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CHOOSING THE RIGHT INFORMATION COORDINATING MECHANISM FOR THE INTERNATIONAL OCEAN SHIPPING PROCESS

A Thesis in

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Abstract

The international shipment of freight container by liner ocean carrier is fraught with uncertainty arising from a number of sources. The deregulation of the international ocean liner industry provided the impetus for carriers to offer Internet portal services to reduce some of this uncertainty. The Federal Maritime Commission expected these services to improve the ocean shipping process especially for smaller shippers. The trade press reports though, were inconsistent with expectations.

The objective of this study is to investigate the current nature of utilization and potential value of the Internet portal, Electronic Data Interchange, and, phone, fax and e-mail for conducting the international shipment of freight containers by ocean liners. The theoretical basis for the model used to answer the research questions utilizes a contingency approach, which assumes that only a certain level of a solution is appropriate for a specific level of a problem. The rationale of the model is that firms increase their information processing capabilities, by using EDI or Internet portals, in response to increasing information processing needs, arising from higher uncertainty. It was expected that firms who displayed such a fit would perform better than firms who did not.

The data analysis revealed the existence of four differently configured *gestalts* of shippers. As expected, the *gestalts* that configured their information processing capabilities according to their information processing requirements performed the best. It was observed that large shippers with a large number of containers shipped and a higher value of shipments along with stable demand and supply, and routine uncomplicated tasks benefited from the long lead times of ocean shipping. They could use low information processing capabilities to manage their shipping process. However, when the number of overseas suppliers increased higher information processing requirements were required to maintain high performance. On the other hand, shippers who face unstable demand and supply, and experience several operational disruptions, and exceptions need to increase their information processing capability to improve performance. The long lead times of international ocean shipping, appear to impair such shippers' ability to respond to changes in demand and supply or, exceptions.

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Glossary of Terms

ANOVA	Analysis of variance
B/L	Bill of lading. A transportation document used as invoice for freight and contract of carriage.
BCO	Beneficial cargo owner
BTS	Bureau of Transportation Statistics
CHB	Customs house broker
CSCR	Center for Supply Chain Research
EDI	Electronic Data Interchange
EE	External environment
EI	External integration
EXW	Ex-works – INCOTERM.
FAS	Free alongside ship – INCOTERM.
FCL	Full container load
FMC	The Federal Maritime Commission
FOB	Free on board – INCOTERM.
GATT	The General Agreement on Tariffs and Trade
IFF	International freight forwarder
II	Internal integration
INCOTERMS	International commercial terms. A uniform set of international rules, promulgated by the International Chamber of Commerce in Paris, for the interpretation of the terms most commonly used in international contracts for the sale of goods.
IOS	Inter-Organizational information Systems. Also refereed to in the literature as IOIS – Inter-Organizational Information Systems enables automatic, inter-firm sharing of transactional data through the computer and communication infrastructure i.e., EDI and Internet portals.
IS	Information systems
ISO	International Standards Organization
IT	Information technology
ITDS	International Trade Data System – US Department of the Treasury
JIT	Just in time
LCL	Less than container load
MANCOVA	Multivariate analysis of covariance

MANOVA	Multivariate analysis of variance
MCAR	Missing completely at random
non-IOS	All information exchange mechanisms that do not allow automatic sharing of transactional data through the computer and communication infrastructure i.e., telephone, fax, e-mail, print publications, postal and courier services.
NVOCC	Non-vessel owning common carrier
OSRA'98	The Ocean Shipping Reform Act of 1998
OTI	Ocean transportation intermediary
PIERS	Port import-export reporting service
PO	Purchase order
RFQ	Request for quote
SC	Supply chain
SCM	Supply chain management
SI	Shipping instructions
SKU	Stock keeping unit
SP	Shipping performance
SPRC/SP_RC	Re-coded shipping performance variables
TA	Task analyzability
TEU	Twenty foot equivalent unit. Unit of measure used to denote size of a marine container.
TI	Task integration
TV	Task variety
US DOT	United States Department of Transportation

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Chapter 1

Introduction

1.1 Research Background

Ocean shipping is one of the oldest forms of international transportation. As a consequence of this legacy the numerous archaic laws and practices governing international ocean commerce over the past several centuries often bog down international ocean transportation. Today, the majority of goods by weight and a sizeable portion by value are transported to and from the US by ocean. Of this total ocean cargo, a large portion by value is carried in liner ships that are typically cellular container ships, that transport cargo in containers.[1] Container operations are very complicated. At one extreme several containers may contain cargoes of the same shipper or at the other extreme a container may contain cargoes owned by several different shippers. Further complicating container transportation is the numerous documents and parties involved in the international movement of a single container from origin to destination. Consequently, there are great demands on ensuring accurate paperwork and coordination of information between the several parties involved.

The phone, fax, mail and later e-mail have been the predominant means of coordinating information and exchanging documents to support liner shipping transactions. Electronic data interchange (EDI) too has been in existence for sometime now, however there is very little work in the academic literature on the extent of EDI use for transacting liner shipping services. Nevertheless, other studies of EDI as an inter-organizational information system (IOS) enumerate several benefits from the use of EDI. By 1999 a new service using public Internet portals was introduced. This service offers shippers a similar ability to exchange and retrieve transactional information. The service allowed shippers and their designated partners to retrieve this information at any time, from anywhere. Most importantly, the service is relatively inexpensive, compared to EDI. Internet portals also have the provision for enabling the use of EDI over the Internet for existing EDI users. Both EDI and Internet portals offered the distinct benefit of automatically retrieving information from ocean carriers' information systems (ISs) and interfacing relevant information into their customers' information systems.

While ocean carriers (who largely finance the Internet portals) and the Federal Maritime Commission (FMC) have been the most visible advocates of Internet portals, there has

[1] Liner trades have ships operating on fixed schedules on fixed routes around the world. Specially designed cellular container ships that are designed to transport only the International Standards Organization (ISO) standard size containers in fixed cells on the ship are the primary type of ship operating on liner trades today. Therefore, the large majority of freight transported by ocean liners is containerized. These ships are sometimes referred to in the trade press as "Lo-Lo", which refers to way in which containers are "loaded-on and loaded-off" the ship. This study focuses on liner carriers operating container ships in trades to and from the U.S.; the term "liner carrier" therefore, will be used synonymously with liner container carriers. Also the term "liner shipping industry" will refer to the sector of the ocean shipping liner industry that operates cellular container ships. Other type of ships operating on liner trades are "Roll-on Roll-off" or "Ro-Ro" ships, which refers to the way cargo is "rolled-on and rolled-off" the ship. These ships therefore, are used to carry freight on trailers, ISO containers and automobiles. But these vessels will not be considered in the study.

been, at best, a mixed reaction among shippers. Some large shippers apparently require carriers to exclusively use Internet portals for transacting ocean liner shipments, while others, especially smaller shippers, see Internet portals as a nuisance and complete waste of time. This has prompted some carriers to suggest that the Internet portal service is suitable to only certain shipper segments. Hence, the first objective of this study is to identify shippers' use of the available information channels for conducting liner shipping transactions for shipping containerized freight and understanding what motivates shippers' use of the different channels for transacting containerized ocean shipments. The second objective is to offer normative advice on what channel would be most suitable to shippers.

1.2 Research Framework

The study was conducted using the research framework for logistics research provided by Mentzer and Kahn (1995). The framework makes it very convenient to section the study into three parts. These are:

i) 'Idea generation' to 'substantive justification'
ii) 'Theory construction' to 'methodology'
iii) 'Methodology' to 'conclusions and future research'

1.2.1 Idea Generation to substantive justification

Substantive justification describes the value of the research in the substantive area. The process from idea generation to substantive justification includes two simultaneous sub-processes. These are: i) Observation, and ii) Literature Review (Mentzer and Kahn, 1995).

As observation is unique to each individual and circumstance, Mentzer and Kahn, (1995) suggest that a variety of approaches for the observational process are acceptable. The motivation for this study was generated by the many paradoxical reports of the value of Internet portals in the trade press. While there were, many benefits cited in the trade press when the portals were first being marketed soon there were numerous articles citing their shortcomings for their advertised functions. It appeared that the use of portals simultaneously provides a few benefits enjoyed by virtually all users of ocean liner services while only a small group of users enjoyed most of the other benefits. Portals market most of their basic transactional services free to customers, while only a few of the non-traditional value-added services have a fee attached. Nevertheless, it appears that portal service providers continue having a difficult task attracting new customers. Additionally other communication channels such as carriers' own private portals and EDI, offering the same services, compete with the public portals.

These initial observations motivated a deeper study of the benefits of IOS services for transacting ocean shipping services for containerized freight. The deeper study consisted of a set of twelve in-depth interviews with industry experts on the issues relating to the use of a variety of information systems (ISs) and communication channels for transacting an international ocean container shipment. These interviews serve to provide a detailed description of the liner shipping process and hence a better understanding of the problem domain. This is in accordance with Mentzer and Kahn's (1995) recommendation that the

observational process must first begin to describe the phenomenon under investigation and second establish general principles for the phenomenon. Golicic and Davis (2003) also strongly recommend gaining a deep understanding of the phenomena under observation.

As will be made apparent in the literature review (Chapter 4) the current study of ISs for facilitating the ocean transaction process involves three distinct research streams. Hence, as suggested by Mentzer and Kahn (1995), first the 'integrative' literature review is used to pull together research from the supply chain management (SCM), IOS and the integrated SCM and IOS research streams, which will support the ideas generated intuitively from the observational process. The process begins by looking at the historical development of the individual research fields and then the rationale behind integrating the research fields for addressing the research questions. The integrative literature review then examines relevant issues of IOS use for SCM, which pertain to the area of ocean shipping. These issues will seek to corroborate the observational data from the trade press and the interviews, while also identifying a theoretical framework to help explain the phenomena being investigated.

1.2.2 Theory Construction to Methodology

In order to address the research objective the literature review was used to identify and develop the theoretical framework, and operationalize a model to answer the research questions.

The inter-firm, information systems context necessitated a review of the IOS literature. The inter-firm transaction for the international transportation of goods warranted a review of the SCM literature. Besides, there is strong research tradition of IOS in SCM in the logistics literature. Hence, this stream of research too was reviewed. The literature review offers a historical development of the IOS and SCM, which provides an appreciation for the use of IOS in facilitating the international liner shipping transaction. The dominant theme emerging from both the SCM and IOS literature was that of adopting the right strategy to fit business need in order to improve firm performance. In SCM, fit is achieved between supply chain strategy and supply chain objectives defined by customer need. IOS fit is achieved between information processing capacity and information processing needs. This is the basis for the fundamentals of contingency theory where the fit between specific levels of two variables result in improving a performance variable.

Galbraith's (1973) information processing view of the firm utilizing structural contingency theory in an information-processing context presented a good fit for the theoretical framework. Bensaou and Venkatraman's (1995) extension of Galbraith's (1973) information processing model adds an economic basis to choosing appropriate coordinating mechanisms and extends Galbraith's (1973) intra-firm model to an inter-firm dyad. The theoretical framework offers a convenient means by which to answer the research questions. Thus for the current study, fit between the appropriate levels of an information coordinating mechanism; i.e., EDI (IOS), Internet portal (IOS) or phone, fax and e-mail (non-IOS); and the appropriate levels of internal or external contingencies

such as environmental uncertainty and task uncertainty is hypothesized to improve shipping and supply chain performance.

The different groupings of shippers are identified using the internal and external contingencies. Each group's choice of information coordinating mechanisms may be evaluated by the fit between their choice of information coordinating mechanism and their contingencies. The type of fit (whether in fit or not) is then evaluated by the groups' performance relative to the other groups. This provides an insight into the correct fit between IOS use and the internal and external contingencies, which offer normative advice for groups not in fit.

The analytical methodology stems from the taxonomy for modeling fit recommended by Venkatraman (1989). Accordingly fit is modeled as, "*fit as gestalts*" and the groupings or *gestalts* are uncovered using cluster analysis while a MANOVA is used for testing the relative performance of the *gestalts*.

1.2.3 Conclusions

The final part of the paper will discuss the results of the analysis seeking to answer the research questions using the theoretical framework provided by the information processing model.

First, a snapshot of the *status quo* of IOS use for the ocean shipment process is provided, which consists of the groups of firms that are using IOS effectively and those that are not. The data analysis revealed the existence of four differently configured *gestalts* of shippers. These *gestalts* were hybrids with a mix of high and low levels of different dimensions of information processing needs – task and environmental uncertainty. Such configurations were not unique to this research and have been observed in the auto industry by Bensaou and Venkatraman (1995). The Mature *gestalts* are composed of large shippers who, faced with low environmental dynamism and low task uncertainty show better information processing configuration and hence perform the best. Of the Mature *gestalts* the one with shippers sourcing from a higher number of overseas suppliers was found to configure higher IOS use. The Young *gestalts* made up of smaller shippers face higher levels of task uncertainty and environmental dynamism. However, the small shippers adopting IOS performed marginally better than those that did not. This indicated that small shippers that faced similar high levels of task and environmental uncertainty saw marginal benefits from adopting IOS for SCM and managing the international ocean shipping process. These results provide further validation of the information processing model proposition that properly configuring information processing requirements to information processing needs results in higher performance.

Next, normative advice is offered to shippers displaying poor performance on how to use the available IOS and non-IOS to improve their shipping and supply chain performance. Examination of the results revealed that the results supported the fit theory. Hence, shippers facing greater uncertainty could adopt configurations to improve their information processing needs to improve shipping and supply chain performance. It is pointed out that the characteristics of the international ocean shipping process along with

the low diffusion of Internet portal use among the shipper population could have hampered the performance of the Young *gestalt* that adopted IOS. Further limitations of the study are discussed and consequently, future research streams have been proposed to clarify the conclusions drawn here and further understand the phenomena revealed in this research.

1.3 Research Contribution

This research contributes to the current understanding of how IOS and non-IOS are currently used, and, can best be used for conducting the international ocean shipping. This research also contributes to the domain of supply chain management by demonstrating the value of a contingency theoretic approach to explaining supply chain and logistics phenomena. This work validates contingency theory and the information processing model by its application in the area of international ocean shipping and supply chain management. The results provide further proof of the model's usefulness for descriptive and normative research in other areas of supply chain management with different levels of information processing needs and information processing capabilities. The methodology used highlights the usefulness of the taxonomy for fit research developed by Venkatraman (1989). Finally the measures used to operationalize the model are rigorously tested for validity and reliability enabling their further application in future studies in the current or other domains.

Chapter 2

Background: Problem Definition

> *"One would be hard pressed to find an industry better suited and in greater need of global Internet communications and web-enabled services than the shipping industry. Ships are strung out across the world, carrying tens of millions of dollars of freight and subject to greater dangers from weather and piracy than any other mode. Just as important, shipping lines also have to deal with the complexities of international trade and Byzantine regulations and reporting requirements that produce mountains of paperwork subject to human error."*
>
> *Parker (2001)*

The percentage of U.S. companies sourcing worldwide increased from 45% to 56% from 1975 to 1982 (Monczka et al, 2002). Purchases from foreign sources have increased from 9% of total purchases in the late 1980s to 27% in 1997, to more than 30% in 2000 (Monczka et al, 2002). In the early to mid-1990's as Europe opened access to its transport sector with fewer barriers to cross-Continent movement and as North America presented prospects for a more unified trading bloc leading companies recognized opportunities for efficiency through global sourcing and manufacturing and for increased market share and revenues via entry into overseas markets (Rao & Young, 1994).

2.1 Globalization

Coyle et al (2000, p. 4) and Bovet & Sheffi (2001) list globalization as a factor affecting the adoption of global SCs, global sourcing trends and international distribution. There have been drivers that have prompted the move towards globalization of business processes; some of these more relevant drivers are discussed below.

2.1.1 Free Trade

Decreasing trade tariffs and lowering of trade barriers introduced by the ratification of the General Agreement on Tariffs and Trade (GATT) have contributed to the trend towards globalization of businesses (Baldiwala, 2001; Monczka et al, 2002, and Bovet & Sheffi, 2001). The opening up of the command economies of the former Communist Eastern Bloc and China has also driven the globalization trend (Monczka et al, 2002). These factors made available lower cost factors of production to U.S. companies who could now outsource manufacturing to offshore locations reducing production costs due to lower labor, raw material and overhead costs (Baldiwala, 2001).

2.1.2 Transportation Technology

Increasing transportation efficiencies is another driver of globalization put forth by Baldiwala (2001), Bovet & Sheffi (2001), and Coyle et al (2000). Innovations such as the development of an International Standards Organization (ISO) standard container size have revolutionized intermodalism and led to the proliferation of containerized freight transport into the mainstream of international ocean shipping. The development of the

ISO container allowed the development of specialized materials handling and transportation equipment such as dedicated lifting gear, ocean ships, trailers and rail cars, all of which contributed to the quick, reliable, and safe transportation of ocean freight. This has reduced the total transportation cost and increased *time utility* and *place utility*, which further fuels the demand for ocean transportation derived from the resulting geographic specialization and large scale production. Thus higher quality components and supplies are sourced from areas of higher specialization and comparative advantage at lower costs and at greater distances from the points of manufacture or final assembly in the U.S., while also allowing U.S. manufacturers realize comparative advantage and distribute their products further in a global market.

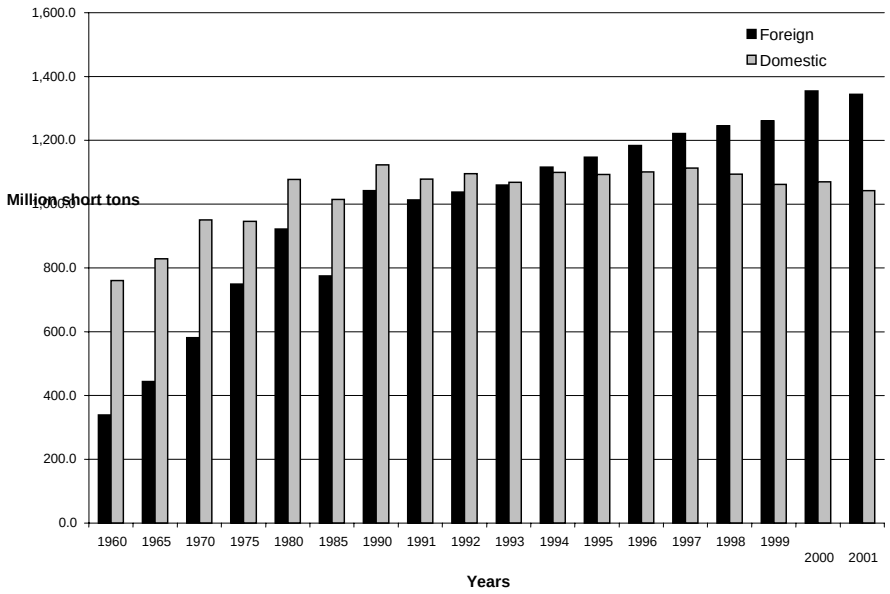
2.1.3 Universal Product Appeal

Baldiwala (2001) also suggests globalization of products as a driver towards globalization. For example, certain products like Coke, Nike shoes and Levi's jeans have universal appeal creating global markets demand for these products.

2.2 Significance of Liner Shipping

Consequently U.S. firms were developing global SCs, which because of the derived nature of transportation demand drove the demand for international freight transport. In 2001 alone 1.3 billion short tons of freight valued at US$ 718 billion were imported and exported through U.S. ports (Bureau of Transportation Statistics – BTS, 2003a). This represented only 38% by value but 77% by weight of the total U.S. international goods trade for 2001 (BTS, 2003a).

Figure 2-1: U.S. Waterborne Freight 1960-2001



Source: U.S. Army Corps of Engineers (2003, part 5, tables 1-1, 1-3, and 1-6)

The chart compiled from the statistics published by the US Army Corps of Engineers in Figure 2-1 illustrates this point indicating a doubling in weight of international freight transported on liner ships between 1975 and 1999 (US Army Corps of Engineers, 2003). Although only 11% by weight (144 million metric tons) of all this international trade by ocean was transported in roughly 18 million TEUs[2], (the large majority of which are transported on liner container ships (BTS, 2003b), liner ships transported a much larger percentage of the total value of international ocean trade. In 1999 for example liners transported approximately US$445 billion or 71% of the total value of international US ocean trade (BTS, 2000).

The West Coast port Strike in 2002 served to illustrate the dependence of U.S. industry and the U.S. market as a whole on liner shipping. During the strike, Steven Cohen, a professor of regional planning at the University of California at Berkeley had estimated that a twenty-day strike would cost the U.S. economy about $48.6 billion (Avery, 2002). Some of the other more visible consequences of the port strike were the shutting down of five automotive manufacturing plants whose just-in-time (JIT) SCs ground to a halt (Anonymous, 2002a). The threat of dire consequences from a prolonged port closure eventually forced President Bush to evoke the Taft-Hartley Act for the first time in 24 years (Anonymous, 2002a).

The above is only a single example of the extremely complex and risk fraught nature of international shipping and global SCs. The most recent factor to have received prominence is the threat of SC disruption from acts of terrorism. This threat has increased the administrative, security, insurance and compliance cost of international shipping due to the additional concerns, steps and procedures in the shipment process, such as the U.S. customs 24-hour manifest filing rule for ocean freight (Russell & Saldanha, 2003).

2.3 Complexity of International Shipping

Even without the above disruptive threats, routine international shipping has always been a complex process. According to an e-commerce study published by Forrester Research in August 1999, 85% of firms cannot fill international orders due to the complexities of international shipping (Schwartz, 2000).

Driving this complexity is the numerous intermediaries that are involved in a global move, which at the very least involves a line-haul ocean carrier and inland carriers on both sides of the line haul. In addition it is not uncommon to also involve intermediaries for both the inland and line-haul legs, such as Ports, Customs Brokers, freight auditing and payment service providers and 3rd party information service providers or 'infomediaries'. Hickey (2000) estimates that the average international container transaction involves about 21 parties. According to King (1991) there can be thirty different companies and agencies involved in one international trade transaction. More recently 'integrators' such as Fed-Ex and UPS have begun offering a one stop shop for inter-continental ocean freight.

[2] TEUs are twenty-foot equivalent units. 1 IOS 20-foot container equals 1 TEU while 1 IOS 40-foot container equals 2 TEUs.

Preparing the accompanying documentation is also a daunting task. However, first navigating through ocean shipping contracts and the task of calculating freight rates to prepare PO estimates alone can be a grueling and often futile process. Updating these contracts is also a complex and laborious task, which inevitably results in a 22-35% error rate in the freight calculated on a bill-of-lading (B/L) (Peruninger, 2003). International trade transactions usually involve handling 40 different documents and up to 360 copies (King, 1991).

Moreover, the large majority of these administrative tasks between shipper and carriers (and all the intermediating parties) are conducted via phone, and fax. More recently, e-mail is being used in lieu of the fax and although it has sped up the process, it still entails manual intermediation and the concomitant errors. There has, been some recent effort to encourage innovation for the streamlining, simplification, and automation of the international shipment process.

2.4 Innovation in Liner Shipping

2.4.1 Ocean Shipping Reform Act 1998

The Ocean Shipping Reform Act 1998 (OSRA '98) was the primary deregulatory effort of the U.S. liner shipping industry aimed at stimulating innovation and reducing shippers' cost of doing business internationally. The regulatory changes of the OSRA '98 were designed to promote a more market-driven, efficient industry enabling shippers to enter into customized service contracts with carriers to suit their individual needs, largely undermining the efficacy of the liner rate-fixing conferences (FMC, 2001).

The OSRA '98 appeared to create the free-market environment that encouraged innovative services. The first FMC report on the impacts of the OSRA '98, documented that liner carriers had established both private and public Internet portals to provide interactive web based services for shippers (FMC, 2001). Although not directly taking the credit for these innovations the FMC argues that the less regulated, market-oriented environment contributed towards the additional importance of these new companies (FMC, 2001). Also, by requiring liner tariffs to be made available on-line the FMC endorsed the Internet as a bona-fide medium for communicating and publishing sensitive data, which may have helped a notoriously conservative shipping community that, "…is typically regarded as 'old economy', asset heavy and not too fast on its feet (Parker, 2001)", to accept this new technology. Clott (2000); Lewis and Vellenga (2000); and, Shashikumar and Schatz (2000) offer more in-depth studies on the changes implemented in the OSRA '98 and their impact on the industry.

2.4.2 Inter-Organizational Services

Electronic Data Interchange (EDI) is the first true IOS that was used for managing the ocean shipping transaction process. Liner carriers have been using EDI services for over a decade. EDI reduces the administrative burden of booking and monitoring containerized ocean shipments by eliminating the need for repeated manual data entry and shipment monitoring. However, the high setup costs of EDI typically excluded small

to medium sized shippers from such services (Anonymous, 2001a). These services have been virtually replicated by the ocean carrier portals, which have now made them available to all types of shippers.

Along with the carrier owned private portals and carrier-backed public portals there are several other service providers offering electronic/digital information services via EDI or the Internet that support the international ocean shipping process. Such information service providers or infomediaries offer niche information technology (IT) services supporting various stages of the international ocean shipment process. Services offered include on-line tariff publication, carrier service rating systems, automatic booking, tracking and tracing of shipments, online publishing of carriers' schedules, freight audit, freight payment and invoicing, and electronic documentation management. For a comprehensive listing of these services, refer to the joint Cargo Systems and Containershipping.com report on the state of e-commerce in container shipping (Jeffery, 1999). This report conducts an exhaustive survey of the e-commerce applications being offered to support the international ocean shipment process.

2.4.3 Carrier Backed Internet Portals

Off all the Internet services, however, the carrier backed public Internet portals have attracted the most interest and attention. The FMC's 41st Annual Report 2002 reports that the carrier backers of all three Internet portals together control between 84-87% of the worldwide container capacity (FMC, 2003). These portals received a lot of publicity when they came into their own during the West Coast port strikes "providing the only good news for carriers", which was: 1) Double digit percentage increases in portal transaction volumes; and, 2) Increase in shippers' use of on-line automatic tracking (Warner, 2002). These Internet portals also got a boost when U.S. Customs' 24-hour manifest rule made the Internet's ubiquity, low cost, ease of use, and high speed even more attractive for meeting the new security rules (Saccomano, 2003a).

Table 2-1: Members of Carrier Portals

INTTRA	**GT Nexus**	**CargoSmart**
Alianca	APL (NOL Group)	Orient Overseas Container Line
ANL	CP Ships	Cosco Container Lines
CMA CGM	Crowley Liner Services	NYK Line
Columbus Line	CSAV	Malaysia International Shipping Corp.
Crowley American Transport	Hanjin Shipping	
DAL Deutsche Afrika Line	Hyundai Merchant Marine	
Hamburg Sud	"K" Line	
Hapag-Lloyd	MOL	
Maersk Sealand	NYK Line	
MSC	Senator Lines	
NYK Lines	Wan Hai	
P&O Nedlloyd	Yang Ming	
Safmarine	Zim Israel Navigation Co.	
United Arab Shipping Co.		
West Afrika Linien Dienste		

Source: Compiled from portals' web sites. September 2003.

Today the three carrier backed portals in service are – INTTRA, GT-Nexus (previously Tradiant) and CargoSmart – their carrier backers are listed in Table 2-1 .

2.4.3.1 Advantages

From the outset, the trade press has reported the benefits of the portal services. Coia, (2001) and Thorby (2002), talk about the benefits of automating the planning and execution of shippers' ocean transportation process with liner carrier contract management, automatic booking and electronic documentation services. Hickey (2000), reiterates that due to the number of parties and document flows involved the benefits from automation are huge. Inter-organizational workflow management is another related benefit, which allows shippers seamless sharing of shipping specific, transactional information with their SC partners. Similarly, shippers are also able to share electronic documents and manage the workflow of electronic documents between SC partners.

Portals also offer the benefit of a single point of contact with several carriers reducing paperwork and administrative burdens. This, Thorby (2002) claims, is the most striking initial benefit provided because of the standardization of processes and information, and simultaneous access to more than one carrier's IT system. The FMC too noted this attraction of portals stating that shippers found it complicated to deal with all the on-line offerings including each carrier's proprietary applications, while portals offered a single standard interface with several carriers (FMC, 2001). In fact, some large shippers have mandated that any carrier seeking their business have to be a member of a portal.

In-transit visibility of shippers' SC throughout the ocean shipping process is another frequently reported benefit (Coia, 2001; Thorby, 2002; Hickey, 2000; and, Anon, 2002). Some of the features offering such visibility are automatic alerts in case of delays and other exceptions, periodic reports on shipment status and on-demand visibility of shipments in transit. This could conceivably help shippers lower SC inventory levels because of the enhanced visibility of in-transit visibility of inventory and purchase orders. Shippers are also able to improve product availability through suitable advanced planning thus improving their own customer service.

Finally, Lloyds List, the premier ocean shipping news daily and information service has featured numerous articles, which supported the notion of internet portals as essential and valuable tools for SC management, driving greater in-transit inventory visibility and transportation efficiency (for example see: Anonymous, 2001a; Anonymous, 2001b; and, Anonymous, 2002c). Thorby (2002) concludes that all three portals have proven their success citing CargoSmart's 1,700 customers and management of over 200,000 of their shipments daily; GT Nexus' 1,800 active users and its transaction growth of over 50% a month; and; INTTRA's 1,400 customers and its transaction growth of up to 20% a week.

2.4.3.2 Drawbacks

Not all has been smooth sailing for the portals and their customers. Right from the start when portals began offering their services there were shippers who were not enthusiastic about the track and trace, which they found cumbersome and inadequate (Parker, 2001).

Samwel (2003b) lists several of the issues portals need to overcome. 1) Shippers complain that portals have been designed to simply replace carriers' customer call

centers. 2) Shippers are receiving insufficient, inaccurate, untimely unreliable and the wrong type of information to enable them to support SC decisions. 3) Portals do not verify the integrity and veracity of the carrier data being fed to shippers. 4) The lack of standards among the portals are forcing shippers to access multiple (three) web-sites and use the software features of each site to manually consolidate the data into internal reports.

Besides smaller shippers may have basic ISs that lack the functionality to seamlessly interface with the portals' web interfaces, and therefore have to rekey the data anyway. Not all portals provide integration directly to a carrier's back office system, a portal merely acts as a channel of communication, in much the same way as phone, fax or e-mail, some rekeying is required to transfer transactional information from the web interface to carriers' back-office systems. So the degree of automation realized by EDI is not achieved. Additionally ocean transportation Intermediaries (OTIs) who maintain their own portal interface for exchanging transaction data with their customers, find portals redundant because they need to re-key the data from their own systems into the portals' interface. OTIs normally have direct EDI links with carriers or may now even use data from carrier portals to update transactional data on their own portals for their customers.

In general, transactional volumes handled by portals have been below carriers' expectations (Saccomano, 2003b). Samwel (2003c) reports that, "less than one percent of all shipments are being handled via ocean portals. Additionally, portals and carriers have been in some conflict over the development of services in the future. Carriers continue to maintain their own portals that duplicate at least some of what is being offered through the portals that many of them helped found (Samwel, 2003a). Saccomano (2003b) reports that carriers may not be willing to back portals development of more sophisticated SC software to offer on the portal platform. Instead, they are developing their own web-based e-commerce capabilities. This dual strategy where carriers are participating in a public portal as well as developing their own proprietary e-commerce applications have left shippers confused with the choices and with the impression that "carriers don't know what they want" (Saccomano, 2003b). Carriers apparently see distinct market segments among shippers and hence find the need for both the portal and their own e-commerce capabilities for all customers, choosing which services to offer on the portals and which to keep in-house (Saccomano, 2003b). In summary, the development of carrier-sponsored public portals has been dogged persistently by technology problems, complicated integration, and industry cynicism (Warner, 2002).

2.4.4 Research Questions

Consequently, there are still several unresolved questions to be answered. The Internet, on-line portals, and e-commerce are still in the growth stages of their product life cycles. Nevertheless, there appear to be a broader acceptance for the notion of a portal especially in the way larger companies are looking at transacting business with their multiple business partners. However, carrier portals, although initially expected to appeal to a wide customer base from large multi-national shippers to small businesses (FMC, 2001),

have yet to realize their much anticipated appeal. In fact, both small shippers and indeed portals themselves believe that their services may not be geared towards the small to medium sized shipper. Also, there are some large shippers who apparently prefer to use their freight forwarders' IT systems, which provide the same or similar services. Shippers unable to obtain the right information or unsure about the veracity or integrity of information received via the portals (especially since portals do not offer any guarantees about the integrity or veracity of data) eventually end up contacting carriers' customer service representatives for their information (Samwel, 2003b). Hence, in addition to the numerous communication channels, conventional (phone, fax and e-mail possibly) and inter-organizational systems (IOS) (EDI and Internet portals), there also appear to be multiple marketing channels (carrier-direct, public portal and OTI) for the provision of these services.

This leaves many unanswered questions about whether portals services will ever appeal to and attract the large customer base necessary to generate the transaction volume that is necessary for their success. Before that though the promise of cost efficiencies and greater effectiveness that portals could bring to the international ocean shipping transaction process needs to be resolved. This is from the point of view of both; i) individual shippers whose global SCs using the ocean mode with the long lead times are plagued with plenty of uncertainty; and ii) the economy in general from the sheer volume of commerce that is conducted by ocean containerized freight.

Therefore, a clear need exists to study the market for these services. This research will attempt to offer some insights to the above issues, which can be summarized as:

i) The international ocean shipping process is complicated.
ii) Complex shipping tasks are made more so by the shipping environment.
iii) There is no clear information of the relative benefits of using the different communication channels i.e., conventional non-IOS (phone, fax, and e-mail), and IOS (EDI, and Internet portals).
iv) Hence, most shippers use the communication channel they are most comfortable with possibly forgoing an opportunity to switch to one that is more cost efficient and effective.

Therefore, the first research question that will be addressed is:

> *How do shippers employ the different IOS & non-IOS to serve their shipping process requirements?*

Answers to this research question will offer insights into the *status quo* that exists describing shippers' current use of the IOS and non-IOS currently available. However, information gathered from the trade press and in-depth interviews suggest that proper utilization of available IOS and non-IOS must be investigated. Hence, the second research question is normative in nature drawing from available theory to offer some guidelines on how to best use the available IOS and non-IOS:

> *How can shippers employ the different IOS & non-IOS that best serve their shipping process requirements to improve shipping and supply chain performance?*

Chapter 3

Liner Shipping Process

> *"There is a huge demand for better, network based IS that speed up international transactions, enabling shippers to predict total logistics costs, re-route shipments while in transit and make the right management decisions based on up to date data."*
>
> *American Shipper editorial (Lewis, 2001)*

As recommended by Mentzer and Kahn (1995) and Golicic and Davis (2003), qualitative field research was undertaken in order to gain an in-depth understanding of the liner shipping industry. Particularly a better understanding of the above issues and problems facing service providers and their customers. The unit of analysis was a shipper firm i.e., a customer of a liner carrier. The field research consisted of twelve semi-structured interviews with industry experts comprised of carriers, shippers, consultants and Internet service providers. Each participant was sent a list of questions to be covered during the interview and depending on whether the participant allowed the interview to be taped, the interview was transcribed from notes taken during the interview or from the taped recording. Questions inquired about:

i) Shippers' interaction and transactions with carriers and intermediaries;
ii) The transactions involved in the international transportation of containerized freight by ocean;
iii) The characteristics of information services, electronic or otherwise (phone, fax, etc.), offered to support the shipment process; and,
iv) The use of information services, electronic or otherwise (phone, fax, etc.), to manage the ocean transportation process.

The interviews generally sought to develop a process map of the shipment process, into and out of the U.S. Initially it was anticipated that twenty interviews would be necessary to obtain the necessary material, however after twelve interviews, it appeared that there was sufficient convergence to a generic description of the shipping process. The final composition of the group of experts was five shippers (4 large and 1 small), four OTIs, two information service providers, and one consultant.

3.1 Contracting Liner Carrier Services

Before deregulation service contracts were negotiated on an annual basis with all contracts expiring on April 30th with the new contract taking effect on May 1st. However, after the OSRA '98 shippers, especially large shippers may require carriers to maintain contracts valid for at least two years. Although, rates may still be negotiated annually large shippers require that rates are maintained steady for at least a year. Shippers enter into negotiations and finalize new contracts with carriers in advance of the current contract expiring. Before the actual negotiation with the carrier can be conducted the shipper gathers the ocean shipping service requirements from its national and international business units/affiliates. Teams from these various international business

units may also meet periodically to discuss negotiation strategies, tactics and objectives for a worldwide ocean service contract request-for-quote (RFQ).

The shipper then consolidates all the above service terms into a master world wide service contract for a world wide ocean bid with all the transportation requirements – trade lanes, commodities and volumes; in an OTI's case, the forecasted demand it anticipates meeting for its target markets, for all its business units world-wide. The RFQ can then be sent as an e-mail (or communicated in some electronic or hard-copy format) consisting of several attachments (appendices), specifying service requirements and a base rate for each lane. This RFQ could be sent to Non-Vessel Operating common carriers (NVOCCs – see description in section below) in addition to liner carriers, who then reply with a comprehensive quote that includes their rate and service description for each lane. Some shippers use an electronic auction, which is a third party web-interface to automate and speed up the process, and reduce the administrative cost of sending out the RFQ and receiving the quote.

After the quotes are received from individual carriers then one-on-one negotiations are conducted between the shipper and carriers. The company then selects a certain number of *core* carriers primarily based on rate, and then service dimensions, such as – 1) transit time; 2) schedule integrity; 3) reliability; 4) equipment availability; 5) information sharing; and 6) IT capability. This last dimension is becoming more important as shippers are requiring carriers to have electronic, automatic slot-booking capability, EDI and even Internet portal membership as explicit requirements in service contract terms. Shippers typically monitor the performance of their core carriers very closely using metrics based upon the service terms in the contracts. Shippers typically survey internal users of ocean shipping services to obtain a perception of the services. Based upon performance measures and users' perceptions, carrier performances are reviewed periodically and changes made in core carriers. This practice was also reported by Brooks (1998, 2000) who surveyed North American shippers' practices of carrier evaluation and found that such subjective evaluation systems were being implemented for carrier performance measurement.

If shippers (the party holding the contract) are not the primary booking party e.g.; a U.S. importer holding the ocean contract buying from an overseas vendor, they must provide their overseas partners with the new set of shipping instructions.[3] These shipping instructions contain the new contract number negotiated with the carrier's name, and with instructions to use the new contract for all shipments (usually after May 1, when all

[3] These shipping instructions are distinct from and not to be confused with the shipping instructions issued by a shipper to a carrier. Shipping instructions issued by a buyer to the seller are used when the buyer controls the major part of the international shipping process, where INCOTERMS (see Appendix A) are EXW, FAS or FOB, such as the case when the buyer is in the US and when the seller is in Asia. Shipping instructions will be made for each foreign country, commodity and sometimes for separate suppliers and typically: i) Point the seller to use a particular carrier (or possibly set of carriers) for which the corresponding contract numbers will be provided; ii) Instruct how to order containers and equipment; iii) Contain the INCOTERMS to use; iv) Point to an export agent or IFF to be used for document preparation and booking assistance; v) Contain instructions on how to prepare package the freight in the container; and, vi) Inland carrier to use (unless FAS or FOB).

contracts expire). A party will be denied a booking if they try to book using an expired contract. If the shipper is the primary booking party then it must make the necessary renewed contract information available to the relevant personnel, affiliates or business units worldwide.

3.1.1 Contract Service Terms

A contract for a trade lane does not guarantee a deterministic, periodic, shipping schedule as carriers typically have more than one schedule serving a set of port pairs. For example, a carrier may have scheduled two ships to call at Hong Kong every period, say three weeks. Although both of these ships will be calling at Long Beach, CA, one may do so via Busan, South Korea and Seattle, WA for a one way trip of about 16 days, while the other may do so via Tokyo, Japan or alternatively, direct service to Long Beach, CA for a one way trip of about 11 days. This causes significant variance in transit time. However, shipper's do not contract for specific schedules in a contract as they prefer the flexibility to use the next *earliest* schedule, in case a shipment misses a schedule, which may be in a week, instead of waiting the full three or four weeks for the next schedule departure. Ocean carriers' service contracts can include any combination of pick-up and delivery options with either the carrier or the shipper (consignor or consignee as determined by the INCOTERMS (see Appendix A) providing the inland transportation in the export and/or import country. Therefore, contracts could be any combination of export country: door, inland port or seaport to import country: seaport, inland port or door.

Contracts contain shippers' detailed service requirements:

- Whether the shipper or the carrier will provide the necessary equipment – container, trailer or rail car;
- Whether shipper or carrier will be responsible for the inland move in the export and import countries;
- An acceptable schedule reliability;
- Demurrage rates[4]; and,
- Space guarantee, for the shipper when demand for transportation is in excess of supply.

An important part of these contracts is the minimum guaranteed shipped quantity carriers fine shippers if this minimum quantity requirement is not met.

3.2 Liner Service Marketing Channels

The market for liner shipping services exists for both inbound (imports) and outbound (exports) shipments to and from the U.S. respectively. Today it is increasingly the case that large US importers, usually beneficial cargo owners (BCOs), especially those who deal with suppliers in Asia, seek to control the ocean carriers used and therefore, negotiate and hold the ocean contracts. Analogously U.S. exporters are happy to relinquish control of the ocean transportation to the foreign buyer.

[4] Demurrage: Is a financial penalty for releasing transport equipment, in this case the ocean container, later than agreed upon between shipper and carrier – normally in the contract.

3.2.1 Service Providers

The primary transportation service providers are liner carriers who own and operate container ships in trades to and from the U.S.; container ship capacities range from 1,000-8,000+ TEUs. In addition, numerous other intermediaries and, information and logistics service providers support the international ocean shipping process. Non-Vessel Operating Common Carriers (NVOCC), International Freight Forwarders (IFF), and Shippers' Associations offer value-adding services as intermediaries between the BCO and liner carriers and are hence termed Ocean Transportation Intermediaries (OTI). Other service providers include domestic inland carriers, customs house brokers (CHB) and freight consolidators for less-than container loads (LCL) cargoes.

A BCO can contract for the carriage of containerized freight by liner carrier (ocean freight services) through two primary channels, direct to a carrier or indirect, through an OTI.

3.2.1.1 Direct Channel

A BCO or an OTI can negotiate directly with the carrier. Carriers prefer to go direct to customers who have volumes of 2,500-5,000+ TEU. Large shippers, i.e.: i) BCOs, either manufacturers such as, GM, Kimberly Clark, and Dell, or merchandisers such as Target and Wal-Mart; and ii) OTIs such as, NVOCCs, IFFs and Shippers' Associations, who consolidate volumes across their many customers; typically have the necessary volumes to go direct to the carrier.

Generally, large shippers negotiate secret service contracts with carriers. OTIs offer these contracts to their customers seeking assistance with the ocean transportation of an international containerized freight shipment (see indirect channels below). Due to the scope of their operations large shippers, usually enter into contracts with anywhere from around six to over 30 different carriers. This enables them to ensure that all trade lanes (also referred to as port pairs) for which international ocean liner shipping is required (in an OTI's case all trade lanes in which it wishes to serve its customers) are covered under the contracts with the different carriers. This is necessary as, no single carrier provides comprehensive coverage in all trade lanes the world over. However, a large portion of a shipper's total business (typically 75-85%) will be reserved for a core group of carriers (typically 6-8), while the remainder is split up among the remaining carriers.

A direct channel need not mean transacting business directly with a carrier's office. It could also mean transacting business with the carrier through the carrier's agency. About 35% of carriers' volumes are booked through an agency. Carriers employ such agencies as a cost cutting measure in lieu of maintaining sales offices in all their markets.

3.2.1.2 Indirect Channel

The type of customers using the indirect channels can be broadly classified into two groups. The first group consists of small to medium sized BCOs. Such shippers lack the volumes that would give them bargaining power for lower rates and other service guarantees. OTIs are able to offer such shippers much lower rates because of the economies of scale realized by the OTIs' volume discounts from the carrier. They also,

do not usually have the expertise to manage the ocean shipment process in-house, and can benefit from outsourcing the non-core competency shipping transaction function to an OTI. Additionally, since OTIs maintain a variety of contracts with multiple carriers they offer a variety of customizable solutions (carriers, routes, inland carriers, rates, etc.). By going to a carrier, shippers are restricted to the limited service offerings of that carrier. The second group of shippers is large BCOs who maintain two distinct management strategies for their shipment needs. They negotiate directly with carriers for their full container load (FCL) business while outsourcing their less critical LCL traffic to OTIs.

In both of the above cases, the OTI is the one who will negotiate the contract with the ocean carrier and provide its customer with the carrier name and contract number to use when making a booking (see section on booking below).

Sometimes a large shipper might outsource its *entire* international ocean container shipping management function to an IFF. However, the shipper would still negotiate contracts with carriers for all its ocean transportation needs. In such as case it is not unusual for representatives from the IFF to work on the shippers' ocean contract negotiating teams. Shippers prefer the one-stop shop feel to the service.

Types of Ocean Transportation Intermediaries

The three basic types of OTIs that shippers can use are now described below in further detail.

i) IFF: Offer the most sophisticated type of value added service, literally managing the planning and execution of the shipment process from the purchase order up to the receiving of the goods. Services such as purchase order (PO) management, overseas supplier management and logistics services, besides the conventional planning and management of the actual shipping move, are offered by IFFs. Shippers without in-house shipping departments use IFFs. Sometimes large shipper BCOs (as mentioned above) outsource their entire ocean shipment operation to IFFs who are housed in the customer's offices and behave like the customer's virtual international shipping office. Large shippers are the ones that typically want such an arrangement, while smaller shippers like to organize their services and typically outsource the transportation management of distinct product lines. Very often IFFs may have a whole range of offerings from high-end complete management of the entire international container shipping business to the low-end straight NVOCC operation.

ii) NVOCC: Are less sophisticated than IFFs offering a basic sub-set of services necessary to support and/or execute customers' shipment processes. For BCO importers in the US this would include export agency services in the foreign export port, customs broker services in the US and arrangement of inland delivery of containerized freight to an inland port in bond or to the customer's door. For US exporters these services would include inland transportation of the container to the port and arrangement for customs clearance and export licenses.

iii) Shippers' Association: Are non-profit organizations of shippers using their collective bargaining power to negotiate for better rate and service terms on

behalf of its member firms. Shippers' Associations would also offer services similar to that of the NVOCCs above, employing dedicated export agents, customs brokers and inland carriers to serve their members.

3.3 Transacting the International Shipping Process

The transaction set for executing an international shipment of containerized freight by liner carrier described below, is generic to any region of the world. Some of the changes that may occur are the availability of communication or information services provided by carriers. Any other U.S. specific differences are mentioned where appropriate.

3.3.1.1 Documentation

As mentioned earlier, the international shipping process is paper intensive. See Appendix B for a summary description of the function of the transport documents in the import-export process. Below are descriptions of most of the documents required to transact an international shipment.

i) Bill of Lading (B/L): A B/L is a document that is issued by the ocean carrier to the consignor. It acknowledges that the carrier has received the shipment of goods and that they have been placed on board a particular vessel, which is bound for a particular destination. It also states the terms of carriage or the operational details of the ocean transportation contract (International Trade Data System – ITDS, 2004). For the ocean transportation process, the Bill of Lading (B/L) is probably the most important document. In the U.S., the B/L is also treated as the invoice for the freight or the transportation service. There are two types of Bills of Lading: 1) Negotiable or *order*, and 2) Non-negotiable or *straight*.
   a. Negotiable Bills of Lading: If the B/L is specifically labeled as being negotiable, ownership to the goods and the right to re-route the shipment are with the person who has ownership of the B/L properly issued or negotiated to it and hence the B/L serves as a title to the goods in the shipment. Such bills of lading are issued to shipper's order, rather than to a specific, named consignee. Where collection and payment is through banking channels, such as under a letter of credit (LoC) or documentary collection, negotiable bills of lading are required. The exporter must endorse the B/L and deliver it to the bank in order to receive payment (ITDS, 2004).
   b. Non-negotiable Bills of Lading: If the B/L is specified as being non-negotiable, the carrier must deliver it only to the consignee named in the B/L, thus the B/L acts both as a receipt of goods and as an agreement to transport these goods to a specific destination and consignee in return for payment of the transportation charges. (ITDS, 2004) These B/Ls are typically not used when a LoC or other type of financial transaction is involved.
ii) Export license: required by the export country to export cargoes from that country.
iii) Commercial invoice: Invoice for the sale of goods being transported.
iv) Certificate of origin: Certifying where the goods were originally produced.
v) Packing list: A list of all items in a consignment; could be a pallet or container.
vi) Fumigation certificate: If the consignment requires fumigation this certifies the procedure was carried out.
vii) Health certificate: If required to certify the condition of the consignment.

viii) Insurance certificate: To insure the consignment while in transit.

ix) IT document: Or the CF7512 I.T. document required for transporting containerized freight in bond, inland in the US. Used when U.S. Customs is cleared at an inland port, not at the seaport where the consignment first arrived in the U.S.

3.3.2 Communication Channels

Several different communication channels are available for executing the transactions necessary to ship containerized freight via ocean liners. These channels can be broadly categorized as Inter-Organizational Systems (IOS) and non-Inter-Organizational Systems (non-IOS). Cash & Konsynski (1995) define an IOS as consisting of a computer and communication infrastructure that permits the sharing of an application (to support a transaction – buying products or services). It crosses company boundaries and separate legal entities. In summary therefore, an IOS between carriers and their customers should consists of: i) Computer infrastructure at carrier and customer; ii) Communications infrastructure at carrier and customer; iii) Automatic sharing of transactional data permitted by the configuration of the computer and communication infrastructures. Non-IOS are therefore all other communication channels that lack any of the above elements. Non-IOS channels are described first as they have been the traditional channels for shipper carrier communication.

3.3.2.1 Non Inter-Organizational Systems

By the above definition the most commonly used non-IOS communication channels for transaction international shipments are: i) telephone, ii) fax, iii) e-mail, and iv) document delivery by courier or postal service.

The most prevalent channel used when very little or no data is required to be exchanged is voice via the phone. The next most prevalent communication channel is via Facsimile, especially when written authorization or substantial data exchange is required to execute a transaction. Email is sometimes used to overcome problems of re-keying by using ASCII data flat-files as attachments that can be directly merged into spreadsheet and database programs. Email is also faster and cheaper than most other communication channels media. Occasionally, post and more often document courier is used to transport official documents necessary to complete payment for freight or goods and/or transfer of title, such as the B/L.

3.3.2.2 Inter-Organizational Systems

By the above definition the two commonly used IOS are i) EDI, and ii) Internet.

<u>EDI</u>

Most carriers have been working to replace the non-IOS, manually intermediated communication channels with EDI, which essentially facilitates the communication of standardized electronic documents or transaction codes. EDI automates the documentation and data transfer processes reducing the administrative costs of carriers and errors in documentation because of re-keying data from shippers' systems into carriers' systems. EDI is used primarily by large shippers – BCOs and OTIs – due to the advantages from the automation of the large volumes of transactions. Also, these large volumes help realize the economies of scale that justify the high fixed cost of EDI.

Shippers may have a direct EDI link with a carrier or if they employ an OTI. The intermediary may provide their own proprietary EDI link to customers while they in turn will be linked to the carriers.

Internet

As mentioned earlier, the newest communication channel available is the Internet portal. The Internet, for the first time, offers the possibility for a shipper's system to interface directly with carriers' back office systems. Internet portals are inexpensive to setup when compared to EDI and can therefore be afforded by all types of shippers. They have the same automated functionality as EDI with the potential for even less human intervention.

As with the EDI, shippers may either exchange transactional information via a carrier's own web portal, a carrier-backed public portal (INTTRA, GTN and CargoSmart) or if they employ an OTI, via that intermediary's portal.

A process flow chart for each of the above communication channels grouped as non-IOS (Appendix C), EDI (Appendix D), and Internet (Appendix E); is provided. These flow charts map the transactions process through the respective channels and provide a handy reference along with the description of the shipping transactions described below.

3.3.3 Shipping transactions

Ocean shipping is typically part of an Intermodal move of a global SC between two stages of a SC, typically a supplier and manufacturer or merchandiser. The move could also be between two affiliates of the same multi-national firm. The need for an ocean transaction itself is usually triggered by a purchase order (PO), which is received from a buyer (the consignee). The seller (consignor) will then consult the shipping instructions[5] provided by the buyer and initiate the process, in accordance with these instructions, to get the goods on a ship bound for the designated port. From this point on, depending on the INCOTERMS (Appendix A) and the ocean carrier contract, the seller, ocean carrier or the buyer or their respective agents (OTIs) arranges for inland transportation, documentation, etc. When an OTI is intermediating the process, it either receives daily reports of POs received by its clients via EDI or by some other *ad hoc* notification (via fax or phone) that a shipment is ready for transportation. As mentioned earlier the OTI may manage all or part of the shipping process on behalf of the seller/consignor after this point.

3.3.3.1 Schedule Lookup

Although not typically considered a transaction on its own, schedule lookup is the first contact the purchaser of ocean transportation (consignor) makes with the ocean carrier. Usually the consignor will consult or enquire about a schedule when making a booking; hence, hence, it is overlooked as a separate transaction. Nevertheless, it does involve the

[5] These shipping instructions are distinct from and not to be confused with the shipping instructions issued by a shipper to a carrier. They are issued by a buyer to the seller and are used when the buyer controls the major part of the international shipping process

transfer of important information from the carrier to its customer and is therefore considered a separate transaction.

There are two types of schedules:

i) A general planning schedule that provides a general idea of ship schedules, and
ii) An execution schedule that contains cut-off dates that specify when containers have to be delivered to the port, which is used for the day-to-day operations to execute bookings.

If the containers do not make the cut-off dates and times they miss the service. Cut-off dates and times have become very crucial at the export port when shipping to the U.S. due to the United States Customs' 24-hour advance manifest filing rule.

The telephone has been widely acknowledged to provide the most convenient and reliable service when the consignor has developed a good relationship with a trusted, resourceful and knowledgeable carrier sales representative. This is especially favored when the shipper/consignor has an established working relationship with the carrier's customer service representative. This is usually the case with large customers who have repeat business. This may also be the source of problems if the regular sales representative is not present and a new sales representative would take a lot more time to understand and respond to a customer's needs. Small to medium size shippers often face the problem where they do not get the personalized service from customer service representatives who are often assigned to manage the accounts of several smaller shippers. Consignors also favor this channel when there is a need to go back and forth in order to identify an appropriate schedule (and subsequently secure a booking) especially to ensure space guarantee on the earliest or best schedule. The consignor's main intention in identifying a suitable schedule is to make a preliminary booking. In the case where the INCOTERMS (Appendix A) are FAS or FOB as with US importers and Asian exporters, when a schedule is unavailable for whatever reason, then the consignor may consult the consignee to check if a later schedule or alternative carrier should be used. Very rarely, if ever, do shippers use the 323 EDI transaction set for schedule lookup.

Published schedules available as weekly advertisements or inserts in trade magazines and newspapers, or on their own are the other common source for schedule information. Consignors will often consult these publications while calling to make a booking. These are used only as a guide as often published schedules are changed or inaccurate when vessels are delayed.

Carriers also publish schedules over the Internet, managed by independent third party information service providers and carrier backed public portals. Carriers realize lower costs from not having to publish advertisements and publish and distribute separate schedule publications to prospective customers. Its schedules are accessible at any time, from anywhere, by anyone with access to the Internet, so they can reach more customers than before. They may also have to deal with fewer inquiries at their customer call centers. Most of these schedules are static and simply a replication of the published schedule. Some on-line schedules however, offer customers the convenience of a database type lookup function via a web browser interface. At least two of the public portals have forced standardization across their carriers and have virtually interfaced to

carriers' backend systems to offer schedules as maintained by carriers in their own systems creating the nearest thing available to real-time schedules.

3.3.3.2 Booking

The booking process in its simplest form consists of a two-step process, a booking request and a booking confirmation. As seen with the schedule look-up, often the booking process is iterative with communications back and forth between the consignor and the carrier and sometimes even involving the consignee.

When a suitable schedule has (or range of schedules have) been identified the consignor makes a request for a booking. At the time of requesting a booking the shipper provides some basic information about the shipment such as, the number of containers, commodity type, origin-destination, if hazardous cargo and under what contract (contract number) the cargo is being shipped. This may be done either by phone, fax, e-mail, EDI (300, 301 and 303) or via the Internet. In most cases bookings received by carriers in any of the above form are reviewed to ensure the ship schedule, available capacity, consignor's identity and other shipment details are correct and match the available service. If there is no problem in the booking request, the carrier will transmit a booking confirmation back to the consignor this could take upwards of two hours to obtain. Often the consignor does a lot of business with a carrier and is familiar with the carrier's customer service representative and the booking may take only a few minutes; this would be true for any communication channel especially by phone.

The preferred form of transmitting a booking request, for large shippers, is via EDI, which reduces the time to make a booking. However, some carriers do not have the capability of receiving EDI bookings and shippers may have to either phone or fax booking requests. The additional re-keying necessitated by phone, fax and e-mail increases documentation errors, which lead to delays due to incorrect documentation as, if the wrong schedule is booked the shipment misses its planned schedule. In such instances there is further expense due to the need to follow up via phone. However, even EDI bookings have to be manually audited, approved and then confirmed with the customer. This explains why certain carriers are not responsive to even automatic booking requests by EDI. Hence, in such cases also, shippers experience a time delay in receiving a booking confirmation.

In the case of certain carriers and portal services, if a shipper has fairly deterministic periodic demand for liner container transportation, then the shipper and carrier can enter into a contract whereby as long as the threshold maximum slot capacity for a period is not exceeded then a booking confirmation is automatically transmitted instantaneously. If this threshold is exceeded then the excess capacity request is treated as normal; below capacity slot fulfillment may be penalized according to the contract.

3.3.3.3 Shipping Instructions

When a booking confirmation is received then the consignor transmits a whole set of detailed shipment instructions (SI) to the carrier containing details of the shipment, the consignee details, LoC details and any other relevant information that would be included

on the B/L. The SI is usually transmitted by fax, e-mail, EDI (304), public or carrier web portals. The SI is sometimes referred to as the "pro-forma B/L" and is treated as the Master B/L or the seaway B/L, which is the straight B/L. The SI is also used these days by carriers to compile the vessel manifest for US imports to comply with the US customs 24-hour rule.

SIs entails large volumes of detailed shipment data, which multiplies paperwork many times over. Carriers can use IOS to save on labor costs by eliminating re-keying of data. Even the use of e-mail would require some sort of human intervention to transfer data from flat files to carriers' back-office systems. Seamless integration enabled via EDI and the Internet can allow carriers to populate their back-office IS to generate the necessary documents such as vessel manifests and bills of lading. Hence, carriers are charging consignors a surcharge (about $25) when not filing electronically via EDI or the Internet. As a result, the filing of SI via web portals has grown in popularity. Errors in the SI that result in both delays in processing SI and delays in transmitting the SI could result in delays to the cargo because of delays to downstream processes, such as delays to the B/L.

Shippers save on communication costs, as the previous mode of communication would most likely be fax. E-mail is a lot less costly, but requires manipulation of data to suit carriers' requirements and necessitates human intervention at the carriers' side. Lower administrative costs are likely from less paperwork and lower labor costs. IOS using EDI and the Internet can allow shipment data fields to be automatically populated from the ERP systems.

3.3.3.4 B/L Management

When transporting by ocean, separate bills of lading are required for both the ocean and the domestic inland transportation legs, unlike the "through bills of lading" that can be made for an air shipment. In case an NVOCC is used as an OTI, the NVOCC will issue a B/L, which will, then *cover* – go on top of – the ocean carrier's B/L. The B/L is typically 'cut' or issued 2-3 days after the ship carrying the shipment has sailed from the export port. The information from the Master bill or seaway bill (SI), as it is often referred to, is used to make the B/L.

In case of an Order B/L the carrier will send this B/L to the consignor (instructions of who to send the B/L to are obtained from the SI, which are used to prepare the B/L). The consignor will then present it to their bank (the advising bank in the LoC process) that will check to see that the B/L complies with the terms of sale requirements and pay the consignor. The issuing bank will then send the B/L to the LoC issuing bank that will pay the advising bank (see Appendix B). The issuing bank will then release the B/L to the consignee in exchange for the payment for the goods shipped. The consignee now has to present the original B/L to the carrier who will then release the goods or sign a delivery note, which enables goods to be picked up. There is usually one more step before the carrier releases the goods, i.e., the carrier's freight has to be paid.

In case of the Straight B/L consignors are typically international affiliates or subsidiaries who ship to other international affiliates or subsidiaries. In this case there is no

accompanying cash transaction and therefore no LoC, bank draft or other similar financial instrument. However, in some rare cases the money for the sale of goods may have already been received or the buyer's integrity may be without question so a straight B/L is issued even though accompanied by a financial transaction. In this case (straight B/L) the B/L does not play any legal role in ensuring transference of title.

The conventional modes of moving negotiable B/Ls have been post and courier. This poses a problem, especially for short voyages, B/Ls may arrive long after the goods have arrived and are discharged from the ship at the import port causing unnecessary delays and costs. The public internet portals have offered a way in which original Order B/Ls can be printed by the legal title owners in a secure environment using carrier's stationary. Carriers save on administrative costs – stationary, document preparation and courier charges. The negotiable B/L is both invoice to freight and title to the goods, hence, earlier possession of the document expedites freight payment and clearance of the consignment in port, which considerably reduces order cycle time.

The 310 B/L EDI transaction set is used as a copy to invoice the shipper for freight charges, as in the U.S. the B/L is also used as the freight invoice. The 310 also acts as a copy of the Seaway B/L. This is similar to internet services that offer to view B/Ls on-line. These services add value by only allowing shippers to view their freight charges, which helps to pay freight charges and clear freight faster. Carriers also benefit from customers viewing B/L information on-line due to the reduced enquiries at customer call centers.

A shipper able to view the B/L information on-line is able to reduce or able to print a legal copy of the B/L. This is because carriers will only release a shipment when the freight for that shipment is received from the shipper. The B/L is the most reliable place from where the shipper can determine the freight payable, as the B/L also acts as an invoice. This affects the clearance of freight at the port of arrival and the associated knock-on effect on down-stream processes. When the negotiable B/L acts as a title to the goods, shippers will benefit largely from receiving the electronic B/L as this enables the clearance of freight at the arrival port. Finally, due to the seamless integration of SI data with the B/L there are fewer errors in information pertaining to shipment destination and consignee, which reduces the incidence of exceptions. Thus, in sum IOS enabled B/L management could allow advance planning, speed payment and reduce exceptions due to errors in documentation.

3.3.3.5 Tracking and Tracing

Traditionally the tracking of cargo was carried out by the concerned party – consignor or consignee according to who was responsible for ocean shipping and delivery according to the INCOTERMS – via a phone call to a carrier customer call center. Even today all carriers continue to maintain the customer call centers. However, cost pressures are causing most of them to encourage tracking enquiries to be conducted via EDI (313, 315 and 312) and carrier or public web portal. These tools offer four basic types of functionality:

i) *Cargo tracking*: where an interested party can log on to a portal and track a shipment or group of shipments using container, B/L, or shipper specific (such as PO) numbers.
ii) *E-mail notification*: these are notices transmitted automatically by e-mail when shipments pass different milestones in the shipment process. It may be possible that the shippers will sometimes set these milestones. Milestones are events, such as, i) Booking request, ii) Empty pick-up, iii) Loaded container received, iv) Depart from inland location, v) Arrival at Port of load, vi) Booking changes, if any, vii) Container Loaded, viii) Received SI, ix) Transshipments, if any, x) Ship arrives at Port of Discharge, xi) Container discharged, xii) B/L received, xiii) Container on Intermodal move, xiv) Container arrives at inland terminal, xv) Container picked up for final delivery, xvi) Empty container delivered; important to calculate demurrage. Notification about status of documentation can also be provided.
iii) *Exception alerts*: are generated automatically when a shipment has not reached a particular event (milestone) within a pre-specified time window. Shippers' may be able to customize these alerts and time windows.
iv) *Customized Reports*: A shipper can generate macro, customized reports based on a number of different variables such as time, commodity, consignor/consignee, carrier, region etc. Therefore, a report containing details on the current status of all the containers/shipments containing a sub-set of commodities from a sub-set of consignors in a particular region of the world can be generated. These reports can be either accessed whenever the need arises or customized reports can be set up in advance to be e-mailed periodically – daily, weekly or monthly.

Shippers have expressed their preference for OTI web portals, as these are perceived as being more comprehensive. For example OTIs are offering track & trace visibility at the stock-keeping-unit (SKU) level while carrier portals offer such visibility at the B/L number, container number and sometimes at the PO level.

The above services are offered by the three web portals as well as by some of the carriers on their private portals. In order to work effectively with their multiple carrier members with respect to the information capture and sharing the three public web portals have driven standardization among their member carriers. With web portals and EDI tracking it must be noted that while the goods may be passing each of the milestones in a deterministic sequence, notifications may be received out of sequence. Hence, a drawback of these systems is that shippers are often left wondering if a milestone should be assumed as passed or whether a notification was generated in error. This often results from the multiple cargo hand-offs between the disjoint, disparate parties to a shipment. Their information systems are not linked and causing information to fall through the gaping cracks of disconnectedness that exist. Track & trace visibility is best while the container is on the ship. For the inland transportation mode U.S. rail carriers do a good job when the container is on a rail car else visibility is not predictable. Track and trace information affects the planning, scheduling, and execution of all downstream activities such as, production, distribution, and inventory management.

3.3.3.6 Freight Invoicing and Receipt

As mentioned above, in the U.S. the ocean B/L (both Order and Straight) acts as the ocean freight invoice as well. Depending upon the ocean carrier contract either the carrier or the shipper (as defined by the INCOTERMS) has to arrange to release the goods through customs or arrange an IT document to move the goods inland in bond.

In case of an Order B/L where the goods are bought either EXW FAS or FOB the B/L is sent to the consignor (seller) who then submits all the transport documents to the bank in return for payment for the goods sold (see INCOTERMS in Appendix A, and import-export process in Appendix B). The bank then sends the documents to the issuing bank who will release the B/L to the consignee (buyer) in return for payment for the goods. The consignee then pays for the freight and surrenders the B/L to the ocean carrier who will then release the goods to the consignee.

In the case of a Straight B/L the carrier sends the B/L to the party paying for the goods (depending upon the INCOTERMS) and releases the goods to the consignee after the freight has been paid for.

With EDI (310) and the Internet, B/L copies with freight charge information are available as soon as the B/L is prepared so that the carrier receives freight payment well in time for the goods to be released when the vessel arrives at the import port.

3.4 Uncertainty in Liner Shipping

From the foregoing discussion it is apparent that uncertainty can arise at every stage of the ocean shipping process. Delays and errors in 'schedule look-up', 'booking', and 'filing shipping instructions' could result in the ultimate delay of the shipment. The cause of delays and errors could originate at the consignor (supplier/seller/exporter), the consignee (receiver/buyer/importer), the carrier, or intermediary. The reasons for these delays and errors could arise from clerical errors due to re-keying data, poor intra-firm inter-functional coordination or poor inter-firm coordination. The most common source of inter-firm coordination is poor information sharing. This in turn has a knock-on effect on all downstream logistics processes such as customs clearance, inland transportation, warehousing and production/assembly or stockouts.

Errors or delays due to improper 'schedule look-up', 'booking', and 'filing shipping instructions' procedures normally occur early on during the ocean shipping transaction cycle. This along with the long lead time required for ocean transportation provides an adequate time window to react to and recover from delays, which is usually done by expediting shipments by air at a considerable cost. Errors in 'shipping instructions' can have a knock-on effect on the B/L, which is prepared from the shipping instructions. Errors and delays in the B/L could hold up freight payments and customs clearances, which would affect the clearance of freight at the port of entry and delivery to the final destination. The longer it takes for errors in shipping instructions to be detected the shorter the time window to react to the delay. Similarly with 'tracking and tracing', the longer it takes a shipper to detect an exception the less time is available to react to and counter a delay.

3.4.1 Liner Shipping and Supply Chain Management

The ocean shipping move is (the line-haul) part of an international Intermodal move in a global SC. The successful execution of an international shipment results in getting the right shipment, to the right customer, in the right quantity, to the right place, at the right time, in the right condition, and at the right price. The successful execution of the shipment affects internal customers such as, production/assembly, distribution and marketing/sales; and, external customer such as retailers and other down stream customers. The use if IOS offers an opportunity for the timely and accurate exchange of information that reduces some of the uncertainty inherent in the international shipping process. The reduction of this uncertainty allows for improved planning and execution of shipping tasks that eventually lead to improved SC performance.

3.5 Summary

In order to execute a perfect shipment, several different functions within a firm (purchasing, logistics and import/export group) have to coordinate with several external firms (suppliers, carrier, and intermediaries). Generally, the more the parties involved the greater is the potential for disruption in the process due to the extra uncertainty of coordinating the tasks between the different parties. Hence, greater inter-functional and inter-firm coordination is required to avoid disruptions. Information sharing facilitates inter-functional and inter-firm coordination, therefore the greater the coordination required the greater the information sharing required.

These basic principles of the international ocean shipping process help identify suitable subject areas and theories from the literature review. Hence, concludes the second requirement of the observational process, namely, establishing general principles for the phenomena.

Chapter 4

Literature Review

> *Information is seen as the "glue" that holds together the business structures that allow supply chains to be agile in responding to competitive challenges*
>
> *Sanders and Premus (2002)*

The foregoing discussion illustrates how international shipping has an immediate and substantial impact on shippers' SCs – material flows, information flows, and cash flows. It is understandable that EDI and most recently the Internet offer some workable solutions to combat the uncertainties of the international ocean shipping process by improving information flows, which can improve materials and cash flows. Hence, an extensive review of the SCM and IOS literature was conducted. In addition, there has been a convergence between the two research streams to produce an extensive research stream investigating IOS in SCM, which is also reviewed.

First, a brief outline of the historical development and background of each of the research streams is provided followed by a detailed look of IOS research in SCM as applied to the liner shipping process. Therein the IOS, SCM and IOS in SCM literature is presented with a view to examining the principles of IOS and SCM and exploring relevant theoretical frameworks to answer the research questions posed.

4.1 Domain Background

The research streams of SCM and IOS are young and immature as compared to marketing, accounting and management, the other more established streams of business, which itself is an immature discipline in the social sciences (Kuhn, 1996). As will be seen in the following discussion both fields lack any firm internal theoretical paradigm that guides and unifies the research effort of scientific discovery. This resembles Kuhn's (1996) pre-paradigm period of scientific conflict or 'extraordinary science'. Kuhn (1996) states that in the absence of paradigm theory, there is no clear understanding of the relationships between the relevant entities of the field. Even the entities that are relevant are not fully understood or even discovered; hence, relationships that are apparently observed between those entities of which we are aware become even more abstruse. In addition, the gross product of research bears scarce resemblance to true science, with little consensus and direction for research to further the theoretical foundations of the field.

This is very much the case for the research streams of IOS, and SCM, and especially for IOS research in SCM, which is a product of the above two streams. As will be elaborated in greater detail below, several studies seek to 'discover' the 'entities' of the field through the articulation of domain specific constructs, while other studies seek to examine 'relationships' between the 'observed entities' by examining the inter-relationship between the constructs. Research is fractured and discontinuous, hence, there is very little intrinsic structure to guide a literature review. The fragmented approach to research

is also apparent from what appears to be some research being conducted on an *ad hoc* basis. Very little research has a consistent longitudinal component of theory testing that enables the building of strong domain specific theories. Where possible therefore, some structure has been presented to help guide the literature review. Also, three tables, one each for SCM, IOS and IOS in SCM literature are presented in Appendices F, G and H, listing the literature reviewed in chronological order. This provides a succinct view of a large portion of the extant literature with a listing of each paper's research objective, theoretical basis for the research, methodology, and the conclusions arrived at.

4.1.1 Supply Chain Management

The concept of SCM has been around a long time, however the name itself has changed a few times over the years. Forrester's (1958) example of a production and distribution system illustrating the principle of demand amplification (bull-whip effect) would be readily recognized today as a SC triad of a retailer, distributor, and manufacturer. The demand amplification and associated waste illustrated by Forrester (1958) was the basis for his *industrial dynamics*, which like its successor, SCM, stresses the management of the inter-firm coordination of the flows of information, materials, labor, money, and capital equipment for firm profit. By the early 1980s consultants began using the term SCM with the management of the inter-firm flows enumerated by Forrester, see Ganeshan et al (1999), Cooper et al. (1997), and Chen and Paulraj (2004). Even after this though, terms such as *integrated logistics management* have been used to describe the inter-firm coordination of flows; see for example Gustin et al (1995), Ellinger et al (1997), and Ganeshan et al (1999). However, *integrated logistics management* was also used to describe the coordination of intra-firm, inter-functional flows, see for example, Daughetry et al (1994), and Gustin et al (1994). Because of this confusion, Cooper et al (1997) set out to distinguish logistics from SCM as being more than simply the extension of logistics principles to the SC. However, there is still inconsistency in terminology and the application of concepts, especially the distinction between the integrated logistics approach and SCM as is evidenced in Rutner et al (2003).

There has also been confusion of the true definition of SCM and indeed that of a SC. Chow et al (1995), Cooper et al (1997), Morash and Clinton (1997), Lambert et al (1998), Ganeshan et al (1999), Ballou et al (2000), Lambert and Cooper (2000), Croxton et al (2001), and Stank et al (2001), to name a few, have all defined SCM differently. In an attempt to resolve this heterogeneity and enable subsequent researchers to preclude the wasteful effort of defining SCM for each new research endeavor, Mentzer et al (2001) conducted a review of the SCM literature and defined SCM as, "*the systemic, strategic coordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the SC, for the purpose of improving the long-term performance of the individual companies and the SC as a whole.*" Mentzer et al (2001) also defined a SC as, *"a set of three or more entities (organizations or individuals) directly involved in the upstream and downstream flows of products, services, finances, and/or information from a source to a customer."* In 1998 the Council of Logistics Management (CLM), renamed the Council of SCM Professionals (CSCMP) in 2004, the leading professional group in the logistics arena, has also clarified their view of the role of logistics, as a sub-set of SCM (CSCMP, 2004). The

organization changed its original definition of logistics to, *"Logistics is that part of the SC process that plans, implements, and controls the efficient, effective flow and storage of goods, services and related information from the point-of-origin to the point-of-consumption to meet consumers' requirements"*. There are however, some common factors to all the above definitions, these are: i) participation of two or more firms; ii) coordination of specific business processes across functional boundaries within a firm and across firm boundaries in the SC; iii) management of material, information and cash flows, iv) joint setting of strategic goals and objectives to maximize SC output; and, v) measurement of SC performance and appropriately sharing risks and rewards to benefit all SC participants. As this description breaks down the definition of SCM into its composite elements, it will be used henceforth for the purpose of this paper.

The SCM literature reflects the newness of the field. At least three studies in the last decade have attempted to categorize the literature to give some structure to the SCM research. Ganeshan et al (1999) and Chen and Paulraj (2004) conducted a comprehensive literature review to trace the development of SCM through the fragmented concepts of physical distribution, materials management and integrated logistics. Ganeshan et al (1999) recognize that the majority of the research has focused on the operations management perspective while insufficient attention has been paid to defining the entities of the domain, such as, what is a SC and what does managing a SC mean, which answers were provided by Mentzer et al. (2001). Valuable contributions to the field by Mentzer and Kahn (1995), provide a framework for conducting logistics research, and Stock (1996), enumerates theories from numerous business and social science disciplines to build SCM theory. Both Mentzer and Kahn's (1995) framework and Stock's (1997) advice to use outside established theory are incorporated into this paper. Ganeshan et al (1999) also acknowledge the value of using numerous social science theories, especially from Economics, to explain phenomena in SCM and to further the development of SCM theory. For example, Reekers and Smithson (1996) use transaction cost economics, resource based theory, and network analysis, to demonstrate how supply chains operations can be rationalized in a series of case studies of supplier relationships in the UK and the German automotive industry.

The majority of the literature reviewed for this paper was of a conceptual nature i.e., attempts to develop an agenda and framework for SCM research. Thomas and Griffin (1996) draw the schematic of a generic SC and describes the research that coordinates multi-echelon inventory at each level of the SC. Cooper et al (1997), Lambert et al (1998), Lambert and Copper (2000), and Croxton et al (2001) all define a framework for SCM along with an illustration of the cross functional and inter-firm business processes, such as customer relationship management, order fulfillment, and returns management. Other articles attempt to detect the entities of SCM. Novack et al (1994, 1996) define constructs and measures for logistics functions or inputs, logistics quality, and the value of logistics service quality provided. Studies that are more recent have begun to explore the impact of SCM on firm performance. Stank et al (2001) develop constructs and measures for internal and external business process integration and empirically tests the impact of SCM integration on logistics service performance. Similarly Narasimhan and Jayaram (1998), Tracey (1998), Elmuti (2002), Vachon and Klassen (2002), and Wisner

(2003) all develop specific SCM constructs and investigate the impact of SCM strategy on different levels (functional, strategic business unit or firm) of firm performance. The SCM literature also consists of research examining relational entities such as inter-firm coordination. Frohlich and Westbrook (2001), look at the different levels of inter-firm integration, developing inter-firm integration constructs, and measures for customers and suppliers. As a result of such studies considerable research effort has been expended defining SCM performance measures, notably among them are Caplice and Sheffi (1994), Brewer and Speh (2000), Lambert and Pohlen (2001), Kleijnen and Smits (2003), and Otto and Kotzab (2003). Finally some studies have articulated strategic relationships between corporate strategy and SCM strategy, most notably among them are Fisher (1997) who defines SC strategy depending upon the product (customer demand uncertainty) characteristics, and Lee (2002) who extends Fisher's framework by defining SCM strategy on the basis of demand uncertainty characteristics as well as supply uncertainty, uniting the materials management and physical distribution aspects of SCM.

4.1.2 Inter-Organizational Systems

Barett and Konsynski (1982) were among the first to explain the growth of IOS. They also set out to classify IOS on five levels according to the level of participation by the organizational partners. Cash and Konsynski (1985), were arguably the first who introduced the term IOS to describe IOS, which they described as, *"An automated IS shared by two or more companies."* They attribute the origination of the idea of IOS to Kaufman (1966) who *"implored general managers to think beyond their boundaries to the possibilities of extra-corporate systems."* Johnston and Vitale (1988) interpret the above definition to describe an IOS as built around a computer and communications technology that facilitates the creation, storage, transformation, and transmission of information. In 1995 Cash and Konsynski (1995) redefined IOS as consisting of a computer and communication infrastructure that permits the sharing of an application (to support a transaction such as purchase of products or services), which crosses company boundaries and separate legal entities. It is this last definition that will be used for the purpose of this paper.

The majority of IOS literature can be broadly sub-divided into two distinct streams: i) the configuration of IOS coordinating mechanisms, and ii) use of IOS for value creation – see Kauffman and Walden (2001) for a comprehensive typology of IOS (e-commerce) literature. In the former, researchers primarily use transaction cost economics to demonstrate whether the optimal IOS coordinating mechanisms should be arranged as electronic markets or electronic hierarchies, to minimize transaction costs; see for example Malone et al (1987), Bakos (1991), and Clemons et al (1993). The latter research stream focuses more on the competitive advantage and value of IOS in specific instances; see for example Barrett and Konsynski (1982), Cash and Konsynski (1985), Porter and Millar (1985), Johnston and Vitale (1988).

As is understandable the body of IOS literature is very broad and cannot all be neatly sub-divided into the above two streams. There are, for example, empirical studies that engage in discovery of domain 'entities' and the definition of the inter-relationships between these entities. Bailey and Pearson (1983) developed a measurement instrument

for computer user satisfaction. DeLone and McLean (1992) defined the construct for IOS success in terms of six measures of IS success. Bensaou and Venkatraman (1996) defined constructs for an information processing model of a firm and hypothesize relationships of the fit between information processing capability and information processing requirement to improve firm performance. Angeles et al (1998) developed a construct for the level of EDI implementation, and Lewis and Byrd (2003) developed a construct for information technology infrastructure.

4.1.3 Inter-organizational System Research in Supply Chain Management

The link between IOS and SCM began developing early on in IOS research. Porter and Millar (1985) use industry examples to illustrate the impact of IOS on various elements of the value chain. The value chain concept is very similar to that of SCM and has been used repeatedly in the logistics and SCM literature, see for example Lambert et al (1998), Lambert and Cooper (2000), Humphreys et al (2001), Mentzer et al (2001), and Otto and Kotzab (2003). It is logical that IOS and SCM research, albeit developing largely independently, should include recognizable elements of the other stream. Even the extension of intra-firm time-sharing computer networks to IOS in the early 1980s is analogous to the extension of the traditional concepts of intra-firm inter-functional coordination of logistics activities, to the inter-firm coordination of SCM activities also in the 1980s. This is because SCM involves the coordination and management of inter-firm flows that include information flows, and IOS research is about IT mediated inter-firm coordination of information. Hence, the integration of the two research streams, while obvious, is also beneficial as Shah et al (2002) argue, because SC strategies are accomplished in conjunction with appropriate IS capabilities. Premkumar (2000) integrates the findings of operations and logistics literature with that of the IS literature to investigate issues related to integrating the traditional SC with IOS. Using a transaction cost economics framework, one of the conclusions he reached was that only firms committed to SCM as a business strategy were well suited to launch an IOS initiative, else it would be "an uphill battle". Sanders and Premus (2002) state that information is the *glue* that holds together the business structures that allow SCs to be agile in responding to competitive challenges.

Research of IOS in SCM is even more fragmented than each individual field, which in a way may be due to the diverse backgrounds and approaches of the researchers who strive to publish their research in the primary journals of their respective fields. The fragmentation is apparent from the numerous conceptual studies; about a third of all the articles reviewed were undertaken to articulate some theoretical basis for the field – see Appendix H. Therefore, the discovery of the 'entities' in this domain, integrating IOS and SCM is even less focused, with most studies developing constructs specific to the context under study with little generalizability. In this author's opinion, only a few studies attempt to establish a clear picture of the entities and how they relate to each other. These studies provide a wide array of settings and theoretical approaches from which relevant frameworks and constructs may be drawn to explain the phenomena investigated in this research.

Srinivasan et al (1994) establish a causal link between EDI use and JIT shipment performance. Gustin et al (1994, 1995) observed empirical evidence of firms who show evidence of cross-functional business processes integration developed higher information capabilities. Srinivasan et al (1994) and Mukhopadhyay et al (1995) found that the use of integrated EDI between Chrysler and its suppliers resulted in supply efficiencies, which resulted in $220 million system wide savings for Chrysler. Bensaou and Venkatraman (1995, 1996) use their information processing model to demonstrate the best fit between information processing requirements and information processing needs for the supply chains of different components in an auto manufacturer/first tier supplier dyad. They conclude that IOS is most effective in a situation of high environmental uncertainty and low partnership uncertainty. Forster and Regan (2001) use the information processing model framework and the constructs therein developed by Bensaou and Venkatraman (1995, 1996) to investigate the impact of electronic integration on the inter-organizational task performance of domestic and international air freight forwarder operations. Williams et al (1998) develop a multi-dimensional construct of EDI use and test the effect of EDI use on EDI value measured in lower costs and greater productivity. In a study of EDI impact on the SC between Campbell and 31 of its grocery customers, Lee et al (1999) found that the EDI adopters realized increased inventory turns, lower stockout rates, reduced paper usage, and fewer data-entry errors. Narasimhan and Kim (2001) developed different constructs for different uses of IS such as logistical operations, value creation management, and infrastructural support. They then test links between these IS constructs and SCM performance to develop a prioritization for implementing the IT components of each IS construct. More recently, research investigating issues in the upstream and downstream coordination of IOS for SCM integration has been conducted. Forhlich (2002) develops constructs for i) internal, supplier and customer barriers to integration; and, ii) supplier, focal firm, and customer e-integration. He then investigates the relationship between barriers and e-integration, and the resultant impact on e-business and operational performance. Shah et al (2002), propose a matrix of best fit for level of SCM integration between suppliers and customers, and IOS integration strategy, empirically validating the model. Finally Rutner et al (2003) empirically develop a basis for the adoption of e-commerce and ERP for SCM.

From the foregoing discussion, it is clear that IOS are capable of facilitating inter-organizational communication and lowering the overall coordination cost for SCM. In addition, virtually every article investigating the use of IOS in SCM reviewed in Appendix H is based on the premise that IOS has a positive influence on SCM. Now the central themes of the two streams will be reviewed, first separately and then for the joint research stream, to identify an appropriate theoretical framework and constructs to meet the research objective.

4.2 IOS and SCM Applied to the Liner Shipping Process

In this section the principles of SCM and IOS will be reviewed separately. Then as recommended by Mentzer and Kahn (1995) these principles will be integrated to view the issues relating to IOS and non-IOS enabled information sharing between ocean carriers and shippers in the context of the shippers' SCs. This will help identify a theoretical

basis and formulate an empirical model that may be used to answer the research questions.

4.2.1 SCM

This section continues from the history and evolution of SCM reviewed in the previous section to discuss the principles of SCM so that they may be applied to developing a theoretical framework to investigate in detail the research questions outlined earlier.

4.2.1.1 SCM Philosophy

The end objective of SCM is to deliver customer value (Brewer and Speh, 2000). Vachon and Klassen (2002) state that delivery performance has become a critical metric of success. Ganeshan et al (1999) indicate that key measures of a delivery construct will provide suitable indication of all other SCM performance measures. However, Brewer and Speh (2000) also stress the balanced approach, which uses the balanced scorecard model to weigh the costs of delivering the service, in addition to delivering customer benefits. In order to achieve this SCM philosophy of maximizing service to customers at the lowest total cost, Stank et al (2001) stresses a strong commitment to close relationships between trading partners.

The basic premise for this argument is that SCM is the integration of specific business processes across functions, within a firm and across formal firm boundaries. Chow et al (1995) define integration as, *"the degree to which the logistics tasks and activities within the firm and across the SC are managed in a coordinated fashion."* Cooper et al (1997), develop a conceptual framework for SCM that illustrates business process integration to facilitate the flows of physical goods and information across i) functions within a firm; and ii) between functions within a firm, and upstream suppliers and downstream customers. This integrated view of SCM across a firm's functional silos and across firm boundaries has been endorsed by Ballou et al (2000), Chopra and Meindl (2001), and Mentzer et al (2001). However, these studies stress the inter-firm integration while underplaying the intra-firm, inter-functional integration, which are also very important for effective inter-firm integration.

4.2.1.2 Internal and External Integration

Several empirical studies have attempted to demonstrate the sub-optimal results from intra-functional management, and the improved results from inter-functional and inter-firm coordination of key business processes. Novack et al (1994) conducted a study of logistics activities' impact on logistics quality and executives' perception of value added by logistics services. The authors noted that as greater importance is placed on the production function, logistics productivity deteriorates because excess, sub-optimal inventory levels may be maintained at various sites to support manufacturing. Similar results were found in a follow-up study by Novack et al (1996). Supporting the inter-functional view of SCM, Novack et al (1994) find that coordination between purchasing and transportation positively affect production and customer delivery. Ellinger et al (1997), and Tracey (1998) also find that firms adopting a cross-functional integrated logistics approach demonstrate better logistics service performance. Morash and Clinton (1997) compare the levels of internal and external integration across automobile firms in

four countries. They find that the integration of the transportation process across functional areas is extremely important to support the strategic objective of the automobile manufacturer. From a global sample of 322 manufacturers Frohlich and Westbrook (2001) extend the study across firm boundaries and conclude that the most successful manufacturers are those who have carefully linked their internal processes with external suppliers and customers in unique SCs. Finally Stank et al (2001) found that external collaboration is a necessary but insufficient condition for improved logistics service performance. That is, firms wanting to improve service performance through collaboration with external customers and suppliers need to first enhance internal collaboration. This step-wise approach elaborates on the previous general mandate for inter-functional and inter-firm integration for effective SCM.

4.2.1.3 Components of Successful SCM

Successful SCM is based on determining: who are the key SC members, what SC processes to link with these members, and what type/level of integration should be applied with each member (Lambert et al, 1998). From this and the foregoing discussion, successful SCM must include: i) SC partners, ii) business processes for inter-functional and inter-firm coordination, and iii) coordinating mechanisms.

SC Partners

The key to determining SC partners says Lambert et al (1998) is by determining which members are critical to the success of the company and the SC. Any firm therefore, that is likely to affect the firm's own and hence, indirectly, the SC's end-customer delivery performance should be allocated managerial attention and resources (Lambert et al, 1998). Thus in keeping with the inter-functional-coordination view it is necessary to identify key internal partners who impact the firm's or SC's end customers. This is in keeping with Lambert and Cooper's (2000) definition of the primary members of a SC, which are all firms or internal business units who add value to a particular output for a customer.

Business Process Integration

The business processes that need to be integrated with key supply chain partners also need to be identified. In a study conducted by Cooper et al (1997) members of the Ohio State University's Global Supply Chain Forum identified eight business processes that need to be integrated across internal and external SC partners. These are: i) customer relationship management, ii) customer service management, iii) demand management, iv) order fulfillment, v) manufacturing flow management, vi) procurement, vii) product development and commercialization, and viii) returns channel. Croxton et al (2001) argue that activities within each process reside inside each functional silo but entire processes cannot be maintained within a function these processes run the length of the SC and cut across firms and functional silos. As mentioned above (Frohlich and Westbrook, 2001; and Stank et al, 2001) firms that are able to integrate these business processes across internal functional and external firms are most likely to achieve SC success.

Coordinating Mechanism

Appropriate coordinating mechanisms must be identified to implement business process integration. Chopra and Meindl (2001) identify four drivers of SCM: i) inventory, ii) transportation, iii) facilities, and iv) information. These drivers are manipulated to modify SCM strategy to match the supply market and customers' demand characteristics, in order to meet end customer's requirements. Fisher (1997) and Lee (2002), (see above) provide us with four fundamental types of SCs, efficient, responsive, risk-hedging, and agile. Fisher (1997) and Lee (2002) suggest manipulating inventory disposition, transportation service characteristics, facility choice and location, and information sharing mechanisms to offer SC output that ranges along a continuum from low cost-low service to high cost-high service in order to meet customer requirements.

While inventory, transportation and facilities are important components of SCM information is the "glue" that holds the disjoint business units together and allow SCs to be agile in the face of competitive challenges. All the authors reviewed by Cooper et al (1997), to identify key components of SCM, recognized information sharing mechanisms as key to SCM. Ballou et al (2000) also, recommend that an information sharing mechanism is important for ensuring coordination among all stakeholders. Also the extensive historical literature of IOS in SCM reviewed, recognizes the information sharing mechanism as closely linked to successful inter-firm coordination, see for example Forrester (1958), Lee and Billington (1992), Sanders and Premus (2002), and Shah et al (2002).

The managing of SC drivers gains further complexity when logistics managers' have to manage thousands of line-items per day, checking what is in-transit, in-stock, or on-order, and when items will be available from suppliers (Sheffi, 2001). Lee and Billington (1992) identified that not enough attention is paid to providing customers with timely and accurate updates on the status of late orders. Sheffi (2001) reports that logistics managers describe their transportation system as a "black-hole" into which shipments disappear with little information available until the shipments reach their destination. This is partly due to the hand-offs between multiple carriers. As has been discussed, the liner shipping process is not only long it is also fraught with uncertainty. Hence, Rishel et al (2003) rightly observe that this information gap of in-transit inventory has been one of the more persistent SCM problems where once goods are loaded on the vehicle they are invisible to, and out of the control of, shippers. Stefansson and Tilanus (2000), Sheffi (2001), and Rishel et al (2003) all conclude that better sharing of shipment information between carriers and their customers is required. Stefansson and Tilanus (2000), and Rishel et al (2003) found that better availability of shipment information status would improve planning of the downstream activities such as connecting transportation, scheduling labor at unloading dock and warehouses, and scheduling of production. Additionally, Sheffi (2001) states that better information sharing along with a given service level and appropriate response to an exception could help lower the safety stock level. Consequently, Sheffi (2001) speculates that shipment information sharing could result in lower inventory carrying costs, avoidance of expedited shipments, reduced warehousing requirements and reduced administrative overheads. This, along with the characteristics of IOS discussed above, provides the impetus to investigate the many SCM productivity

and efficiency improvements from using IOS for managing the lengthy trans-oceanic supply chains.

4.2.2 IOS

Relevant IOS literature is examined next to explore the pertinent issues that would contribute to the development of a theoretical framework that centers on information sharing in the SC context.

4.2.2.1 Benefits of Inter-Organizational Systems

The benefits of IOS stem from the characteristics of IT, which; i) speed up information processing; ii) communicate information faster; and, iii) quickly and accurately transmit large amounts of information (Bakos, 1991). The efficiencies of IT reported by Porter and Millar (1985) put some of these characteristics into perspective: i) the cost of computer power relative to the cost of manual information processing was at least 8,000 times less expensive than in the previous 30 years; ii) between 1958 and 1980 the time for one electronic transmission fell by a factor of 80 million; and iii) Department of Defense studies showed that error rates in recording data through bar codes was 1 in 3 million, compared to 1 in 300 for manual data entries. Therefore, Bakos (1991) concludes that IOS are likely to increase inter-organizational communication and lower overall coordination costs; more so in today's context where the processing power, storage capacity and communication bandwidth are much more powerful than they were in the early 1990s.

Transactional Efficiency

Porter and Millar (1985) observe that historically the impact of information technology on cost was confined to activities in which "repetitive information processing" played a part. Hence, automation of inter-organizational transactions is universally recognized as the primary benefit of IOS. Barrett and Konsynski (1982) observed: i) cost reductions from the order processing capacity of high volumes of orders; and, ii) productivity improvements from processing fewer exceptions as a result of decreased error rates, elimination of data entry tasks and reduced searching costs. All these advantages combined with the instantaneous transmission time result in compressed cycle times. In addition to the internal benefits, standardized data representation and quicker data capture, Johnston and Vitale (1988) enumerates the inter-organizational efficiencies that firms who implement IOS realize: i) getting customers to do data entry, ii) allowing customers to "shop" electronically without tying up customer service representatives, iii) permit inexpensive rapid transmission of sales and service messages, iv) remove a level of the distribution channel by going directly to the customer, v) extend market reach to customers who could not be economically served by conventional field sales calls, and vi) deliver services and products electronically. Malone et al (1987, 1989) observed these benefits of quicker and accurate order processing, and customer billing in existing IOS set up by United Airlines (Apollo), American Airlines (Saber), and American Hospital System (ASAP).

Promoting Inter-organizational Integration

As is apparent, most of the efficiencies of IOS use are reaped by the IOS champion; i.e., from the examples above, United Airlines, American Airlines and American Hospital System. In the context of ocean shipping IOS networks this would explain the ocean carriers' motivation to set up IOS for transacting international ocean shipments. However, early on in the short history of IOS research Barett and Konsynski (1982) studied the integration of numerous inter-organizational information processing applications between the primary IOS champion and lower level application users. In the case of American Durable Manufacturers (ADM) Barett and Konsynski (1982) report that its dealers were able to retrieve daily sale summaries, initiate parts ordering, check warranty claims, update inventories and automate payroll and accounting procedures using ADM's IOS network. This is because ADM created a virtual integration between its own and its dealers' (ADM customers) ISs for standardization of data. This eased data sharing and facilitated data manipulation by all users.

More recently, the inexpensive, high-speed transmission and storage of large volumes of data using the ubiquitous Internet has made such electronic integration a reality. Stefansson (2002) observed several technical advantages of the Internet over EDI, which was the first IOS channel before the proliferation of the Internet. The Internet uses public domain code and protocol specifications allowing a large heterogeneous installation base providing users with the ability to browse data independent of the computing equipment used. It is easy to use and provides good browsing capabilities. The availability of inter-protocol gateways, making it compatible with many other existing protocols allowing for example, the transmission of EDI over the Internet. Corsi (2003) uses an example of the information from a customer order placed through an Internet portal being shared across the organization and to the extended enterprise partners in real-time. Therefore, Corsi (2003) concludes that real-time net centric supply chains can result in fewer mistakes in orders, reduced lead times, shortened cycle times, reduced inventories, and better resource utilizations across the supply chains. Boyson, et al. (2003) review a case of electronic integration for an aircraft engine spare parts SC between the United States Air Force (USAF) and General Electric (GE) where an Internet portal for managing the spare parts SC resulted in a system wide reduction in SC cycle times due to seamless sharing of information and task and workflow automation.

4.2.2.2 Choice of IOS

Just as in SCM, specific strategies need to be tailored to specific supply and demand conditions. Bakos (1991) states that in inter-organizational relationships, inter-organizational information links are not always the best way to reduce coordination costs between suppliers and customers. Sahin and Robinson (2002) observe that besides extranets, electronic marketplaces, and EDI, traditional forms of information exchange such as fax, e-mail, and the telephone provide unique cost and performance trade-offs. Therefore, structuring and streamlining operations to reduce information requirements may be cheaper than expanding information processing capability by implementing technology intensive solutions (Bakos, 1991).

Konsynski and McFarlan (1990) enumerate several factors essential for IOS success. These factors can be boiled down to: i) the need for top management support; ii) an IT corporate culture within the partner firms; and, iii) the compatibility of both IT infrastructure and corporate culture. Angeles et al (1998) empirically tested some of these relationships and found that investments in a higher level of EDI implementation do not automatically lead to success. There needs to be sensitivity to the work culture and the socio-technical environment for EDI implementation to work. Allen et al (2000) reached a similar conclusion; they found that users' unfamiliarity with systems due to organizational culture was detrimental to the success of the IOS. In addition to the social dimensions, Forester and Regan (2001) also examined the task specific and environmental dimensions that moderate the effect of IOS on performance. They found that the effect of electronic integration between U.S. air freight forwarders and their trading partners on on-time performance was fully moderated by the nature of the inter-organizational task, the environmental dynamism, and the power relationship between the firms.

Angeles et al (1998) found that corporate IT culture is also very important to the success of IOS. Teo and Pian (2003) empirically establish that a firm's business technology strategy positively affects the level of Internet adoption for IOS, which in turn positively affects the competitive advantage of the firm. Lewis and Byrd (2003) empirically validated technology integration and top management support as important measures of a firm's IT infrastructure. There also needs to be technical compatibility between the numerous IT applications inside a company, otherwise the benefits of IOS will be lost (Porter and Millar, 1985).

Hence, the use of IOS should not be a universal prescription for all firms. Firms need to change their business processes and even their culture to adapt to doing business using IOS (Allen et al., 2000). A firm may able to, exert strong cost management, and explore simpler and cheaper options than IOS, which are more compatible with current business processes. The risk of not doing so is simply overspending (Carr, 2003).

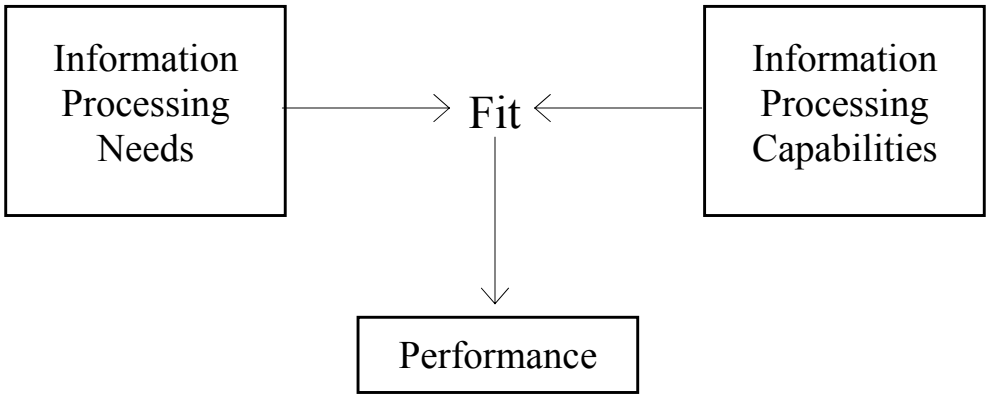
4.2.2.3 Information Coordinating Mechanism

The theoretical framework developed by Bensaou and Venkatraman (1995, 1996) can be used to empirically examine several research issues related to a firm's best choice of IOS. The framework builds on such diverse theoretical perspectives as organizational theory, transaction cost economics, and political economy. The premise for integrating the three theories is that singly the three theories are concerned with a specific part of a larger phenomenon. However, collectively they complement each other and provide insights into the determinants, components and implications of different inter-organizational strategies.

The framework provided by Bensaou and Venkatraman (1995, 1996) contends that organizations can be conceptualized as information processing systems. The function of organization design can be seen as to create the most appropriate configurations of structures, processes and information technologies to facilitate the collection, distribution, and processing of information. Firms' information processing needs are derived from

different sources of uncertainty, while their information processing capability is derived from an array of information processing mechanisms. Bensaou and Venkatraman (1995, 1996) use Galbraith's (1977) information processing view of the firm to postulate that the "fit" between the information processing needs and information processing capabilities is a strong determinant of task effectiveness or performance. A conceptual representation of the information processing model for inter-organizational coordination developed by Bensaou and Venkatraman (1995) is presented in Figure 4-1.

Figure 4-1: A schematic representation of the information processing model



Source: Benasou and Venkatraman (1996, p. 86)

Umanath (2003) states that the proposition tested by this "systems" approach" is that the lack of alignment of a business unit's structural components (information processing capabilities) to specific requirements (information processing needs) dictated by its context will adversely affect its performance. Bensaou and Venkatraman (1996) propose that the framework is very useful in linking theory to practice and has the capability of developing managerially relevant guidelines for the use of different informational coordinating mechanisms for inter-organizational coordination.

4.2.3 IOS and SCM Strategy: The Case of Ocean Liner Freight

Thomas and Griffin (1996), and Lee and Whang (2000), state that long SCs inhibit a firm's ability to respond to customer requirements and hence requires the maintenance of high buffer stocks. The uncertainty related to overseas supplier capacities, and unreliable service characteristics of international transportation such as delays, damage, and long transit times has long posed a challenge to the managing of inventory. Shippers are often left guessing whether shipments have been filled and dispatched, when they will arrive, and what condition shipments may be in once they arrive. Shippers, therefore, must view ocean carriers along with their downstream suppliers as core SC partners. Adequate information sharing between suppliers, carriers and shipper is necessary to coordinate the storage and flow of materials during the order cycle from order placement to order delivery. Shippers need to consider suppliers' capacity, inland and ocean carriers' schedules and equipment availability during the ordering process. This highlights the role of information sharing mechanisms during the entire ocean shipping for effective SCM.

Inventory, inland transportation and facilities (e.g., loading dock labor, production schedules, storage capacity, etc.) need to be managed in order to account for the uncertainty linked to supplier and carrier service delivery. These supply chain drivers, are manipulated to meet internal or external customer requirements. All this requires shippers to coordinate tasks across several business processes such as customer service management, customer relationship management, demand management, order fulfillment, manufacturing flow management, and procurement. These processes cross all functional boundaries, which include purchasing, transportation, production, marketing and logistics. Hence, as is adequately apparent from the SCM literature, shippers must ensure that their inter-functional business processes are first integrated internally to ensure effective coordination with external SC partners such as suppliers, carriers (ocean and inland) and other intermediaries. In order for the different types of coordination to succeed there needs to be a flow of information accompanying the flows of goods throughout the order cycle.

The IOS in SCM literature offers plenty of empirical evidence on the advantages of developing IOS links with suppliers for the ordering process (Srinivas et al 1994; Mukhopadhyay et al 1995). IOS adoption has also been observed to improve the supply chain processes of inventory management and customer service (Lee et al 1999). The availability of shipment tracking and tracing information, can considerably reduce safety stocks (Sheffi, 2001). Sharing such information with other SC partners can help reduce inventory carrying costs, avoid of expedited shipments, reduce warehousing requirements and reduce administrative overheads (Sheffi, 2001). In this regard EDI and web-portals tracking and tracing services offer shippers round-the-clock access to shipment status information from carriers' back-office ISs enabling better planning of shippers' downstream processes. Automated reports results in lower search costs, labor costs and communication costs, as shippers do not need to continuously get shipment status information from the carriers' call centers. Further reducing search, labor and communication costs is the display of standardized shipment information from several carriers on a single Internet portal generated report.

Besides tracking and tracing EDI and Internet portals services offer some considerable advantages over the phone, fax and e-mail. Real-time round-the-clock schedule availability improves shipment planning dramatically, enabling shippers access to carriers' own IS via Internet portals. Seamless integration of carriers' IS into Internet portals eliminate re-keying of shipping schedule data. Booking and filing SI via EDI and Internet also eliminates re-keying of data and reduces cycle times. In some cases Internet portals have automated the booking process, considerably reducing the booking cycle time. The advantage of the shorter cycle time is considerable for large shippers who handle the booking of a large numbers of shipments simultaneously. Internet portals have achieved some degree of work flow automation by integrating ship schedules with on-line booking forms, thus reducing shippers' search times. Shippers also realize lower communication, labor, and administrative costs due to the capacity of EDI and the Internet to rapidly process and inexpensively communicate large amounts of information especially during booking and filing SI. The time savings increase the planning window for all downstream logistics processes such as inland transportation, customs clearance,

warehouse management and production management. Eliminating re-keying of data shortens cycle time and also reduces the occurrence of errors, which means that shippers' face less disruption either from planning shipments with wrong schedule information or from placing a wrong booking. In the case of errors in the SI these can be carried into the B/L that then holds up freight clearance at the port. Another advantage of EDI and Internet portals is standardization. Everyone sees the same information so fewer incorrect decisions are made. Also, delivery arrangements and arrival notifications triggered from information in the B/L obtained from the SI or original booking are theoretically more accurate when using IOS.

However, IOS is not the only or the best way to organize inter-organizational communication and information. Adopting an IOS requires investment in process re-engineering to fully exploit its advantages. Additionally adoption of IOS such as the EDI can be expensive. The conventional phone, fax and e-mail may offer simpler and cost effective solutions to reduce uncertainty by simple reconfiguration of current operations (Sahin and Robinson 2002; Bakos 1991). The Bensaou and Venkatraman (1995) framework offers a means to empirically explore the best way to configure IOS to suit a particular shipper's needs. .

4.3 Summary

The literature review has provided a general understanding of the fields of SCM and IOS and their application to the international trans-oceanic supply chain. The foregoing discussion has made clear the role of IOS in this process and potential advantages this could have on shippers' SCs. Theoretical frameworks, developed in both IOS (Bensaou and Venkatraman, 1995) and SCM (Fisher, 1997; and, Lee, 2002) suggest taking a measured approach to the adoption of IOS and SCM strategies as a one size fits all approach does not work. This is because IOS and SCM strategies are dependent on certain firm-specific, and, internal and external environmental contingencies. Only when strategies 'fit' the contingencies will there be a positive impact on firm performance. Such a framework might help explain the mixed response to the use of Internet portals in the trade press and the interviews. The application of this theoretical framework is further developed to answer the research questions posed earlier.

Chapter 5

Theoretical Framework

'It is the theory that decides what we can observe.'
Albert Einstein (Crainer, 1997)

This next section of the paper develops the theoretical framework and analytical methodology used, which is in keeping with the research framework recommended by Mentzer and Kahn (1995). Although Forrester (1958) started out articulating a theory for industrial dynamics that would help explain the inter-firm coordination of flows of information, materials, etc., the field of SCM has remained largely atheoretical without a central unifying theory (Chow et al., 1995; and, Stock, 1997). This is apparent from Appendix F where there is a dearth of literature that uses a theoretical framework as the basis for their work. The only studies that feature some theoretical basis are Chow et al (1995), structural contingency theory; and, Hobbs (1996), and Grover and Malhotra (2003), transaction cost economics. These studies however, only advocate their respective theories for the development of SCM research rather than apply their theories empirically for SCM theory building. Studies of IOS in SCM that use a theoretical basis for empirical research (see Bensaou and Venkatraman (1995), Reekers and Smithson (1996), Forster and Regan (2001) in Appendix H draw heavily on theory developed in the field of IOS.

5.1 Identifying a Theory

The use of theories from other disciplines to advance the field of logistics follows a trend identified and advocated by Stock (1997). He notes that logistics, and therefore SCM, being a new field, has borrowed concepts, definitions, theories, rules and principles from other fields as, scholars deliberately search for these in other related disciplines to avoid "reinventing the wheel". This also helps strengthen the linkages between logistics and the other disciplines, especially the business disciplines. Illustrating this fact Stock (1997) lists theories that have both been used, and could be used, to advance the study of logistics. Hence, Stock's (1997) recommendation for applying theory from other disciplines will be followed and relevant theories from the literature reviewed will be analyzed in order to choose an appropriate theory with which to address the research questions.

5.1.1 Transaction Cost Economics

The IOS literature in Appendix G illustrates the dominance of transaction cost economics as a theoretical framework for IOS research. As mentioned earlier transaction cost economics has also been recommended for theory building in SCM. This theoretical framework is most valuable when applied to determining the coordinating mechanism; marketplace versus hierarchy. For example, when should firms seeking to minimize transaction costs conduct inter-firm transactions in a marketplace (electronic market for IOS) versus a hierarchical vertically integrated (virtual inter-firm electronic integration via IOS) setting.

Grover and Malhotra (2003) review studies where this application of transaction cost economics in SCM is restricted to the macro view of inter-firm relationships as evident in buyer-supplier linkages and other downstream transactions between manufacturers and distributors. Hobbs (1996) for example, recommends that transaction cost economics can be used to test theories about SCM by explaining the existence of structures of firms and the nature of vertical coordination in a SC. At the macro level transaction cost economics can be used to illustrate how coordinating mechanism for purchasing ocean shipping services can be firmly established as a closely integrated hierarchical relationship between shipper and carrier. This is because transactions involving high asset specificity normally involve a long process of development and adjustment for the supplier to meet the needs of the customer; hence, such a process favors the continuity of relationships found in a hierarchy (Malone and Yates, 1987). This is true for products having complex product descriptions. In the case of the inter-organizational transactions between shippers and carriers, carriers offer very specialized and expensive assets for the movement of containerized freight. The post-OSRA'98 environment has made it conducive for very specific customizable service contracts between carriers and shippers. Ocean carrier contracts are therefore very complex and entail a lot of time and effort to prepare, and negotiate. Hence, in the case of inter-firm coordination for purchasing ocean shipping services, shippers have settled on a vertical coordinating mechanism using long-term contracts that establish the exact specifications and quantity of service with each carrier.

Such a macro view though does not suit the needs of the current study, which looks at the coordination of material flows between two stages of an international trans-oceanic supply chain. Grover and Malhotra (2003) suggest that the transaction cost economics framework can also be used to evaluate micro-level supply chain coordinating mechanisms, such as electronic proximity, for their effectiveness in improving supply chain performance. The authors recommend conducting these studies under varying configurations of product and SC architectures under conditions characterized by high or low levels of environmental uncertainty. The Bensaou and Venkatraman (1995) framework builds on among other theories, transaction cost economics, to do just that. The primary limitation to the use of this theory though is the focus on the economic dimensions of inter-organizational relationships (Bensaou and Venkatraman, 1995, 1996; and, Rikers and Smithson, 1996).

5.1.2 Structural Contingency Theory.

Structural contingency theory provides a useful theoretical framework for the inclusion of additional organizational variables that would represent the non-economic variables of inter-organizational relationships. This theory draws from the discipline of organizational structure design, specifically from the contingency theory. In its most abstract form contingency theory states that the effect of a variable X on another variable Y depends upon some third variable Z (Donaldson, 2001, p. 5). The fundamental principles as applied to the design of organizational structures are summed up by Galbraith (1973, p. 2; and, 1977, p. 28) as:

i) There is no one way to best organize, and
ii) Any way of organizing is not equally effective.

Structural contingency theory therefore, provides an explanation for the best way to organize to maximize *organizational effectiveness* (*Y*) by *fitting organizational characteristics* (*X*), such as structure, to internal and external environmental *contingencies* (*Z*) that reflect the situation of the organization (Donaldson, 2001, p. 1). An extension of the contingency theory view of firm organization is that firms need to continue to adapt over time by ensuring their organizational structure fits the relevant internal and external environmental contingencies to sustain good firm performance

Persson (1982) demonstrated the value of structural contingency theory in explaining the organization of the logistics function according to logistics task complexity. However, Chow et al. (1995, p. 299) observed that only one study (Pfohl and Zöllner, 1987) actually use contingency theory to explain the organization of the logistics function. Since Chow et al (1995), only two other logistics/SCM studies (Forster and Regan, 2001; and, Premkumar *et al*, 2005) study used structural contingency theory for the purpose of explaining logistics/SCM phenomena.

Nevertheless, the Fisher (1997) and Lee (2002) frameworks for organizing SCM strategies in accordance with demand and supply characteristics are essentially contingency theoretic approaches to organizing SCM. Using the contingency theory approach to analyze these frameworks, the demand and supply, and the internal characteristics (*Z* variables) of a supply chain can be seen as the external and internal characteristics (contingencies) respectively, to which the firm must fit organizational characteristics (*X* variables) in order to improve SC performance (*Y* variable). So in case of functional or innovative products a firm must organize their supply chain drivers (Inventory, Transportation, Facilities and Information) to change organizational characteristics to form an efficient or responsive supply chain respectively and thus improve SC performance (Fisher, 1997). Similarly, Lee's (2002) framework that extends Fisher's (1997) framework to include supply characteristics suggest organizing into risk-hedging or agile supply chains according to the demand and supply uncertainty (internal and external contingencies). For example, Srinivasan et al (1994) observe that as suppliers deliver a large variety of parts (internal contingency) and/or serve a large number of customers (external contingency) shipment discrepancy rates go up. Modifying organizational structure with customers using EDI however, enabled these suppliers to use the information driver of SCM to improve the timeliness and accuracy of delivery.

Similarly, although no reference is made to this theory, further justification for a structural contingency theoretic approach to advancing research in SCM and IOS is available throughout the literature. Daugherty et al. (1994) observe that the potential exists for firms to waste time and resources by becoming too responsive, and instituting programs that customers neither value nor want. In effect this demonstrates that firms are instituting organizational structures that do not fit external contingencies (customers' needs and wants) and hence result in reduced performance (waste of time and other resources). Premkumar (2000) observes that organizational design must be modified to ensure that information processing capability (organizational structure) matches task uncertainty (function of internal and external contingencies); a mismatch between the two

causes reduced performance. Even Grover and Malhotra (2003) who advocate the use of transaction cost economics, recommend conducting these studies under varying configurations of product and SC architectures under conditions characterized by high or low levels of environmental uncertainty, which are contingency variables. Other studies such as, DeLone and McLean (1992), and Stefansson and Tilanus (2000), acknowledge the need to use contingency variables to accurately account for different conditions and hence achieve results that are more realistic.

Hence, structural contingency theory appears to be especially useful in being able to explain the different coordinating mechanisms, IOS or non-IOS, which firms use for SCM. These coordinating mechanisms or structural organization decisions are chosen according to firms' particular needs, as defined by the relevant contingencies, in order to maximize performance. Structural contingency theory extends transactional cost theory by introducing structural contingencies to account for the economical impact of conducting inter-organizational transactions in different organizational contexts.

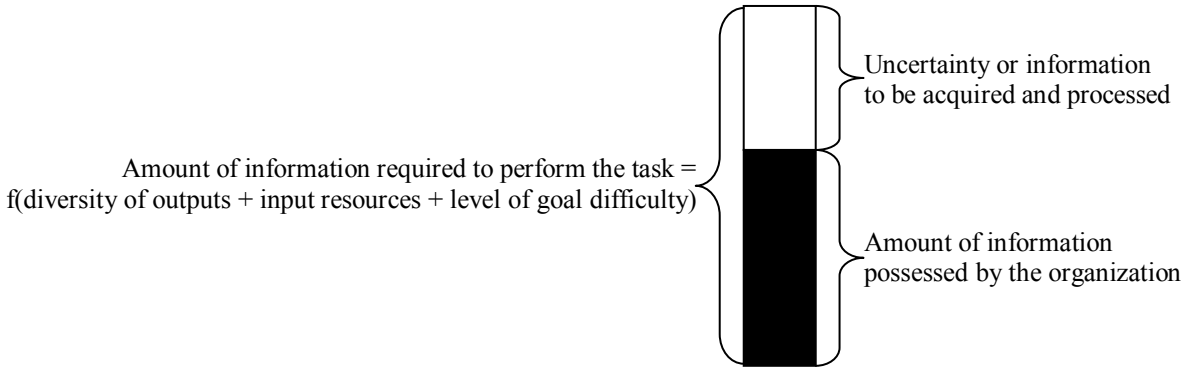
5.2 Information Processing Model

While transaction cost economics provides an economic basis for choice of coordinating mechanism, structural contingency theory provides an 'organizational structure' basis for matching the coordinating mechanism with environmental and structural contingencies for shippers to conduct day-to-day transactions with carriers. A theoretical framework that integrates both these theories is developed by Bensaou and Venkatraman (1995) and is based on Galbraith's (1977) information processing view of the firm.

5.2.1 Uncertainty

According to Galbraith (1977, p. 38) the greater the uncertainty of the task, the greater the amount of information that has to be processed between decision makers during the execution of the task. Uncertainty is defined as the difference in the amount of information that is required to perform a task and the amount of information already possessed by the firm (Galbraith, 1973, p. 5; and 1977, p. 36). Information is considered a function of: i) diversity of outputs; ii) input resources; and iii) the desired task performance required.

Figure 5-1: Determinants of information and task uncertainty



Source: Galbraith (1977, p. 38)

The effect of uncertainty is to limit an organization's ability to preplan or make decisions about activities in advance of their execution (Galbraith, 1973, p. 4; and 1977, p. 36). The information processing view of the firm is conceptualized in Figure 5-1 . From this, it can be inferred that Galbraith (1973, 1977) is suggesting that firms discover ways to: 1) organize in order to increase information processing capability to reduce uncertainty or 2) reduce uncertainty and thereby avoid increasing information processing capability. Fundamentally this can be explained by structural contingency theory as, the tendency of firms to find a fit between their information processing capability (*X*) and uncertainty contingencies (conceptualized as internal and external environmental factors – *Z*) in order to improve their task performance (*Y*). The strategy to do so would depend upon the circumstances that would dictate the most efficient and effective way by which the firm could eliminate uncertainty. If a firm's internal business processes were the source of uncertainty then an internal business process re-engineering would be able to eliminate that uncertainty, which could then lead to better performance. Conversely, if uncertainty arose externally in the firm's operating environment, over which it had no influence, then an increase in firm's information processing capability may be required to reduce uncertainty. The uncertainty plaguing international shippers is very apparent from the review of the industry in sections 2.2 and 2.3 of Chapter 2.

Galbraith's (1973, 1977) information processing view is restricted to the organizational structure design of a single firm. Bensaou and Venkatraman (1995, 1996) extend this to any inter-firm dyad. The information processing model proposed by Bensaou and Venkatraman (1995, 1996) in its simplest form in Figure 4-1 hypothesizes that firms organize their information processing capability to fit their information processing needs (determined by contingency variables) and thus achieve superior task performance. Bensaou and Venkatraman (1995, 1996) recommend the framework for prescriptive (normative) research. As mentioned earlier Forester and Regan (2001) used this framework to investigate the effect of the contingency variables on the relationship between electronic integration and SC performance of air freight forwarders. They used the concept of fit to demonstrate that electronic integration at air freight forwarders was wholly determined by the contingency variables suggested by Bensaou and Venkatraman (1995, 1996). Premkumar *et al* (2005) empirically test the information processing model's concept of fit between information processing requirements and capabilities. They do so by operationalizing the model in the procurement context across different products. Fit is assessed between product characteristics and IOS used for their procurement to judge the best IOS to be used for their procurement.

As has been demonstrated in these earlier studies, the empirical application of the framework will be used to address the research questions and explain the different levels of information coordinating capabilities that are best suited to the different levels of environmental uncertainty for optimum SCM.

5.2.2 Modeling Fit

An objective of the current study is to understand shippers' use of the information coordinating mechanisms to serve their shipping process requirements. This requires

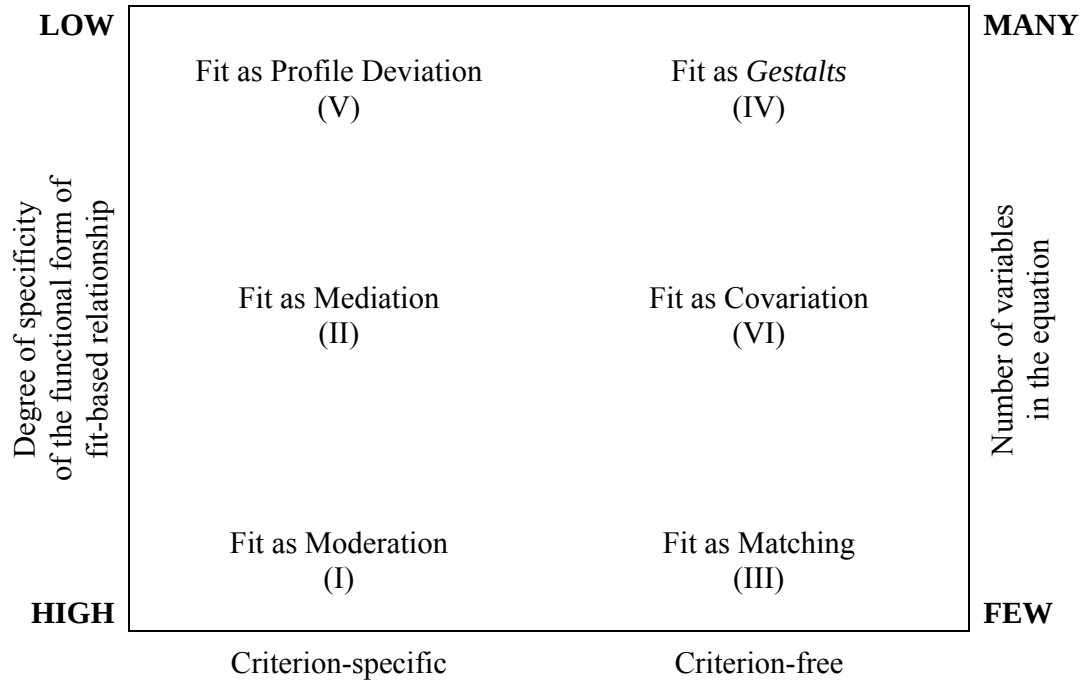
operationalizing the different information processing capability variables for planning, executing and coordinating the international SC processes including the shipping transactions using EDI, Internet portals and non-IOS. The complexity of the international ocean shipping process with the diversity of shippers the numbers of parties involved the numerous IS available and uncertain environment needs to be modeled effectively to generate meaningful results.

Venkatraman (1989) discusses six concepts of fit in organizational design research offering compelling arguments for aligning distinct theoretical meanings of fit with analytical requirements. These are:

i) Fit as Moderation: Used when the impact that a predictor variable (strategy) has on a criterion variable (performance) is dependent on the level of a moderator variable (contingency). Fit is operationalized moderated regression analysis.
ii) Fit as Mediation: Such a perspective suggests the existence of a significant intervening mechanism (contingency) between the predictor variable (strategy) and the criterion variable (performance). Fit is operationalized as a path analytic framework.
iii) Fit as Matching: A measure of fit between two related variables is developed independently of any criterion variable. The matching perspective has been operationalized by the deviation score analysis, the residual analysis and the analysis of variance (ANOVA).
iv) Fit as *Gestalts*: Is a multivariate perspective of fit developed through the identification of *gestalts* that are defined by their degree of internal coherence among a set of theoretical attributes. There are two major analytical issues. First, a cluster analysis is conducted to uncover the *gestalts*. Then the performance implications of fit are demonstrated by detecting the low performing and high performing *gestalts*.
v) Fit as Profile Deviation: Is the degree of adherence to an externally specified profile. Adherence to the profile positively relates to performance, while deviation from the profile implies weakness in the contingency-strategy co-alignment resulting in negative effect on performance. This form of fit has the hardest operationalization of fit primarily because a multivariate profile of fit needs to be specified *a priori*.
vi) Fit as Covariation: Is a pattern of covariation or internal consistency among a set of underlying theoretically related variables. Covariation is modeled as a second order factor analysis and differs from fit as *gestalts* in relation to the degree of specificity of the functional form of fit.

These conceptualizations of fit are classified in Figure 5-2 according to the number of variables used to evaluate fit; and, the specificity of performance criteria used to measure that fit.

Figure 5-2: Classificatory framework for mapping the six perspectives of fit in strategy research



Source: Venkatraman (1989, p. 245)

There is no *a priori* information on the best way for shippers to organize there use of the information coordinating mechanisms to best suit their firms' unique external environments and internal configurations. Hence, the degree of specificity of the functional form of fit between information processing needs and capabilities is unknown. This along with the need to use a large number of multi measure constructs to effectively model reality naturally selects either fit as profile deviation or fit as *gestalts* as the two possible methods to model fit. Fit as profile deviation is criterion specific and the degree of fit can be immediately assessed from shippers' shipping and supply chain performance. However, developing ideal profiles is operationally hard, although there are verbal statements to define the ideal strategies, it is difficult to translate these into numerical scores for creating the baseline ideal for modeling fit with deviation scores (Venkatraman, 1989). Moreover specification of the ideal profile requires exact knowledge of the ideal fit i.e.; the varying degrees of fit between information processing needs, and requirements that will affect the criterion variable (performance). A drawback of profile deviation highlighted by Umanath (2003) is that the results are not easily interpretable. Venkatraman (1989) recommends that early on in a research stream using exploratory perspectives that are less precise in specifying the functional form of fit are more appropriate but as the stream matures more confirmatory perspectives are more appropriate.

Bensaou and Venkatraman (1995) demonstrate how fit as *gestalts* can be used for such an exploratory study. Simultaneously studying a large number of attributes yields a small number of rich *gestalts* that can account for a large percentage of organizations providing a detailed holistic integrated image of reality within any giving setting. Umanath (2003)

also recommends a similar operationalization of fit in such a context. The systems approach specified by him models fit as *gestalts* that are characterized by holistic patterns of interdependencies simultaneously subjected to multiple contingencies. As the modeling of fit should be driven by the theoretical arguments of the research objectives rather than the convenience of available analytical techniques (Venkatraman, 1989; and, Umanath, 2003) the current study will use 'fit as *gestalts*' to model fit. Although the classificatory framework specifies fit as *gestalt* to be criterion free Venkatraman (1989) recommends testing the predictive validity of the *gestalts* by establishing the performance implications of fit. Bensaou and Venkatraman (1995) demonstrate this using a series of ANOVAs to test the performance implications of fit as defined by the *gestalts* on independent measures of shipping and supply chain performance. Hence, although not immediately prescriptive as compared to profile deviation, this approach provides some prescriptive value.

5.3 Operationalizing the Model

Bensaou and Venkatraman (1995, 1996) represents the model in Figure 4-1 using three dimensions each for information processing capability and information processing needs. Information processing capability is represented using: i) *structural mechanisms;* ii) *process mechanisms;* and, iii) *IT-mediated mechanisms*; while information processing needs is represented by: i) *environmental uncertainty*; ii) *partnership uncertainty*; and, iii) *task uncertainty*.

5.3.1 Information Processing Capability

Firms can modify the levels of the information processing capability constructs of the inter-organizational dyad to fit the levels of uncertainty arising from the internal and external environmental contingencies – information processing needs.

5.3.1.1 Structural Mechanisms

Bensaou and Venkatraman (1995) explain *structural mechanisms* as rules and procedures, direct contacts, liaison roles, integral roles, task forces, and teams, which fit along a continuum with respect to their relative capability for reducing uncertainty. This definition stems from Galbraith's (1977, pp. 52-55) explanation of coordinating mechanisms to reduce uncertainty. The objective of the current study though is to explain the fit of IOS and non-IOS coordinating mechanisms, hence, for the sake of simplicity the structural mechanisms constructs will not be considered here. This dimension was similarly excluded from the Forster and Regan (2001) study of IT related coordination mechanisms in the air freight forwarder industry; and, the Premkumar *et al* (2005) study of fit between IOS and uncertainty contingencies in the procurement life cycle of various products.

5.3.1.2 Process Mechanisms

Bensaou and Venkatraman (1995, 1996) define *process mechanisms* as the socio-political climate within which the *structural mechanisms* are embedded. Such a climate ranges from one of cooperation to one of conflict and affects the amount of information exchanged between the two firms. The current study is concerned with the exchange of transactional information in the context of trans-oceanic supply chains. Information

exchange therefore, is a function of the transactions initiated by shippers and is not a function of the cooperative-conflicting relationship of shippers with their supply chain partners. This dimension would be useful when considering the information exchange at a strategic level with the carrier . It is not useful when considering coordinating mechanisms for transactional information exchange on a day-to-day context and will be therefore eliminated from this study. Again, Forster and Regan (2001) and Premkumar *et al* (2005) do not consider this particular dimension for their study. Hence, the political economy theory from which this dimension was developed will not be reviewed.

5.3.1.3 IT-Mediated Mechanisms

Bensaou and Venkatraman (1995, 1996) define *IT-mediated mechanisms* as the use of IT for facilitating inter-organizational coordination. In their application of the information processing model to U.S. and Japanese auto manufacturers, the authors represent this dimension using constructs for: i) *scope of IT use*, ii) *intensity of IT use*, iii) *EDI use in purchasing*, and iv) *EDI use in engineering*. Forster and Regan (2001) use: i) *IT investment*, ii) *IT technologies used*, iii) *intensity of use*, and iv) *IT connectivity with partners*; to represent the organizational structure dimension of *IT mediated mechanisms*. Premkumar *et al* (2005) use four different types of IOS to operationalize this construct.

Due to the uncertainty involved in the international ocean shipping process shippers seek to increase their information processing capability, as argued above using Galbraith's (1973, 1977) information processing view of the firm. One of the objectives of this current study is to explain which IOS or non-IOS information coordinating mechanisms shippers choose to facilitate their ocean shipping process, and explain why. In this regard, this dimension should at the very least include a construct for *intensity of use* for each of the information coordinating mechanisms considered: i) *non-IOS*, conventional channels of communication such as, phone, fax, e-mail, and courier; ii) IOS, *EDI*; and iii) *IOS, Internet Portals*.

However, the ocean shipping process is only a small part of the order fulfillment process as defined by Croxton et al (2001). In order not to account for all the variability among the high and low performing *gestalts i*t is necessary to the IOS and non-IOS connectivity for all aspects of the order fulfillment process that contribute to shipping and supply chain performance. First, an order is generated and communicated. Next, the order is received, entered and processed. Then inventory is checked and the order is filled from inventory or from a production run. Finally, transportation is arranged with appropriate packaging and documentation and the order is monitored until delivery confirmation. Timely filling of orders is contingent on the timely receipt of orders. Forster and Regan (2001) hypothesize that the greater the number of connections the greater is the information processing capability. Srinivasan et al (1994) found that suppliers with a higher percentage of EDI partners and who handled a higher percentage of customers electronically performed better and had lower shipment errors. Hence, *IOS connectivity with external SC partners* will be used as a construct of *IT-mediated mechanisms*. Besides, external IOS integration, the IOS and SCM literature also suggests improved internal integration of IOS and information systems as improving information processing capability. Right at the start of the order fulfillment process a firm needs to have good

internal information coordination to generate and communicate an order in a timely manner. Daugherty et al (1994) demonstrate that besides improving external relationships, responsive firms improve intra-firm inter-functional information sharing to gain greater efficiency. Srinivasan et al (1994) found that firms who were able to map IOS data directly into their own firm's information systems were able to reduce data errors and improve timeliness and accuracy of shipments. Hence, *internal integration of IOS* i) with firms' information systems, and ii) between firms' functional areas, will also be considered as a construct of *IT-mediated mechanisms*.

Measures of IT-mediated Mechanisms

As is apparent from the transaction-information flow charts for each coordinating mechanism (non-IOS – Appendix C, EDI – Appendix D, Internet – Appendix E) transaction-information flows are bi-directional. Hence, shipping transactions have been further broken down into their component tasks, these are defined in Table 5-1 . The intensity of use of the IOS and non-IOS for each of the shipping transactions will be considered separately.

Table 5-1: Shipping transaction tasks

Shipping Transactions		***Description***
i)	*Shipping Schedule Lookup*	Task of looking up carriers' shipping schedules to plan shipments and make bookings.
ii)	*Booking Request*	Booking space for a shipment on a particular vessel schedule.
iii)	*Booking Confirmation*	Confirmation received from the carrier confirming, declining or recommending alternative schedule.
iv)	*Booking Cancellation*	A request made by the shipper to cancel a previously made booking.
v)	*Shipping Instruction Filing*	Detailed cargo information and other shipping instructions sent by the shipper to the carrier after booking is confirmed.
vi)	*Bill of Lading Information Receipt*	Receiving appropriate B/L information to ensure related activities such as freight payment, goods release, and payment for goods, may be carried out.
vii)	*Bill of Lading Information Sharing*	Sharing appropriate B/L information to ensure related activities such as freight payment, goods release, and payment for goods, may be carried out.
viii)	*Tracking and Tracing*	Information provided by carriers to shippers on current status of shipments in carrier's system.

IOS and non-IOS use

IOS (EDI or Internet) use or non-IOS use can be measured by the actual use of these information coordinating mechanisms for the purpose of conducting the shipping transactions. In order to reduce the complexity and size of the study and also the measurement instrument this study is limited to transactions that were identified being of primary concern to U.S. importers (listed in Table 5-2). To further reduce the complexity of the analysis and measurement instrument measures were collected for the typical type of full container shipment on a shipper's most significant trade lane. Recognizing that shippers would communicate with their OTI as if they were the carriers, measures were collected for such shippers, as if the OTI were the carrier. The concern for realism of the study articulated by Mentzer and Flint (1997) was addressed by ensuring that the

simplified scenario solicited from the respondent would be as close to the real situation facing the respondent everyday, as described by the information gathered in the preliminary interviews reported in Section 3 and pre-tested in the survey pilot. 'Use' will be measured by the perceived use of each information channel for a firm's typical annual shipping needs defined by the survey and as illustrated in Table 5-2.

Table 5-2: Measures of information channel use

Perception of how often a communication channel is used for each shipping transaction.

Scale:

Never	Very Seldom	Seldom	About half the time	Often	Very Often	Always
1	2	3	4	5	6	7

	Shipping Transactions	***Conventional***	***EDI***	***Internet Portal***
(a)	*Shipping Schedule Lookup (323)**			
(b)	*Booking Confirmation (301)**			
(c)	*Bill of Lading Information Receipt (310)**			
(d)	*Track and Trace (312, 313 & 315)**			

* EDI Transaction Sets.

External & Internal IOS Connectivity

Measures of *internal IOS connectivity* were reviewed from Srinivasan et al (1994), Forster and Regan (2001), Frohlich and Westbrook (2001), Stank et al (2001), and Frohlich (2002) and are presented in Table 5-3 .

Table 5-3: Measures of *internal IOS connectivity.*

	0	<1	1-5	6-10	>10
(II1) For how many years has your firm been using Enterprise Resource Planning (ERP) software:	☐	☐	☐	☐	☐

	Agree				*Disagree*
(II2) My firm maintains an integrated database and access method to facilitate information sharing.	1	2	3	4	5
(II3) My firm effectively shares information between departments. †	1	2	3	4	5
(II4) My firm has adequate ability to share both standardized and customized information internally. †	1	2	3	4	5

Similarly, measures for *external IOS connectivity* were reviewed from Srinivasan (1994), Forster (2001), Stank et al (2001), and Lewis and Byrd (2003) and are presented in Table 5-4 .

Table 5-4: Measures of external IOS connectivity.

	0%	1-10%	11-30%	31-60%	60+%
(EI1) Please provide your best estimate of the percentage of suppliers with whom your firm has an EDI or Internet communication link	☐	☐	☐	☐	☐
(EI2) Please provide your best estimate of the percentage of customers with whom your firm has an EDI or Internet communication link	☐	☐	☐	☐	☐

	Agree				*Disagree*
(EI3) My firm effectively shares operational information externally with suppliers.	1	2	3	4	5
(EI4) My firm effectively shares operational information externally with customers.	1	2	3	4	5
(EI5) My firm has implemented web-based processes with suppliers for procurement of materials.	1	2	3	4	5
(EI6) My firm has implemented web-based integrated processes for inventory planning with suppliers.	1	2	3	4	5
(EI7) My firm has implemented web-based integrated processes for order scheduling with suppliers.	1	2	3	4	5
(EI8) My firm has implemented web-based integrated processes for demand forecasting with suppliers.	1	2	3	4	5
(EI9) My firm has implemented web-based integrated processes for inventory planning with customers.	1	2	3	4	5
(EI10) My firm has implemented web-based order-receipt processes for customers.	1	2	3	4	5
(EI11) My firm has implemented web-based after sales service support for customers.	1	2	3	4	5
(EI12) EDI and Internet portal data from ocean carriers can be seamlessly integrated into my office systems	1	2	3	4	5

	0	1-5	6-10	11-20	>20
(EI13) For how many years has your firm been using EDI to communicate with external business partners?	☐	☐	☐	☐	☐

5.3.2 Information Processing Needs

The information processing needs arise from internal and external environmental contingencies that lead to uncertainty. Donaldson (2001) categorizes contingencies from structural contingency theory as within organizations: 1) *task uncertainty*, 2) *task interdependence*, and 3) *size*; and outside organizations: *environmental uncertainty*. These have been included in Bensaou and Venkatraman's (1995) framework to operationalize the relevant contingency constructs. Suitable contingencies that are relevant to the ocean shipping context from both the Bensaou and Venkatraman (1995) and Forster and Regan (2001) studies are considered here.

5.3.2.1 Environmental Uncertainty

Bensaou and Venkatraman (1995) suggest three dimensions for *environmental uncertainty*: 1) capacity, 2) complexity, and 3) dynamism (see also Donaldson, 2001, pp. 19-20). *Capacity* is the extent to which the environment can and does support growth. High growth environments result in greater uncertainty and hence the need for greater information processing. Bensaou and Venkatraman (1995) operationalized *capacity* using *market growth*. *Complexity* is the range and heterogeneity of a firm's activities. The greater the inputs (suppliers/components) and the greater the outputs (customers/products), the more complex a firm's environment and hence, the greater the information processing requirement. Bensaou and Venkatraman (1995) operationalized

complexity using *product customization*, ranging from a highly specialized to a standardized product. Finally, *dynamism* is the degree to which the contingencies remain the same over time or are in a continual process of change. Bensaou and Venkatraman (1995) operationalized *dynamism* using *technical complexity of a product*, ranging from a mature to a new technology. Forster and Regan (2001) focus on this last dimension of environmental uncertainty. They interpret environmental *dynamism* in terms of the environmental instability that affects decision makers. Their argument is that when an environment is stable, firms can preplan and reduce much of the uncertainty and therefore, the information required during task execution. When the environment is unstable there will be greater instability and hence more information required during task execution. Forster and Regan (2001) operationalize environmental *dynamism* using the dynamism of a firm's market and industry environment.

Measures for Environmental Capacity

In the case of the current problem, the environmental *capacity* can be operationalized using *market growth*, the construct developed by Bensaou and Venkatraman (1995). Hence, shippers who find themselves in mature markets are faced with less uncertainty and hence need less information, while shippers in high growth markets are faced with a higher degree of uncertainty and, hence, need more information to execute the order fulfillment process and hence the ocean shipping transaction. This measure is shown in Table 5-5 .

Table 5-5: Measure of environmental capacity

	Growing		*Stable*		*Declining*
(EE1) The market growth for your organization's product(s) can be best described as:	1	2	3	4	5

Measures for Environmental Complexity

Complexity is an interesting dimension for the order fulfillment and ocean shipping process. Bensaou and Venkatraman (1995), and Premkumar *et al*. (2005) use product complexity in a procurement context as a proxy for environmental complexity. Forster and Regan (2001) do not operationalize a construct for environmental complexity. It is important that environmental complexity is considered in this study given the earlier discussion on the complexity of the ocean shipping process.

Murphy and Daley (1996) found that international freight forwarders (IFFs) who offer a 'one-stop-shop' all-inclusive service are more likely to use and view EDI use as important than their counterparts who offer services that are more basic. Srinivasan et al (1994) found that auto part suppliers who deliver a large number of parts to a large number of customers are the most likely to benefit from the use of EDI links with their customers. Both these relate to the number of inputs and outputs, which affect the uncertainty and information required to conduct a task. Hence, in the case of an ocean shipper the *complexity* dimension of *environmental uncertainty* can be represented by the *number of suppliers* from whom products are being bought and shipped by ocean (variety of inputs) and the *number of customers* to whom the shipper is delivering finished

products or goods (outputs). Another aspect of complexity is the *number of parties involved* in an ocean shipment. As mentioned earlier, shippers may outsource or maintain in-house any combination of functions to support the ocean shipping task. Therefore, the greater the number of outsourced functions the less the information is required to conduct a task. However, greater information may be needed to coordinate tasks between all parties to ensure successful execution of the shipment. Hence, in the absence of any similar studies in this area, it is not clear whether greater outsourcing results in more or less information requirements. Finally, *size* is an oft-used contingency in the organizational theory literature (Donaldson, 2001, p. 21). In the context of structural contingency theory size is synonymous with number of employees or some sort of membership variable. In the current context of international shipping firms may organize differently and the international shipping tasks may be conducted by several disparate and disjoint departments, which may not be properly identified when seeking the proper number of employees involved in international shipping. Hence, in this study it is proposed that size of a firm is related to the number of transactions conducted by a shipper, therefore, as transaction volumes increase so does uncertainty and hence, information requirement. The premise is based on observations made by Barett and Konsynski (1982) that large firms have a high volume of orders, which require large order processing capacity and hence, obtain more benefit from adopting IOS than smaller firms. Also, as large shippers have more containers in the ocean transportation pipeline this increases the likelihood of exceptions and the associated uncertainty, therefore, requiring more information to execute the task. Shipper size will be determined by the number of transactions conducted with carriers, which depends upon the number of containers shipped annually. Hence, the number of containers shipped annually is used as one measure to determine shipper's size. Another measure that can be used to measure shipper size, is total annual value of shipments. A shipper may not have too many containers to ship annually but because of the value of each container the information requirements could increase regarding accurate, updated shipment schedules, accurate timely B/L information, and tracking & tracing. Hence, total annual value of shipments is used as another measure of shipper size. While the previous measures are illustrated in Table 5-6 below the measures for shipper size were calibrated on a 6 point scale from the PIERS Importers Database.

Table 5-6: Measures of environmental complexity

	<5	5-25	26-100	101-500	>500
(EE2) Number of overseas suppliers from whom you import.	☐	☐	☐	☐	☐
(EE3) Number of customers who you export your finished products.	☐	☐	☐	☐	☐
	0	1-5	6-10	11-20	>20
(EE7) International Freight Forwarders/NVOCCs	☐	☐	☐	☐	☐
(EE8) Inland Carriers	☐	☐	☐	☐	☐
(EE9) Ocean Carriers	☐	☐	☐	☐	☐
(EE10) Customs house brokers	☐	☐	☐	☐	☐

Measure for Environmental Dynamism

Environmental dynamism in the order fulfillment and ocean shipping process can be operationalized using the *environmental stability* argument presented by Forster and Regan (2001) above. Shippers facing greater instability in their supply environment or customer demand environment will face greater uncertainty and hence face a greater

requirement for information. This argument is also used in Fisher's (1997) and Lee's (2002) framework for SCM strategies to fit the supply and demand environment. A related aspect is that of shippers facing seasonal demand. Barett and Konsynski (1982) observe that seasonality can result in unbalanced resource (personnel, IS) utilization, hence firms with high seasonality would face greater benefits from use of inexpensive IOS links to increase information processing capability at peak periods, than those firms with low seasonality. The measures for environmental dynamism are listed in Table 5-7.

Table 5-7: Measures of environmental dynamism

	Unstable				*Stable*
(EE4) Finished products *demand*.	1	2	3	4	5
(EE5) Materials and components' *supply*.	1	2	3	4	5
	Seasonal				*Unseasonal*
(EE6) Finished products demand.	1	2	3	4	5

5.3.2.2 Partnership Uncertainty

Related to the information processing capability construct of *process mechanism* is the information processing requirements' contingency construct of *partnership uncertainty*. This is defined by Bensaou and Venkatraman (1995) as the uncertainty a dyad member experiences about its relationship with the other member. In the case of shippers and carriers, transaction cost economics was used to argue that their explicit contractual relationships are characterized by hierarchical vertical coordination. Bensaou and Venkatraman (1996) suggest that in the case of hierarchical structures *task uncertainty* should be the relevant construct. Furthermore, the measures of *partnership uncertainty*: 1) goal compatibility; 2) trust; and 3) power-dependence are not relevant in the current context of the shipper-ocean carrier information coordinating mechanism. This is again because of the explicit contract between the two, where the goals are established in the contract, trust is implicit in the contractual arrangements where penalties (demurrage and minimum quantity tenders) are levied, and power-dependence effects are played out in the contract negotiations. Any trust and power-dependence effects will be implicitly manifested in the other contingency variables. Partnership uncertainty plays a role during the contract negotiation stage but is not specifically relevant at the operational stage of order fulfillment or ocean shipment.

5.3.2.3 Task Uncertainty

Bensaou and Venkatraman (1995) consider *task uncertainty* as a function of three constructs: 1) *task analyzability*; 2) *task variety*; and 3) *task interdependence*. Bensaou and Venkatraman (1995) have decomposed the *task uncertainty* contingencies into more general information processing needs constructs, which capture the necessary effects of task uncertainty. Hence, these constructs of *task uncertainty* will be used.

Measures of Task Analyzability

Bensaou and Venkatraman (1995) define *task analyzability* as the extent to which there is a known procedure that specifies the sequence of steps to be followed in performing a task. Tasks that can be decomposed into well defined steps are highly analyzable and lend themselves to preplanning, thus, give rise to less uncertainty. Hence, the clarity with which shippers' have defined the steps in their ocean shipping process will determine the information needs required to execute the task. In the context of the ocean shipping process the definition of *task analyzability* and hence the construct and measures are easily transferable from the Bensaou and Venkatraman (1995) study. These were also used by Forster and Regan (2001) and are listed in Table 5-8.

Table 5-8: Measures of task analyzability.

	Agree				*Disagree*
(TA1) There are clearly established procedures and practices to guide the planning, execution and monitoring of shipments in your organization	1	2	3	4	5
(TA2) Your job is clearly defined in detail.	1	2	3	4	5

Measures of Task Variety

Bensaou and Venkatraman (1995) define *task variety* as the number of exceptions or the frequency of unanticipated and novel events, which require different methods or procedures for doing the job. The degree of regularity in the shipment process will determine the uncertainty and therefore, the information requirements to execute the task. Hence, t*ask variety* can also be directly extrapolated from the Bensaou and Venkatraman (1995) and Forster and Regan (2001) studies to the current study and are reproduced in Table 5-9.

Table 5-9: Measures of task variety.

	Agree				*Disagree*
(TV1) The same shipping tasks are largely done in the same way most of the time	1	2	3	4	5
(TV2) Operational problems frequently arise for which there are no standard solutions	1	2	3	4	5
(TV3) Most operational problems are routine and have routine solutions	1	2	3	4	5

Measures of Task Interdependence

Bensaou and Venkatraman (1995) define *task interdependence* as, "the extent to which personnel responsible for executing a task are dependent upon one another to do their individual job." Hence, the more interdependence, the greater the information processing need. Donaldson (2001, p.19) defines *task interdependence* as being specific to internal environmental contingencies related to firm strategy. These include contingencies that define in what ways functions within organizations are connected with each other: pooled (indirect connection), sequential (direct, one-way connection), and reciprocal (direct, two-way connection. The *task interdependence* construct that is proposed for this study is modified from the one developed by Bensaou and Venkatraman (1995) for *task*

interdependence between the focal firm and the external supplier of services (ocean carrier, OTI, inland carrier, customs house broker) and is listed in Table 5-10.

Table 5-10: Measures of task interdependence.

	<5%	5-10%	11-25%	26-50%	>50%
(TI) Please estimate how much of your total ocean shipping job is spent interacting with the information systems or personnel of service providers listed in **A4** above	☐	☐	☐	☐	☐

5.3.3 Performance Measures

Fit between the *information processing needs* and the *information processing capability* will determine the performance of the firm. This concept of fit is represented by Bensaou and Venkatraman (1995, 1996) in Figure 4-1. In the current study the *information processing needs* arise from the different internal and external sources of uncertainty that arise during the ocean shipping process. To counter their firm specific uncertainties it is hypothesized that shippers use different configurations of *IT-mediated mechanisms* in order to achieve maximum effectiveness from the ocean shipping process. As seen earlier in chapter 3 on Liner Shipping, the ocean shipping process has an effect on various internal logistics costs and external downstream SC tasks and processes. Hence, any evaluation of fit in this context would require appropriate shipping and supply chain measures.

5.3.3.1 Supply Chain Performance

Chow et al (1994) look at logistics performance as a multi-dimensional subset of the larger notion of firm or organizational performance. Lai et al (2002) also advocate a multi-dimensional measure for evaluating supply chain performance in transport logistics. Ganeshan et al (1999) noted that financial measures have dominated empirical research in SCM. However, the authors note that these measures are not effective in capturing SC performance. At best these measures are too summarized and at worst provide a misleading picture of firm performance. Hence, they advocate the use of operational measures, which provide a more timely and direct indication of SC performance. Also, DeLone and McLean (1992) noted that researchers tend not to use organizational level performance measures because of the difficulty of isolating the IS effect from the others that affect organizational performance. The same applies to the difficulty of isolating the SCM effect on firm performance. Lambert and Pohlen (2001) reviewed the SCM literature and concluded that most of the metrics being used were logistics measures that had an internal focus, which could prove to be dysfunctional by attempting to optimize own firm's performance at the expense of the others in the SC. Brewer and Speh (2000) also note that such traditional logistics measures, although useful to isolate individual problems in firms within a SC, are neither adequate to assess SC performance nor embody measures that motivate employees to behave with a SC orientation. Hence, Brewer and Speh (2000) advocate a balanced approach using Kaplan and Norton's (1996) balanced scorecard to develop appropriate measures of supply chain performance. They integrate the four goals of SCM with the four areas that support balanced performance measurement to define a balanced framework for SC performance measurement. The four goals of SCM as defined by Brewer and Speh (2000) are: 1) waste reduction; 2) time compression; 3) flexible response; and 4) unit cost reduction. The four areas that support balanced performance measurement are: 1) customer

perspective; 2) internal business process perspective; 3) innovation and learning perspective; and 4) financial perspective. Such a framework can be used to define appropriate supply chain performance measures that reflect the performance output as it applies to the SC as opposed to only that of the firm.

Both the Bensaou and Venkatraman (1995) and Forster and Regan (2001) studies use operational measures that are more appropriate to the context of the study. However, neither of the studies uses a balanced approach to performance measurement. Bensaou and Venkatraman (1995) operationalize firm performance using three constructs: 1) supplier ratings – evaluated by the internal manufacturers' team, across ten dimensions of performance; 2) *satisfaction* – perceived satisfaction with supplier across seven dimensions of supplier satisfaction; and 3) the levels of inventory held at four different points between supplier and manufacturer. These are very specific to the auto supplier-manufacturer dyad relationship studied. Bensaou and Venkatraman (1995) include a customer and financial component, but do not include an internal business process component to their performance measurement. Forster and Regan (2001) only use a uni-dimensional measure of on-time delivery performance, which, nevertheless, is appropriate as a component of the total performance measurement for the current study.

Caplice and Sheffi (1994), discuss how to choose appropriate SC performance measures depending upon a trade-off between the specificity versus comparability versus usefulness (to provide actionable guidance) of the measure. In this study, measures that can be generalized across the population of shippers are required to enhance comparability and the effectiveness of the results. Beamon (1998) offers a variety of qualitative and quantitative performance measures for the different categories of the Brewer and Speh (2000) balanced scorecard framework. These include measures relevant to the current study such as: 1) customer perspective – customer satisfaction, fill rate, product lateness, customer response time, lead time; 2) internal business process perspective – flexibility; and 3) financial perspective – total cost, and inventory cost. Gunasekaran et al (2001) enumerate an exhaustive list of financial and non-financial strategic, tactical and operational performance measures. They also classify performance measures according to the process links in the SC as defined by the SCOR model. This classification provides a convenient means of identifying operational performance measures that affect shipment performance at each stage of the ocean shipment process.

The above discussion therefore motivates this study to identify operational performance measures that can be compared across the whole population of shippers and that reflect the balanced measure of shippers SC performance as affected by the effective management of the ocean shipping transaction.

5.3.3.2 Performance Measures

Gunasekaran et al (2001) states that delivery performance relies heavily on the quality of information exchanged. Hence, in the current context, delivery performance is an important measure of shipment task performance. Caplice and Sheffi (1994) also recommend transit time and on-time performance as important metrics for logistics performance. Forster and Regan (2001) use a multiple measure on-time performance,

which is adapted for use here. However, in order to develop an effective, balanced, multi-dimensional construct for shipping task performance that can be compared across the entire population of shippers other measures have to be incorporated using the criteria suggested above. Chow et al (1994), Beamon (1998), and Brewer and Speh (2000) all recommend some form of order cycle, delivery cycle, transit or lead time compression as alternate measures of delivery performance. Besides, cash-to-cash or order-to-cash cycle times are impacted by on-time deliveries and meet the balanced approach to SC performance recommended by Brewer and Speh (2000) and Gunasekaran et al (2001).

Cost effectiveness is an important generic measure for supply chain performance. There is an important trade-off between cost and SC performance. If a firm has to stretch its financial resources to meet its targeted SC performance then that could be sub-optimal for the SC as a whole. Fisher (1997) and Lee (2002) both demonstrate this trade-off in their guidelines for SC design strategy. Hence, according to the customer requirement a SC may either be cost efficient with low service or high cost with effective service. Chow et al (1994), Caplice and Sheffi (1994), Beamon (1998), Gunasekaran et al (2001), Brewer and Speh (2000), and Lambert and Pohlen (2001) all recommend cost efficiency as a measure of SC performance, because of this key trade-off between cost efficiency and service effectiveness. In the current context the effectiveness of the SC output is measured using the on-time delivery performance, while the cost of delivering that service would provide the other dimension of SC performance. Hence, the costs of delivering shipping services to internal and external customers are used to measure this dimension of SC performance.

Finally, using the balanced score card approach both Brewer and Speh (2000), and Gunasekaran et al (2001) recommend viewing SC performance from the customer's perspective. Hence, appropriate measures for SC performance as seen from the customers' perspective are developed to measure shipping task performance. All these measures for shipping transaction performance discussed above are enumerated in Table 5-11. A single weighted measure of on-time delivery performance is computed from the component measures a-e of SPRC in Table 5-11.

Table 5-11: Measures for shipping transaction performance.

On time performance

	<5%	**5-25%**	**26-50%**	**51-75%**	**76-90%**	**91-95%**	**>95%**
(SP1) Just before or at the estimated delivery time	☐	☐	☐	☐	☐	☐	☐
(SP2) 1 day after the estimated delivery time	☐	☐	☐	☐	☐	☐	☐
(SP3) 2 days after the estimated delivery time	☐	☐	☐	☐	☐	☐	☐
(SP4) 3 days after the estimated delivery time	☐	☐	☐	☐	☐	☐	☐
(SP5) >3 days after the estimated delivery time	☐	☐	☐	☐	☐	☐	☐

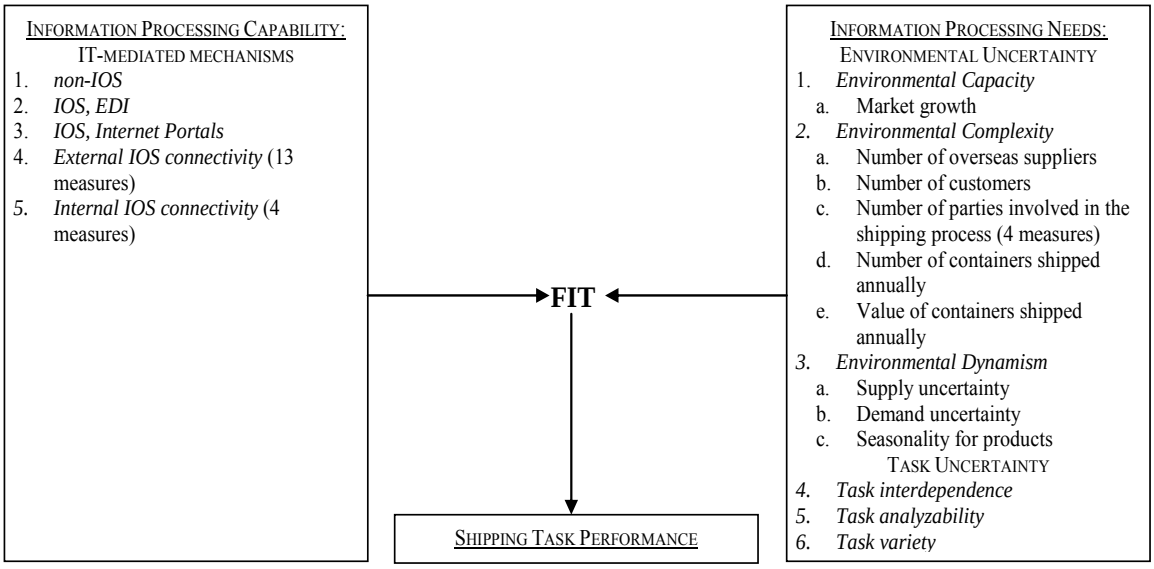
Performance Measures

	Agree				*Disagree*
(SP6) The number of shipments missing their scheduled departures is insignificant.	1	2	3	4	5
(SP7) Your organization's order cycle time is satisfactory and being managed effectively.	1	2	3	4	5
(SP8) Your organization's order-to-cash cycle time is satisfactory and being managed effectively.	1	2	3	4	5
(SP9) Your organization's labor costs for managing ocean shipments is satisfactory, and being managed effectively.	1	2	3	4	5
(SP10) Your organization's cost of communication for managing ocean shipments is satisfactory, and being managed effectively.	1	2	3	4	5
(SP11) Your organization's total cost of international ocean shipping is satisfactory and being managed effectively.	1	2	3	4	5
(SP12) The cost of expedited shipments is minimal.	1	2	3	4	5
(SP13) Your organization's internal/external customers are very satisfied with the delivery performance of international ocean shipments.	1	2	3	4	5
(SP14) Your organization provides rapid and accurate responses to internal/external customer queries in order status.	1	2	3	4	5
(SP15) Your organization is able to respond rapidly to special internal/external customer requests for changes to orders.	1	2	3	4	5

5.4 Analytical Model

The information processing model can be operationalized for the purpose of the current study as illustrated in Figure 5-3. From the classic contingency model *IT-mediated mechanisms* are the independent variables, *information processing requirements* are the contingency variables, while *shipping task and supply chain performance* variables are the dependent variables.

Figure 5-3: Conceptualization of the information processing model for the ocean shipping process, modified from



Source: Forster and Regan (2001, p. 50)

This model along with the supporting theory and the chosen form of fit will be used to uncover the *gestalts* that will explain shippers' use of information coordinating

mechanisms for the ocean shipping process and identify the best performing *gestalts*. This will answer the research questions posed in Chapter 2 and reproduced below.

i) How do shippers employ the different IOS & non-IOS to serve their shipping process requirements?
ii) How can shippers employ the different IOS & non-IOS to best serve their shipping process requirements and improve shipping performance?

The first research question seeks to uncover the *status quo* describing how shippers utilize the current set of *IT-mediated mechanisms* to manage their international shipping process requirements. The contingency constructs would provide an understanding of how shipper facing varying intensities of *environmental uncertainty*, and *task uncertainty* differ in their use of the *IT-mediated mechanisms* available for the order fulfillment process and specifically for the ocean shipment process.

Answering the second question would offer normative advice to shippers on how to best utilize the available *IT-mediated mechanisms* to manage their international container shipping requirements to suit their specific i*nformation processing needs*. This will be achieved by modeling the goodness of 'fit' between shippers' *IT-mediated mechanisms* and *information processing needs*; when the two constructs are in 'fit' then shipping and supply chain performance is better than when the two constructs are not in fit.

5.5 Summary

This chapter reviewed alternative theoretical basis and proposed a unified theoretical framework for answering the research questions. The framework developed by Bensaou and Venkatraman (1995) extends Galbraith's (1973) information processing view of the firm to an inter-organizational level of analysis using transaction cost economics and structural contingency theory. The concept of fit was discussed and the modeling of 'fit as *gestalts*' for the purpose of this study was justified. The model was then operationalized with discussion on appropriate measures for the constructs to address the research questions. In the next chapter the data collection and data analysis procedures are reported.

Chapter 6

Data Collection & Analysis

6.1 Data Collection

Data were collected using a mass mailing survey instrument employing the techniques to improve response rates proposed by Larson and Poist (2004).

6.1.1 Survey Pretest

In the design stage the survey instrument was pre-tested for content validity in three iterative steps. The purpose of each step of the pretest was to: 1) identify questions that could not be understood or could be confusing to respondents; 2) gauge if all questions could be understood and completed by a single person and determine the principal respondent; and, 3) determine how long it took to complete the survey.

The first stage of the pretest involved detailed feedback from the project committee on specific items of survey design and items scaling. In the second stage the survey was piloted with experts drawn from the membership of the Center for Supply Chain Research at Penn State, and participants in the exploratory interviews. The pretest instrument was sent to senior executives at shipper firms, public portal service providers, OTIs and carriers. Following the techniques to improve response rate proposed by Larson and Poist (2004) respondents were offered the incentive of having a $50 donation made in their name to a charity of their choice. Of the 36 firms who received the surveys, ten were returned for a response rate of 27.8%. In the third step, three respondents to the pilot test were involved in detailed interviews offering recommendations to reduce the length of the survey simplify the language of the questions and identify a suitable principal respondent at a shipper who would be best suited to complete the survey.

Based on the responses and feedback at each stage of the survey, the study was narrowed to focus on U.S. shippers importing into North America. As a result the survey length was reduced by half. The principal respondent at shipper firms was identified as an import/export or international shipping manager in-charge of, or familiar with, international ocean container shipping operations.

6.1.2 Survey Administration

The first round of surveys was administered through the U.S. mail. The survey mail packet included the following items:

- Personalized cover letter from the Center for Supply Chain Research (CSCR) that sponsored the research – Appendix I.
- Seven page survey questionnaire – Appendix J.
- Postage-paid return envelope.

The mailing list was compiled from the 2003 PIERS database of US importers that is compiled from the population of shipments that are processed through U.S. Customs. This consists of virtually every import shipment into the U.S. in 2003 and hence would consist of every U.S. importer active in the year 2003. Importers with no contact information were first eliminated from the list. The resulting list was stratified by six

categories each, across value of shipment and number of TEUs shipped annually as illustrated in Table 6-1. These categories were the same as those used in the PIERS database. A random sample was generated from each of the resulting 36, proportionate to the membership of each stratum, to yield the mailing list of 4,171 importers.

Table 6-1: PIERS importers database stratified by annual TEU and shipment value

	TEU							
VALUE	**1 to 5**	**5 to 10**	**10 to 25**	**25 to 100**	**100 to 500**	**500+**	*Row Total*	*Row %*
$1 to $99,999	2141	535	202	23	0	0	*2901*	*17.06%*
$100,000 to $499,999	1035	1362	1643	596	14	0	*4650*	*27.35%*
$500,000 to $999,999	101	261	760	900	81	1	*2104*	*12.38%*
$1,000,000 to $4,999,999	74	138	509	2020	1040	42	*3823*	*22.49%*
$5,000,000 to $24,999,999	25	15	60	354	1341	528	*2323*	*13.66%*
$25,000,000+	20	17	23	44	213	884	*1201*	*7.06%*
Column Total	*3396*	*2328*	*3197*	*3937*	*2689*	*1455*	**17002**	
Column Percent	*19.97 %*	*13.69%*	*18.80%*	*23.16%*	*15.82%*	*8.56%*		

Following the techniques to improve response rate proposed by Larson and Poist (2004), in addition to the postage paid return envelope and an offer of the executive summary of the results, respondents were provided with an incentive to respond by offering their names to be entered into a prize drawing for three cash prizes. Additionally packets and covering letters were personalized with the respondents' names and titles.

The packets were mailed out on November 23rd, 2004 and 62 responses were received from the first wave of responses by January 15th, 2005. After eliminating the undeliverable, and returned survey packets, a postcard reminder was mailed to the remaining 3,780 firms on February 3, 2005, roughly two months after the first mailing. Due to the low response to the first wave a random list of half the original mailing list was simultaneously contacted by telephone.

6.1.2.1 Non-Response Bias

Due to the low response, non-response bias needs to be considered when generalizing the results to the population of U.S. importers. Lambert and Harrington (1990) describe non-response bias as the difference between the answers of the non-respondents and respondents. Mentzer and Flint (1997) suggest contacting a random list of at least 30 non-respondents and asking them five non-demographic questions. A total of 2,171 non-respondents were randomly contacted by phone, of which 41 returned surveys and 3 responded to the postcard mailing, see Table 6-2 for a complete breakdown of the mailings and response rate. Using Mentzer and Flint's (1997) method for assessing response rate the 41 responses to telephone solicitation were considered non-respondents.

Table 6-2: Data Collection Summary

- 4,171 surveys mailed in November 2004
- 62 responses received to first mailing
- 3,780 reminder postcards mailed 2 months after first mailing
- 2,171 non-respondents contacted by phone 2-3 months after first mailing
- 180 promised to return survey from phone calls
- 41 received from phone calls
- 2 received from postcard reminder
- 105 total responses
- 1,207 undeliverable, unreachable, unqualified and disinterested in the survey
- 2,964 effective mailing list
- 3.54% effective response rate
- 105+6 from pilot test, N=111

The characteristic comparison method proposed by Lambert and Harrington (1990) and Mentzer and Flint (1997) was first used to test the non-response bias using the responses from the set of non-respondents contacted by telephone. The results of the *t-tests* comparing key measures to be used in the analysis across the groups of respondents and non-respondents are reported in Appendix K. Where equal variances were not found between the groups the Satterthwaite and Cochran approximate t-tests were computed. The null hypothesis that the means differ across groups cannot be rejected for virtually all the measures except ExtInt_3 (p-value=0.07), which is a measure of *External Integration* (EI). This measure shall be dropped from future analysis.

Lambert and Harrington (1990) demonstrated the use of a $\chi 2$ goodness of fit test to check for non-response bias by comparing the zip codes of respondents to that of the total population of non-respondents. This study used the criteria employed for generating the strata for random sampling to compare the survey sample to the population across the groups used for the stratified random sampling. Also, as the information is available, the respondents' were not compared to the non-respondents as defined by Lambert and Harrington (1990) but instead to the entire population of shippers, hence representing an accurate picture of the generalizability of the results to that of the entire population. The number of respondents in the survey sample and the population of importers for each stratified cell are presented in Table 6-3. A number of the cells were combined, as represented by the uniform shaded areas with the heavy borders, to ensure that less than 20% of all cells had expected cell frequencies greater than or equal to five and that no single cell had an expected value less than one. The three cells in the corner North East quadrant of the table are excluded from the analysis, as they are not representative of the population.

Table 6-3: Survey sample and population frequency for each stratum.

Row #	VALUE	Col #	TEU 1	2	3	4	5	6
			1-5	5-10	10-25	25-100	100-500	500+
1	$1 to $99,999	Pop Count	2192	510	194	22	0	0
		Pop %	**12.89%**	**3.00%**	**1.14%**	**0.13%**	**0.00%**	**0.00%**
		Survey Count	9	2	0	0	0	0
		Survey %	**9.47%**	**2.11%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**
2	$100,000 to $499,999	Pop Count	1098	1341	1611	586	14	0
		Pop %	**6.46%**	**7.89%**	**9.48%**	**3.45%**	**0.08%**	**0.00%**
		Survey Count	4	7	7	1	0	0
		Survey %	**4.21%**	**7.37%**	**7.37%**	**1.05%**	**0.00%**	**0.00%**
3	$500,000 to $999,999	Pop Count	104	262	758	898	81	1
		Pop %	**0.61%**	**1.54%**	**4.46%**	**5.28%**	**0.48%**	**0.01%**
		Survey Count	0	1	2	7	0	0
		Survey %	**0.00%**	**1.05%**	**2.11%**	**7.37%**	**0.00%**	**0.00%**
4	$1,000,000 to $4,999,999	Pop Count	76	140	510	2019	1036	42
		Pop %	**0.45%**	**0.82%**	**3.00%**	**11.88%**	**6.09%**	**0.25%**
		Survey Count	0	1	0	16	12	0
		Survey %	**0.00%**	**1.05%**	**0.00%**	**16.84%**	**12.63%**	**0.00%**
5	$5,000,000 to $24,999,999	Pop Count	25	15	61	353	1341	528
		Pop %	**0.15%**	**0.09%**	**0.36%**	**2.08%**	**7.89%**	**3.11%**
		Survey Count	0	0	0	1	11	5
		Survey %	**0.00%**	**0.00%**	**0.00%**	**1.05%**	**11.58%**	**5.26%**
6	$25,000,000+	Pop Count	21	16	23	44	213	884
		Pop %	**0.12%**	**0.09%**	**0.14%**	**0.26%**	**1.25%**	**5.20%**
		Survey Count	0	0	0	0	0	11
		Survey %	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**11.58%**

Table 6-4 shows that the survey sample is different from the population at the 0.05 level of significance ($\chi 2$ = 18.6064, 10 df; p-value=0.046), however, not at the stricter 0.01 level of significance. As an additional guide to indicate where the sample may differ from the population Agresti (2002) suggests using Pearson's residuals to further analyze the difference between the distributions. The Pearson residual for cell j is defined by $r_j = \frac{(O_j - E_j)}{\sqrt{E_j}}$. Suppose that the computed Pearson residual for cell j is much larger than $\sqrt{(k-1)/k}$, which means the survey sample cannot well represent the population at cell j. The cells greater than $\sqrt{10/11} = 0.95$ in Table 6-4 are highlighted in bold text in Table 6-3.

Table 6-4: Chi-square goodness-of-fit test for equality of cell population and cell sample by VALUE-TEU

#	Pearsons Residuals $\frac{(E_i - O_i)}{\sqrt{E_i}}$	$\frac{(E_i - O_i)^2}{E_i}$	Expected Frequency (E_i)	Sample Frequency (O_i)	Population %	Cell groupings by VAL TEU (From Table 6-3)
1	-0.902643643	0.814764	6.258065	4	6.4516%	2 1
2	-0.232599517	0.054102	7.643046	7	7.8794%	2 2
3	**2.803211961**	7.857997	8.047711	16	8.2966%	**5 6,6 6**
4	**-1.121241789**	1.257183	15.40008	11	15.8764%	**1 1,1 2**
5	-0.142696719	0.020362	9.438392	9	9.7303%	3 3,3 4
6	0.417726161	0.174495	14.41407	16	14.8599%	4 3,4 4
7	**-1.551283123**	2.406479	13.75292	8	14.1783%	**1 3,1 4,2 3,2 4**
8	-0.723175558	0.522982	3.317116	2	3.4197%	3 1,3 2,4 1,4 2
9	0.343067786	0.117695	10.86897	12	11.2051%	5 4,5 5,6 5
10	**2.052301782**	4.211942	6.691227	12	6.8982%	**2 5,3 5,3 6,4 5,4 6**
11	**-1.08092554**	1.168400	1.1684	0	1.2045%	**5 1,5 2,5 3,6 1,6 2,6 3,6 4**
	Chi-square stat.	**18.60640**		***n=97***		
	$X^2_{(0.05,10df)}$	**18.30702**				
	p-value	**0.045556**				
	$(10/11)^{1/2}$	**0.953462**				

Sanders and Premus (2005) conducted a variation of the Chi-square goodness-of-fit test by Lambert and Harrington (1990). They compared the characteristics of non-respondents (second wave respondents) to that of the respondents (first wave respondents). Here, the second wave of respondents was considered those contacted by phone as recommended by Mentzer and Flint (1997). As the majority of the cells in each stratum would have expected values less than 5 non-response bias was analyzed separately across the six levels of each stratifying criterion, TEU and Value. Additionally the expected cell count for half the levels of the Value criterion were less than 5 hence these were combined into three levels for analysis. The result of the analysis for the Value criterion is provided in Table 6-5 and for the TEU criterion in Table 6-6.

The test for non-response bias is not significant at the p=0.1 level for the Value criterion ($\chi 2 = 4.31$, 2 df; p-value=0.12) and not significant at the p=0.05 level of significance for the TEU criterion ($\chi 2 = 10.22$, 5 df; p-value=0.07). The tests so far indicate the absence of any severe non-response bias. The stricter Chi-square test comparing the sample with

the population across the thirty-six strata test indicates the possibility of some marginal bias at the 0.05 level of significance. Using Pearson's residuals some guidance is offered for the generalizability of these results to different sections of the population.

Table 6-5: Non-response bias for the Value stratification criterion

VALUE

VALUE Levels	Respondents Freq	%	Exp Freq (E_i)	Non-respondents Freq (O_i)	%	$\sum E_i$	$\frac{(E_i - O_i)^2}{E_i}$
1	5	8.93%	3.66*	6	14.63%	15.38	2.64
2	16	28.57%	11.71	3	7.32%		
3	2	3.57%	1.46*	8	19.51%	14.64	1.30
4	18	32.14%	13.18	11	26.83%		
5	9	16.07%	6.59	8	19.51%	10.98	0.37
6	6	10.71%	4.39*	5	12.20%		
SUM	**56**			**41**		**Chi-sq statistic**	**4.31**
			*E_i < 5			$X^2_{(0.05,2df)}$	**5.99**
						p-value	**0.12**

Table 6-6: Non-response bias for the TEU stratification criterion

TEU

TEU Levels	Respondents Freq	%	Non-respondents Freq (O_i)	%	Exp Freq (E_i)	$\frac{(E_i - O_i)^2}{E_i}$
1	6	10.71%	7	17.07%	4.39	0.97
2	8	14.29%	3	7.32%	5.86	2.72
3	7	12.50%	2	4.88%	5.13	4.88
4	14	25.00%	11	26.83%	10.25	0.05
5	11	19.64%	12	29.27%	8.05	1.30
6	10	17.86%	6	14.63%	7.32	0.29
SUM	**56**		**41**		**Chi-sq statistic**	**10.22**
					$X^2_{(0.05,5df)}$	**11.07**
					p-value	**0.07**

6.1.3 Survey Respondents

For the final analysis six valid responses from the pilot test are included and hence the following demographic information includes these pre-test respondents where available. The survey demographics of the key stratification criteria of Value and TEU, which have also been used to indicate the size of shippers, are reported in Table 6-4, Table 6-5, and Table 6-6. The firms targeted were primarily shipper firms responsible for managing or co-managing their ocean transportation needs. However, some of the respondents include IFF who reported on behalf of their clients and an NVOCC response was used from the pre-test as indicated in Table 6-7.

Table 6-7: Survey respondents' firm type.

Shipper Type	Freq	%age
BCO	85	76.58%
IFF	7	6.31%
NVOCC	1	0.90%
Not Reported	18	16.22%
	111	

A concern of using a survey instrument for data collection is the selection of respondents as representative of the managers who are familiar with the items being measured (Mentzer and Flint, 1997). The titles of the respondents are given in Table 6-8 and indicate close to half of the respondents in upper management positions.

Table 6-8: Survey respondents' titles.

Title	Freq	%age
Owner	3	2.88%
President	9	8.65%
Sr VP	2	1.92%
VP	17	16.35%
Director	13	12.50%
Manager	48	46.15%
Not reported	13	12.50%
Total	105	

Another aspect of ensuring the identity of the principal informant for this study is ensuring the person has a sufficient understanding of international trade, especially importing. The majority of the respondents are involved in either importing and/or exporting as indicated in Table 6-9.

Table 6-9: Respondents' operational responsibility for importing and/or exporting.

Import/Export	Freq	%age
Import	50	45.05%
Export	15	13.51%
Import and Export	38	34.23%
Not Reported	8	7.21%
	111	

The size of the firms measured by annual revenues is reported in Table 6-10.

Table 6-10: Survey respondent firms' annual revenue.

Revenue	Freq	%age
0 to $25 million	31	27.93%
$26 – $100 million	34	30.63%
$101 – $500 million	16	14.41%
$501 – $1 billion	6	5.41%
>$1 billion – $5 billion	4	3.60%
>5 billion – $10 billion	0	0.00%
>$10 billion	1	0.90%
Not Reported	19	17.12%
	111	

The survey respondents also came from a diverse set of industries as indicate in Table 6-11.

Table 6-11: Survey respondents' industries

Industry	Freq	%age
Appliances	1	0.90%
Automotive & Transport Equip.	3	2.70%
Aviation	0	0.00%
Building Materials/Lumber Prod.	7	6.31%
Chemicals & Plastics	6	5.41%
Clothing & Textiles	8	7.21%
Computer Hardware & Periph'ls.	2	1.80%
Construction/Farm/Garden Equip.	0	0.00%
Dept. Store/Retail General Merch	7	6.31%
Electronics & Related Instrum'ts	2	1.80%
Electrical Machinery	3	2.70%
Food & Beverage	16	14.41%
Furniture	2	1.80%
Hardware	2	1.80%
Machinery Tools	1	0.90%
Metal Products	8	7.21%
Mining & Minerals	4	3.60%
Office Equip/Supplies	0	0.00%
Paper & Related Products	2	1.80%
Petroleum & Petrochemicals	0	0.00%
Pharmaceuticals, drugs, toiletries	1	0.90%
Primary Metals	0	0.00%
Other	22	19.82%
Not Reported	14	12.61%
	111	

As mentioned earlier in section 5.3.1.3 on "Measures of IT-mediated Mechanisms" to reduce the complexity of the survey, respondents were asked to respond for a particular scenario while ensuring responses were kept uniform across all respondents and to maintain the realism of the study. To achieve this, respondents were asked to indicate

whether they communicated directly with the carrier or through an OTI. As can be seen from the breakdown of responses provided in Table 6-12, the majority of respondents communicate directly with the carriers.

Table 6-12: Respondent firms' use of OTI for communication.

Communication Type	Freq	%age
Carrier direct	76	68.47%
Via OTI	23	20.72%
Both	4	3.60%
Not Reported	8	7.21%
	111	

6.2 Data Screening

Prior to analysis a number of data screening exercises were conducted to ensure that problems due to missing data, and the assumptions of future analyses, such as normality, were accounted for. After reviewing univariate statistics for normality (Appendix L) two measures for environmental complexity (EE7 and EE10) were removed from further consideration because of large values of skewness and kurtosis that indicated extreme non-normality.

6.2.1 Missing data

The missing data diagnostics were conducted along the lines prescribed by Hair *et al* (1998). The first step is to visually examine any patterns in missing data. For this purpose a table excluding all data except missing values, which were marked as "**M**", was constructed. There are 67 cases with missing values listed in Appendix M. The table is sorted in descending order of missing values and indicates that no case has greater than 50% missing values, with the large majority having less than 10% (5) missing values. Hence, no cases have levels of missing data significantly high enough to automatically dictate their exclusion (Hair *et al*, 1998).

The patterns of missing data illustrated in Appendix M have been identified with specific issues regarding instrument design and data collection. After checking back with respondents on the reason for their frequent omission, the frequent occurrence of simultaneous missing values for the *Task Variety* (TV), *Task Analyzability* (TA), *Task Integration* (TI) and *External Environment Complexity* (EE7-EE10) was identified as likely due to respondents' misinterpretation of survey instructions to go directly to section B of the survey – see bottom of first page of survey instrument in Appendix J. The frequent simultaneous occurrence of missing values for TEU and Value is because these measures were not collected in the pilot test stage, although valid pilot test responses are included in the final analysis. Also, these measures were not explicitly reported by respondents but were compiled by using the respondent's firm name to cross-reference the PIERS database, which contains the TEU and Value data. Hence, where respondents omitted their firm name the TEU and Value data could not be retrieved from the PIERS database. Finally, the large number of missing values for the first measure of internal integration (II1), years of firm experience with ERP, is due to either respondents equating no

experience with no response or missing the question at the bottom of the page. Besides these patterns, visual inspection reveals no other significant missing data patterns.

The next step is diagnosing the randomness of data i.e., to determine whether the missing data are distributed randomly across the cases and the variables. For this purpose Hair *et al* (1998) prescribe three tests. The first test is to compare the observations with and without missing data for each variable on the other variables. For example, the observations with missing data on X_1 are placed in one group and those with valid responses for X_1 are placed in another group. These two groups are compared to identify any differences across the remaining variables. Because of its size, 54x54 matrix, and three statistics per cell, the resultant table is not produced. The group comparison analysis across variables revealed several variables showing patterns of significant t-values. However, the impact of these differences is marginal as the number of cases with missing data on the variables ranges from only two to five (Hair *et al*, 1998). Variables exhibiting group differences with higher cases of missing data (greater than five) were limited to less than ten variables from a total of the fifty four variables considered and most of the variables for which these group differences are recorded are those identified by the missing data processes earlier i.e., survey design and data collection. Hence, it is unlikely there is any other respondent driven missing data process.

The next test for randomness involves using the correlations on dichotomized variables formed by replacing observed data with a one and missing data with a zero. The correlations for the dichotomized variables considered in the analysis are reported in Appendix N. The correlations highlighted in bold text are those considered moderate to high (>0.4). The shipping and supply chain performance measures (SPRC and SP6-SP15) all have high correlations as can be seen by the two cases, 101 and 3, which completely omit reporting of shipping and supply chain performance measures (Appendix N). Similarly, the shipping and SC performance measures are highly correlated with the IOS and non-IOS use measures due to their omission by the same two cases above, 101 and 3. The measures on the second page of the survey (TA, TV, TI, and EE7-EE10) are highly correlated and again indicate the missing data process, which may be due to the survey design issues discussed above. The external integration measures show some moderate to high correlation from the missing data patterns. The three cases that did not report a large number of these measures are probably responsible for these missing data patterns. Finally, the IOS, non-IOS measures are all highly inter-correlated, which can be attributed to the previously identified two cases not reporting these measures.

The last test is an overall test of the missing data for being missing completely at random (MCAR). The test makes a comparison of the actual pattern of missing data with what would be expected if the missing data were totally randomly distributed. After implementing the simulation in SAS the missing data process was shown as not MCAR ($\mathbf{X^2}_{\mathbf{(1487df)}}$=693.2157, p-value <0.0001), hence, remedies for missing data cannot be applied to the data set as this may introduce potential biases into the analyses.

In summary, Hair *et al* (1998) recommend retaining variables that do not significantly contribute to an unknown, respondent driven missing data process. As is apparent from Appendix M only a limited number of cases with missing data over sets of variables have contributed to a pattern of respondent missing data process. Eliminating these cases would be an ineffective approach to reducing the missing data, it also risks further limiting the information available to perform the analysis and yield meaningful results (Hair *et al*, 1998). Hence, as no significant respondent-driven missing data process is identified those variables and cases identified in the missing data processes are retained for further analysis.

6.3 Construct Validity – Clustering Variables

Similar to Premkumar *et al* (2005) except for measures of IOS and non-IOS use, which are direct measures of the items being represented and not measures for a higher order factor, all the multi-item constructs for information processing needs and information processing capabilities were tested for construct validity. IOS and non-IOS use are not measures of a construct of information processing capability, they are simply a measure of how often a particular information channel is used for conducting specific transactions.

This is essentially an exploratory study at the early stages in a research stream. Nevertheless this study attempts to build on the Bensaou and Venkatraman (1995), and Forster and Regan (2001) studies, which used simple tests for reliability using Cronbach alpha's, by using stricter construct validity techniques to further advance the theory. Accordingly, extensive psychometric testing was carried out to ensure the validity and reliability of the multi-item constructs.

Nomological validity is the degree to which the constructs fit within the logical network of the theory. Content validity evaluates the degree to which the measures of a construct cover all dimensions of the construct. Trait validity is composed of: 1) convergent validity; 2) discriminant validity; and, 3) reliability. Convergent validity ensures that items measuring a particular construct load on that particular construct. Discriminant validity ensures that the items load on the theorized construct and not on the other constructs included. Reliability, measures the internal consistency of the measures, i.e.; how consistently the measures actually measure the construct.

Nomological validity is treated as a qualitative assessment of logical consistency of the theory building, its consistency with previous research and the real world (Mentzer and Flint, 1997). All construct measure development is grounded in, and builds on, previous theory and the real world context as explained in section 5.3.

Content validity was ensured by adopting pre-validated scales for most constructs. The detailed interviews with pilot test respondents were also used to ensure the content validity of new measures and constructs.

6.3.1 Unidimensionality

The convergent and discriminant validity means nothing without construct reliability. The normal way to test for construct reliability has been to calculate Cornbach's

coefficient alpha. However, the coefficient alpha assumes unidimensionality of constructs and cannot infer it. Steenkamp and van Trip (1991) demonstrate the testing of construct unidimensionality using the standardized residuals in LISREL. Accordingly, a first order factorial model was specified in LISREL with all the measures loading on their respective constructs. After initial fitting of the model the following measures were removed from the analysis because of insignificant factor loadings: *External Environment Complexity* – EE8, and EE9; *External Integration* – EI1, EI2, and EI4; *Internal Integration* – II1. The standardized residuals from the respecified model without these measures are reported in Table 6-13. Steenkamp and van Trijp (1991) recommend that standardized residuals greater than $|2.58|$ indicate misspecification. In order to correct this they recommend looking for patterns of high residuals where a subset of items have large negative residuals with other items pertaining to the same factor (representing over fitting), and large positive residuals between each other (representing under fitting). An examination of Table 6-13 indicates that EI9, EI10, and EI11 display such a pattern with five of the eight high standardized residuals. They exhibit high negative standardized residuals with the other measures of *External IOS Integration* while also exhibiting high positive standardized residuals between each other. Hence, a new model is respecified with two measures of *External Integration*; one is made up of EI5, EI6, EI7, EI8, EI12, and EI13 and the other is made up of EI9, EI10 and EI11.

Table 6-13: Standardized residuals: Diagnostics for unidimensionality of constructs: Eight factor base model.

	TEU	VALUE	EE2	EE4	EE5	EE6	TA1	TA2	TV1	TV2	TV3	II2	II3	II4	EI5	EI6	EI7	EI8	EI9	EI10	EI11	EI12	EI13	TI	EE1
TEU	- -																								
VALUE	0.48	- -																							
EE2	-0.52	0.43	- -																						
EE4	-0.15	-0.51	0.02	- -																					
EE5	0.29	0.77	0.68	-1.38	- -																				
EE6	-0.7	-0.06	-1.15	-0.24	1.24	- -																			
TA1	-0.81	-0.06	-0.11	0.14	2.21	0.87	- -																		
TA2	0.76	0.11	0.4	-0.84	-1.16	1.48	- -	- -																	
TV1	-0.48	1.22	0.14	0.74	1.17	1.87	2.18	-0.93	- -																
TV2	-0.93	-0.71	0.63	0.87	-0.5	1.34	-0.61	0	0.48	- -															
TV3	0.73	0.43	1.88	-0.97	-2.36	-0.31	-2.01	0.81	-1.3	1.03	- -														
II2	0.68	0.89	-1.91	0.97	-0.34	1.24	0.07	-1.03	-0.68	0.02	0.21	- -													
II3	0.34	0.93	-0.21	-0.88	0.65	2.04	0.34	0.03	-0.71	-0.71	0.75	-0.13	- -												
II4	-0.93	-0.82	-1.05	-1.4	0.08	1.91	0.34	0.08	1.1	0.06	-0.36	-0.24	0.51	- -											
EI5	1.67	1.7	-1.77	-0.06	-0.38	-0.76	-0.28	-1.29	-1.24	-0.8	2.23	0.15	-1.96	-1.96	- -										
EI6	0.33	-0.43	-2.42	0.53	0.21	0.25	-0.53	0.26	-2.39	-0.67	1.06	1.17	-0.63	-0.64	1.49	- -									
EI7	-0.88	-0.92	-2.36	0.32	0.9	0.94	-0.08	1.07	-1.53	-0.61	1.05	1.22	0.28	-0.26	-1.22	**2.95**	- -								
EI8	0.84	-0.09	-1.58	0.07	-0.92	0.75	-0.21	0.69	-0.97	-0.67	1.95	0.88	-0.53	0.04	-0.74	0.7	0.83	- -							
EI9	0.16	0.01	-0.6	-1.28	0.64	0.08	-1.22	-1.44	0.03	-1.73	2.06	0.83	0.38	-0.52	-0.5	**-2.94**	-1.26	1.9	- -						
EI10	0.23	0.52	-1.67	-0.14	0.7	0.28	0.48	-0.4	1.54	-0.06	1.37	1.36	1.17	0.19	-0.02	-2.19	0.29	**-2.91**	**3.92**	- -					
EI11	-1.67	-1.35	-1.56	-2.21	-1.14	-0.2	0.22	0.69	-0.09	-1.13	1.92	0.32	0.02	-0.6	2.1	**-3.72**	-2.45	-0.75	2.36	**4.74**	- -				
EI12	-1.23	-1.68	-2.56	0.45	-1.93	1.21	0.55	0.98	0.23	1.17	**2.61**	**2.88**	2.11	1.68	0.63	0.5	-0.8	-0.28	-2.01	0.4	1.27	- -			
EI13	-0.11	-0.11	-1.56	1.2	0.41	0.04	0.52	-0.42	-1.09	0.92	-0.37	1.67	-0.54	-0.51	1.44	0.3	-1.55	0.22	-0.42	-0.99	1.18	1.3	- -		
TI	-0.62	0.3	2.29	0.72	-0.67	-0.16	0.76	-0.76	1.44	-1.88	-0.41	-1.02	1.18	-0.58	0.27	-1.28	-1.16	0.94	1.02	1.73	0.69	-1.17	-1.61	- -	- -
EE1	0.37	-0.18	-1.53	-0.48	0.67	-0.57	-0.63	0.63	0.16	-0.47	0.11	-1.65	0.9	0.11	-1.08	-2.26	0.47	1.07	0.97	-0.65	1.35	1.36	-0.89	- -	- -

* Standardized residuals > ABS(2.58) are marked in bold underlined text.

Table 6-14: Standardized residuals: Diagnostics for unidimensionality of constructs: Nine factor model.

	TEU	VALUE	EE2	EE4	EE5	EE6	TA1	TA2	TV1	TV2	TV3	II2	II3	II4	EI5	EI6	EI7	EI8	EI12	EI13	EI9	EI10	EI11	TI	EE1
TEU	- -																								
VALUE	0.33	- -																							
EE2	-0.67	0.61	- -																						
EE4	-0.22	-0.54	0.02	- -																					
EE5	0.41	0.83	0.71	-1.29	- -																				
EE6	-0.68	-0.03	-1.14	-0.37	1.33	- -																			
TA1	-0.82	-0.13	-0.13	0.32	1.94	0.86	- -																		
TA2	0.82	0.02	0.39	-0.62	-1.18	1.46	- -	- -																	
TV1	-0.26	1.41	0.16	0.96	0.85	1.83	2.09	-1.32	- -																
TV2	-0.94	-0.73	0.62	0.76	-0.68	1.29	-0.46	0.15	0.63	- -															
TV3	0.71	0.39	1.87	-1.07	-2.5	-0.38	-1.74	0.96	-1.53	1.21	- -														
II2	0.7	0.89	-1.9	1.14	-0.36	1.24	0.09	-1.04	-0.8	0.13	0.33	- -													
II3	0.4	0.89	-0.2	-0.72	0.52	2.04	0.37	0.02	-1	-0.53	0.93	-0.08	- -												
II4	-0.9	-0.76	-1.05	-1.31	0.02	1.91	0.37	0.06	0.95	0.21	-0.15	-0.27	0.48	- -											
EI5	1.58	1.58	-1.78	-0.14	-0.7	-0.82	-0.38	-1.44	-0.91	-0.65	2.42	0.23	-1.79	-1.82	- -										
EI6	0.2	-0.54	-2.43	0.62	-0.14	0.2	-0.69	0.03	-2.19	-0.52	1.32	1.2	-0.66	-0.66	1.11	- -									
EI7	-1.21	-1.02	-2.37	0.33	0.4	0.87	-0.24	0.88	-1.16	-0.44	1.32	1.28	0.43	-0.18	-1.6	1.29	- -								
EI8	0.7	-0.18	-1.6	-0.02	-1.28	0.67	-0.33	0.48	-0.52	-0.5	2.18	0.97	-0.33	0.2	-0.41	-0.36	0.27	- -							
EI12	-1.28	-1.71	-2.57	0.42	-2.09	1.16	0.49	0.9	0.45	1.26	**2.75**	**2.92**	2.17	1.74	0.7	0.19	-1.1	-0.21	- -						
EI13	-0.12	-0.12	-1.57	1.19	0.33	0.02	0.5	-0.45	-1.01	0.96	-0.3	1.68	-0.52	-0.49	1.41	0.15	-1.85	0.19	1.28	- -					
EI9	0.63	0.28	-0.56	-1.06	0.96	0.14	-0.87	-1.16	-1.31	-2.05	1.59	0.74	0.15	-0.99	1.14	-0.91	1.36	**3.72**	-0.94	-0.1	- -				
EI10	0.71	0.93	-1.65	0.74	1.31	0.39	1.03	0.14	0.77	-0.36	0.87	1.18	0.98	-0.38	0.45	-2.01	0.67	-1.78	0.6	-0.91	-1.5	- -			
EI11	-1.87	-1.41	-1.55	-2.03	-0.96	-0.12	0.54	1.22	-0.96	-1.4	1.56	0.06	-0.44	-1.13	1.91	**-3.2**	-1.73	-0.39	1.26	1.17	-1.46	**2.94**	- -		
TI	-0.75	0.44	2.31	0.62	-0.58	-0.17	0.75	-0.75	1.37	-1.85	-0.42	-1.02	1.18	-0.58	0.63	-0.81	-0.51	1.55	-0.99	-1.55	-0.7	0.83	-0.17	- -	
EE1	0.42	-0.24	-1.54	-0.22	0.41	-0.58	-0.64	0.64	0.03	-0.39	0.19	-1.65	0.89	0.12	-0.88	-2.26	0.91	1.38	1.46	-0.86	0.84	-1.78	1.29	- -	- -

* Standardized residuals > ABS(2.58) are marked in bold underlined text.

From the measures for this construct in Table 5-4 it is clear that the first construct represents external IOS connectivity with suppliers (including OTIs and ocean carriers) and the second construct represents external IOS connectivity with customers. The residuals for the new seven factor model are reported in Table 6-14 where although some high residuals are observed these do not display any clear pattern and are not excessive enough to warrant elimination of any variables.

Table 6-15: Goodness of fit statistics for the six factor and seven factor model

Goodness of fit statistics	Nine Factor Solution	Eight Factor Solution
Chi-Square (d.f.)	$\chi^2(241) = 300.23$, p=0.006	$\chi^2(249) = 348.18$, p<0.001
Root Mean Square Error of Approximation (RMSEA)	0.048	0.061
90 Percent Confidence Interval for RMSEA	(0.027 ; 0.065)	(0.045 ; 0.076)
P-Value for Test of Close Fit (RMSEA S 0.05)	0.56	0.12
Non-Normed Fit Index (NNFI)	0.94	0.92
Comparative Fit Index (CFI)	0.95	0.93
Standardized RMR	0.073	0.075
Goodness of Fit Index (GFI)	0.82	0.79

The seven factor model fits the data better than the six factor model, as can be seen from the comparison of goodness of fit statistics in Table 6-15. Hence, having the two separate factors explaining the external IOS integration for customer and supplier provides a better fit for the data.

6.3.2 Reliability and Convergent Validity

Now that the unidimensionality of the constructs have been established reliability is calculated using Cronbach's coefficient alpha and the composite reliability ρ_ξ (Table 6-16). The reliabilities of most constructs are fairly high. *External Environment Dynamism* and *Task Variety* though show lower reliabilities. In early stages of theory development however, such low reliabilities (>0.5) are acceptable in lieu of better measures and more reliable constructs.

The multivariate coefficient of relative kurtosis computed from PRELIS is not substantial (1.036) indicating reasonable multivariate normality and that there is no danger of poor estimation of standard errors and t-values (Steenkamp and van Trijp, 1991). A weak condition of convergent validity is that the factor loadings are statistically significant as is the case of all the loadings in Table 6-16. Bagozzi and Baumgartner (1994) propose the use of Fornell and Larcker average variance (ρ_{ave}) extracted by each construct as a more robust form of testing convergent validity. A value $\rho_{ave} > 0.5$ is sufficient to demonstrate convergent validity.

The ρ_{ave} is reported along the diagonal of the correlation matrix ϕ in Table 6-17. Except for *External Environment Dynamism* (EEdy), *Task Variety* (TV), *External Integration-Suppliers* (EIsupp), and *External Integration-Customers* (EIcust) all other constructs exhibit high degree of convergent validity.

Table 6-16: Measurement Model (CFA) – Factor loadings and reliability

Factors	Factor Loadings[a]	T-Values	Cronbach's Coefficient α[b]	Composite Reliability[b]
1) External Environment Complexity			*0.7662*	0.8161
TEU	**2.64**	11.98		
VALUE	**2.19**	10.83		
EE2	**0.31***	2.82		
2) External Environment Dynamism			*0.5401*	0.6218
EE4	**0.84**	7.07		
EE5	**0.59**	6.58		
EE6	**0.41****	2.09		
3) Task Analyzability			-	0.8120
TA1	**0.93**	7.59		
TA2	**1.17**	8.74		
4) Task Variety			*0.5036*	0.5095
TV1	**0.61**	6.11		
TV2	**0.46***	2.55		
TV3	**0.67**	4.67		
5) Internal IOS Integration			*0.8551*	0.8666
II2	**1.64**	7.82		
II3	**1.62**	11.46		
II4	**1.51**	10.79		
6) External IOS Integration - Supplier			*0.8828*	0.8867
EI5	**1.81**	9.98		
EI6	**1.64**	11.69		
EI7	**1.74**	12.41		
EI8	**1.51**	11.82		
EI12	**1.12**	6.68		
EI13	**0.22***	2.76		
7) External IOS Integration - Customer			*0.8529*	0.8531
EI9	**1.43**	10.73		
EI10	**1.59**	10.58		
EI11	**1.1**	8.01		
8) Task Integration			-	-
TI	**1.54**	14.56		
9) Market Capacity			-	-
EI11	**0.81**	14.56		

Notes: Goodness of Fit Index (GFI) = 0.70

[a] all loadings λ_i are significant at better than $p < 0.0001$ except where indicated;

[b] Cronbach α is not reported for factors with fewer than three measures;

* significant at the p=0.01 level

** significant at the p=0.05 level

[b] reliability $\alpha = \left(\sum \lambda_i\right)^2 \Big/ \left[\left(\sum \lambda_i\right)^2 + \left(\sum 1 - \lambda_i{}^2\right)\right]$;

Table 6-17: Correlation matrix ϕ with the average variance extracted on the diagonal.

	EEco	EEdy	TA	TV	II	EIsupp	EIcust
EEco	**0.6398(0.7999)***						
EEdy	0.14	**0.3932(0.6271)***					
TA	-0.23	-0.32	**0.6849(0.8276)***				
TV	-0.2	-0.4	**0.53**	**0.2781(0.5273)***			
II	-0.02	-0.24	0.39	**0.54**	**0.6870(0.8289)***		
EIsupp	0.04	-0.32	0.1	0.07	0.36	**0.5896(0.7678)***	
EIcust	0.02	-0.34	0.04	0.21	0.36	**0.84**	**0.6611(0.8131)***
TaskInt	0.2	-0.13	0-.06	0.14	0.14	-0.12	0.01
MarkCap	-0.07	-0.28	-0.01	0.25	0.04	0.04	0.08

Hence, for the purpose of this study the constructs exhibit sufficient convergent validity, even though the $\rho_{ave} < 0.5$ for two constructs the factor loadings are significant demonstrating minimal construct validity.

6.3.3 Discriminant Validity

The Fornell and Larcker test for discriminant validity recommends that the square root of ρ_{ave} of a construct should be greater than that construct's correlations with each of the other constructs. The values in brackets on the diagonal in Table 6-17 are the $\sqrt{\rho_{AVE}}$. The $\sqrt{\rho_{AVE}}$ for *Task Variety* (TV) is marginally lower than that for *Task Analyzability* (TA) and *Internal IOS Integration* (II), while that for the new factors *External Integration-Customer* and *External Integration-Supplier* are less than the correlation between them.

Discriminant validity was also calculated by first estimating ϕij freely then for the construct correlations that failed the Fornell and Larcker test setting ϕij to 1 and comparing the χ^2 value for the two models with one degree of freedom. The model with freely estimated f-values has a χ^2 value = 300.23 (df = 241). First setting ϕ_{54}, correlation between TV and II, to 1 we get χ^2 (242) = 305.41 and which results in χ^2 (1) = 5.18 > $\chi^2(1)$ = 3.841 at p = 0.05 level of significance. Hence, we can reject Ho: $\phi_{54} = 1$. Similarly, for ϕ_{43}, (correlation between TV and TA) yields a χ^2 (242) = 305.67 where χ^2 (1) = 5.44 > $\chi^2(1)$ = 3.841 at p = 0.05 level of significance; and, for ϕ_{76}, (correlation between EIsupp and EIcust) yields a χ^2 (242) = 333.46 where χ^2 (1) = 33.23 > $\chi^2(1)$ = 3.841 at p = 0.05 level of significance. Hence, we can reject Ho: $\phi_{54} = 1$, and Ho: $\phi_{76} = 1$.

A final test of discriminant validity for the correlations not satisfying the Fornell and Larcker test is to check if the inter factor correlations is significantly different from zero. In order to do so the confidence intervals of the correlations in question were calculated using $CI\phi = \hat{\phi}_{ij} \pm 2s_{\phi_{ij}}$ and checked to see if these include zero. The confidence intervals for $\phi_{54} = 0.54 \pm 0.22$, for $\phi_{43} = 0.53 \pm 0.24$ and for $\phi_{76} = 0.84 \pm 0.08$ all of which do not include one. Therefore, discriminant validity for the constructs is established.

With the constructs displaying unidimensionality, reliability, and convergent and divergent validity the next step of the analysis is to assess for fit using cluster analysis reported after section 6.4.

6.4 Construct Validity – Shipping and SC Performance

Similar psychometric tests were carried out separately on the shipping and SC performance variables to ensure the validity and reliability of the construct.

Again, the detailed interviews with pilot test respondents were used to ensure the content validity of the measures.

6.4.1 Unidimensionality

A first order confirmatory factor analysis model was specified in LISREL and the standardized residuals were examined for unidimensionality. After the first pass,

measures ShipPerf_8 and ShipPerf_9 were removed because of high ($>|2.58|$) standardized residuals and a poorly fitting model. ShipPerf_6 was also removed because of insignificant factor loading (t-value = -1.21, p-value = 0.8869). The standardized residuals for the refitted model are provided in Table 6-18 and although there is one high residual the overall model fit is good.

Table 6-18: Standardized residuals: Diagnostics for unidimensionality of the Shipping and SC Performance Construct.

	SPRC	SP7	SP10	SP11	SP12	SP13	SP14	SP15
SPRC	- -							
SP7	-0.58	- -						
SP10	1.48	-1	- -					
SP11	0.13	-1.85	2.19	- -				
SP12	-0.69	0.04	0.1	0.94	- -			
SP13	-0.43	2.18	-0.1	0.38	0.87	- -		
SP14	0.17	-0.18	0.84	-1.41	-1.18	-1.26	- -	
SP15	-0.71	0.03	-1.41	0.56	-1.44	-1.94	**3.14**	- -

Eliminating ShipPerf_6 also improves the model's fit of the data. The single factor model fits the data quite satisfactorily, as can be seen from the goodness of fit statistics in Table 6-19.

Table 6-19: Goodness of fit statistics for the six factor and seven factor model

Goodness of fit statistics	
Chi-Square (d.f.)	$\chi^2(20) = 29.1$, p=0.086
Root Mean Square Error of Approximation (RMSEA)	0.066
90 Percent Confidence Interval for RMSEA	(0.0 ; 0.11)
P-Value for Test of Close Fit (RMSEA S 0.05)	0.28
Non-Normed Fit Index (NNFI)	0.96
Comparative Fit Index (CFI)	0.97
Standardized RMR	0.054
Goodness of Fit Index (GFI)	0.93

6.4.2 Reliability

Now that the unidimensionality of the construct has been established, reliability is calculated using Cronbach's coefficient alpha and the composite reliability ρ_ξ (Table 6-20). The reliability is quite high (>0.70). A weak condition of convergent validity is that the factor loadings are statistically significant as is the case of all the loadings in Table 6-20.

Bagozzi and Baumgartner (1994) propose the use of Fornell and Larcker average variance (ρ_{ave}) extracted by each construct as a more robust form of testing convergent validity. A value $\rho_{ave} > 0.5$ is sufficient to demonstrate convergent validity, however, $\rho_{ave} = 0.3568$ for the shipping and SC performance construct. Nevertheless, minimum conditions of convergent validity and reliability are met.

Table 6-20: Measurement Model (CFA) – Factor loadings and reliability, Shipping and SC Performance

Factors	Factor Loadings[a]	T-Values	Cronbach's Coefficient α	Composite Reliability[b]
Shipping and SC Performance			*0.7328*	0.8002
SP_RC	**1.22**	3.23		
ShipPerf_7	**0.73**	7.17		
ShipPerf_10	**0.51**	7.53		
ShipPerf_11	**0.71**	6.38		
ShipPerf_12	**0.37**	2.03*		
ShipPerf_13	**0.63**	8.8		
ShipPerf_14	**0.56**	7.8		
ShipPerf_15	**0.46**	5.58		

Notes:

[a] all loadings λ_i are significant at better than $p < 0.0001$ except where indicated;

* loadings are significant at the p=0.05 level of significance

[b] reliability $\alpha = \left(\sum \lambda_i\right)^2 \Big/ \left[\left(\sum \lambda_i\right)^2 + \left(\sum 1 - \lambda_i{}^2\right)\right]$;

6.5 Cluster Analysis

The primary purpose of cluster analysis is to assemble groups or clusters of similar cases based on the characteristics they posses. The information processing model and fit theory have identified the modeling of fit as *gestalts* as the most appropriate for the current study. Accordingly, Venkatraman (1989) proposes the use of cluster analysis as the most appropriate methodology to uncover the internally consistent *gestalts*. Hair and Black (2000) recommends a six step process to cluster analysis. These stages are discussed in the following sections in tandem with the steps taken to comply and perform the cluster analysis.

6.5.1 Stage 1: Research Problem

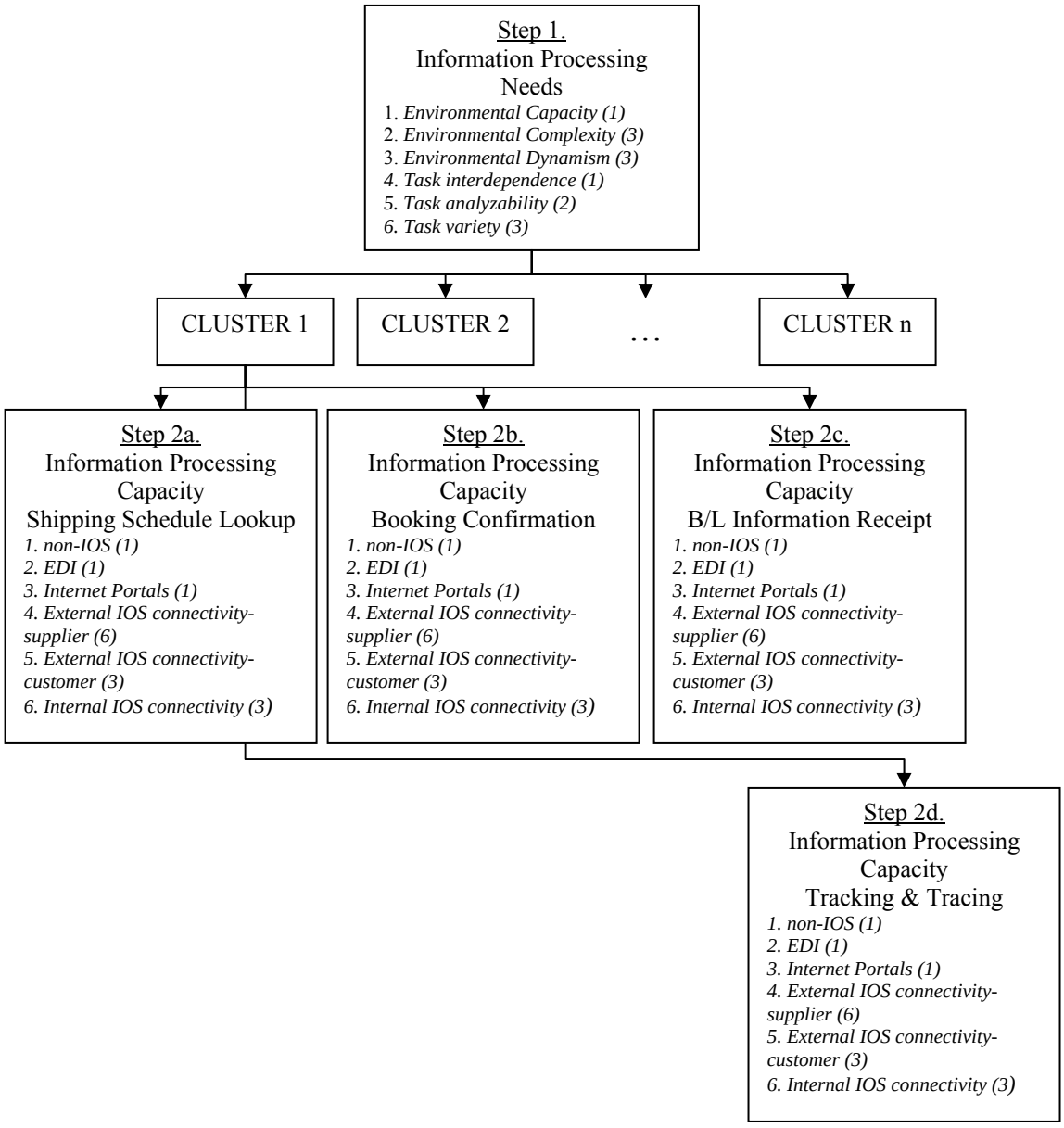
The research objectives guide the research design and analysis. Cluster analysis has typically been used to achieve three research objectives: 1) Taxonomy description; 2) Data simplification; and 3) Relationship identification. The research objectives of this study fit closely with that of description of a taxonomy. Venkatraman (1989) is very careful to point out that although very similar, there is a subtle yet important distinction between strategy taxonomies and fit as *gestalts*. Strategy taxonomies represent an empirical identification of naturally occurring strategy types that does not use internal congruence, except indirectly to name the *gestalts*. Also, the selection of variables for taxonomic inquiry is guided by the need to balance parsimony and exhaustiveness of coverage. On the other hand, specifying the testing of fit as *gestalts* requires a careful enumeration of the underlying dimensions so that the *gestalts* can be ordered along their levels of fit or congruence. For the current study, extensive theory discussion and review led to the constructs chosen and measure development. Finally, the validity of the constructs was tested to ensure the development of these underlying dimensions to model the *gestalts* as fit. This is important because in cluster analysis there is no means of checking the relevant from the irrelevant variables, which can significantly alter the results (Hair and Black, 2000).

6.5.2 Stage 2: Research Design

The research for this study is designed to answer the research questions. These questions require each transaction of the shipping process studied, to be analyzed differently across the three non-IOS and IOS information modes. Accordingly, a separate cluster analysis is conducted for the four different transaction sets using the non-IOS and IOS use measures for that particular transaction. The cluster analysis is conducted in a two step process as demonstrated by Bensaou and Venkatraman (1995). As the information processing needs are common to all transactions in the first step all the cases are first clustered around these variables. For the second step the cases in each of the resulting clusters are clustered separately using the *information processing capability* variables for each of the four transactions. Hence, all design considerations, assumptions and cluster analyses are discussed for this two step process, with the second step being split into four for the different transactions as illustrated in Figure 6-1.

At the design stage there are three considerations for initializing the cluster analysis: 1) can outliers be detected; 2) the similarity measure to use; and, 3) whether data should be standardized or not. The following section presents discussion from Hair and Black (2000) on the guidelines to make these decisions and the methods used for the current study.

Figure 6-1: Cluster analysis process design



6.5.2.1 Outlier Detection

Cluster analysis is sensitive to the presence of outliers, which can represent either (a) truly aberrant observations not representative of the general population or (b) an undersampling of actual groups in the population that causes an underrepresentation of these groups and distort the true structure of clusters (Hair and Black, 2000). In the case of numerous variables and cases, Hair and Black (2000) propose the use of multivariate techniques such as the use of Mahalanobis distances (*D2*) to identify multivariate outliers. The results of this test are presented in Table 6-21 and show no significant outliers at the 0.1 level of significance. The Bonferroni adjustment for multiple

comparisons is used, it is a more appropriate and much stricter test, which shows no significant outliers.

Table 6-21: Identification of multivariate outliers

id	D^2	Significance	id	D^2	Significance
45	23.311	0.0252	71	11.354	0.49881
36	22.733	0.03008	64	11.277	0.50531
10	22.176	0.0356	38	11.138	0.51712
47	21.631	0.04187	62	10.987	0.53003
100	20.335	0.061	57	10.932	0.53474
101	19.901	0.06898	4	10.666	0.55772
20	19.378	0.07981	51	10.578	0.56539
40	19.358	0.08024	21	10.346	0.58559
31	18.711	0.09574	73	10.182	0.60003
78	18.609	0.0984	105	9.98	0.61774
98	18.51	0.10105	49	9.823	0.63147
22	17.922	0.11809	104	9.757	0.63728
33	17.344	0.13712	1	9.676	0.6444
97	17.148	0.14413	29	9.489	0.66066
83	17.045	0.14792	82	9.474	0.66199
5	16.871	0.15451	94	9.191	0.68653
15	16.407	0.1733	65	9.122	0.69246
34	16.308	0.17753	95	8.745	0.72458
93	15.586	0.21096	87	8.513	0.74384
3	15.58	0.21125	84	8.416	0.75185
16	15.059	0.23824	35	8.199	0.76942
12	15.025	0.24008	50	7.949	0.78909
7	14.786	0.25335	13	7.859	0.79601
24	14.724	0.25686	28	7.842	0.79732
48	14.394	0.27626	91	7.38	0.83152
77	14.377	0.27728	103	6.405	0.89433
26	14.294	0.28231	14	6.315	0.89938
6	14.096	0.2946	17	6.29	0.90076
70	14.09	0.29499	89	6.281	0.90125
67	13.947	0.30413	54	6.206	0.90536
81	13.383	0.34181	52	4.791	0.96459
30	13.278	0.34919			
9	13.098	0.36193			
11	12.933	0.37394			
72	12.882	0.37765			
60	12.724	0.38944			
19	12.698	0.39134			
75	12.623	0.39702			
86	12.455	0.40984			
61	12.244	0.42631			
18	12.129	0.43541			
96	12.009	0.44495			
76	11.925	0.45171			
39	11.878	0.45556			
102	11.605	0.47789			
90	11.575	0.48042			
55	11.524	0.48463			
80	11.438	0.49178			
85	11.396	0.49534			

***df* = 12;**

Adj Bonf p-value=0.0006

Mahalanobis D^2 value based on the following variables (TV1 TV2 TV3 TA1 TA2 TI EE1 TEU VALUE EE2 EE4 EE5 EE6)

6.5.2.2 Similarity Measures

The interobject similarity is a measure of correspondence or resemblance between the objects to be clustered. There are three types of similarity measures: 1) correlational measures; 2) distance measures; and, 3) association measures. The first similarity measure is to observe patterns in the data and the last similarity measure is used in the case of non-metric, ordinal or nominal data. Distance measures are the most appropriate and most commonly used measures of similarity when it comes to identifying similar clusters of objects on metric variables. This method is also used by Bensaou and Venkatraman (1995) and is therefore used here. There are a number of distance measures available and the squared Euclidean distance measure is used as this is the most appropriate measure for Ward's linkage method used (discussed later).

6.5.2.3 Standardization

A problem faced by all of the distance measures is the inconsistencies between the cluster solutions when the scale of the variables is changed. The most common method for standardization is centering using *z* scores by centering using the mean and scaling using the standard deviation. As the variables to be used in the analysis all have different scales they have been standardized and *z* scores are used in the cluster analysis.

6.5.3 Stage 3:Assumptions

Cluster analysis is not a statistical inferential technique where the parameters from a sample are assessed as possibly being representative of the population. The requirements of normality, linearity, and homoskedasticity that are usually important in other statistical techniques are hence not important. Instead the critical assumptions are: (1) representativeness of the sample and (2) multicollinearity.

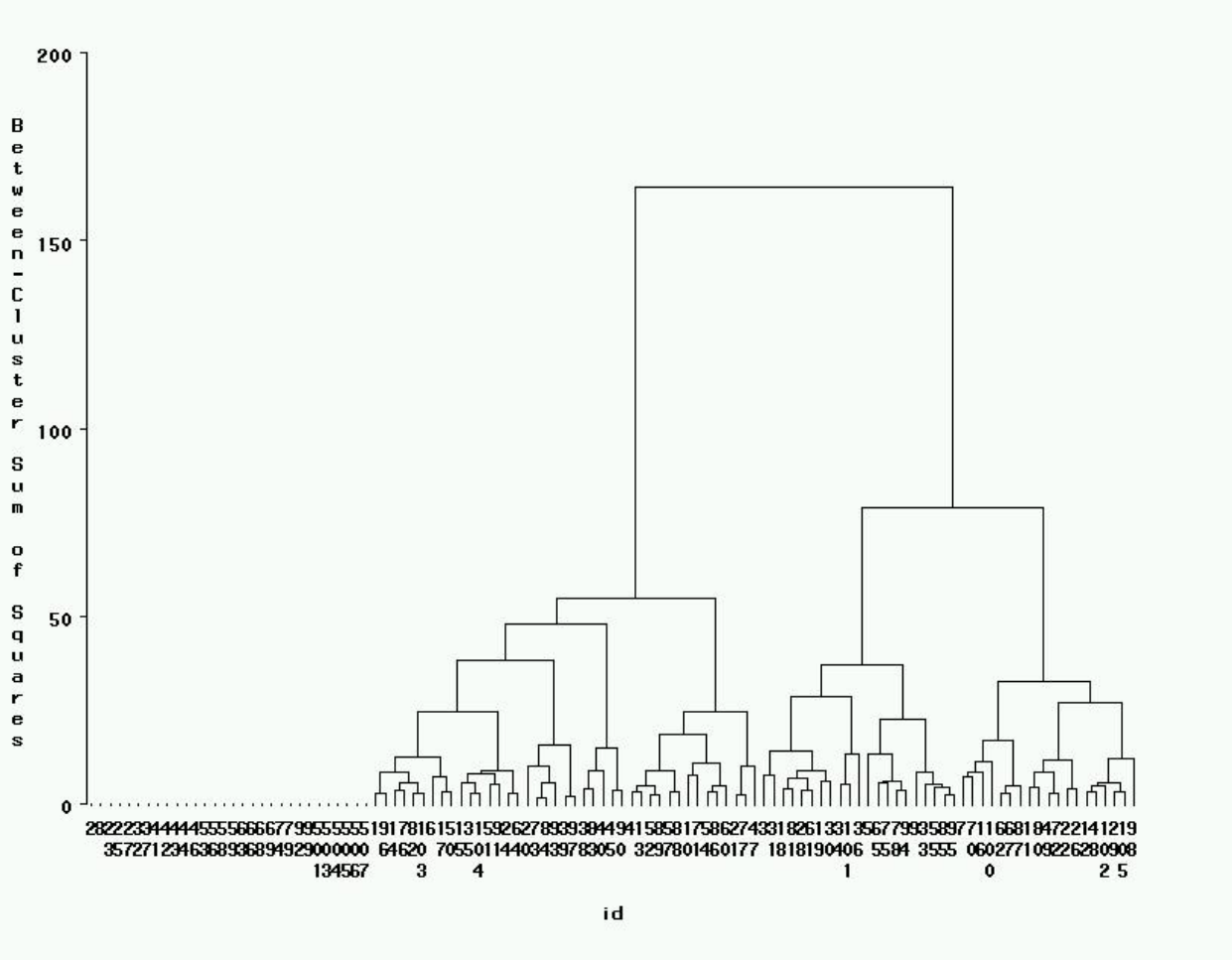
The cluster analysis is only as good as the sample in its representativeness of the population from which the sample cases are obtained. This consideration was addressed in detail in section 6.1.2.1 on non-response bias and was demonstrated as being more or less representative of the population. Multicollinearity is a problem as multicollinear variables implicitly are weighted more heavily and thus are more likely to affect the similarity measures. As multicollinearity is a requirement of the measures of a factor and since all the variables used in the cluster analysis are measures of higher order factors there is some multicollinearity to be contended with. However, this influence on the structure of the clusters produced should be negated by the two step validation method employing a combination of hierarchical and non-hierarchical clustering algorithms to form the final clusters. This is discussed next.

6.5.4 Stage 4: Cluster Derivation and Assessment of Overall Fit.

At this stage a decision on the type of algorithm used and the number of clusters to be formed has to be made. The latter can follow only after the necessary clustering method has been chosen and will be affected by the results of a preliminary analysis. There are two basic groups of algorithms available for clustering: 1) hierarchical and 2) non-hierarchical. For most effective clustering Hair and Black (2000) recommend the combination of the hierarchical and non-hierarchical techniques, which combines the

advantages of the hierarchical techniques and the "fine-tuning" ability of the non-hierarchical techniques by allowing switching of cluster membership to obtain the most robust clusters. The method first uses a hierarchical technique to establish the number of clusters, profile the cluster centers and identify any obvious outliers. After outliers are eliminated the remaining observations are then clustered by a non-hierarchical method, with the cluster centers from the hierarchical results as the initial seed points.

Figure 6-2: Dendogram for Information Processing Needs



The hierarchical method chosen is the Ward's method to minimize the within cluster differences and to avoid the chaining problem in single linkage solutions. This method was also used by Bensaou and Venkatraman (1995) and Premkumar *et al* (2005) and is implemented using the CLUSTER procedure in SAS 9.1. The FASTCLUS procedure in SAS 9.1 is used for the non-hierarchical clustering method. The number of clusters is determined according to numerous objective criteria recommended for the purpose, such as dendograms, and Semi-Partial R-Squared (SPRSQ). The results of these cluster analyses as outlined above and structured according to the clustering process in Figure 6-1 are now reported starting with the cluster analysis of the *Information Processing Needs* variables.

6.5.4.1 Information Processing Need

The dendogram displaying the results of the cluster analysis are displayed in Figure 6-2 and the clustering schedule is reported in Table 6-22. The number of clusters was decided using the stopping rule that looks for a large jump in a similarity measure between two successive steps. The similarity measures used are the *Semi-Partial R2* and the *R2* . Additionally Venkatraman (1989) recommends the use of the C-H index developed by Caliński and Harabasz (1974). The C-H index or the Variance Criterion Ration (VCR) was used by the Bensaou and Venkatraman (1995) study where an extensive explanation of the rationale for its use and calculation is provided.

Table 6-22: Clustering schedule for Information Processing Needs

NCL	Clusters Joined*		FREQ	NCL	Clusters Joined*		FREQ
80	73	84	2	40	CL58	CL60	4
79	39	97	2	39	7	70	2
78	52	89	2	38	6	CL68	3
77	85	95	2	37	10	71	2
76	21	77	2	36	3	31	2
75	82	103	2	35	CL46	CL49	5
74	24	64	2	34	9	CL50	5
73	62	67	2	33	CL56	CL71	4
72	35	104	2	32	CL70	CL45	6
71	49	72	2	31	CL39	16	3
70	1	96	2	30	CL40	CL42	6
69	54	86	2	29	CL35	CL74	7
68	17	50	2	28	CL57	40	3
67	57	88	2	27	CL52	CL67	6
66	29	105	2	26	CL76	47	3
65	12	48	2	25	20	CL47	4
64	4	13	2	24	CL37	CL51	5
63	78	94	2	23	CL31	100	4
62	45	90	2	22	CL33	CL59	6
61	14	76	2	21	CL43	98	6
60	28	61	2	20	CL32	CL38	9
59	22	26	2	19	5	CL41	5
58	18	81	2	18	CL48	36	3
57	38	83	2	17	CL36	CL30	8
56	11	80	2	16	CL28	CL62	5
55	55	CL77	3	15	CL25	CL79	6
54	CL65	102	3	14	CL23	CL53	7
53	CL73	87	3	13	CL27	CL24	11
52	CL64	CL78	4	12	CL19	CL34	10
51	CL69	60	3	11	CL13	CL26	14
50	33	CL55	4	10	CL20	CL29	16
49	51	91	2	9	CL22	CL21	12
48	34	101	2	8	CL17	CL18	11
47	CL80	93	3	7	CL14	CL9	19
46	15	CL72	3	6	CL8	CL12	21
45	CL61	CL75	4	5	CL10	CL15	22
44	65	75	2	4	CL5	CL16	27
43	CL54	CL66	5	3	CL4	CL11	41
42	19	30	2	2	CL6	CL7	40
41	CL44	CL63	4	1	CL3	CL2	81

**Note*: The numbers represent individual cases and the numbers prefixed by CL represent Clusters of cases formed earlier, the number referring to the step when the cluster was formed

The plots of *Semi-Partial R2*, *R2*, and the C-H index or Variance Criterion Ratio (VCR) to the number of clusters is provided in Figure 6-3, Figure 6-4, and Figure 6-5 respectively.

Figure 6-3: Information Processing Needs: Plot of Semi-Partial R^2 to number of clusters

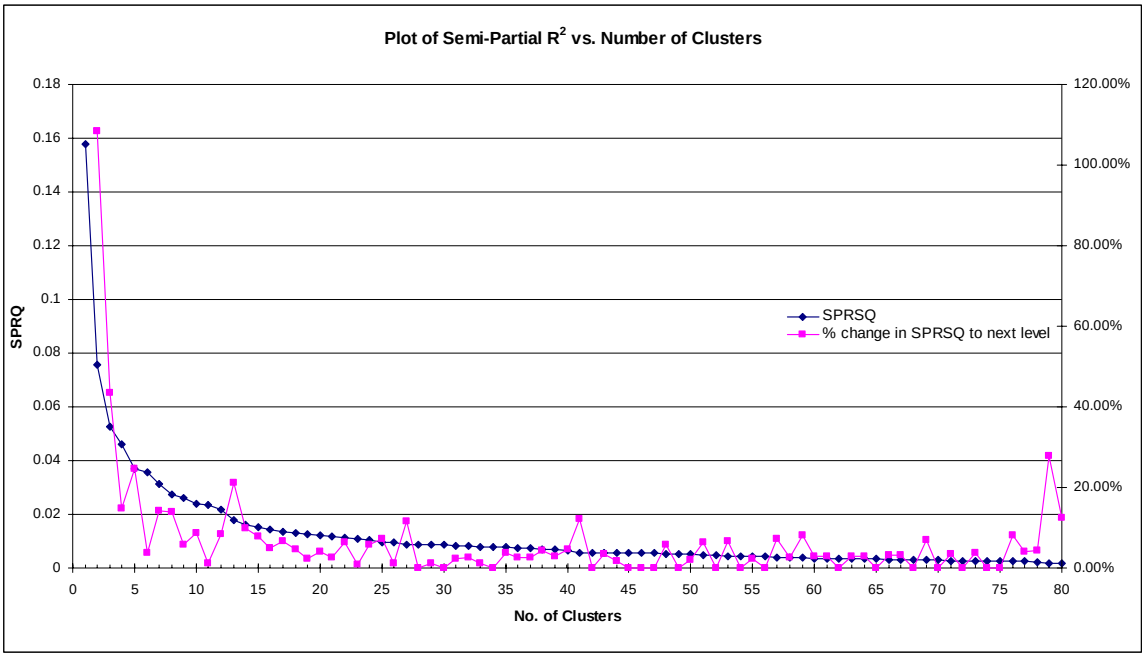
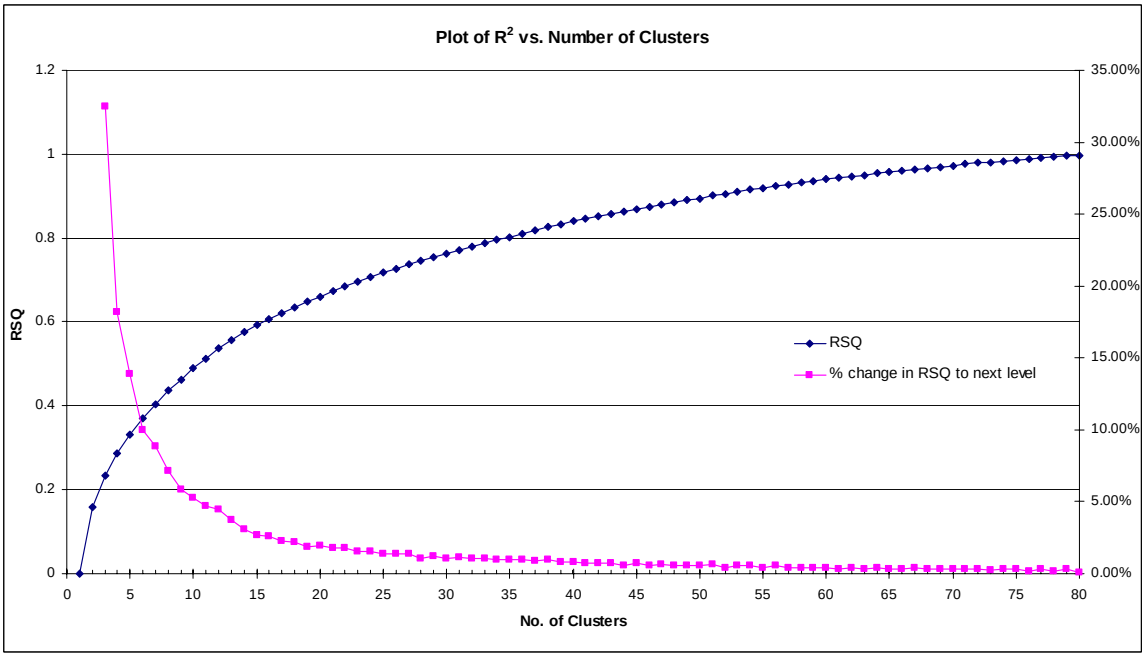
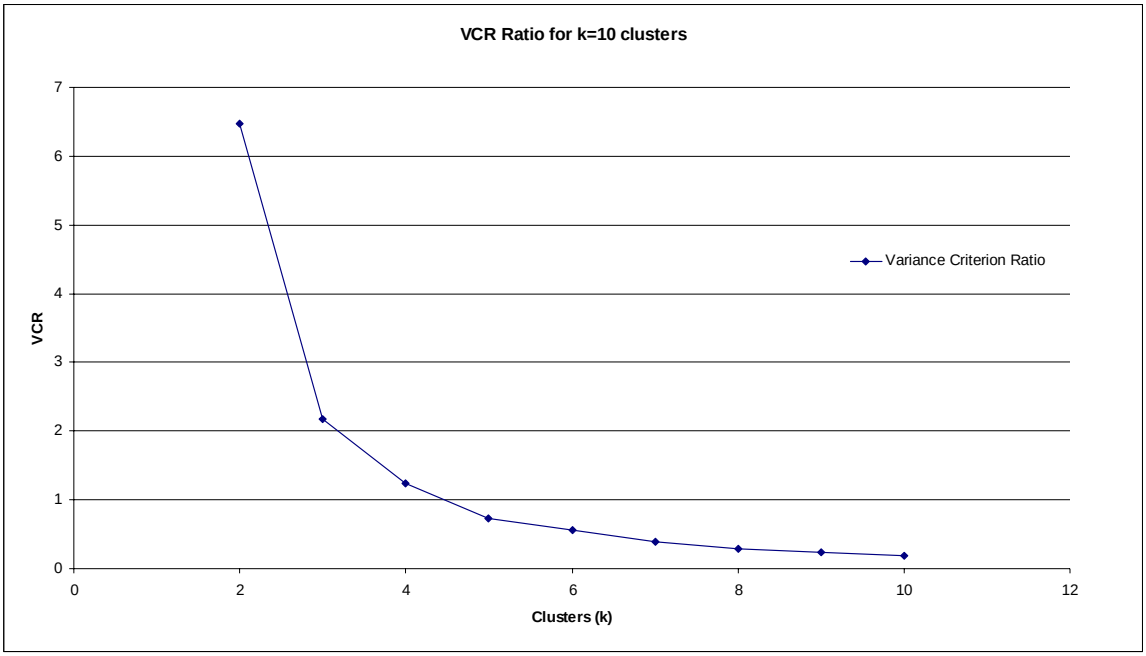


Figure 6-4: Information Processing Needs: Plot of R^2 to number of clusters



An examination of Figure 6-3 and Figure 6-4 clearly indicate a jump in the respective values at the two-cluster solution. Inspection of the dendogram also confirms this where the jump from the two cluster solution to the one cluster solution is considerable.

Figure 6-5: Information Processing Needs: Plot of VCR to number of clusters



The Caliński, and Harabasz (1974) rule selects the best number of clusters for which VCR has a local or general maximum. In Figure 6-5 a local maximum can be seen at the two-cluster solution confirming the conclusions from the previous stopping rules.

The next step is to fine-tune the clusters using a non-hierarchical cluster analysis that uses cluster centroids and the number of clusters from the hierarchical clustering results. The advantages of the non-hierarchical clustering algorithm is that cases with missing observations on some variables that were excluded from the hierarchical clustering can be included in the cluster analysis, minimizing the loss of information.

As a first validity check for the stability of the cluster solution, Hair and Black (2000) recommend a second non-hierarchical cluster analysis where the seed values are randomly selected (not specified *a priori*). A comparison of the stability of the cluster membership obtained using all the cluster methods was undertaken and these results are reported in Table 6-23, which shows fairly stable cluster membership across all five clustering methods. Of the nineteen cases that show changes in membership, ten show changes for the randomly selected seeds (validation clustering), three show a switch between the hierarchical and non-hierarchical methods and only three show no clear pattern for changes in membership. With the stability of the cluster membership established, step 2 of the clustering process can be undertaken.

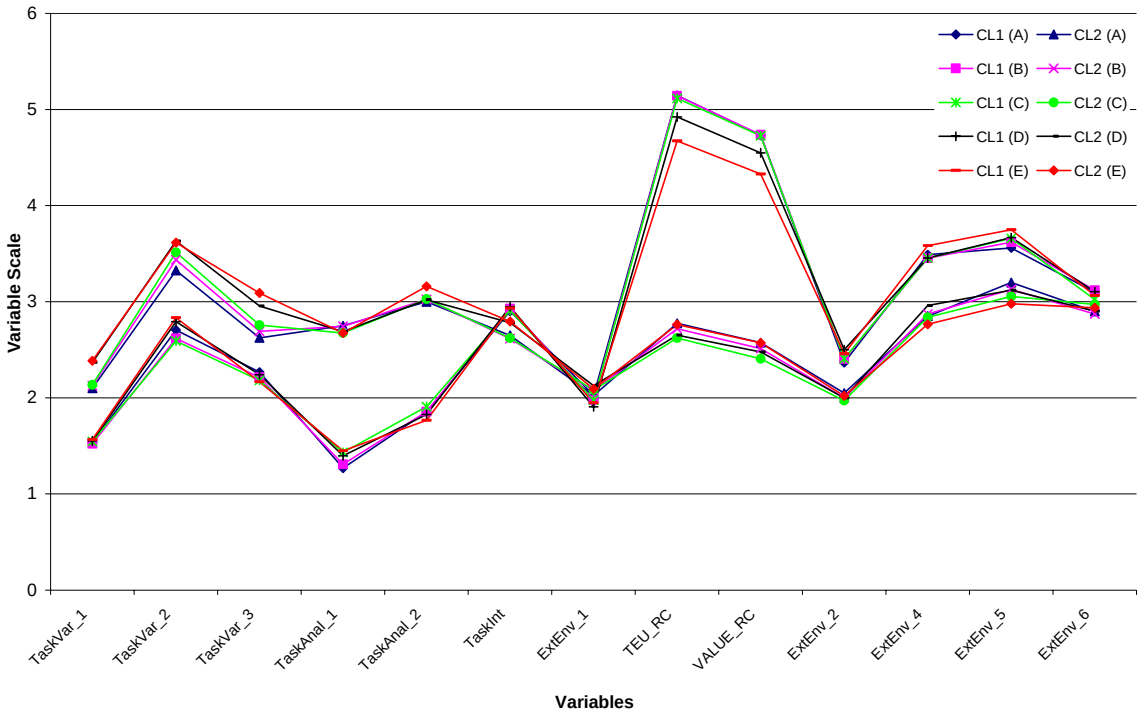
Table 6-23: Comparison of cluster membership across five clustering methods

id	A	B	C	D	E	id	A	B	C	D	E	id	A	B	C	D	E
1	1	1	1	1	1	**38**	1	1	1	1	1	**75**	2	2	2	2	2
2		.	.	2	2	**39**	1	1	1	1	1	**76**	1	1	1	1	1
3	2	2	2	2	2	**40**	1	1	1	1	1	**77**	1	1	1	1	2
4	1	1	1	1	1	**41**		.	.	2	2	**78**	2	2	2	2	2
5	2	2	2	2	2	**42**		.	.	2	2	**79**		.	.	1	1
6	1	1	1	1	1	**43**		.	.	2	2	**80**	2	2	2	2	2
7	2	1	1	1	1	**44**		.	.	2	2	**81**	2	2	2	2	2
8		.	.	1	1	**45**	1	1	1	1	1	**82**	1	1	1	1	1
9	2	2	2	2	2	**46**		.	.	2	2	**83**	1	1	1	1	1
10	1	1	1	1	1	**47**[b]	1	2	2	2	2	**84**	1	1	1	1	1
11	2	2	2	2	2	**48**	2	2	2	2	2	**85**[c]	2	2	1	1	1
12	2	2	2	2	2	**49**	2	2	2	2	2	**86**	1	1	1	1	1
13	1	1	1	1	1	**50**	1	1	1	1	1	**87**	2	2	2	2	2
14	1	1	1	1	1	**51**	1	1	1	1	1	**88**	1	1	1	1	1
15	1	1	1	1	1	**52**	1	1	1	1	1	**89**	1	1	1	1	1
16	2	2	2	2	2	**53**		.	.	2	2	**90**	1	1	1	1	1
17	1	1	1	1	1	**54**	1	1	1	1	1	**91**	1	1	1	1	1
18[a]	2	2	1	2	1	**55**	2	2	2	2	2	**92**		.	.	2	2
19[a]	2	2	1	2	1	**56**		.	.	1	1	**93**	1	1	1	1	1
20	1	1	1	1	1	**57**	1	1	1	1	1	**94**	2	2	2	2	2
21	1	1	1	1	1	**58**		.	.	1	1	**95**	2	2	2	2	2
22	2	2	2	2	2	**59**		.	.	1	1	**96**	1	1	1	1	1
23		.	.	1	1	**60**	1	1	1	1	1	**97**	1	1	1	1	1
24	1	1	1	1	1	**61**	2	2	2	2	2	**98**[a]	2	2	1	2	1
25		.	.	2	2	**62**	2	2	2	2	2	**99**		.	.	1	1
26	2	2	2	2	2	**63**		.	.	1	1	**100**[c]	2	2	1	1	1
27		.	.	2	2	**64**	1	1	1	1	1	**101**	2	2	2	2	2
28	2	2	2	2	2	**65**	2	2	2	2	2	**102**	2	2	2	2	2
29	2	2	2	2	2	**66**		.	.	2	2	**103**	1	1	1	1	1
30[a]	2	2	1	2	1	**67**	2	2	2	2	2	**104**	1	1	1	1	1
31	2	2	2	2	2	**68**		.	.	1	1	**105**	2	2	2	2	2
32[d]		.	.	2	1	**69**		.	.	1	1	**501**		.	.	1	1
33	2	2	2	2	2	**70**[b]	2	1	1	1	1	**503**		.	.	2	2
34	2	2	2	2	2	**71**	1	1	1	1	1	**504**		.	.	1	1
35	1	1	1	1	1	**72**	2	2	2	2	2	**505**		.	.	1	1
36	2	2	2	2	2	**73**	1	1	1	1	1	**506**		.	.	1	1
37		.	.	1	1	**74**		.	.	1	1	**507**		.	.	2	2

NOTES:
a = the cluster membership of these cases are different for the validation clustering
b = the cluster membership of these cases switch with the non-hierarchical clustering
c = the cluster membership of these cases show no pattern
d = these cases have missing data and are included only with the non-hierarchical clustering with missing values, cluster membership of these cases switch for validation clustering
CLUSTERING METHOD
A=Hierarchical
B=Non-hierarchical no missing values hierarchical cluster seed values
C=Non-hierarchical no missing values no seed values (validate)
D=Non-hierarchical include missing values hierarchical cluster seed values
E=Non-hierarchical include missing values no seed values (validate)

As a second method of validating the cluster structure the cluster means for each variable were compared across the two clusters produced by each of the five methods. A graphical representation of the two cluster means for each variable across all the clustering methods is provided in Figure 6-6. It is quite clear that the two cluster means for each of the variables are quite consistent across all the clustering methods.

Figure 6-6: Comparison of the variable cluster means across five clustering methods.



CLUSTERING METHOD
A=Hierarchical
B=Non-hierarchical no missing values hierarchical cluster seed values
C=Non-hierarchical no missing values no seed values (validate)
D=Non-hierarchical include missing values hierarchical cluster seed values
E=Non-hierarchical include missing values no seed values (validate)

6.5.4.2 Information Processing Capability

As illustrated in Figure 6-1 the cases in each one of the two clusters formed by Method D, the non-hierarchical clustering using all cases including those with missing values, are separately clustered for the *Information Processing Capability* variables of each of the transactions. The clustering procedures for each of these analyses use the same stopping rules as in 6.5.4.1 and cluster membership using Method D as in Table 6-23 above. For the sake of brevity only the important results have been reported. The dendograms and, the plots for *Semi-Partial* R^2, R^2 and VCR against number of cluster are reported in Appendix O.

For the shipping schedule lookup transaction an examination of Table O-1 of Appendix O shows that a two cluster solution is the best solution for the cluster analysis on Cluster 1. In case of Cluster 2 the dendogram suggests the possibility of a three cluster solution. The *Semi-Partial* R^2 also shows the possibility of a three cluster solution. However, both the *Semi-Partial* R^2, and R^2 indicate that highest percentage change in their respective values is from the three to two cluster solutions. The VCR also confirms the two cluster solution. For all the other transactions the dendogram and the diagnostic graphs exhibit a similar pattern that indicates a two cluster solution.

After fine tuning the clusters using the k-means non-hierarchical clustering technique and the cluster means from the hierarchical clustering, the first validity check for each of the cluster analyses was conducted using a random seed for the cluster means. The cluster membership for each of these techniques was checked across the different methods to check for the stability of the cluster structure. No significant departures in cluster membership between the clustering methods were found. Finally, the cluster means were checked across the different methods and again no significant patterns were found, validating cluster stability.

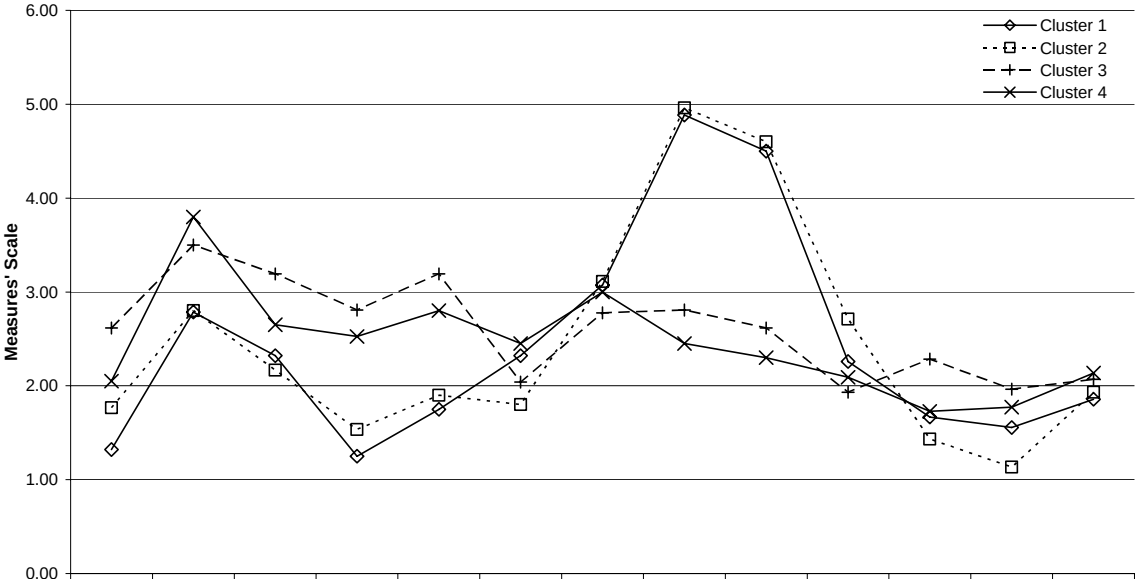
6.5.5 Stage 5: Interpreting the Clusters

The interpretation of clusters, involves an examination of each cluster's variates to name or assign a label accurately describing the nature of the clusters. This entails examining the cluster means for each variable across the clusters and defining the clusters based on the variables that exhibit significant differences among the clusters. A one way ANOVA was performed across the clusters for each of the twenty-eight cluster variables, separate sets of analyses were conducted for each shipping transaction. The clusters formed for each shipping transaction will now be defined using the results of the ANOVA. The ANOVA diagnostics were examined for violations of the assumptions of homoskedasticity and normality of the residuals and where appropriate transformations were employed to correct these.

6.5.5.1 Information Processing Needs

The results of the analyses for the information processing needs variables are the same for all the shipping transactions considered. The profile plots of the cluster means across the variables are provided in Figure 6-7 with the significance tests summarized in Table 6-24. Of these variables, Task Interdependence (TaskInt), market capacity (ExtEnv_1), and seasonality (ExtEnv_6) did not exhibit any significant differences among the clusters at the 0.05 level of significance.

Figure 6-7: Cluster Analysis – Information Processing Needs (All Transactions))



	TaskVar_1	TaskVar_2	TaskVar_3	TaskAnal_1	TaskAnal_2	TaskInt*	ExtEnv_1*	TEU_RC	VALUE_RC	ExtEnv_2	ExtEnv_4*	ExtEnv_5*	ExtEnv_6*
Cluster 1	1.32	2.79	2.32	1.25	1.75	2.32	3.07	4.88	4.50	2.26	1.67	1.56	1.86
Cluster 2	1.77	2.80	2.17	1.53	1.90	1.80	3.11	4.96	4.60	2.71	1.43	1.13	1.93
Cluster 3	2.62	3.50	3.19	2.81	3.19	2.04	2.78	2.81	2.62	1.93	2.29	1.96	2.07
Cluster 4	2.05	3.80	2.65	2.53	2.80	2.45	3.00	2.45	2.30	2.09	1.73	1.77	2.14

* The scale for these variables is reversed for display.

Table 6-24: Information Processing Needs – Significant differences in cluster means (All Transactions)

Comparison Cluster *i/j*	TaskVar_1	TaskVar_2	TaskVar_3	TaskAnal_1	TaskAnal_2	TaskInt	ExtEnv_1	TEU_RC	VALUE_RC	ExtEnv_2	ExtEnv_4	ExtEnv_5	ExtEnv_6
1-2													
1-3	S		S	S	S			S	S				
1-4	S	S		S	S			S	S				
2-3	S		S	S	S			S	S	S	S	S	
2-4		S		S	S			S	S			S	
3-4													

Note: "S" is significant at p-value<0.05

Cluster 1

This *gestalt* of firms displays significantly lower task variety and higher task analyzability, as compared with both clusters 3 and 4. The environmental complexity though is medium. TEU and Value are significantly higher than both clusters 3 and 4 but there are no significant differences between this and other clusters for the number of overseas suppliers (ExtEnv_2). From Figure 6-7 it is apparent that the environmental dynamism is low but with no significant differences in product demand uncertainty and supply uncertainty.

Cluster 2

This cluster is similar to cluster 1. Shippers exhibit low task uncertainty, and highest environmental complexity with shippers in this cluster sourcing from the highest number of overseas suppliers. The environmental dynamism faced by this cluster is the lowest, significantly lower than clusters 3 and 4.

Cluster 3

The firms in this cluster have a very high level of task uncertainty exhibiting the highest levels of task variety and lowest levels of task analyzability, differing significantly from both clusters 1 and 2. On the other hand, environmental complexity is low significantly lower than clusters 1 and 2 while environmental dynamism is high significantly different from cluster 2.

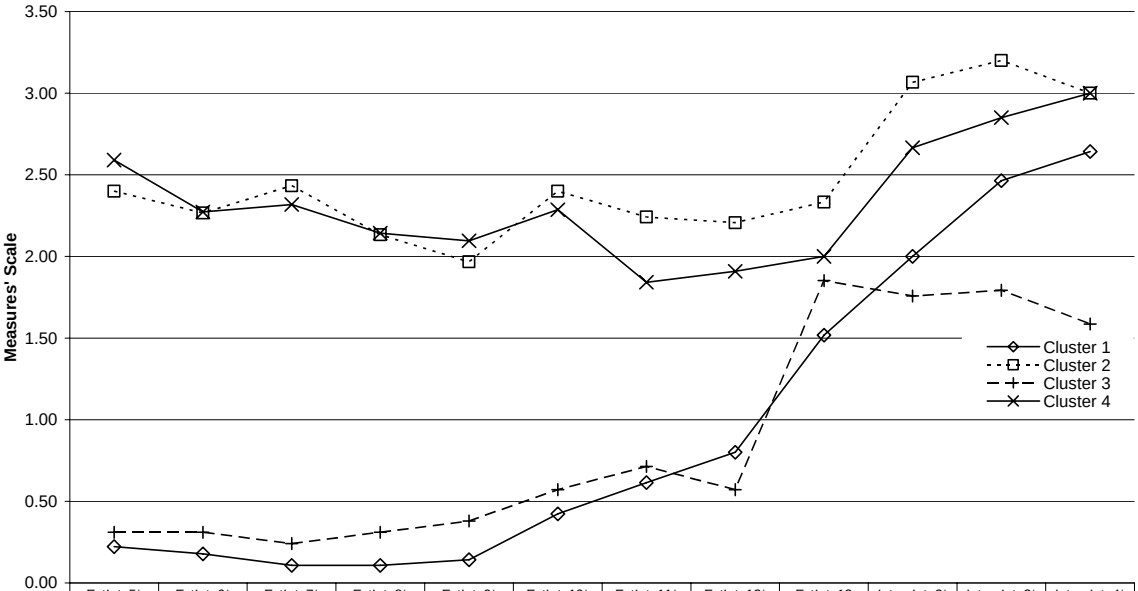
Cluster 4

This cluster is similar to cluster 3. Firms have a very high level of task uncertainty and low levels of analyzability, differing significantly from both clusters 1 and 2. On the other hand, environmental complexity is very low significantly lower than clusters 1 and 2 while there is some environmental dynamism, significantly different from cluster 2 for supply uncertainty.

6.5.5.2 Information Processing Capability

The results of the analyses for the information processing capability variables are also largely the same across all the transactions. The two differences are: 1) for the Shipping Schedule transaction there is a significant difference between clusters 3 and 4 for the InternInt_3 variable; and 2) for the Booking Confirmation transactions there is no significant difference between clusters 1 and 2 for the InternInt_2 variable. The profile plots of the cluster means across the variables are provided in Figure 6-8 with the significance tests summarized in Table 6-27.

Figure 6-8: Cluster Analysis – Information Processing Needs (All Transactions)



	ExtInt_5*	ExtInt_6*	ExtInt_7*	ExtInt_8*	ExtInt_9*	ExtInt_10*	ExtInt_11*	ExtInt_12*	ExtInt_13	InternInt_2*	InternInt_3*	InternInt_4*
Cluster 1	0.22	0.18	0.11	0.11	0.14	0.42	0.62	0.80	1.52	2.00	2.46	2.64
Cluster 2	2.40	2.27	2.43	2.13	1.97	2.40	2.24	2.21	2.33	3.07	3.20	3.00
Cluster 3	0.31	0.31	0.24	0.31	0.38	0.57	0.71	0.57	1.85	1.76	1.79	1.59
Cluster 4	2.59	2.27	2.32	2.14	2.10	2.29	1.84	1.91	2.00	2.67	2.85	3.00

* The scale for these variables is reversed for display.

Table 6-25: Information Processing Needs – Significant differences in cluster means (All Transactions)

Comparison Cluster i/j	ExtInt_5	ExtInt_6	ExtInt_7	ExtInt_8	ExtInt_9	ExtInt_10	ExtInt_11	ExtInt_12	ExtInt_13	InternInt_2	InternInt_3	InternInt_4
1-2	S	S	S	S	S	S	S	S	S	S		
1-3												S
1-4	S	S	S	S	S	S	S	S				
2-3	S	S	S	S	S	S	S	S		S	S	S
2-4												
3-4	S	S	S	S	S	S	S	S				S

Note: "S" is significant at p-value<0.05

Cluster 1

The information processing capability of this *gestalt* is low. Firms have maintained EDI connectivity with external business partners for the shortest time in this cluster. There is low external IOS integration with customers and suppliers. Firms in this cluster also exhibit low internal IOS integration with low inter-departmental information sharing, and low database integration.

Cluster 2

These firms display high information processing capability using EDI for the longest periods of time. External IOS integration with suppliers and customers is very high. Internal IOS integration within the firm is also very high.

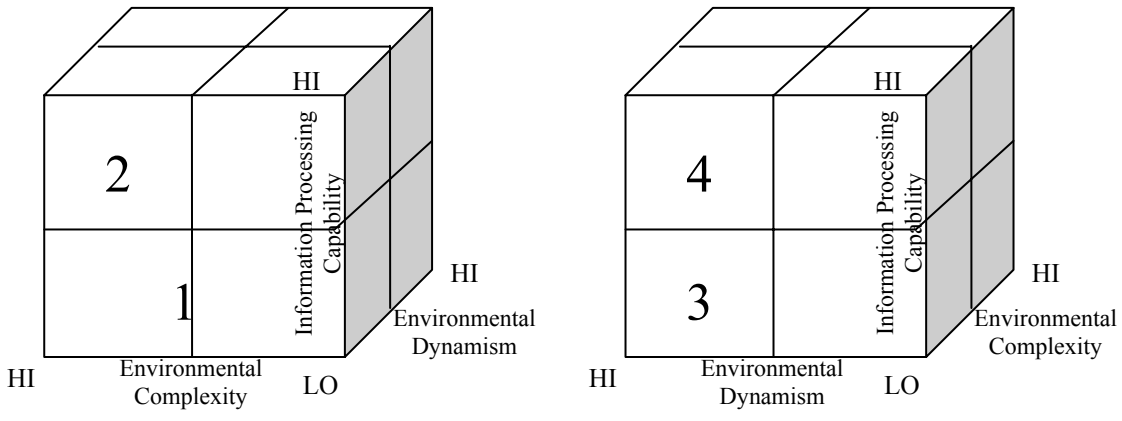
Cluster 3

The information processing capability for these firms is also very low with significantly lower external IOS integration with suppliers and customers, and the lowest internal IOS integration.

Cluster 4

The information processing capability of this *gestalt* is high. There is high external IOS integration with customers and suppliers. Firms in this cluster also exhibit medium to high internal IOS integration. This cluster exhibits higher interdepartmental information sharing during the shipping schedule lookup for shipment planning.

Figure 6-9: Clusters categorized according to information processing needs and capabilities



LOW TASK UNCERTAINTY (A)

HIGH TASK UNCERTAINTY (B)

The *gestalts* formed are a hybrid of high and low environmental uncertainty. The cluster composition for all the shipping transactions is represented in Figure 6-9 in two sets of three-dimensional axes. Each set of axes indicates the two dimensions of *environmental uncertainty* along the horizontal and *information systems use* along the vertical for high and low *task uncertainty*. Cluster 1 is placed at the mid point along the environmental complexity axis in Figure 6-9 (A) to indicate medium environmental complexity, lower than cluster 2 whose shippers source from a significantly higher number of overseas suppliers. This will be further discussed in the conclusions chapter next.

6.5.5.3 Shipping Transactions

For each one of the shipping transactions, there is very little significant difference among the clusters for IOS use (see Table 6-26). From Figure 6-10 it is apparent that the non-IOS (UNON) is used the most and EDI (UEDI) is used the least across all the transactions. The Internet portals are used more for shipping schedule lookup, and tracking and tracing than for booking confirmation and receiving B/L information.

Figure 6-10: Cluster Analysis – IOS to conduct the shipping transactions.

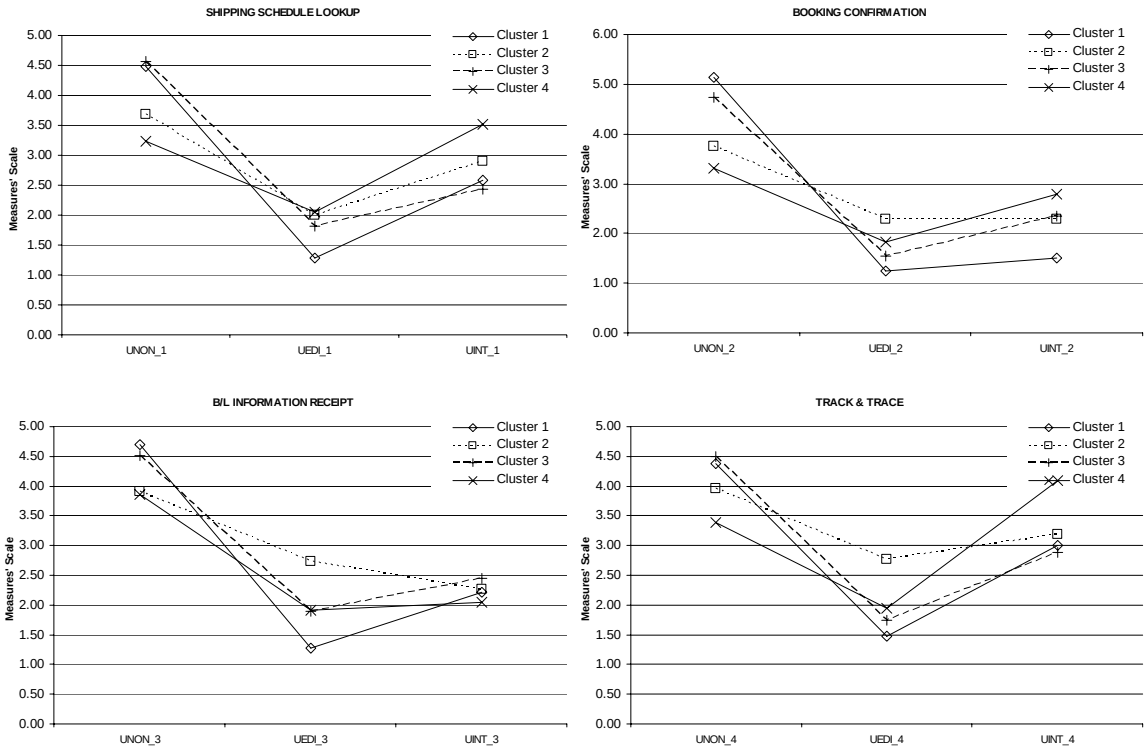


Table 6-26: IOS for shipping transactions – Significant differences in cluster means

Comparison Cluster i/j	Shipping Schedule Lookup			Booking Confirmation			B/L Information Receipt			Track & Trace		
	UNON_1	UEDI_1	UINT_1	UNON_2	UEDI_2	UINT_2	UNON_3	UEDI_3	UINT_3	UNON_4	UEDI_4	UINT_4
1-2				SS				S			S	
1-3												
1-4				S								
2-3												
2-4												
3-4												

Note: "S" is significant at p-value<0.05; "SS" is significant at p-value<0.1

Clusters 1 and 3 clearly show low IOS use across all the transactions with cluster 1 exhibiting the highest non-IOS use and lowest EDI and Internet portal use. Except for shipping schedule lookup, cluster 1 differs significantly from cluster 2 in the use of non-IOS. For booking confirmation, cluster 1 also differs significantly from cluster 4. Cluster 3 shows very high non-IOS use for all shipping transactions. This cluster's pattern of EDI use and Internet portal use though is not as clear. For shipping schedule lookup and B/L information receipt EDI use appears average, while for the others it appears low. Use of Internet portals is actually higher than the other clusters for B/L information receipt, though the difference is very small. The use of Internet portal is average for booking confirmation, and low for the others. However, none of these differences is statistically significant.

Clusters 2 and 4 display high IOS use. Cluster 2 displays the highest EDI use across all the shipping transactions, significantly different from cluster 1 for B/L information receipt and track and trace. This is consistent with cluster 2 using EDI for the longest time as compared to the other clusters. Except for B/L information receipt (where EDI use in general is the lowest), cluster 4 exhibits the highest use of Internet portals. However, the use of Internet portals by cluster 4 is not statistically significant from the other clusters.

6.5.6 Stage 6: Validation and Predictive Validity

Venkatraman (1989) recommends the use of predictive validity for establishing the performance implications of fit and for demonstrating the existence of generic strategy types or multiple configurations of equally successful strategies. This will uncover the best configured *gestalts* that match the appropriate levels of information processing capabilities with the appropriate levels of information processing needs, as indicated by their relative shipping and SC performance. The methodology recommended is the final stage of a cluster analysis prescribed by Hair et al (1998). The predictive validity of the clusters, which is tested by observing the differences in cluster profiles across some additional response variables, such as performance, not used in the clustering.

The predictive validity of the clusters in each transaction is tested using a MANOVA with the measures of the shipping and SC performance construct developed in section 6.4 as the response variables. Compliance with the assumptions of the MANOVA analysis was ensured by inspecting the residual plots and conducting specific tests for homoskedasticty of the response variables' variance-covariance matrix. Independence is ensured due to the random sampling of the survey sample from the population. Homoskedasticty of the variance co-variance matrix was tested using Bartlett's test of

homogeneity of within covariance matrices operationalized in the *DISCRIM* procedure in SAS 9.1. While violations of the assumption of homoskedasticty was observed for all transactions, Hair *et al* (1998) argue that for groups that have very similar number of observations (ratio between largest and smallest group is less than 1.5) then this violation does not pose a serious threat to the analysis. The cluster groups for all of the transactions considered had a largest to smallest group ratio < 1.5. Multivariate normality was investigated using univariate and bivariate plots of residuals. In addition, residuals from individual ANOVAs were checked and as a result several transformations were made. These transformations were common for the shipping and SC performance across all the transactions and also ensured homogeneity of within covariance matrices at $p<0.05$.

Figure 6-11: Profile plot for cluster means across performance variables

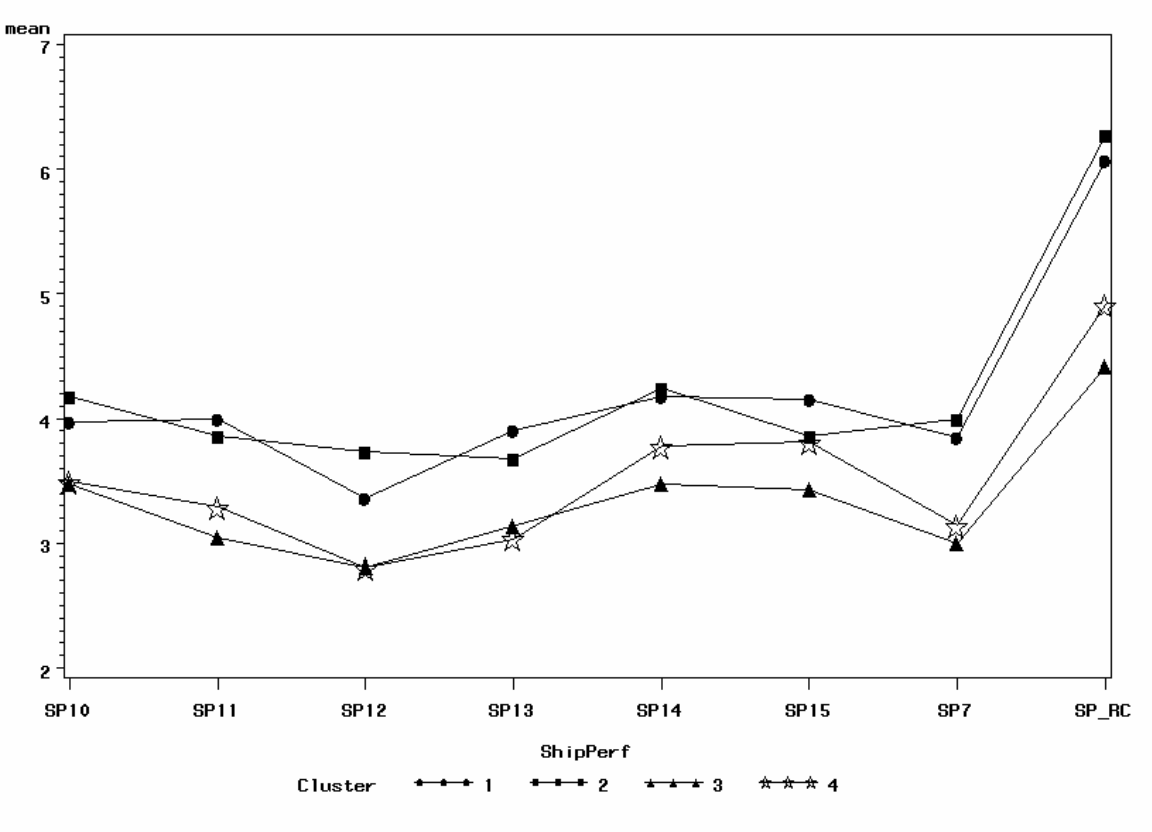


Table 6-27: Group comparisons for one-way ANOVAs on performance measures (all transactions)

Comparison Cluster i/j	SP_RC	ShipPerf_7	ShipPerf_10	ShipPerf_11	ShipPerf_12	ShipPerf_13	ShipPerf_14	ShipPerf_15
1-2	-	-	-	-	-	-	-	-
1-3	S	S	-	S	-	S	-	-
1-4	-	-	-	-	-	-	-	-
2-3	S	S	-	S	-	S	-	-
2-4	-	-	-	-	-	S	-	-
3-4	-	-	-	-	-	-	-	-

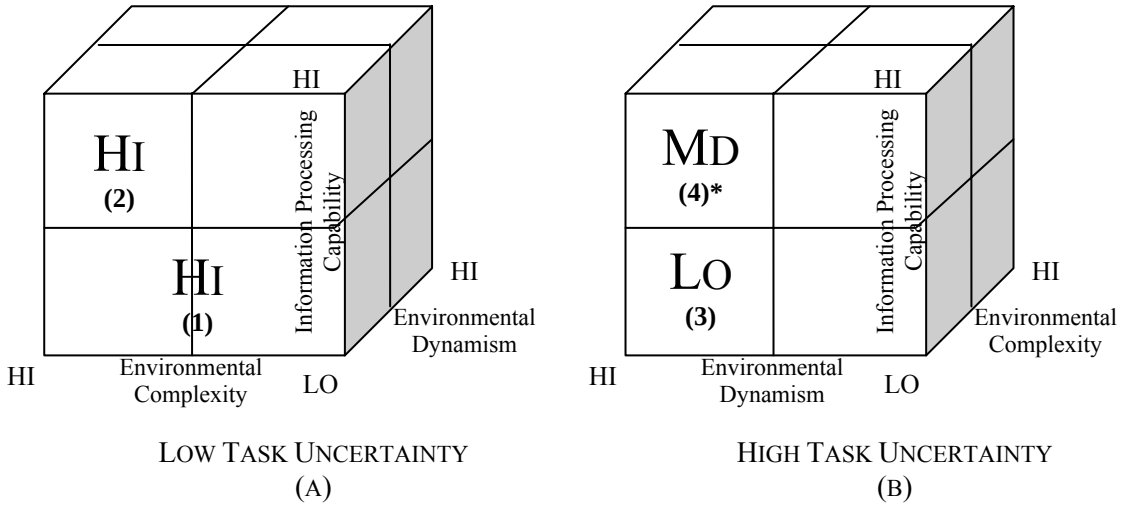
Note: "S" is significant at p-value = 0.0125 which is 0.05 level of significance with the Bonferroni adjustment for number of groups (clusters) ? /4

The significance of the MANOVA was checked using the Wilks Lambda statistic which was significant for all the shipping transactions at the $p<0.01$ level. The profile plot representing the cluster means across all the performance variables is presented in Figure 6-11. One option with which to uncover the specific group difference for each performance measure would be to construct *a priori* orthogonal contrasts. However, only G-1 orthogonal contrasts exist for G groups, which does not allow all six comparisons of the four cluster groups. Hair *et al* (1998) suggest the use of Scheffe's or Tukey's method for multiple comparisons for the high power of the tests. As Tukey's is the most suitable for multiple pair-wise comparisons the Honest Significant Difference (HSD) method with the Tukey-Kramer adjustment for unbalanced groups is used. The profile plot for the means of the clusters across the performance variables is illustrated in Figure 6-11. The significant differences in means across clusters for each performance variable are reported in Table 6-27. SP_RC is a weighted measure for on-time performance with higher levels indicating better on time performance than lower levels. All the other measures are 1-5 with 1 being high level of performance and 5 being low level of performance. The MANOVA results for all of the shipping transactions were very similar. The differences across the shipping transactions were as follows:

i) Booking confirmation:
   a. Clusters 1 and 2 are significantly different from cluster 4 at the 0.05 level for ShipPerf_7
   b. Cluster 2 is significantly different from cluster 4 at the 0.05 level for SP_RC.

ii) B/L information receipt:
   a. Clusters 1 and 2 are significantly different from cluster 4 at the 0.05 level for ShipPerf_7.
   b. Clusters 1 and 2 are significantly different from cluster 4 at the 0.05 level for SP_RC.

Figure 6-12: Relative performance of the clusters



* Cluster 4 performance is considered 'medium' because of the fewer number of significant differences from the high performing clusters 1 and 2 as compared to cluster 3.

The Figure 6-12 illustrates performance of the clusters in bold type with the cluster numbers in brackets. The figure shows some evidence that the results support the theory that configuring higher levels of information processing capabilities according to higher levels of information processing requirements improve performance. It appears that cluster 2 has configured higher information processing capability when faced by higher environmental complexity to improve performance. Clusters 1 and 2 both exhibit equally significant high performance. Both these clusters differ in their configuration of information processing capability with cluster 2 being the higher user of IOS when faced with apparently similar levels of uncertainty. They differ though on the environmental complexity measure of "number of overseas suppliers". Hence, it appears that "number of overseas supplier" rather than number of TEU and Value of shipments is the differentiating variable for environmental complexity between clusters 1 and 2. Cluster 1 has a low level of the overseas supplier measure and is therefore, deemed to face medium environmental complexity. Hence, clusters 1 and 2 both exhibit well configured information processing requirements to meet needs, which result in high performance. Cluster 3 and cluster 4 have adopted different levels of information processing capabilities. Faced with almost identical task uncertainty and environmental dynamism, the high information processing capability of cluster 4 appears to improve its performance as compared to cluster 3. These results will be examined in further detail in the conclusion chapter next.

6.6 Summary

In this chapter the data collection and analysis have been detailed. The survey method for data collection is explained and the tests for non-response bias are conducted. These tests demonstrate that non-response bias is not present. Hence, the survey sample is a reasonable approximation of the population and the results are generalizable to the population of US importers.

The initial data screening is carried out next, examining for missing data processes, of which there are no significant missing data processes present. A confirmatory factor analysis model is then used in LISREL to check the validity of the construct used in the cluster analysis.

Venkatraman's (1989) recommendations for descriptive and prescriptive validity of fit are followed. The six stages of the cluster analysis as prescribed by Hair *et al* (1998) are detailed and results reported. These cluster analyses result in the identification and description of the internally consistent configurations of firms according to the theoretical position implied by fit. The predictive validity of 'fit' is then tested using a MANOVA with the measures of shipping and SC performance as the dependent variable.

Next, the conclusions discuss the descriptive and predictive validity of fit offering normative advice from the conclusions reached by answering the research questions.. The contributions of this research are discussed including this study's contribution to fit research. Finally, the limitations of the current research will be discussed with suggestions for improvement and future research opportunities.

Chapter 7

Conclusions

The description of the *gestalts*' configurations from the cluster analysis provide the answer to the first research question regarding the current use of the available IOS and non-IOS to manage the international ocean shipping and supply chain process. The second research question regarding the best use of IOS for the shipping transaction is addressed by testing the predictive validity of fit, which is achieved by uncovering the best performing *gestalts.*

7.1 Discussion

7.1.1 Gestalt Configurations

The theory requires that descriptive validity of the *gestalts* is achieved by interpreting their composition in terms of the theoretical position implied by fit (Venkatraman, 1989). Accordingly, the environmental and task uncertainty variables are used to describe the information processing requirements, while the external IOS, internal IS integration, and shipping transaction IOS are used to describe the information processing capabilities. To ensure descriptive validity only the variables exhibiting statistically significant differences among the clusters will be considered. As can be expected the *gestalts* were found to be largely consistent across all the shipping transactions studied and will be described in their numerical order.

The *gestalts* are hybrids of information processing capabilities. This is similar to the Bensaou and Venkatraman (1995) study, where different configurations of high and low information processing needs' dimensions were uncovered. Hence, other configurations of firms may exist that experience high information processing needs across all the dimensions and have configured high information processing capabilities to achieve fit and improve performance, or vice versa. However, because of their small size and the low diffusion of Internet portals, these *gestalts* may not have been detected and were instead absorbed into the other *gestalts*. From sections 6.5.5.1 and 6.5.5.2 it is clear that clusters 1 and 2 exhibit low task uncertainty and environmental dynamism, and medium and high environmental complexity respectively. Clusters 3 and 4 exhibit high task uncertainty and environmental dynamism, and low environmental complexity. For information processing capabilities clusters 1 and 3 exhibit low capability while, clusters 2 and 4 exhibit high capability, across all four shipping transactions.

7.1.1.1 Information Processing Needs

Shippers in clusters 1 and 2 are able to decompose the shipping process tasks into well defined steps that are highly analyzable and lend themselves to preplanning, thus, giving rise to the lowest task uncertainty. This situation may also aided by the high degree of standardization of the shipping process; and, the low frequency of exceptions, operational disruptions, and unanticipated and novel events, which require different methods or procedures for doing the job. Clusters 3 and 4 have low task analyzability that allows less preplanning, which contributes to increasing overall task uncertainty. These clusters

experience a high number of exceptions and unanticipated novel events, which further increases their task uncertainty.

The shippers in clusters 1 and 2 exhibit much greater shipment activity than clusters 3 and 4, measured both in terms of TEU and in shipment value. Additionally, the number of suppliers from whom these shippers import are relatively higher than clusters 3 and 4. However, the only significant difference is between clusters 2 and 3, cluster 1 is closer to clusters 3 and 4 than it is to cluster 2. Hence, cluster 2 faces higher environmental complexity than even cluster 1. The environmental dynamism for cluster 3 is the highest, both demand and supply uncertainty is very unstable, significantly higher than cluster 2. Materials and components supply uncertainty for cluster 4 is significantly higher than that for cluster 2. Demand and supply uncertainty for cluster 1 is not significantly different from the other clusters.

The most significant measures of environmental complexity, TEU and Value, are also measures of shipper size suggesting that clusters 1 and 2 are made up of large size shippers and clusters 3 and 4 are made up of small shippers. From the foregoing discussion it can be concluded that the membership of clusters 1 and 2 appears to be large shippers, operating in a stable environment and whose environmental complexity is apparently affected more by sourcing from a large number of overseas shippers than by a large annual throughput. This is typical of firms that have achieved a degree of maturity in their offerings and consequently their operations. Their market is matured with a relatively stable, high velocity demand. The day-today operations change very little and non-standard exceptions are relatively rare. Hence, these clusters are labeled *Mature*. The other two clusters have much smaller annual shipment volumes and face considerable environmental dynamism and task uncertainty. These characteristics are the opposite of the previous two Mature clusters, with firms still in the early stages of their product offerings and service operations. Hence, clusters 3 and 4 are labeled *Young*.

7.1.1.2 Information Processing Capability

The information processing capability for clusters 1 and 3 is low. Shippers in cluster 3 have the least developed internal IS integration while firms in cluster 1 do not show any significant differences in internal IS development from clusters 2 and 4. Shippers in clusters 1 and 3 do not have well developed Internet-based information systems for managing supply chain processes with suppliers. They have not implemented adequate Internet-based systems for materials procurement, order scheduling, inventory planning, and demand forecasting systems with suppliers. Similarly, shippers in these two clusters have not implemented adequate Internet-based systems for inventory planning, order processing, and after sales support with customers. EDI and Internet portal data from ocean carriers cannot be seamlessly integrated into shippers' office systems. Firms in cluster 1 have been the last to use EDI.

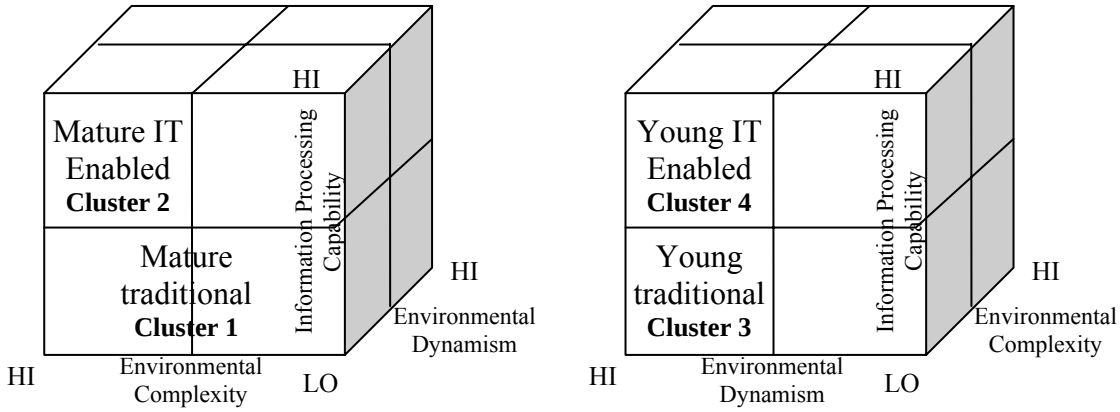
Clusters 2 and 4 have the highest information processing capability. Shippers in cluster 2 have the best internal IS integration, are able to share information in standardized and customizable formats between departments, and have used EDI the longest. Cluster 4 appears to have slightly less developed internal IS than cluster 2 and does not differ

significantly from clusters 1 and 3 regarding the state of internal IS integration. However, firms in cluster 4 are able to share information in standardized and customizable formats between departments and show some evidence of integrated database to facilitate information sharing.

The use of IOS and non-IOS for conducting shipping transactions is consistent with the information processing capabilities exhibited by the clusters across the external and internal IOS variables. Overall, Figure 6-10 helps illustrate that non-IOS is the best used channel for conducting shipping transactions. Although it is a recent IOS, Internet Portals are used more than EDI. Across all shippers, Internet portals are used more during shipping schedule lookup, and track and trace. This confirms some of the discussion in the literature review that favored Internet over EDI. Very few of the differences in use are statistically significant.

Consistent with the low information processing capabilities cluster 1 exhibits low use of EDI and Internet portals, and high use of non-IOS across all the shipping transactions. Cluster 1 uses non-IOS for booking confirmation significantly higher than cluster 2. Analogously, cluster 2 shows high use of EDI for all the shipping transactions, significantly different from cluster 1 for the B/L information receipt and track and trace transactions. Clusters 3 and 4 do not show any significant differences in use compared to the other clusters. Nevertheless, from Figure 6-10 it can be seen that in keeping with its low information processing capability cluster 3 exhibits consistently high use of non-IOS for all shipping transactions. Additionally, EDI use is seldom used and Internet portal use is very low. Conversely, cluster 4 exhibits consistently low use of non-IOS across all the shipping transactions. Although, shippers in cluster 4 use EDI very seldom it can be seen that these shippers exhibit the highest use of Internet portals across all the shipping transactions except B/L information receipt, where the spread of use is very small.

Figure 7-1: Gestalt configurations



Hence, clusters 2 and 4 clearly exhibit high information processing capabilities and are labeled *IT Enabled*, while clusters 1 and 3 are labeled *Traditional* for their low use of IOS, which assumes a greater use of the traditional means of communicating information and not sharing any additional information normally allowed only by the adoption of IOS.

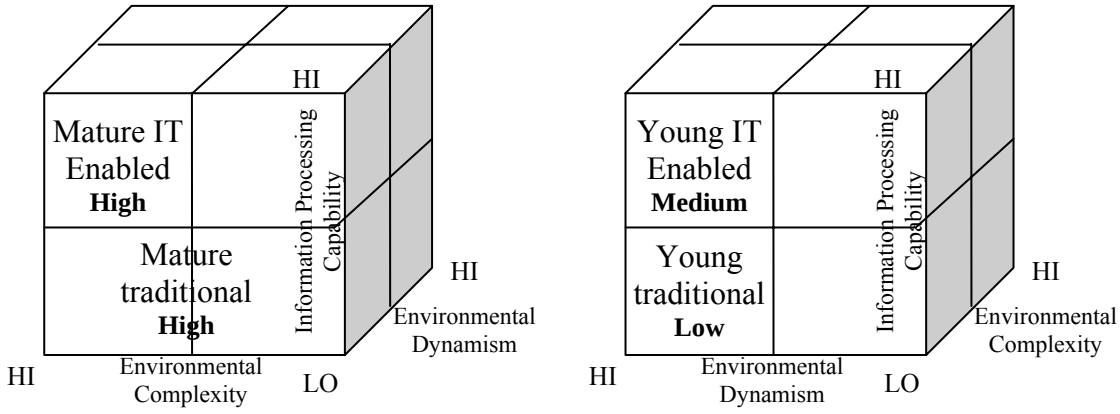
Therefore, four *gestalts* with unique configurations of information processing needs and information processing capabilities have been uncovered. The insignificance of Task Interdependence demonstrates the lack of any partnership effects and supports the exclusion of political economy from the model consideration. These newly formed *gestalts* are named in Figure 7-1 and are summarized as follows:
1) The Mature Traditional *gestalt* is made up of large volume shippers importing from relatively fewer overseas supplier. Firms face low task uncertainty and have configured low information processing capabilities using non-IOS the most and IOS the least for conducting shipping transactions.
2) The Mature IT Enabled *gestalt* is made up of large volume shippers importing from the highest number of overseas suppliers. Firms face low task uncertainty, and low environmental dynamism. They have configured high information processing capabilities and show some evidence of using IOS, especially EDI, for conducting the shipping transactions.
3) The Young Traditional *gestalt* is made up of small volume shippers importing from the fewest overseas suppliers. Firms face high task uncertainty and high environmental dynamism. They have configured low information processing capabilities and mostly exhibit high use of non-IOS for conducting shipping transactions.
4) The Young IT Enabled *gestalt* is made up of small volume shippers importing from relatively few overseas suppliers. Firms face high task uncertainty and some environmental dynamism. They have configured high information processing capabilities and exhibit the highest use of Internet Portal for conducting shipping transactions.

This provides an answer to the first research question regarding shippers' use of IOS to serve their shipping process requirements. The results indicate that shippers, both large and small, who have increased their information processing capabilities to counter higher information processing needs in the international shipping process are most likely to use IOS for shipping transactions. Large shippers are more likely to use EDI while smaller shippers are more likely to use Internet portals.

7.1.2 Assessment of Fit

The results clearly indicate that the Mature *gestalts* (clusters 1 and 2) outperform the Young *gestalts* (clusters 3 and 4) on all four of the significant shipping and SC performance measures (Figure 7-2). The Young Traditional *gestalt* though performs consistently worse than the Mature *gestalts*. The Young IT Enabled *gestalts* performs poorly only on customer delivery satisfaction across all shipping transactions. Hence, their shipping performance is considered 'medium'. The Young Traditional *gestalts* performs poorly when measured on ocean shipment on-time delivery performance, order cycle time, total cost of international ocean shipping, and customer delivery satisfaction, hence their performance is low.

Figure 7-2: Relative performance of the gestalts



LOW TASK UNCERTAINTY (A)

HIGH TASK UNCERTAINTY (B)

In this study the Mature *gestalts* with high environmental complexity also faced low task uncertainty and low environmental dynamism. In the context of an international ocean shipment, the long lead times provides a time cushion to deal with the complexity of inputs and outputs. So long as the environment is stable, tasks are standardized, and the number of exceptions and operational disruptions are kept to a minimum it seems possible to remain in fit by employing non-IOS for coordinating supply chain processes and conducting shipping transactions as demonstrated by the Mature Traditional *gestalt*. However, when the number of inputs increase significantly as a consequence of sourcing from multiple overseas suppliers then an increase in IOS use is necessary to stay in fit as demonstrated evidenced by the Mature IT-enabled *gestalt*. This is likely due to the need to co-ordinate the flows of information for multiple shipments simultaneously with multiple suppliers.

On the other hand the long lead times hamper the Young *gestalts* ability to react to frequent, new operational exceptions, and a constantly changing environment. Once the carriage for a shipment is transacted or the shipment is enroute it is very costly or even impossible to stop or reroute the shipment. Hence, even with all the IOS to enable supply chain processes, the long lead times of ocean shipping effects the ability of shippers from the Young IT enabled *gestalt* to counter the environmental dynamism and improve performance. On the one hand they do not have the economies of scale to justify the use of EDI, and on the other, Internet portals have not yet reached a stage of diffusion to realize its full potential as an IOS.

Additionally, the Young IT-enabled *gestalt* performs significantly worse than the Mature *gestalts* when using IOS for booking confirmation and receiving the B/L information. It is possible that this poor delivery performance and order cycle times when considering Booking Confirmation and B/L Information Receipt transactions is because of the firms' heavy reliance on Internet Portals (see Figure 6-10). As discussed in 3.3.3, problems during the booking confirmation and B/L information receipt will affect late delivery,

which in-turn impacts order cycle time and downstream customers' delivery satisfaction. Contrastingly, the Mature IT enabled *gestalt* exhibit consistently high performance and the highest use of EDI for conducting all their shipping transactions. EDI is a mature technology that has been in place for over a decade with accepted standards in place for sufficient time for companies to adapt their business processes to exploit its advantages. The Young IT-enabled *gestalts* do not perform as badly for the Shipping Schedule Lookup, Track and Trace transactions as, Internet portals have had very high usage of these services, and therefore, customers have seen significant improvements in their reliability and functionality and have probably become familiar with their use.

Although experts have argued that the Internet is a better IOS than EDI, it is still in the early stages of diffusion. The Internet portal services are only a few years old and still in their early stages of development. These services have not diffused sufficiently for service providers to be able to fine-tune. Consequently, any problems with the services will affect the early adopters of these services, i.e., the Young IT enabled *gestalt*. In the early stages of EDI diffusion, Weiss and Dale (1998) argue that its greater 'operational novelty' or operational complexity, and incompatibility with adopters' operational experiences with the incumbent technology caused significant barriers to its proper use. When EDI was first introduced, it was replacing the phone, fax and the postal service. Hence, adopters were dealing with a completely new operational interface for communicating documents and information. In addition, a considerable degree of operational complexity was involved, as it was very likely that users would need additional training for use of the EDI system. Analogously, early adopters of Internet portal services are affected by the challenges and barriers of adopting a new innovation.

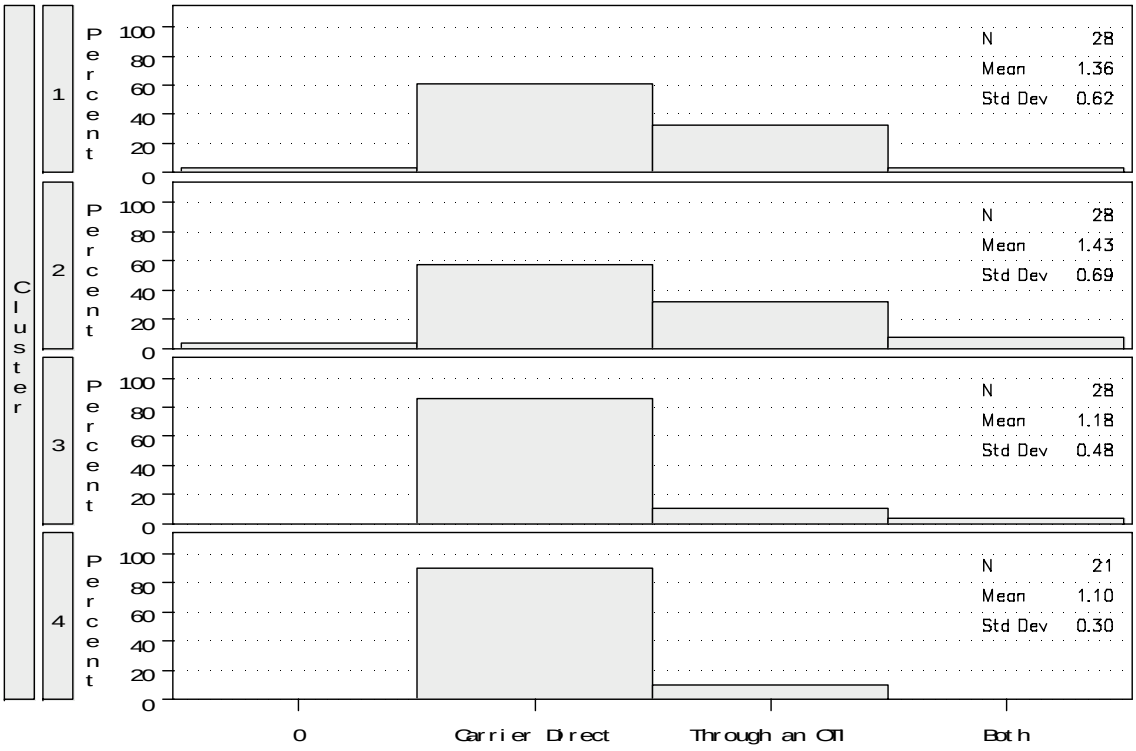
To answer the second research question, in the international ocean container shipping process there is some evidence to support the theory that fit between information processing needs and information processing capabilities improves shipping and SC performance. In the case of the hybrid configurations uncovered by this research multiple overseas suppliers appears to exert a greater influence on environmental complexity. Number of TEU and shipment value do not appear to effect uncertainty due to the possible time cushion of the long lead times of ocean shipping. This is true as long as environmental dynamism and task uncertainty is low. Shippers in *gestalts* facing high task uncertainty and environmental dynamism are adversely affected by the long lead times of ocean shipping and need to counter the increased uncertainty by adopting high information processing capabilities. Using the lessons learnt from the early stages of EDI adoption, users from the Young *gestalts* need to use the Internet portal services to ensure they are well placed to take advantage of their performance enhancing benefits when the services fully mature.

7.1.3 Post Hoc Analysis

In order to check whether there may have been any other variables affecting the relative performance of the *gestalts* ANOVAs were conducted across several demographic variables. The variables used were: 1) number of employees; 2) whether import only or import and export; 3) firm/business unit revenue; 4) number of carriers and OTIs employed; and, 5) Connect direct to carrier or through OTI. None of these variables was

significant. However, it was interesting to observe that both the Mature *gestalts* appeared to use a greater percentage of OTIs to connect to carriers than go direct, as compared to the Young *gestalts* (see Figure 7-3).

Figure 7-3: Comparison of clusters according to how shipper connects to carriers.



This may be due to newer shippers believing that they can go it alone especially with the assistance of the services of Internet portals, which may be perceived to eliminate the need for intermediaries.

The effect of firm size on performance was tested by performing a multivariate analysis of covariance (MANCOVA) using TEU and value as covariates. Neither variable was significant as covariate and the results of the MANOVA on predictive validity did not change either. Hence, no firm size effects influence the relative performance of the clusters.

7.2 Managerial Implications

The SCM and IOS literature provides sufficient empirical evidence of the value of IOS to coordinate inter-firm business processes and manage supply chain activities for improved performance. Most of these studies have however focused on a restricted land-locked geographic region where trade flows are unencumbered by international boundaries and long lead times of trans-oceanic transportation. As discussed earlier, the level of uncertainty increases many times when comparing the domestic modes to international ocean transportation. In the case of international ocean containerized freight transportation implementing IOS to manage supply chain activities is inadequate. The

number of parties and hand-offs involved in the shipment of a single container increase the likelihood of exceptions. This puts greater demands on the available resources to coordinate the supply chain activities across all the involved parties during the shipment of an ocean freight container to meet the seven "R's" of logistics customer service.

The results of this study have a number of implications, not only for shippers but also, for carriers and providers of IOS. The primary concern is how to best use the available IOS for managing supply chain processes and shipping transactions to improve shipping and supply chain performance. Descriptive validity, which defines the extant *gestalts,* offers IOS providers a good market picture of the current users of their services. The conclusions drawn from the results of the predictive validity answer the second research question, which offers normative advice to shippers on the best configuration for their information processing capabilities to meet their information processing needs. Hence, shippers are able to make a structured assessment of their information processing needs and configure their information processing capabilities accordingly. This also informs providers of IOS services of the value their customers derive from the services and how to develop appropriate marketing strategies to target the specific shipper segments defined by the *gestalts*.

7.2.1 Shippers

The long lead times of ocean shipping allows the use of non-IOS in conjunction with specific manual processes to manage the large volume of inputs and outputs during the shipping and related supply chain processes. This is true when tasks are conducive to pre-planning, operational disruptions are minimal and, supply and demand is stable. However, this changes when the number of overseas suppliers starts increasing. IOS for managing both the supply chain and shipping processes needs to be implemented to deal with the uncertainty that arises from simultaneously managing the flows of shipment information from an increasing number of overseas suppliers.

Firms in the Young Traditional *gestalt* must attempt to reduce some of their uncertainty as demonstrated by the Young IT Enabled *gestalt*. They need to increase their use of IOS to coordinate the order process with the shipping schedules. This becomes particularly effective as real-time shipping schedules and work flow management become available as part of the portals' services. Adoption of IOS for managing supply chain processes would help reduce the uncertainty due to the constantly changing environment by improving forecasting and planning activities. Adoption of IOS for transacting international container shipments would lower the total costs of shipments by lowering search costs and result in fewer disruptions due to incorrect decisions made from erroneous schedule publications. Similarly with Track and Trace, the adoption of IOS to manage the supply chain processes using the information provided by track and trace helps reduce total cost of shipment by lowering administrative and communication costs of continuously seeking manual updates of shipment status, especially when dealing with multiple carriers. Also, automated alerts and status update reports can be shared in real-time for preplanning and in case of an exception, implement contingency plans for all downstream processes to avoid costly disruptions. In order to properly ramp up to the use of Internet portals as an effective low cost IOS for small volume shippers, the Young

gestalts need to develop a comprehensive and coherent strategy to reduce uncertainty arising from task uncertainty and environmental dynamism. First firms should be aware of the underlying causes of both dimensions of the uncertainty. Next, they need to configure an IOS adoption strategy that would produce and disseminate the correct information to the correct places in the process to reduce the uncertainty. Built into this process should be information available to execute contingencies as and when they happen to minimize their impacts on the cost of the process and customer satisfaction.

From the post hoc analysis reported above it appears that a high percentage of the Mature *gestalts* employ OTIs to conduct their transactions with the carriers. Such outsourcing of the shipping and associated supply chain functions to OTIs may have some effect in reducing the uncertainty arising from the large shipment volumes of the large shippers. This effect though, has not been tested here and the differences in OTI use among the clusters were not significant. Nevertheless, shippers from the Young *gestalts* may consider outsourcing the shipping function to OTIs. This is a non-core competency. The cost of employing OTIs expertise in reducing the uncertainty due to environmental dynamism and task uncertainty may be well worth the returns on improved shipping and supply chain performance.

7.2.2 IOS Providers and Ocean Carriers

As discussed in the background section, the Federal Maritime Commission report had anticipated the advent of portal services to level the playing field for shippers whose small volumes did not justify the use of EDI for transacting international container shipments. The shippers in the Young IT-enabled *gestalt* conformed to these expectations, exhibiting high use of IOS to manage their supply chain processes and Internet portals to manage their ocean shipping process. However, shippers in this *gestalt* performed poorly relative to shippers in the Mature *gestalts*. A reason for this may be due to the poor diffusion of Internet portal services. Without a knowledge of performance prior adoption the performance implications of portal use are not known. It may be possible that the disenchantment with portal services reported in the trade press is due to small shippers perceiving no significant change in performance.

In order to overcome these early negative perceptions carriers and the portal providers need to work towards an effective diffusion of Internet portal use and realize the critical mass for the services to be adopted successfully. Since small volume shippers exhibit the largest customer segment using the services, carriers and IOS providers need to target this customer segment and work with these shippers to determine their specific needs and their unique challenges. More work also needs to be done to align the services to reflect the real needs of these shippers. For example, a greater availability of real-time shipping schedules involving tighter portal integration with carrier back-office systems. There needs to be greater standardization of data and report formats within a portal and among portals. Finally track and trace information needs to be more pro-active providing information on estimated times of arrival and current status of shipments rather than notification of shipments crossing a milestone. Very often such notification is received too late to implement cost effective contingencies and recover from a disruption.

7.3 Limitations of the Research

The primary limitation of this research is the simplification of the research problem necessitated to effectively model the phenomena studied and keep data collection within the limits of reason. Consequently, only some of the transactions of the entire shipping process were considered for this research, which limited the scope of this research to US importers only. Additionally, the effect of ocean carriers' delivery performance on shippers' downstream delivery performance was aggregated across all ocean and inland carriers and assumed to be the same. Similarly, the effect of the ports of entry into the US were aggregated and considered to have the same effect on shippers' final delivery performance.

Another limitation is the low response rate. The reason postulated for this is the database used, which had not be used for such a purpose before. The data was not up to date and often inaccurate, which led to a large percentage of the mailing list being useless. In future, it is recommended that primary data collection studies using survey instruments follow the advice of Lambert and Harrington (1990) to pre-qualify survey respondents. The concern with the non-random nature of such a sample is overcome by randomly choosing subjects from the database used to compile the mailing list. The advantage is that this method eliminates the unnecessary waste of resources on mailing lists that are inaccurate and result in low response rates. In a sense, a more representative mailing list is compiled when the spurious entries have been eliminated. Nevertheless, the primary concern from low response rates is non-response bias, which when tested indicated no significant effect of non-response bias. Hence, this study is generalizable to the population of US importers.

Exacerbating the low response rate is the low diffusion of Internet portal use among the population of shippers. Portal services have been offered for four years before the data were collected in fall 2004. The analysis demonstrated that although portal services were used more than EDI, they were still not used as much as non-IOS, which is still the most popular channel for conducting shipping transactions. The low response rate and low rate of diffusion leaves open the question of other *gestalts* that may exist. If these exist they may have not been uncovered in this research due to their relatively small size and therefore were absorbed into another cluster.

Part of the initial research plan was to design the study so as to model fit in more than one way to permit comparative evaluation of as many forms of fit as possible, as suggested by Venkatraman (1989). However, the low response rate precluded testing fit as covariation using a structural equation modeling approach. Consequently, fit was modeled as *gestalts* only.

7.4 Research Contributions

As mentioned earlier in section 4.1 there is very little research that has a consistent longitudinal component of theory testing that enables the building of strong domain specific theories. Section 5.1.2 outlines the value of employing a structural contingency theoretic approach to developing domain strong specific theories in logistics and SCM as recommended by Persson (1982). Since then, although the underlying principles of

structural contingency theory have been applied to further theory building in the field, there has been no explicit reference to the theory, and advances in the field of logistics and SCM have been largely atheoretical. In the absence of such a framework the theory building in the field is at best uncoordinated and at worst chaotic representing Kuhn's (1996) pre-paradigm period of scientific conflict or 'extraordinary science'. This paper has presented a logical approach for the development and advancement of theory in the field of logistics and SCM using structural contingency theory. The information processing model has been used to explain how firms can avoid the one size fits all approach to adopting IOS, instead using their operating environment uncertainty to develop a strategy for IOS adoption. Such a framework may be used for a number of different problems in the field of logistics and SCM.

The measures used for operationalizing the dimension of task and environmental uncertainty in the information processing model have been rigorously tested for unidimensionality, convergent and discriminate validity, and reliability. The only previous study to model fit as *gestalts*, Bensaou and Venkatraman (1995), used very rudimentary methods for scale refinement. Additionally, specific measures for SCM IOS use and, shipping and supply chain performance were developed, using the same rigorous scale refinement techniques. Future studies where such scales are appropriate can therefore benefit from the set of ready-made scales developed and tested in this study.

The research offers numerous managerial insights into the phenomena of IOS use for the management of international SCM and the international ocean shipping process. These insights concern not only shippers, but also carriers and IOS service providers. Shippers are able to use the framework to assess the levels of their operating environment uncertainty to develop a strategy for adopting IOS. Carriers and IOS providers have a snapshot of the market segments, which they can employ to develop service development and marketing strategy.

The results of this study support the information processing model developed by Bensaou and Venkatraman (1995) and the underlying structural contingency theory. It also provides another example of the usefulness of the taxonomy proposed by Venkatraman (1989). Besides, this study offers other important lessons for the future application of the information processing model.

7.5 Future Research

The first step is to replicate the current study in another similar industry, after taking consideration for all the improvements suggested above to increase response rate. A comparison of the results will validate the operationalization of the model and demonstrate the value of the model for descriptive and normative research. Improving the response rate will permit comparisons of multiple forms of fit as recommended by Venkatraman (1989). Modeling fit as covariation would be able to demonstrate the robustness of the predictive validity of fit as well provides a picture of the functional form of fit.

A natural extension of this study would be a longitudinal study to get a better understanding of fit after the use of Internet portal services has properly diffused among the population of shippers. Additionally, this will also help verify the true number and nature of the *gestalts* that exist among the population. In order to do so the diffusion of Internet portal services needs to be understood. Hence, a related research opportunity to study the diffusion of Internet portal use among US shippers also presents itself. Data on Internet portal use in 2003 is available. Some more data can be collected in the near future to understand the barriers to, motivations for, and patterns of, diffusion. With the results of this research the longitudinal study for understanding fit after the use of Internet portals have diffused can be conducted.

Directly related to the results of the current research is the question of how can Young *gestalt* shippers use the available IOS to improve their shipping and SC performance. An in-depth comparative, ethnographic study of a small sample of shippers from the Mature and Young *gestalts* can be conducted to understand how the practices of the Mature *gestalts* can be used to improve the performance of the Young *gestalts*. Such as study can also answer the question, of the three measures: 1) number of overseas suppliers, 2) number of TEU, and 3) Value of shipments, which measure or combination thereof has a significant effect on increasing environmental complexity? The question of whether the use of OTIs by large shippers helps reduce environmental complexity can be answered. Moreover, the question whether the use of OTIs by small shippers can help reduce task uncertainty and environmental dynamism can be addressed.

Finally, a marketing study is necessary on how best to market Internet portal services to the Young *gestalts* in order to motivate carriers and portal service providers to improve services to this group of shippers.

7.6 Conclusion

The international shipment of freight container by liner ocean carrier is fraught with uncertainty arising from a number of sources. From the quantity and variety of inputs and outputs to the frequency and type of exceptions to the stability of shippers' operating environment. The deregulation of the international ocean liner industry provided the impetus for carriers to offer innovative IOS services to their customers as a tool to reduce some of this uncertainty. These services were endorsed by the Federal Maritime Commission and expected to realize significant improvements in the ocean shipping process especially for smaller shippers, using the ubiquitous, inexpensive, super fast Internet. The reports in the trade press though, indicated a confusing picture completely inconsistent with the prior expectations.

The framework for logistics research recommended by Mentzer and Kahn (1995) was followed for conducting the substantive justification, theory construction and methodology. Substantive justification was achieved by reviewing the trade press and conducting in-depth interviews on IOS utilization for the international ocean shipping process. Theory construction was achieved by a thorough review of the IOS and SCM literature, which helped identify an appropriate theoretical framework. The framework used is Bensaou and Venkatraman's (1995) information processing model, which builds

on Galbraith's (1973) information processing view of the firm. The framework utilizes a structural contingency approach, which assumes that only a particular level of a structural variable (information processing capability) is appropriate to counter a specific level of a contingency variable (uncertainty). The theory behind the model posits that firms increase their information processing capabilities in response to increased information processing needs to be in fit and effectively conduct a task. It is hypothesized that firms who displayed such a fit would perform better than firms who did not. This model provided an elegant framework by which to delineate and define the uncertainty that lead to the information processing needs during the international ocean shipping process, which necessitated the use of the IOS being studied. In addition, it provided a means for simultaneously answering both research questions. The model was operationalized using strictly tested, valid and reliable measures. The methodology for modeling fit was chosen using Venkatraman's (1989) taxonomy for fit research, which in this case was modeling 'fit as *gestalts*'.

The objective of this study was to understand the true picture surrounding the employment of the Internet portal services for the international shipment of freight containers by ocean liners and their value to shippers compared to the existing EDI and non-IOS services. The two research questions to be answered were, 1) the current nature of utilization of IOS services, and 2) the potential value of the IOS services. The data analysis revealed the existence of four differently configured *gestalts* of shippers. These *gestalts* were hybrids with a mix of high and low levels of different dimensions of information processing needs. Such configurations were not unique to this research and have been observed in the auto industry by Bensaou and Venkatraman (1995). The Mature *gestalts* are composed of large shippers who, faced with low environmental dynamism and low task uncertainty show better information processing configuration and hence perform the best. Of the Mature *gestalts* the one with shippers sourcing from a higher number of overseas suppliers was found to configure higher IOS use. The Young *gestalts* made up of smaller shippers face higher levels of task uncertainty and environmental dynamism. However, the small shippers adopting IOS performed marginally better than those that did not. This indicated that of the small shippers that faced high levels of task and environmental uncertainty the ones that adopted IOS for SCM and managing the international ocean shipping process saw some marginal benefits. The characteristics of the international ocean shipping process along with the low diffusion of Internet portal use among the shipper population could have influenced the low performance of the small shippers using IOS for conducting the ocean shipping transactions. The results offered some other interesting insights as well. The possibility that large shippers use of OTIs may help reduce task and or environmental uncertainty and the possibility for small shippers facing high levels of uncertainty to do the same. In addition, so long as demand and supply are stable and tasks are manageable, large shippers with large numbers of shipments do not need to employ IOS. This is because the long lead times of ocean shipping provide a large enough time window to deal with the high volume of inputs and outputs. However, when demand and supply are unstable and there are many operational disruptions then IOS is necessary to manage the uncertainty in the SC and the ocean shipping process.

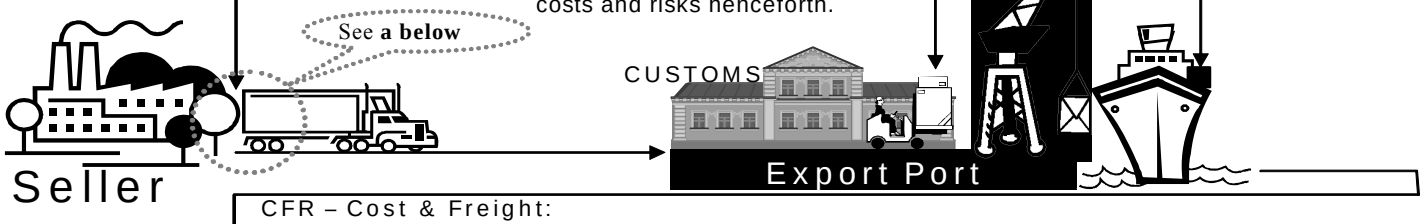
Appendix A

Schematic of buyer/seller responsibilities as defined by INCOTERMS.

EXW – Ex Works: goods available only at the seller's premises. Buyer is responsible for loading the goods on truck or container at the seller's premises, for arranging inland transport and the subsequent costs and risks

FAS – Free Alongside Ship: Goods are placed in the dock shed or at the side of the ship, on the dock or lighter, within reach of its loading equipment so that they can be loaded aboard the ship, at seller's expense. Buyer is responsible for the loading fee, main carriage/freight, cargo insurance, and o costs and risks henceforth.

FOB – Free On Board: The delivery of goods on board the vessel at the named port of origin (loading), at seller's expense. Buyer is responsible for the main carriage/freight, cargo insurance and other costs and risks henceforth.



CFR – Cost & Freight: The delivery of goods to the named port of destination (discharge) at the seller's expense. Buyer is responsible for the cargo insurance and other costs and risks.

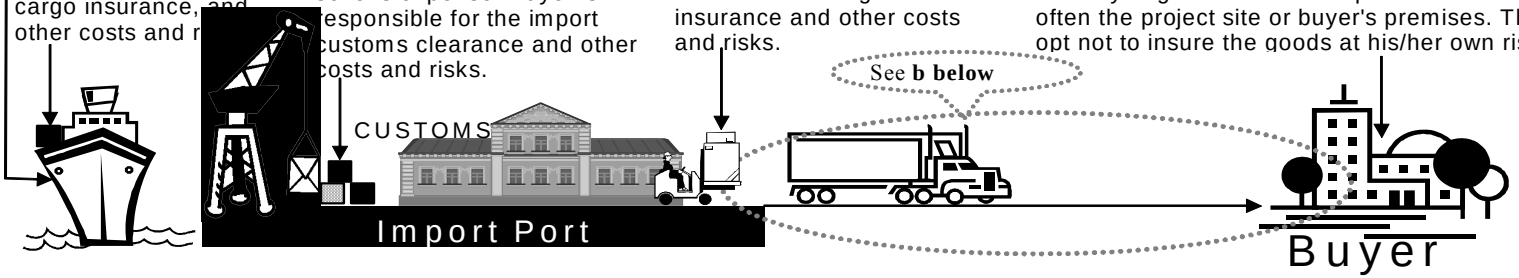
CIF – Cost, Insurance & Freight: The cargo insurance and delivery of goods to the named port of destination (discharge) at the seller's expense. Buyer is esponsible for the import ustoms clearance and other osts and risks.

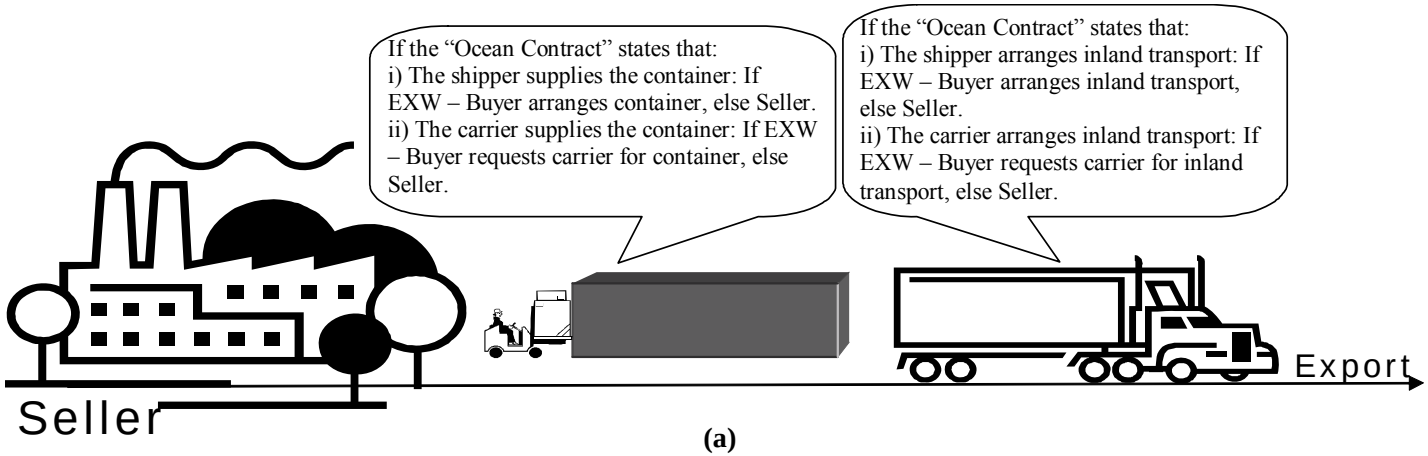
DES – Delivered Ex Ship: The delivery of goods on board the vessel at the named port of destination (discharge), at seller's expense. Buyer assumes the unloading fee, import customs clearance, payment of customs duties and taxes, cargo insurance, and other costs and r

DEQ – Delivered Ex Quay: The delivery of goods to the quay (the port) at destination at seller's expense. Seller is responsible for the import customs clearance and payment of customs duties and taxes at the buyer's end. Buyer assumes the cargo insurance and other costs and risks.

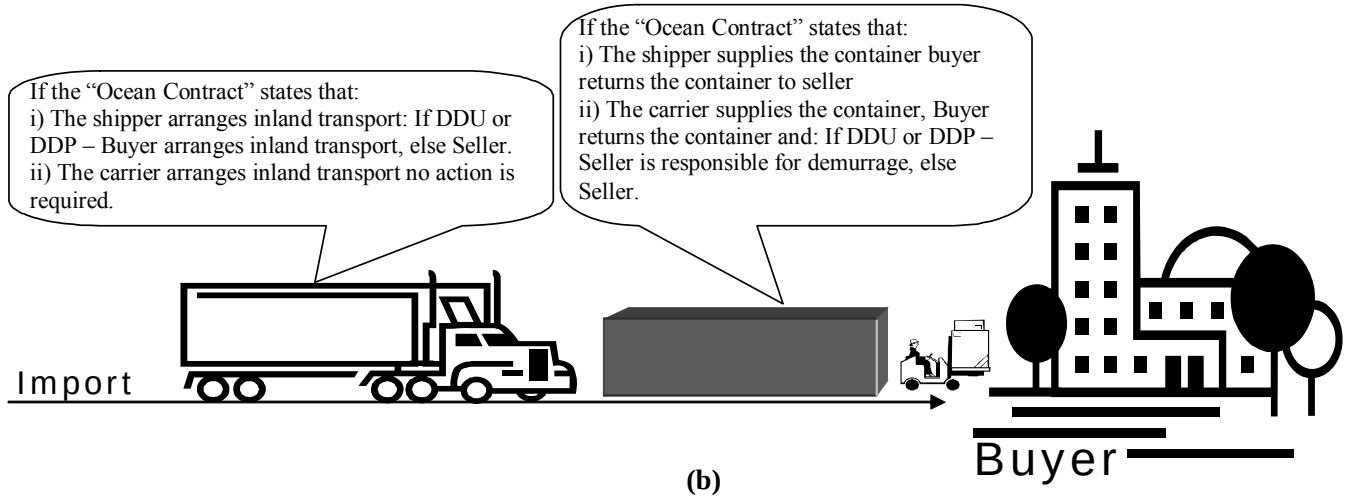
DDU – Delivered Duty Unpaid: The delivery of goods and the cargo insurance to the final point at destination, which is often the project site or buyer's premises, at seller's expense. Buyer assumes the import customs clearance and payment of customs duties and taxes. The seller may opt not to insure the goods at his/her own risks.

DDP – Delivered Duty Paid: The seller is responsible for most of the expenses, which include the cargo insurance, import customs clearance, and payment of customs duties and taxes at the buyer's end, and the delivery of goods to the final point at destination, which is often the project site or buyer's premises. The seller may opt not to insure the goods at his/her own risks.




If the "Ocean Contract" states that:
i) The shipper supplies the container: If EXW – Buyer arranges container, else Seller.
ii) The carrier supplies the container: If EXW – Buyer requests carrier for container, else Seller.
If the "Ocean Contract" states that:
i) The shipper arranges inland transport: If EXW – Buyer arranges inland transport, else Seller.
ii) The carrier arranges inland transport: If EXW – Buyer requests carrier for inland transport, else Seller.
Export
Seller

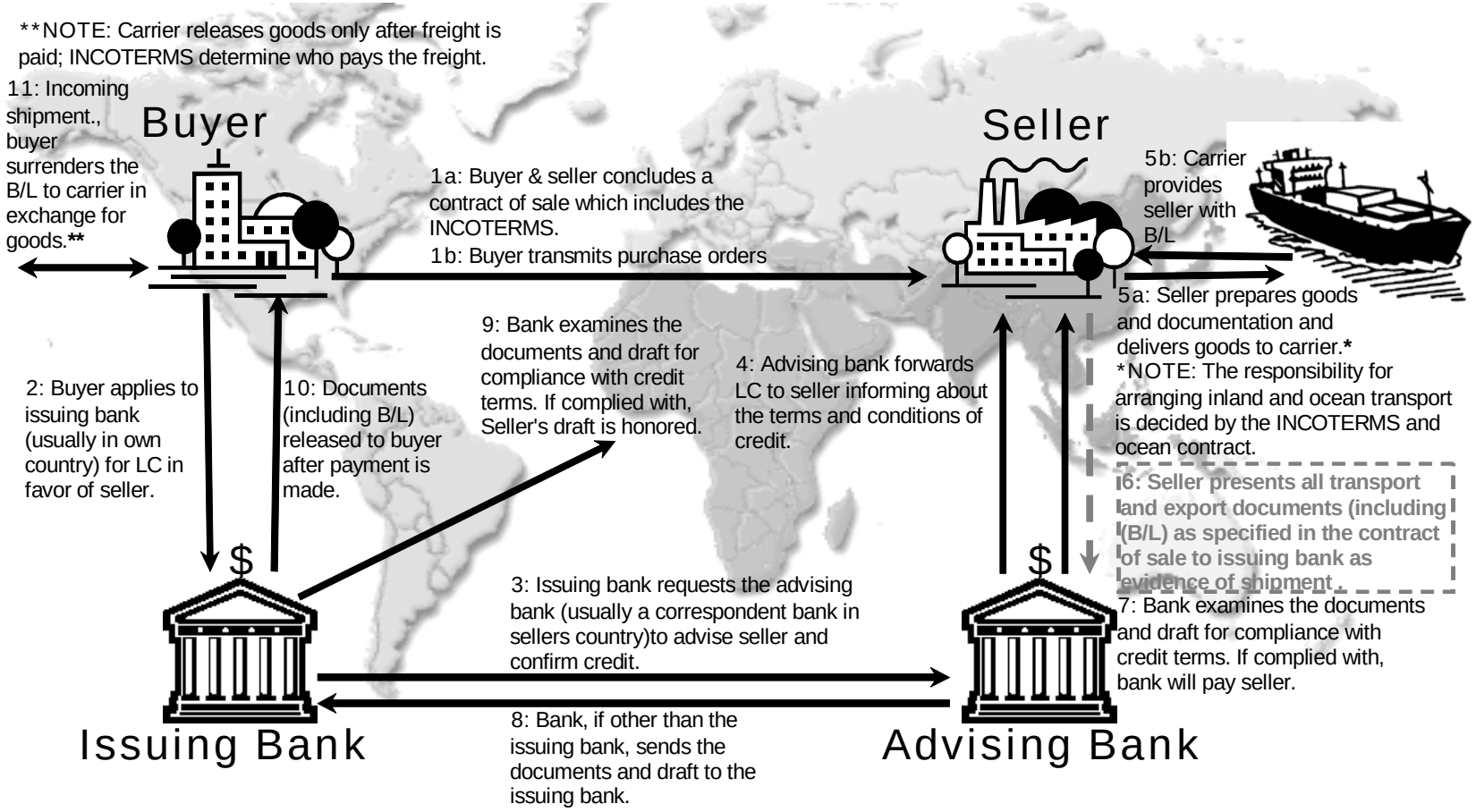
(a)


If the "Ocean Contract" states that:
i) The shipper arranges inland transport: If DDU or DDP – Buyer arranges inland transport, else Seller.
ii) The carrier arranges inland transport no action is required.
If the "Ocean Contract" states that:
i) The shipper supplies the container buyer returns the container to seller
ii) The carrier supplies the container, Buyer returns the container and: If DDU or DDP – Seller is responsible for demurrage, else Seller.
Import
Buyer

(b)

Appendix B

The import-export process using the ocean mode.


**NOTE: Carrier releases goods only after freight is paid; INCOTERMS determine who pays the freight.
11: Incoming shipment., buyer surrenders the B/L to carrier in exchange for goods.**
Buyer
Seller
1a: Buyer & seller concludes a contract of sale which includes the INCOTERMS.
1b: Buyer transmits purchase orders
5b: Carrier provides seller with B/L
5a: Seller prepares goods and documentation and delivers goods to carrier.*
*NOTE: The responsibility for arranging inland and ocean transport is decided by the INCOTERMS and ocean contract.
6: Seller presents all transport and export documents (including (B/L) as specified in the contract of sale to issuing bank as evidence of shipment.
7: Bank examines the documents and draft for compliance with credit terms. If complied with, bank will pay seller.
2: Buyer applies to issuing bank (usually in own country) for LC in favor of seller.
10: Documents (including B/L) released to buyer after payment is made.
9: Bank examines the documents and draft for compliance with credit terms. If complied with, Seller's draft is honored.
4: Advising bank forwards LC to seller informing about the terms and conditions of credit.
3: Issuing bank requests the advising bank (usually a correspondent bank in sellers country)to advise seller and confirm credit.
8: Bank, if other than the issuing bank, sends the documents and draft to the issuing bank.
$
$
Issuing Bank
Advising Bank

Appendix C

Non-IOS (phone, fax, e-mail, post/courier) transaction flow chart supporting the liner shipping transaction process

Step	Shipper‡	Non-IOS Transact'n	Carrier	Remarks
1	Check schedules in trade publications or by phone call to carrier's customer call center.	**Schedule Check** ←	Publishes **Schedule** in trade publications and maintains current knowledge with call centers	i) **If** EXW – Consignee* is shipper **else** Consignor†. ii) Shipper may be an OTI employed by and representing the BCO. iii) Schedules are generally double-checked when shipper calls to make a booking.
2a	Phones, Faxes or E-mails call center to make a **Booking Request**	→	Processes shipper's booking request	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This can be done only when the transportation need arises.
2b	Go to step 3	←	Provides a **Booking Confirmation OR**, go to 2b.	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) If booking is made by phone this may take a few minutes only, if by fax/e-mail, processing time is similar for EDI/Internet portal.
2c	1) If shipper finds the counter proposal agreeable – go to step 3 2) If shipper does not find the counter proposal agreeable – go to step 2d	**Booking** ←	Sends a **Counter Proposal** based on the original booking request with some changes **OR**, go to 2d.	Same as 2b
2d	Either tries again or goes to another carrier.	←	Transmits message **Declining** shipper's booking	Same as 2b
2e	Requests a **Booking Cancellation**, for an accepted booking	→	Receives and processes booking cancellation	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) By phone this may take a few minutes, by fax/e-mail, processing time is similar to EDI/Internet portal.
3	Files **Shipping Instructions**	**Shipping Inst.** →	Receives Shipping Instructions and prepares B/L (and vessel manifest).	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This is primarily done by Fax/e-mail.
4	The seller courier's or post the Order B/L to the Advising bank in exchange for payment for goods sold.	**B/L Mgmt** ←	Carrier 'cuts' the B/L 2-3 days after the ship with the shipment departs. Carrier posts or courier's the Order B/L to the seller (consignor).	i) **If** Order B/L – Consignor is always shipper. ii) **If** Straight B/L Shipper may be an OTI employed by and representing the BCO. ii) The Straight B/L remains with the carrier and functions as the delivery instructions and freight bill.
5	**Track & Trace**: Shipper typically calls or may e-mail carrier customer service to enquire about the status about a set of shipments.	**Track & Trace** ↔	Carrier maintains customer service call center that conveys customer shipment status from carrier's proprietary systems.	i) **If** EXW, FAS or FOB – Consignee is shipper **else** Consignor. ii) This information is accessible by shippers and any other authorized personnel who have access to container or B/L numbers.

***** Consignee is the buyer and/or importer, who will use or consume the goods.

† Consignor is the seller and/or exporter, who make the goods available.

‡ 'Shipper' is not used in the strict sense as the party who submits the goods for shipment but is used loosely to indicate the party (consignor or consignee) who is in contact with the carrier at that stage in the shipment process.

Appendix D

EDI transaction flow chart supporting the liner shipping transaction process.

Step	Shipper	EDI Trans. Set	Carrier	Remarks
1	Receives schedule	**323** ←	Transmits **Schedule**	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This transmission may be either pre-planned or on request.
2	Transmits a **Booking Request**	**300** →	Receives shipper's booking request	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This transmission is made whenever the transportation need arises.
3a	Go to step 5	←	Transmits a **Booking Confirmation OR**, go to 3b	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This transmission is made in response to a 300.
3b	1) If shipper finds the counter proposal agreeable – go to step 5 2) If shipper does not find the counter proposal agreeable – go to step 4	**301** ←	Transmits a **Counter Proposal** alternative service based on the original booking request with some changes **OR**, go to 3c.	Same as 3a
3c	Either tries calling the carrier or going to another carrier.	←	Transmits message **Declining** shipper's booking	Same as 3a
4	Transmits a B**ooking Cancellation**, canceling an accepted or counter proposed booking	**303** →	Receives booking cancellation	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) If shipper cannot transmit a 303 cancellation is done by phone.
5	Transmits **Shipping Instructions** (SI) to carrier	**304** →	Receives Shipping Instructions and prepares B/L (and vessel manifest)	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This message is sent after the booking confirmation is received.
6	Receives B/L copy and freight bill	**310** ←	Transmits a virtual **B/L Copy** that also acts as the freight bill.	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This message can be directed to other parties to the shipment.
7	Transmits a R**equest for Shipment Status**	**313** →	Carrier responds – go to step 8	i) **If** EXW, FAS or FOB – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by the BCO. iii) This may be sent at any time while the ocean carrier possesses the freight.
8a	Receives a separate message for each container in which shipper has freight	←	Transmits **Shipment Status** in response to a 313	i) **If** EXW, FAS or FOB – Consignee is shipper **else** Consignor. ii) Shipper may be OTI employed by and representing the BCO, this message can be directed to other interested parties as specified by shipper.
8b	Receives a separate message for each container in which shipper has freight and for each event.	**315** ←	Transmits **Shipment Status** message triggered by: equipment movement, B/L or schedule change events	i) **If** EXW, FAS or FOB – Consignee is shipper **else** Consignor. ii) Shipper may be OTI employed by and representing the BCO, this message can be directed to other interested parties as specified by shipper. iii) Events triggering these transmissions can be specified by the shipper.
9	Respective parties (Consignee, Customs Broker, Inland carrier, etc.) take action accordingly	**312** ←	Transmits an A**rrival Notice** 3-4 days before vessel's arrival	i) **If** EXW, FAS or FOB – Consignee is shipper **else** Consignor. ii) Message sent to consignee, notify party 1 (e.g. customs broker), notify party 2 (e.g. inland carrier)

Appendix E

Internet web portal transaction flow chart supporting the liner shipping transaction process.

Step	Shipper	Portal Transact'n	Carrier	Remarks
1	Views schedule on-line	**Schedule** ← **Check**	Maintains **Schedule** current, which is updated on or directly linked to, Portal's schedule page	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) Shipper can view the schedule at any time.
2a	Makes a **Booking Request**	→	Receives shipper's booking request	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This can be done whenever the transportation need arises.
2b	Go to step 3	←	Sends a **Booking Confirmation OR**	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) Carrier responds to the booking request after checking availability.
2c	1) If shipper finds the counter proposal agreeable – go to step 3 2) If shipper does not find the counter proposal agreeable – go to step 2e	**Booking** ←	Sends a **Counter Proposal** based on the original booking request with some changes **OR**	Same as 2b
2d	Either tries again or goes to another carrier.	←	Transmits message **Declining** shipper's booking	Same as 2b
2e	Transmits a **Booking Cancellation**, canceling an accepted or counter proposed booking	→	Receives booking cancellation	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO.
3	Files **Shipping Instructions** on-line	**Shipping Inst.** →	Receives Shipping Instructions and prepares B/L (and vessel manifest).	i) **If** EXW – Consignee is shipper **else** Consignor. ii) Shipper may be an OTI employed by and representing the BCO. iii) This can be filed on-line after the booking confirmation is received.
4	Uses Relationship Manager to Share B/L with authorized parties e.g., *Advising Bank* to receive payment for goods, consignor, consignee, customs broker, etc.	**B/L Mgmt** ←	Either a **copy of the B/L** is made available on-line, or secure **printing of the B/L** by shipper-authorized parties is allowed – see Relationship Mgmt.	i) **If** Order B/L – Consignor is normally always shipper. ii) **If** Straight B/L Shipper may be an OTI employed by and representing the BCO, consignor or consignee depending on Incoterms. iii) Shipper-authorized parties may either view the B/L on-line or print a secure original depending on shipper specified rights.
5a	On demand **Track & Trace**, can log on to the portal at any time and search for the status for a set of shipments, by container, B/L or PO number.	**Track & Trace** →	Carrier updates tracking information for all the shipments in its systems, which is linked to the portal.	i) **If** EXW, FAS or FOB – Consignee is shipper **else** Consignor. ii) This information is accessible by users within the shipper's firm and at firms, party to the shipment such as, the OTI, customs broker, inland carrier, etc.
5b	E-mail: **Notification & Exception Alerts**	←	Transmits a shipment status message triggered by discrete events such as, equipment movement, B/L or schedule change events, etc.	i) **If** EXW, FAS or FOB – Consignee is shipper **else** Consignor. ii) These messages are sent to authorized users within the shipper's firm and at firms, party to the shipment such as, the OTI, customs broker, inland carrier, etc.

Appendix F

SCM Literature Review Quick Reference.

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
1992	Lee, Hau L., and Billington, Corey	Managing Supply Chain Inventory: Pitfalls and Opportunities.	Describe 14 pitfalls of SCM	Conceptual, Case Study.	*SCM*	The more complex the network of suppliers, manufacturers and distributors, the more likely a firm is to gain operational efficiencies by attending to inventory.
1994	Caplice, Chris, and Sheffi, Yossi	A Review and Evaluation of Logistics Metrics	The pressing need is not for the development of novel performance metrics: there is a great abundance of sufficient metrics already in existence. Rather, there is a need for a method with which to evaluate existing metrics.	Conceptual, Typological.	*SCM (Logistics Metrics)*	Suggest a set of evaluation criteria for individual logistics performance metrics and identifying the inherent trade-offs. A taxonomy of logistics performance metrics, organized by process rather than by function, is also presented and the metrics are evaluated using the established criteria
1994	Novack, Robert A.; Rinehart, Lloyd M. and Langley, C. John Jr.	An Internal Assessment of Logistics Value.	To study the relationship between logistics activities performed by the firm, level of logistics quality attained, and the logistics executives' perception of value created from the performance of the logistics activities.	Survey (66), Regression	Consumer Behavior (Service Quality)	Logistics executives do not perceive logistics productivity as an element of quality. Cost reductions in the firm therefore are construed as not generating more business. Service performance is an important element of quality and adds value to products. Hence, logistics executives see a service differentiating strategy rather than a cost efficiency strategy to be more effective for customer satisfaction.
1995	Chow, Garland; Heaver, Trevor D., and Henriksson, Lennart E.	Logistics Performance Definition and Measurement.	To examine the definition and measurement of performance in logistics research.	Conceptual, Typological	*SCM (Performance Measures)*	Defining and measuring performance in logistics is a difficult enterprise. Need more efforts to develop measures
1995	Chow, Garland; Heaver, Trevor D., and Henriksson, Lennart E.	Strategy, Structure and Performance: A Framework for Logistics Research.	To set out a conceptual framework for research on organizational issues in logistics, which is consistent with the	Conceptual	Organizational Theory (Structural Contingency Theory)	There has been a great heterogeneity of definitions in the logistics literature. Definitions from organizational theory are provided with the hope of providing some consistency. A

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
			organizational sciences literature and which can encompass features of corporate and supply-chain structures.			contingency approach is recommended to provide insights into the complex links among strategy, structure and performance and the influence of mediating variables.
1996	Hobbs, Jill E.	A Transaction Cost Approach to Supply Chain Management.	To provide those interested in SCM but not familiar with Transaction Cost Economics, with an overview of the approach and a discussion of how to apply the theory empirically.	Conceptual	Transaction Cost Economics.	Transaction costs, and their reduction, lie at the heart of the interest in supply chain management. Transaction cost analysis appears to provide a means to bridge the gap between those interested in the results of research and those who can provide the research.
1996	Novack, Robert A.; Rinehart, Lloyd M. and Langley, C. John Jr.	A Comparative Assessment of Senior Logistics Executives' Perceptions of Logistics Value.	To present a comparison between logistics executives and senior executives perceptions of logistics value.	Mail and, Telephone Survey (22), Regression	Consumer Behavior (Service Quality)	A perceptual gap exists between both groups concerning logistics.
1996	Thomas, Douglas J., and Griffin, Paul M.	Coordinated Supply Chain Management.	Review the literature addressing coordinated planning between two or more stages of the supply chain, placing particular emphasis on models that would lend themselves to a total supply chain model.	Conceptual, Typological	*SCM (Inventory models)*	Independently managing facilities in a supply chain ca result in very poor overall behavior. Recent advances in communications and IT offer an opportunity for significant savings in logistics costs by coordinating the planning of the various stages in SCM.
1997	Cooper, Martha C.; Lambert, Douglas M., and Pagh, Janus D.	Supply Chain Management: More than a New Name for Logistics.	Proposes a conceptual framework that provides guidance for future supply chain decision-making and research.	Conceptual	*SCM*	SCM is often used as a synonym for logistics. There is a need for integration in business operations beyond logistics. The integration of key business processes across the supply chain is true SCM.
1997	Ellinger, Alexander E.; Daugherty,	The Relationship between Integrated Logistics and	Are firms who have adopted the integrated logistics concept able to	Survey (127), Simple *t-tests*.	*SCM (integrated logistics)*	There is strong support for linkages between logistics integration and customer service.

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
	Patricia J., and Gustin, Craig M.	Customer Service.	accommodate customer requests more easily?			
1997	Fisher, M. L.	What is the Right Supply Chain for your Product?	The root cause of the problems plaguing many supply chains is a mismatch between the type of product and the type of supply chain. A framework to aid supply chain design to fit product type is offered	Conceptual	*SCM (Supply Chain Design)*	Defines functional and innovative products, and efficient and responsive supply chains. Proposes an efficient supply chain design for functional products and a responsive supply chain for innovative products.
1997	Morash, Edward A., and Clinton, Steven R.	The Role of Transportation Capabilities in International Supply Chain Management.	Investigate and compare the supply chain organizational structures and integrative capabilities of U.S., Japan, Korea, and Australia.	Survey (1,951), ANOVA	*SCM*	Country differences in supply chain structures and transportation capabilities. Without the integration of transportation into supply chain design the transportation capabilities of reliability, time compression, and j-i-t delivery cannot be successfully implemented.
1998	Beamon, Benita	Supply Chain Design and Analysis: Models and Methods.	Review the literature in the multi-stage supply chain modeling and define a future research agenda.	Conceptual	*SCM*	Need to: evaluate and develop SCM metrics, develop methods and procedures to relate decision variables to the metrics, and classify supply chain systems to allow rule of thumb design and analysis of supply chains.
1998	Lambert, Douglas M.; Cooper, Martha C., and Pagh, Janus D.	Supply Chain Management: Implementation Issues and Research Opportunities.	Operationalize the supply chain management framework. (Follow up on Lambert *et al.*, 1997).	Conceptual, Case Study	*SCM*	Successful SCM is based on determining who are the key supply chain members with whom to integrate processes, what supply chain processes to link, and what type/level of integration to be applied.
1998	Narasimhan, Ram, and Jayaram, Jayanth	Causal Linkages in Supply Chain Management: An Exploratory Study of North American Manufacturing	Does an integrated supply chain involve aligning sourcing decisions to achieve manufacturing goals, which are in turn set to	Survey (127), Structural Equation Modeling	*SCM (Impact on firm performance)*	Customer integration translates customer requirements into manufacturing goals. Refinement of manufacturing goals along with supply base assessment should lead to an assessment of manufacturing

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
		Firms.	respond favorably to customer needs?			capabilities kept in-house and those out-sourced.
1998	Tracey, Michael	The Importance of Logistics Efficiency to Customer Service and Firm Performance.	Uncover the specific logistics processes that consistently impact customer service and performance.	Survey (474), Structural Equation Modeling	*SCM (Impact on firm performance)*	Logistics creates value by performing any of its functions efficiently. Improved performance is linked to functional integration. Flexible manufacturing entails competing on product variety, while competing on price and quality means less product variety.
1999	Ganeshan, Ram; Jack, Eric; Magazine, Michael J. and Stephens, Paul	A Taxonomic Review of Supply Chain Management Research.	To carefully chart the historical development of SCM and to synthesize future directions of research. In order to do this the authors discuss, describe, and categorize the work being done in supply chain management.	Conceptual, Typological	*SCM*	SCM research has been focused in the logistics and operations management areas. SCM definition requires answering: What is a SC? What does managing a SC mean? Who manages the SC? External forces have largely driven SCM. SCM requires a heavy emphasis on integration of activities, coordination, cooperation and information sharing.
2000	Ballou, Ronald H.; Gilbert, Stephen M., and Mukherjee, Ashok	New Managerial Challenges from Supply Chain Opportunities.	Discuss the evolution of logistics, how it is defined and practiced today. Highlight emerging opportunities for channel performance improvement.	Conceptual	*SCM*	Success in SCM will be the net frontier for lowering costs and increasing service in the product-flow channel.
2000	Brewer, Peter C. and Speh, Thomas W.	Using the Balanced Scorecard to Measure Supply Chain Performance.	Explain the limitations of traditional logistics performance measures used to manage SCs and to develop appropriate SCM metrics using the balanced scorecard approach.	Conceptual	*SCM (performance Metrics), Balanced Scorecard*	This approach emphasizes: the inter-functional and inter-firm nature of SCs; a balanced approach to measuring SC performance; measures appropriate to every unique circumstance; and, focus employees attention on achieving goals beyond typical intra-firm measures.
2000	Lambert, Douglas M., and Copper,	Issues in Supply Chain Management.	Present a framework for SCM as well as pose	Conceptual, Case Study	*SCM*	Successful SCM is based on determining who are the key supply

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
	Martha C.		questions for how it can be implemented and questions for future research (Very similar to the Lambert *et al.*, 1998 study).			chain members with whom to integrate processes, what supply chain processes to link, and what type/level of integration to be applied.
2001	Croxton, Keely L.; García-Dastugue, Sebastián J.; Lambert Douglas M., and Rogers, Dale S.	The Supply Chain Management Processes.	What processes are to be considered in SCM? What sub-processes and activities are contained in each process? How do the processes interact with each other and with the traditional functional silos?	Conceptual, Case Study	*SCM*	Eight business processes that must be implemented within a firm and linked with supply chain members. Provides, managers with a framework to be used in implementing SCM, instructors with materials for a SCM course, and researchers with a framework to develop research questions.
2001	Frohlich, Markham T. and Westbrook, Roy	Arcs of Integration: An International Study of Supply Chain Strategies.	Examine supplier-customer integration strategies. Develop scales to measure supply chain integration with suppliers and customers.	Survey (322), ANOVA	*SCM (Integration)*	The Internet provides an opportunity to extend the arcs of integration to suppliers and customers.
2001	Gunasekaran, A.; Patel C., and Tirtioglu, E.	Performance Measures and Metrics in a Supply Chain Environment.	To develop a framework for measuring the strategic, tactical and operational level performance in a supply chain.	Conceptual, Typological.	*SCM (Performance Measures, Metrics)*	There is a shift from traditional to overall SCM performance. People in organizations should be held accountable for not only their functional, but overall SC performance.
2001	Hausman, Warren H.	Supply Chain Performance Metrics.	Describe, and illustrate the shortcomings of, several common supply chain metrics designed to support and monitor SC performance improvements.	Conceptual	*SCM (Metrics)*	In order to achieve SC wide metrics partners need to resolve the confidentiality issue. One way to do so is to recognize that the end consumer measures one's performance.
2001	Lambert, Douglas M., Pohlen, Terrance L.	Supply Chain Metrics	Develop supply chain metrics that translate performance into	Conceptual	*SCM (Logistics Metrics)*	The translation of process improvements into supplier and customer profitability provides a

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
			shareholder value.			method for developing metrics that identify opportunities for improved profitability and align objectives across all of the firms in the supply chain.
2001	Mentzer, John T.; DeWitt, William; Keebler, James S.; Min, Soonhong; Nix, Nancy W.; Smith, Carlo D., and Zacharia, Zach G.	Defining Supply Chain Management.	To examine the existing research in an effort to understand the concept of SCM	Conceptual	*SCM*	Defines and provides a guide to SCM. Offers a framework for deriving SCM related research questions. Highlights the need to develop a theoretical framework for SCM.
2001	Stank, Theodore P.; Keller, Scott B. and Daugherty, Patricia J.	Supply Chain Collaboration and Logistical Service Performance.	To i) develop measures of internal supply chain collaboration, external supply chain collaboration, and supply chain performance; and ii) test the relationship between internal, and external supply chain collaboration and logistical performance.	Survey (306), Structural Equation Modeling	*SCM (collaboration)*	Firms should promote cooperation and collaboration across internal processes to achieve logistical effectiveness. External collaboration is a necessary but not sufficient condition for performance improvement. Internal collaboration mediates the relationship between external collaboration and logistical service performance.
2002	Christopher, Martin & Towill, Denis R.	Developing market specific supply chain strategies.	Investigate the extent to which appropriate global supply chain strategies are contingent upon market characteristics.	Conceptual	*SCM*	Need to build the right supply chain (agile or lean) for the right product (special standard).
2002	Ellram, Lisa M.; Zsidisn, George A.; Siferd, Sue Perrott, and Stanly, Michael J.	The Impact of Purchasing and Supply Management Activities on Corporate Success.	To establish a linkage between the application of purchasing and supply management best practices and organizational success.	Survey (246), Factor Analysis, ANOVA	*SCM (Impact on firm performance)*	Difficult to study complex interactions among systems and outcomes using traditional survey methods alone. Purchasing and supply management practices cannot be isolated and linked to corporate success.
2002	Elmuti, Dean	The Perceived Impact of Supply	Explore current SCM issues and practices, and	Survey (402), Multiple	*SCM (Impact on firm performance)*	SCM allows companies to reduce costs, improve quality, increase

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
		Chain Management on Organizational Effectiveness.	identifies problems that affect SCM success. Also, investigate the impact of SCM on organizational effectiveness.	Regression		productivity, reduce cycle time and improve organizational competitiveness.
2002	Harrison, A., and New, C.	The Role of Coherent Supply Chain Strategy and Performance Management in Achieving Competitive Advantage: An International Survey.	Explore the relationship between corporate strategy, supply chain strategy, and SCM performance	Survey (258)	*SCM (Performance Metrics)*	Identified five groups of SCM adopters. Those that report a close link between SCM strategy and SCM technology rate SCM strategy as more important to corporate strategy and in achieving competitive advantage. They also have a formal means for measuring SCM performance.
2002	Lai, Kee-Hung; Ngai, E.W.T., and Cheng, T.C.E	Measures for Evaluating Supply Chain Performance in Transport Logistics.	Develop a construct of and the measurement for, supply chain performance in transport logistics.	Conceptual, Survey (134), Confirmatory Factor Analysis	*SCM (SCOR model), Service Quality*	A 26 item supply chain performance measurement instrument is constructed reflecting service effectiveness for shippers and consignees and operational efficiency for transport logistics providers.
2002	Lee, Hau L.	Aligning Supply Chain Strategies with Product Uncertainties.	Extends the supply chain-product fit discussion of Fisher (1997) to the supply side.	Conceptual	*SCM (Supply Chain Design)*	A new framework is provided with a supply process uncertainty dimension added to the demand uncertainty dimension.
2002	Tan, Keah Choon	Supply Chain Management: Practices, Concerns and Performance Issues.	List and rate a set of SCM practices, identify issues and concerns in implementing SCM programs, and identify practices associated with successful SCM programs.	Survey (411), Factor Analysis, Regression	*SCM (Impact on firm performance)*	SCM is a viable option. Integrating the purchasing and logistics processes with other key corporate processes allows firms to deliver products and services to internal and external customers in a timely and effective manner.
2002	Vachon, Stephen & Klassen, Robert D.	An exploratory investigation of the effects of supply chain complexity on	To explore the links between supply chain complexity and delivery.	Conceptual, Survey (469), Regression	*SCM (complexity)*	Complexity is conceptualized along two dimensions i) form of technology, and ii) nature of information processing. Only process/product

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
		delivery performance.				complicatedness (structural elements) and management systems uncertainty (infrastructural elements) were significantly related to delivery speed and reliability. The above relationship was moderated by competitive pressures (country level economic development).
2003	Grover, Varun, and Malhotra, Manoj K.	Transaction Cost Framework in Operations and Supply Chain Management Research: Theory and Measurement.	Provide a cogent synthesis of Transaction Cost Economics, its assumptions, constructs, and propositions to stimulate theoretical research of relevant inter-firm relationships.	Conceptual	Transaction Cost Economics, *SCM*	Develops measures for a conceptual model. Argue that researchers from the operations management field need to take advantage of the knowledge base of Transaction Cost Economics.
2003	Kleijnen, J.P.C., and Smits, M.	Performance Metrics in Supply Chain Management.	Proposes multiple metrics in SCM via the balance scorecard.	Conceptual	*SCM (Metrics)*	Provides a critical analysis of current SCM metrics. Summarizes how economic theory treats multiple performance metrics. Suggest forecasting values using simulation and a statistical methodology for reviewing the simulation results.
2003	Otto, Andreas, and Kotzab, Herbert	Does Supply Chain Management Really Pay? Six Perspectives to Measure the Performance of Managing a Supply Chain.	Explore suitable metrics to isolate and measure the impact of SCM.	Conceptual	*SCM*	Six unique sets of metrics from i) System dynamics, ii) Operations research/Information technology, iii) Logistics, iv) Marketing, v) Organization, and vi) Strategy.
2003	Wisner, Joel, D.	A Structural Equation Model of Supply Chain Management Strategies and Firm Performance.	Develop and analyzes a theoretical framework for supplier and customer issues and concerns, SCM strategy, and firm performance.	Survey (350), Structural Equation Modeling	*SCM (Impact on firm performance)*	Empirically illustrates the relationships between strategies focusing on immediate suppliers and customers, SCM strategy, and firm performance.

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
2004	Chen, I.J., and Paulraj, A.	Understanding supply chain management: critical research and a theoretical framework.	The field of SCM is in danger of collapsing into a discredited fad unless a reliable conceptual basis is developed. Therefore the study attempts to fill the need for clearly defined constructs and conceptual frameworks to advance the field.	Conceptual, Typological	*SCM*	Develops a research framework that improves understanding of SCM, and stimulates and facilitates researchers to undertake both theoretical and empirical investigation on the critical constructs of SCM, and the exploration of their impacts of SC performance.

Appendix G

IOS Literature Review Quick Reference.

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
1982	Barrett, Stephanie and Konsynski, Benn	Inter-Organization Information Sharing Systems.	Explain the growth in IOS	Conceptual	*IOS*	Provides a classification scheme for IOS. Organizational impact associated with IOS is investigated.
1983	Bailey, James E. and Pearson, Sammy W.	Development of a Tool for Measuring and Analyzing Computer User Satisfaction.	Present a technique for measuring and analyzing computer user satisfaction.	Conceptual (Literature review)	*IOS (user satisfaction)*	Presents a list of 22 factors, from the literature review, in an instrument to measure computer user satisfaction.
1985	Porter, Michael E. and Millar, Victor E.	How Information Gives You a Competitive Advantage.	i) What strategies should a company pursue to exploit technology? ii) Of the many opportunities for investment in IT which are the most urgent?	Conceptual	*IOS, SCM (Value Chain), Organizational Strategy (Competitive Advantage)*	Companies that anticipate the power of IT will be in control of events. Companies that do not respond will be forced to accept changes that others initiate and find themselves at a competitive disadvantage.
1987	Malone, Thomas W.; Yates, JoAnn and Benjamin, Robert I.	Electronic Markets and Electronic Hierarchies.	Discuss how advances in IT are affecting are affecting firm and market structures and the options therefore, these changes present for corporate strategy.	Conceptual	Transaction Cost Economics	Authors predict that the electronically connected world will not be simply faster and more efficient but will be accompanied by a fundamental changes in how firms and markets organize the flows of goods and services
1988	Johnston, H. Russell and Vitale, Michael R.	Creating Competitive Advantage With Inter-organizational Systems.	Discuss an explanatory framework for the competitive advantages achieved through IOS.	Conceptual	*IOS*	An electronic link between separate organizations is a part of a major change in the relationships between the parties. Successful users of IOS have found that it was an avenue for increased familiarity with partners that led to wider opportunities and improved economic performance.
1991	Bakos, Yannis	Information Links and	Investigate two types of IOS,	Conceptual	Transaction Cost	Market systems will play an

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
	J.	Electronic Marketplaces: The Role of Inter-organizational Information Systems in Vertical Markets.	electronic marketplaces and information links. Study the implications of information links for the coordination firms with customers and suppliers and the implications of implications of electronic market systems for efficiency and competition in vertical markets.		Economics	increasing role in the economy, offering efficiencies from improved coordination. This will be especially true in the information intense industries, who will first begin to establish bilateral information links.
1992	DeLone, William H. and McLean, Ephraim R.	Information Systems Success: The Quest for the Dependent Variable.	What are the factors that contribute to the success of IS.	Conceptual, Typological	Communication Theory, *IOS*	Six measures of IS success: 1) System quality, 2) Information quality, 3) Use, 4) User satisfaction, 5) Individual impact, 6) Organizational impact.
1993	Clemons, Eric K.; Reddi, Sashidhar P. and Row, Michael C.	The Impact of Information Technology on the Organization of Economic Activity: The "Move to the Middle" Hypothesis.	An argument that IT has the ability to lower coordination cost without increasing the associated transaction risk, leading to more outsourcing and less transaction risk.	Conceptual	Transaction Cost Economics	IT reduces the cost of coordination. The use of outside suppliers, enjoying economies of scale should result in reduced cost and improved component quality. Outsourcing could be complicated by human factors, different objectives and different traditions.
1996	Bensaou, M. & Venkatraman N.	Inter-Organizational Relationships and Information Technology: A Conceptual Synthesis and a Research Framework.	Develop a framework for conduction IOS research	Conceptual	Transaction Cost Economics, Organization Theory and Political Economy. *Information Processing Model*	Argues for an information processing view of inter-organizational coordination. Provides a framework that articulates the fit between coordinating mechanisms and uncertainty as a critical condition for improved performance.
1998	Angeles, Rebecca; Nath,	An Empirical Investigation of the	Examine the construct of "level of EDI implementation"	Survey (64 dyads), Regression	*IOS*	Investments in higher-level implementation of EDI do not

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
	Ravinder, and Hendon, Donald W.	Level of Electronic Data Interchange (EDI) Implementation and its Ability to Predict System Success Measures and EDI Implementation Factors.	and observe the relationship between "level of EDI implementation" and the criticality of the selected implementation factors.			automatically lead to success. There needs to be sensitivity to cultural issues that may subvert EDI implementation success.
2000	Allen, David K.; Colligan, David; Finnie, Andrew and Kern, Thomas	Trust, power, and inter-organizational information systems: the case of the electronic trading community TransLease.	Illustrate the importance of soft organizational issues in IOS management.	Case Study (TransLease)	*IOS*	Social or relational dimensions to inter-organizational systems are often neglected, as the technology becomes the actual focus of the venture. In the presence of mistrust, cooperation between participating organizations is unlikely.
2001	Kauffman, Robert J., and Walden, Eric A.	Economics and Electronic Commerce: Survey and Directions for Research.	A review of the body of research on electronic commerce.	Conceptual, Typological	Economic Theory, *IOS*	Research in electronic commerce is essentially business oriented. Developments in this area will occur across multiple business-disciplines. Hence, there will be a growing impetus for greater inter-disciplinary communications and interaction.
2003	Lewis, Bruce R. & Byrd, Terry Anthony	Development of a Measure for the Information Technology Infrastructure Construct.	To operationalize the Information Technology Infrastructure (ITI) concept by identifying the underlying dimensions and establishing a valid and reliable measure for the construct.	Conceptual, Survey (150), Confirmatory Factor Analysis,	*IOS*	7 validated measures of ITI: CIO, IT planning, IT security, technology integration, advisory committee, enterprise model, and data administration.
2003	Teo, Thompson S.H., and Pian, Yujun	A contingency perspective on Internet adoption and	Examine the contingency factors that affect the levels of Internet adoption and their	Survey (159), Structural Equation	*IOS*	Contingency factors: business technology strategy, top management support, and

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
		competitive advantage.	impact on competitive advantage.	Modeling		technology compatibility. Firms with higher market performances (Revenues) are more likely to use websites to reach their customers.

Appendix H

IOS & SCM joint studies Literature Review Quick Reference.

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
1992	Rogers, Dale S.; Daugherty, Patricia J., and Stank, Theodore P.	Enhancing Service Responsiveness: The Strategic Potential of EDI.	To assess the extent of EDI involvement among warehousing firms and to understand better the impact which EDI has had on the firms' operations and service capabilities.	Survey (164), Simple *t-tests*	*SCM*	Firms with EDI in place indicated significantly greater ease in accommodating special or unusual requests and events than did firms that have not implemented EDI.
1994	Daugherty, Patricia J; Ellinger, Alexander E. and Rogers, Dale S.	Information Accessibility: Customer Responsiveness and Enhanced Performance.	Explain the relationship between, i) information and corporate responsiveness, and ii) responsiveness and a firm's operating performance. Perspective of warehousing	Survey (292), Simple *t-tests*	*SCM (JIT)*	Information availability and responsiveness are positively related and responsive firms have leveraged information availability to improving operating efficiency. The potential exists for firms to waste time and resources by becoming, in effect, too responsive. This can occur when firms try to do too much or institute programs that customers neither value nor want.
1994	Gustin, Craig M.; Daugherty, Patricia J, and Stank, Theodore P.	Computerization: Supporting Integration	Presents a profile of the level of computerization for various cross-functional logistics integrating activities of firms who perceive themselves as integrated or non-integrated (for logistics activities)	Survey (393), Simple *t-tests*	*SCM (Integrated Logistics)*	Integrated firms had electronic data on many more functions than non-integrated firms. Integration cannot be achieved without the free flow of critical information.
1994	Srinivasan, Kannan; Kekre, Sunder and Mukhopadhyay, Tridas	Impact of Electronic Data Interchange Technology on JIT Shipments	Investigation degree to which increasing vertical information integration using EDI technology enhances shipment performance of suppliers in a JIT environment. What are the key factors that	Case study (Chrysler), Econometric model: i) Baseline Logit, ii) Logit with random intercept (Mover/Stayer), parametric, and iii)	*IOS, SCM (JIT)*	Timely sharing of JIT schedules using integrated EDI result in over 50% reduction in shipment discrepancy. Suppliers that are able to map incoming information directly to internal systems enjoy even greater benefits.

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
			drive JIT shipment performance and the role of EDI in facilitating JIT material flows?	non-parametric.		Suppliers who handle a higher percentage of customers electronically find shipment errors continuously decreasing.
1995	Bensaou, M. & Venkatraman N.	Configurations of Inter-organizational Relationships: A Comparison Between U.S. and Japanese Automakers.	Uncover the dominant inter-organizational relationships in the automotive industry. The unit of observation is the auto manufacturer-supplier dyad for a component at U.S. and Japanese automakers.	Conceptual & Cluster Analysis	Transaction Cost Economics, Organization Theory and Political Economy. *Information Processing Model*	Uncover a set of five naturally occurring patterns of inter-organizational relationship: 1. Structural relationship. 2. Remote relationship. 3. Electronic control. 4. Electronic interdependence. 5 Mutual adjustments.
1995	Bowersox, Donald J. and Daugherty, Patricia J.	Logistics Paradigms: The Impact of Information Technology.	Conceptual discussion of different information technology mediated structures of logistics strategy.	Conceptual	*SCM (Logistics strategy – extended enterprise model)*	IT mediated logistics structures are contingent on firm specific strategic performance goals: i) Efficiency, ii) Effectiveness, and iii) Flexibility.
1995	Gustin, Craig M.; Daugherty, Patricia J, and Stank, Theodore P.	The Effect of Information Availability on Logistics Integration.	Gain insight into the relationship between information and the successful implementation of the integrated distribution concept.	Survey (345), Simple *t-tests*	*SCM (Integrated Logistics)*	Firms that have adopted the logistics approach with a centrally programmed closely coordinated integrated distribution strategy to lower total distribution costs and increase customer service quality place a higher premium on information systems performance.
1995	Holland, Christopher P.	Cooperative Supply Chain Management: The Impact of Inter-organizational Information Systems.	Predict the evolution and discuss the management of different types of market structures in an electronic trading environment.	Conceptual, Case Study	*IOS (electronic market, electronic hierarchies)*	Firms are moving towards cooperative relationships in an effort to make the supply chain as a whole more competitive. The resulting market structure is an electronic hierarchy in which business processes are integrated across

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
						organizational boundaries using IOS.
1995	Mukhopadhyay, Tridas; Kekre, Sunder & Kalathur, Suresh	Business Value of Information Technology: A Study of Electronic Data Interchange.	Impacts of EDI on supply chain partnership dyads	Case Study (Chrysler), Moderator Regression	*IOS, SCM (JIT)*	Benefits of EDI systems: Improved, information exchanges, and preparing and processing of documents. EDI transmission of documents resulted in about $220 million saving system wide for Chrysler.
1995	Teo, H.H.; Tan, B.C.Y; Wei, K.K. and Woo, L.Y.	Reaping EDI benefits through a pro-active approach	Examines the impact of TradeNet (Port of Singapore Extranet) on customers' effectiveness and efficiency.	Case Study	*IOS (Portals for trade facilitation)*	Participants that integrated TradeNet with their internal MIS benefited more in terms of increased organizational effectiveness.
1996	Murphy, Paul R. and Daley, James M.	International Freight Forwarder Perspectives on Electronic Data Interchange and Information Management Issues.	Because good IS are critical to the survival of many IFFs an empirical study is conducted to learn about selected EDI and information management issues.	Survey (98), Simple *t-test*	*IOS, SCM*	Usual results of EDI studies: EDI barrier – high setup cost. Quick access to information most cited EDI benefit. Large firms more likely to use EDI. Firms realize that IT strategy must complement corporate strategy.
1996	Reekers, N. & Smithson, S.	The role of EDI in inter-organizational coordination in the European automotive industry.	Assess the impact of EDI use on the trading relationships between car manufacturers and their suppliers	Case Study	Transaction Cost Economics, Resource Based Theory, Network Analysis	EDI enables both parties to rationalize their operations. However, manufacturers still optimize their production at the expense of their suppliers, which jeopardize true long-term partnerships.
1997	Teo, Hock-Hai; Tan, Bernard C.Y., and Wei, Kwok-Kee	Organizational Transformation Using Electronic Data Interchange: The Case of TradeNet in Singapore.	Identify key measures for organizational change and external relationships. Detail changes made possible by TradeNet. Determine strategic impact on the Trade Development	Case Study	*IOS (Portals for trade facilitation)*	Similar results to Teo *et al.* (1995). Reason for success: i) change existing mindset, ii) institute radical transformation, iii) leverage knowledge and technology, and iv) foster a win-win

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
			Board from introducing TradeNet, and managerial implications of these changes.			situation.
1998	Williams, Lisa R.; Magee, George D., and Suzuki, Yoshinori	A Multidimensional View of EDI: Testing the Value of EDI Participation to Firms	Develop a multidimensional view of EDI usage. To determine if level of EDI participation is associated with the perceived effect of EDI value	Survey (275), Regression Analysis	*IOS & SCM*	Firms who have EDI capability tend only to do business with firms who have EDI capability. Current business environment requires use of EDI, but not intensively.
1999	Hewitt, Frederick	Information Technology Mediated Business Process Management – Lessons from the Supply Chain.	To investigate the difficulties in introducing radically new, integrated decision-making processes without the disruptions to the discrete specialist legacy systems. Are integrated IS necessary?	Case study (Xerox)	*IOS & SCM*	The key to solving the problem is better informed people, empowered to make wide ranging decisions, rather than producing more sophisticated IS. IT does not drive but mediates BPR.
1999	Kwan, Albert Tan Wee	The Use of Information Technology to Enhance Supply Chain Management in the Electronics and Chemical Industries.	To determine the use of IT for SCM by manufacturing companies in Singapore.	Survey (148)	-	Reported survey results.
1999	Lee, Ho Geun; Clark, Theodore, and Tam, Kar Yan	Research Report: Can EDI Benefit Adopters?	Determine the impact of EDI on adopters (31 grocery stores) who adopted Campbell's (EDI-champion) EDI network.	Case study, Transaction Data, Two-Stage Least Square Regression	*IOS, SCM (CRP)*	EDI adopters realized increased inventory turns, reduced stockouts, and paper usage and data-entry errors.
2000	Jayaram, Jayanth; Vickery, Shawnee K., and Droge, Cornelia	The Effects of Information System Infrastructure and Process Improvements on Supply-Chain Time	To investigate the direct and complementary effects of information system infrastructure and process improvements on time based performance in the	Survey (57), Moderator Regression.	*SCM*	Three dimensions of information systems infrastructure – design manufacturing integration, manufacturing technology, and information technology –

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
		Performance.	U.S. automotive industry.			influenced manufacturing lead time. Provides support for joint deployment of information system infrastructure and process improvement to streamline supply chain cycle time performance.
2000	Lancioni, Richard A.; Smith, Michael F., and Olivia, Terence A.	The Role of the Internet in Supply Chain Management.	Discuss how the Internet is being used in managing the major components of supply chains: transportation, purchasing, inventory management, customer service, production scheduling, warehousing and vendor relations.	Survey (181), Simple *t-tests*	-	Reports the results of the survey. Comparison between large and small company use of the Internet. No conclusive patters.
2000	Lee, Hau L., and Whang, Seungjin	Information Sharing in a Supply Chain	Describes the types of information shared: inventory, sales, demand, forecast, order status, and production schedule. Discuss **how** and **why** information is shared and discuss three alternative models for information sharing.	Case study	*Bull whip effect*	Information sharing is only an enabler for better coordination and planning of the supply chain. Hence, companies must develop capabilities to utilize the shared information in an effective way.
2000	Murphy, Paul R., and Daley, James, M.	An Empirical Study of Internet Issues Among International Freight Forwarders.	Is the Internet a complement or substitute for EDI? What is the usage and importance of the Internet among IFFs? What are the barriers to and benefits of Internet use? Are there any contingency variables affecting the	Survey (80)	*SCM & IOS*	The Internet is a complement to EDI; firms are skeptical of, but the majority still uses the Internet; firms believe that the Internet offers numerous benefits; and, larger firms are more likely to use the Internet.

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
			answers to the above questions.			
2000	Premkumar, G. Prem	Inter-organizational Systems and Supply Chain Management	To provide an integrated perspective of supply chain management and inter-organizational systems that highlight the potential benefits, and management issues and provides guidelines for implementation.	Conceptual	Transaction cost economics	Supply chain management links trading partners for efficient and effective movement of materials. IOS provides effective information flows. A climate of trust and true partnership must exist for these initiatives to be a success.
2000	Stefansson, Gunnar, and Tilanus, Bernhard	Tracking and Tracing: Principles and Practice.	Clarify the concept of tracking and tracing identifying attributes of tracking and tracing	Conceptual	-	Identifies eight attributes of tracking and tracing.
2001	Edwards, Peter; Peters, Melvyn, and Sharman, Graham	The Effectiveness of Information Systems in Supporting the Extended Supply Chain.	To understand the extent to which information systems have supported the way that companies are meeting the challenges of the global market.	Conceptual, Case study	*SCM*	Leading companies are exploiting technology to forge links with their trading partners and designing their business models around the needs of their customers. The capability to build IOS is dependent upon the building of inter-organizational trust.
2001	Essig, Michael, and Arnold, Ulli	Electronic Procurement in Supply Chain Management: Information Economics-Based Analysis of Electronic Markets	Analyzes the possibilities of electronic market places primarily from the perspective of buyers.	Conceptual	Information Economics Theory & Transaction Cost Economics	Transaction Cost Analysis and Information Economic Theory view of e-procurement and the conditions that favor electronic markets because of the lower transaction coordination costs enabled by today's information technology. Develops an e-procurement matrix to help systematize the different e-procurement instruments.
2001	Forster, Paul W., and Regan,	Electronic Integration in the Air Cargo	What impact does electronic integration have	Survey (194), Multiple Moderated	Organizational Theory (Contingency theory).	There is no evidence of a direct impact of electronic

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
	Amelia C.	Industry: An Information Processing Model of On-Time Performance.	on inter-organizational task performance? What factors (contingencies) limit the effectiveness of electronic integration?	Regression	*Information processing model*.	integration on performance. The effectiveness of electronic integration across firms is limited by the nature of: i) inter-organizational task, ii) environmental dynamism, iii) power relationships between firms.
2001	Humphreys, P.K.; Lai, M.K. and Sculli, D.	An Inter-organizational Information System for Supply Chain Management.	Review of the theoretical foundations for the study of inter-organizational relationships within a supply chain context, and examine the contingencies of deploying IOIS	Conceptual	Exchange Theory, Political Economy & Transaction Cost Economics	Develops a model from a 3rd party IOS integration service provider's perspective with a focus defining the role of the service provider and on the contingencies necessary for providing the service.
2001	Narasimhan, Ram, and Kim, Soo Wook	Information System Utilization Strategy for Supply Chain Integration.	Analyze the characteristics of information systems utilized in supply chain management. Prioritize the implementation of IS for SCM. Develop a set of guidelines for using IS SCM.	Survey (244), Structural Equation Modeling.	*SCM*	IS use for infrastructural support has an indirect relationship on SCM. IS use for value creation management is a precondition for the utilization of IS for logistical operations. A successful IS strategy must be coordinated with the firm's external integration.
2001	Shore, Barry	Information Sharing in Global Supply Chain Systems.	Develop a framework for information sharing within a supply chain.	Case study (4 cases)	*SCM*	Develops a framework for information sharing in a supply chain. Proposes six variables that affect information flows between supply chain partners.
2002	Auramo, Jaana; Aminoff, Anna, and Punakivi, Mikko	Research Agenda for E-Business Logistics Based on Professional Opinions.	What are the major research areas regarding logistics of electronic business.	Delphi Survey (65/30)	*SCM*	When implementing a new technology to old processes there is a danger of creating only new, expensive, and inefficient performance. Internal business processes

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
						have to be changed or altered to fit the IOS.
2002	Frohlich, Markham T.	E-Integration in the Supply Chain: Barriers and Performance.	i) Is Internet based supply chain integration with upstream suppliers and downstream customers superior to traditional ways of doing business? ii) What are the upstream, internal, and downstream barriers to implementing e-integration?	Survey (486), Structural Equation Modeling.	*IOS (e-integration), SCM*	i) A positive link exists between (upstream and downstream) e-integration and performance; and ii) internal, more than either upstream or downstream barriers, impede e-integration.
2002	Golicic, Susan L., Davis, Donna F., McCarthy, Teresa M., and Mentzer, John T.	The impact of e-commerce on supply chain relationships.	Qualitative study of eight e-commerce companies to develop a grounded theory of the impact of e-commerce on managing supply chain relationships.	Case Study, Grounded Theory.	Grounded Theory, Transaction Cost Economics, Resource Based Theory.	As SCM is essentially managing relationships among companies in a SC the impact of e-commerce on SCM occurs primarily through the management of relationships. Companies emphasize relationship management to overcome uncertainty from information overload.
2002	Moberg, Christopher R.; Cutler, Bob D.; Gross, Andrew, and Speh, Thomas W.	Identifying Antecedents of Information Exchange Within Supply Chains.	Identify possible antecedents of information exchange in a supply chain.	Survey (248), Canonical Correlation Analysis	*SCM*	As managers invest significant resources acquiring and implementing new systems and software to support their logistics operations, it is extremely important to consider the quality of information being used. Also commitment is more important than trust in fostering strategic information exchange.
2002	Sahin, Funda & Robinson, E. Powell	Flow Coordination and Information Sharing in Supply Chains.	To fill the gaps in the incomplete understanding of the value of information and physical flow	Conceptual, Typological – information sharing and coordination	*SCM (bullwhip effect), IOS*	Develop a typology for information sharing and physical coordination research. Highlight gaps in current

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
			coordination.			research and identify future research opportunities.
2002	Sanders, Nada R. and Premus, Robert	IT Applications in Supply Chain Organizations: A Link between Competitive Priorities and Organizational Benefits.	Do IT sophisticated firms focus on a specific set of competitive priorities, different form less sophisticated IT firms. In addition, is there some degree of alignment between competitive priorities, IT application selected, and the measurable benefits achieved?	Survey (116), Simple *t-tests*	*SCM (extended enterprise model)*	'High IT use' firms focus on quality and flexibility for competitive priorities but still use operationally oriented IT. Could not prove that High IT use leads to improved performance.
2002	Shah, Rachna; Goldstein, Susan Meyer & Ward, Peter T.	Aligning supply chain management characteristics and inter-organizational information system types: An exploratory study.	Demonstrate the enhancement of knowledge that can be obtained by juxtaposing the SCM and IOS research areas.	Conceptual, Survey (1,349), Factor Analysis	*SCM & IOS*	Proposes a framework: "SCM-IOS" matrix, to help understand the alignment of IOS capabilities with that of SC partners. Empirical study found that firms align their IOIS investments with the sophistication and coordination of their SCM efforts.
2002	Stefansson, Gunnar	Business-to-Business Data Sharing: A Source for Integration of Supply Chains	To what extent do small, medium, large and huge companies taking part in supply chain, utilize advanced information technology to share data	Case study	-	Data sharing in supply chains via EDI or Internet is more a vision than a reality. But the Internet promises data sharing and therefore coordination capability for small and medium sized companies.
2002	Vakharia, Asoo J.	E-Business and Supply Chain Management	EDITORIAL			
2003	Boyson, Sandor; Corsi, Thomas & Verbraeck,	The e-supply chain portal: a core business model.	Report on a pilot project for the U.S. Department of Defense to create a portal	Case study	*IOS (Web Portals), SCM (CPFR)*	Explains the detailed functionality of the portal. Contrasts pre and post portal

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
	Alexander		for supply chain integration (USAF-GE, low-pressure turbine for F-101 engines).			environments for SCM. Several benefits, primarily cycle times.
2003	Corsi, Thomas M.	Real-time e-supply chain management: diffusion of new technologies and business practices	EDITORIAL			
2003	Ellinger, Alexander E.; Lynch, Daniel F., and Hansen, John D.	Firm Size, Web Site, and Financial Performance in the Transportation Industry.	Analyze the informational and interactive content of the top 100 U.S. motor carrier firms' web sites to examine the relationship between firm size and Internet utilization.	Web survey of Internet web site services. Multivariate Canonical Correlation.	-	Firm size affects Internet utilization, large firms make greater use of the Internet. Firm size has a greater effect on interactive web services than informational content.
2003	García-Dastugue, Sebastián J., and Lambert, Douglas M.	Internet-Enabled Coordination in the Supply Chain.	Develop a framework to help managers select the Internet-coordinated mechanisms that best fit the needs of a variety of business situations.	Conceptual	Transaction Cost Economics	A framework to guide the choice of an Internet-coordinating mechanism for a variety of business needs.
2003	Goldsby, Thomas J, and Eckert, James A.	Electronic Transportation Marketplaces: A Transaction Cost Perspective.	A guide to help transportation managers decide whether to buy transportation services through an Internet-based intermediary or in the traditional manner.	Conceptual	Transaction Cost Economics (*e-markets)*	A Transaction Cost Economics framework to guide the decision for buying transportation services through on-line markets or traditionally.
2003	Lancioni, Richard A.; Smith, Michael F. & Schau, Hope Jensen	Strategic Internet Application Trends in Supply Chain Management.	To explore Internet adoption patterns and operational applications in all aspects of U.S. supply chain networks. Follow up on the Lancioni *et al*. (2000) survey.	Survey (193)	-	Integration of the Internet into SCM has increased and become more focused and is maturing with more precise expectations and measurable goals.
2003	Murphy, Paul R.;	An Analysis of Select	Investigate possible	Survey (304),	-	Early adopters differ from late

Year	Author	Title	Research Objective	Methodology	Theory/*Concept*	Conclusion
	Poist, Richard F.; Lynagh, Peter M., and Grazer, William F.	Web Site Practices Among Supply Chain Participants.	relationships between web site practices and organizational characteristics: firm size, firm type, firm age, length of Internet adoption, and percentage of revenues derived from the Internet.	ANOVA		adopters. Perceptions of informational practices tend to be relatively similar across firm size and age. Results are dissimilar when analyzed across percentage of corporate revenues gained from the Internet.
2003	Patterson, Kirk A., Grimm, Curtis M., and Corsi, Thomas M.	Adopting New Technologies for Supply Chain Management.	Develop a model of key factors influencing the adoption of supply chain technology	Conceptual	SCM & Diffusion Theory (*Adoption of Innovations)*	Factors affecting SCM technology: i) org size, ii) Decentralized org. structure, iii) org. performance, iv) Supply chain strategy integration, v) interorg. factors, and vi) Environmental uncertainty.
2003	Presutti, William D. Jr.	Supply Management and E-Procurement: Creating Value Added in the Supply Chain.	Discusses the importance of e-procurement in creating value for the firm.	Conceptual	*SCM (e-procurement)*	Given the importance of e-procurement contribution to the firm supply managers need to make a strong business case for its adoption.
2003	Rutner, Stephen M.; Gibson, Brian J. & Williams, Susan R.	The impacts of the integrated logistics systems on electronic commerce and enterprise resource planning systems.	To report the results of a longitudinal survey of the use of logistics information systems especially the use of e-commerce and ERP.	Survey (265), Pearson X^2-difference test.	*IOS (ERP, e-commerce) & SCM (integrated logistics)*	There is a sequence to the adoption of e-commerce. Firms who have adopted the integrated logistics concept are more likely to implement e-commerce and ERP.
2003	Skjøtt-Larsen, Tage; Kotzab, Herbert, and Grieger, Martin	Electronic Marketplaces and Supply Chain Relationships.	To test the hypothesis that different types of buyer–supplier relationships require different types of electronic marketplaces.	Conceptual	*SCM*	Categorized electronic marketplaces, hypothesis is true.

Appendix I

Survey Invitation Letter

CSCR Header

November 23, 2004

To,
«Soc_Title» «First_Name» «Middle_Name» «Last_Name»
«Title»
«Company»
«Address»
«City», «State» «Zip»

Dear «Soc_Title» «Last_Name»,

The Center for Supply Chain Research at The Pennsylvania State University is conducting a nationwide study to learn how the use of information channels between shippers and ocean carriers may improve the shipment of ocean containerized freight and therefore, also improve supply chain performance. We invite your firm's participation in this critical research. An import/export or international shipping manager in-charge of, or familiar with, international ocean container shipping operations at your company would best be suited for completing the survey, which should take between 20-30 minutes

Utilizing the right information channel with an ocean carrier for communicating transactional information on containerized shipments may have a significant impact on a shipper's supply chain performance. The advent of Internet portals offers shippers the opportunity to realize a competitive advantage by leveraging the right communication channel – phone/fax/e-mail, EDI, Internet portal – to improve supply chain performance. We will attempt to determine the impact of the different information channels on supply chain performance for different segments of shippers.

In return for your participation you may request an Executive Summary of the findings, which will be available in the second quarter of 2005. Some key outputs of the Executive Summary will include:

- Shippers' use of, and perception of, the different information channels' information quality, and systems quality.
- Which information channels are best suited for use by each shipper segment and why.
- How does use of specific information channels affect shipping and supply chain performance.

Also, in recognition of your valuable time and effort spent completing the survey we are offering you the chance to enter a drawing for a ***first prize of $300, second prize of $200, and third prize of $100***. Winners will be drawn from qualifying survey respondents

In order to help our study and qualify for the prize drawing, please return your completed survey no later than January 15th, 2005 in the self-addressed stamped envelopes provided. If you have any questions regarding items in the survey please call John Saldanha, principal investigator, at (814) 863-1232 or send an e-mail to jps278@psu.edu. Completion and return of the survey is considered consent to participate in this research. Please keep a copy of this letter for your records. Your participation in this study is voluntary; you may withdraw your participation at any

time and decline to answer specific questions. Penn State's Office of Research Protections may review records relating to this project.
[CONTINUED]
You may contact the Office for Research Protections at (814) 865-1775 if you have questions about your rights as a research participant. *This consent letter (IRB#19594) was reviewed and approved by the Office for Research Protections at The Pennsylvania State University on 11/16/04 and will expire on 09/22/05 (JKG).* Response data will be held in the strictest confidence by the Centre for Supply Chain Research and no data identifiable to specific firms will be released to any other party. Data reported and published will be aggregated and will not reveal the identity of specific companies.

We encourage your firm's participation in this important research and believe the resulting Executive Summary will be valuable in enhancing your firm's competitiveness. We look forward to your participation.

Sincerely

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Appendix J

2004 Survey Shipper-Ocean Carrier Information Channels

INTRODUCTION

This survey seeks to understand your firm's use of the different communication channels for shipping *full* container loads by ocean.
The information channels of interest are:

1) **Conventional**– trade publications and static web pages (for shipping schedules), phone, fax, e-mail; and, post and courier (for B/L).
2) **EDI** – Electronic data interchange using the standard ocean transportation industry transaction sets.
3) **Internet Portals** – carrier-backed, public Internet portals; *CargoSmart*, *GT-Nexus*, and *Inttra*.

This study will be investigating the following stages in the ocean-liner containerized-freight shipping process where the ocean carriers communicate transactional information to shippers:

1) **Shipping Schedule Lookup** – when a shipper looks up a carrier's shipping schedules to plan shipments and make bookings.
2) **Booking Confirmation** – confirmation received by the shipper confirming, declining or recommending an alternative schedule.
3) **Bill of Lading Information Receipt** – B/L information received by the shipper to ensure that freight payment, goods release, and payment for goods may be carried out.
4) **Tracking and Tracing** – information provided by carriers to shippers on current status of shipments in carrier's system.

PLEASE READ

Survey Instructions

1) You manage ocean freight-container shipments for:

☐ The entire firm	☐ A single business unit

We request that you use the most typical type of full container shipment that you are familiar with within your firm/business unit as described by your responses to 1 below to complete the survey. *To further simplify the task of completing the survey, we suggest you limit your responses to only the* ***most significant trade-lanes*** *you deal with. For example if China – W. Coast USA is your most challenging trade-lane use only this trade-lane to respond to the survey*

2) You manage ocean freight-container:

☐ Imports	☐ Exports	☐ Imports and Exports

3) From the following please select the stages of the ocean freight-container shipping process that are routinely conducted within your firm/business unit:

	Shipping Transactions	***IMPORT***	***EXPORT***
(a)	*Shipping Schedule Lookup (323)**	☐	☐
(b)	*Booking Confirmation (301)**	☐	☐
(c)	*Bill of Lading Information Receipt (310)**	☐	☐
(d)	*Track and Trace (312, 313 & 315)**	☐	☐

If your job involves ***imports only and you do not directly conduct all the shipping steps*** *listed in 3, please report to the best of your ability your* ***overseas supplier's use and perceptions of information and systems quality*** *of each communication channel.*

4) Instead of communicating directly with the ocean carrier do you communicate with an intermediary (International Freight Forwarder or NVOCC) using phone, fax, EDI, or the intermediary's Internet portal:

☐ Yes	☐ No

If you answered "Yes" to 4 above please answer parts B, C and D of the survey for your communications with your intermediary as if the intermediary were the carrier.

A) Ocean Container Shipping Operations

A1) For the organization you listed in question 1 above please indicate the approximate sales revenue for 2003

☐ 0 to $25 million	☐ $26 – $100 million	☐ $101 – $500 million
☐ $501 – $1 billion	☐ >$1 billion – $5 billion	☐ >5 billion – $10 billion
☐ >$10 billion		

A2) Please indicate the industry which best describes your organizations business activities

☐ Appliances	☐ Dept. Store/Retail General Merch	☐ Mining & Minerals
☐ Automotive & Transport Equip.	☐ Electronics & Related Instrum'ts	☐ Office Equip/Supplies
☐ Aviation	☐ Electrical Machinery	☐ Paper & Related Products
☐ Building Materials/Lumber Prod.	☐ Food & Beverage	☐ Petroleum & Petrochemicals
☐ Chemicals & Plastics	☐ Furniture	☐ Pharmaceuticals, drugs, toiletries
☐ Clothing & Textiles	☐ Hardware	☐ Primary Metals
☐ Computer Hardware & Periph'ls.	☐ Machinery Tools	☐ Other
☐ Construction/Farm/Garden Equip.	☐ Metal Products	_____

A3) Your organization is:

☐ The beneficial cargo owner	☐ An International Freight Forwarder	☐ An NVOCC

A4) Please provide your best estimate for the number of external parties your organization employs to execute your ocean freight-container shipment process:

	0	1-5	6-10	11-20	>20
(a) International Freight Forwarders/NVOCCs	☐	☐	☐	☐	☐
(b) Inland Carriers	☐	☐	☐	☐	☐
(c) Ocean Carriers	☐	☐	☐	☐	☐
(d) Customs house brokers	☐	☐	☐	☐	☐

A5)

	<5%	5-10%	11-25%	26-50%	>50%
Please estimate how much of your total ocean shipping job is spent interacting with the information systems or personnel of service providers listed in **A4** above	☐	☐	☐	☐	☐

A6) Please indicate your level of agreement with the following statements by circling the appropriate number

	Agree				*Disagree*
(a) There are clearly established procedures and practices to guide the planning, execution and monitoring of shipments in your organization	1	2	3	4	5
(b) Your job is clearly defined in detail.	1	2	3	4	5
(c) The same shipping tasks are largely done in the same way most of the time	1	2	3	4	5
(d) Operational problems frequently arise for which there are no standard solutions	1	2	3	4	5
(e) Most operational problems are routine and have routine solutions	1	2	3	4	5

B) Information Channels Use

B1) Please use the scale provided to indicate <u>your perception</u> of how often a communication channel is used for each shipping transaction.

Scale:

Never	Very Seldom	Seldom	About half the time	Often	Very Often	Always
1	2	3	4	5	6	7

	Shipping Transactions	***<u>Conventional</u>***	***<u>EDI</u>***	***<u>Internet Portal</u>***
(a)	*Shipping Schedule Lookup (323)**			
(b)	*Booking Confirmation (301)**			
(c)	*Bill of Lading Information Receipt (310)**			
(d)	*Track and Trace (312, 313 & 315)**			

* EDI Transaction Sets.

B1) If you use Internet Portals please indicate how often you use each, relative to your total use of all three Internet Portals, by circling the appropriate number below.

	1 Never	*2 Very Seldom*	*3 Seldom*	*4 the Half Time*	*5 Often*	*6 Very Often*	*7 Always*
(a) Cargosmart	1	2	3	4	5	6	7
(b) GT-Nexus	1	2	3	4	5	6	7
(c) INTTRA	1	2	3	4	5	6	7

C) Information Channel: Information Quality

C1) Accuracy*: How up-to-date, correct, and complete is the information.*
By circling the appropriate number, please indicate <u>your perception</u> of the ***accuracy*** of the shipping transaction information obtained using each of the information channels below.

Accurate 1 2 3 4 5 6 7 *Inaccurate*

		extremely	*quite*	*slightly*	*neither*	*slightly*	*quite*	*extremely*
Conventional	*(a) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(b) Booking Confirmation	1	2	3	4	5	6	7
	(c) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(d) Tracking and Tracing	1	2	3	4	5	6	7
EDI	*(e) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(f) Booking Confirmation	1	2	3	4	5	6	7
	(g) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(h) Tracking and Tracing	1	2	3	4	5	6	7
Internet Portal	*(i) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(j) Booking Confirmation	1	2	3	4	5	6	7
	(k) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(l) Tracking and Tracing	1	2	3	4	5	6	7

***C2) Timeliness**: Whether the information is available at the time when it is required or, too early or too late (untimely).*

By circling the appropriate number, please indicate <u>your perception</u> of the ***timeliness*** of the shipping transaction information obtained using each of the information channels below.

		Timely	1	2	3	4	5	6	7	*Untimely*
			extremely	*quite*	*slightly*	*neither*	*slightly*	*quite*	*extremely*	
Conventional	*(a) Shipping Schedule Lookup*		1	2	3	4	5	6	7	
	(b) Booking Confirmation		1	2	3	4	5	6	7	
	(c) Bill of Lading Information Receipt		1	2	3	4	5	6	7	
	(d) Tracking and Tracing		1	2	3	4	5	6	7	
EDI	*(e) Shipping Schedule Lookup*		1	2	3	4	5	6	7	
	(f) Booking Confirmation		1	2	3	4	5	6	7	
	(g) Bill of Lading Information Receipt		1	2	3	4	5	6	7	
	(h) Tracking and Tracing		1	2	3	4	5	6	7	
Internet Portal	*(i) Shipping Schedule Lookup*		1	2	3	4	5	6	7	
	(j) Booking Confirmation		1	2	3	4	5	6	7	
	(k) Bill of Lading Information Receipt		1	2	3	4	5	6	7	
	(l) Tracking and Tracing		1	2	3	4	5	6	7	

***C3) Usefulness**: How useful the information is to conducting the shipping task.*

By circling the appropriate number, please indicate <u>your perception</u> of the ***usefulness*** of the shipping transaction information obtained using each of the information channels below.

		Useful	1	2	3	4	5	6	7	*Useless*
			extremely	*quite*	*slightly*	*neither*	*slightly*	*quite*	*extremely*	
Conventional	*(a) Shipping Schedule Lookup*		1	2	3	4	5	6	7	
	(b) Booking Confirmation		1	2	3	4	5	6	7	
	(c) Bill of Lading Information Receipt		1	2	3	4	5	6	7	
	(d) Tracking and Tracing		1	2	3	4	5	6	7	
EDI	*(e) Shipping Schedule Lookup*		1	2	3	4	5	6	7	
	(f) Booking Confirmation		1	2	3	4	5	6	7	
	(g) Bill of Lading Information Receipt		1	2	3	4	5	6	7	
	(h) Tracking and Tracing		1	2	3	4	5	6	7	
Internet Portal	*(i) Shipping Schedule Lookup*		1	2	3	4	5	6	7	
	(j) Booking Confirmation		1	2	3	4	5	6	7	
	(k) Bill of Lading Information Receipt		1	2	3	4	5	6	7	
	(l) Tracking and Tracing		1	2	3	4	5	6	7	

D) Information Channel: System Quality

D1) Responsiveness*: The speed with which the shipping transaction task can be executed using the information channel.*

By circling the appropriate number, please indicate your perception of the ***responsiveness*** of each of the information channels below to execute the shipping transaction tasks.

Quick 1 2 3 4 5 6 7 *Slow*

		extremely	*quite*	*slightly*	*neither*	*slightly*	*quite*	*extremely*
Conventional	*(a) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(b) Booking Confirmation	1	2	3	4	5	6	7
	(c) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(d) Tracking and Tracing	1	2	3	4	5	6	7
EDI	*(e) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(f) Booking Confirmation	1	2	3	4	5	6	7
	(g) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(h) Tracking and Tracing	1	2	3	4	5	6	7
Internet Portal	*(i) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(j) Booking Confirmation	1	2	3	4	5	6	7
	(k) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(l) Tracking and Tracing	1	2	3	4	5	6	7

D2) Ease of use*: How easy is it to use and access the information channel to conduct the shipping task.*

Please indicate your perception of the ***ease of using*** each of the information channels below to execute the shipping transaction tasks.

Easy 1 2 3 4 5 6 7 *Difficult*

		extremely	*quite*	*slightly*	*neither*	*slightly*	*quite*	*extremely*
Conventional	*(a) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(b) Booking Confirmation	1	2	3	4	5	6	7
	(c) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(d) Tracking and Tracing	1	2	3	4	5	6	7
EDI	*(e) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(f) Booking Confirmation	1	2	3	4	5	6	7
	(g) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(h) Tracking and Tracing	1	2	3	4	5	6	7
Internet Portal	*(i) Shipping Schedule Lookup*	1	2	3	4	5	6	7
	(j) Booking Confirmation	1	2	3	4	5	6	7
	(k) Bill of Lading Information Receipt	1	2	3	4	5	6	7
	(l) Tracking and Tracing	1	2	3	4	5	6	7

E) Information systems: Internal Integration

E1) ERP use, please circle the appropriate date range

	0	<1	1-5	6-10	>10
For how many years has your firm been using Enterprise Resource Planning (ERP) software:	☐	☐	☐	☐	☐

E2) Please indicate your level of agreement with the statements below regarding the level of information system integration within your firm:

	Agree				*Disagree*
(a) My firm maintains an integrated database and access method to facilitate information sharing.	1	2	3	4	5
(b) My firm effectively shares information between departments. †	1	2	3	4	5
(c) My firm has adequate ability to share both standardized and customized information internally.	1	2	3	4	5

F) Information systems: External Integration

F1) Please mark the appropriate entry:

	0%	**1-10%**	**11-30%**	**31-60%**	**60+%**
(a) Please provide your best estimate of the percentage of suppliers with whom your firm has an EDI or Internet communication link	☐	☐	☐	☐	☐
(b) Please provide your best estimate of the percentage of customers with whom your firm has an EDI or Internet communication link	☐	☐	☐	☐	☐

F2) By circling the appropriate number, please indicate your level of agreement with the statements below regarding the level of **external** IOS integration at your firm:

	Agree				*Disagree*
(a) My firm effectively shares operational information externally with suppliers.	1	2	3	4	5
(b) My firm effectively shares operational information externally with customers.	1	2	3	4	5
(c) My firm has implemented web-based processes with suppliers for procurement of materials.	1	2	3	4	5
(d) My firm has implemented web-based integrated processes for inventory planning with suppliers.	1	2	3	4	5
(e) My firm has implemented web-based integrated processes for order scheduling with suppliers.	1	2	3	4	5
(f) My firm has implemented web-based integrated processes for demand forecasting with suppliers.	1	2	3	4	5
(g) My firm has implemented web-based integrated processes for inventory planning with customers.	1	2	3	4	5
(h) My firm has implemented web-based order-receipt processes for customers.	1	2	3	4	5
(i) My firm has implemented web-based after sales service support for customers.	1	2	3	4	5
(j) EDI and Internet portal data from ocean carriers can be seamlessly integrated into my office systems	1	2	3	4	5

F3) EDI use, please mark the appropriate entry	0	1-5	6-10	11-20	>20
For how many years has your firm been using EDI to communicate with external business partners?	☐	☐	☐	☐	☐

G) External Environmental

G1) Market growth, please circle the appropriate entry

	Growing		*Stable*		*Declining*
The market growth for your organization's product(s) can be best described as:	1	2	3	4	5

G2) By circling the appropriate number, please provide your best estimates for:

	<5	5-25	26-100	101-500	>500
(a) Number of overseas suppliers from whom you import.					
(b) Number of customers who you export your finished products.					

G3) Please indicate your best judgment of the *uncertainty* of:

	Unstable				*Stable*
(a) Finished products *demand*.	1	2	3	4	5
(b) Materials and components' *supply*.	1	2	3	4	5

G4) Please indicate your best judgment of the *seasonality* for your organization's:

	Seasonal				*Unseasonal*
Finished products *demand*.	1	2	3	4	5

H) Shipping Task Performance

If you responded to parts B and C for imports AND exports please aggregate the performances for your import and export operations as best you can to respond to the following questions.

H1) What percent of ocean container shipments are available at the final destination at the following times:

	<5%	**5-25%**	**26-50%**	**51-75%**	**76-90%**	**91-95%**	**>95%**
(a) Just before or at the estimated delivery time	☐	☐	☐	☐	☐	☐	☐
(b) 1 day after the estimated delivery time	☐	☐	☐	☐	☐	☐	☐
(c) 2 days after the estimated delivery time	☐	☐	☐	☐	☐	☐	☐
(d) 3 days after the estimated delivery time	☐	☐	☐	☐	☐	☐	☐
(e) >3 days after the estimated delivery time	☐	☐	☐	☐	☐	☐	☐

H2) Please circle the appropriate entry

	Agree				*Disagree*
(a) The number of shipments missing their scheduled departures is insignificant.	1	2	3	4	5
(b) Your organization's order cycle time is satisfactory and being managed effectively.	1	2	3	4	5
(c) Your organization's order-to-cash cycle time is satisfactory and being managed effectively.	1	2	3	4	5
(d) Your organization's labor costs for managing ocean shipments is satisfactory, and being managed effectively.	1	2	3	4	5
(e) Your organization's cost of communication for managing ocean shipments is satisfactory, and being managed effectively.	1	2	3	4	5
(f) Your organization's total cost of international ocean shipping is satisfactory and being managed effectively.	1	2	3	4	5
(g) The cost of expedited shipments is minimal.	1	2	3	4	5
(h) Your organization's internal/external customers are very satisfied with the delivery performance of international ocean shipments.	1	2	3	4	5
(i) Your organization provides rapid and accurate responses to internal/external customer queries in order status.	1	2	3	4	5
(j) Your organization is able to respond rapidly to special internal/external customer requests for changes to orders.	1	2	3	4	5

Thanks for your participation!

Would you like a copy of the Executive report? ☐ **Yes** ☐ **No**
Would you like your name entered in the prize drawing ☐ **Yes** ☐ **No**
Would you be willing to participate in a follow-up study? ☐ **Yes** ☐ **No**

If you would like a copy of the executive report or like your name entered in the prize drawing, please fill out your contact information below or attach a business card.

Company Name:		
Your Name:		
Your Title:		
Your Address:		
Telephone Number:	**Area Code:**	**Number:**
Fax Number:	**Area Code:**	**Number:**
E-Mail Address		

Appendix K

Two sample T-test for non-response bias: Comparison of responses of respondents and non-respondents across all variables.

		t-Test			Equality of Variance				Respondents			Non-respondents		
Construct	**Variable**	**DF**	**t Value**	**Pr > |t|**	**Num DF**	**Den DF**	**F Value**	**Pr > F**	**N**	**Mean**	**Std Dev**	**N**	**Mean**	**Std Dev**
On-Time Performance	SP_RC	100	0.49	0.6223	60	40	1.16	0.6278	61	5.452	1.9711	41	5.6433	1.8314
Shipping Performance	ShipPerf_6	100	-1.28	0.2021	40	60	1.09	0.7413	61	3.1148	1.4503	41	2.7317	1.517
	ShipPerf_7	100	-0.53	0.6007	60	40	1.13	0.6801	61	2.4754	1.0584	41	2.3659	0.9939
	ShipPerf_8	96	0.03	0.9734	59	37	1.11	0.7388	60	2.4667	1.0328	38	2.4737	0.9792
	ShipPerf_9	100	-0.93	0.3555	60	40	1.15	0.6422	61	2.1148	0.8963	41	1.9512	0.8352
	ShipPerf_10	99	-0.02	0.9835	40	59	1.05	0.8479	60	2.15	0.8601	41	2.1463	0.8821
	ShipPerf_11	99	0	0.997	40	59	1.14	0.6331	60	2.3667	1.041	41	2.3659	1.1126
	ShipPerf_12	97	0.45	0.6536	38	59	1.26	0.4129	60	2.7	1.2392	39	2.8205	1.3931
	ShipPerf_13	99	-0.82	0.4136	59	40	1.33	0.3449	60	2.5667	0.9632	41	2.4146	0.8359
	ShipPerf_14	100	-0.71	0.4776	60	40	1.46	0.2087	61	2.082	0.9712	41	1.9512	0.8047
	ShipPerf_15	98	-1.05	0.2958	59	39	1.36	0.3141	60	2.25	0.9851	40	2.05	0.8458
Task Variety	TaskVar_1	95	-1.01	0.3167	55	40	1.98	0.0249**	56	1.9464	1.0343	41	1.7561	0.7342
	Satterthwaite	94.9	-1.06	0.2919	Tests for Unequal Variances									
	Cochran	.	-1.06	0.2946										
	TaskVar_2	95	0.62	0.5374	40	55	1.12	0.6912	56	2.8393	1.2325	41	3	1.3038
	TaskVar_3	95	-0.6	0.5486	55	40	1.45	0.2171	56	2.5536	1.2048	41	2.4146	0.9994
Task Analyzability	TaskAnal_1	95	0.18	0.8579	55	40	1.01	0.9843	56	1.9107	1.1	41	1.9512	1.0943
	TaskAnal_2	95	1.26	0.2123	40	55	1.04	0.873	56	2.1964	1.1188	41	2.4878	1.1428
Task Interdependence	TaskInt	95	-1.36	0.1762	55	40	1.01	0.9934	56	3	1.221	41	2.6585	1.2168
Environmental Capacity	ExtEnv_1	93	1.2	0.2313	58	35	1.3	0.4128	59	1.9322	0.9625	36	2.1667	0.8452
Environmental Complexity	TEU_RC	94	0.16	0.8754	39	55	1.11	0.7027	56	3.8214	1.608	40	3.875	1.6975
	ExtEnv_2	100	-0.38	0.7049	59	41	1.53	0.1522	60	2.2167	1.043	42	2.1429	0.8431
	ExtEnv_3	87	0.02	0.9834	39	48	1.06	0.8382	49	2.4694	1.2433	40	2.475	1.2808
	ExtEnv_7	92	0.01	0.9945	53	39	1.18	0.5924	54	2.0741	0.6688	40	2.075	0.6155
	ExtEnv_8	84	-1.65	0.1037	48	36	1.63	0.13	49	2.449	0.9588	37	2.1351	0.7514
	ExtEnv_9	86	-1.46	0.1487	51	35	1.26	0.4732	52	2.5577	1.0178	36	2.25	0.9063
	ExtEnv_10	90	-0.27	0.7894	50	40	1.01	0.9942	51	2.0588	0.6136	41	2.0244	0.6119
Environmental Dynamism	ExtEnv_4	98	-0.16	0.875	59	39	1.25	0.4658	60	3.2333	1.0793	40	3.2	0.9661
	ExtEnv_5	98	0.22	0.8238	39	59	1.29	0.3663	60	3.3833	0.8654	40	3.425	0.9842
	ExtEnv_6	99	-0.3	0.768	59	40	1.12	0.7021	60	3.0333	1.4018	41	2.9512	1.322
External Integration	ExtInt_1	101	-1.32	0.1914	61	40	1.2	0.5381	62	2.9194	1.592	41	2.5122	1.4512
	ExtInt_2	102	-1.02	0.3109	61	41	1.11	0.7331	62	2.9032	1.544	42	2.5952	1.466
	ExtInt_3	101	1.83	0.07*	41	60	1.13	0.6672	61	2.8689	1.2971	42	3.3571	1.3761
	ExtInt_4	100	1.3	0.1961	60	40	1.01	0.9935	61	2.8033	1.4002	41	3.1707	1.3947
	ExtInt_5	99	-0.4	0.6915	58	41	1.2	0.5416	59	3.7627	1.5463	42	3.6429	1.4111
	ExtInt_6	100	-0.25	0.7993	59	41	1.19	0.567	60	3.8333	1.4399	42	3.7619	1.3217
	ExtInt_7	100	0.44	0.6635	59	41	1.19	0.5524	60	3.7333	1.4598	42	3.8571	1.3357
	ExtInt_8	100	-0.25	0.8017	59	41	1.03	0.9352	60	3.9	1.3238	42	3.8333	1.3051
	ExtInt_9	100	0.26	0.793	59	41	1.28	0.4095	60	3.8833	1.3666	42	3.9524	1.2088
	ExtInt_10	97	-0.13	0.9	59	38	1.37	0.3076	60	3.6	1.4637	39	3.5641	1.2523
	ExtInt_11	94	0.01	0.9889	57	37	1.18	0.6027	58	3.7069	1.2843	38	3.7105	1.1834
	ExtInt_12	96	0.31	0.7589	56	40	1.4	0.2606	57	3.5965	1.4621	41	3.6829	1.2337
	ExtInt_13	96	0.39	0.7	57	39	1.06	0.868	58	1.8793	0.8999	40	1.95	0.8756
Internal Integration	InternInt_1	86	-1.28	0.2047	50	36	1.99	0.0331**	51	1.8627	1.3118	37	1.5405	0.9308
	Satterthwaite	*86*	*-1.35*	*0.1813*	Tests for Unequal Variances									
	Cochran	.	*-1.35*	*0.1848*										
	InternInt_2	100	-0.85	0.3971	59	41	1.18	0.5797	60	2.7167	1.5955	42	2.4524	1.4684
	InternInt_3	99	-0.52	0.6071	58	41	1	1	59	2.4746	1.3564	42	2.3333	1.3555
	InternInt_4	99	-0.47	0.6392	58	41	1.21	0.5256	59	2.5085	1.3942	42	2.381	1.2678
Use of non-IOS	Sched lookup	100	0.51	0.6113	61	39	1.06	0.8552	62	3.9194	2.2565	40	4.15	2.1903
	Bkg Conf	100	0.19	0.8531	61	39	1.03	0.9461	62	4.3387	2.3043	40	4.425	2.2746
	B/L info rcpt	100	0.36	0.7186	39	61	1.06	0.8198	62	4.3065	2.2731	40	4.475	2.3423
	Track & Trace	100	0.59	0.5534	39	61	1.01	0.9625	62	4.0645	2.1567	40	4.325	2.1648
Use of EDI	Sched lookup	100	0.88	0.3796	39	61	1.15	0.621	62	1.7097	1.4416	40	1.975	1.544
	Bkg Conf	100	1.34	0.1823	39	61	1.5	0.1542	62	1.5806	1.409	40	2	1.7246
	B/L info rcpt	100	0.78	0.4374	39	61	1.3	0.3567	62	1.8065	1.6078	40	2.075	1.8312
	Track & Trace	100	-0.21	0.8361	61	39	1.19	0.573	62	1.9194	1.7015	40	1.85	1.5616
Use of Internet Portals	Sched lookup	100	1.83	0.0704	39	61	1.22	0.473	62	2.5	1.9397	40	3.25	2.1454
	Bkg Conf	100	0.48	0.6334	39	61	1	0.9697	62	2.0968	1.8351	40	2.275	1.8396
	B/L info rcpt	99	0.49	0.6285	38	61	1.1	0.7347	62	2.1452	1.8629	39	2.3333	1.9512
	Track & Trace	100	0.94	0.3483	39	61	1.18	0.5452	62	3.0323	2.1114	40	3.45	2.2977

Appendix L

Univariate statistics.

Construct	Measure	Mean	Median	Mode	Std Dev	Var	Skew	Kurt	Min	Max	Range
On-Time Performance	SP_RC	5.5154	5.45	7.575	1.91618	3.67	-0.156	-1.14	1.98	8.575	6.6
Shipping Performance	ShipPerf_6	2.9908	3	1	1.481337	2.19	-0.001	-1.41	1	5	4
	ShipPerf_7	2.4404	2	2	1.049084	1.1	0.3567	-0.53	1	5	4
	ShipPerf_8	2.4762	2	3	1.038631	1.08	0.3534	-0.28	1	5	4
	ShipPerf_9	2.0734	2	2	0.86823	0.75	0.5481	-0.26	1	4	3
	ShipPerf_10	2.1852	2	2	0.866275	0.75	0.4205	-0.38	1	4	3
	ShipPerf_11	2.3981	2	2	1.084641	1.18	0.6256	-0.21	1	5	4
	ShipPerf_12	2.781	3	2	1.315448	1.73	0.1824	-1.16	1	5	4
	ShipPerf_13	2.5185	2	2	0.90152	0.81	0.1776	-0.4	1	5	4
	ShipPerf_14	2.0367	2	2	0.891592	0.79	0.4863	-0.55	1	4	3
	ShipPerf_15	2.1495	2	2	0.929635	0.86	0.4134	-0.67	1	4	3
Task Variety	TaskVar_1	1.9135	2	1	0.935913	0.88	0.827	-0.16	1	4	3
	TaskVar_2	2.8365	3	4	1.270353	1.61	0.024	-1.09	1	5	4
	TaskVar_3	2.5577	2	2	1.147618	1.32	0.5829	-0.42	1	5	4
Task Analyzability	TaskAnal_1	1.9612	2	1	1.110753	1.23	0.822	-0.56	1	5	4
	TaskAnal_2	2.3558	2	1	1.156814	1.34	0.3786	-0.9	1	5	4
Task Interdependence	TaskInt	2.875	3	3	1.228208	1.51	0.1147	-0.88	1	5	4
Environmental Capacity	ExtEnv_1	2.0099	2	1	0.899945	0.81	0.4842	-0.25	1	5	4
Environmental Complexity	TEU_RC	3.8454	4	4	1.628779	2.65	-0.439	-0.94	1	6	5
	VALUE_RC	3.567	4	4	1.540476	2.37	-0.146	-1.03	1	6	5
	ExtEnv_2	2.2661	2	2	1.033174	1.07	0.7264	0.171	1	5	4
	ExtEnv_3	2.5106	2	1	1.284688	1.65	0.3956	-0.91	1	5	4
	ExtEnv_7	2.1313	2	2	0.751142	0.56	**2.1378**	**6.092**	1	5	4
	ExtEnv_8	2.3804	2	2	0.935765	0.88	1.22	1.222	1	5	4
	ExtEnv_9	2.4632	2	2	0.997982	1	1.3172	1.085	1	5	4
	ExtEnv_10	2.0918	2	2	0.689939	0.48	**2.5701**	**9.257**	1	5	4
Environmental Dynamism	ExtEnv_4	3.2243	3	3	1.039851	1.08	-0.003	-0.62	1	5	4
	ExtEnv_5	3.4112	3	3	0.910663	0.83	0.0778	-0.77	2	5	3
	ExtEnv_6	3.0093	3	2	1.343001	1.8	0.1951	-1.16	1	5	4
External Integration	ExtInt_1	2.8056	2	1	1.531344	2.35	0.2709	-1.42	1	5	4
	ExtInt_2	2.8426	2.5	1	1.523413	2.32	0.2065	-1.46	1	5	4
	ExtInt_4	2.9266	3	2	1.37912	1.9	0.1988	-1.17	1	5	4
	ExtInt_5	3.6667	4	5	1.503889	2.26	-0.705	-0.98	1	5	4
	ExtInt_6	3.789	4	5	1.361327	1.85	-0.797	-0.6	1	5	4
	ExtInt_7	3.7706	4	5	1.378627	1.9	-0.765	-0.71	1	5	4
	ExtInt_8	3.8796	4	5	1.287739	1.66	-0.842	-0.5	1	5	4
	ExtInt_9	3.9074	4	5	1.286428	1.65	-0.844	-0.48	1	5	4
	ExtInt_10	3.6	4	5	1.362972	1.86	-0.4	-1.17	1	5	4
	ExtInt_11	3.6667	4	5	1.245454	1.55	-0.405	-0.97	1	5	4
	ExtInt_12	3.6346	4	5	1.365722	1.87	-0.639	-0.78	1	5	4
	ExtInt_13	1.9208	2	2	0.879581	0.77	0.876	0.271	1	4	3
Internal Integration	InternInt_1	1.7556	1	1	1.173788	1.38	1.2594	0.347	1	5	4
	InternInt_2	2.6389	2	1	1.537435	2.36	0.4404	-1.31	1	5	4
	InternInt_3	2.4393	2	1	1.333017	1.78	0.5346	-0.94	1	5	4
	InternInt_4	2.4766	2	1	1.31999	1.74	0.5406	-0.86	1	5	4
Use of non-IOS	UNON_1	4.0367	4	1	2.21496	4.91	-0.073	-1.48	1	7	6
	UNON_2	4.2477	5	7	2.32202	5.39	-0.217	-1.49	1	7	6
	UNON_3	4.2569	5	7	2.307009	5.32	-0.196	-1.48	1	7	6
	UNON_4	4.1009	4	1	2.13847	4.57	-0.151	-1.32	1	7	6
Use of EDI	UEDI_1	1.7706	1	1	1.444229	2.09	1.7263	1.598	1	6	5
	UEDI_2	1.7431	1	1	1.53601	2.36	2.0828	3.307	1	7	6
	UEDI_3	1.9725	1	1	1.745145	3.05	1.7146	1.666	1	7	6
	UEDI_4	2.0092	1	1	1.771667	3.14	1.5837	1.188	1	7	6
Use of Internet Portals	UINT_1	2.8165	2	1	2.04199	4.17	0.5988	-1.25	1	7	6
	UINT_2	2.2018	1	1	1.849824	3.42	1.361	0.468	1	7	6
	UINT_3	2.25	1	1	1.904863	3.63	1.2952	0.26	1	7	6
	UINT_4	3.2385	3	1	2.176895	4.74	0.3184	-1.47	1	7	6

Appendix M

Graphical presentation of cases with missing data, sorted in descending order of missing data

ID	SPRC	SP6	SP7	SP8	SP9	SP10	SP11	SP12	SP13	SP14	SP15	TV1	TV2	TV3	TA1	TA2	TI	EE1	TEU	VALUE	EE2	EE3	EE7	EE8	EE9	EE10
101	M	M	M	M	M	M	M	M	M	M	M															
58												M	M	M	M	M	M				M		M	M	M	M
3	M	M	M	M	M	M	M	M	M	M	M															
75																										
27												M	M	M	M	M	M					M	M	M	M	M
32												M	M	M	M	M	M					M	M	M	M	M
46												M	M	M	M	M	M						M	M	M	M
14																						M				
42												M	M	M	M	M	M						M	M	M	M
44												M	M	M	M	M	M						M	M	M	M
63												M	M	M	M	M	M						M	M	M	M
504																			M	M				M		M
507								M							M				M	M		M				
23																		M				M				
53																			M	M		M				
503																			M	M			M			
505																		M	M	M		M				
506																			M	M						
8																						M				
30																								M	M	M
74											M							M				M				
79				M				M																		
94																							M	M	M	
99																		M	M	M						
2																			M	M						
10																						M	M	M	M	
25																		M						M	M	M
69								M										M								
501																			M	M			M			
6							M		M		M															
13																						M				
18																						M				M
37																			M	M		M				
43				M		M												M								
50																							M	M		M
59																			M	M	M					
68																		M	M	M						
21																										
24																								M	M	
29																						M				
41																			M	M						
45																								M		M
56																			M	M						
60																										
66																		M								
70				M																						
77																									M	
78																								M	M	
82				M																						
84																						M				
96																									M	
11																										
12																										
17																								M		
20								M																		
33																										
40																						M				
48																										
57																						M				
71																										
73																										
86																										
90																										
92																		M								
95																								M		
97																									M	
100																								M		
1	109	109	109	105	109	108	108	105	108	109	107	104	104	104	103	104	104	101	97	97	109	94	99	92	95	98

Figure: [CONTINUED]

ID	EE4	EE5	EE6	EI1	EI2	EI3	EI4	EI5	EI6	EI7	EI8	EI9	EI10	EI11	EI12	EI13	II1	II2	II3	II4	UNON1	UNON2	UNON3	UNON4	UEDI1	UEDI2	UEDI3	UEDI4	UINT1	UINT2	UINT3	UINT4	MissVal	%Miss'g
101																M	M				M	M	M	M	M	M	M	M	M	M	M	25	43.10%
58								M	M	M	M	M	M	M	M																	19	32.76%
3																	M	M	M	M													15	25.86%
75																					M	M	M	M	M	M	M	M	M	M	M	M	12	20.69%
27																																	11	18.97%
32																																	11	18.97%
46																	M																11	18.97%
14						M	M	M	M	M	M	M		M	M																		10	17.24%
42																																	10	17.24%
44																																	10	17.24%
63																																	10	17.24%
504															M	M	M	M	M	M													10	17.24%
507											M	M	M	M																			9	15.52%
23			M													M	M	M	M	M													8	13.79%
53	M	M											M	M	M																		8	13.79%
503				M	M											M	M																7	12.07%
505					M											M	M																7	12.07%
506				M	M											M	M																6	10.34%
8	M	M	M					M																									5	8.62%
30																			M	M													5	8.62%
74	M	M																															5	8.62%
79	M	M					M																										5	8.62%
94														M																	M		5	8.62%
99			M										M																				5	8.62%
2																M	M																4	6.90%
10																																	4	6.90%
25																																	4	6.90%
69				M										M																			4	6.90%
501																	M																4	6.90%
6																																	3	5.17%
13																M	M																3	5.17%
18																	M																3	5.17%
37																																	3	5.17%
43																																	3	5.17%
50																																	3	5.17%
59																																	3	5.17%
68																																	3	5.17%
21															M		M																2	3.45%
24																																	2	3.45%
29																	M																2	3.45%
41																																	2	3.45%
45																																	2	3.45%
56																																	2	3.45%
60														M	M																		2	3.45%
66														M																			2	3.45%
70													M																				2	3.45%
77														M																			2	3.45%
78																																	2	3.45%
82																M																	2	3.45%
84																	M																2	3.45%
96															M																		2	3.45%
11																	M																1	1.72%
12																	M																1	1.72%
17																																	1	1.72%
20																																	1	1.72%
33																M																	1	1.72%
40																																	1	1.72%
48																	M																1	1.72%
57																																	1	1.72%
71																	M																1	1.72%
73													M																				1	1.72%
86																	M																1	1.72%
90																	M																1	1.72%
92																																	1	1.72%
95																																	1	1.72%
97																																	1	1.72%
100																																	1	1.72%
1	107	107	108	108	108	110	109	108	109	109	108	108	105	102	104	101	90	108	107	107	109	109	109	109	109	109	109	109	109	109	108	109	317	

Appendix N

Assessing the randomness of missing data by the dichotomized variable correlations.

	SPRC	SP6	SP7	SP8	SP9	SP10	SP11	SP12	SP13	SP14	SP15	TV1	TV2	TV3	TA1	TA2	TI	EE1	TEU	VALUE	EE2	EE8	EE9	EE4	EE5	EE6
SPRC	**1**																									
SP6	**1**	**1**																								
SP7	**1**	**1**	**1**																							
SP8	**0.566658**	**0.566658**	**0.566658**	**1**																						
SP9	**1**	**1**	**1**	**0.566658**	**1**																					
SP10	**0.812743**	**0.812743**	**0.812743**	**0.697217**	**0.812743**	**1**																				
SP11	**0.812743**	**0.812743**	**0.812743**	**0.451531**	**0.812743**	**0.657407**	**1**																			
SP12	**0.566658**	**0.566658**	**0.566658**	**0.471429**	**0.566658**	**0.451531**	**0.451531**	**1**																		
SP13	**0.812743**	**0.812743**	**0.812743**	**0.451531**	**0.812743**	**0.657407**	**1**	**0.451531**	**1**																	
SP14	**1**	**1**	**1**	**0.566658**	**1**	**0.812743**	**0.812743**	**0.566658**	**0.812743**	**1**																
SP15	**0.70059**	**0.70059**	**0.70059**	0.381305	**0.70059**	**0.56393**	**0.862007**	0.381305	**0.862007**	**0.70059**	**1**															
TV1	-0.03514	-0.03514	-0.03514	-0.06202	-0.03514	-0.04324	-0.04324	-0.06202	-0.04324	-0.03514	-0.05016	**1**														
TV2	-0.03514	-0.03514	-0.03514	-0.06202	-0.03514	-0.04324	-0.04324	-0.06202	-0.04324	-0.03514	-0.05016	**1**	**1**													
TV3	-0.03514	-0.03514	-0.03514	-0.06202	-0.03514	-0.04324	-0.04324	-0.06202	-0.04324	-0.03514	-0.05016	**1**	**1**	**1**												
TA1	-0.03775	-0.03775	-0.03775	-0.06662	-0.03775	-0.04645	-0.04645	0.087439	-0.04645	-0.03775	-0.05388	**0.930906**	**0.930906**	**0.930906**	**1**											
TA2	-0.03514	-0.03514	-0.03514	-0.06202	-0.03514	-0.04324	-0.04324	-0.06202	-0.04324	-0.03514	-0.05016	**1**	**1**	**1**	**0.930906**	**1**										
TI	-0.03514	-0.03514	-0.03514	-0.06202	-0.03514	-0.04324	-0.04324	-0.06202	-0.04324	-0.03514	-0.05016	**1**	**1**	**1**	**0.930906**	**1**	**1**									
EE1	-0.04262	-0.04262	-0.04262	0.063935	-0.04262	0.141596	-0.05244	0.063935	-0.05244	-0.04262	0.107988	-0.08163	-0.08163	-0.08163	-0.08769	-0.08163	-0.08163	**1**								
TEU	-0.05146	-0.05146	-0.05146	-0.09082	-0.05146	-0.06332	-0.06332	0.029191	-0.06332	-0.05146	-0.07345	-0.09856	-0.09856	-0.09856	-0.00095	-0.09856	-0.09856	0.164796	**1**							
VALUE	-0.05146	-0.05146	-0.05146	-0.09082	-0.05146	-0.06332	-0.06332	0.029191	-0.06332	-0.05146	-0.07345	-0.09856	-0.09856	-0.09856	-0.00095	-0.09856	-0.09856	0.164796	**1**	**1**						
EE2	-0.01835	-0.01835	-0.01835	-0.03238	-0.01835	-0.02258	-0.02258	-0.03238	-0.02258	-0.01835	-0.02619	0.243488	0.243488	0.243488	0.224146	0.243488	0.243488	-0.04262	0.152546	0.152546	**1**					
EE8	-0.06156	-0.06156	-0.06156	-0.10863	-0.06156	-0.07574	-0.07574	-0.10863	-0.07574	-0.06156	-0.08787	**0.570886**	**0.570886**	**0.570886**	**0.52077**	**0.570886**	**0.570886**	-0.05946	-0.1006	-0.1006	0.118256	**1**				
EE9	-0.05559	-0.05559	-0.05559	-0.0981	-0.05559	-0.0684	-0.0684	-0.0981	-0.0684	-0.05559	-0.07935	**0.63217**	**0.63217**	**0.63217**	**0.579908**	**0.63217**	**0.63217**	-0.03955	-0.15591	-0.15591	0.137239	**0.698765**	**1**			
EE4	-0.02619	-0.02619	-0.02619	0.167543	-0.02619	-0.03222	-0.03222	0.167543	-0.03222	-0.02619	0.221963	-0.05016	-0.05016	-0.05016	-0.05388	-0.05016	-0.05016	0.107988	0.072142	0.072142	-0.02619	-0.08787	-0.07935	**1**		
EE5	-0.02619	-0.02619	-0.02619	0.167543	-0.02619	-0.03222	-0.03222	0.167543	-0.03222	-0.02619	0.221963	-0.05016	-0.05016	-0.05016	-0.05388	-0.05016	-0.05016	0.107988	0.072142	0.072142	-0.02619	-0.08787	-0.07935	**1**	**1**	
EE6	-0.02258	-0.02258	-0.02258	-0.03984	-0.02258	-0.02778	-0.02778	-0.03984	-0.02778	-0.02258	-0.03222	-0.04324	-0.04324	-0.04324	-0.04645	-0.04324	-0.04324	0.335636	0.104022	0.104022	-0.02258	-0.07574	-0.0684	0.265853	0.265853	**1**
EI1	-0.02258	-0.02258	-0.02258	-0.03984	-0.02258	-0.02778	-0.02778	0.205845	-0.02778	-0.02258	-0.03222	-0.04324	-0.04324	-0.04324	-0.04645	-0.04324	-0.04324	0.141596	0.271363	0.271363	-0.02258	-0.07574	-0.0684	-0.03222	-0.03222	-0.02778
EI2	-0.02258	-0.02258	-0.02258	-0.03984	-0.02258	-0.02778	-0.02778	-0.03984	-0.02778	-0.02258	-0.03222	-0.04324	-0.04324	-0.04324	-0.04645	-0.04324	-0.04324	0.141596	**0.438703**	**0.438703**	-0.02258	-0.07574	-0.0684	-0.03222	-0.03222	-0.02778
EI4	-0.01835	-0.01835	-0.01835	0.267139	-0.01835	-0.02258	-0.02258	0.267139	-0.02258	-0.01835	-0.02619	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	0.3372	0.3372	-0.02258
EI5	-0.02258	-0.02258	-0.02258	-0.03984	-0.02258	-0.02778	-0.02778	-0.03984	-0.02778	-0.02258	-0.03222	0.185312	0.185312	0.185312	0.168377	0.185312	0.185312	-0.05244	-0.06332	-0.06332	0.395083	0.071755	0.089773	0.265853	0.265853	0.314815
EI6	-0.01835	-0.01835	-0.01835	-0.03238	-0.01835	-0.02258	-0.02258	-0.03238	-0.02258	-0.01835	-0.02619	0.243488	0.243488	0.243488	0.224146	0.243488	0.243488	-0.04262	-0.05146	-0.05146	**0.490826**	0.118256	0.137239	-0.02619	-0.02619	-0.02258
EI7	-0.01835	-0.01835	-0.01835	-0.03238	-0.01835	-0.02258	-0.02258	-0.03238	-0.02258	-0.01835	-0.02619	0.243488	0.243488	0.243488	0.224146	0.243488	0.243488	-0.04262	-0.05146	-0.05146	**0.490826**	0.118256	0.137239	-0.02619	-0.02619	-0.02258
EI8	-0.02258	-0.02258	-0.02258	-0.03984	-0.02258	-0.02778	-0.02778	0.205845	-0.02778	-0.02258	-0.03222	0.185312	0.185312	0.185312	0.383203	0.185312	0.185312	-0.05244	0.104022	0.104022	0.395083	0.071755	0.089773	-0.03222	-0.03222	-0.02778
EI9	-0.02258	-0.02258	-0.02258	-0.03984	-0.02258	-0.02778	-0.02778	0.205845	-0.02778	-0.02258	-0.03222	0.185312	0.185312	0.185312	0.383203	0.185312	0.185312	-0.05244	0.104022	0.104022	0.395083	0.071755	0.089773	-0.03222	-0.03222	-0.02778
EI10	-0.03238	-0.03238	-0.03238	0.119048	-0.03238	-0.03984	-0.03984	0.119048	-0.03984	-0.03238	-0.04622	0.101886	0.101886	0.101886	0.241499	0.101886	0.101886	0.063935	0.269203	0.269203	0.267139	-0.00286	0.015328	0.167543	0.167543	0.205845
EI11	-0.04024	-0.04024	-0.04024	-0.07101	-0.04024	-0.04951	-0.04951	0.220911	-0.04951	-0.04024	-0.05743	0.058716	0.058716	0.058716	0.172467	0.058716	0.058716	0.137086	0.085981	0.085981	0.20789	0.04026	0.16	0.119651	0.119651	-0.04951
EI12	-0.03514	-0.03514	-0.03514	-0.06202	-0.03514	-0.04324	-0.04324	-0.06202	-0.04324	-0.03514	-0.05016	0.085165	0.085165	0.085165	0.071012	0.085165	0.085165	-0.08163	0.124711	0.124711	0.243488	0.078896	0.10457	0.148693	0.148693	-0.04324
EI13	0.193933	0.193933	0.193933	0.203088	0.193933	0.141596	0.141596	0.063935	0.141596	0.193933	0.107988	-0.08163	-0.08163	-0.08163	-0.08769	-0.08163	-0.08163	0.120792	0.354354	0.354354	-0.04262	-0.05946	-0.12913	-0.06084	-0.06084	0.141596
II1	0.280423	0.280423	0.280423	0.087977	0.280423	0.203186	0.203186	0.087977	0.203186	0.280423	0.153436	-0.03069	-0.03069	-0.03069	-0.04568	-0.03069	-0.03069	0.008685	0.2322	0.2322	-0.06543	-0.09738	-0.13275	-0.0934	-0.0934	0.061339
II2	0.395083	0.395083	0.395083	0.205845	0.395083	0.314815	0.314815	0.205845	0.314815	0.395083	0.265853	-0.04324	-0.04324	-0.04324	-0.04645	-0.04324	-0.04324	0.141596	0.104022	0.104022	-0.02258	0.071755	-0.0684	-0.03222	-0.03222	0.314815
II3	0.3372	0.3372	0.3372	0.167543	0.3372	0.265853	0.265853	0.167543	0.265853	0.3372	0.221963	-0.05016	-0.05016	-0.05016	-0.05388	-0.05016	-0.05016	0.107988	0.072142	0.072142	-0.02619	0.168795	0.058271	-0.03738	-0.03738	0.265853
II4	0.3372	0.3372	0.3372	0.167543	0.3372	0.265853	0.265853	0.167543	0.265853	0.3372	0.221963	-0.05016	-0.05016	-0.05016	-0.05388	-0.05016	-0.05016	0.107988	0.072142	0.072142	-0.02619	0.168795	0.058271	-0.03738	-0.03738	0.265853
UNON1	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UNON2	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UNON3	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UNON4	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UEDI1	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UEDI2	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UEDI3	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UEDI4	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UINT1	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UINT2	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258
UINT3	0.395083	0.395083	0.395083	0.205845	0.395083	0.314815	0.314815	0.205845	0.314815	0.395083	0.265853	-0.04324	-0.04324	-0.04324	-0.04645	-0.04324	-0.04324	-0.05244	-0.06332	-0.06332	-0.02258	0.071755	0.089773	-0.03222	-0.03222	-0.02778
UINT4	**0.490826**	**0.490826**	**0.490826**	0.267139	**0.490826**	0.395083	0.395083	0.267139	0.395083	**0.490826**	0.3372	-0.03514	-0.03514	-0.03514	-0.03775	-0.03514	-0.03514	-0.04262	-0.05146	-0.05146	-0.01835	-0.06156	-0.05559	-0.02619	-0.02619	-0.02258

Table: [CONTINUED]

	EI1	EI2	EI4	EI5	EI6	EI7	EI8	EI9	EI10	EI11	EI12	EI13	II1	II2	II3	II4	UNON1	UNON2	UNON3	UNON4	UEDI1	UEDI2	UEDI3	UEDI4	UINT1	UINT2	UINT3	UINT4
SPRC																												
SP6																												
SP7																												
SP8																												
SP9																												
SP10																												
SP11																												
SP12																												
SP13																												
SP14																												
SP15																												
TV1																												
TV2																												
TV3																												
TA1																												
TA2																												
TI																												
EE1																												
TEU																												
VALUE																												
EE2																												
EE8																												
EE9																												
EE4																												
EE5																												
EE6																												
EI1	**1**																											
EI2	**0.657407**	**1**																										
EI4	-0.02258	-0.02258	**1**																									
EI5	-0.02778	-0.02778	0.395083	**1**																								
EI6	-0.02258	-0.02258	**0.490826**	**0.812743**	**1**																							
EI7	-0.02258	-0.02258	**0.490826**	**0.812743**	**1**	**1**																						
EI8	-0.02778	-0.02778	0.395083	**0.657407**	**0.812743**	**0.812743**	**1**																					
EI9	-0.02778	-0.02778	0.395083	**0.657407**	**0.812743**	**0.812743**	**1**	**1**																				
EI10	-0.03984	-0.03984	-0.03238	0.205845	0.267139	0.267139	**0.451531**	**0.451531**	**1**																			
EI11	0.154023	-0.04951	0.20789	0.357553	**0.456017**	**0.456017**	**0.561084**	**0.561084**	0.36687	**1**																		
EI12	-0.04324	-0.04324	0.243488	**0.413864**	**0.522119**	**0.522119**	**0.413864**	**0.413864**	0.265789	**0.466056**	**1**																	
EI13	0.335636	**0.529675**	-0.04262	-0.05244	-0.04262	-0.04262	-0.05244	-0.05244	-0.07522	-0.09347	0.047814	**1**																
II1	0.203186	0.345033	-0.06543	-0.08051	-0.06543	-0.06543	-0.08051	-0.08051	-0.11547	-0.14349	0.063939	**0.490725**	**1**															
II2	-0.02778	-0.02778	-0.02258	-0.02778	-0.02258	-0.02258	-0.02778	-0.02778	-0.03984	-0.04951	0.185312	0.335636	0.345033	**1**														
II3	-0.03222	-0.03222	-0.02619	-0.03222	-0.02619	-0.02619	-0.03222	-0.03222	-0.04622	-0.05743	0.148693	0.276814	0.276851	**0.862007**	**1**													
II4	-0.03222	-0.03222	-0.02619	-0.03222	-0.02619	-0.02619	-0.03222	-0.03222	-0.04622	-0.05743	0.148693	0.276814	0.276851	**0.862007**	**1**	**1**												
UNON1	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**											
UNON2	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**										
UNON3	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**									
UNON4	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**	**1**								
UEDI1	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**	**1**	**1**							
UEDI2	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**	**1**	**1**	**1**						
UEDI3	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**	**1**	**1**	**1**	**1**					
UEDI4	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**				
UINT1	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**			
UINT2	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**		
UINT3	-0.02778	-0.02778	-0.02258	-0.02778	-0.02258	-0.02258	-0.02778	-0.02778	-0.03984	0.154023	-0.04324	0.141596	0.061339	-0.02778	-0.03222	-0.03222	**0.812743**	**0.812743**	**0.812743**	**0.812743**	**0.812743**	**0.812743**	**0.812743**	**0.812743**	**0.812743**	**0.812743**	**1**	
UINT4	-0.02258	-0.02258	-0.01835	-0.02258	-0.01835	-0.01835	-0.02258	-0.02258	-0.03238	-0.04024	-0.03514	0.193933	0.107495	-0.02258	-0.02619	-0.02619	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**0.812743**	**1**

Appendix O

Cluster analysis diagnostics.

Figure O-1: Diagnostics for the *Schedule Lookup* transaction

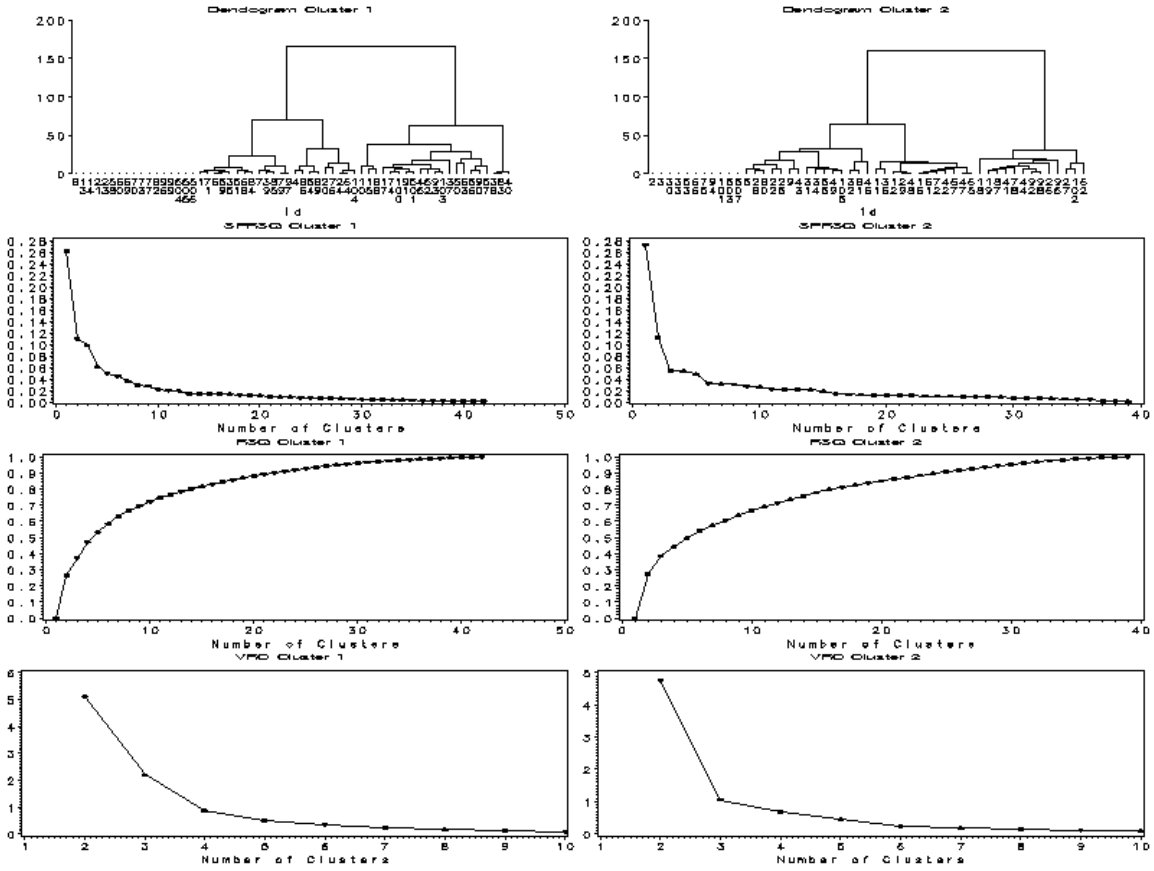


Figure O-2: Diagnostics for the *Booking Confirmation* transaction

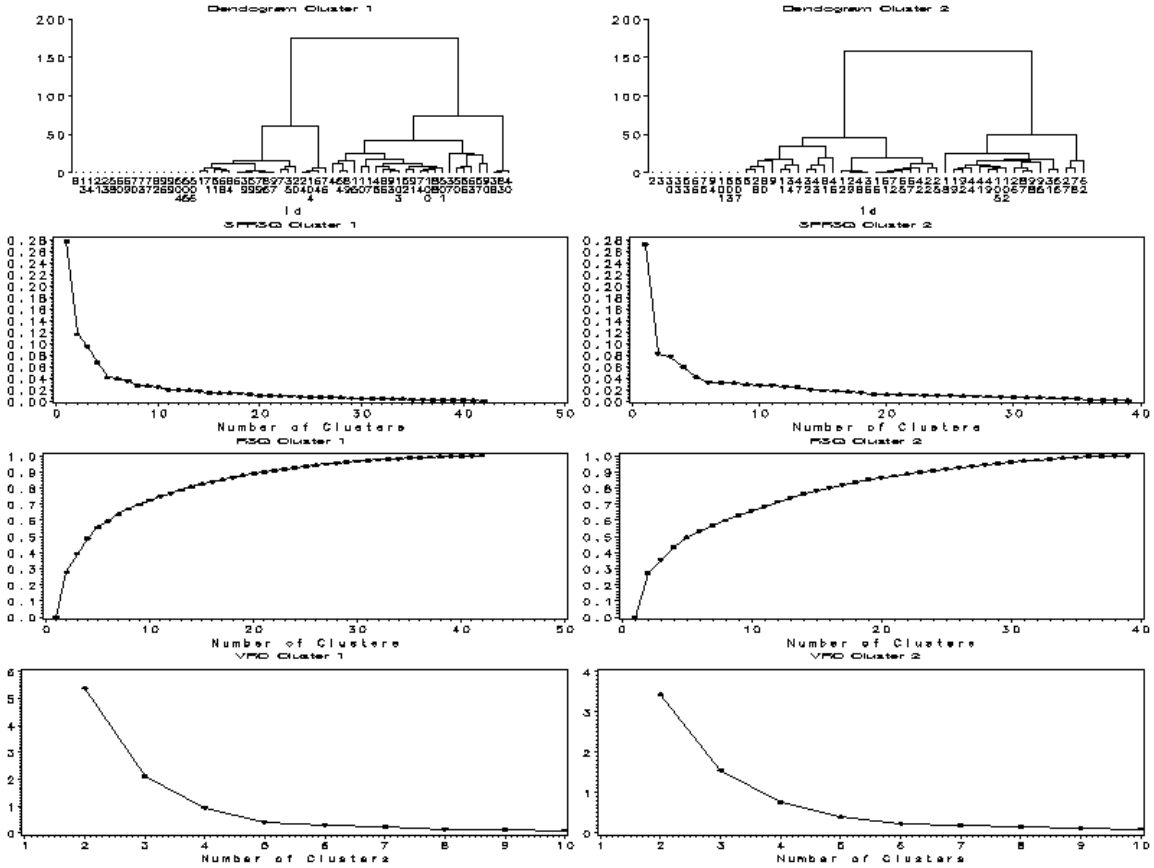


Figure O-3: Cluster analysis diagnostics for the *B/L Information Receipt* transaction

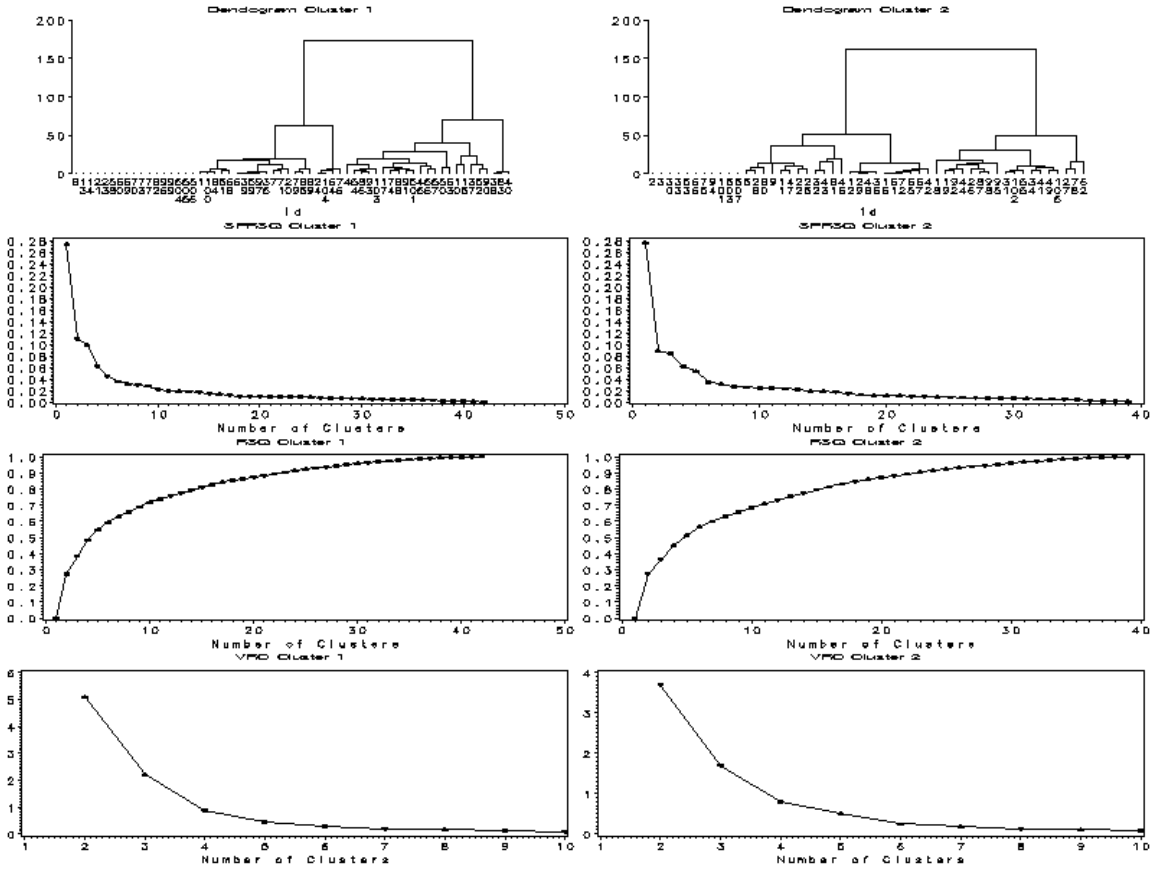
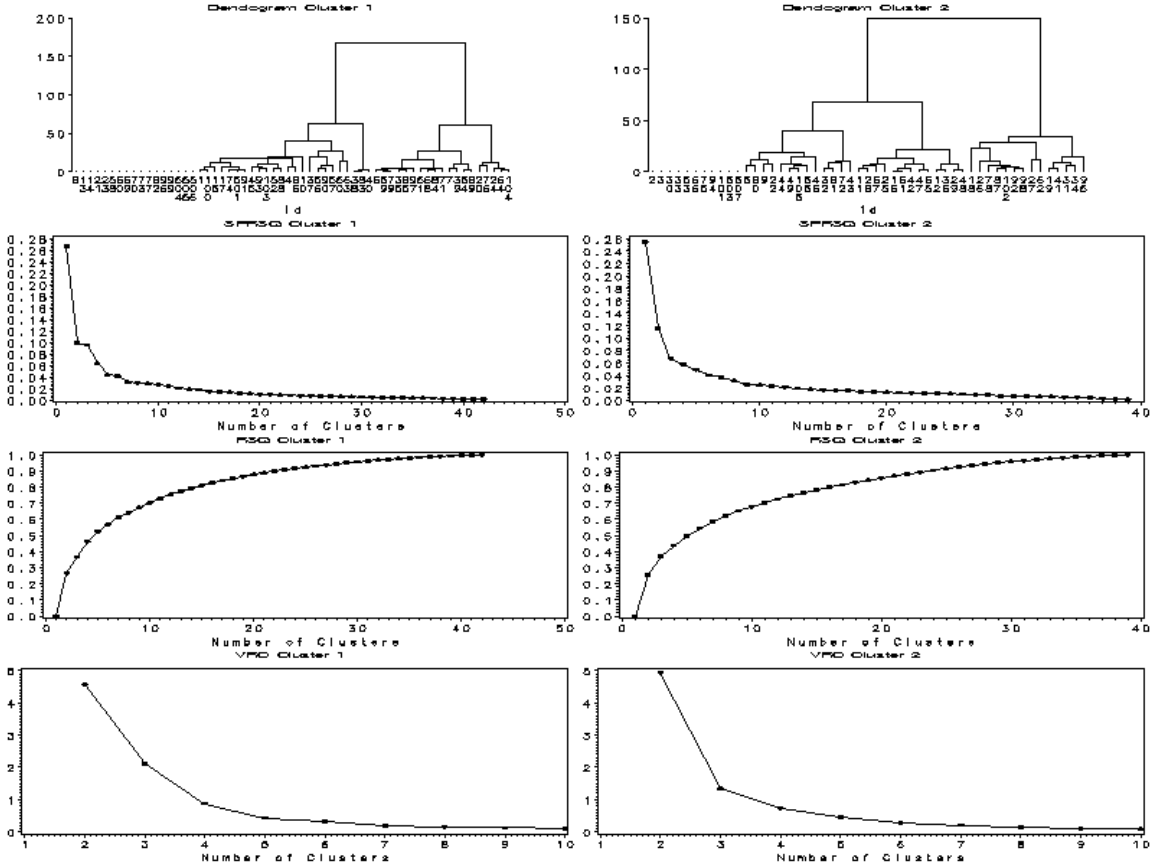


Figure O-4: Cluster analysis diagnostics for the *Track and Trace* transaction



References

Agresti, Alan. (2002). Categorical data analysis, (2nd ed.). New York, NY: Wiley.

Allen, David K.; Colligan, David; Finnie, Andrew and Kern, Thomas (2000). Trust, power, and inter-organizational information systems: the case of the electronic trading community TransLease. Information Systems Journal. **10** (1), pp. 21-40.

Angeles, Rebecca; Nath, Ravinder, and Hendon, Donald W. (1998). An Empirical Investigation of the Level of Electronic Data Interchange (EDI) Implementation and its Ability to Predict System Success Measures and EDI Implementation Factors. International Journal of Physical Distribution & Logistics. **28** (9/10); pp. 773-793.

Anonymous (November 30, 2002a). United States: Dock Around the Clock; the End of the Port Strike. The Economist. **365** (8301), p. 46.

Anonymous, (March 21, 2002b). Real Savings to be Made in E-Commerce. Lloyds List. p. 2. Lexis Nexis Academic Universe On-Line, last accessed 2/16/2004.

Anonymous, (February 6, 2001a). Data Flows Hold the Key to Coordinated Supply Chain. Lloyds List. p. 8. Lexis Nexis Academic Universe On-Line, last accessed 2/16/2004.

Anonymous, (April 28, 2001b). Long-Term Relationships Untouched by Technology. Lloyds List. p. 7. Lexis Nexis Academic Universe On-Line, last accessed 2/16/2004.

Auramo, Jaana; Aminoff, Anna, and Punakivi, Mikko (2002). Research Agenda for E-Business Logistics Based on Professional Opinions. International Journal of Physical Distributional and Logistics Management. **32** (7), pp. 513-531.

Avery, Simon (October 7, 2002). Stakes Grow Higher as Port Strike Continues; Plants are Shutting Down; Farm Exports are Piling Up. St Louis Post – Dispatch. p. A1.

Bagozzi, Richard P., and Baumgartner, Hans (1994). The Evaluation of Structural Equation Models and Hypothesis Testing, in: Richard P. Bagozzi (ed.), Principles of Marketing Research. Cambridge, MA: Blackwell Publishers, pp. 386-422.

Bailey, James E., and Pearson, Sammy W. (May, 1983). Development of a Tool for Measuring and Analyzing Computer User Satisfaction. Management Science. **29** (5), pp. 530-545.

Bakos, Yannis J. (Fall, 1991). Information Links and Electronic Marketplaces: The Role of Inter-organizational Information Systems in Vertical Markets. Journal of Management Information Systems. **8** (2), pp. 31-52.

Baldiwala, Quraish (2001). Developing a Global Supply Chain. Logistics Spectrum. **35** (4), pp. 25 (5)

Ballou, Ronald H.; Gilbert, Stephen M., and Mukherjee, Ashok (January, 2000). New Managerial Challenges from Supply Chain Opportunities. Industrial Marketing Mnagement. **29** (1), pp. 7-18.

Barrett, Stephanie, and Konsynski, Benn (1982). Inter-Organization Information Sharing Systems. MIS Quarterly. **6** (Special Issue), pp. 93-105.

Beamon, Benita (1998). Supply Chain Design and Analysis: Models and Methods. International Journal of Production Economics. **55** (3), pp. 281-294.

Bensaou, M., and Venkatraman N. (1995). Configurations of Inter-organizational Relationships: A Comparison Between U.S. and Japanese Automakers. Management Science. **41** (9), pp. 1471-1492.

Bensaou, M., and Venkatraman, N. (June, 1996). Inter-Organizational Relationships and Information Technology: A Conceptual Synthesis and a Research Framework. European Journal of Information Systems. **5** (2), pp. 84-91.

Bovet, David, and Sheffi, Yossi (2001). The Brave New World of Supply Chain Management. The Supply Chain Yearbook. John A. Woods and Edward J. Marien (eds.), pp. 3-16.

Bowersox, Donald J., and Daugherty, Patricia J. (1995). Logistics Paradigms: The Impact of Information Technology. Journal of Business Logistics. **16** (1), pp. 65-80.

Boyson, Sandor; Corsi, Thomas, and Verbraeck, Alexander (2003). The E-Supply Chain Portal: A Core Business Model. Transportation Research Part E. **39** (2), pp. 175-192.

Brewer, Peter C., and Speh, Thomas W. (2000). Using the Balanced Scorecard to Measure Supply Chain Performance. Journal of Business Logistics. **21** (1), pp. 75-93.

Brooks, Mary R. (1998). Performance Evaluation in the North American Transport Industry: Users' Views. Transport Reviews, **18** (1), pp. 1-16.

Brooks, Mary R. (2000). Performance Evaluation of Carriers by North American Companies. Transport Reviews, **20** (2), pp. 205-218.

BTS – Bureau of Transportation Statistics (2000). Transportation Statistics Annual Report 2000 – p. 160 U.S. Foreign Waterborne Trade by Value: 1988-1999.. BTS, USDOT

BTS – Bureau of Transportation Statistics (2003a). U.S. International Trade and Freight Transportation Trends – Table 7: Value and Weight of U.S. International Merchandise Trade by Mode of Transportation: 1997 and 2001. BTS, USDOT: Washington. Accessed on-line at http://www.bts.gov/publications/us_international_trade_and_freight_transportation_trends/2003/pdf/entire.pdf, on 1/14/2006.

BTS – Bureau of Transportation Statistics (2003b). U.S. International Trade and Freight Transportation Trends – Table 12: U.S. Containerized Exports and Imports by Coastal Port Regions, 2001. BTS, USDOT: Washington. Accessed on-line at http://www.bts.gov/publications/us_international_trade_and_freight_transportation_trends/2003/pdf/entire.pdf, on 1/14/2006.

Caliński, T., and Harabasz, J. (1974). A Dendrite Method for Cluster Analysis. Communications in Statistics. **3** (1), pp.1-27.

Caplice, Chris, and Sheffi, Yossi (1994). A Review and Evaluation of Logistics Metrics. International Journal of Logistics Management. **5** (2), pp. 11-28.

Carr, Nicholas G. (May, 2003). IT Doesn't Matter. Harvard Business Review. **81** (5), pp. 5-12.

Cash, James I. Jr. & Konsynski, Benn R. (March-April, 1985). IS Redraws Competitive Boundaries. Harvard Business Review. **63** (2), pp. 134-142.

Cash, James I. Jr., and Konsynski, Benn R. (March-April, 1995). Electronic Links can Enlarge a Company's Strategic Options, but they can also Ensnare the Unwary. Harvard Business Review. **73** (2), pp. 134-142.

Chen, I.J., and Paulraj, A. (2004). Understanding Supply Chain Management: Critical Research and a Theoretical Framework. International Journal of Production Research. **42** (1), pp. 131-163.

Chopra, Sunil & Meindl, Peter (2001). Supply Chain Management: Strategy, Planning and Operation. Upper Saddle River, NJ: Prentice Hall.

Chow, Garland; Heaver, Trevor D., and Henriksson, Lennart E. (1994). Logistics Performance Definition and Measurement. International Journal of Physical Distribution & Logistics. **24** (1); pp. 17-28.

Chow, Garland; Heaver, Trevor D., and Henriksson, Lennart E. (December, 1995). Strategy, Structure and Performance: A Framework for Logistics Research. Logistics and Trannsportation Review. **31** (4), pp. 285-308.

Christopher, Martin, and Towill, Denis R. (2002). Developing Market Specific Supply Chain Strategies. International Journal of Logistics Management. **13** (1), pp. 1-14.

Clemons, Eric K.; Reddi, Sashidhar P., and Row, Michael C. (Fall, 1993). The Impact of Information Technology on the Organization of Economic Activity: The "Move to the Middle" Hypothesis. Journal of Management Information Systems. **10** (2), pp. 9-35.

Clott, Christopher B. (Winter, 2000). Ocean Freight Intermediaries: An Analysis of Non-Vessel Operating Common Carriers (NVOCC's) and Maritime Reform. Transportation Journal. **40** (2), pp. 17-26.

Coia, Anthony ((June 7, 2001). Multi-Carrier Internet Portals Simplify Shipping Process. Purchasing. pp. 47-48

Cooper, Martha C.; Lambert, Douglas M., and Pagh, Janus D. (1997). Supply Chain Management: More than a New Name for Logistics. International Journal of Logistics Management. **9** (2), pp. 1-18.

Corsi, Thomas M., (2003). Real-Time E-Supply Chain Management: Diffusion of New Technologies and Business Practices (Editorial). Transportation Research Part E. **39** (2), pp. 79-82.

CSCMP – Council of Supply Chain Management Professionals (2004). Glossary of Terms. Web-site http://cscmp.org/Downloads/Resources/glossary03.pdf, last accessed 1/14/2006.

Coyle, John; Bardi, Edward J., and and Novack, Robert A. (2000). Transportation, (5th ed.). St. Paul, MN: West Publishing Company.

Crainer, Stuart (1997). The Ultimate Book of Business Quotes. Oxford: Capstone Publishing Ltd..

Croxton, Keely L.; García-Dastugue, Sebastián J.; Lambert Douglas M., and Rogers, Dale S. (2001). The Supply Chain Management Processes. International Journal of Logistics Management. **12** (2), pp. 13-36.

Daugherty, Patricia J; Ellinger, Alexander E. and Rogers, Dale S. (1994). Information Accessibility: Customer Responsiveness and Enhanced Performance. International Journal of Physical Distribution and Logistics Management. **25** (1), pp. 4-17.

Daugherty, Patricia J; Ellinger, Alexander E., and Rogers, Dale S. (1995). Information Accessibility: Customer Responsiveness and Enhanced Performance. International Journal of Physical Distribution and Logistics Management. **25** (1), pp. 4-17.

DeLone, William H., and McLean, Ephraim R. (March, 1992). Information Systems Success: The Quest for the Dependent Variable. Information Systems Research. **3** (1), pp. 60-95.

Donaldson, Lex (2001). The Contingency Theory of Organizations. Thousand Oaks, CA: Sage Publications.

Edwards, Peter; Peters, Melvyn, and Sharman, Graham (2001). The Effectiveness of Information Systems in Supporting the Extended Supply Chain. Journal of Business Logistics. **22** (1), pp. 1-27.

Ellinger, Alexander E.; Daugherty, Patricia J., and Gustin, Craig M. (1997). The Relationship between Integrated Logistics and Customer Service. Transportation Research Part E. **33** (2), pp. 129-138.

Ellinger, Alexander E.; Lynch, Daniel F., and Hansen, John D. (April, 2003). Firm Size, Web Site, and Financial Performance in the Transportation Industry. Industrial Marketing Management. **32** (3), pp. 177-185.

Ellram, Lisa M.; Zsidisn, George A.; Siferd, Sue Perrott, and Stanly, Michael J. (Winter, 2002). The Impact of Purchasing and Supply Management Activities on Corporate Success. The Journal of Supply Chain Management. **38** (1), pp. 4-15.

Elmuti, Dean (Summer, 2002). The Perceived Impact of Supply Chain Management on Organizational Effectiveness. The Journal of Supply Chain Management. **38** (3), pp. 49-57.

Essig, Michael, and Arnold, Ulli (2001). Electronic Procurement in Supply Chain Management: Information Economics-Based Analysis of Electronic Markets. Journal of Supply Chain Management. **37** (4), pp. 43-49.

FMC – Federal Maritime Commission (September, 2001). The Impact of The Ocean Shipping Reform Act of 1998. http://www.fmc.gov/images/pages/OSRA_Study.pdf, last accessed 1/14/2006.

FMC – Federal Maritime Commission (2003). 41st Annual Report Fiscal Year 2002. www.fmc.gov/Dockets/Annual%20Report%20FY2002.pdf, last accessed 1/14/2006.

Fisher, M. L. (Mar-Apr, 1997). What is the Right Supply Chain for your Product? Harvard Business Review. **75** (2), pp. 105-116.

Forrester, Jay W. (July-August, 1958). Industrial Dynamics a Major Breakthrough for Decision Makers. Harvard Business Review. **36** (4), pp. 37-66.

Forster, Paul W., and Regan, Amelia C. (Summer 2001). Electronic Integration in the Air Cargo Industry: An Information Processing Model of On-Time Performance. Transportation Journal. **40** (4), pp. 46-61.

Frohlich, Markham T., and Westbrook, Roy (February, 2001). Arcs of Integration: An International Study of Supply Chain Strategies. Journal of Operations Management. **19** (2), pp. 185-200.

Frohlich, Markham T. (Fall, 2002). E-Integration in the Supply Chain: Barriers and Performance. Decision Sciences. **33** (4), pp. 537-556.

Galbraith, J. (1977). Organizational Design. Reading, MA: Addison Wesley.

Galbraith, Jay (1973). Designing Complex Organizations. Reading. MA: Addison-Wesley Publishing Company.

Ganeshan, Ram; Jack, Eric; Magazine, Michael J., and Stephens, Paul (1999). A Taxonomic Review of Supply Chain Management Research. In Sridhar Tayur, Ram Ganeshan, and Michael J. Magazine (eds.). Quantitative Models for Supply Chain Management (International Series in Operations Research & Management Science, 17). Boston: Kluwer Academic Publishers.

García-Dastugue, Sebastián J., and Lambert, Douglas M. (April, 2003). Internet-Enabled Coordination in the Supply Chain. Industrial Marketing Management. **32** (3), pp. 251-263.

Goldsby, Thomas J, and Eckert, James A. (April, 2003). Electronic Transportation Marketplaces: A Transaction Cost Perspective. IndustrialMarketign Management. **32** (3), pp. 187-198.

Golicic, Susan L., and Davis, Donna F. (2003). A Balanced Approach to Research in Logistics and Supply Chain Management. Proceedings of the Annual Confenerence of the Council of Logistics Management (2003).

Golicic, Susan L., Davis, Donna F., McCarthy, Teresa M., and Mentzer, John T. (2002). The impact of e-commerce on supply chain relationships. International Journal of Physical Distribution and Logistics Management. **32** (10), pp. 851-871.

Grover, Varun, and Malhotra, Manoj K. (July, 2003). Transaction Cost Framework in Operations and Supply Chain Management Research: Theory and Measurement. Journal of Operations Management. **21** (4), pp. 457-473.

Gunasekaran, A.; Patel C., and Tirtioglu, E. (2001). Performance Measures and Metrics in a Supply Chain Environment. Intenrational Journal of Operations and Production Management. **21** (1/2), pp. 71-87.

Gustin, Craig M.; Daugherty, Patricia J, and Stank, Theodore P. (1994). Computerization: Supporting Integration. International Journal of Physical Distribution and Logistics Management. **24** (1), pp. 11-16.

Gustin, Craig M.; Daugherty, Patricia J, and Stank, Theodore P. (1995). The Effect of Information Availability on Logistics Integration. Journal of Business Logistics. **16** (1), pp. 1-21.

Hair, J.F., & Black, W.C. (2000). Cluster Analysis. In Grimm, L.G & Yarnold, P.R. (Eds.), Reading and understanding more multivariate statistics. American Psychological Association, Washington, DC.

Hair, Joseph F.; Tatham, Ronald, L.; Anderson, Rolph E., and Black, William (1998). Multivariate Data Analysis,(5th ed.). Upper Saddle River, N.J. : Prentice Hall.

Harrison, A., and New, C. (March, 2002). The Role of Coherent Supply Chain Strategy and Performance Management in Achieving Competitive Advantage: An International Survey. Journal of the Operational Research Society. **53** (3), pp. 263-271.

Hausman, Warren H. (2003). Supply Chain Performance Metrics. In Terry P. Harrison, John J. Neale, Hau Leung Lee (eds.), The Practice of Supply Chain Management: Where Theory and Application Converge (International Series in Operations Research & Management Science). pp. 61-73. Boston, MA: Kluwer Academic Publishers.

Hewitt, Frederick (1999). Information Technology Mediated Business Process Management – Lessons from the Supply Chain. International Journal of Technology Management. **17** (1/2), pp. 37-53.

Hickey, Kathleen (December 18, 2000). Open Seas. Traffic World. **264** (12/13) p. 32.

Hobbs, Jill E. (1996). A Transaction Cost Approach to Supply Chain Management. Supply Chain Management. **1** (2), pp. 15-17.

Holland, Christopher P. (1995). Cooperative Supply Chain Management: The Impact of Inter-organizational Information Systems. Journal of Strategic Information Systems. **4** (2), pp. 117-133.

Humphreys, P.K.; Lai, M.K., and Sculli, D. (April, 2001). An Inter-Organizational Information System for Supply Chain Management. International Journal of Production Economics. **70** (3), pp. 245-255.

ITDS – International Trade Data System (2004). Import/Export Resources: General Import/Export Information, Bills of Lading and Air Waybills. International Trade Data System, Department of the Treasury: Washington D.C. Accessed on-line at http://www.itds.treas.gov/bills_lading.htm, on 1/14/2006.

Jayaram, Jayanth; Vickery, Shawnee K., and Droge, Cornelia (2000). The Effects of Information System Infrastructure and Process Improvements on Supply-Chain Time Performance. International Journal of Physical Distribution & Logistics Management. **30** (3/4), pp. 314-330.

Jeffery, Karl (June, 1999). Electronic commerce and container shipping. LLR Publications Ltd.: London

Johnston, H. R., and Vitale, M. R. (1988). Creating Competitive Advantage with Inter-organizational Information Systems. MIS Quarterly. **12** (2), pp. 153-165.

Kaplan, Robert S., and Norton, David P. (Jan/Feb96). Using the Balanced Scorecard as a Strategic Management System. Harvard Business Review. **74** (1), pp. 75 (11).

Kauffman, Robert J., and Walden, Eric A. (2001). Economics and Electronic Commerce: Survey and Directions for Research. International Journal of Electronic Commerce. **5** (4), pp. 5-116.

Kaufman, Felix (January-February, 1966). Data Systems that Cross Company Boundaries. Harvard Business Review. **44** (1), pp. 141 (11).

King, Elliot (1991). EDI Slowly Steps into the Limelight. Global Trade. **111** (11), pp. 19 (3).

Kleijnen, J.P.C., and Smits, M. (May, 2003). Performance Metrics in Supply Chain Management. Journal of the Operational Research Society. **54** (5), pp. 507-514.

Konsynski, Benn R., and McFarlan, F. Warren (September-October, 1990). Information Partnerships – Shared Data, Shared Scale. Harvard Business Review. **68** (5), pp. 114-120.

Kuhn, Thomas S. (1996). The Structure of Scientific Revolutions. Chicago, IL: University of Chicago Press.

Kwan, Albert Tan Wee (1999). The Use of Information Technology to Enhance Supply Chain Management in the Electronics and Chemical Industries. Production and Inventory Management Journal. **40** (3), pp. 7-14.

Lai, Kee-Hung; Ngai, E.W.T., and Cheng, T.C.E. (November, 2002). Measures for Evaluating Supply Chain Performance in Transport Logistics. Transportation Research Part E. **38** (6), pp. 439-456.

Lambert, Douglas M., and Harrington, Thomas C. (1990). Measuring Nonresponse Bias in Customer Service Mail Surveys. Journal of Business Logistics. **11** (2), pp. 5-25.

Lambert, Douglas M.; Cooper, Martha C., and Pagh, Janus D. (1998). Supply Chain Management: Implementation Issues and Research Opportunities. International Journal of Logistics Management. **9** (2), pp. 1-18.

Lambert, Douglas M., and Copper, Martha C. (2000). Issues in Supply Chain Management. Industrial Marketing Management. **29** (1), pp. 65-83.

Lambert, Douglas M., Pohlen, Terrance L. (2001). Supply Chain Metrics. International Journal of Logistics Management. **12** (1), pp. 1-19.

Lancioni, Richard A.; Smith, Michael F. & Schau, Hope Jensen (April, 2003). Strategic Internet Application Trends in Supply Chain Management. Industrial Marketing Management. **32** (3), pp. 211-217.

Lancioni, Richard A.; Smith, Michael F., and Oliva, Terence A. (January, 2000). The Role of the Internet in Supply Chain Management. Industrial Marketing Management. **29** (1), pp. 45-56.

Larson, Paul D., and Poist, Richard F. (Fall, 2004). Improving Response Rates to Mail Surveys: A Research Note. Transportation Journal. **43** (4), pp. 67-74.

Lee, Hau L., and Billington, Corey (Spring, 1992). Managing Supply Chain Inventory: Pitfalls and Opportunities. Sloan Management Review. **33**(3), pp. 65-73.

Lee, Hau L., and Whang, Seungjin (2000). Information Sharing in a Supply Chain. International Journal of Manufacturing Technology and Management. **1** (1), pp. 79-93.

Lee, Hau L. (Spring, 2002). Aligning Supply Chain Strategies with Product Uncertainties. California Management Review. **44** (3), pp. 105-119.

Lee, Ho Geun; Clark, Theodore, and Tam, Kar Yan (June, 1999). Research Report: Can EDI Benefit Adopters? Information Systems Research. **10** (2), pp. 186-195.

Lewis, Bruce R., and Byrd, Terry Anthony (2003). Development of a Measure for the Information Technology Infrastructure Construct. European Journal of Information Systems. **12** (2), pp. 93-109.

Lewis, Ira (2001). Logistics and Ecommerce: An Inter-organizational Systems Perspective. Transportation Journal. **40** (4), pp. 5-13.

Lewis, Ira, and Vellenga, David B (Summer, 2000) The Ocean Shipping Reform Act of 1998. Transportation Journal. **39** (4), pp. 27-34.

Malone, Thomas W.; Yates, JoAnn, and Benjamin, Robert I. (June, 1987). Electronic Markets and Electronic Hierarchies. Communications of the ACM. **30** (6), pp. 484-497.

Malone, Thomas W.; Yates, JoAnn, and Benjamin, Robert I. (May-June, 1989). The Logic of Electronic Markets. Harvard Business Review. **67** (3), pp. 166-169.

Mentzer, John T., and Kahn, Kenneth B. (1995). A Framework of Logistics Research. Journal of Business Logistics. **16** (1), pp. 231-250.

Mentzer, John T., and Flint, Daniel J. (1997). Validity in Logistics Research. Journall of Business Logistics. **18** (1), pp. 199-216.

Mentzer, John T.; DeWitt, William; Keebler, James S.; Min, Soonhong; Nix, Nancy W.; Smith, Carlo D., and Zacharia, Zach G. (2001). Defining Supply Chain Management. Journal of Business Logistics. **22** (2), pp. 1-25.

Moberg, Christopher R.; Cutler, Bob D.; Gross, Andrew, and Speh, Thomas W. (2002). Identifying Antecedents of Information Exchange Within Supply Chains. International Journal of Physical Distribution and Logistics Management. 32 (9), pp. 755-770.

Monczka, Robert; Trent, Robert and Handfield, Robert (2002). Purchasing and Supply Chain Management. (2nd ed.). South-Western: Cincinnati, OH.

Morash, Edward A., and Clinton, Steven R. (Spring, 1997). The Role of Transportation Capabilities in International Supply Chain Management. Transportation Journal. **36** (3), pp. 5-17.

Mukhopadhyay, Tridas; Kekre, Sunder, and Kalathur, Suresh (June, 1995). Business Value of Information Technology: A Study of Electronic Data Interchange. MIS Quarterly. **19** (2), pp. 137-156.

Murphy, Paul R., and Daley, James M. (1996). International Freight Forwarder Perspectives on Electronic Data Interchange and Information Management Issues. Journal of Business Logistics. **17** (1), pp. 63-84.

Murphy, Paul R., and Daley, James, M. (Summer, 2000). An Empirical Study of Internet Issues Among International Freight Forwarders. Transportation Journal. **39** (4), pp. 5-13.

Murphy, Paul R.; Poist, Richard F.; Lynagh, Peter M., and Grazer, William F. (April, 2003). An Analysis of Select Web Site Practices Among Supply Chain Participants. Industrial Marketing Management. **32** (3), pp. 243-250.

Narasimhan, Ram, and Jayaram, Jayanth (1998). Causal Linkages in Supply Chain Management: An Exploratory Study of North American Manufacturing Firms. Decision Sciences. **29** (3), pp. 579-605.

Narasimhan, Ram, and Kim, Soo Wook (2001). Information System Utilization Strategy for Supply Chain Integration. Journal of Business Logistics. **22** (2), pp. 51-75.

Novack, Robert A.; Rinehart, Lloyd M., and Langley, C. John Jr. (1994). An Internal Assessment of Logistics Value. Journal of Business Logistics. **15** (1), pp. 113-152.

Novack, Robert A.; Rinehart, Lloyd M., and Langley, C. John Jr. (1996). A Comparative Assessment of Senior Logistics Executives' Perceptions of Logistics Value. Journal of Business Logistics. **17** (1), pp. 135-178.

Otto, Andreas, and Kotzab, Herbert (2003). Does Supply Chain Management Really Pay? Six Perspectives to Measure the Performance of Managing a Supply Chain. European Journal of Operational Research. **144** (2), pp. 306-320.

Parker, John (May 28, 2001). What Shippers Want. Traffic World. **265** (22) p. 11

Patterson, Kirk A., Grimm, Curtis M., and Corsi, Thomas M. (March, 2003). Adopting New Technologies for Supply Chain Management. Transportation Research Part E. **39** (2), pp. 95-121.

Persson, G. (1982). Organisation Design Strategies for Business Logistics. International Journal of Phsyical Distribution and Materials Management. **8** (6), pp. 27-36.

Peruninger, John (May 26, 2003). The Case for Contract Automation. Journal of Commerce. p. 46

Pfohl, Hans Chrsitian, and Zöllner, Werner (1987). Organisation for Logistics: The Contingency Approach. International Journal of Physical Distribution & Materials Management. **17** (1), pp. 3-16.

Porter, Michael E., and Millar, Victor E. (July-August, 1985). How Information Gives You a Competitive Advantage. Harvard Business Review. **63** (4), pp. 149-160.

Premkumar, G. (Summer, 2000). Inter-organizational Systems and Supply Chain Management. Information Systems Management. **17** (2), pp. 56-69.

Premkumar, G., Ramamurthy, K., and Saunders, C.S. (Summer, 2005). Information Processing View of Organizations: An Exploratory Examination of Fit in the Context of Inter-organizational Relationships. Journal of Management Information Systems. **22** (1), pp. 257-294.

Presutti, William D. Jr. (April, 2003). Supply Management and E-Procurement: Creating Value Added in the Supply Chain. Industrial Marketing Management. **32** (3), pp. 219-226.

Rao, Kant, and Young, Richard R. (1994). Global Supply Chains: Factors Influencing Outsourcing of Logistics Functions. International Journal of Physical Distribution & Logistics. **24** (6), pp. **11** (9).

Reekers, N., and Smithson, S. (1996). The Role of EDI in Inter-Organizational Coordination in the European Automotive Industry. European Journal of Information Systems. **5** (2), pp. 120-130.

Rishel, Tracy D.; Scott, J. Phillip, and Stenger, Alan J. (Fall, 2003). A Preliminary Look at Using Satellite Communication for Collaboration in the Supply Chain. Transportation Journal. **42** (5), pp. 17-30.

Rogers, Dale S.; Daugherty, Patricia J., and Stank, Theodore P. (1992). Enhancing Service Responsiveness: The Strategic Potential of EDI. International Journal of Physical Distribution & Logistics. **22** (8); pp. 15-20.

Rutner, Stephen M.; Gibson, Brian J., and Williams, Susan R. (2003). The Impacts of the Integrated Logistics Systems on Electronic Commerce and Enterprise Resource Planning Systems. Transportation Research Part E. **39** (2), pp. 83-93.

Russell, Dawn M., and Saldanha, John P. (Summer, 2003). Five Tenets of Security-Aware Logistics and Supply Chain Operation. Transportation Journal. **42** (4), pp. 44-54.

Saccomano, Ann (March 3, 2003a). Inttra Moves into Procurement. The Journal of Commerce. p. 1.

Saccomano, Ann (July 7-13, 2003b). Tension. The Journal of Commerce. pp. 10-12.

Samwel, Emad (July 14-20, 2003a). C for Collaboration – or Control. The Journal of Commerce. p. 53.

Samwel, Emad (August 11, 2003b). The Cargo-Visibility Mirage. The Journal of Commerce. p. 38.

Samwel, Emad (October 20-26, 2003c). The Future of Carrier Portals. The Journal of Commerce. p. 17.

Sahin, Funda & Robinson, E. Powell (Fall, 2002). Flow Coordination and Information Sharing in Supply Chains. Decision Sciences. **33** (4), pp. 505-536.

Sanders, Nada R., and Premus, Robert (2005). Modeling the Relationship between Firm IT Capability, Collaboration, and Performance. **26** (1), pp. 1-23.

Sanders, Nada R., and Premus, Robert (2002). IT Applications in Supply Chain Organizations: A Link between Competitive Priorities and Organizational Benefits. Journal of Business Logistics. **23** (1), pp. 65-83.

Schwartz, Beth (June, 2000). Global Realities. Transportation & Distribution. **41** (6), p. 39.

Shah, Rachna; Goldstein, Susan Meyer, and Ward, Peter T. (August, 2002). Aligning Supply Chain Management Characteristics and Inter-organizational Information System Types: An Exploratory Study. IEEE Transactions on Engineering Management. **49** (3), pp. 282-292.

Shashikumar, N, and Schatz, G. L. (Fall, 2000). The Impact of U.S. Regulatory Changes on International Intermodal Movements. Transportation Journal. **40** (1) pp. 5-14.

Sheffi, Y. (2001). Supply Chain Management Under the Threat of International Terrorism. International Journal of Logistics Management. **12** (2), pp. 1-11.

Shore, Barry (2001). Information Sharing in Global Supply Chain Systems. Journal of Global Information Technology Management. **4** (3), pp. 27-50.

Skjøtt-Larsen, Tage; Kotzab, Herbert, and Grieger, Martin (April, 2003). Electronic Marketplaces and Supply Chain Relationships. Industrial Marketing Management. **32** (3), pp. 199-210.

Srinivasan, Kannan; Kekre, Sunder, and Mukhopadhyay, Tridas (October 1994). Impact of Electronic Data Interchange Technology on JIT Shipments. Management Science. **40** (10), pp. 1291-1304.

Stank, Theodore P.; Keller, Scott B., and Daugherty, Patricia J. (2001). Supply Chain Collaboration and Logistical Service Performance. Journal of Business Logistics. **22** (1), pp. 29-48.

Steenkamp, Jan-Benedict E.M., and van Trijp, Hans C.M. (1991). The use of LISREL in validating marketing constructs. International Journal of Research in Marketing. **8** (4), pp. 283-299.

Stefansson, Gunnar (2002). Business-to-Business Data Sharing: A Source for Integration of Supply Chains. International Journal of Production Economics. **75** (1/2), pp. 135-146.

Stefansson, Gunnar, and Tilanus, Bernhard (2000). Tracking and Tracing: Principles and Practice. International Journal of Technology Management. **20** (3/4), pp. 252-271.

Stock, James R. (1997). Applying Theories from other Disciplines to Logistics. International Journal of Physical Distribution & Logistics Management. **27** (9/10), p. 515.

Tan, Keah Choon (Winter, 2002). Supply Chain Management: Practices, Concerns and Performance Issues. The Journal of Supply Chain Management. **38** (1), pp. 42-53.

Teo, H.H.; Tan, B.C.Y; Wei, K.K., and Woo, L.Y. (March, 1995). Reaping EDI benefits through a pro-active approach. Information & Management. **28** (3), pp. 185-195.

Teo, Hock-Hai; Tan, Bernard C.Y., and Wei, Kwok-Kee (Spring, 1997). Organizational Transformation Using Electronic Data Interchange: The Case of TradeNet in Singapore. Journal of Management Information Systems. **13** (4), pp. 139-165.

Teo, Thompson S.H., and Pian, Yujun (2003). A Contingency Perspective on Internet Adoption and Competitive Advantage. European Journal of Information Systems. **12** (2), pp. 78-92.

Thomas, Douglas J., and Griffing, Paul M. (1996). Coordinated Supply Chain Management. European Journal of Operational Research. **94** (1), pp. 1-15.

Thorby, Chris (March, 2002). Standard Bearers. Containerisation International. pp. 63, 65.

Tracey, Michael (1998). The Importance of Logistics Efficiency to Customer Service and Firm Performance. The International Journal of Logistics Management. **9** (2), pp. 65-81.

Umanath, N.S. (2003). The Concept of Contingency Beyond "It Depends": Illustrations from IS Research Stream. Information & Management. **40** (6), pp. 551-562.

US Army Corps of Engineers (March, 2003). Waterborne Commerce of the United States, 1960-2001. (US Army Corps of Engineers: New Orleans, LA).

Vachon, Stephen, and Klassen, Robert D. (August, 2002). An Exploratory Investigation of the Effects of Supply Chain Complexity on Delivery Performance. IEEE Transactions on Engineering Management. **49** (3), pp. 218-230.

Vakharia, Asoo J. (Fall, 2002). E-Business and Supply Chain Management (Editorial). Decision Sciences. **33** (4), pp. 495-504.

Venkatraman, N. (July, 1989). The Concept of Fit in Strategy Research: Toward Verbal and Statistical Correspondence. Academy of Management Review. **14** (3), pp. 423-444.

Warner, Mark (November 1, 2002). End of Strikes Sounds Advance for Portals. Lloyds List. p. 6. Lexis Nexis Academic Universe On-Line, last accessed 2/16/2004.

Weiss, Joel A., and Dale, Bruce C. (July, 1998). Diffusing against Mature Technology: Issues and Strategy. Industrial Marketing Management. **27** (4), pp. 293-304.

Williams, Lisa R.; Magee, George D., and Suzuki, Yoshinori (1998). A Multidimensional View of EDI: Testing the Value of EDI Participation to Firms. Journal of Business Logistics. **19** (2), pp. 73-87.

Wisner, Joel, D. (2003). A Structural Equation Model of Supply Chain Management Strategies and Firm Performance. Journal of Business Logistics. **24** (1), pp. 1-25.

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Russell, Dawn, and Saldanha, J. (2003), "Five Tenets of Security-Aware Logistics and Supply Chain Operation," *Transportation Journal*, Volume 42, Number 4, pp. 44-54.

Saldanha, John, and Gray, R. (2002), "The Potential for British Coastal Shipping in a Multimodal Chain," *Maritime Policy and Management*, Volume 29, Number 1, pp. 77-92.

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