, e.g. in the case of direct putaway, enters storage location number where the pallet or case has been placed into the warehouse management system correctly, or in the case of directed putaway, places each pallet or case in the location pre-assigned by the warehouse management system correctly	1	2	3	4	5	6	7	8	9
WP6	The 3PL warehouse has accurate information concerning the physical location of production materials or finished products	1	2	3	4	5	6	7	8	9
WP7	The 3PL warehouse is able to issue production materials or finished goods according to FIFO (first-in, first-out) or other methods (LIFO – last-in, first-out) as specified by the customer	1	2	3	4	5	6	7	8	9
WP8	The 3PL warehouse operators pick the allocated production materials or finished goods from locations correctly	1	2	3	4	5	6	7	8	9
WP9	The 3PL warehouse prepares orders for delivery (shipping) without errors	1	2	3	4	5	6	7	8	9

Continued page 4

Item	Measure	Importance								
		very low		low		moderate		high		very high
WP10	The 3PL warehouse prepares delivery documents e.g. delivery note with complete and correct information	1	2	3	4	5	6	7	8	9
WP11	The 3PL warehouse summits accurate inventory reports regarding the quantity of production material or finished products on hand	1	2	3	4	5	6	7	8	9
WP12	The 3PL warehouse is able to complete receiving in of a new shipment within the agreed elapsed time (from when a receipt arrives on the warehouse premises until it is putaway into storage location)	1	2	3	4	5	6	7	8	9
WP13	The 3PL warehouse is able to complete issuing of a new order within the agreed elapsed time (from when an order is released to the warehouse floor until it is picked, packed, and ready for delivery)	1	2	3	4	5	6	7	8	9
WP14	The production materials or finished products are warehoused with little or no damage	1	2	3	4	5	6	7	8	9
WP15	The production materials or finished products are warehoused with little or no loss (pilferage)	1	2	3	4	5	6	7	8	9
WP16	When they operate on the customer's premises (e.g. onsite warehouse), the 3PL strictly adheres to the customer's rules and regulations	1	2	3	4	5	6	7	8	9
WP17	The 3PL warehouse maintains a good standard of storekeeping	1	2	3	4	5	6	7	8	9

Continued page 5

Section D **Please rate the level of importance of the following 3PL transportation performance measures. Please circle only one number for each statement.**

Item	Measure	Importance								
		very low		low		moderate		high		very high
TP1	The 3PL provider is able to secure and confirm space booking request (air cargo, ocean or truck) promptly	1	2	3	4	5	6	7	8	9
TP2	The 3PL provider is able to expedite emergency delivery	1	2	3	4	5	6	7	8	9
TP3	The 3PL provider picks up outbound shipments on time	1	2	3	4	5	6	7	8	9
TP4	The 3PL provider delivers inbound shipments on time	1	2	3	4	5	6	7	8	9
TP5	The 3PL provider delivers outbound shipments to their destination correctly	1	2	3	4	5	6	7	8	9
TP6	The 3PL provider helps to uplift complete shipments onboard the confirmed flight, vessel or truck	1	2	3	4	5	6	7	8	9
TP7	The 3PL provider delivers shipments in the condition they were presented for transport	1	2	3	4	5	6	7	8	9
TP8	The 3PL provider delivers shipments without loss due to pilferage	1	2	3	4	5	6	7	8	9
TP9	The 3PL provider prepares shipping documents e.g. invoice, export entry with complete and correct information	1	2	3	4	5	6	7	8	9

We would appreciate it if you could complete this questionnaire by or before (dd/mmm/yyyy). Your completed questionnaire will be picked up by (Name), (Phone #), (Fax #).

We sincerely thank you for your participation and contribution in this survey.

APPENDIX IV: Cover Letter

Business School
The University of Western Australia

Date:

Participant's Information Sheet

Dear ……

I am currently studying for a Doctor of Business Administration degree at the Business School, the University of Western Australia. My doctoral thesis focuses on third-party logistics (3PL) performance measurement concentrating on warehousing and transportation), and is being conducted under the supervision of Professor Jane Klobas. The title of this thesis is:

The Development of Measures to Assess
the Operational Performance of Third Party Logistics Providers

This research consists of two phases: The first preparatory phase uses in-depth interviews to identify measures used by 3PL customer managers to evaluate the operational performance of their logistics service providers. The second phase uses a questionnaire survey to test the results obtained from the first phase in a wider context, and the target participants are 3PL user and non-user managers.

You are kindly requested to participate in this second phase study. The questionnaire should take about 20 minutes to complete. Returning a completed questionnaire serves as your consent to participate in this research.

As can be seen from the questionnaire, no sensitive personal questions are asked. Confidentiality is assured as you do not have to disclose your identity, the name of your company, or the names of your logistics service providers. Your participation is entirely voluntary and may be withdrawn at any time without reason or justification and without prejudice. However, due to anonymity, if data have already been input, we will not be able to retrieve and delete your answers from the database.

Though I am presently working for a logistics service provider, I would like to assure you that all information obtained will be treated as strictly confidential and solely used for the academic research purpose. No data gathered will be seen by my employer or any other commercial firms.

Should you have any further questions, or if you would like a summary of the findings of this research, do please contact my supervisor Professor Jane Klobas <email address> or me <email address>.

I sincerely thank you for your participation.

Yours sincerely,

Santi Visuddhisat

The Human Research Ethics Committee at the University of Western Australia requires that all participants are informed that, if they have any complaint regarding the manner, in which a research project is conducted, it may be given to the researcher or, alternatively to the Secretary, Human Research Ethics Committee, Registrar's Office, the University of Western Australia, 35 Stirling Highway, Crawley, WA 6009 (telephone + 61-8-9380-3703). All study participants will be provided with a copy of this information sheet for their personal records.